CITY OF ALEXANDRIA

Strawberry Run
Stream Restoration

Grant Application for the Stormwater Local Assistance Fund (SLAF)

Department of Transportation & Environmental Services (T&ES) Stormwater Management Division

October 12, 2018

Strawberry Run is proposed to be restored using natural channel design methods. This document serves as a narrative to the application to Virginia DEQ SLAF to offset the costs incurred by the City of Alexandria of this restoration project.

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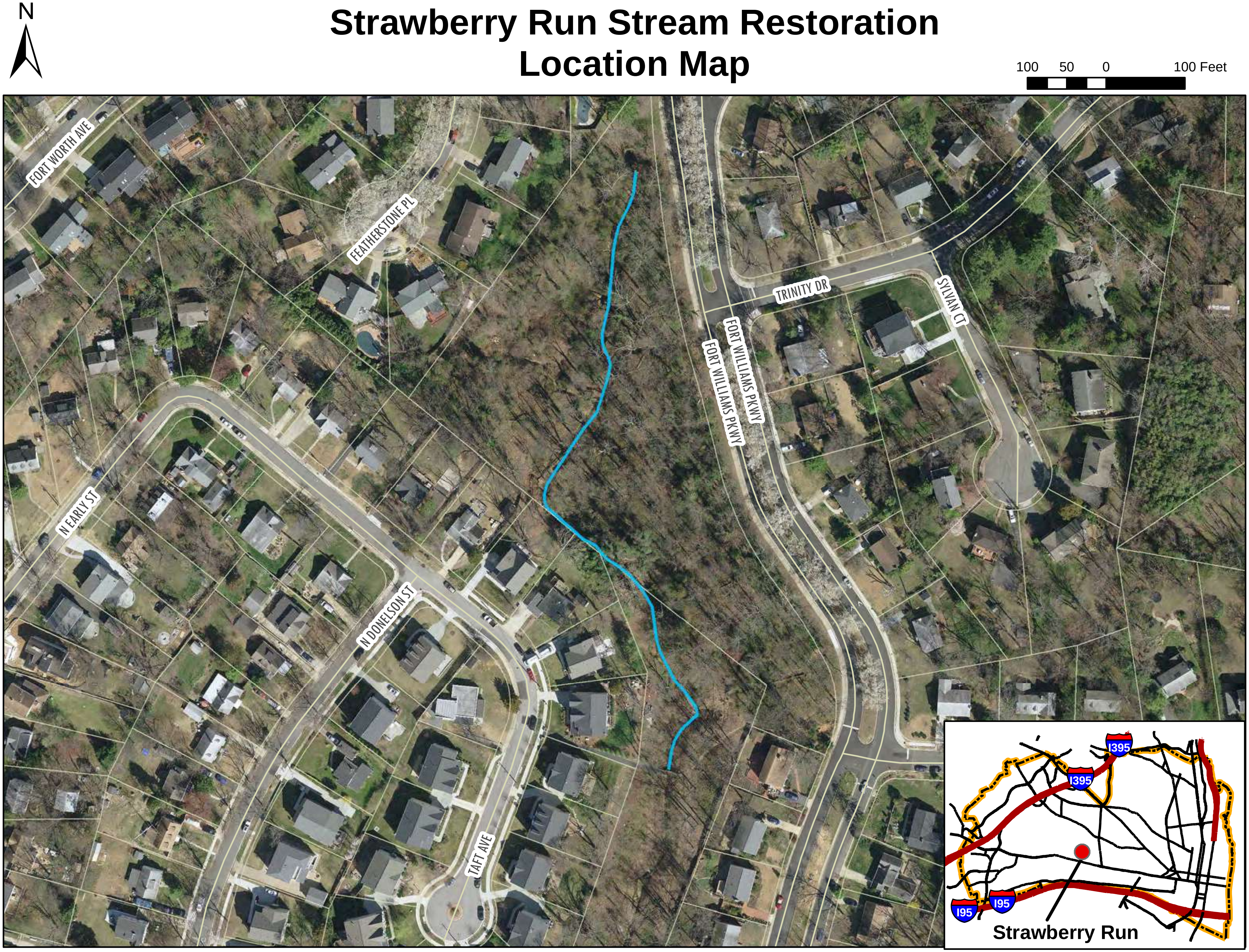
Strawberry Run Stream Restoration Location Map



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Signed SLAF Application

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DEPARTMENT OF ENVIRONMENTAL QUALITY

APPLICATION FOR STORMWATER LOCAL ASSISTANCE FUND (SLAF)

STORMWATER CAPITAL PROJECTS

SECTION A - ORGANIZATIONAL DATA

Name of Project: Strawberry Run Stream Restoration

Name of Applicant: City of Alexandria

Applicant Address: 2900-B Business Center Dr.
Alexandria, VA 22314

Contact Person: Jesse Maines

Phone: 703.746.4643 Email: jesse.maines@alexandriava.gov

Name of Engineer: Wood Environment & Infrastructures Solutions, Inc.

Engineer Address: 4795 Meadow Wood Lane, Suite 310 East
Chantilly, VA 20151

Contact Person: Tucker Clevenger

Phone: 703.209.6394 Email: tucker.clevenger@woodplc.com

SECTION B - PROPOSED FUNDING

PROJECT FUNDING

a) Amount of SLAF Grant Funds Requested: 800,000

	Source of Local Match Funds	Amount	CHECK BOX IF COMMITTED
1	Capital Improvement Funds FY2019	800,000	✓
2			
3			

b) Total Other Funding Available (1 + 2 + 3...)*: 800,000

c) Total Project Cost (a + b): 1,600,000

*This amount must be at least equal to the amount of Grant Funds being requested.

SECTION C – WATER QUALITY DATA

Location of Project Latitude: 38.81202694° Longitude: 77.095°

(**Latitude and Longitude of project is a required entry on this application**)

Name of Stream / Waterbody impacted by stormwater runoff being addressed by the project

Strawberry Run

River Basin for Receiving Stream / Waterbody

Potomac River / Chesapeake Bay

SECTION D -BRIEF PROJECT DESCRIPTION AND STATEMENT OF NEED

(attach additional pages if necessary)

Please see Section D in the narrative, Attachment 3, and Attachment 5.

SECTION E -POLLUTANT REDUCTION

The calculated Total Pounds (Per Year) of Total Phosphorous reduced from stormwater as a result of this project

= 343.27 pounds per year

SECTION F - READINESS-TO-PROCEED

ANTICIPATED SCHEDULE

	Schedule Item Description	*Date*
a.	Notice to Proceed on Design	March 2019
b.	Completion of Plans/Specifications	December 2019
c.	Plans and Specs Approved	March 2020
d.	Advertise for Bids	June 2020
e.	Bid Opening	July 2020
f.	Award Contracts	October 2020
g.	Estimated Construction Time (expressed in months)	8

SECTION F - READINESS-TO-PROCEED

PROJECT STATUS

	Check One
1. Final Designs approved by Locality?	
2. Design Plans submitted and under review by Locality?	
3. Preliminary / Concept Engineering complete?	✓
4. Executed engineering contract with approved task order and notice to proceed issued for the project?	
5. Project included in the CURRENT YEAR Capital Improvement Plan?	
6. Project identified in Comprehensive Stormwater Management Plan, Watershed Management Plan, or TMDL Action Plan?	

	Yes	No
7. Is acquisition of land and/or easements necessary to complete project?	✓	
8. Has the land and/or easements necessary for the project already been acquired?		✓

SECTION G -PROJECT BUDGET INFORMATION

Legal / Administration	$0.00
Land, Right-of-Way	$0.00
Architectural Engineering Basic Fees	260,000
Project Inspection Fees	270,000
Other (Explain)	$0.00
Stormwater BMP Construction	1,020,000
Contingencies	$50000.00
TOTAL*	1,600,000

*This amount should be the exact same as the amount in Item c) Total Project Cost, Section B, Page 1.

SECTION H

	Yes	No	N/A
Has applicant adopted a dedicated source of revenue to implement a stormwater control program in accordance with §15.2-2114? (If so, attach documentation)	✓		
Is the applicant subject to an MS4 discharge permit in accordance with §62.1-44.5?	✓		
Does the project address requirements of your MS4 permit?	✓		

If yes, explain:

Please see Sections D and H in the narrative.

Name of MS4 Permittee if different from Applicant: NA

SECTION I - ASSURANCES AND CERTIFICATIONS

The undersigned representative of the applicant certifies that the information contained herein and the attached statements and exhibits are true, correct and complete to the best of their knowledge and belief. The undersigned also agrees to clarify or supplement information pertaining to this application upon request.

Name: Mark B. Jinks Title: City Manager

Signature: [signature] Date: 10-11-18

SECTION J - ATTACHMENTS

Include all required attachments appropriate for your application. The following is a list of potential attachments:

1) Commonwealth of Virginia substitute W-9 form from DEQ web site (required of **all** applications, Section A)

2) Documentation of project costs for conventional technology and for green technology (only required if applicant chooses incremental cost option for a green infrastructure project, Section B).

3) Documentation supporting site selection process and photographs of the reach of stream (only required for stream restoration projects, Section D).

4) Documentation supporting the Pollution Reduction methodology, calculations, text, etc. (Section E)

5) Documentation of highest project status option. (Section F)

6) Information substantiating project budget figures. (Section G)

7) Documentation of Dedicated Revenue Source for Stormwater Management Program. (Section H)

Section A – Organizational Data

The City of Alexandria, Virginia, (City) is an urban community of 15.75 square miles with a population of approximately 155,000. With its stable residential neighborhoods, its historic districts, and its proximity to Washington, D.C., the City continues to attract new residents, tourists, and businesses.

Please see the Stormwater Local Assistance Fund (SLAF) application for additional organizational data.

Section B – Proposed Funding

The City's FY2019-FY2028 approved Capital Improvement Program (CIP) Stormwater Management section includes funding in MS4-TMDL Compliance Water Quality Improvement, Stream & Channel Maintenance, and Environmental Restoration subsections that will be used to match the SLAF funding for the Strawberry Run Stream Restoration project.

Please see the SLAF application for the local funds match amount.

Section C – Water Quality Data

Please see the SLAF application for latitude and longitude of the project, impacted stream, and receiving stream/waterbody.

1. Project Location

The project involves stream restoration for approximately 900 linear feet of stream north of Duke Street and continuing north to the culvert under Fort Williams Parkway. It is bounded by residential development along Taft Avenue, residential development along Featherstone Place, and Fort Williams Parkway. When the Taft Avenue development was constructed, stream restoration was completed for a 500-foot section of Strawberry Run just to the north of Duke Street. This project will restore the reach above this previously restored section and extend to the culvert under Fort Williams Parkway. This project section of stream mainly lies within City parkland; however, there are a few locations where the stream may meander onto a few residential lots. A detailed survey will be conducted with the 60% design and will determine how much of the stream (if any) lies on private property.

Strawberry Run is part of the Cameron Run watershed prior to its confluence with the Potomac River, as part of the Chesapeake Bay Watershed. Approximately 185 acres drain to this section of Strawberry Run, all of which has is identified as located in the City's regulated Municipal Separate Storm Sewer System (MS4).

FIGURE 1: City of Alexandria Ortho-Imagery (2017)

2. Flood Map Information

Strawberry Run is located in a FEMA regulated floodplain on FIRM Panels 515519 0028 E and 515519 0036 E, effective June 16, 2011, in a Zone AE with Base Flood Elevations (BFEs). The Zone AE floodplain with BFEs along Strawberry Run designates the 1-percent-annual-chance floodplain and the BFEs designate the elevations associated with that floodplain. FEMA has a no-rise requirement of 1.00 foot for Zone AE areas, so a Conditional Letter of Map Revision (CLOMR) would be required for a project in this area only if BFEs were changed by greater than 1.00 foot. Once a project is completed, a Letter of Map Revision (LOMR) would be required to incorporate any changes into the FIRM if this condition is created. The City does have stricter requirements than FEMA, but variances are issued for good and sufficient cause. See Attachment B for the FEMA FIRMs with Strawberry Run.

Section D – Project Description and Statement of Need

1. Project Summary

The Chesapeake Bay has been assigned a Total Maximum Daily Load (TMDL) allocation for phosphorus, nitrogen, and sediment. Subsequently, the City has received pollutant load reduction requirements as part of the MS4 General Permit Special Conditions. As part of the effort to meet the goals of the Chesapeake Bay TMDL and to further reduce pollutant discharges into the MS4, the City has proposed the Strawberry Run Stream Restoration project to City Council. To mitigate the design and construction costs for the project, the City is requesting funding from the Virginia Department of Environmental Quality (DEQ) SLAF to restore a portion of Strawberry Run. The restoration project will include several improvements, which are depicted on the conceptual design in Attachment 5.

2. TMDL or Impaired Water the Current Project Addresses

Strawberry Run is part of the Cameron Run watershed prior to its confluence with the Potomac River, as part of the Chesapeake Bay watershed. The Bay TMDL targets for phosphorus, nitrogen, and sediment will be addressed with the project. A stream restoration project to stabilize the stream banks and provide overall improvement to the stream's function is a stormwater treatment strategy that protects local water quality and mitigates the transport of pollutants to the Chesapeake Bay. The project will mitigate channel and bank erosion, preventing sediment and phosphorous associated with that erosion from being delivered downstream from an actively incising urban stream. The project will also provide nitrogen reduction through design features that promote denitrification during base flow.

3. Specific Need for This Project

Alexandria is a highly urbanized area and Strawberry Run is considered an urban stream. The stream corridor is highly disturbed with severe erosion in various locations along the stream, including exhibiting evidence of downcutting with abandoned meanders which are approximately 3-feet higher than the current stream bed. In addition, significant amounts of broken concrete were observed in the channel, where it approaches and runs approximately parallel to Taft Avenue. Restoration is necessary to reestablish a stable pattern and profile in the stream. Please see Attachment 5 for additional project details presented in the conceptual designs.

4. Site Selection Process

The City has been working with Wood Environment & Infrastructure Solutions, Inc. since November 2017 on a study to evaluate and prioritize five potential stream restoration projects. This study is considered Phase III of the City's Stream Assessment Program to evaluate, assess, and improve the City's streams in support of its watershed management program. Phase I involved mapping the streams and categorizing them as perennial, ephemeral, or intermittent. Phase II was an assessment of the streams including steam habitat, infrastructure impacts, problem areas, and stream characteristics. The Phase III study not only evaluated and ranked the potential projects, but also included the development of conceptual designs for the top two ranked projects. Several categories were examined when evaluating the different projects including bed and bank stability, stream health, feasibility, cost/benefits, and other benefits.

The Strawberry Run Stream Restoration project was determined to be one of the top two projects with the project scoring high in potential to improve channel dimension, planform pattern, longitudinal profile, bank stability, channel obstructions, and riparian vegetation. The City is also submitting for a grant for the Taylor Run Restoration project, which was determined to be the second top rated project. The site assessment field report and the summary sheet from the decision matrix can be found in Attachment 3.

FIGURE 2: Abandoned meander sitting about 3-feet higher than the existing stream bed

FIGURE 3: Bamboo and channel debris blockage in

FIGURE 4: Bank erosion

FIGURE 5: Bank erosion

FIGURE 6: Bank erosion, concrete and bamboo

FIGURE 7: Bank erosion, concrete, and bamboo

FIGURE 8: Bank erosion and bamboo

Section E - Proposed Pollutant Reduction

For the Phase III study, a BANCS assessment was completed for the Strawberry Run potential project. Using Protocol 1, Credit for Prevented Sediment during Storm Flow, defined in *Recommendations of the Expert Panel to Define Removal Rates for Individual Stream Restoration Projects* (September 2014), the stream restoration project will help the City achieve a load reduction of 343.27 pounds of phosphorus per year. Bulk density of the soil was determined through bank sampling and the Hickey Run Erosion Rate Prediction curve was used. The phosphorus pollutant reduction is based on converting the BANCS sediment load to phosphorus and multiplying the value by the assumed efficiency of 50%.

This is a significant contribution towards meeting the City's target pollution reduction requirements as identified in the City's MS4 General Permit. As you know, phosphorus is a keystone pollutant in water quality treatment and serves as a benchmark for removal potential for nitrogen, bacteria, suspended solids, heavy metals, etc. The table below summarizes the reductions of total phosphorus (TP), total nitrogen (TN), and total suspended solids (TSS) expected to be achieved with this stream restoration project as calculated Protocol 1. As the design process continues and the designs are finalized, the applicability of Protocols 2 and 3 will also be examined.

Table 1: Estimated Pollutant Reductions for Strawberry Run Stream Restoration			
	Total Phosphorus (TP) lb/year:	***Total Nitrogen (TN) lb/year:***	***Total Suspended Solids (TSS) lb/year:***
Proposed Strawberry Run Stream Restoration (approximately 880 linear feet)	343.27	745.39	118,347

Documentation supporting the pollutant reduction methodology and calculations supporting the potential pollutant removals can be found in Attachment 4.

Section F – Readiness-to-Proceed

Please see the SLAF application for the anticipated schedule. As stated in Section D, conceptual designs for the project have been developed and can be found as Attachment 5.

As stated above, the project section of stream lies mainly within the City's parkland; however, there are two locations where the stream may meander onto private residential lots. A detailed survey will be conducted with the 60% design and will determine how much of the stream (if any) lies on private property. Easements will be obtained for work conducted on the properties that will be impacted by constructions. We do not anticipate any issues with obtaining easements from these properties. Letters were sent out to several properties regarding the field work for the study and no response was received. In addition, the restoration work that was completed downstream provides a good example to residents of stream restoration benefits.

Section G – Project Budget Information

Please see the SLAF application for the anticipated budget.

The cost feasibility of the project is outlined in the SLAF grant application instructions and in previous years only SLAF project applications with costs below $50,000 per pound of total phosphorus treatment were authorized for funding. This project's budget has an estimated total cost of $1.6 million, which roughly yields a **$4,661 per pound phosphorus treated** using the Protocol 1 for stream restoration. Thus, this project meets the cost guidelines of the SLAF grant application procedure.

Section H – Other Information

Please see the SLAF application for this completed section.

The City recently adopted a Stormwater Utility Fee in May 2017, with first billing occurring May 2018 for the second half of the City's approved FY2018 operating and capital budget. This fee provides dedicated funding for stormwater infrastructure projects to address Chesapeake Bay cleanup mandates, as well as other operating and capital improvement needs for the City's Stormwater Management Program.

The City is an MS4 permittee and submitted a registration statement in May 2018 for coverage under the new permit (once effective). The pollutant reductions associated with this project will be applied toward the Chesapeake Bay TMDL pollutant reduction requirements outlined in the City's Phase II MS4 General Permit. In addition, this project is along a walking trail which provides the perfect opportunity for public outreach and education, Minimum Control Measure #1. It is anticipated that the project will include signage to educate the public on stream restoration and the corresponding physical, chemical, and biological benefits.

SLAF Application Attachments

(Section J of Application)

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Attachment 1

Commonwealth of Virginia Substitute W-9 Form

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Form **W-9**
Commonwealth of Virginia
Substitute W-9 Form
Revised July 2014

Request for Taxpayer Identification Number and Certification

Section 1 - Taxpayer Identification

- ☐ **Social Security Number (SSN)**
- ☒ **Employer Identification Number (EIN)**

5 4 6 0 0 1 1 0 3

Please select the appropriate Taxpayer Identification Number (EIN or SSN) type and enter your 9 digit ID number . The EIN or SSN provided must match the name given on the "Legal Name" line to avoid backup withholding. If you do not have a Tax ID number, please reference "Specific Instructions - Section 1." If the account is in more than one name, provide the name of the individual who is recognized with the IRS as the responsible party.

Dunn & Bradstreet Universal Numbering System (DUNS) (see instructions)

0 7 4 8 5 3 2 5 0

Legal Name: City of Alexandria

Business Name:

Entity Type		**Entity Classification**		**Exemptions (see instructions)**
☐ Individual	☐ Corporation	☐ Professional Services	☐ Medical Services	Exempt payee code (if any):
☐ Sole Proprietorship	☐ S-Corporation	☒ Political Subdivision	☐ Legal Services	(from backup withholding) 3
☐ Partnership	☐ C-Corporation	☐ Real Estate Agent	☐ Joint Venture	
☐ Trust	☐ Disregarded Entity	☐ VA Local Government	☐ Tax Exempt Organization	Exemption from FATCA reporting code (if any):
☐ Estate	☐ Limited Liability Company	☐ Federal Government	☐ OTH Government	
☒ Government	☐ Partnership	☐ VA State Agency	☐ Other	C
☐ Non-Profit	☐ Corporation			

Contact Information

Legal Address:	City of Alexandria	Name:	IAN GREAVES
		Email Address:	ian.greaves@alexandriava.gov
City: Alexandria State : VA Zip Code: 22313		Business Phone:	703.746.4314
Remittance Address:	P.O. Box 178	Fax Number:	703.836.0418
		Mobile Phone:	
City: Alexandria State : VA Zip Code: 22313		Alternate Phone:	

Section 2 - Certification

Under penalties of perjury, I certify that:

1. The number shown on this form is my correct taxpayer identification number (or I am waiting for a number to be issued to me), and
2. I am not subject to backup withholding because: (a) I am exempt from backup withholding, or (b) I have not been notified by the Internal Revenue Service (IRS) that I am subject to backup withholding as a result of a failure to report all interest or dividends, or c) the IRS has notified me that I am no longer subject to backup withholding, and
3. I am a U.S. citizen or other U.S. person (defined later in general instructions), and
4. The FATCA code(s) entered on this form (if any) indicating that I am exempt from FATCA reporting is correct.

Certification instructions: You must cross out item 2 above if you have been notified by the IRS that you are currently subject to backup withholding because you have failed to report all interest and dividends on your tax return. For real estate transactions, item 2 does not apply. For mortgage interest paid, acquisition or abandonment of secured property, cancellation of debt, contributions to an individual retirement arrangement (IRA), and generally, payments other than interest and dividends, you are not required to sign the certification, but you must provide your correct TIN. See instructions titled Certification

Printed Name: IAN GREAVES

Authorized U.S. Signature: [signature] **Date:** 8/21/2018

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Attachment 2

Excerpts from City's Capital Improvement Plan

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MS4-TMDL Compliance Water Quality Imprv.

DOCUMENT SUBSECTION:	Stormwater Management	PROJECT LOCATION:	Citywide
MANAGING DEPARTMENT:	Department of Transportation and Environmental Services	REPORTING AREA:	Citywide
		PROJECT CATEGORY:	3
PRIMARY STRATEGIC THEME:	Theme 8: Environmental Sustainability	ESTIMATE USEFUL LIFE:	30+ Years

MS4-TMDL Compliance Water Quality Imprv.

	A (B + M)	B	C	D	E	F	G	H	I	J	K	L	M (C:L)
	Total Budget & Financing	Through 2018	FY 2019	FY 2020	FY 2021	FY 2022	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	FY 2028	Total FY 2019 - FY 2028
Expenditure Budget	48,500,000	0	500,000	3,000,000	3,000,000	3,500,000	3,500,000	7,000,000	7,000,000	7,000,000	9,000,000	5,000,000	48,500,000
Financing Plan													
Cash Capital	0	0	0	0	0	0	0	0	0	0	0	0	0
GO Bonds	0	0	0	0	0	0	0	0	0	0	0	0	0
GO Bonds (Stormwater)	31,310,000	0	250,000	2,250,000	2,300,000	2,750,000	2,750,000	4,250,000	4,190,000	4,190,000	6,190,000	2,190,000	31,310,000
Stormwater Utility	17,190,000	0	250,000	750,000	700,000	750,000	750,000	2,750,000	2,810,000	2,810,000	2,810,000	2,810,000	17,190,000
Total Financing Plan	48,500,000	0	500,000	3,000,000	3,000,000	3,500,000	3,500,000	7,000,000	7,000,000	7,000,000	9,000,000	5,000,000	48,500,000
Additional Operating Impact	1,153,889	0	50,000	51,500	53,045	100,000	103,000	150,000	154,500	159,135	163,909	168,800	1,153,889

Changes from Prior Year CIP

No changes from prior CIP.

Project Description & Justification

The Virginia Department of Environmental Quality (DEQ) issued the City's current Municipal Separate Storm Sewer System (MS4) Permit on July 1, 2013 that mandates City-specific stormwater nutrient and sediment reduction targets for the Chesapeake Bay (Bay) Total Maximum Daily Load (TMDL) enforced through three 5-year MS4 permit cycles. Accordingly, the permit requires the City to implement stormwater treatment best management practices (BMPs) sufficient to achieve 5% of the reduction targets during first 5-year permit (2013-2018), while successive MS4 permits will require implementation of practices to achieve an additional 35% or 40% of total reduction targets during the second 5-year permit (2018-2023) by 2023, and the remaining 60% or 100% of the reductions on or before the end of the third permit cycle (2023-2028), no later than by 2028.

The City continues planning efforts and identifying options to comply with these targets and discusses these through the Water Quality Steering Committee and Water Quality Workgroup, along with other internal stakeholders. Additionally, the City completed the Chesapeake Bay TMDL Compliance Analysis and Options report (August 2014) that considered options and alternatives for treating stormwater to meet the Bay TMDL regulatory mandates, along with the corresponding costs to implement these alternatives, formed the basis of the strategies included in the City's Phase 1 Chesapeake Bay TMDL Action Plan, and form the basis of the strategies in the draft Phase 2 Chesapeake Bay Action Plan due June 1, 2018, with the final Action Plan due no later than one year from the effective date of the 2018 – 2023 MS4 General Permit. This budget is based on funding that can be used to implement a diverse mix of strategies to achieve a large portion of the required reductions in the next ten years. In addition to retrofit of regional facilities, implementation of Green Infrasturture as stormwater quality retrofits of City facilitiesand right-of-way retrofits, along with urban stream restoration, are some of the strategies that will be implemented to meet the required reductions. As the specific projects to achieve these reductions are identified and developed, this funding is used to support those projects.

The Bay TMDL Action Plan for 5% compliance was approved by DEQ on January 12, 2016. The City's draft Bay TMDL Action Plan for achieving a total 40% compliance is due June 2018, with the final submitted for DEQ no later than one year from the effective date of the 2018 – 2023 MS4 General Permit.

The budgetary estimates were developed with engineers from the firms conducting the Chesapeake Bay TMDL Compliance Analysis and Options study. Please note that these MS4-TMDL Compliance Water Quality Improvement projects, along with the inclusion of City Facilities BMP projects, Green Infrastructure projects, and stream restorations projects will likely satisfy the second permit cycle (2018 - 2023 permit). For FY 2019 and beyond, estimates are based on staff planning and will be revised as the 2018 – 2023 MS4 permit requirements and other regulatory expectations become clearer through the development of the Phase III Watershed Implementation Plan (WIP III) and the issuance of the next MS4 permit.

External or Internal Adopted Plan or Recommendation

City of Alexandria Municipal Separate Storm Sewer System (MS4) Permit, Program Plan, and Year 5 Annual Report; City's Chesapeake Bay TMDL Action Plan; T&ES Strategic Plan; Eco-City Charter; Eco-City Action Plan

Additional Operating Impacts

Operating impact to cover for the maintenance of the retrofit facilities that will be coming online is estimated at $50,000 in FY 2019 and increasing to $150,000 by FY 2024. Costs will be lower in FY 2019 as the facilities that come online will be newer. With passing time, the City's inspection and maintenance program will continue to become more rigorous to maintain the Bay TMDL water pollution reduction credits and compliance with the City's MS4 permit and Bay TMDL Action Plans.

Stream & Channel Maintenance

Document Subsection:	Stormwater Management	Project Location:	Citywide
Managing Department:	Department of Transportation and Environmental Services	Reporting Area:	Citywide
		Project Category:	1
Primary Strategic Theme:	Theme 8: Environmental Sustainability	Estimate Useful Life:	Varies

Stream & Channel Maintenance

	A (B + M) Total Budget & Financing	B Through 2018	C FY 2019	D FY 2020	E FY 2021	F FY 2022	G FY 2023	H FY 2024	I FY 2025	J FY 2026	K FY 2027	L FY 2028	M (C:L) Total FY 2019 - FY 2028
Expenditure Budget	11,534,584	7,119,584	365,000	450,000	450,000	450,000	450,000	450,000	450,000	450,000	450,000	450,000	4,415,000
Financing Plan													
Cash Capital	250,000	250,000	0	0	0	0	0	0	0	0	0	0	0
GO Bonds	0	0	0	0	0	0	0	0	0	0	0	0	0
GO Bonds (Stormwater)	2,475,000	450,000	0	225,000	225,000	225,000	225,000	225,000	225,000	225,000	225,000	225,000	2,025,000
Prior City Funding	6,219,584	6,219,584	0	0	0	0	0	0	0	0	0	0	0
Prior Year/Close-Out	0	0	0	0	0	0	0	0	0	0	0	0	0
Stormwater Utility	2,590,000	200,000	365,000	225,000	225,000	225,000	225,000	225,000	225,000	225,000	225,000	225,000	2,390,000
Total Financing Plan	11,534,584	7,119,584	365,000	450,000	450,000	450,000	450,000	450,000	450,000	450,000	450,000	450,000	4,415,000
Additional Operating Impact	0	0	0	0	0	0	0	0	0	0	0	0	0

Changes from Prior Year CIP

Funding in the amount of $700,00 in prior year funds and $585,000 in planned FY 2019 funds was transferred from the Stream & Channel Maintenance project to Lucky Run Stream Restoration.

Project Description & Justification

This project provides funding for annual capital infrastructure improvements to various streams and channels throughout the City to preserve their capacity to carry a 100-year floodwater and for repairs to erosion damage, stream corridor degradation, grade control structures, storm sewer discharge points, and stream stabilization/restoration.

Prior to moving ahead with restoration projects originally planned for FY 2019 and FY 2020, a citywide stream study will be conducted, which will help the City to develop overall strategy to deal with degraded streams and will assist in prioritizing the projects. This Phase III Stream Assessment and Outfall Restoration is currently underway, which will prioritize identified projects for future construction.

Project funds will be utilized to mitigate damages caused by heavy storm events, provide water quality benefits, and mitigate flooding. Project costs may be funded directly, or may form the basis of funding for new projects broken out into single projects, such as Lucky Run Stream Restortation.

The urban nature of the City and the areas of Fairfax County whose stormwater drains into the City puts stress on the vitality of natural streams throughout the City. This has caused erosion, loss of natural habitat, impacted riparian areas, infrastructure damage, and flooding issues in these streams. Designing and implementing restoration for these streams will provide the additional capacity needed to handle the added stormwater runoff from urbanization, allowing for the return of natural habitat and enhancing the health of these important resources in our City. Restoration of these resources can also provide the added benefit of creating nutrient and sediment pollution reductions and help the City address Chesapeake Bay Total Maximum Daily Load (TMDL) mandates.

External or Internal Adopted Plan or Recommendation

Eco-City Charter; Water Quality Management Supplement to City Master Plan; MS4 General Permit and Program Plan; Chesapeake Bay TMDL Action Plan; Strategic Plan

Additional Operating Impacts

No additional operating impacts identified at this time.

ENVIRONMENTAL RESTORATION

DOCUMENT SUBSECTION:	Waterways Maint. & Imprv.	PROJECT LOCATION:	Citywide
MANAGING DEPARTMENT:	Department of Transportation and Environmental Services	REPORTING AREA:	Citywide
		PROJECT CATEGORY:	2
PRIMARY STRATEGIC THEME:	Theme 8: Environmental Sustainability	ESTIMATE USEFUL LIFE:	Varies

Environmental Restoration

	A (B + M)	B	C	D	E	F	G	H	I	J	K	L	M (C:L)
	Total Budget & Financing	Through 2018	FY 2019	FY 2020	FY 2021	FY 2022	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	FY 2028	Total FY 2019 - FY 2028
Expenditure Budget	4,134,677	1,612,517	304,560	159,300	314,100	168,900	324,000	179,100	334,500	190,200	345,900	201,600	2,522,160
Financing Plan													
Cash Capital	970,000	220,000	150,000	0	150,000	0	150,000	0	150,000	0	150,000	0	750,000
Prior City Funding	248,475	248,475	0	0	0	0	0	0	0	0	0	0	0
Private Capital Contributions	1,144,042	1,144,042	0	0	0	0	0	0	0	0	0	0	0
Sanitary Sewer Fund	590,720	0	51,520	53,100	54,700	56,300	58,000	59,700	61,500	63,400	65,300	67,200	590,720
Stormwater Utility	590,720	0	51,520	53,100	54,700	56,300	58,000	59,700	61,500	63,400	65,300	67,200	590,720
TIP	590,720	0	51,520	53,100	54,700	56,300	58,000	59,700	61,500	63,400	65,300	67,200	590,720
Total Financing Plan	4,134,677	1,612,517	304,560	159,300	314,100	168,900	324,000	179,100	334,500	190,200	345,900	201,600	2,522,160
Additional Operating Impact	0	0	0	0	0	0	0	0	0	0	0	0	0

CHANGES FROM PRIOR YEAR CIP

Funding added throughout 10-year plan to continue funding the Sustainability Coordinator out of this project.

PROJECT DESCRIPTION & JUSTIFICATION

This program provides for various projects within the City that will enhance local water quality and eventually the water quality of the Chesapeake Bay. The City's local, more stringent requirement in the Environmental Management Ordinance requires stormwater treatment from all impervious area for development/redevelopment within the City.

In circumstances where required stormwater treatment is not feasible because of site constraints, fees are collected in the form of developer contributions in lieu of providing stormwater treatment to meet the City’s local, more stringent requirements beyond the state requirements. These fees collected in lieu of water quality improvements or other mitigation required under the City’s ordinance from development and redevelopment are used to supplement larger water quality efforts to address City-wide water quality benefits, including the City’s water quality requirements under the Chesapeake Bay Total Maximum Daily Load (TMDL). Thus, these funds must be used to improve water quality through projects such as stream restorations, water quality improvement structures for public facilities, wetland enhancements, riparian buffer improvements such as tree plantings and invasive species removal, green infrastructure applications such as green roofs, pervious pavement, bioswales, urban bioretention, etc. City funds are used to supplement the fees collected to implement these larger projects.

The City, state and federal regulations have pollutant load reduction targets that are mandated to be achieved through its Municipal Separate Storm Sewer System (MS4) Permit requirements for the Chesapeake Bay TMDL and other impairements on our local waterways. All eligible water quality improvements achieved through implementation of these projects get credited towards City's pollutant load reduction targets. Completion of these initiatives will help maintain and improve the quality and sustainability of Alexandria's environment by enhancing the ecological integrity of waterways, maintaining and improving stormwater infrastructure, and enhancing stream system health to minimize environmental impacts.

Additionally, funding in FY 2019 and beyond this project will be used for the Sustainability Coordinator position that City Council added to this project in FY 2017. Funding sources for this position include the Sanitary Special Revenue Fund, Stormwater Utility, and Transportation Improvement Plan.

EXTERNAL OR INTERNAL ADOPTED PLAN OR RECOMMENDATION

Environmental Management Ordinance Article XIII; Water Quality Management Supplement to the City Master Plan; MS4 Permit and Program Plan; Chesapeake Bay TMDL Action Plan; Strategic Plan; Eco-City Alexandria Charter and Environmental Action Plan

ADDITIONAL OPERATING IMPACTS

No additional operating impacts identified at this time.

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Attachment 3

Documentation Supporting Site Selection Process

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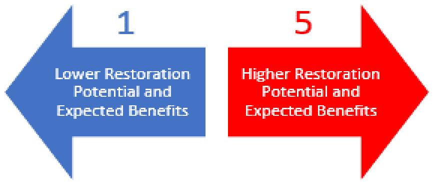
Stream Projects

Ranking Criteria	Importance Score 1-10	Normalized Weight	Unnamed Tributary near Walleston Court	Strawberry Run near Taft Avenue	Taylor Run near Chinquapin Park	Holmes Run, north of N. Beauregard St.	Timber Branch near Ivy Hill Cemetery
Channel Dimension at Bankfull Cross-Section	7	5.0%	5	5	5	3	5
Channel Planform Pattern	7	5.0%	5	5	3	3	5
Channel Bed Longitudinal Profile	7	5.0%	3	5	5	3	3
Streambank Stability and Protection from Erosion	8	5.8%	3	5	1	1	5
Presence of Urbanite	4	2.9%	1	5	5	3	3
Channel Obstructions	4	2.9%	3	5	5	3	3
Riparian Vegetation	2	1.4%	1	5	3	3	1
Presence of desirable fish and wildlife	3	2.2%	1	3	3	1	1
Environmentally Sensitive Areas	4	2.9%	5	3	3	3	3
Impacts to Trees	5	3.6%	1	3	1	3	1
Construction Access	8	5.8%	5	1	3	3	3
Property Ownership	9	6.5%	1	1	3	5	1
Utility Conflicts	5	3.6%	5	5	1	1	3
Stakeholders	9	6.5%	1	3	3	5	1
Historically Sensitive Areas	5	3.6%	1	1	3	1	3
Public Education and Outreach	7	5.0%	3	1	5	5	1
Recreation Potential	3	2.2%	3	3	3	5	3
Infrastructure at Risk	8	5.8%	1	1	3	5	1
Public Safety Concerns	5	3.6%	1	3	5	5	1
Associated Infrastructure Project Opportunity	7	5.0%	1	1	5	5	3
Cost per lb. of Phosphorous Removal Interim Rate	2	1.4%	5	3	1	1	3
Cost per lb. of Phosphorous Removal BANCS Model	10	7.2%	3	3	1	1	5
MS4 Draining to Project Site	10	7.2%	5	5	5	1	5
Total			**2.80**	**3.14**	**3.30**	**3.07**	**2.91**

Print Stream Restoration Matrix

Project	Rank	Weighted Score
Taylor Run near Chinquapin Park	1	3.30
Strawberry Run near Taft Avenue	2	3.14
Holmes Run, north of N. Beauregard St.	3	3.07
Timber Branch near Ivy Hill Cemetery	4	2.91
Unnamed Tributary near Walleston Court	5	2.80



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Section 1 - General Information

Site Name	Strawberry Run
Project Type	Stream
Site Latitude	38.81161
Site Longitude	-77.09453
Date	04/05/2018
Staff	☑ Troy Biggs ☑ Mike Hepp ☑ Alexandria Staff ☐ Other
Watershed	Strawberry Run
Drainage Area	0.27

Section 2 - Field Photos

Image 1

Image 1 - add caption, description, etc.

Upstream storm sewer outfall. 6ft dai. CMP

Image 2

Image 2 - add caption, description, etc.:
Eroded right bank in upstream portion of reach

Image 3

Image 3 - add caption, description, etc.:
Abandoned meander/floodplain. Evidence current channel has downcut approx. 4 ft.

Image 4

Image 4 - add caption, description, etc.:
Broken concrete pieces (appears to be old curb & gutter) in the channel.

Image 5

Image 5 - add caption, description, etc.:
Channel obstructions (downed tree & concrete) in the lower project reach.

Image 6

Image 6 - add caption, description, etc.:
Highly eroded, vertical bank.

Image 7

Image 7 - add caption, description, etc.:
Highly eroded bank. English ivy provides minimal cover, no stabilization.

Image 8

Image 8 - add caption, description, etc.:
Relatively stable section of stream channel. Located upstream of broken concrete segment.

Image 9

Image 9 - add caption, description, etc.:
Pedestrian bridge at downstream project extents.

Section 3 - General Site Observations

High Visibility?

- (x) Yes
- ( ) No

Construction Access

- ( ) Easy
- ( ) Medium
- (x) Hard

Steep Slopes?

- (x) Yes
- ( ) No

Bedrock Outcroppings?

- ( ) Yes
- (x) No

Critical Infrastructure at risk?

- ( ) Yes
- (x) No

Storm Sewer at Project Start?

- (x) Yes
- ( ) No

Size:	6ft
Material:	CMP

Storm Sewer at Project End?

- ( ) Yes
- (x) No

Ex. Utilities?

- ( ) Yes
- (x) No

Utility Crossing?

- ( ) Yes
- (x) No

Section 4 - Channel

CHANNEL GEOMETRY	
Width	15
Depth	8
Slope (%)	2

CHANNEL FEATURES	
Evolution Stage	2/3
Rosgen Type	G4
Trend	○ Aggrading ◉ Degrading
Features	☐ Riffles ☐ Pools ☑ Runs ☐ Other
Lat. Instability?	◉ Yes ○ No
Lat. Instability Details:	☑ Mid. Channel Bars ☑ Cutoffs ☑ Meanders ☐ Other
Vert. Instability?	◉ Yes ○ No
Vert. Instability Details:	☐ Headcuts ☐ Knickpoints ☑ Other
"Other" Vert. Instability:	Abandoned meanders approx. 4ft above current channel bottom. Scour pools downstream of obstructions.
Grade Control?	◉ Yes ○ No
Grade Control Details:	☐ Utility X-ing ☐ Bedrock ☑ Trees/Roots ☑ Other
"Other" Grade Control:	Cross vanes in downstream portion from previous restoration.
Tribs Along Reach?	◉ Yes ○ No
Trib Details:	☑ Natural ☐ Conc. Lined ☑ Pipes ☐ Other

BED

Bed Load Supply?	(•) Yes ( ) No
Supply Size (mm):	81
Supply Source:	Local banks
Bed Substrate	[x] Sand [x] Gravel [x] Cobble [ ] Boulder [x] Lined [ ] Other
Bed Sample Taken?	(•) Yes ( ) No
Bed D50 (mm)	50

BANKS	
Bank Material	[x] Silt [x] Sand [x] Gravel [x] Cobble [ ] Lined [x] Other
"Other" Bank Material:	Clay
Bank Sample Taken?	(•) Yes ( ) No
Sample Location:	BEHI 2
Bank D50 (mm)	NA

WATER	
Appearance	Murky, walking in stream kicks up lots of fine material
Odor?	( ) Yes (•) No
Algae?	(•) Yes ( ) No

Section 5 - Floodplain

Floodplain

- ○ Confined
- ● Open

Structures w/in Floodplain

- ○ Yes
- ● No

Floodplain Constriction?

- ● Yes
- ○ No

Constriction Details:	Necks down near bridge at downstream extents

Floodplain Scour?

- ○ Yes
- ● No

Debris Line/HW Mark?

- ● Yes
- ○ No

Line/Mark Details:	Debris

Channel Restriction/BW Effects?

- ● Yes
- ○ No

Restriction/BW Details:	☑ Debris ☐ Culvert ☐ Bridge ☐ Dams ☐ Dump Sites ☑ Other
"Other" Restriction:	Downed trees

Section 6 - Vegetation

Riparian Area Maintained?

- [ ] Yes
- [x] No

Riparian Veg.

- [ ] Turf Grass
- [ ] Tall Grass
- [x] Shrubs
- [x] Trees

Riparian Width

100+

Observed Invasives

- [x] English Ivy
- [ ] Japanese Stiltgrass
- [ ] Mile-a-minute
- [x] Multi-flora Rose
- [ ] Privet
- [ ] Kudzu
- [x] Bamboo
- [ ] Other

Observed Habitat/Fauna

Birds, deer, water striders

Large healthy trees?

- [x] Yes
- [ ] No

Section 7 - Sign and Complete Assessment

Please sign to complete this assessment

Signature Time and Date

04/06/2018 02:54:12 PM GMT-04:00

Attachment 4

Documentation Supporting the Pollution Reduction Methodology

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Recommendations of the Expert Panel to Define Removal Rates for Individual Stream Restoration Projects

Joe Berg, Josh Burch, Deb Cappuccitti, Solange Filoso, Lisa Fraley-McNeal,
Dave Goerman, Natalie Hardman, Sujay Kaushal, Dan Medina, Matt Meyers, Bob Kerr,
Steve Stewart, Bettina Sullivan, Robert Walter and Julie Winters

Accepted by Urban Stormwater Work Group (USWG): **February 19, 2013**
Approved by Watershed Technical Work Group (WTWG): **April 5, 2013**
Final Approval by Water Quality Goal Implementation Team (WQGIT): **May 13, 2013**
Test-Drive Revisions Approved by the USWG : **January 17, 2014**
Test-Drive Revisions Approved by the WTWG: August 28, 2014
Test-Drive Revisions Approved by the WQGIT: September 8, 2014

Prepared by:
Tom Schueler, Chesapeake Stormwater Network
and
Bill Stack, Center for Watershed Protection

that include design features to promote denitrification during base flow. Qualifying projects receive credit under Protocol 1 and use this protocol to determine enhanced nitrogen removal through denitrification within the stream channel during base flow conditions. The credit is applied to a "theoretical" box where denitrification occurs through increased hyporheic exchange for that portion of the channel with hydrologic connectivity to the adjacent riparian floodplain.

Protocol 3: Credit for Floodplain Reconnection Volume-- This protocol provides an annual mass sediment and nutrient reduction credit for qualifying projects that reconnect stream channels to their floodplain over a wide range of storm events. Qualifying projects receive credit for sediment and nutrient removal under Protocols 1 and 2 and use this protocol to determine enhanced sediment and nutrient removal through floodplain wetland connection. A wetland-like treatment is used to compute the load reduction attributable to floodplain deposition, plant uptake, denitrification and other biological and physical processes.

Protocol 4: Credit for Dry Channel RSC as an Upland Stormwater Retrofit-- This protocol computes an annual nutrient and sediment reduction *rate* for the contributing drainage area to a qualifying dry channel RSC project. The rate is determined by the volume of stormwater treatment provided in the upland area using the retrofit rate adjustor curves developed by the Stormwater Retrofit Expert Panel (WQGIT, 2012).

The protocols are additive, and an individual stream restoration project may qualify for credit under one or more of the protocols, depending on its design and overall restoration approach however the WTWG recommended that the aggregate load reductions from a practice should not exceed estimated loads in the Watershed Model for any given land-river segment. The next four sections describe how each protocol is applied to individual stream restoration projects.

Protocol 1
Credit for Prevented Sediment during Storm Flow

This protocol follows a three step process to compute a mass reduction credit for prevented sediment:

1. Estimate stream sediment erosion rates and annual sediment loadings,
2. Convert erosion rates to nitrogen and phosphorus loadings, and
3. Estimate reduction attributed to restoration.

Estimates of sediment loss are required as a basis to this protocol. The options to estimate stream sediment erosion rates and annual sediment loadings in Step 1 of this protocol are included below. States are encouraged to select an approach to estimate stream bank erosion rates that best fits their unique conditions and capabilities. In addition, they are encouraged to pursue their own more robust methods to yield the most accurate estimates possible.

- Monitoring

- BANCS method
- Alternative modeling approach

Monitoring through methods such as cross section surveys and bank pins is the preferred approach, however can be prohibitive due to cost and staffing constraints. The extrapolation of monitoring data to unmeasured banks should be done with care and the monitored cross sections should be representative of those within the project reach. Based on these factors, the use of a method that can be applied to unmonitored stream banks and calibrated to monitoring data, such as the BANCS method described below, is a useful tool.

When monitoring is not feasible, the Panel recommends a modeling approach called the "Bank Assessment for Non-point Source Consequences of Sediment" or BANCS method (Rosgen, 2001; U.S. EPA, 2012; Doll et al., 2003) to estimate sediment and nutrient load reductions. The BANCS method was developed by Rosgen (2001) and utilizes two commonly used bank erodibility estimation tools to predict stream bank erosion; the Bank Erosion Hazard Index (BEHI) and Near Bank Stress (NBS) methods. *Alternative modeling approaches, such as the Bank Stability and Toe Erosion Model (BSTEM) developed by the USDA-ARS National Sedimentation Laboratory, may also be used provided they are calibrated to measured stream bank erosion rates.*

The BANCS method has been used by others for the purpose of estimating stream erosion rates. For example, MDEQ (2009) used the BANCS method to develop sediment TMDLs. U.S. EPA has also recommended the BANCS method in its TMDL Guidance (U.S. EPA, 2012). The Philadelphia Water Department has used the BANCS method to prioritize streams for restoration (Haniman, 2012), although they did note some accuracy issues attributed to misuse of the BEHI and NBS methods.

Altland (2012) and Beisch (2012) have used a modified BANCS method with reasonable success and the general approach has been used in Anne Arundel County to prioritize their stream restoration projects (Flores, 2012) and in Fairfax County to evaluate cost-effectiveness of restoration projects (Medina and Curtis, 2011). More information on the technical derivation of Protocol 1 can be found in Appendix B.

The Panel identified a series of potential limitations to the BANCS method, including:

- The method is based on the NCD stream restoration approach, which uses assumptions regarding bank full storm frequency that are not shared in other design approaches (e.g., LGS, RSC).
- Some studies have found that frost heaving may be a better predictor of stream bank erosion than NBS.
- Estimates of BEHI and NBS can vary significantly among practitioners.
- Extrapolation of BEHI and NBS data to unmeasured banks may not be justifiable.
- The BANCS method is not effective in predicting future channel incision and bank erodibility in reaches upstream of active head cuts. These zones upstream of active head cuts, failing dams, or recently lowered culverts/utility crossings often

yield the greatest potential for long-term sediment degradation and downstream sediment/nutrient pollution.
- This method estimates sediment supply and not transport or delivery. Refer to Appendix B for additional information about this method and sediment delivery.

Despite these concerns, the Panel felt that the use of a method that allows the estimation of stream bank erosion from an empirical relationship between standard assessment tools (BEHI and NBS) and in-stream measurements justified its use for the purposes of crediting stream restoration. Furthermore, a literature review of the BANCS Method in Appendix B indicates further refinements to this method that can improve the accuracy. States are encouraged to add parameters or stratify data for the BANCS Method to account for local conditions. The Panel recommended several steps to improve the consistency and repeatability of field scoring of BEHI and NBS, as follows:

- The development of a standardized photo glossary to improve standardization in selecting BEHI and NBS scores.

- Continued support for the development of regional stream bank erosion curves for the BANCS method using local stream bank erosion estimates throughout the watershed and a statistical analysis of their predicted results. Ideally, measured bank erosion rates within each subwatershed or County would be used to validate the BANCS method specific to that location. Given that these data may not be readily available, additional methodologies for adjusting the BEHI and NBS scores to accommodate local subwatershed characteristics may be useful. For example, adjustments to the BEHI to account for areas with predominantly sandy soils, agricultural channels, or legacy sediment.

- Using other methods to validate the BANCS method such as aerial photographs that can be used to estimate historical erosion rates, dendro-geomorphic studies of exposed roots and new shoots, time series channel surveys, and/or bank pins.

- The BANCS method should only be performed by a qualified professional, as determined by each permitting authority.

- Extrapolation of BEHI and NBS to unmeasured banks should not be allowed unless photo documentation is used to provide the basis of extrapolation.

- If BEHI and NBS data are not available for *existing* stream restoration projects, the current CBP approved rate will apply.

Step 1. *Estimate stream sediment erosion rate*

Studies have shown that when the BANCS method is properly applied it can be an excellent predictor of the stream bank erosion rate (e.g., Rosgen, 2001; Starr, 2012, Doll et al., 2003). An estimate of the pre-project erosion rate is made by performing BEHI and NBS assessments for each stream bank within the restoration reach. BEHI and NBS scores are then used to estimate erosion rates as determined from a regional bank erosion curve. An example of a regional curve is shown in Appendix B, which shows the USFWS curve for Hickey Run in Washington, DC.

The pre-project erosion rate, is then multiplied by the bank height, qualifying stream bank length and a bulk density factor to estimate the annual sediment loading rate (in tons/year) using Equation 1 below.

$$S = \frac{\sum(cAR)}{2{,}000} \qquad \text{(Eq. 1)}$$

where: S = sediment load (ton/year) for reach or stream
c = bulk density of soil (lbs/ft^3)
R = bank erosion rate (ft/year) (from regional curve)
A = eroding bank area (ft^2)
2,000 = conversion from pounds to tons

The summation is conducted over all stream reaches being evaluated. Bulk density measurements, although fairly simple, can be highly variable and each project site should have samples collected throughout the reach to develop site-specific bulk density estimates. Van Eps et al. (2004) describes how bulk density is applied using this approach. Note that if monitoring data or other models similar to the BANCS method are used, loading rates will also have to be adjusted for bulk density.

Step 2. *Convert stream bank erosion to nutrient loading*

To estimate nutrient loading rates, the prevented sediment loading rates are multiplied by the median TP and TN concentrations in stream sediments. The default values for TP and TN are from Walter et al. (2007) and are based on bank samples in Pennsylvania (Table 5):

- 1.05 pounds P/ton sediment
- 2.28 pounds N/ton sediment

Localities are encouraged to use their own values for stream bank and stream bed nutrient concentrations, if they can be justified through local sampling data.

Step 3. *Estimate stream restoration efficiency*

Stream bank erosion is estimated in Step 1, but not the efficiency of stream restoration practices in preventing bank erosion. The Panel concluded that the mass load reductions should be discounted to account for the fact that projects will not be 100% effective in preventing stream bank erosion and that some sediment transport occurs naturally in a stable stream channel.

Consequently, the Panel took a conservative approach and assumed that projects would be 50% effective in reducing sediment and nutrients from the stream reach. The technical basis for this assumption is supported by the long term Spring Branch Study mentioned in Section 2.3 and the sediment and nutrient removal rates reported in Table 2. The Panel felt that efficiencies greater than 50% should be allowed for projects that have shown through monitoring that the higher rates can be justified subject to approval by the states. This will hopefully promote monitoring (e.g., Big Spring Run in Pennsylvania) of stream restoration projects.

The reduction efficiency is applied at the "edge of field." Additional losses between the edge of field and Chesapeake Bay are accounted for in the Chesapeake Bay Watershed Model, as referenced below. An alternative approach is to use the erosion estimates from banks with low BEHI and NBS scores to represent "natural" conditions which is the approach taken by Van Eps et al. (2004) and to use the difference between the predicted erosion rate and the "natural" erosion rate as the stream restoration credit. The Philadelphia Water Department has also suggested using this approach (Haniman, 2012). While the Panel felt the "natural background" approach had merit, it agreed that the recommended removal efficiency would provide a more conservative estimate, and would be less susceptible to manipulation.

For CBWM purposes, the calculated sediment mass reductions would be taken at the edge of field, and would be subject to a sediment delivery ratio which should be applied to account for loss due to depositional processes between the edge-of-field and edge-of-stream. Sediment delivery ratios have been averaged for coastal plain (0.061) and non-coastal plain (0.181) streams and should be multiplied by the erosion rate to determine the sediment load reduction that is reported. Riverine transport processes are then simulated by HSPF to determine the delivered load. See design example in section 6.1 to see how the sediment delivery ratio is applied. Additional information on the sediment delivery ratio can be found in Appendix B. The calculated nutrient mass reductions are not subject to a delivery ratio and would be deducted from the annual load delivered to the river basin segment (edge-of-stream) in the CBWM.

Protocol 2
Credit for In-Stream and Riparian Nutrient Processing within the Hyporheic Zone during Base Flow

This protocol applies to stream restoration projects where in-stream design features are incorporated to promote biological nutrient processing, with a special emphasis on denitrification. Qualifying projects receive credit under Protocol 1 and use this protocol to determine enhanced nitrogen removal through denitrification within the stream channel during base flow conditions. Hyporheic exchange between the stream channel and the floodplain rooting zone is improved, however is confined by the dimensions in Figure 3. Situations where the restored channel is connected to a floodplain wetland are also eligible for additional credit under Protocol 3. Protocol 2 only provides a nitrogen

Worksheet 3-11. Form to calculate Bank Erosion Hazard Index (BEHI) variables and an overall BEHI rating. Use **Figure 3-7** with BEHI variables to determine BEHI score.

Stream:	**Strawberry Run**	Location:	**BEHI #6**
Station:	**70 ft**	Observers:	**Biggs/Hepp**
Date:	**4/5/18**	Stream Type: **G4**	Valley Type: **VI**

Variable	Inputs	Result	BEHI Score (Fig. 3-7)
Study Bank Height / Bankfull Height (C)	**Study Bank Height** (ft) = 8.50 (A); **Bankfull Height** (ft) = 0.55 (B); (A) / (B) =	15.45 (C)	10.0
Root Depth / Study Bank Height (E)	**Root Depth** (ft) = 4.00 (D); **Study Bank Height** (ft) = 8.50 (A); (D) / (A) =	0.47 (E)	4.0
Weighted Root Density (G)	**Root Density** as % = 15.00 (F); (F) × (E) =	7.06 (G)	9.0
Bank Angle (H)	**Bank Angle** as *Degrees* =	120 (H)	9.0
Surface Protection (I)	**Surface Protection** as % =	0% (I)	10.0

Bank Material Adjustment:

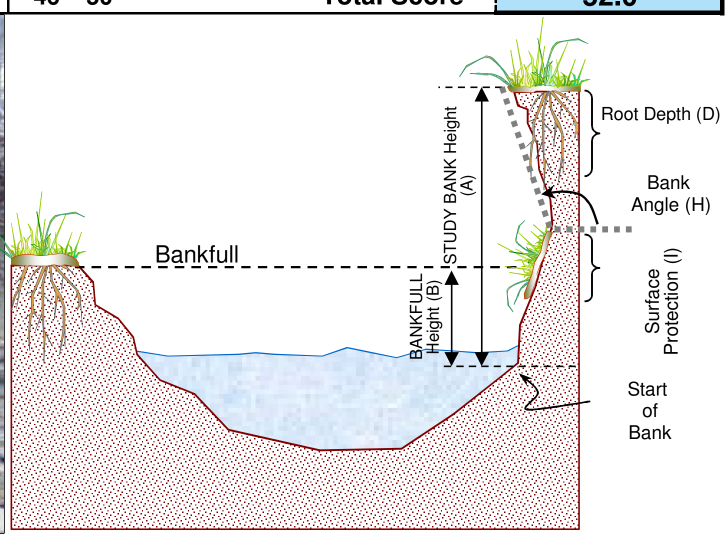
- **Bedrock** (Overall Very Low BEHI)
- **Boulders** (Overall Low BEHI)
- **Cobble** (Subtract 10 points if uniform medium to large cobble)
- **Gravel or Composite Matrix** (Add 5–10 points depending on percentage of bank material that is composed of sand)
- **Sand** (Add 10 points)
- **Silt/Clay** (no adjustment)

Bank Material Adjustment: 5

Stratification Adjustment
Add 5–10 points, depending on position of unstable layers in relation to bankfull stage: 5

Very Low	Low	Moderate	High	Very High	Extreme
5 – 9.5	10 – 19.5	20 – 29.5	30 – 39.5	40 – 45	46 – 50

Adjective Rating and **Total Score**: **Extreme** — **52.0**



Worksheet 3-12. Various field methods of estimating Near-Bank Stress (NBS) risk ratings to calculate erosion rate.

Estimating Near-Bank Stress (NBS)

Stream: **Strawberry Run**	Location: **BEHI #6**	
Station: **70 ft**	Stream Type: **G4**	Valley Type: **VI**
Observers: **Biggs/Hepp**		Date: **4/5/18**

Methods for Estimating Near-Bank Stress (NBS)

(1) Channel pattern, transverse bar or split channel/central bar creating NBS	Level I	Reconaissance
(2) Ratio of radius of curvature to bankfull width (R_c / W_{bkf})	Level II	General prediction
(3) Ratio of pool slope to average water surface slope (S_p / S)	Level II	General prediction
(4) Ratio of pool slope to riffle slope (S_p / S_{rif})	Level II	General prediction
(5) Ratio of near-bank maximum depth to bankfull mean depth (d_{nb} / d_{bkf})	Level III	Detailed prediction
(6) Ratio of near-bank shear stress to bankfull shear stress (τ_{nb} / τ_{bkf})	Level III	Detailed prediction
(7) Velocity profiles / Isovels / Velocity gradient	Level IV	Validation

Level I

(1)	Transverse and/or central bars-short and/or discontinuous………… ………………..…..NBS = High / Very High
	Extensive deposition (continuous, cross-channel)…………..……………..……. …………...NBS = Extreme
	Chute cutoffs, down-valley meander migration, converging flow…………………..…………..NBS = Extreme

Level II

(2)	Radius of Curvature R_c (ft)	Bankfull Width W_{bkf} (ft)	*Ratio* R_c / W_{bkf}	Near-Bank Stress (NBS)

(3)	Pool Slope S_p	Average Slope S	*Ratio* S_p / S	Near-Bank Stress (NBS)

(4)	Pool Slope S_p	Riffle Slope S_{rif}	*Ratio* S_p / S_{rif}	Near-Bank Stress (NBS)

Dominant Near-Bank Stress
Extreme

Level III

(5)	Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkf} (ft)	*Ratio* d_{nb} / d_{bkf}	Near-Bank Stress (NBS)

(6)	Near-Bank Max Depth d_{nb} (ft)	Near-Bank Slope S_{nb}	Near-Bank Shear Stress τ_{nb} (lb/ft^2)	Mean Depth d_{bkf} (ft)	Average Slope S	Bankfull Shear Stress τ_{bkf} (lb/ft^2)	Ratio τ_{nb} / τ_{bkf}	Near-Bank Stress (NBS)

Level IV

(7)	Velocity Gradient (ft / sec / ft)	Near-Bank Stress (NBS)

Converting Values to a Near-Bank Stress (NBS) Rating

Near-Bank Stress (NBS) ratings	Method number (1)	(2)	(3)	(4)	(5)	(6)	(7)
Very Low	N / A	> 3.00	< 0.20	< 0.40	< 1.00	< 0.80	< 0.50
Low	N / A	2.21 – 3.00	0.20 – 0.40	0.41 – 0.60	1.00 – 1.50	0.80 – 1.05	0.50 – 1.00
Moderate	N / A	2.01 – 2.20	0.41 – 0.60	0.61 – 0.80	1.51 – 1.80	1.06 – 1.14	1.01 – 1.60
High	See	1.81 – 2.00	0.61 – 0.80	0.81 – 1.00	1.81 – 2.50	1.15 – 1.19	1.61 – 2.00
Very High	(1)	1.50 – 1.80	0.81 – 1.00	1.01 – 1.20	2.51 – 3.00	1.20 – 1.60	2.01 – 2.40
Extreme	Above	< 1.50	> 1.00	> 1.20	> 3.00	> 1.60	> 2.40

Overall Near-Bank Stress (NBS) rating	**Extreme**

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Worksheet 3-11. Form to calculate Bank Erosion Hazard Index (BEHI) variables and an overall BEHI rating. Use **Figure 3-7** with BEHI variables to determine BEHI score.

Stream:	**Strawberry Run**	Location:	**BEHI #7**
Station:	**112 ft**	Observers:	**Biggs/Hepp**
Date:	**4/5/18**	Stream Type: **G4**	Valley Type: **VI**

Study Bank Height / Bankfull Height (C) — **BEHI Score** (**Fig. 3-7**)

Study Bank Height (ft) =	8.50 (A)	Bankfull Height (ft) =	0.55 (B)	(A) / (B) =	15.45 (C)	10.0

Root Depth / Study Bank Height (E)

Root Depth (ft) =	3.00 (D)	Study Bank Height (ft) =	8.50 (A)	(D) / (A) =	0.35 (E)	5.2

Weighted Root Density (G)

Root Density as % =	10.00 (F)	(F) × (E) =	3.53 (G)	9.5

Bank Angle (H)

Bank Angle as *Degrees* =	70 (H)	4.5

Surface Protection (I)

Surface Protection as % =	10% (I)	9.0

Bank Material Adjustment:

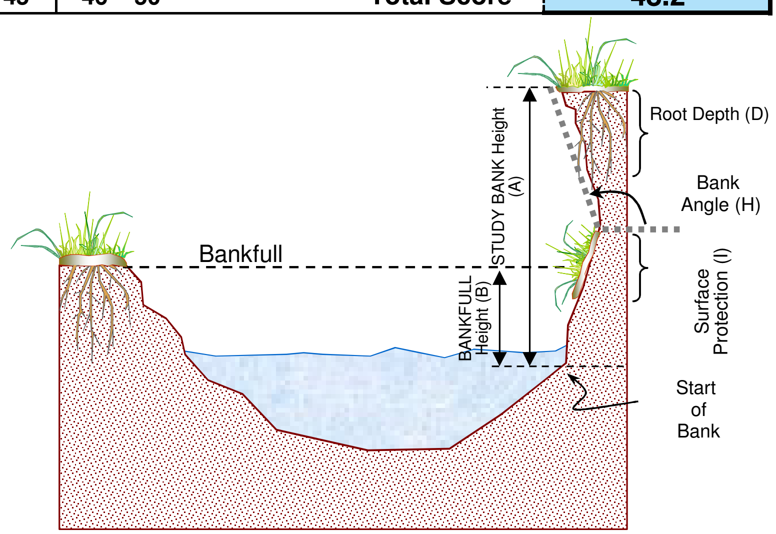
- **Bedrock** (Overall Very Low BEHI)
- **Boulders** (Overall Low BEHI)
- **Cobble** (Subtract 10 points if uniform medium to large cobble)
- **Gravel or Composite Matrix** (Add 5–10 points depending on percentage of bank material that is composed of sand)
- **Sand** (Add 10 points)
- **Silt/Clay** (no adjustment)

Bank Material Adjustment: 5

Stratification Adjustment
Add 5–10 points, depending on position of unstable layers in relation to bankfull stage: 5

Very Low	Low	Moderate	High	Very High	Extreme
5 – 9.5	10 – 19.5	20 – 29.5	30 – 39.5	40 – 45	46 – 50

Adjective Rating and **Total Score**: **Extreme** / **48.2**



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Worksheet 3-12. Various field methods of estimating Near-Bank Stress (NBS) risk ratings to calculate erosion rate.

Estimating Near-Bank Stress (NBS)

Stream: **Strawberry Run**	Location: **BEHI #7**	
Station: **112 ft**	Stream Type: **G4**	Valley Type: **VI**
Observers: **Biggs/Hepp**		Date: **4/5/18**

Methods for Estimating Near-Bank Stress (NBS)

(1) Channel pattern, transverse bar or split channel/central bar creating NBS	Level I	Reconaissance
(2) Ratio of radius of curvature to bankfull width (R_c / W_{bkf})	Level II	General prediction
(3) Ratio of pool slope to average water surface slope (S_p / S)	Level II	General prediction
(4) Ratio of pool slope to riffle slope (S_p / S_{rif})	Level II	General prediction
(5) Ratio of near-bank maximum depth to bankfull mean depth (d_{nb} / d_{bkf})	Level III	Detailed prediction
(6) Ratio of near-bank shear stress to bankfull shear stress (τ_{nb} / τ_{bkf})	Level III	Detailed prediction
(7) Velocity profiles / Isovels / Velocity gradient	Level IV	Validation

Level I

(1)
- Transverse and/or central bars-short and/or discontinuous……………………...……NBS = High / Very High
- Extensive deposition (continuous, cross-channel)……………..…………….……..……NBS = Extreme
- Chute cutoffs, down-valley meander migration, converging flow…………………….……………NBS = Extreme

Level II

(2)	Radius of Curvature R_c (ft)	Bankfull Width W_{bkf} (ft)	*Ratio* R_c / W_{bkf}	Near-Bank Stress (NBS)

(3)	Pool Slope S_p	Average Slope S	*Ratio* S_p / S	Near-Bank Stress (NBS)

(4)	Pool Slope S_p	Riffle Slope S_{rif}	*Ratio* S_p / S_{rif}	Near-Bank Stress (NBS)

Dominant Near-Bank Stress
High

Level III

(5)	Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkf} (ft)	*Ratio* d_{nb} / d_{bkf}	Near-Bank Stress (NBS)

(6)	Near-Bank Max Depth d_{nb} (ft)	Near-Bank Slope S_{nb}	Near-Bank Shear Stress τ_{nb} (lb/ft^2)	Mean Depth d_{bkf} (ft)	Average Slope S	Bankfull Shear Stress τ_{bkf} (lb/ft^2)	Ratio τ_{nb} / τ_{bkf}	Near-Bank Stress (NBS)

Level IV

(7)	Velocity Gradient (ft / sec / ft)	Near-Bank Stress (NBS)

Converting Values to a Near-Bank Stress (NBS) Rating

Near-Bank Stress (NBS) ratings	Method number						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Very Low	N / A	> 3.00	< 0.20	< 0.40	< 1.00	< 0.80	< 0.50
Low	N / A	2.21 – 3.00	0.20 – 0.40	0.41 – 0.60	1.00 – 1.50	0.80 – 1.05	0.50 – 1.00
Moderate	N / A	2.01 – 2.20	0.41 – 0.60	0.61 – 0.80	1.51 – 1.80	1.06 – 1.14	1.01 – 1.60
High	See	1.81 – 2.00	0.61 – 0.80	0.81 – 1.00	1.81 – 2.50	1.15 – 1.19	1.61 – 2.00
Very High	(1)	1.50 – 1.80	0.81 – 1.00	1.01 – 1.20	2.51 – 3.00	1.20 – 1.60	2.01 – 2.40
Extreme	Above	< 1.50	> 1.00	> 1.20	> 3.00	> 1.60	> 2.40

Overall Near-Bank Stress (NBS) rating	**High**

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Worksheet 3-13. Summary form of annual streambank erosion estimates for various study reaches.

Stream:	**Strawberry Run**			Location: **Project Reach**			
Graph Used:	**District of Columbia**	Total Stream Length (ft): **816.0**				Date: **10/3/18**	
Observers:	**Biggs/Hepp**		Valley Type: **VI**			Stream Type: **G4**	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Station (ft)	**BEHI rating (Worksheet 3-11) (adjective)**	**NBS rating (Worksheet 3-12) (adjective)**	**Bank erosion rate (Figure 3-9 or 3-10) (ft/yr)**	**Length of bank (ft)**	**Study bank height (ft)**	**Erosion subtotal [(4)×(5)×(6)] (ft^3/yr)**	**Erosion Rate (tons/yr/ft)**
1. **BEHI #1**	**Extreme**	**High**	**2.40**	**140.0**	**7.5**	**2520.00**	**1.008**
2. **BEHI #2**	**Extreme**	**High**	**2.40**	**141.0**	**7.5**	**2538.00**	**1.008**
3. **BEHI #3**	**High**	**High**	**1.00**	**38.0**	**5.0**	**190.00**	**0.280**
4. **BEHI #4**	**Very High**	**High**	**1.00**	**141.0**	**6.0**	**846.00**	**0.336**
5. **BEHI #5**	**High**	**High**	**1.00**	**29.0**	**4.5**	**130.50**	**0.252**
6. **BEHI #6**	**Very High**	**High**	**1.00**	**43.0**	**5.0**	**215.00**	**0.280**
7. **BEHI #7**	**Extreme**	**Extreme**	**4.50**	**70.0**	**8.5**	**2677.50**	**2.142**
8. **BEHI #8**	**Extreme**	**High**	**2.40**	**112.0**	**8.5**	**2284.80**	**1.142**
9. **BEHI #9**	**Moderate**	**Moderate**	**0.30**	**67.0**	**5.0**	**100.50**	**0.084**
10. **BEHI #10**	**Very High**	**Moderate**	**0.62**	**35.0**	**8.0**	**173.60**	**0.278**
Sum erosion subtotals in Column (7) for each BEHI/NBS combination					**Total Erosion (ft^3/yr)**	**11675.90**	
Convert erosion in ft^3/yr to yds^3/yr {divide Total Erosion (ft^3/yr) by 27}					**Total Erosion (yds^3/yr)**	**432.44**	
Dry Bulk Density of the Soil is 112 lb/cf.					**Total Erosion (tons/yr)**	**653.85**	
Calculate erosion per unit length of channel {divide Total Erosion (tons/yr) by total length of stream (ft) surveyed}					**Total Erosion (tons/yr/ft)**	**0.801**	

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		BANCS ASSESSMENT										
Project Site	***Physiographic Province***	*Assessment Length (ft)*	*TSS (ton/yr)*	*TSS (lb/yr)*	*Stream Restoration Efficiency (%)*	*TSS $_{EFFICIENCY}$ (lb/yr)*	*TP lb/ton sediment*	*TN lb/ton sediment*	*TP (lb/yr)*	*TN (lb/yr)*	*Delivery Ratio (%)*	*TSS Credited (lb/yr)*
000109 Holmes Run	Piedmont											
000166 Holmes Run	Piedmont	50	39.44	78,880.00	50	39,440	1.05	2.28	20.71	44.96	18.1	7,138.64
Dual 90 in. Cameron Run	Coastal Plain											
Holmes Run	Piedmont	1,307	784.36	1,568,720.00	50	784,360	1.05	2.28	411.79	894.17	18.1	141,969.16
JBFNC Holmes Run	Piedmont											
Strawberry Run	Piedmont	816	653.85	1,307,700.00	50	653,850	1.05	2.28	343.27	745.39	18.1	118,346.85
Taylor Run	Coastal Plain	1,295	562.35	1,124,700.00	50	562,350	1.05	2.28	295.23	641.08	6.1	34,303.35
Timber Branch	Coastal Plain	737	666.60	1,333,200.00	50	666,600	1.05	2.28	349.97	759.92	6.1	40,662.60
Unnamed Walleston Trib	Coastal Plain	850	439.27	878,540.00	50	439,270	1.05	2.28	230.62	500.77	6.1	26,795.47
									1,651.58	***3,586.29***		***369,216.07***

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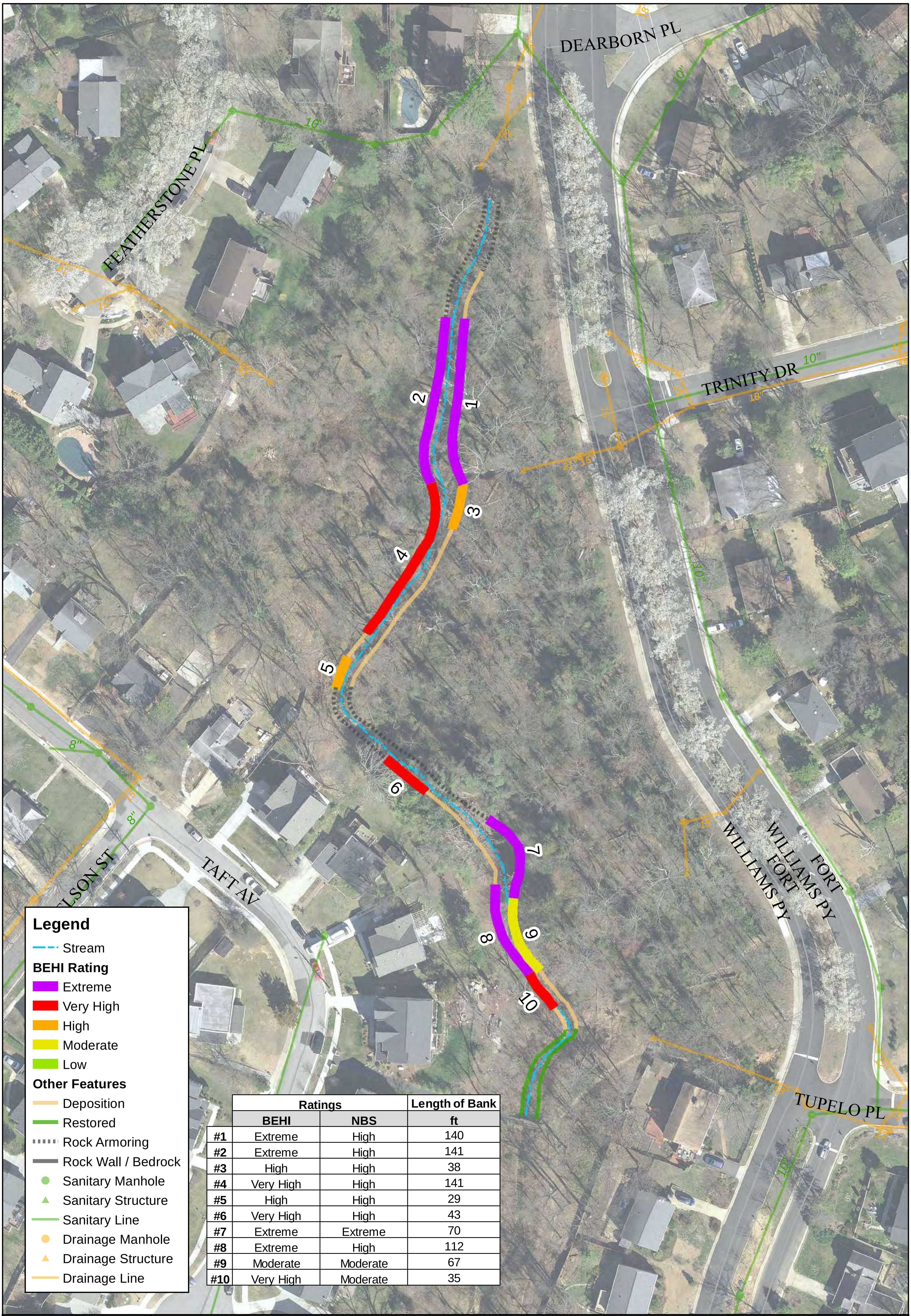

	Ratings		Length of Bank
	BEHI	NBS	ft
#1	Extreme	High	140
#2	Extreme	High	141
#3	High	High	38
#4	Very High	High	141
#5	High	High	29
#6	Very High	High	43
#7	Extreme	Extreme	70
#8	Extreme	High	112
#9	Moderate	Moderate	67
#10	Very High	Moderate	35

N
W E
S

Strawberry Run

BANCS Assessment

0 25 50 75 150 225
1 in = 75 ft

wood.

Environment & Infrastructure
14424 Albemarle Point Place, Suite #115
Chantilly, VA 20151

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Attachment 5

(Section F)

Documentation of Highest Project Status Option:

Strawberry Run Conceptual Designs

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CITY OF ALEXANDRIA, VIRGINIA

STRAWBERRY RUN
CONCEPTUAL DESIGN

Sheet Index	
Sheet Number	**Sheet Title**
01	COVER
02	EXISTING CONDITIONS - PHOTOS
03	EXISTING CONDITIONS - PROFILE
04	CONCEPT LAYOUT
05	TYPICAL SECTIONS & ROCK AND LOG VANE DETAILS
06	CONSTRUCTED RIFFLE DETAIL
07	ROCK CROSS VANE DETAILS
08	STACKED ROCK WALL AND ROCK TOE
09	TOE WOOD DETAILS
10	PLUNGE & STEP POOL DETAILS
11	PLANTING DETAILS
12	CASCADE DETAILS

VICINITY MAP

60 0 60 120 FT
1 inch = 60 feet

N

PROJECT DESCRIPTION:

APPROXIMATELY 811 LF OF PROPOSED STREAM RESTORATION DOWNSTREAM OF AN EX. 72 INCH CMP OUTFALL.

EXISTING CONDITIONS NOTES:

THE STREAM CHANNEL HAS DOWNCUT WITH ABANDONED MEANDERS WHICH ARE APPROXIMATELY 3 FT. HIGHER THAN THE CURRENT STREAM BED, AND TRIBUTARIES ALONG THE REACH HAVE HEADCUT. SIGNIFICANT AMOUNTS OF BROKEN CONCRETE WERE OBSERVED IN THE CHANNEL, WHERE IT APPROACHES AND RUNS APPROXIMATELY PARALLEL TO TAFT AVENUE. DOWNSTREAM OF THE PROJECT REACH, THERE IS A STREAM RESTORATION PROJECT THAT HAS BEEN RECENTLY COMPLETED NEAR THE VICINITY OF THE PEDESTRIAN BRIDGE.

STRAWBERRY RUN CONCEPT DESIGN

NOT FOR CONSTRUCTION

NO.	DD	MON	YYYY	ISSUE / REVISION DESCRIPTION	ENG.	APPR.

CLIENT:
CITY OF ALEXANDRIA
301 KING STREET
ALEXANDRIA, VA 22314

ENGINEER:
Wood Environment & Infrastructure Solutions
4795 Meadow Wood Lane, Suite 310 East
Chantilly, VA 20151-1678
Tel. (703) 488-3700
www.woodplc.com

DRAWN BY: CAL
CHECKED BY: MTB
APPROVED BY: MTB
SCALE: AS NOTED

PROJECT:
STRAWBERRY RUN STREAM RESTORATION
207 FORT WILLIAMS PARKWAY
ALEXANDRIA, VA 22304

SHEET TITLE: COVER

PROJECT NO.: 7526173001
DATE: 21 AUGUST 2018
DWG. SIZE: ARCH D
SHEET NUMBER: 01 OF 12

PLOTTED BY:LASH, CHRISTA SHEET SET:Alexandria Concepts LAYOUT:COVER August 21, 2018 03:59:39pm \\CHY-FS1\CAD_PROJECTS\7526173001_ALEXANDRIA_STREAM_ASSESS\PLANSHEETS\01-COVER.DWG

N

LEGEND

LOCATION AND PHOTO DIRECTION

50 0 50 100 FT

1 inch = 50 feet

STRAWBERRY RUN CONCEPT DESIGN

NOT FOR CONSTRUCTION

NO.	DD	MON	YYYY	ISSUE / REVISION DESCRIPTION	ENG.	APPR

CLIENT:
CITY OF ALEXANDRIA
301 KING STREET
ALEXANDRIA, VA 22314

ENGINEER:
Wood Environment & Infrastructure Solutions
4795 Meadow Wood Lane, Suite 310 East
Chantilly, VA 20151-1678
Tel. (703) 488-3700
www.woodplc.com

wood.

DRAWN BY: CAL
CHECKED BY: MTB
APPROVED BY: MTB
SCALE: AS NOTED

PROJECT:
STRAWBERRY RUN STREAM RESTORATION
207 FORT WILLIAMS PARKWAY
ALEXANDRIA, VA 22304

SHEET TITLE:
EXISTING CONDITIONS - PHOTOS

PROJECT NO.: 7526173001
DATE: 21 AUGUST 2018
DWG. SIZE: ARCH D
SHEET NUMBER: 02 OF 12

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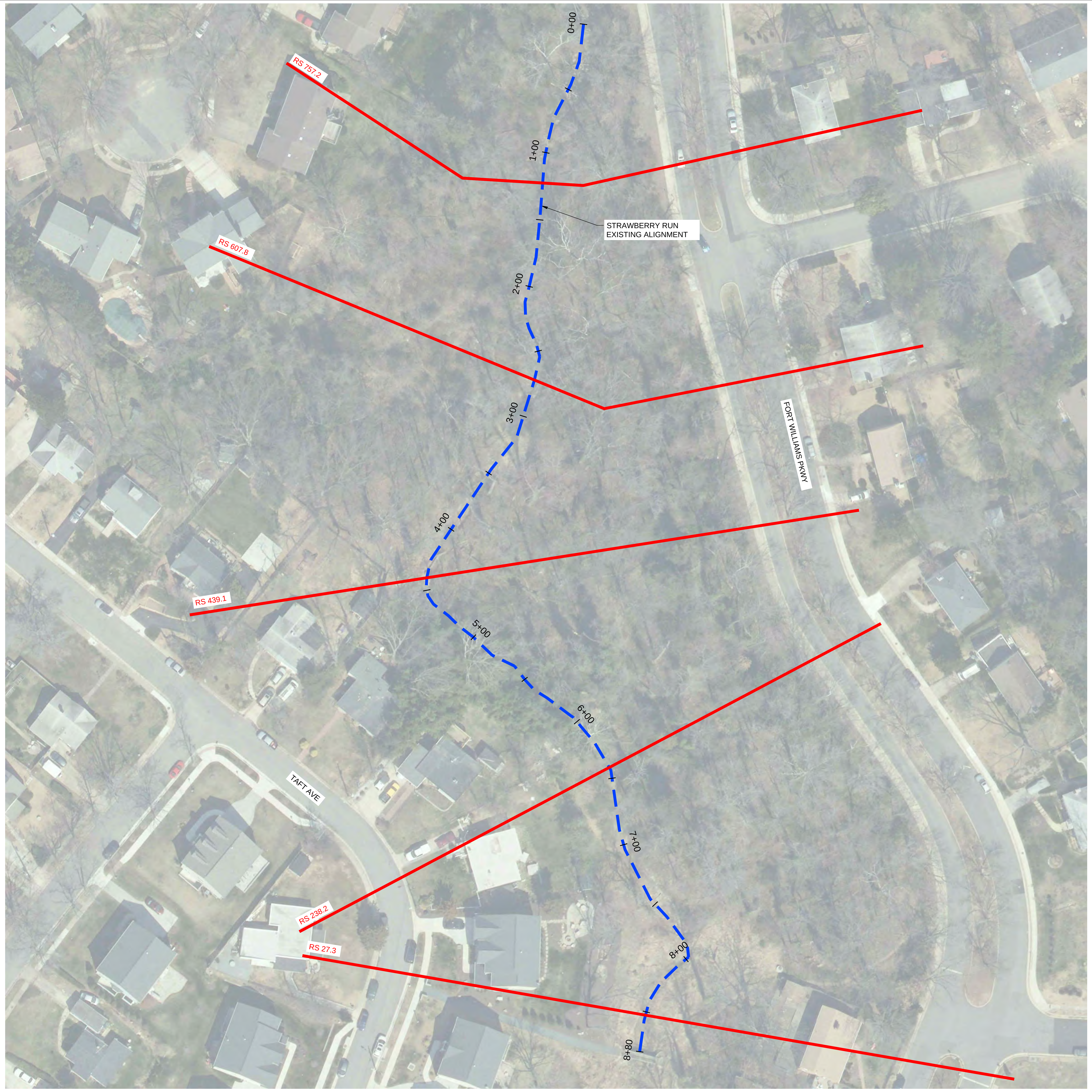
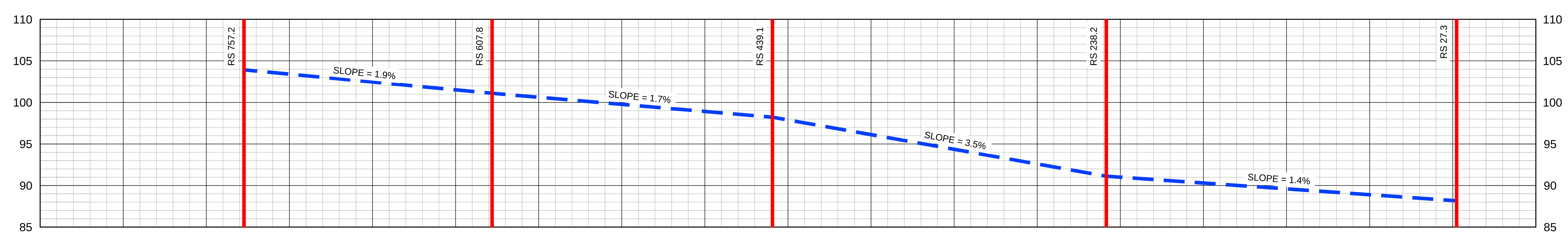


N

50 0 50 100 FT

1 inch = 50 feet

PLAN VIEW



10 FT 5 0 5

50 0 50 100 FT

PROFILE

STRAWBERRY RUN CONCEPT DESIGN

NOT FOR CONSTRUCTION

NO.	DD	MON	YYYY	ISSUE / REVISION DESCRIPTION	ENG.	APPR

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ALEXANDRIA, VA 22314

ENGINEER:
Wood Environment & Infrastructure Solutions
4795 Meadow Wood Lane, Suite 310 East
Chantilly, VA 20151-1678
Tel. (703) 488-3700
www.woodplc.com

DRAWN BY: CAL
CHECKED BY: MTB
APPROVED BY: MTB
SCALE: AS NOTED

PROJECT:
STRAWBERRY RUN STREAM RESTORATION
207 FORT WILLIAMS PARKWAY
ALEXANDRIA, VA 22304

SHEET TITLE:
EXISTING CONDITIONS - PROFILE

PROJECT NO.: 7526173001
DATE: 21 AUGUST 2018
DWG. SIZE: ARCH D
SHEET NUMBER: 03 OF 12

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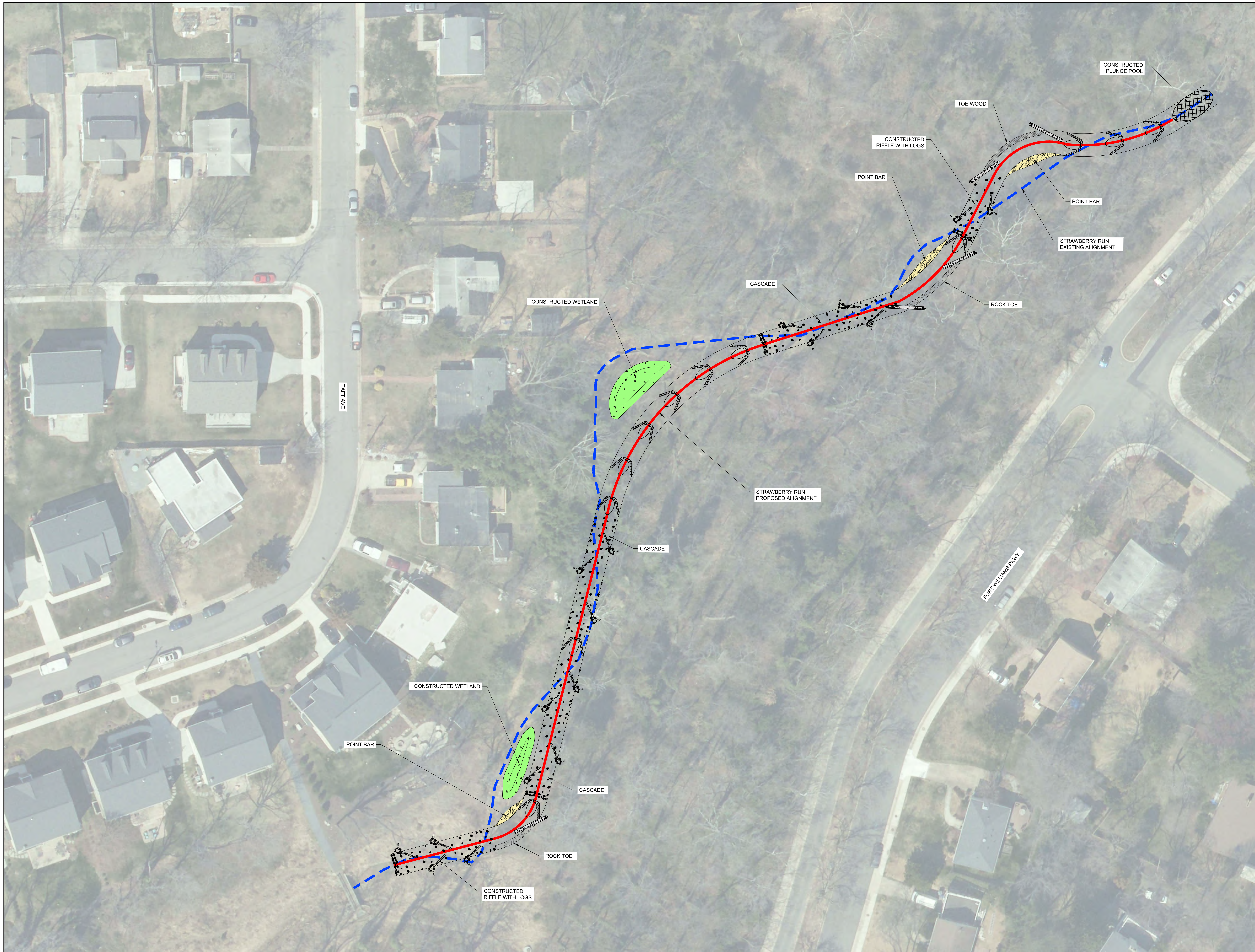

LEGEND

- CROSS VANE
- LOG VANE
- RIFFLE/CASCADE
- TOE WOOD
- ROCK TOE
- CONSTRUCTED PLUNGE POOL

40 0 40 80 FT

1 inch = 40 feet

STRAWBERRY RUN CONCEPT DESIGN

NOT FOR CONSTRUCTION

NO.	DD	MON	YYYY	ISSUE / REVISION DESCRIPTION	ENG.	APPR

CLIENT: CITY OF ALEXANDRIA
301 KING STREET
ALEXANDRIA, VA 22314

ENGINEER: Wood Environment & Infrastructure Solutions
4795 Meadow Wood Lane, Suite 310 East
Chantilly, VA 20151-1678
Tel. (703) 488-3700
www.woodplc.com

DRAWN BY: CAL
CHECKED BY: MTB
APPROVED BY: MTB
SCALE: AS NOTED

PROJECT: STRAWBERRY RUN STREAM RESTORATION
207 FORT WILLIAMS PARKWAY
ALEXANDRIA, VA 22304

SHEET TITLE: CONCEPT LAYOUT

PROJECT NO.: 7526173001
DATE: 21 AUGUST 2018
DWG. SIZE: ARCH D
SHEET NUMBER: 04 OF 12

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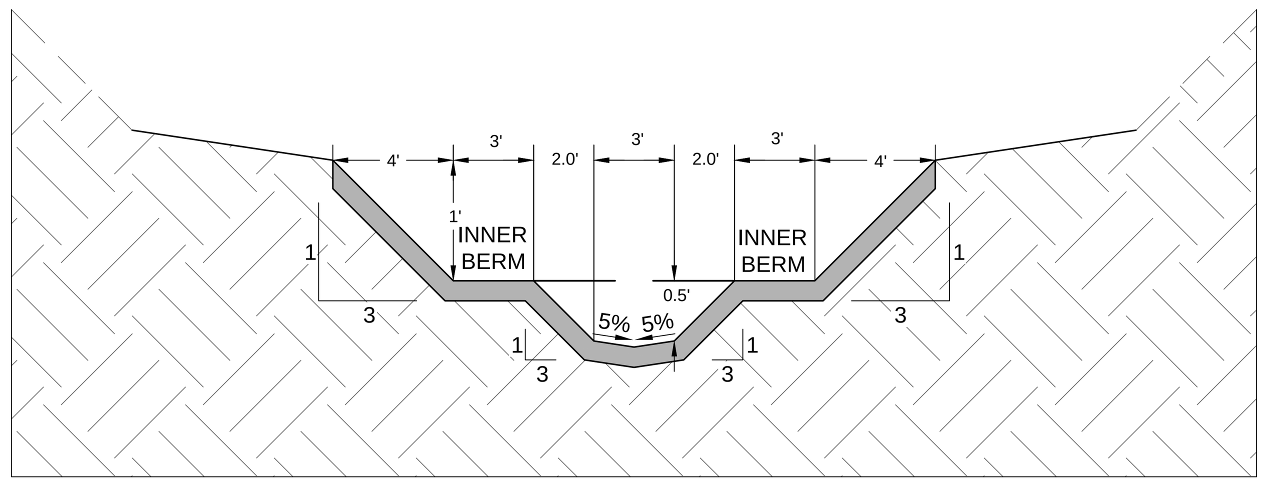
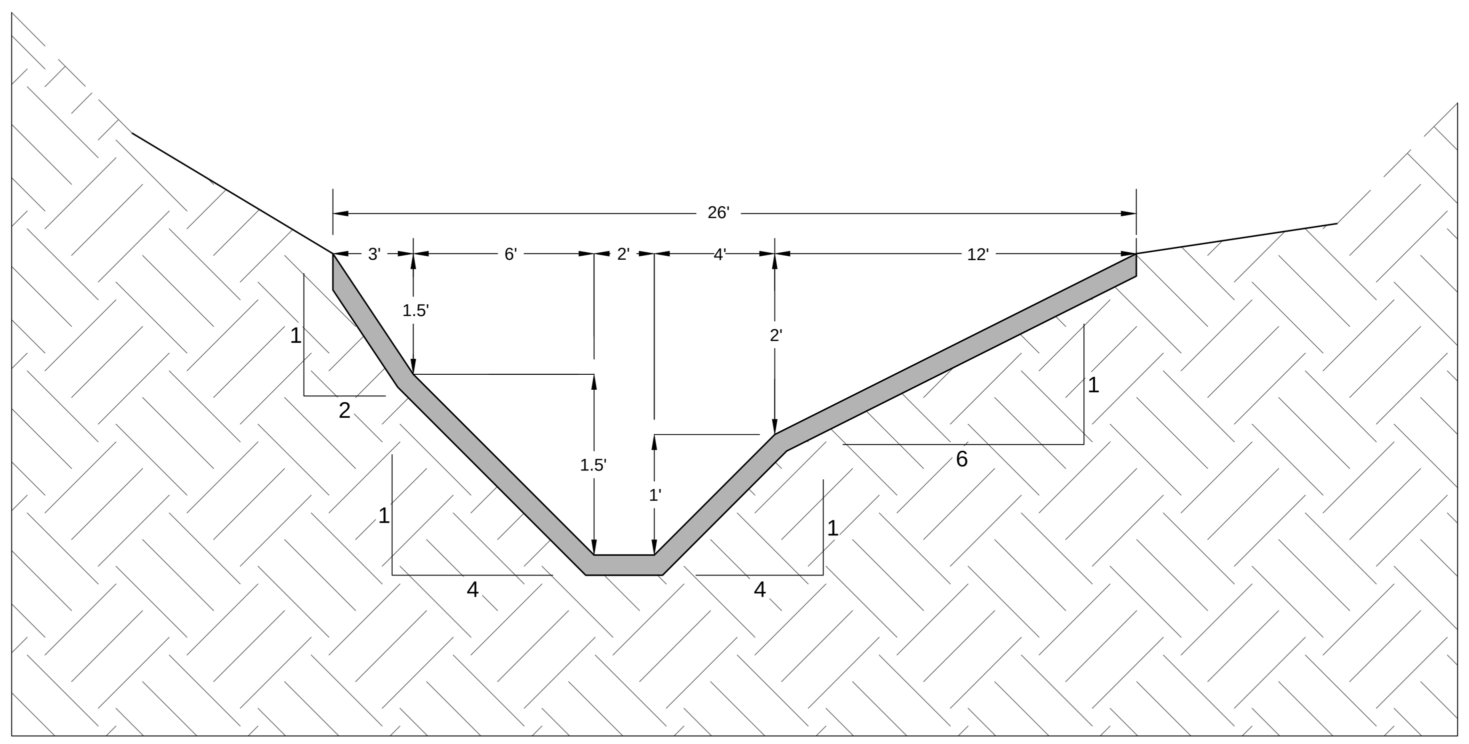
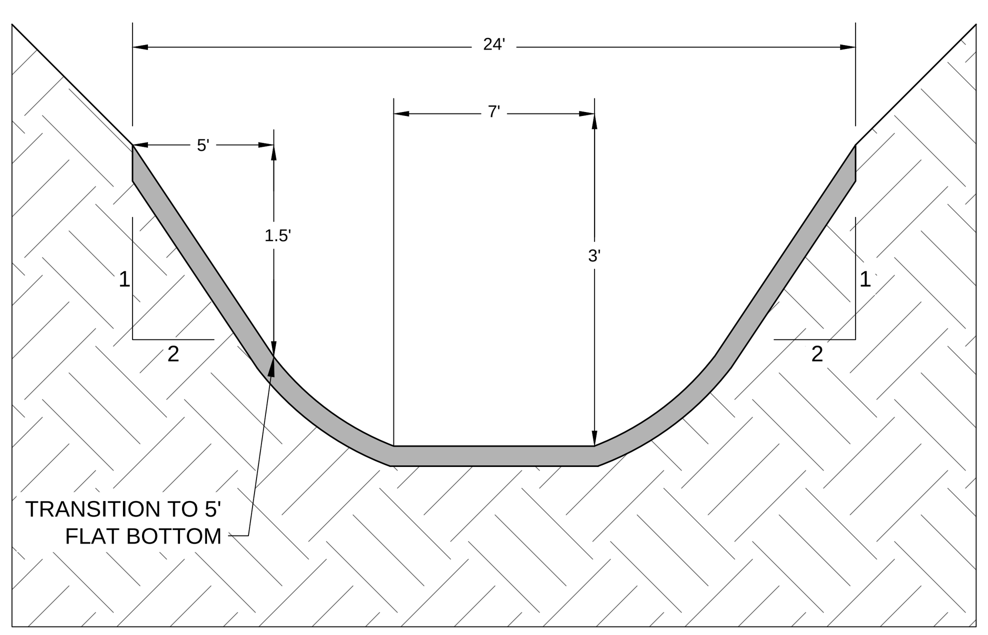


TYPICAL RIFFLE SECTION



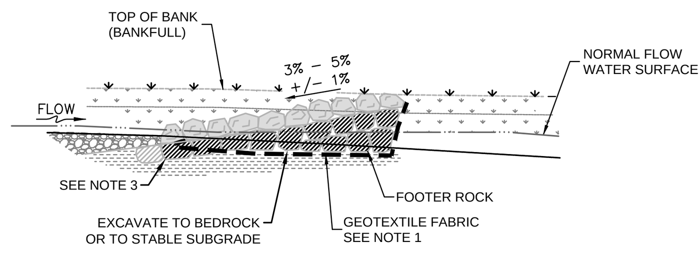
TYPICAL POOL IN BEND SECTION



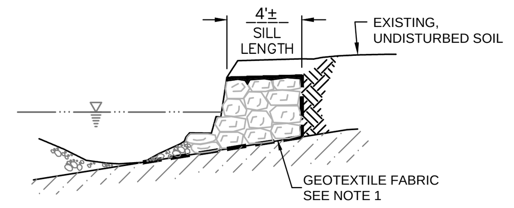
TYPICAL STRAIGHT POOL SECTION

TYPICAL USES:

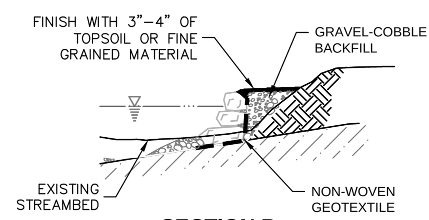
- RE-DIRECTION OF FLOW AWAY FROM LOCALIZED AREA OF BANK EROSION WHERE A FULL J-HOOK VANE IS NOT PRACTICAL.
- IN SHARP STREAM BENDS WHERE THERE IS NOT ENOUGH SPACE FOR A J-HOOK VANE.
- LOWER COST ALTERNATIVE TO FULL J-HOOK STRUCTURE. HOWEVER, A J-HOOK VANE PROVIDES MORE BENEFITS.



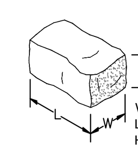
PROFILE
(ALONG ARM)
N.T.S.



SECTION A
(AT CUTOFF SILL)
N.T.S.



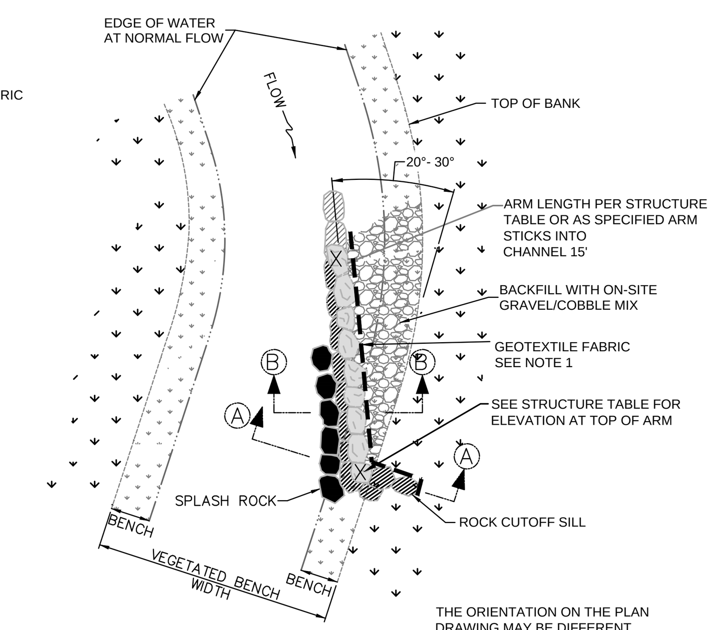
SECTION B
(AT VANE ARM)
N.T.S.



W: Intermediate Axis (Diameter)
L: Long Axis (Length)
H: Short Axis (Height)

STRUCTURE ROCK SIZE				
	Representative Size			
	W or Dia (Feet)	Length (Feet)	Height (Feet)	Weight (Ton)
Minimum	3	4	2	2

Assumed Rock Density: 165 LB/CU-FT



PLAN VIEW
N.T.S.

THE ORIENTATION ON THE PLAN DRAWING MAY BE DIFFERENT AND MAY NOT BE IN A BEND. THE LOW END OF THE ARM POINTS UPSTREAM.

ROCK NOTES:

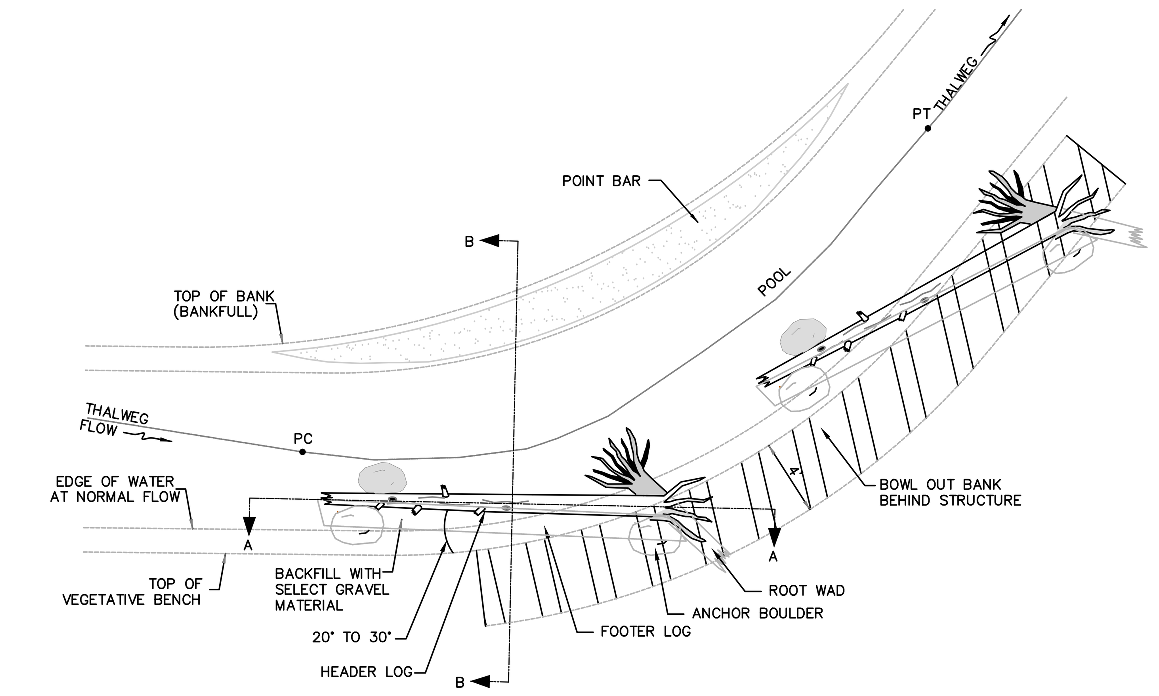
A. PROVIDE A RANGE OF ROCK SIZES FOR FLEXIBILITY TO MEET DESIGN GRADES & LINES. AT LEAST 80% OF THE ROCK SHALL MEET OR EXCEED THE AVERAGE SIZE ROCK REQUIREMENTS; UP TO 15% OF ROCK MAY BE IN THE MINIMUM TO AVERAGE SIZE CATEGORY; AND 5% MAY BE SMALLER FRAGMENTS FOR CHINKING USE.
B. SMALLER HEIGHT ROCKS ARE REQUIRED TO TAPER STRUCTURES AT APEX ON BEDROCK. FOOTER ROCKS SHALL MEET STRUCTURE ROCK REQUIREMENTS.
C. FOR MAIN STRUCTURE ROCK, SILL, AND FOOTER ROCK, THE ROCK SOURCE SHALL BE FROM AN ACCEPTABLE WVDOH QUARRY OR FROM ENGINEER APPROVED SOURCE.
D. ON-SITE COBBLE AND BOULDERS MAY BE USED TO FILL VOIDS AND FOR SPLASH ROCKS, BUT NOT FOR USE AS ANY MAIN STRUCTURE ROCK, UNLESS APPROVED BY ON-SITE ENGINEER.

NOTES:

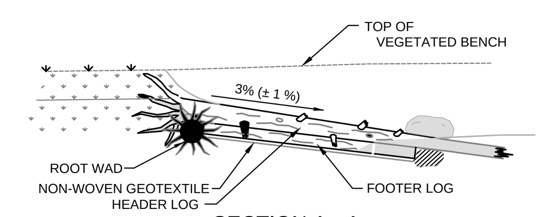
1. USE CLASS I, NON-WOVEN GEOTEXTILE FABRIC AS DESCRIBED IN THE SPECIFICATIONS. PLACE GEOTEXTILE BEHIND THE ARM (UPSTREAM SIDE), DRAPED FROM TOP OF ROCK STRUCTURE TO BOTTOM OF FOOTER ROCK AND EXTEND A MINIMUM OF HALF THE TRENCH BOTTOM WIDTH. TRIM EXCESS OR VISIBLE FABRIC. EXTEND GEOTEXTILE ALONG HALF OF THE SILL LENGTH.
2. ON BEDROCK STREAM BEDS , EXCAVATE POOL BEFORE INSTALLING STRUCTURE. EXCAVATION AND BACKFILL WORK RELATED TO THIS

ROCK VANE DETAIL

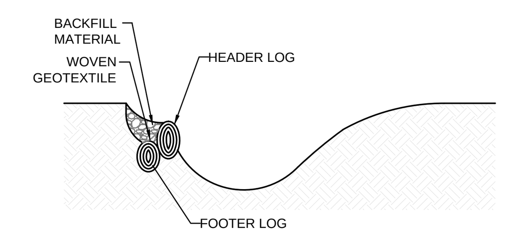
NOT TO SCALE



PLAN VIEW



SECTION A - A



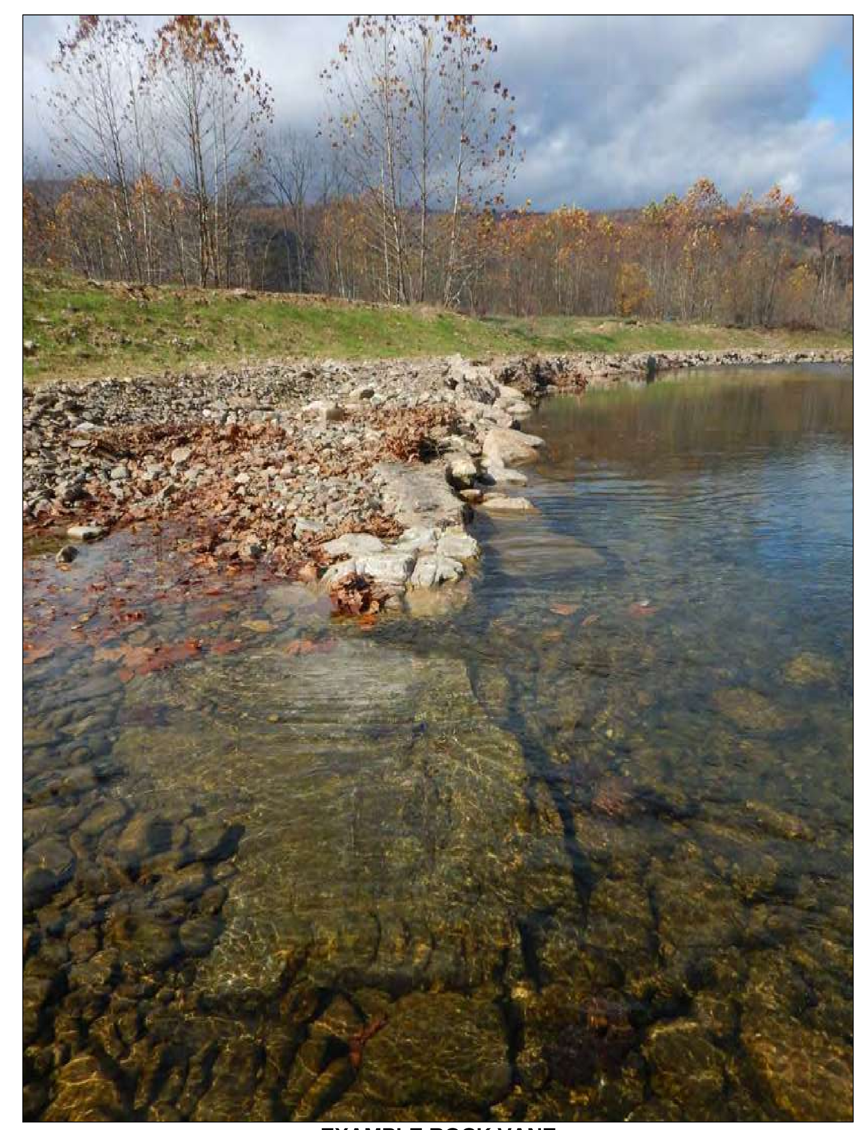
SECTION B - B

NOTES:

1. FILTER FABRIC SHALL BE PLACED ON THE UPSTREAM SIDE OF THE STRUCTURE ¼ DIAMETER FROM THE TOP OF THE LOG. THE NAILS SHALL BE ON 12IN CENTERS. FILTER FABRIC SHALL BE BURIED IN THE BOTTOM OF THE CHANNEL AND SHALL BE PLACED THE ENTIRE LENGTH OF THE STRUCTURE.
2. A TRENCH SHALL BE DUG IN SUCH A MANNER THAT THE ANCHOR BOULDERS ARE BURIED BENEATH THE BED SURFACE ELEVATION.
3. A HYDRAULIC EXCAVATOR WITH A BUCKET THAT CONTAINS A HYDRAULIC THUMB SHALL BE USED TO PLACE BOULDERS AND LOGS WITH THE SUPERVISION OF THE ENGINEER
4. HEADER AND FOOTER LOGS SHALL BE A MINIMUM OF 18-24 IN. IN DIAMETER WITH A LENGTH OF 35 TO 53 FT. THE HEADER LOG SHALL BE SET IN PLACE FIRST WITH THE FOOTER LOG UNDERNEATH AND BEHIND THE HEADER LOG PRIOR TO BACKFILLING THE TRENCH
5. 1/3 OF THE WAY ACROSS THE CHANNEL FROM THE OUTSIDE BANK THE HEADER ROCK SHALL BE PLACED AT 2 IN. ABOVE THE CHANNEL INVERT ELEVATION
6. EXCAVATE POOL TO A MINIMUM DEPTH OF 3 FEET BELOW EXISTING STREAMBED. IF BEDROCK IS ENCOUNTERED BEFORE REACHING THE MINIMUM DEPTH, THE EXCAVATION MAY STOP AT BEDROCK. EXCAVATED MATERIAL MAY BE USED FOR BACKFILLING ALONG THE LOG VANE.
7. SEED, MULCH, AND RESTORE DISTURBED AREAS TO PRE-EXISTING CONDITIONS OR BETTER. PROVIDE PLANTINGS AS REQUIRED BY PLANTING PLAN, IF PROVIDED.
8. ANY SOIL DISTURBED DURING THE PLACEMENT OF J-HOOK VANES, SHALL BE SEEDED USING TEMPORARY AND PERMANENT SEEDING METHODS.
9. FILTER FABRIC SHALL BE PLACED ON THE UPSTREAMM SIDE OF THE VANE STRUCTURE TO PREVENT WASHOUT OF SEDIMENT THROUGH BOULDER GAPS. FILTER FABRIC SHALL EXTEND FROM THE BOTTOM OF THE FOOTER BOULDER TO FINISHED GRADE ELEVATION AND SHALL BE PLACED THE ENTIRE LENGTH OF THE STRUCTURE.
10. THE GAP BETWEEN THE HEADER AND FOOTER LOG SHALL BE CHINKED BY HAND WITH GRAVEL COBBLE AND WOODY DEBRIS FROM THE UPSTREAM DIRECTION.
11. THE HORIZONTAL ANGLE OF THE HEADER LOG OF THE VANE AND THE BANK SHALL BE BETWEEN 20-30 DEGREES
12. SELECT GRAVE MATERIAL CAN BE HARVESTED FROM SPOIL PILES ON SITE BUT SHOULD HAVE A GRADATION WITH A D16 40MM/1.6IN, D50~80MM/3.1IN, D84~200MM/8IN, D95~300MM/12IN, OR BE APPROVED BY ON-SITE TECHNICAL REPRESENTATIVE.
13. THE ROOTWAD SHALL BE A MINIMUM OF 6.5 FT IN LENGTH, WITH A ROOT FAN WITH A DIAMETER OF AT LEAST 3 FT. AND A DIAMETER OF 18IN - 24"IN.
14. STRUCTURE INVERT ELEVATION SHALL BE THE SAME ELEVATION AS THE RIFFLE IMMEDIATELY DOWNSTREAM OF THE STRUCTURE IN THE PLAN VIEW.

EXAMPLE ROCK VANE

EXAMPLE ROCK VANE



EXAMPLE ROCK VANE
(LOOKING DOWNSTREAM, ALONG VANE ARM)

EXAMPLE CONSTRUCTED LOG VANE

PLOTTED BY:LASH, CHRISTA SHEET SET: Alexandria Concepts LAYOUT: TYPICAL SECTIONS & ROCK AND LOG VANE DETAILS August 21, 2018 04:00:30pm \\CHY-FS1\CAD_PROJECTS\7526173001_ALEXANDRIA STREAM ASSESS\PLANSHEETS\05-CONCEPT DETAILS.DWG

STRAWBERRY RUN CONCEPT DESIGN

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CLIENT: CITY OF ALEXANDRIA
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SCALE: AS NOTED

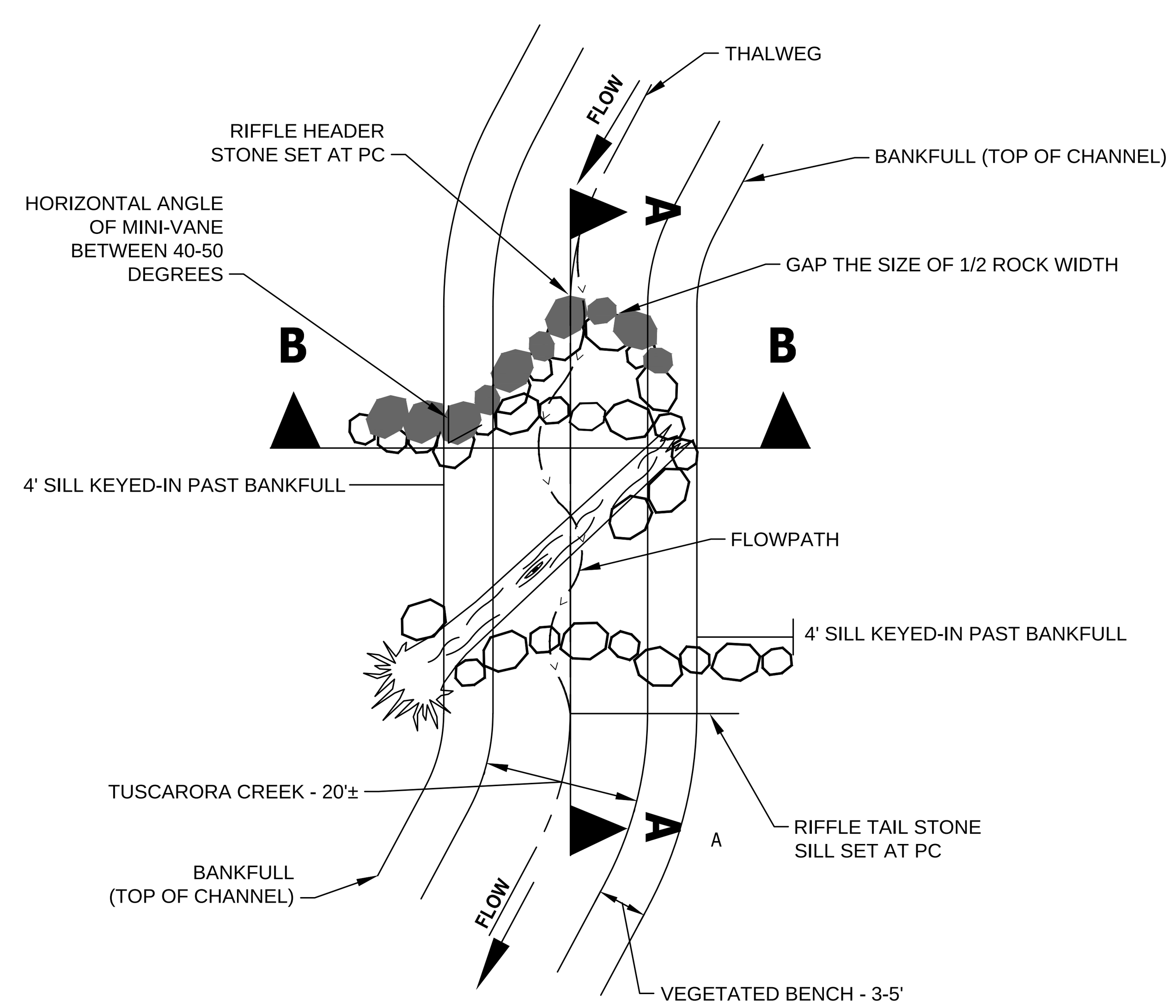
PROJECT: STRAWBERRY RUN STREAM RESTORATION
207 FORT WILLIAMS PARKWAY
ALEXANDRIA, VA 22304

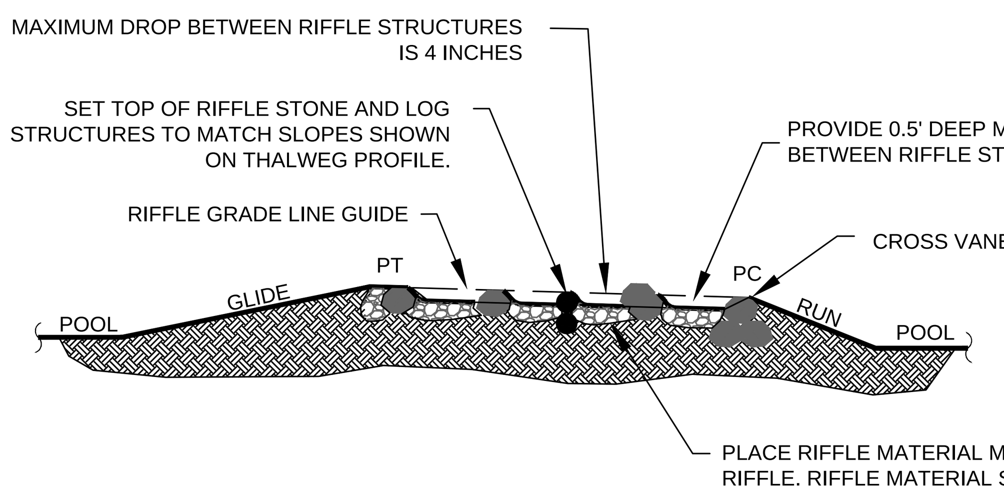
SHEET TITLE: TYPICAL SECTIONS & ROCK AND LOG VANE DETAILS

PROJECT NO.: 7526173001
DATE: 21 AUGUST 2018
DWG. SIZE: ARCH D
SHEET NUMBER: 05 OF 12

RIFFLE SECTION STRUCTURES

NTS

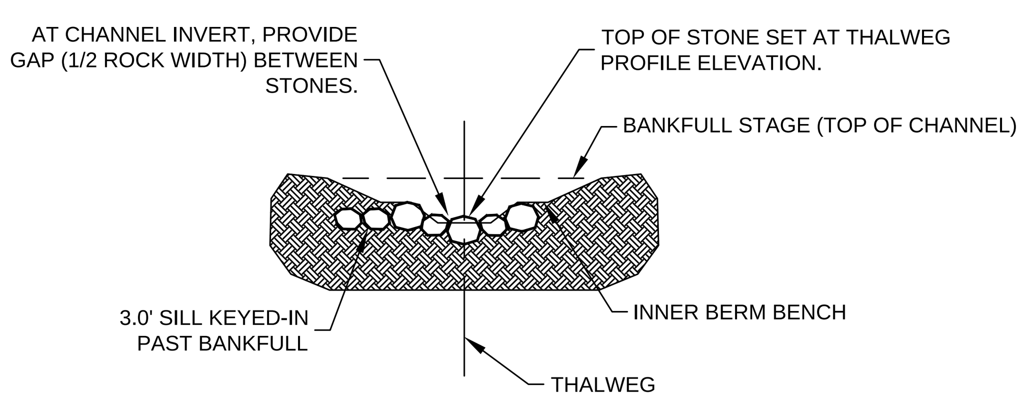




TYPICAL RIFFLE STRUCTURE INSTALLATION PROFILE

(NOT TO SCALE)

SECTION A-A



TYPICAL RIFFLE STRUCTURE INSTALLATION CROSS SECTION

(NOT TO SCALE)

SECTION B-B

RIFFLE MATERIAL MIXTURE

4' X 3' X 2' STRUCTURE STONE
CLASS I (D_{50} = 1.1')
CLASS III (D_{50} = 2.2')
57 STONE
SUPPLEMENTAL EX. BED MATERIAL

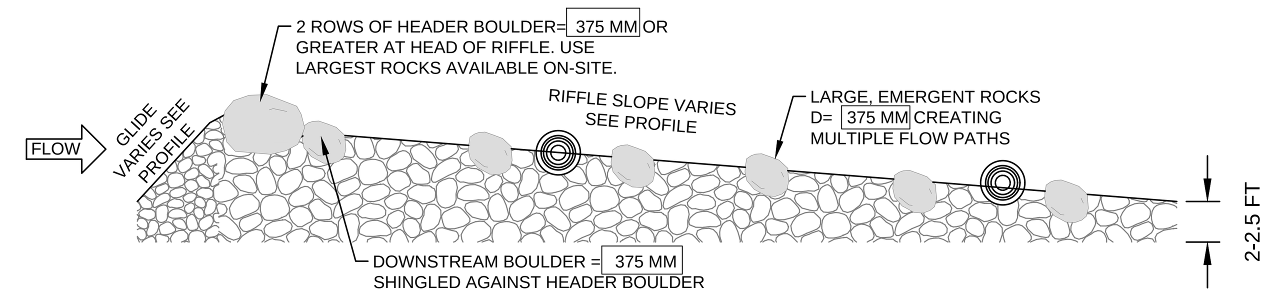
*CLASS I, CLASS III, AND 57 STONE SHALL BE EQUALLY MIXED AND SUPPLEMENTED WITH EXISTING BED MATERIAL AT THE DIRECTION OF THE FIELD ENGINEER.

EXAMPLE RIFFLE

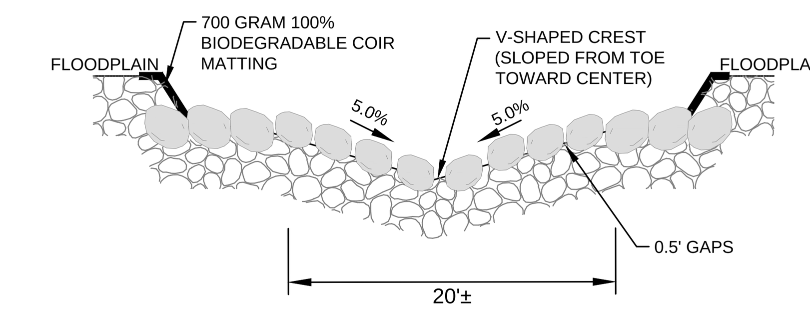
(SHOWN FOR INFORMATION ONLY)

RIFFLE NOTES:

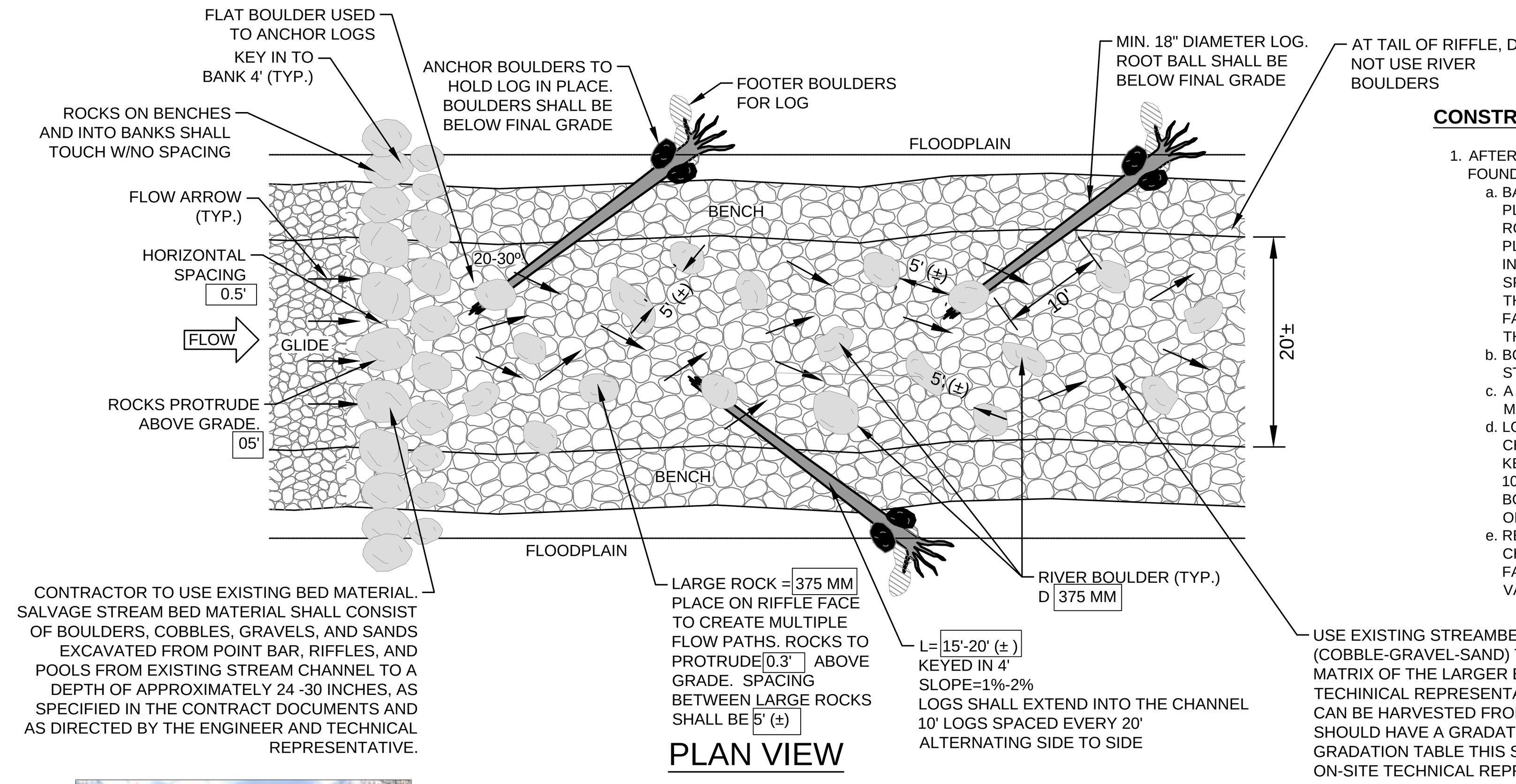
1. THE MAXIMUM AMOUNT OF DROP FROM ONE MINI-VANE TO THE NEXT SHALL BE NO GREATER THAN 4-INCHES. THE COMBINED AMOUNT OF DROP OVER ALL THE MINI-VANES SHALL NOT EXCEED THE TOTAL AMOUNT OF FALL ALONG THE RIFFLE SLOPE.
2. MINI-VANES SHALL BE EQUALLY SPACED ALONG THE RIFFLE.
3. A HYDRAULIC EXCAVATOR WITH A BUCKET THAT CONTAINS A HYDRAULIC THUMB SHALL BE USED TO PLACE BOULDERS AND LOGS WITH THE SUPERVISION OF THE ENGINEER.
4. LOGS FOR CONSTRUCTED RIFFLE SHALL BE A MINIMUM OF 1.5-FOOT IN DIAMETER WITH A LENGTH OF 10± FEET. LOGS AND BOULDERS CAN BE SUBSTITUTED DURING CONSTRUCTION WITH THE APPROVAL OF THE TOWN OF LEESBURG.
5. ½ OF THE WAY ACROSS THE CHANNEL FROM THE OUTSIDE BANK, THE HEADER ROCK SHALL BE PLACED AT 2 INCHES ABOVE THE CHANNEL INVERT ELEVATION.
6. THERE SHALL BE A GAP BETWEEN THE HEADER ROCKS OF 1/2 ROCK WIDTH.
7. THE BOULDERS SHALL SLOPE FROM THE BED ELEVATION, AT THE HEAD OF THE VANE, TO $\frac{1}{2}$ BANKFULL ELEVATION AT A SLOPE OF 3%-5%. HEADER AND FOOTER BOULDERS SHALL BE TIED SECURELY INTO THE BANK IN SUCH A WAY THAT IT ELIMINATES THE POSSIBILITY OF STREAMFLOW DIVERTING AROUND THEM.
8. ANY SOIL DISTURBED DURING THE PLACEMENT OF THE RIFFLE SHALL BE SEEDED USING TEMPORARY AND PERMANENT SEEDING METHODS.
9. THE THALWEG OR LOW POINT IN THE CHANNEL SHALL ALTERNATE LEFT AND RIGHT OF THE CHANNEL CENTERLINE BY 10 INCHES.
10. THE GAP BETWEEN THE HEADER AND FOOTER BOULDERS SHALL BE CHINKED BY HAND WITH GRAVEL AND COBBLE FROM THE UPSTREAM DIRECTION.
11. THE HORIZONTAL ANGLE OF THE HEADER BOULDERS OF THE MINI-VANE AND THE BANK SHALL BE BETWEEN 40-50 DEGREES.
12. RIFFLE MATERIAL SHALL CONSIST OF A 2' - 2.5' THICKNESS OF CLASS I, CLASS III AND 57 STONE MIXED IN EQUAL PARTS BY THE CONTRACTOR AND SUPPLEMENTED WITH EXISTING BED MATERIAL AT THE DIRECTION OF THE ON-SITE TECHNICAL REPRESENTATIVE. ANY DEVIATION FROM THE SPECIFIED MIX DESIGN SHALL BE APPROVED BY THE TOWN OF LEESBURG.
13. IF A ROOT WADS IS USED IN THE STRUCTURE, THE ROOT WAD SHALL BE A MINIMUM OF 7 FT IN LENGTH, WITH A ROOT FAN WITH A DIAMETER OF AT LEAST 4 FT AND A DIAMETER OF 1.5 FT. 90% OF THE ROOT FAN SHALL BE BURIED IN THE BANK OF THE STRUCTURE.
14. THE ELEVATION OF THE STRUCTURES CAN BE INTERPOLATED FROM THE DESIGN PROFILE AT THE LOCATION AND STATIONING OF EACH INDIVIDUAL STRUCTURE.
15. AS THE TAIL OF THE RIFFLE APPROACHES THE PROPOSED CROSS VANES, THE CONTRACTOR SHALL CONSTRUCT THE INNER BERM FEATURE SUCH THAT IT GRADUALLY REDUCES AND FANS OUT/TAPERS INTO THE BACKSIDE OF THE VANE ARM AND DOES NOT IMPEDE OR BLOCK THE FLOW OF WATER THROUGH THE THROAT OF THE CROSS VANE.



PROFILE VIEW



CROSS-SECTION VIEW



PLAN VIEW

CONSTRUCTED RIFFLE WITH LOGS NOTES:

1. AFTER ROCK AND GRAVEL SOURCES HAVE BEEN EITHER BROUGHT TO THE SITE OR FOUND IN THE EXISTING STREAM, A TYPICAL CONSTRUCTION SEQUENCE IS AS FOLLOWS:
   a. BANK CLEARING, SURVEY STAKING AT THE HEEL, CREST (ELEVATION) AND TOE, PLACING A ROW OF LARGE ROCK ACROSS A TRENCH AT THE RIFFLE CREST (LARGE ROCKS TO PROTRUDE NO MORE THAN 6 IN. AND GAPS SPACING EQUAL TO 0.5 FT), PLACING A SECOND BACK UP ROW OF SLIGHTLY SMALLER ROCKS DOWNSTREAM, IN-FILLING RIFFLE VOLUME WITH A RANGE OF ROCK SIZES AND IN-FILLING THE SPACES BETWEEN ROCKS WITH COBBLES AND GRAVELS SO THERE ARE NO VOIDS IN THE RIFFLE STRUCTURE, FINISHING THE UPPER SURFACE OF THE DOWNSTREAM FACE WITH LARGER EMERGENT ROCKS TO CREATE 4 OR 5 FLOW PATHS THROUGH THE RIFFLE (OFTEN ROUNDED ROCKS).
   b. BOULDERS SHALL BE PLACED IN RANDOM PATTERNS THAT REPLICATE NATURAL STREAM CONDITIONS AS DIRECTED BY THE PROJECT ENGINEER.
   c. A GRADED MIX OF SMALLER DIAMETER COBBLES AND GRAVELS WILL FORM THE MATRIX OF THE RIFFLE (SEE GRADATION ON THIS SHEET).
   d. LOGS (18” MIN DIAMETER) ARE TO BE PLACED AT 20-30 DEGREE ANGLE WITH THE CHANNEL AND SLOPED FROM THE BED SURFACE AT 1%-2%. THE LOGS SHALL BE KEYED INTO THE BANK MINIMUM OF 4 FT. LOGS SHALL EXTEND INTO THE CHANNEL 10 FT. FROM THE EDGE OF THE BENCH. LOGS SHALL BE ANCHORED WITH BOULDERS. “POCKET POOL” AREAS SHALL BE CREATED ON THE DOWNSTREAM SIDE OF THE LOG.
   e. REINFORCED BED MATERIAL SHALL BE PLACED ALONG THE ENTIRE RESTORED CHANNEL UPSTREAM AND DOWNSTREAM OF THE LOG VANES, WITH THE GEOTEXTILE FABRIC BETWEEN THE STREAM BED MATERIAL AND ANCHOR ROCKS AND LOG VANES.

- HEADER BOULDERS SHALL BE 3FT.
- RIVER BOULDERS PLACED ON RIFFLE SURFACE SHALL BE 375 MM.

EXAMPLE RIFFLE SECTION

SHOWN FOR INFORMATION ONLY

CONSTRUCTED RIFFLE WITH LOGS DETAIL

N.T.S.

EXAMPLE CONSTRUCTED RIFFLE

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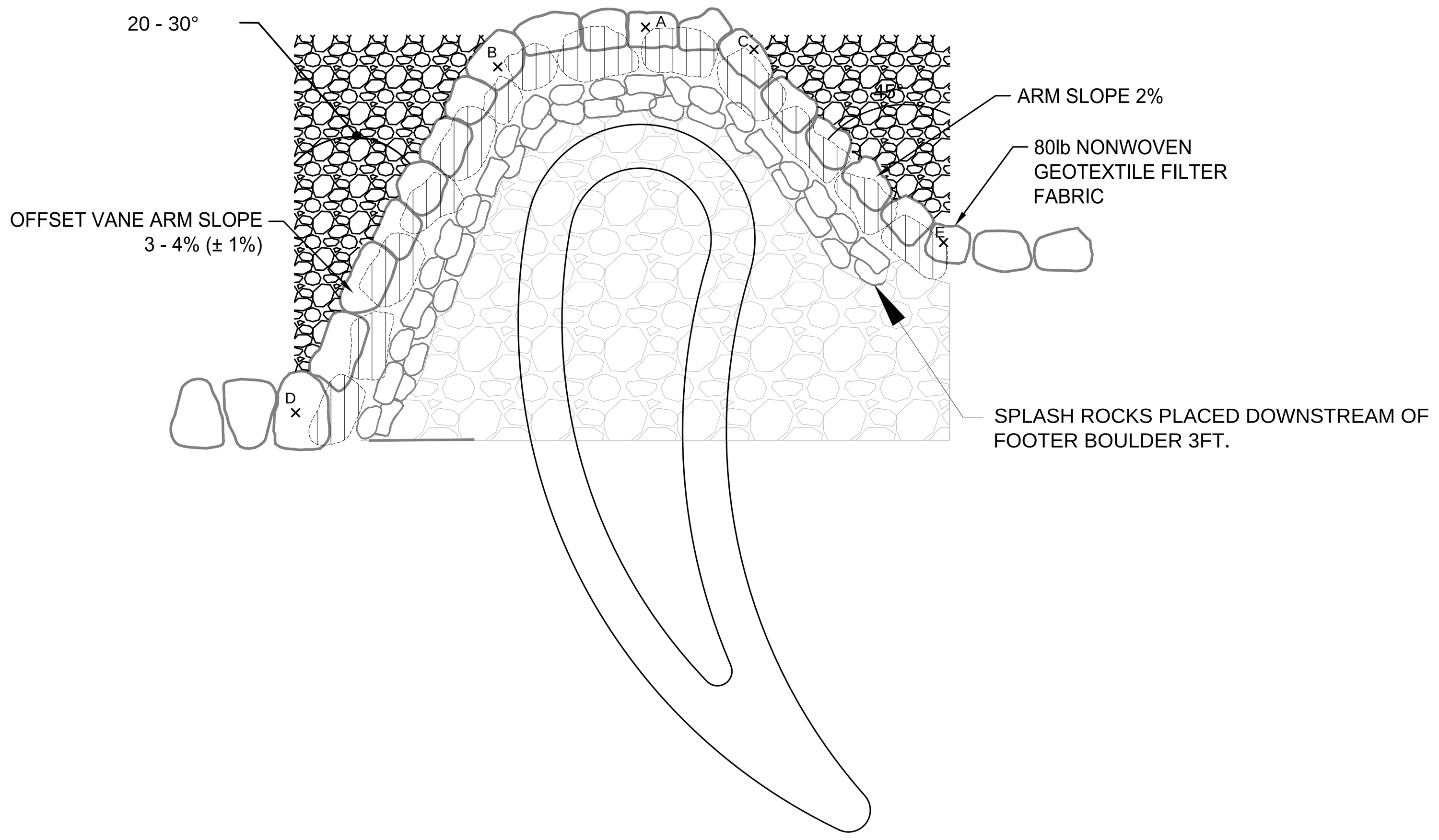
APPROVED BY: MTB
SCALE: AS NOTED

PROJECT: STRAWBERRY RUN STREAM RESTORATION
207 FORT WILLIAMS PARKWAY
ALEXANDRIA, VA 22304

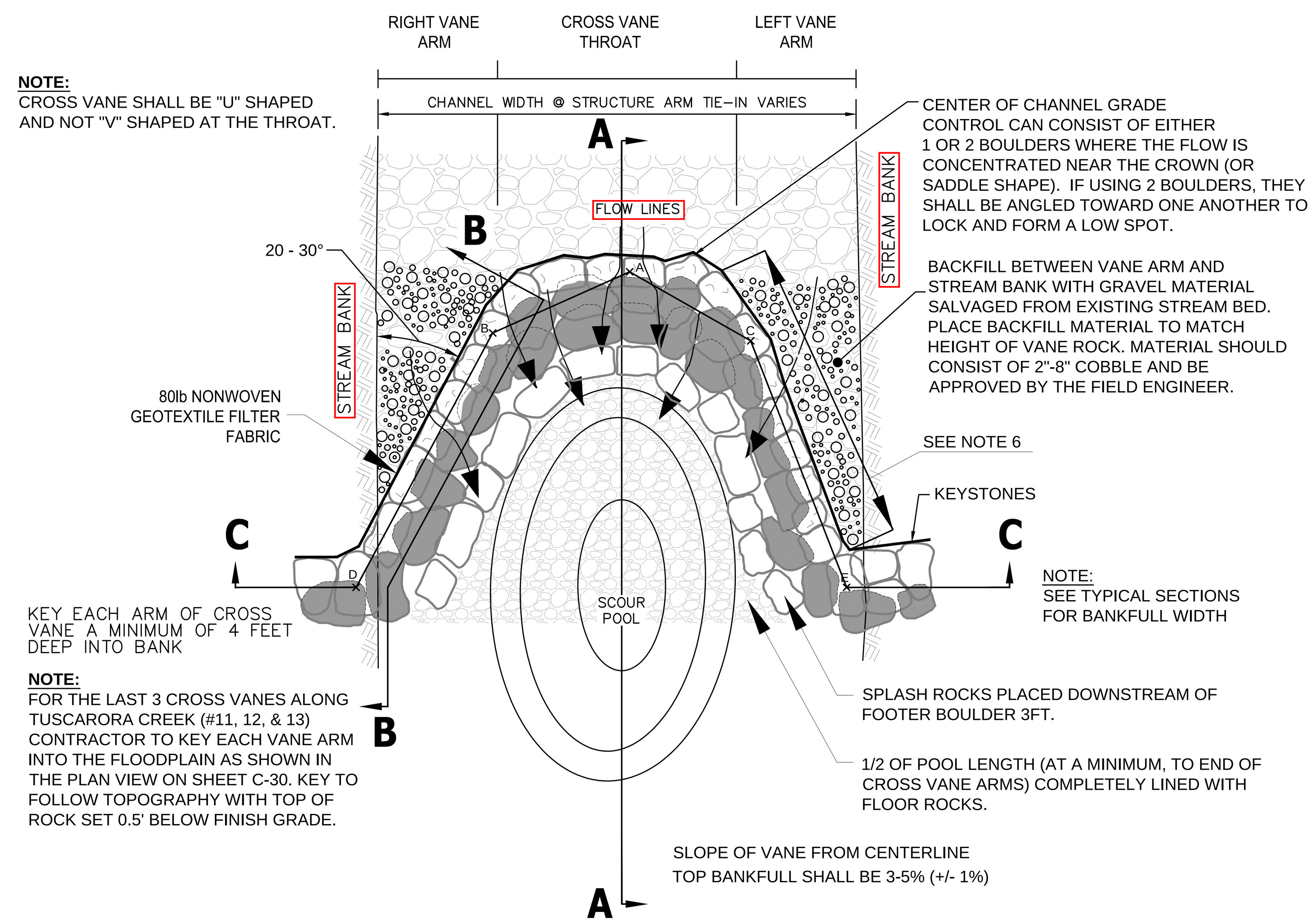
SHEET TITLE: CONSTRUCTED RIFFLE DETAIL

PROJECT NO.: 7526173001
DATE: 21 AUGUST 2018
DWG. SIZE: ARCH D
SHEET NUMBER: 06 OF 12

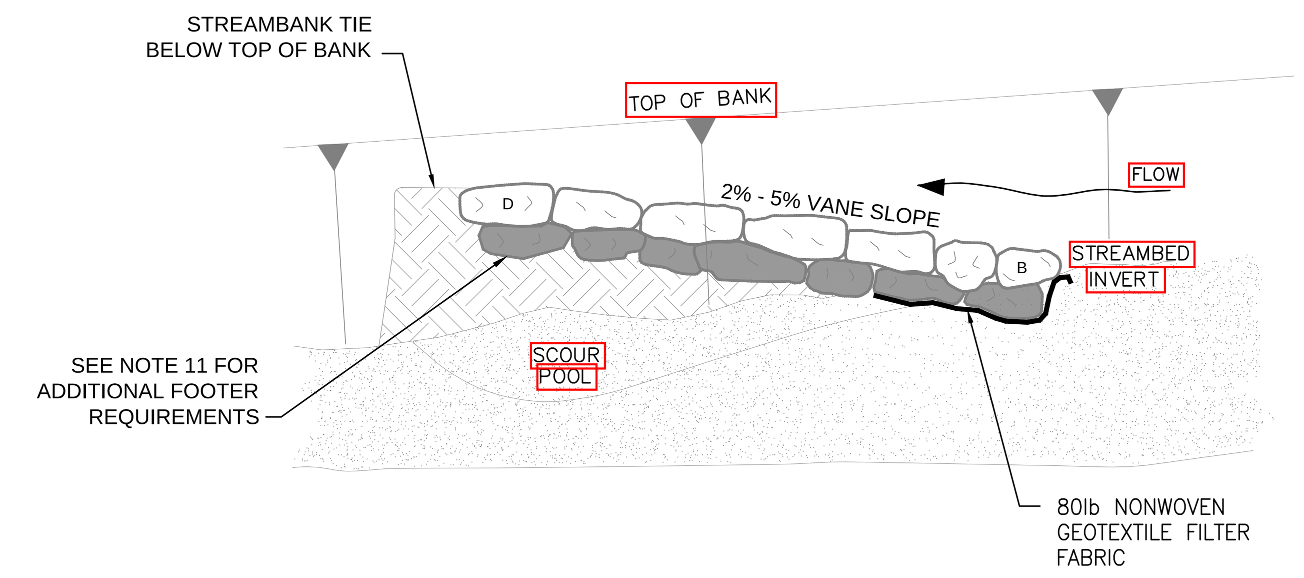


PLAN VIEW
OFFSET CROSS VANE

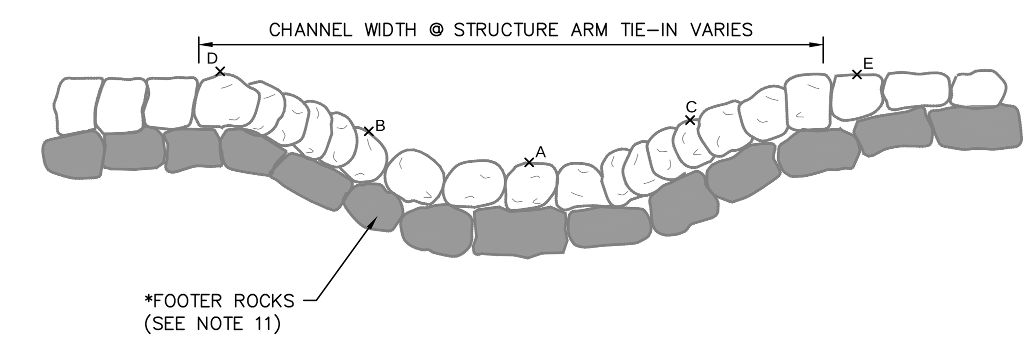
CROSS VANE - PLAN VIEW



PLAN VIEW



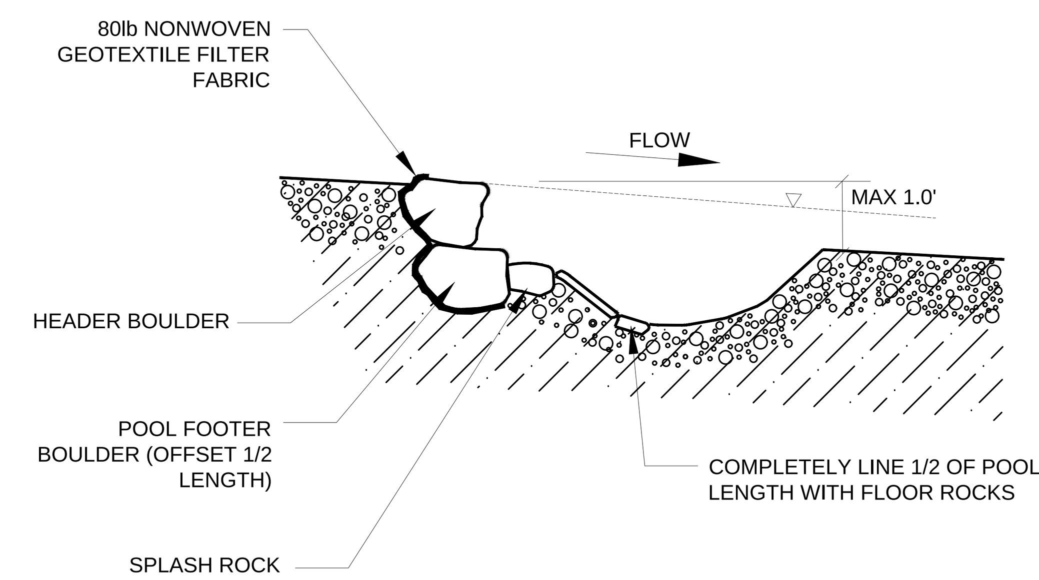
SECTION B-B
PROFILE OF VANE ARM



SECTION C-C
CROSS SECTION THROUGH CENTER OF CROSS VANE

CROSS VANE NOTES

1. ALL STONES ARE TO BE STRUCTURE STONE. STRUCTURE STONE IS DEFINED AS BLOCK LIKE, CUBICAL, OR STRAIGHT EDGED BOULDERS.
2. GAPS BETWEEN BOULDERS SHALL BE MINIMIZED BY FITTING BOULDERS TOGETHER, PLUGGING WITH STRUCTURE STONE CLASS A AND NO.57 OR CHINKING STONE, AS APPROVED BY THE TOWN OF LEESBURG, AND LINING WITH FILTER FABRIC.
3. DIMENSIONS AND SLOPES MAY BE ADJUSTED TO FIT BY THE TOWN OF LEESBURG'S QUALIFIED REPRESENTATIVE.
4. CONTRACTOR WILL BE REQUIRED TO FIT BOULDERS TIGHTLY.
5. FOOTER BOULDERS AND VANE BOULDERS SHALL BE NATIVE STONE OR SHOT ROCK, CUBICAL OR RECTANGULAR IN NATURE.
6. THE SLOPE OF THE VANE ARM FROM CENTERLINE ELEVATION TO THE TIE-IN AT THE BANK SHALL BE 2-5%.
7. THERE SHALL BE NO DROP GREATER THAN 1.0 FOOT. VERTICAL TOLERANCE SHALL BE 0.1' FOR CROSS VANE STRUCTURES.
8. THE ELEVATION OF EACH GRADE CONTROL STRUCTURE SHOULD BE EQUAL TO OR GREATER THAN THE ELEVATION OF THE TOP OF THE FOOTER BOULDER DIRECTLY UPSTREAM.
9. FILTER FABRIC SHALL BE PLACED ON THE UPSTREAM SIDE OF THE STRUCTURE TO PREVENT WASHOUT OF SEDIMENT THROUGH BOULDER GAPS. FILTER FABRIC SHALL EXTEND FROM THE BOTTOM OF THE FOOTER BOULDER TO THE FINISHED GRADE ELEVATION AND SHALL BE PLACED THE ENTIRE LENGTH OF STRUCTURE.
10. ½ THE POOL LENGTH OR POOL LENGTH TO THE END OF THE CROSS VANE ARMS (WHICHEVER IS GREATER) IS TO BE LINED WITH FLOOR ROCKS. SPLASH ROCKS SHALL EXTEND A MINIMUM LENGTH OF 3 FEET DOWNSTREAM OF THE FOOTER BOULDERS AND BE PLACED TO PROVIDE A ROUGH SURFACE SUCH THAT ROCK EDGES PROTRUDE 0.3 TO 0.5 FT ABOVE THE BED SURFACE.
11. IF BEDROCK IS PRESENT DIRECTLY BELOW SURFACE BOULDER, FOOTING MAY NOT BE NECESSARY. HOWEVER, BASED ON THE DEPTH TO BEDROCK, ADDITIONAL FOOTER BOULDERS MAY BE REQUIRED IN ORDER TO SEAT FOOTERS ON BEDROCK. CHIP BEDROCK 0.5' FOR PLACEMENT AND SEAT FOOTER BOULDERS IN BEDROCK AT THE DIRECTION OF THE FIELD ENGINEER. IF BEDROCK IS NOT ENCOUNTERED, ADDITIONAL FOOTER BOULDERS MAY BE REQUIRED. IN THIS CASE THE ADDITIONAL TIER OF FOOTER BOULDERS SHALL EXTEND BELOW THE MAX SCOUR DEPTH (CHANNEL INVERT).
12. AS THE TAIL OF RIFFLE APPROACHES THE PROPOSED CROSS VANES, THE CONTRACTOR SHALL CONSTRUCT THE INNER BERM FEATURE SUCH THAT IT GRADUALLY REDUCES AND FANS OUT/TAPERS INTO THE BACKSIDE OF THE VANE ARM AND DOES NOT IMPEDE OR BLOCK THE FLOW OF WATER THROUGH THE THROAT OF THE CROSS VANE.



SECTION A-A
PROFILE THROUGH CENTER OF CROSS VANE

EXAMPLE ROCK CROSS VANE
(SHOWN FOR INFORMATION ONLY)

EXAMPLE OFFSET ROCK CROSS VANE
(SHOWN FOR INFORMATION ONLY)

STRAWBERRY RUN CONCEPT DESIGN

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CLIENT: CITY OF ALEXANDRIA, 301 KING STREET, ALEXANDRIA, VA 22314

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DRAWN BY: CAL
CHECKED BY: MTB
APPROVED BY: MTB
SCALE: AS NOTED

PROJECT: STRAWBERRY RUN STREAM RESTORATION, 207 FORT WILLIAMS PARKWAY, ALEXANDRIA, VA 22304

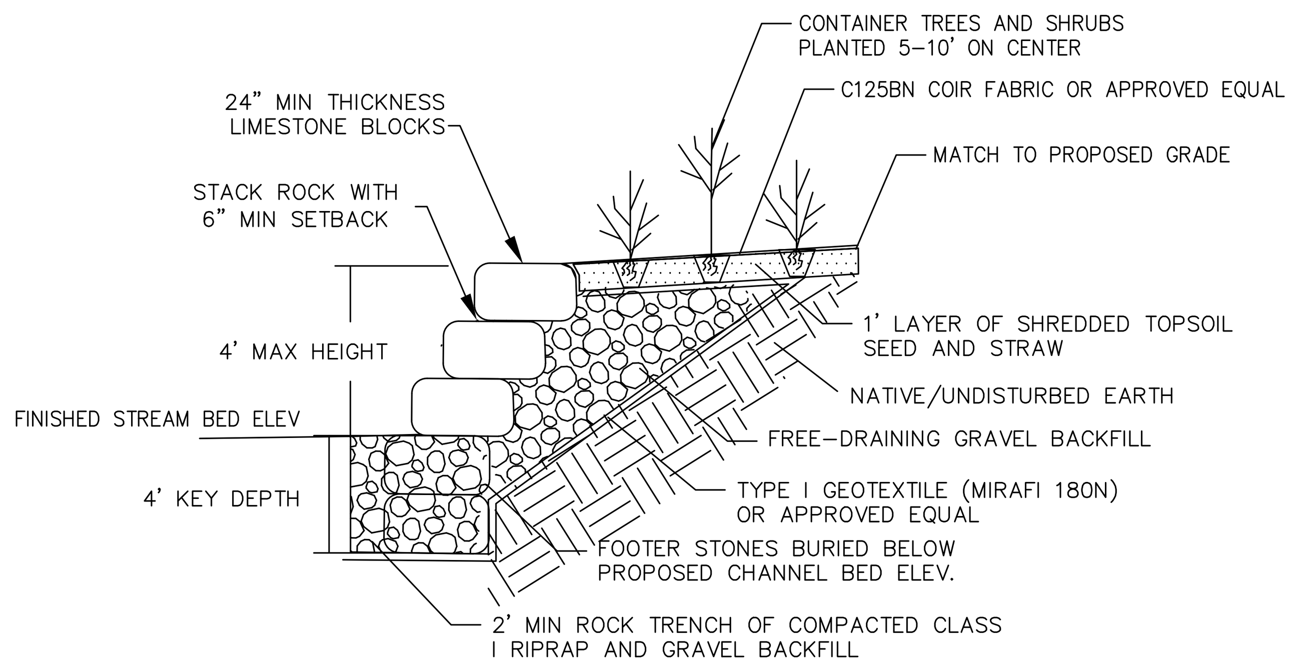
SHEET TITLE: ROCK CROSS VANE DETAILS

PROJECT NO.: 7526173001
DATE: 21 AUGUST 2018
DWG. SIZE: ARCH D
SHEET NUMBER: 07 OF 12

PLOTTED BY:LASH, CHRISTA SHEET SET: Alexandria Concepts LAYOUT:ROCK CROSS VANE DETAILS August 21, 2018 04:00:59pm \\CHY-FS1\CAD_PROJECTS\7526173001_ALEXANDRIA STREAM ASSESS\PLANSHEETS\05-CONCEPT DETAILS.DWG

ROCK TOE REVETMENT - PLAN VIEW

NTS



IMBRICATED ROCK WALL

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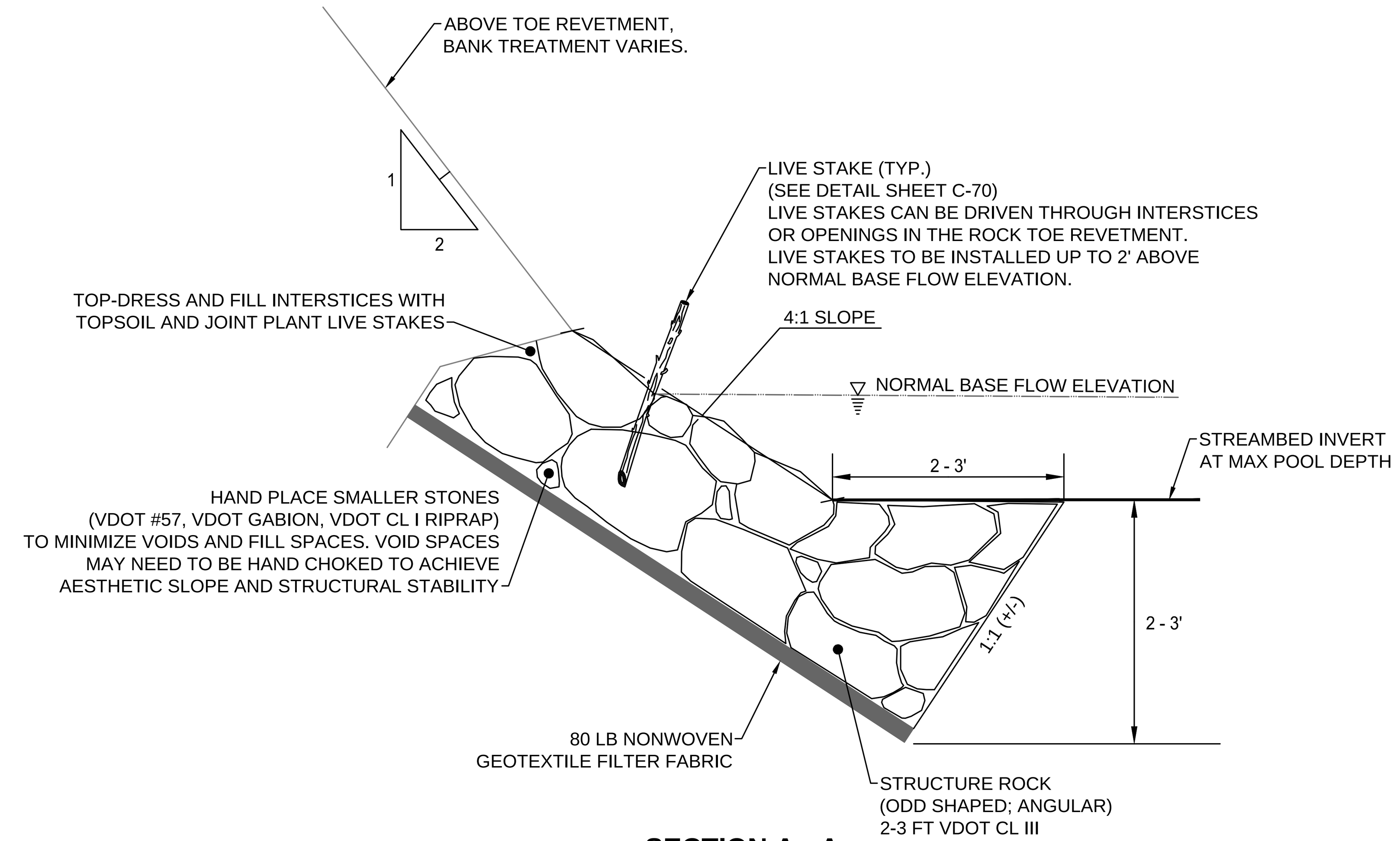
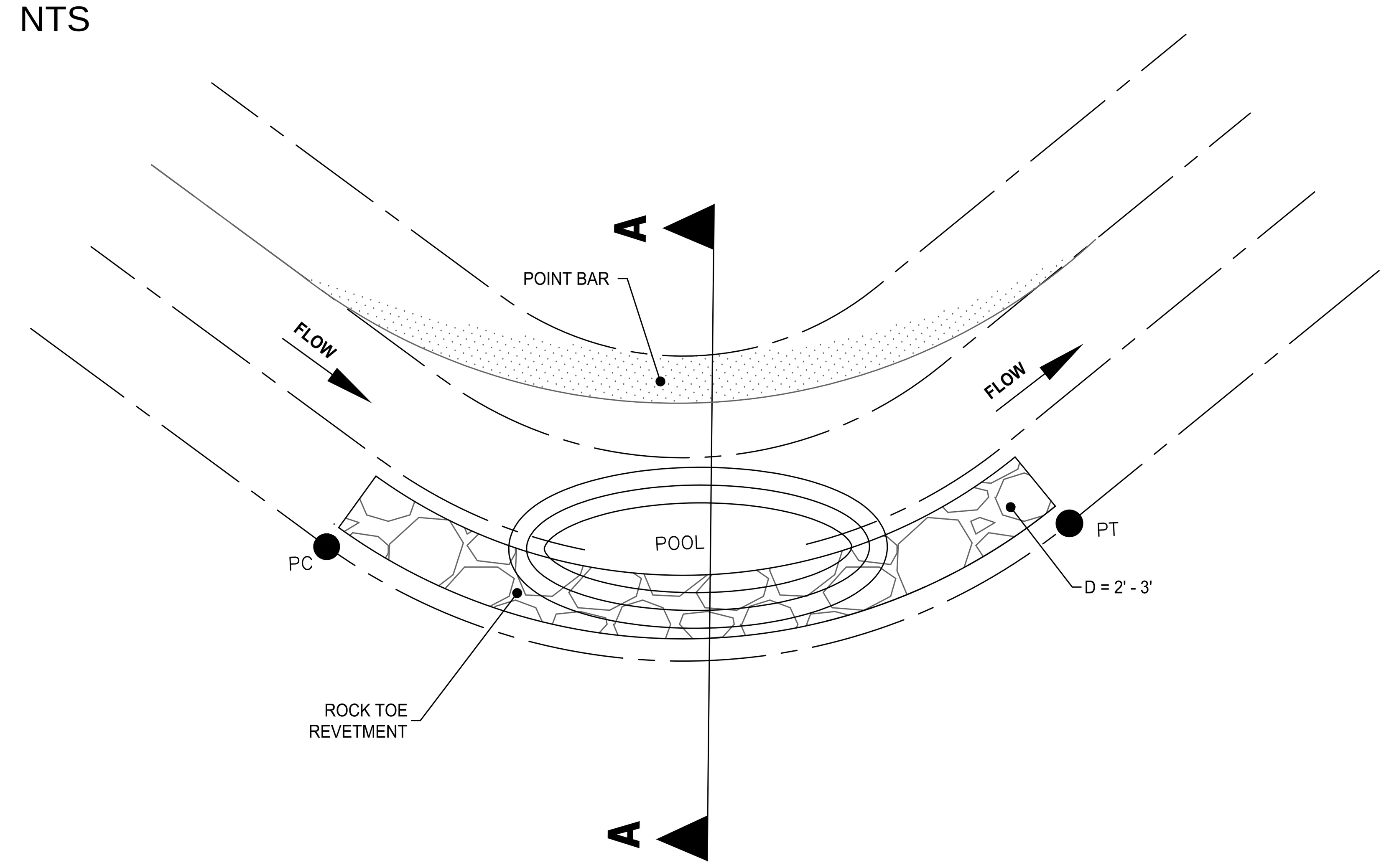


SECTION A - A



EXAMPLE IMBRICATED ROCK WALL

(SHOWN FOR INFORMATION ONLY)

EXAMPLE ROCK TOE REVETMENT

(SHOWN FOR INFORMATION ONLY)

ROCK TOE REVETMENT NOTES:

1. ALL STRUCTURE ROCK TOE SHALL BE 2-3 FT DIAMETER BOULDER (LARGE ANGULAR ODD SHAPED) OR APPROVED BY THE ENGINEER BEFORE INSTALLATION.
2. ROCK TOE SHALL BE PLACED SUCH THAT MATERIALS LOCK TOGETHER.
3. SELECT BACKFILL AND SOIL BACKFILL MATERIAL SHALL BE COMPACTED SUCH THAT FUTURE SETTLEMENT OF THE MATERIAL IS KEPT TO A MINIMUM.
4. ASSUMED ROCK DENSITY = 165 LB/FT3.
5. IF BEDROCK IS ENCOUNTERED, SEAT FOOTER REVETMENT IN BEDROCK AT DIRECTION OF THE FIELD ENGINEER.
6. ROCK TOE REVETMENT TO BEGIN AT CROSS VANE ARM AND END AT PT (HEAD OF RIFFLE)
7. CONTRACTOR TO DIG 1" PILOT HOLES FOR PLACEMENT OF LIVE STAKES IN ROCK TOE REVETMENT.
8. CONTRACTOR TO INSTALL ROCK TOE REVETMENT TO A DEPTH 2-3' BELOW MAXIMUM POOL DEPTH INVERT THE ENTIRE LENGTH OF THE ROCK TOE REVETMENT.

INSTALLATION GUIDELINES:

1. EXCAVATE A TRENCH ALONG THE TOE OF THE STREAMBANK TO 2-3 FT BELOW THE STREAMBED INVERT.
2. PLACE FILTER CLOTH ALONG THE BACKSIDE OF THE TRENCH. PLACE FILTER FABRIC LOOSELY AND EVENLY ON THE PREPARED SLOPE AND SECURED WITH STAKES ON 2 FOOT CENTERS. ADJACENT STRIPS SHOULD OVERLAP 12 INCHES AND BE STAPLED ON 12 INCH CENTERS. THE UPSTREAM OR UPSLOPE FILTER FABRIC SHOULD ALWAYS BE PLACED OVER THE DOWNSTREAM OR DOWNSLOPE FILTER FABRIC. IF THE FILTER FABRIC IS TORN OR DAMAGED, IT SHOULD BE REPAIRED OR REPLACED.
3. PLACE STRUCTURE ROCK STARTING IN THE BOTTOM OF THE TRENCH WORKING UP THE BANK. ROCK MAY HAVE TO BE HAND PLACED IN VOIDS TO ACHIEVE THE DESIRED RESULTS OF LOCKING THE REVETMENT.

PLOTTED BY:LASH, CHRISTA SHEET SET:Alexandria Concepts LAYOUT:STACKED ROCK WALL AND ROCK TOE August 21, 2018 04:01:03pm \\CHY-FS1\CAD_PROJECTS\7526173001_ALEXANDRIA STREAM ASSESS\PLANSHEETS\05-CONCEPT DETAILS.DWG

STRAWBERRY RUN CONCEPT DESIGN

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DRAWN BY:	CAL
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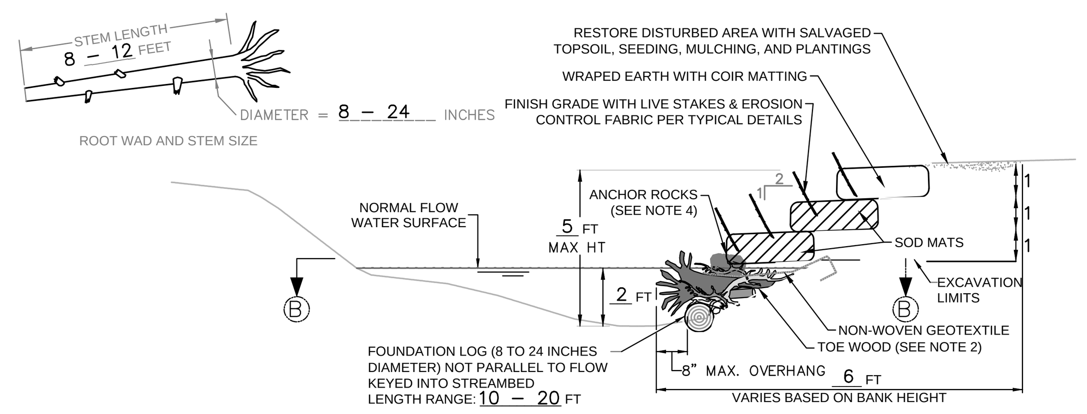
APPROVED BY:	MTB
SCALE:	AS NOTED

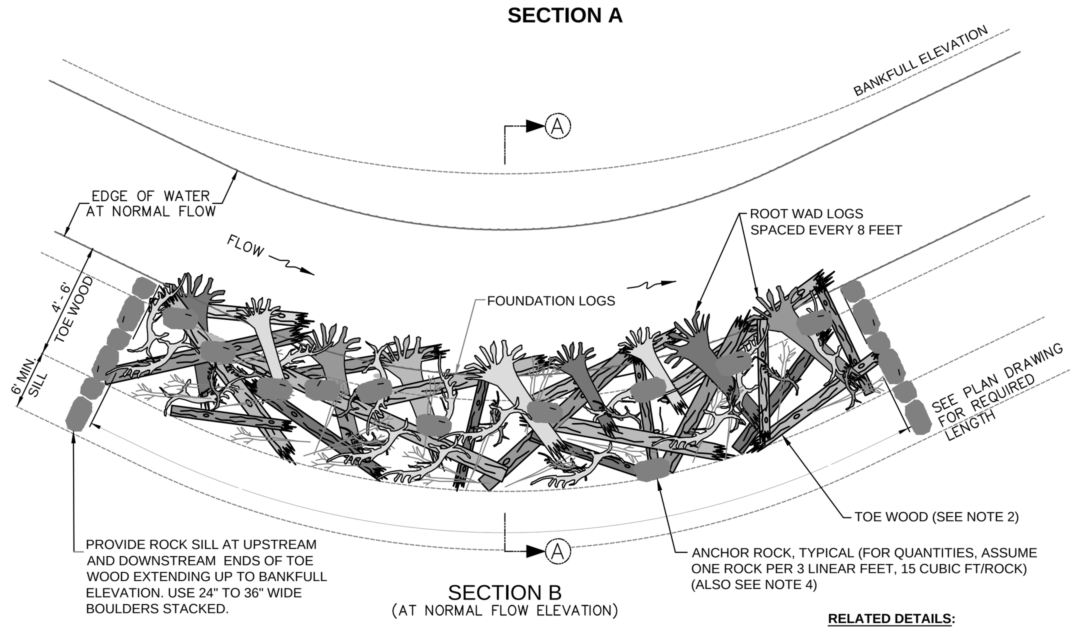
PROJECT:
STRAWBERRY RUN STREAM RESTORATION
207 FORT WILLIAMS PARKWAY
ALEXANDRIA, VA 22304

SHEET TITLE:
STACKED ROCK WALL AND ROCK TOE

PROJECT NO.:	7526173001
DATE:	21 AUGUST 2018
DWG. SIZE	ARCH D
SHEET NUMBER:	08 OF 12



SECTION A



SECTION B
(AT NORMAL FLOW ELEVATION)

RELATED DETAILS:

- LIVE STAKES
- EROSION CONTROL FABRIC
- STREAMBANK SHAPING

TYPICAL TOE WOOD WITH BANK SHAPING IN BEND

NOT TO SCALE

NOTES:

1. PLACE THE TOP OF TOE WOOD AT OR WITHIN ONE FOOT OF THE ESTABLISHED NORMAL FLOW ELEVATION.
2. TOE WOOD CONSISTS OF A MIX OF "DEAD WOOD" LOGS, BRANCHES, SHRUBS, AND OTHER WOODY VEGETATION INSTALLED AT VARIOUS ANGLES, BUT NOT PARALLEL TO THE FLOW. LAYER THE WOOD WITH LARGER MATERIAL ON BOTTOM AND FORM A MAT OF BRANCHES ON TOP LAYER. ANGLE ROOT WADS SLIGHTLY UPSTREAM INTO FLOW.
3. FILL BETWEEN ROOT WAD LOGS WITH MIX OF WOODY DEBRIS PER NOTE 2.
4. PROVIDE ANCHOR ROCKS TO WEIGHT DOWN LARGER SIZE LOGS. USE A MINIMUM ROCK SIZE OF 2.0 FT MEDIAN DIAMETER.

TYPICAL USES:

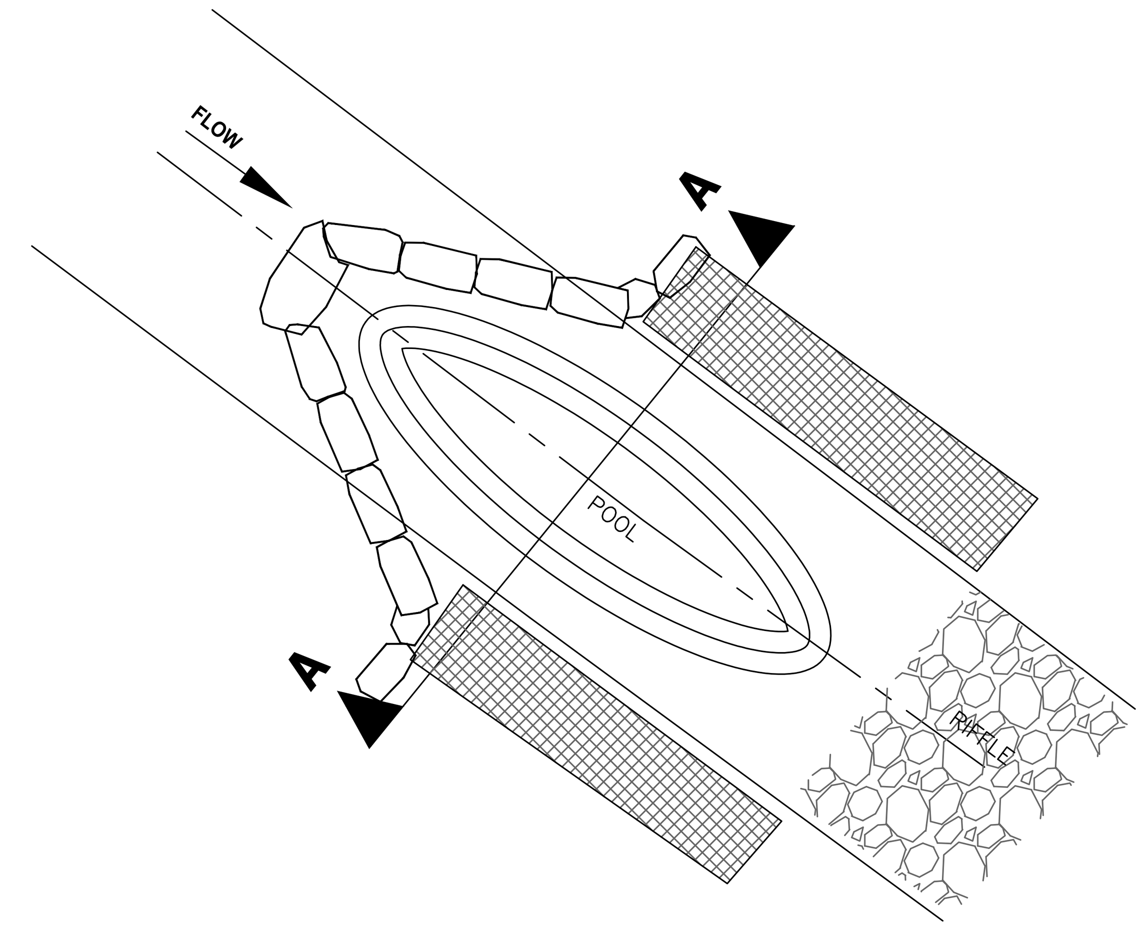
- PROVIDES EXCELLENT AQUATIC HABITAT BY INTRODUCING ORGANIC MATTER AND COVER TO THE RIPARIAN ENVIRONMENT.
- REDUCES NEAR BANK SHEAR STRESS, WHICH STOPS OR SLOWS BANK EROSION, REDUCES SEDIMENT LOAD, AND SAVES SOIL.
- REINFORCES STREAMBANK USING VEGETATION THAT STRENGTHENS THE BANK OVER TIME.

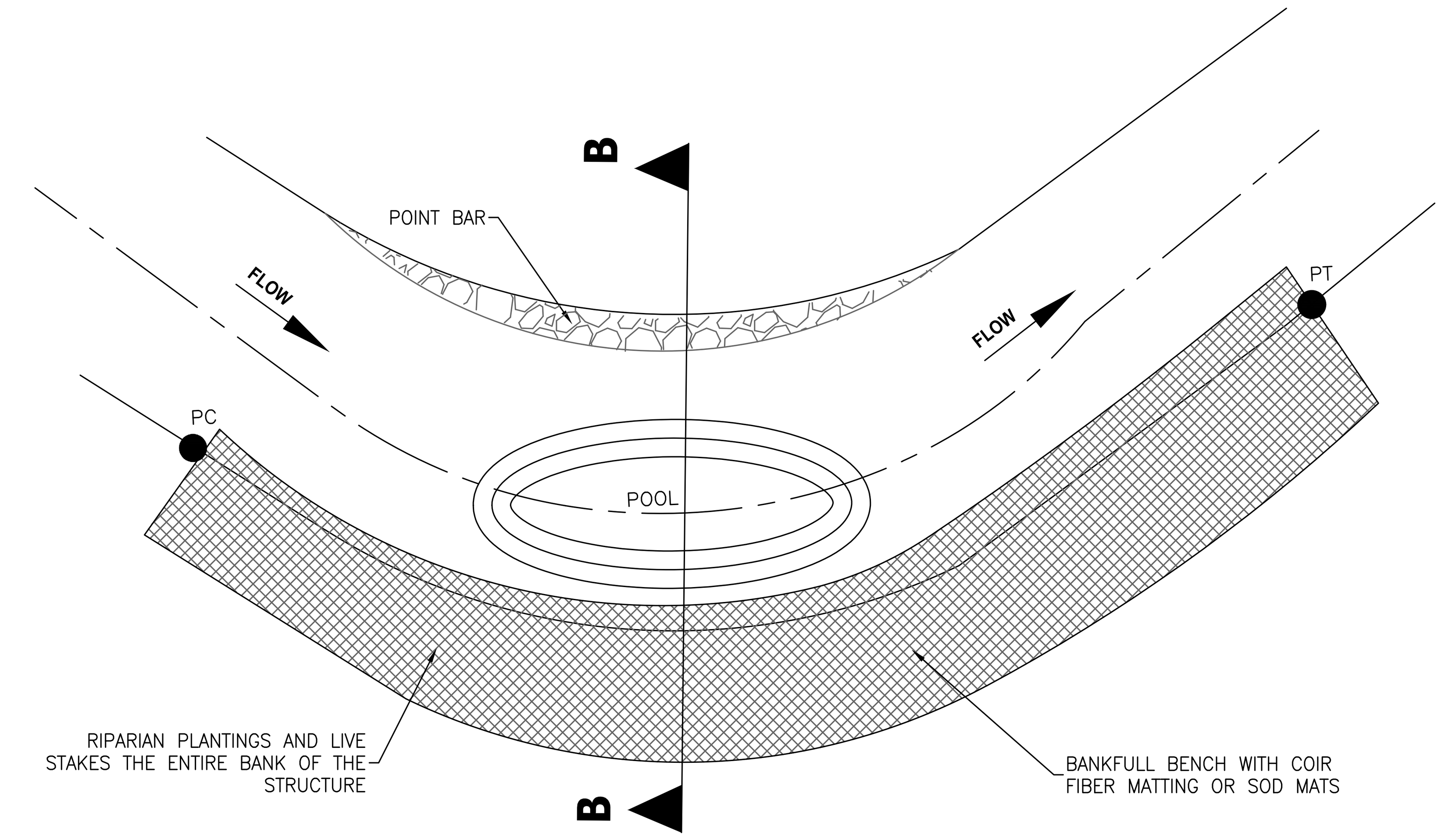
EXAMPLE TOE WOOD

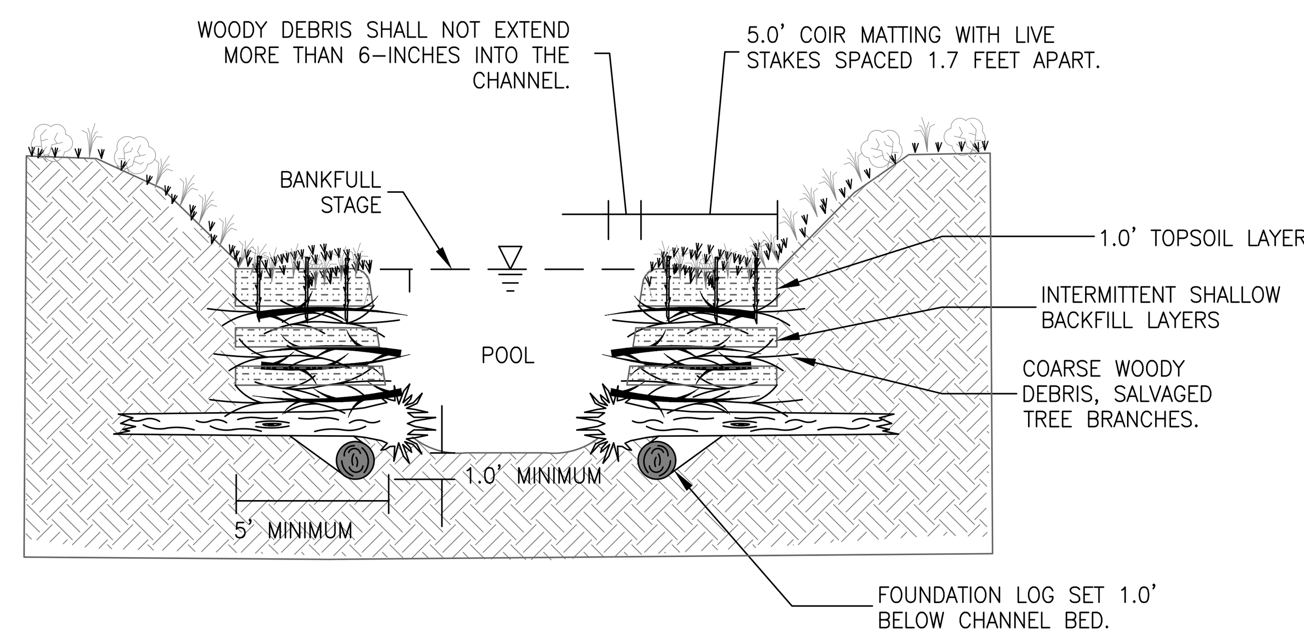
EXAMPLE ROCK WALL WITH TOE WOOD

TOE WOOD - PLAN VIEW

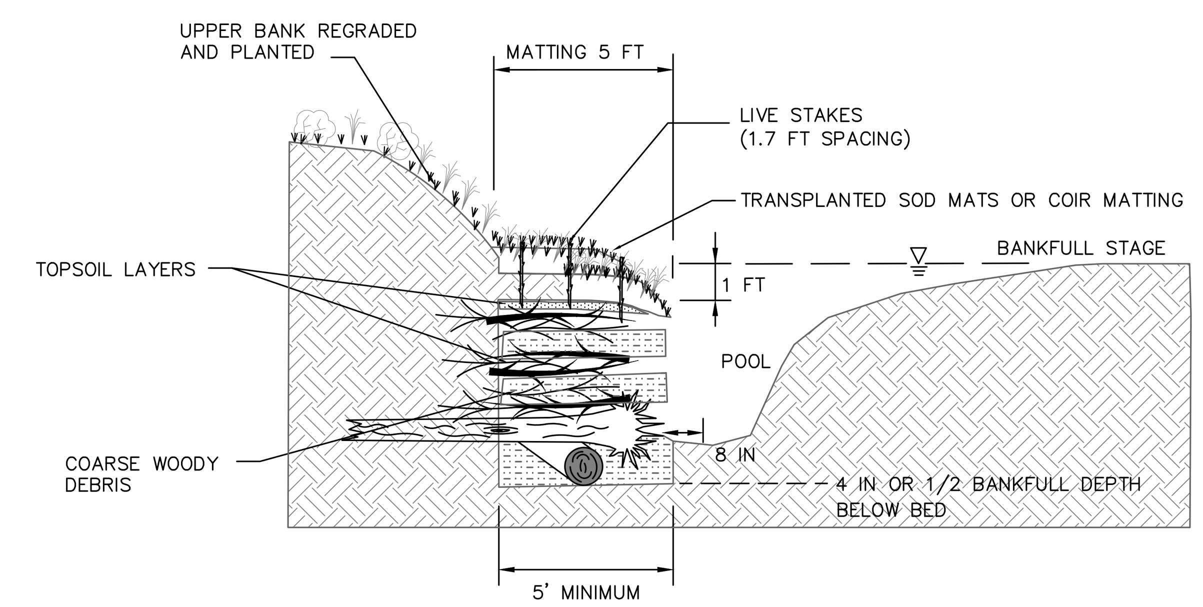
NTS







SECTION A-A



SECTION B-B

TOE WOOD STRUCTURE NOTES:

1. SALVAGE TREE TOPS AND BRANCHES FROM FALLEN ON-SITE TREES FOR RE-USE AS COARSE WOODY DEBRIS.
2. MIX LAYERS OF TOPSOIL ON TOP OF COARSE WOODY DEBRIS.
3. FOR THE BOTTOM LAYER, INSTALL LIVE STAKES ON TOP OF COARSE WOODY DEBRIS AND COVER WITH A LAYER OF TOPSOIL. THIS SHALL BE AT A DEPTH OF 4 INCHES OR 1/2 BANKFULL, BELOW THE BOTTOM OF THE BED.
4. WOODY DEBRIS SHALL NOT EXTEND INTO THE CHANNEL MORE THAN 8 INCHES.
5. ON STRAIGHT POOL SECTIONS, TOE WOOD SHALL EXTEND FROM END OF VANE ARMS TO HEAD OF RIFFLE.

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STRAWBERRY RUN CONCEPT DESIGN

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CLIENT:
CITY OF ALEXANDRIA
301 KING STREET
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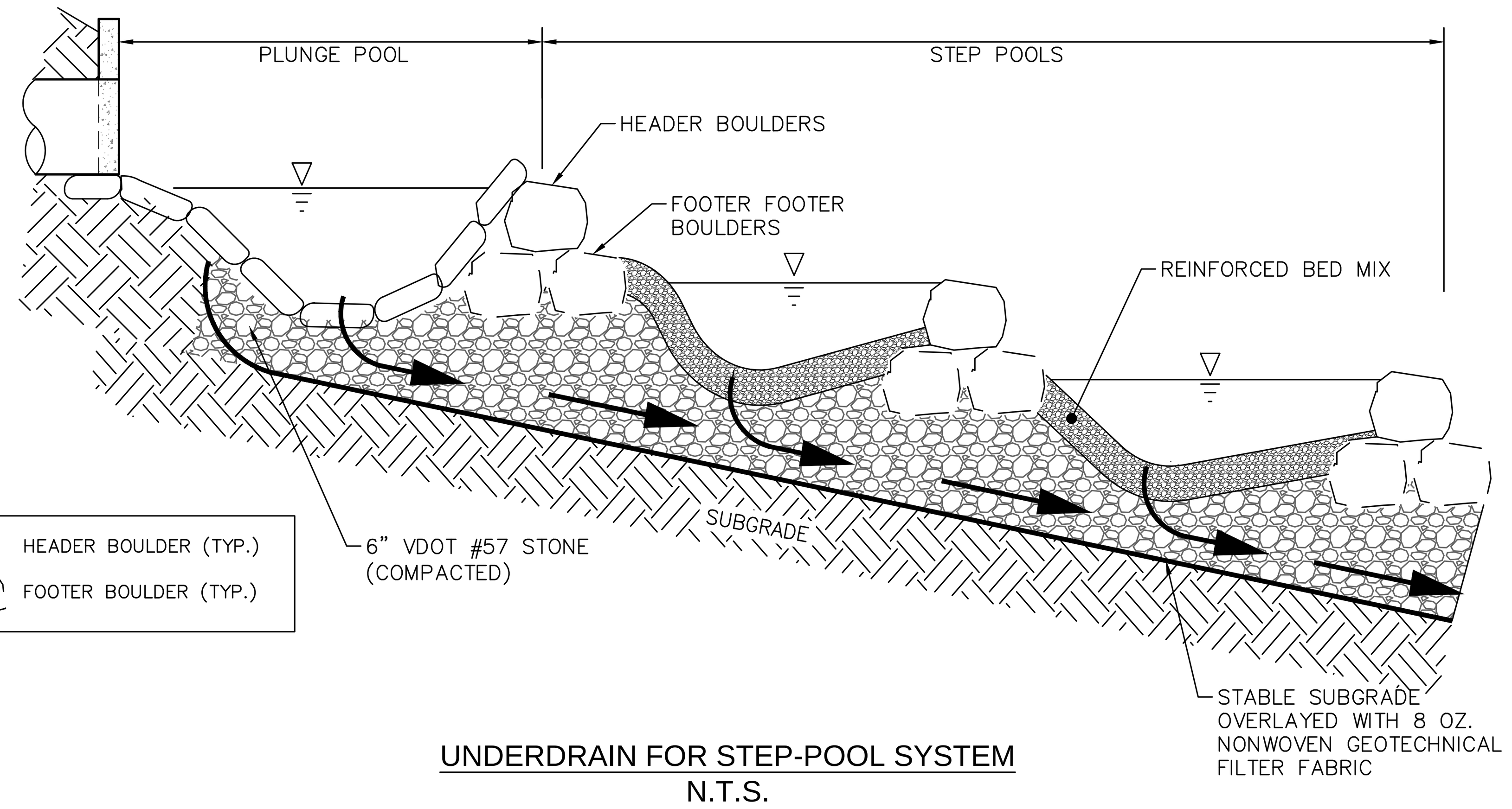
APPROVED BY:	MTB
SCALE:	AS NOTED

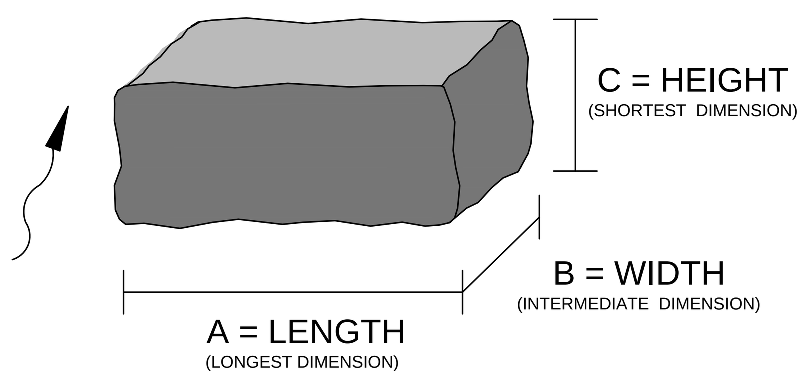
PROJECT:
STRAWBERRY RUN STREAM RESTORATION
207 FORT WILLIAMS PARKWAY
ALEXANDRIA, VA 22304

SHEET TITLE:
TOE WOOD DETAILS

PROJECT NO.:	7526173001
DATE:	21 AUGUST 2018
DWG. SIZE	ARCH D
SHEET NUMBER:	09 OF 12



UNDERDRAIN FOR STEP-POOL SYSTEM
N.T.S.



NOTE: MINIMUM A AND B DIMENSIONS FOR ALL BOULDERS SHALL BE 1.5 FT. BACKFILL COMPACTED TO 90% MAXIMUM STANDARD PER STANDARD PROCTOR AASHTO T-99 OR ASTMD 698 SHALL BE PLACED AS CHANNEL BACKFILL IN 8" LOOSE LIFTS. BEFORE PLACEMENT OF BACKFILL, CHANNEL SHALL BE EXCAVATED TO A STABLE SUBGRADE (APPROVED BY CITY OF AUSTIN ON-SITE ENGINEER). FOOTER BOULDERS MUST HAVE ATLEAST ONE CONTACT POINT WITH HEADER BOULDERS, AND MAY BE MORE ROUNDED THAN HEADER. FOR VANE ARMS, MULTIPLE FOOTERS MAY BE REQUIRED FOR HEADER STONE DEPENDING UPON HEADER BOULDER SIZE AND DEPTH TO STABLE SUBGRADE.

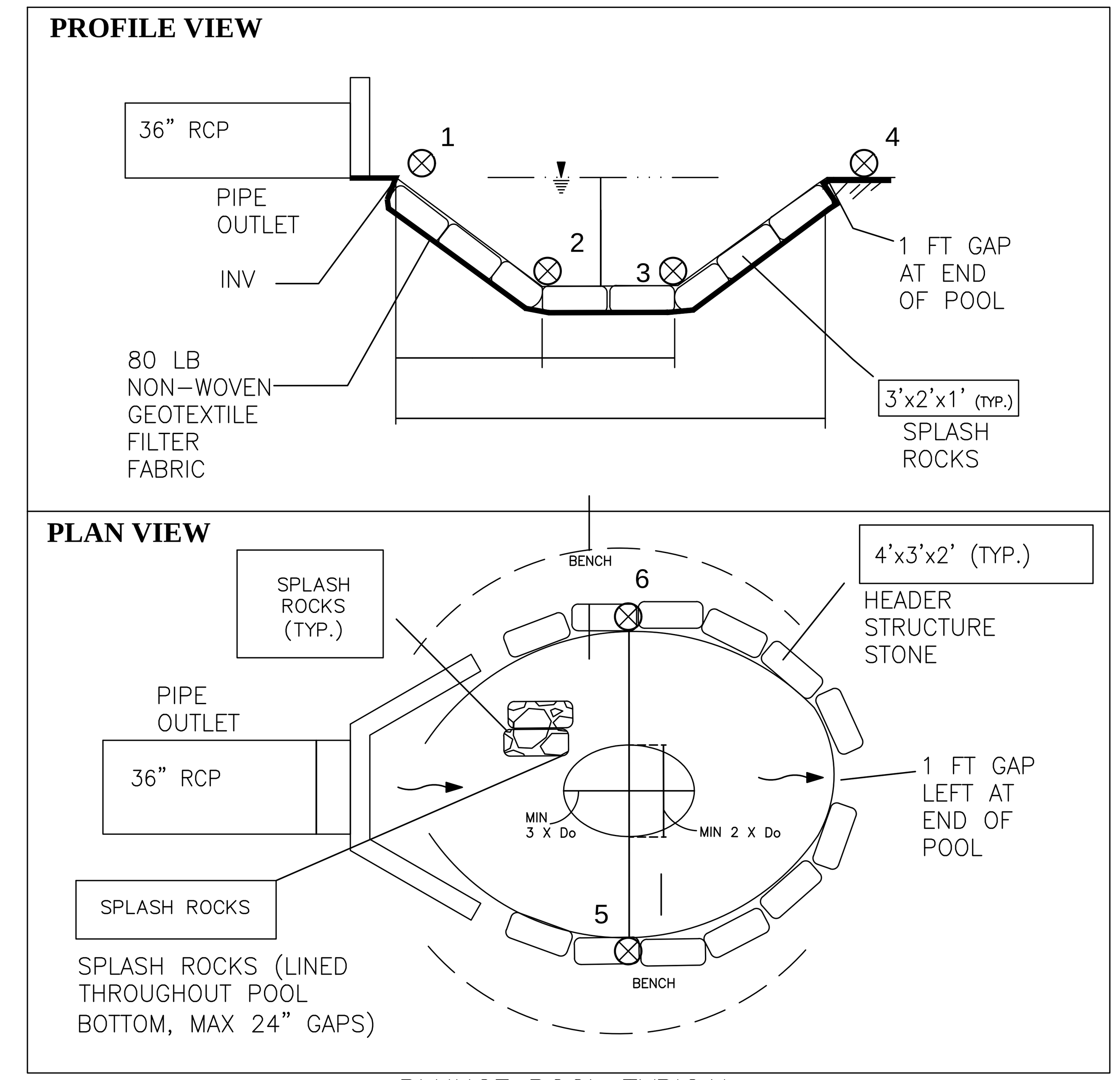
STRUCTURE DIMENSIONS

STRUCTURE SIZE TABLE		A	B	C
STRUCTURES	HEADER BOULDER/ VANE ARMS	4'	3'	2'
	FOOTER BOULDER	4'	3'	2'
	SPLASH ROCKS	3'	2'	1'
CHANNEL BED MATERIAL SPECS				
REINFORCED BED MIX	SPLASH BOULDERS (TYP. 3' X 2' X 1') VOID SPACES AND 2.5 FT DEPTH FILLED WITH MIX OF #57 (2 PARTS), GABION STONE (1 PART), AND COA CLASS IV RIPRAP (1 PART). EXISTING ON-SITE RIPRAP HARVESTED FROM EXISTING CHANNEL MAY BE USED TO SUPPLEMENT THE BED MIX.			
SELECT BACKFILL	COMPACTED TO 90% PER MAXIMUM STANDARD PROCTOR DENSITY AASHTO T-99 OR ASTMD 698			

CONSTRUCTED STEP POOL SYSTEMS
(SHOWN FOR INFORMATION ONLY)

PLUNGE POOL (FIRST POOL BELOW PIPE OUTFALL)
NTS

CONSTRUCTED PLUNGE POOL
(SHOWN FOR INFORMATION ONLY)



PLUNGE POOL TYPICAL DETAIL
N.T.S.

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APPROVED BY: MTB
SCALE: AS NOTED

PROJECT: STRAWBERRY RUN STREAM RESTORATION
207 FORT WILLIAMS PARKWAY
ALEXANDRIA, VA 22304

SHEET TITLE: PLUNGE & STEP POOL DETAILS

PROJECT NO.: 7526173001
DATE: 21 AUGUST 2018
DWG. SIZE: ARCH D
SHEET NUMBER: 10 OF 12

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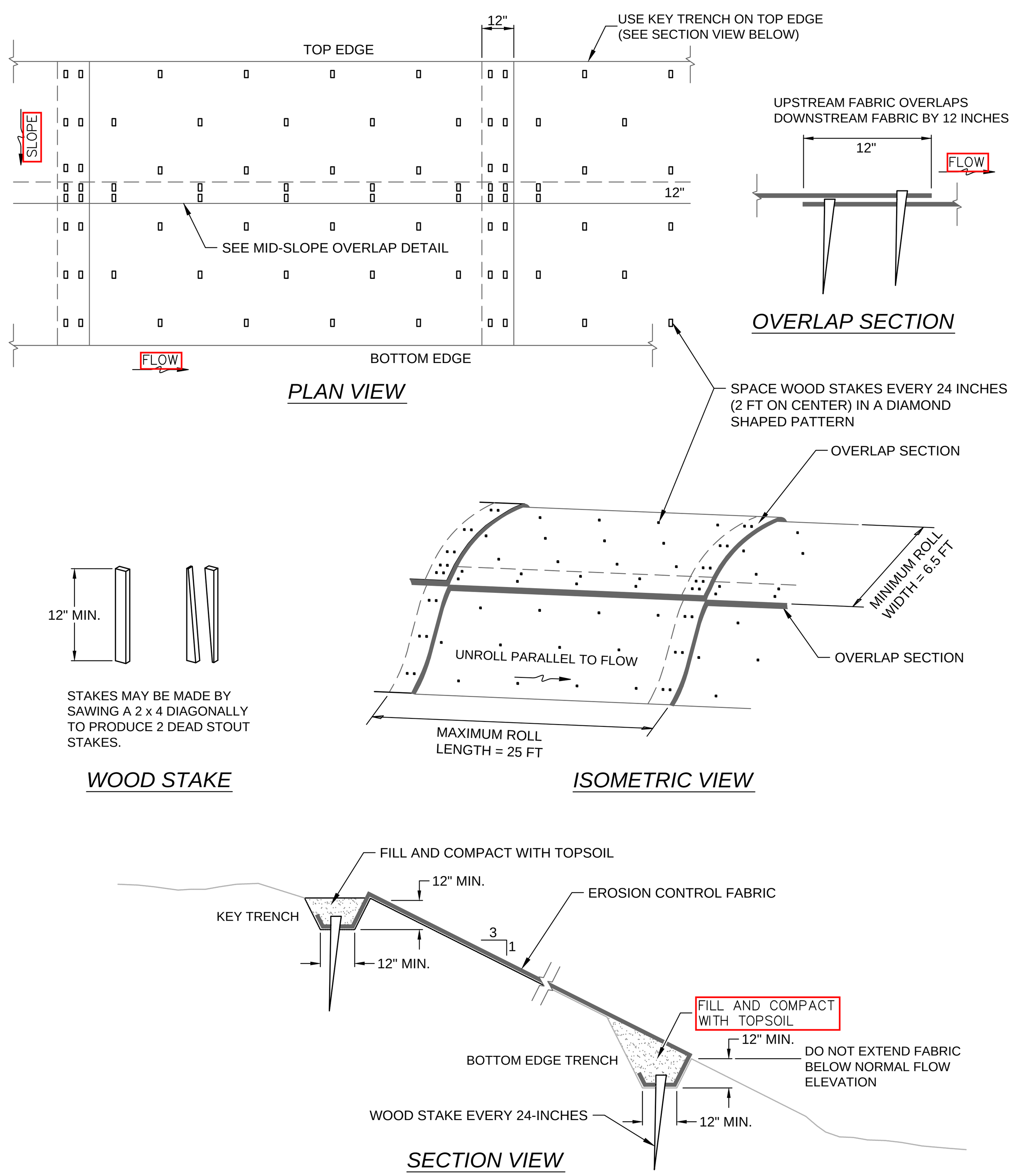
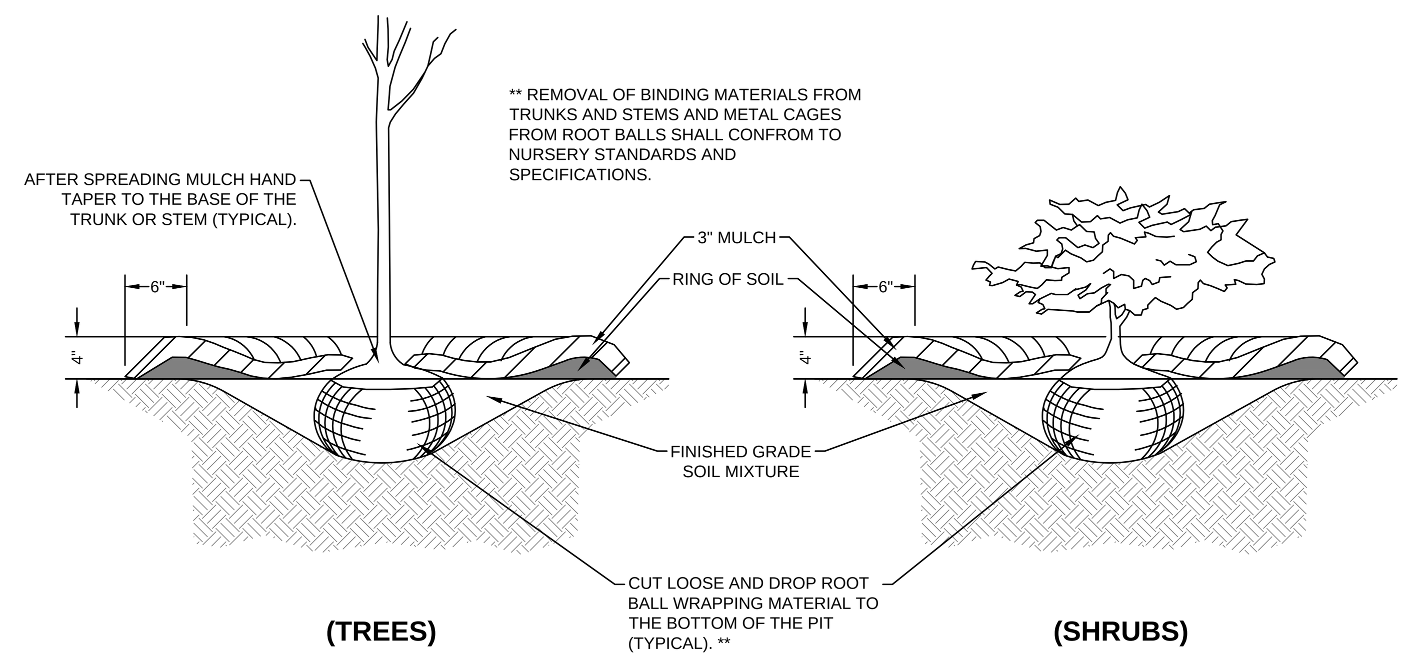


EROSION CONTROL FABRIC DETAIL

NOT TO SCALE

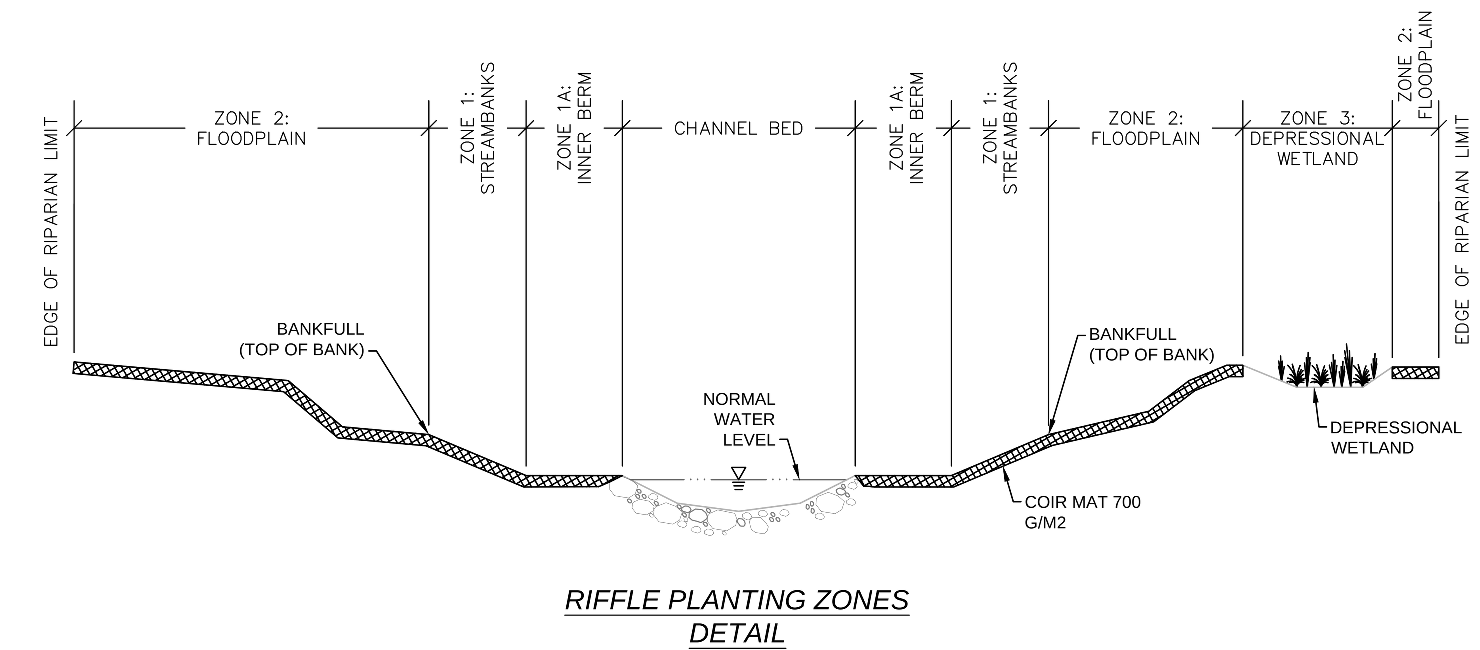


PLANTING NOTES

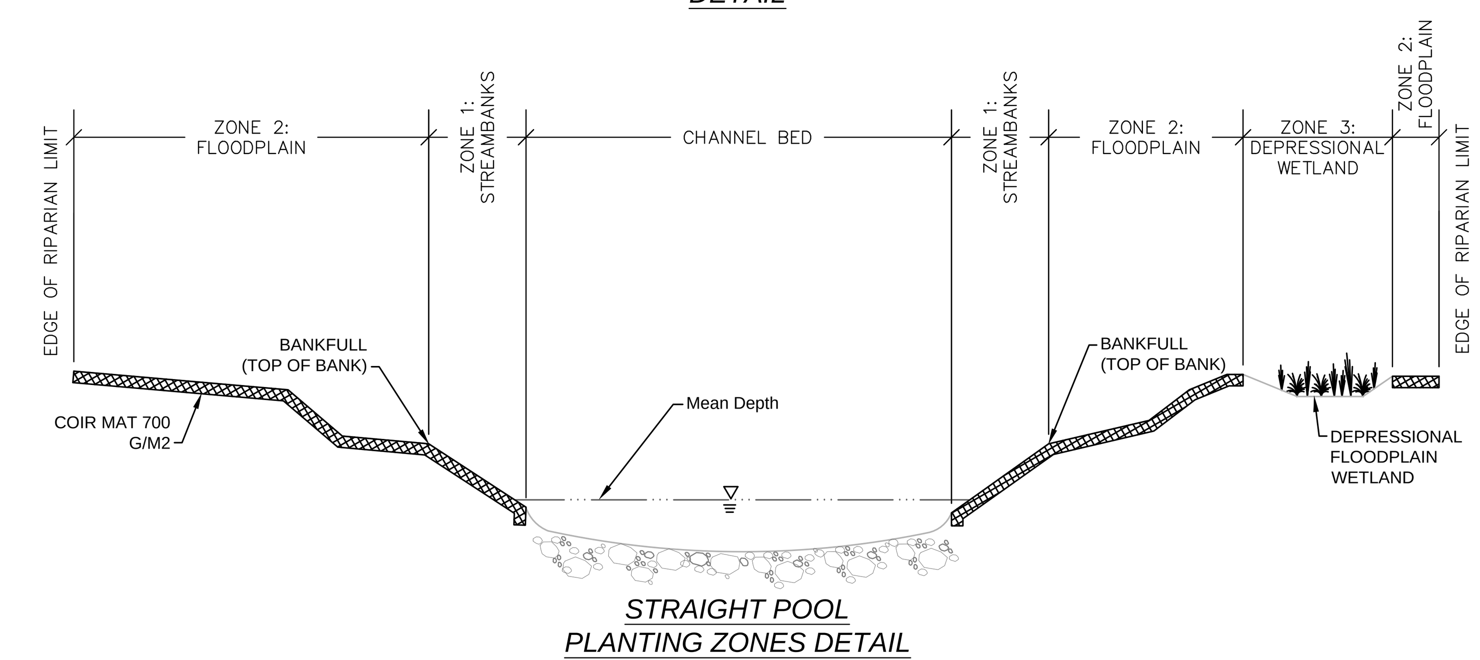
1. THE PLANT MATERIAL SHALL BE WOODY SHRUB SPECIES RECOMMENDED FOR PLANTING WITHIN ZONE 2 OF THE RIPARIAN AREA AND SHALL INCLUDE A COMBINATION OF BLACK HAW, AMERICAN ELDERBERRY, AND/OR MAPLELEAF VIBURNUM. TREE SPECIES ARE NOT PROPOSED TO BE INSTALLED IN ZONE 2.
2. THE PLANT MATERIAL SHALL BE FROM COMMERCIAL SOURCES. THE PLANT MATERIAL ORDER SHALL BE PLACED WELL IN ADVANCE OF PLANNED WORK DATES TO ENSURE A TIMELY DELIVERY OF MATERIAL. ROOT SYSTEMS, LIMBS, AND BARK SHALL BE KEPT INTACT AND UNDAMAGED. THE PLANT MATERIAL SHALL BE FREE FROM DISEASE OR BLIGHT.
3. SHIPPED PLANT MATERIAL SHALL BE TRANSPORTED IN ENCLOSED OR COVERED TRUCKS, AND SCHEDULED TO ARRIVE ON SITE WITHIN 24 HOURS. THE PLANT MATERIAL SHALL BE PROPERLY PACKAGED AND HANDLED DURING TRANSPORTATION TO PROTECT THEM FROM INJURY. THE SHIPMENT OF PLANTS TO THE PROJECT SITE SHALL REQUIRE A DELIVERY TICKET INDICATING THE SOURCE OF SUPPLY, EXACT QUANTITIES, SIZES, AND SPECIES DELIVERED.
4. THE PLANT MATERIAL SHALL BE INSPECTED UPON DELIVERY BY THE SITE ENGINEER OR OTHER OWNER'S REPRESENTATIVE PRIOR TO INSTALLATION. PLANTING STOCK NOT MEETING MATERIAL SPECIFICATIONS WILL NOT BE APPROVED AND SHALL BE REPLACED BY THE CONTRACTOR AT THE CONTRACTOR'S EXPENSE.
5. THE PLANT MATERIAL SHALL HAVE NORMAL, WELL-DEVELOPED BRANCHES AND VIGOROUS ROOT SYSTEMS. PLANTS SHALL BE SOUND, HEALTHY, AND VIGOROUS, WITHOUT DEFECTS, DISFIGURING KNOTS, BARK ABRASIONS, SUN SCALE, DISEASE, INSECT INFESTATIONS, BORERS AND ALL OTHER FORMS OF INFECTIONS.
6. THE INSTALLATION OF THE PLANT MATERIAL SHALL BE ACCOMPLISHED DURING THE DORMANT SEASON, TYPICALLY FROM NOVEMBER TO APRIL. SCHEDULING OF PLANT MATERIAL DELIVERY AND INSTALLATION WORK SHALL BE CONDUCTED IN A PROFESSIONAL AND ORGANIZED MANNER. PLANT MATERIAL ORDERS SHALL BE PLACED WELL IN ADVANCE OF THE PLANNED WORK DATE(S) TO ENSURE A TIMELY DELIVERY OF MATERIAL.
7. THE PLANTING AREA SHALL BE PREPARED VIA CLEARING, GRADING, GRUBBING, SCARIFYING AND/OR OTHER ACCEPTABLE CONSTRUCTION PRACTICE TO ENHANCE SURVIVORSHIP OF THE PLANT MATERIAL TO BE INSTALLED. THE SLOPE OF THE PLANTING AREA SHALL BE PROTECTED FROM EROSION BY MULCHING WITH STRAW MULCH AND/OR CHOIR WATTLES PLACED AT THE TOP OF THE SLOPE.
8. FIELD ADJUSTMENTS DURING INSTALLATION SHALL BE MADE, IF NECESSARY, TO IMPROVE SURVIVORSHIP OF PLANT MATERIAL.
9. THE PLANT MATERIAL SHALL BE INSTALLED WITH A SHOVEL OR AUGER, RATHER THAN A DIBBLE BAR. THE SOIL SHALL BE BACKFILLED AND HAND-COMPACTED AROUND EACH SAPLING. THE PLANT MATERIAL SHALL NOT BE PLANTED IF THE SOIL IS FROZEN OR DRY. THE SAPLINGS SHALL BE PLANTED IN A VERTICAL POSITION WITH THE ROOT COLLARS APPROXIMATELY ½-INCH BELOW THE SOIL SURFACE. THE PLANTING HOLE SHALL BE DEEP AND WIDE ENOUGH TO PERMIT ROOTS TO SPREAD OUT AND DOWN WITHOUT J-ROOTING OR L-ROOTING. AFTER INSTALLATION OF THE PLANT MATERIAL, THE SOIL AROUND EACH PLANT SHALL BE PACKED FIRMLY TO ELIMINATE AIR POCKETS. THE INSTALLED PLANT MATERIAL SHALL BE PERIODICALLY WATERED TO REDUCE DESICCATION.

CONTAINER PLANTS TYPICAL DETAIL

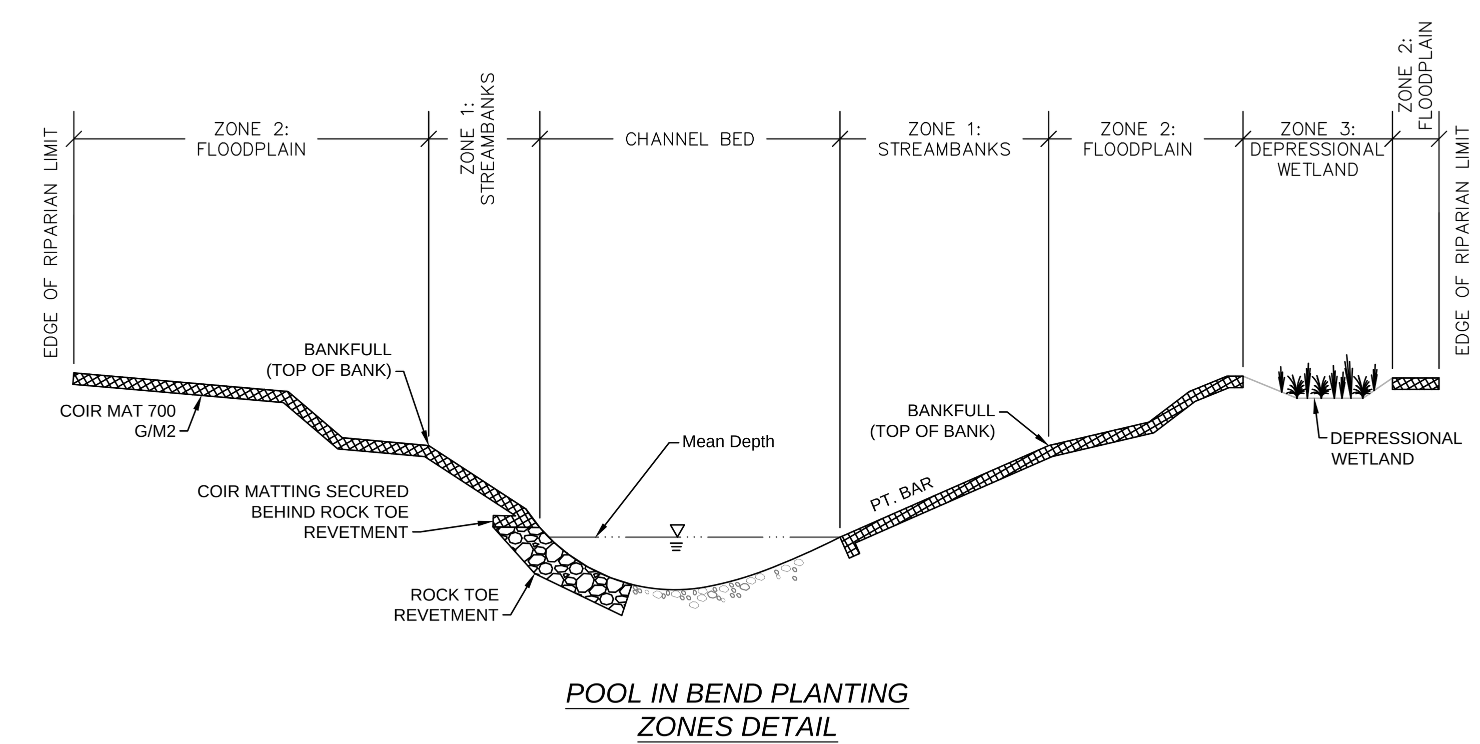
NOT TO SCALE



RIFFLE PLANTING ZONES DETAIL



STRAIGHT POOL PLANTING ZONES DETAIL



POOL IN BEND PLANTING ZONES DETAIL

INSTALLATION NOTES:

1. PREPARE SOIL BEFORE INSTALLING MAT, INCLUDING APPLICATION OF SEED.
2. BEGIN AT UPSTREAM END OF CHANNEL BY ANCHORING MAT IN 12" DEEP x 12" WIDE TRENCH. BACKFILL AND COMPACT SOIL IN TRENCH AFTER INSTALLING WOOD STAKES.
3. ROLL MATS IN DIRECTION OF WATER FLOW.
4. PLACE MATS END OVER END (SINGLE STYLE WITH UPSTREAM END ON TOP) WITH A 12" OVERLAP. USE 2 STAKES TO SECURE MAT AT OVERLAP POINTS (AS SHOWN ON OVERLAP SECTION) SPACED AT 24".
5. MATS ON SIDE SLOPES MUST OVERLAP CENTER BLANKET 12".
6. FULL LENGTH EDGE OF MATS AT TOP OF SIDE SLOPES MUST BE ANCHORED IN 12" DEEP x 12" WIDE TRENCH. BACKFILL AND COMPACT SOIL IN TRENCH AFTER INSTALLING WOOD STAKES.
7. THE TERMINAL END OF MATS MUST BE ANCHORED IN 12" DEEP x 12" WIDE TRENCH. BACKFILL AND COMPACT SOIL IN TRENCH AFTER INSTALLING WOOD STAKES.
8. SECURE MAT THROUGHOUT WITH WOOD STAKES USING PATTERN SHOWN. INSTALLED MAT SHALL BE TAUT, LAYING FLUSH WITH SOIL SURFACE, IN CORRECT ALIGNMENT AND LOCATION, AND PROPERLY ANCHORED TO PREVENT DISPLACEMENT.

100% BIODEGRADABLE EROSION CONTROL BLANKET FOR RE-VEGETATION MADE OF COIR YARN. COIR YARN IS A COARSE FIBER EXTRACTED FROM THE FIBROUS OUTER SHELL OF A COCONUT. THESE FIBERS ARE RELATIVELY WATERPROOF AND ARE ONE OF THE FEW NATURAL FIBERS RESISTANT TO DAMAGE BY SALT WATER. COMPLETELY BIODEGRADABLE MATTING IS AN IDEAL METHOD TO STOP EROSION DAMAGE AND TO KEEP SOIL IN PLACE UNTIL PLANT MATERIAL HAS TAKEN HOLD. EXCELLENT COVERAGE ON ALL TERRAINS, EVEN SLOPES. THE NATURAL LOOKING, HIGH STRENGTH COIR YARN MESH PROTECTS THE SOIL SURFACE FROM WATER AND WIND EROSION WHILE OFFERING PARTIAL SHADE AND HEAT STORAGE TO ACCELERATE VEGETATIVE DEVELOPMENT ALLOWING UNINHIBITED GROWTH OF WOOD PLANT SPECIES, GRASS AND GROUND COVER.

NOTES:

1. COIR MATS TO BE USED IN ALL AREAS WITHIN LIMITS OF DISTURBANCE WHERE NEW VEGETATION IS TO BE ESTABLISHED (NOT TO BE USED IN CHANNEL BEDS OR WETLAND BOTTOMS).
2. USE COIR BLANKET WITH TIGHT WEAVE AND WEIGHT OF 700 GRAMS PER SQUARE METER SUCH AS COIRMAT 700 (BY ROLANKA INTERNATIONAL, INC.) OR APPROVED EQUAL.

BIO-EROSION CONTROL BLANKET

COIR YARN

COIR BIO-EROSION CONTROL FABRIC INFORMATION

(OR APPROVED EQUAL)

"MAT," "BLANKET," AND "FABRIC" ARE USED INTERCHANGEABLY TO REFER TO THIS PRODUCT WITHIN THESE PLANS.

LIVE STAKE NOTES:

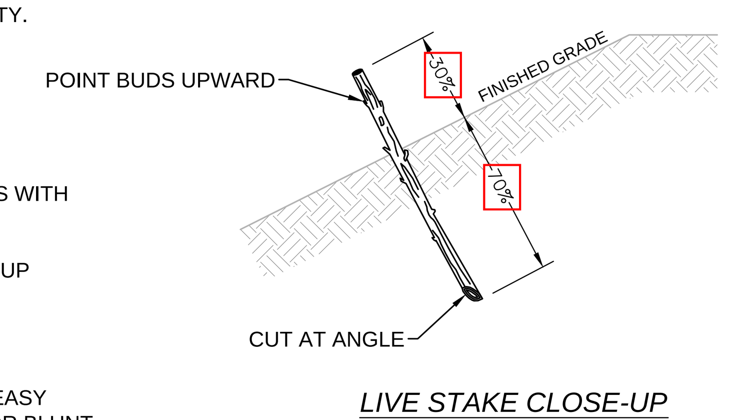
1. SPECIES SELECTION MAY VARY DUE TO AVAILABILITY. IF AVAILABLE, USE NATIVE SPECIES.
2. DO NOT ALLOW STAKES TO DRY OUT.
3. SOAK STAKES BEFORE PLANTING.
4. DRIVE A PILOT HOLE IN FIRM SOIL AT RIGHT ANGLES WITH BUDS ORIENTED UP.
5. BURY 70% OF STAKE LENGTH AS SHOWN IN CLOSE-UP DETAIL.
6. PLANT STAKES ON DIAMOND SPACING.
7. CUT THE BASAL OR BUTT ENDS AT AN ANGLE FOR EASY INSERTION INTO THE SOIL. CUT THE TOP SQUARE OR BLUNT.
8. LIVE STAKES MAY EXTEND DOWN TO NORMAL WATER LEVEL AND MAY EXTEND 2 FT VERTICALLY FROM EDGE OF WATER. USE WATER TOLERANT SPECIES BELOW BANKFULL.
9. RECOMMENDED SPECIES FOR THIS SITE (CHOOSE AT LEAST 3 AS AVAILABLE FROM NURSERY):

   SILKY DOGWOOD, BLACK WILLOW, AND SMOOTH ALDER

   DIAMETER RANGE = 1.0 TO 1.5 INCHES

   LENGTH RANGE = 3 TO 4 FEET

   PLANTING DENSITY, EVERY 2 FT ON DIAMOND SPACING WITHIN WESTERN (UPSTREAM) AND CENTRAL PORTIONS OF REACH.



LIVE STAKE CLOSE-UP

TYPICAL LIVE STAKE DETAIL

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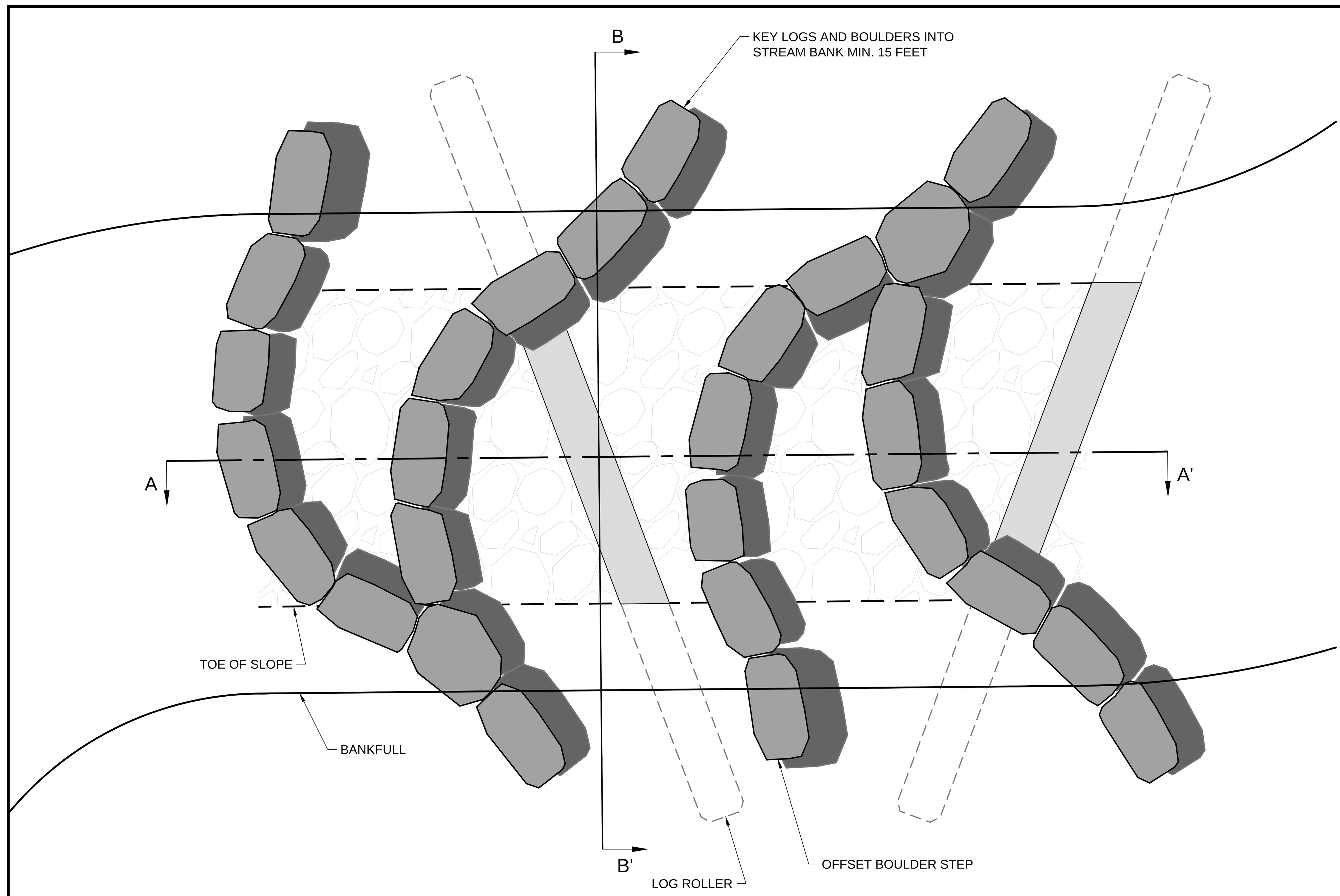
PROJECT: STRAWBERRY RUN STREAM RESTORATION, 207 FORT WILLIAMS PARKWAY, ALEXANDRIA, VA 22304

SHEET TITLE: PLANTING DETAILS

PROJECT NO.: 7526173001
DATE: 21 AUGUST 2018
DWG. SIZE: ARCH D
SHEET NUMBER: 11 OF 12

PLOTTED BY:LASH, CHRISTA SHEET SET:Alexandria Concepts LAYOUT:PLANTING DETAILS August 21, 2018 04:01:18pm \\CHY-FS1\CAD_PROJECTS\7526173001_ALEXANDRIA STREAM ASSESS\PLANSHEETS\05-CONCEPT DETAILS.DWG



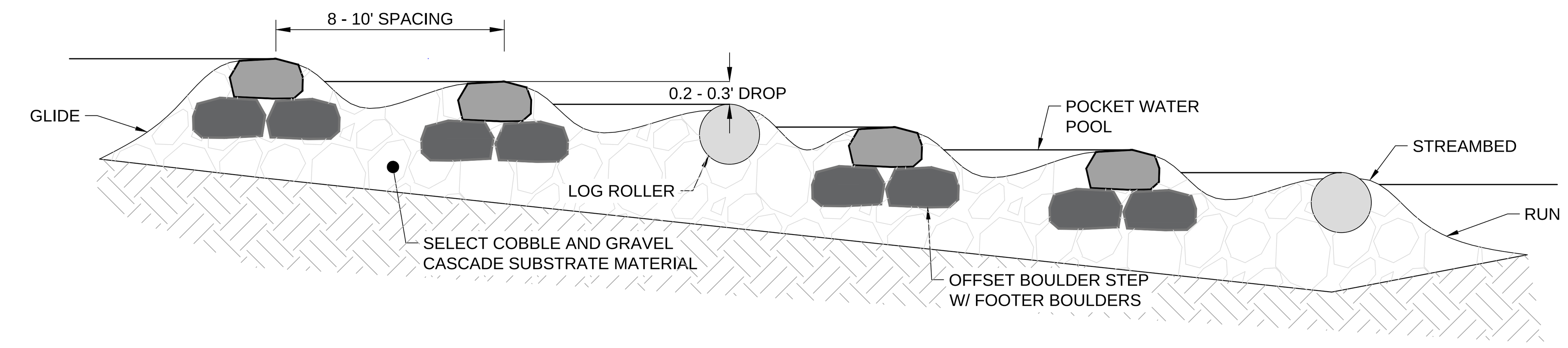
CASCADE WITH BOULDER STEPS AND LOGS

NOT TO SCALE

PLAN VIEW

CONSTRUCTED CASCADE

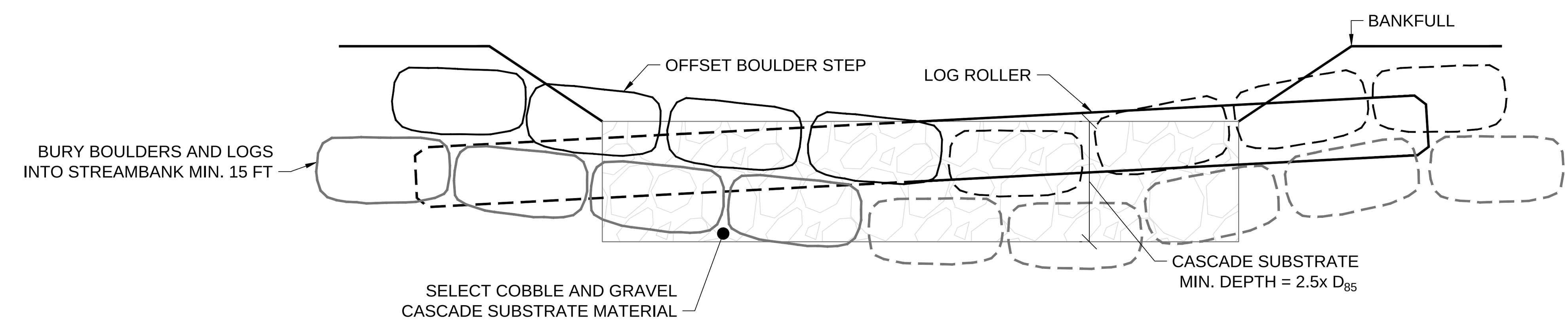
(SHOWN FOR INFORMATION ONLY)



CASCADE WITH BOULDER STEPS AND LOGS

NOT TO SCALE

PROFILE A-A' VIEW



CASCADE WITH BOULDER STEPS AND LOGS

NOT TO SCALE

CROSS-SECTION B-B' VIEW

CASCADE WITH BOULDER STEPS AND LOGS

NOTES

1. THE CASCADE STRUCTURE WITH OFFSET BOULDER STEPS AND LOG ROLLERS IS A STREAM AND RIVER RESTORATION DESIGN FEATURE THAT INCORPORATES COARSE SUBSTRATE MATERIAL, BOULDERS AND LARGE WOOD (LOGS) IN THE CHANNEL BOTTOM THAT WILL NOT BE MOBILIZED UNDER DEFINED FLOW CONDITIONS. REPLACING (OR ADDING TO) THE NATIVE CHANNEL BED MATERIAL WITH LARGER DIAMETER ROCK AND LARGE WOOD CREATES A RIFFLE THAT FUNCTIONS AS A RIGID GRADE CONTROL AND HABITAT FEATURE. LARGER ROCK MATERIAL AND WOOD ENHANCES FLOW DIVERSITY AND TURBULENCE UNDER BASE FLOW CONDITIONS, WHICH PROMOTES AQUATIC HABITAT, NUTRIENT PROCESSING, AND RE-AERATION OF STREAM FLOW BENEFITING WATER QUALITY. THE D50, D85, D90, OR D100 PARTICLES OF THE CONSTRUCTED CASCADE SHOULD BE DESIGNED TO RESIST tBKF WHILE ALLOWING SMALLER SUBSTRATE PARTICLES TO BE MOBILIZED AND REPLACED BY UPSTREAM SEDIMENT SUPPLY. THIS STRUCTURE MAY BE USED AS RIFFLE WITH STEEPER SLOPES AS GRADE CONTROL.
2. ALL SELECT CASCADE MATERIAL SHALL BE QUARRIED STONE UNLESS NATIVE MATERIAL OF SIMILAR SIZE IS AVAILABLE ONSITE AND MEETS THE CONSTRUCTED CASCADE SIZE SPECIFICATIONS. THE ENGINEER MUST APPROVE THE USE OF ALL ONSITE NATIVE MATERIAL.
3. THE GRAVEL AND COBBLE SUBSTRATE USED FOR THIS DESIGN FEATURE SHOULD BE PREFERENTIALLY HARVESTED FROM THE EXISITING CHANNEL AND OTHER DESIGNATED MINING AREAS ONSITE.
4. SORTING AND SIEVING OF THE HARVESTED RIFFLE SUBSTRATE IS INCIDENTAL TO THE CONSTRUCTION OF THIS STRUCTURE.
5. LOGS SHALL HAVE MINIMUM DIAMETER OF 2.0 FEET. LOGS SHALL HAVE A MINIMUM LENGTH OF R_W.
6. ALL LOGS SHALL BE RELATIVELY STRAIGHT AND LIMBS AND BRANCHES SHALL BE TRIMMED FLUSH.
7. FOR INSTALLATION, THE CONTRACTOR SHALL OVER EXCAVATE THE LENGTH OF THE CASCADE, INSTALL 700 GRAM COIR FIBER EROSION CONTROL MATTING, KEY MATTING INTO THE CASCADE TRENCH AND BACKFILL WITH THE SPECIFIED SELECT CASCADE SUBSTRATE MATERIAL TO THE ELEVATIONS SHOWN ON THE PROPOSED PROFILE.
8. CONSTRUCTED CASCADE MATERIAL SHALL EXTEND A MINIMUM OF 15 FEET UPSTREAM OF THE P.T. INTO THE GLIDE AND DOWNSTREAM TO THE P.C.
9. P.T. AND P.C. STATIONS AND ELEVATIONS ARE INCLUDED IN THE PROPOSED PLAN AND PROFILE SHEETS. SET RIFFLE INVERTS AT ELEVATION SHOWN ON THE PLAN AND PROFILE SHEETS. NO ELEVATIONS OF THE CONSTRUCTED RIFFLE WITH LOG ROLLERS MAY VARY FROM THE PLAN SHEETS WITHOUT DIRECTION FROM THE ENGINEER.
10. THE VERTICAL SLOPE OF EACH LOG AND BOULDER ARM SHALL NOT EXCEED 2% UNLESS OTHERWISE DIRECTED BY THE ENGINEER. THE SLOPES WILL BE DICTATED BY THE WIDTH TO DEPTH RATIO OF THE REACH, TYPICAL RIFFLE INNER BERM CHANNEL, AND THE VERTICAL DROP OVER THE LOG AND LOG DIAMETER.
11. SELECT CASCADE MATERIAL SHALL BE USED AS BACKFILL MATERIAL AROUND THE STRUCTURE.
12. SECURE ALL GEOTEXTILE FABRIC ON TOP OF FOOTER LOGS USING 3 INCH 10D GALVANIZED COMMON NAIL ON 12 INCH SPACING ALONG LOG. NAIL NON-WOVEN GEOTEXTILE TO EDGE OF HEADER LOG AND BACKFILL.
13. SELECT RIFFLE MATERIAL DEPTH SHALL BE AT LEAST 2.5 TIMES THE D85.
14. SELECT RIFFLE MATERIAL WILL BE PLACED AT A UNIFORM THICKNESS.
15. THE SELECT CASCADE MATERIAL WILL BE PLACED SUCH THAT, IN CROSS-SECTION, ITS LOWEST ELEVATION OCCURS IN THE CENTER OF THE CHANNEL AS PER THE DETAIL.
16. SELECT CASCADE MATERIAL SHALL BE COMPACTED USING TRACKED EQUIPMENT OR AN EXCAVATOR BUCKET SUCH THAT FUTURE SETTLEMENT OF THE MATERIAL IS KEPT TO A MINIMUM.
17. THE SURFACE OF THIS STRUCTURE SHALL BE FINISHED TO A SMOOTH AND COMPACT SURFACE IN ACCORDANCE WITH THE LINES, GRADES, AND CROSS-SECTIONS OR ELEVATIONS SHOWN ON THE DRAWINGS. THE DEGREE OF FINISH FOR INVERT ELEVATIONS SHALL BE WITHIN 0.1 FT OF THE GRADES AND ELEVATIONS INDICATED.
18. RE-DRESSING OF CHANNEL AND BANKFULL BENCH/FLOODPLAIN WILL LIKELY BE REQUIRED FOLLOWING INSTALLATION OF IN-STREAM STRUCTURES AND SHALL BE CONSIDERED INCIDENTAL TO CONSTRUCTION.

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DRAWN BY: CAL

CHECKED BY: MTB

APPROVED BY: MTB

SCALE: AS NOTED

PROJECT: STRAWBERRY RUN STREAM RESTORATION, 207 FORT WILLIAMS PARKWAY, ALEXANDRIA, VA 22304

SHEET TITLE: CASCADE DETAILS

PROJECT NO.: 7526173001

DATE: 21 AUGUST 2018

DWG. SIZE: ARCH D

SHEET NUMBER: 12 OF 12

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Attachment 6

(Section G)

Information Substantiating Project Budget Finances

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CAPITAL COST ESTIMATES FOR STRAWBERRY RUN STREAM RESTORATION
(BASED ON CONCEPTUAL DESIGN)

Item	***Quantity***	***Unit***	***Unit Cost***	***Total Cost***	***Note***
Legal/AdminIstrative				$ -	Will be done internally
Land, Right-of-Way				$ -	Will be done internally
Architectural Engineering Basic Fees	1	LS	$ 260,000	$ 260,000	Design from 30% to Final Bid Package
Project Inspection Fees	1	LS	$ 270,000	$ 270,000	Inspection costs for 10 months
Other				$ -	Not Applicable
Stormwater BMP Construction	880	LF	$ 1,159	$ 1,020,000	
Contingencies	1	LS		$ 50,000	5% of construction costs
TOTAL				$ 1,600,000	

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Attachment 7

(Section H)

Documentation of Dedicated Revenue Source for Stormwater Management Program

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STORMWATER MANAGEMENT FUNDING

The Stormwater Maintenance Fee allows the City to more equitably fund stormwater management and Chesapeake Bay cleanup mandates. The Stormwater U ity Management Fee makes the funding burden more equitable by basing the fee amount on the amount of impervious surface on a property. The fee structure for residen roper s, such as condos, townhomes, and single family homes, will be billed using a red method. For all non-residen rope es, such as commercial, industrial, apartments, non-pro s, and religious prope s, the approved fee structure will be billed using a variable method. This means that the fee will be individually calculated for each non-residen roperty.

In FY 2018, the new Stormwater U ity is scheduled to take ect January 1, 2018. As result, the real estate tax dedica n for stormwater will only be in ect for half of scal year FY 2018 (as seen in the table below). r January 1, 2018, expenditures supported by the tax ded are instead supported by the Stormwater Management U ity Fee (detailed on the following page). The half year of the fee will also support $2.42M in expenditures related to stormwater management that were previously budgeted in the General Fund.

Dedicated Tax - Revenues	FY 2018 Approved
Real Estate Tax Dedication for Stormwater per year	$0.005
% of FY tax dedication is in effect (July 2017-December 2017)	50%
Revenue from Stormwater Tax Dedication	**$957,681**
Dedicated Tax - Operating Expenditures	**FY 2018 Approved**
Personnel (TES & DPI)	$814,002
Administration Non-Personnel	$0
Operations and Maintenance Non-Personnel	$87,179
Engineering and Planning Non-Personnel	$0
Debt Service	$0
Indirect Costs	$56,500
Transfer to Capital Improvement Program	$0
Cash Reserve and Operational Reserve	$0
Dedicated Tax Expenditures	**$957,681**

Con ed on next page

STORMWATER MANAGEMENT FUNDING (CONTINUED)

Stormwater Management Utility Fee - Revenues	FY 2018 Approved
Stormwater Utility Rate per billable unit/year	$140
% of FY the Stormwater Utility is in effect (beginning January 1, 2018)	50%
Billable Units	59,935
Revenue Generation	$4,195,450
Other Revenue Sources (interest, permit fees)	$9,050
Revenue Reductions (credits, bad debt)	-$73,954
Revenue from Stormwater Management Utility Fee	**4,130,546**

Stormwater Management Utility Fee - Operating Expenditures	FY 2018 Approved
Personnel (TES & DPI)	$1,846,799
Administration Non-Personnel	$5,250
Operations and Maintenance Non-Personnel	$490,880
Engineering and Planning Non-Personnel	$23,475
Debt Service	$283,877
Indirect Costs	$269,884
Transfer to Capital Improvement Program	$700,000
Cash Reserve and Operational Reserve	$510,381
Stormwater Management Utility Fee Expenditures	**$4,130,546**

Alexandria City Council Adopts Fiscal Year 2018 Budget

Page archived as of May 18, 2017

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- Mayor & City Council
- Boards & Commissions
- Alexandria City Government
- City Departments
- City News Releases

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PLEASE NOTE: THIS PAGE HAS BEEN ARCHIVED AND WILL NO LONGER BE UPDATED.

Alexandria City Council Adopts Fiscal Year 2018 Budget

For Immediate Release: May 4, 2017

By a 6-1 vote on May 4, the Alexandria City Council adopted a $728.1 million General Fund Operating Budget for Fiscal Year (FY) 2018, which represents an increase over the current year of 5.8%. The budget includes $242.6 million in operating funds and debt service for public schools (a 3.6% or $8.4 million increase over FY 2017 funding), while spending on City operations and debt service increased by just 2.5% after $4.1 million of spending reductions. The budget also invests $2.1 billion over 10 years in Alexandria's Capital Improvement Program. FY 2018 begins on July 1, 2017.

To account for stagnant revenue growth, increasing school enrollment, needed City and school infrastructure investments, and Metro cost increases, the proposed budget includes an increase in the real estate tax rate of 5.7 cents, from $1.073 to $1.13 per $100 of assessed value. This would increase the average homeowner's tax bill by 6.3%, or $356 per year. Alexandria's real estate tax rate will remain among the lowest in Northern Virginia for homeowners and the second lowest for commercial property owners. There are n increases in any other tax rates.

The adopted budget provides for a real estate tax rate 3.0 cents higher than that proposed by the City Manager. From this additional revenue, $4.3 million will support a major affordable housing project, and the remaining $130.1 million expected to be received over the next 10 years will be placed in a contingent capital reserve to be allocated after recommendations from a blue-ribbon task force on City and school construction needs.

The approved 10-year Capital Improvement Program includes substantially increased funding of $144.7 million to improve Metro safety and reliability and $370.2 million for accelerated sewer outfall projects.

A new stormwater utility fee will be applied to all residential and non-residential property owners to pay for costly new federal and state mandates. This will fund stormwater management more equitably than by raising the real estate tax further, since a fee shifts stormwater management costs to the properties with greater impact on stormwater runoff. The average homeowner will pay $70 for the second half of FY 2018. Smaller residential properties will pay less, and very large homes will pay more. Non-residential properties will pay a fee based on the impervious surface area they contain. Revenue from the stormwater utility fee is projected to raise $4.2 million in FY 2018. The annual refuse fee will increase from $363 to $373 for households receiving City collection services.

Although the City has already been actively working to significantly reduce sewage overflows from its four combined sewer outfalls, work will be dramatically accelerated to comply with a new deadline of 2025 recently enacted by the General Assembly and approved by the Governor. Revenue for these projects will come from a 30% increase in the sanitary sewer fee in FY 2018 (from $1.40 to $1.82 per thousand gallons), with significant increases in sewer-related fees over the next decade. The budget also includes the assumption of $45 million in state aid, like the assistance previously provided to Lynchburg and Richmond to address combined sewer outfalls in those cities.

The adopted budget underscores the City's investment in its workforce by funding merit increases for employees who earn them through performance, and creating a pay incentive for dual-role firefighter/medic staff. The budget reflects City Council's Strategic Plan, analysis in the City's Five-Year Financial Plan, the City Manager's budget priorities, and extensive input from community engagement meetings and online forums.

To learn more about the entire budget process and view all budget documents, visit www.alexandriava.gov/Budget.

For media inquiries, please contact Craig Fifer, Director of Communications and Public Information, at craig.fifer@alexandriava.gov or 703.746.3965.

# # #

This news release is available at www.alexandriava.gov/97640.

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SLAF Application Attachments

Supplemental Information

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Attachment A

City of Alexandria’s Small Municipal Separate Storm Sewer System (MS4) General Permit

(No. VAR040057)

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COMMONWEALTH of VIRGINIA

DEPARTMENT OF ENVIRONMENTAL QUALITY

Douglas W. Domenech
Secretary of Natural Resources

Street address: 629 East Main Street, Richmond, Virginia 23219
Mailing address: P.O. Box 1105, Richmond, Virginia 23218
TDD (804) 698-4021
www.deq.virginia.gov

David K. Paylor
Director

(804) 698-4020
1-800-592-5482

July 5, 2013

Rashad M. Young, City Manager
City of Alexandria
301 King Street
Alexandria, Virginia 22314

RE: General Permit for Discharges of Stormwater from Small Municipal Separate Storm Sewer Systems
General Permit No. VAR040057
City of Alexandria

Dear Permittee:

Department staff has reviewed your Registration Statement and determined that the referenced Municipal Storm Sewer System (MS4) is hereby covered under the General Permit for Discharges of Stormwater from Small Municipal Separate Storm Sewer Systems. The effective date of your coverage under this general permit is July 1, 2013, or the date of this letter, whichever is later. The enclosed copy of the general permit contains the applicable reporting requirements and other conditions of coverage.

During its 2013 Legislative Session, the General Assembly passed Chapters 756 (HB2048) and 793 (SB1279) which moved several programs from the Virginia Department of Conservation and Recreation (DCR) to the Virginia Department of Environmental Quality (DEQ). As a result of this legislative change, the General Assembly transferred the administration and oversight of the General Permit for Discharges from Small Municipal Separate Storm Sewer Systems from DCR to DEQ. Please submit future permit correspondence and your annual MS4 program reports to the DEQ Northern Regional Office at the following address:

DEQ Northern Regional Office
13901 Crown Court
Woodbridge, VA 22193

The general permit will expire on June 30, 2018. The conditions of the permit require that you submit a new registration statement on or before April 1, 2018, if you wish to have continued coverage under the general permit.

If you have any questions about this letter or the general permit, please contact Mr. Bryant Thomas, Water Permits Manager, at (703) 583-3843 or Bryant.thomas@deq.virginia.gov .

Sincerely,

Melanie D. Davenport

Melanie D. Davenport, Director
Water Division

Enc. General Permit No. VAR040057

Cc. Bryant Thomas, DEQ-NRO

Joni Calmbacher

From: Selengut, Jeffrey <jeffrey.selengut@deq.virginia.gov>
Sent: Friday, June 01, 2018 8:07 AM
To: Joni Calmbacher
Subject: Re: Registration Package for Reissuance of General VPDES Permit for Discharges of Stormwater from MS4s; Permit No. VAR040057

Joni,

Thank you for your submittal.

On Thu, May 31, 2018 at 3:36 PM, Joni Calmbacher <joni.calmbacher@alexandriava.gov> wrote:

> Please acknowledge receipt of this email.
>
> ------------------
>
> Mr. Selengut,
>
> Please find attached the complete registration package with cover letter submitted by the City of Alexandria pursuant to the requirements of the General VPDES Permit for Discharges of Stormwater from MS4s; Permit No. VAR040057. As a current MS4 general permit holder, the City provides this registration package to continue permit coverage via administrative continuation of the current permit and/or with the reissuance of the MS4 general permit. Pursuant to 9VAC25-870-370 A, the City Manager has signed the enclosed Registration Statement.
>
> Included in this transmittal is a memorandum identifying the duly authorized representative for the City's MS4 Permit pursuant to 9VAC25-870-370 B. This will allow the duly authorized representative to sign MS4 Permit reports and submit other information as requested from DEQ as a normal part of business.
>
> Please contact me at 703-746-4174 if you have any questions regarding this registration package.
>
> Thank you,
>
> **Joni Calmbacher, P.E.**

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Civil Engineer III

Stormwater Management Division

Transportation & Environmental Services

City of Alexandria, Virginia

2900 Business Center Drive

Alexandria, VA 22314

703.746.4174 (direct)

703.795.8476 (mobile)

www.alexandriava.gov

--

Jeff Selengut

MS4 Permit Writer

Department of Environmental Quality

1111 East Main Street

Richmond, VA 23219

(804) 698-4265

jeffrey.selengut@deq.virginia.gov

www.deq.virginia.gov

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Attachment B

FEMA Flood Insurance Rate Map

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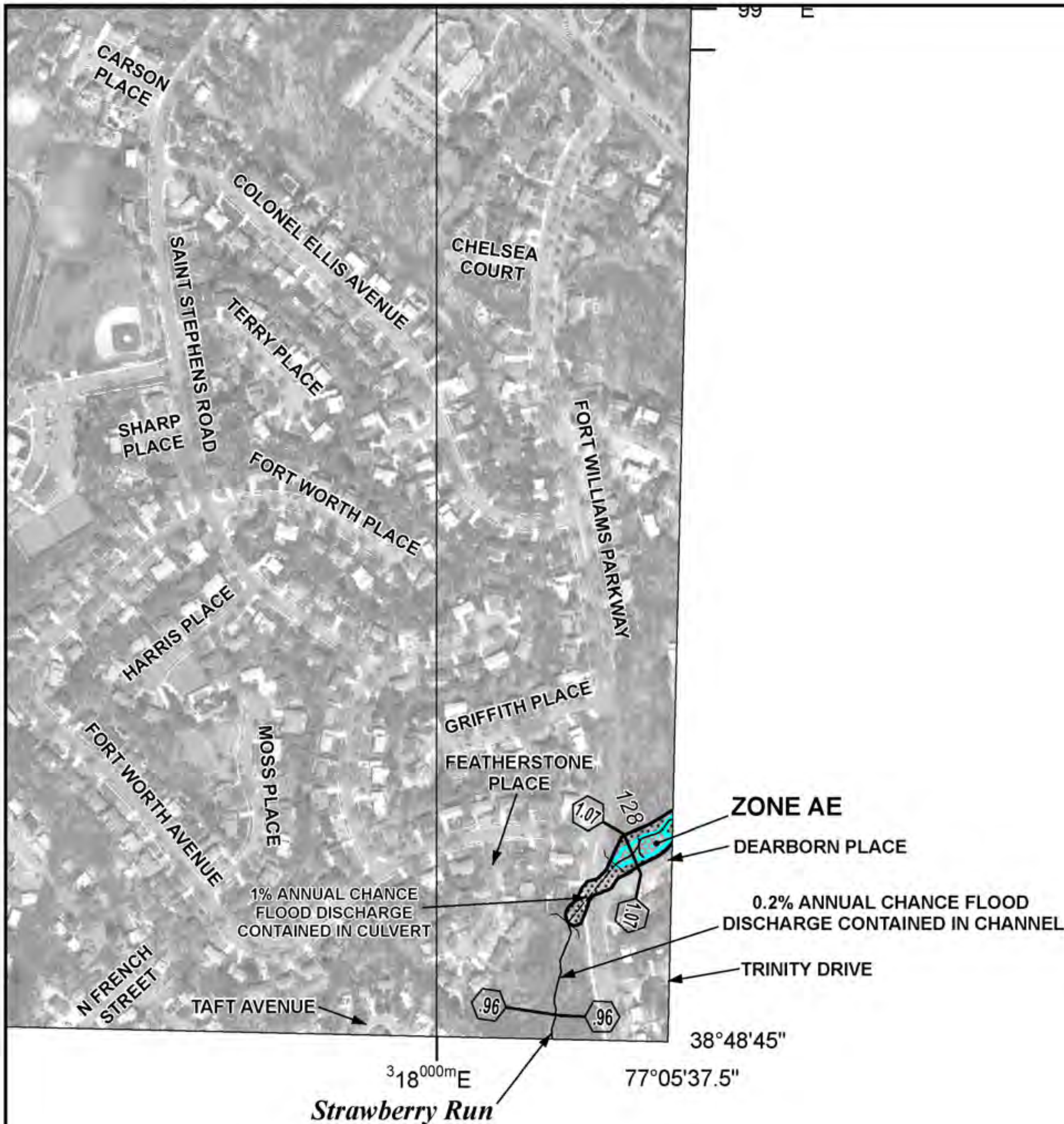


MAP SCALE 1" = 500'

0 500 1000 FEET

METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0028E

FIRM
FLOOD INSURANCE RATE MAP

CITY OF ALEXANDRIA, VIRGINIA
INDEPENDENT CITY

PANEL 28 OF 45

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
ALEXANDRIA, CITY OF (INDEPENDENT CITY)	515519	0028	E

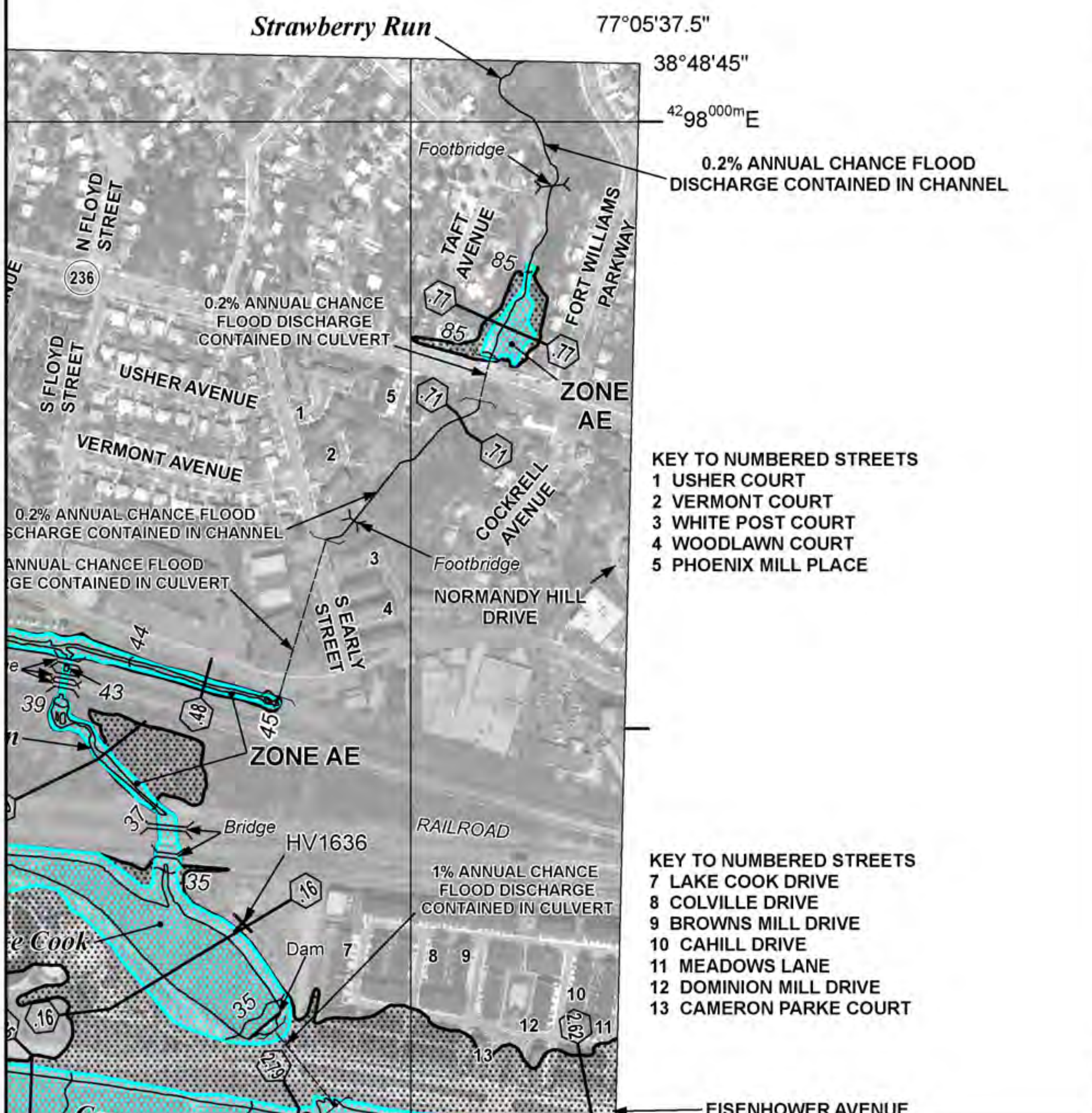
Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER 5155190028E

MAP REVISED JUNE 16, 2011

Federal Emergency Management Agency

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



MAP SCALE 1" = 500'

250 0 500 1000 FEET

NATIONAL FLOOD INSURANCE PROGRAM

NFIP

PANEL 0036E

FIRM
FLOOD INSURANCE RATE MAP

CITY OF ALEXANDRIA, VIRGINIA
INDEPENDENT CITY

PANEL 36 OF 45

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
ALEXANDRIA, CITY OF (INDEPENDENT CITY)	515519	0036	E

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

MAP NUMBER
5155190036E

MAP REVISED
JUNE 16, 2011

Federal Emergency Management Agency

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

Attachment C

Memo to Mayor and Members of City Council

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City of Alexandria, Virginia

MEMORANDUM

DATE: SEPTEMBER 20, 2018

TO: THE HONORABLE MAYOR AND MEMBERS OF CITY COUNCIL

FROM: MARK B. JINKS, CITY MANAGER

DOCKET TITLE:
..TITLE
Consideration of grant applications to the Virginia Stormwater Local Assistance Fund for up to $800,000 for Strawberry Run Stream Restoration and $2,255,000 for Taylor Run Stream Restoration
..BODY

ISSUE: Consideration of two matching grant applications to the Virginia Stormwater Local Assistance Fund (SLAF).

RECOMMENDATION: That City Council:

1. Approve submission of a $800,000 matching grant application to restore a portion of Strawberry Run and a $2,255,000 matching grant application to restore a portion of Taylor Run. The projects will generate pollution reduction credits towards meeting the City's Chesapeake Bay water quality compliance mandates.

2. Authorize the City Manager to execute the necessary documents that may be required for these two grants.

BACKGROUND: To reduce nonpoint source pollution from stormwater runoff and help localities meet Chesapeake Bay cleanup mandates, the Virginia General Assembly in 2014 created the Stormwater Local Assistance Fund (SLAF). This fund administered by the Virginia Department of Environmental Quality (DEQ) consists of bond proceeds authorized by the General Assembly to serve as 50-50 matching grants available to local governments for the planning, design, and implementation of stormwater infrastructure known as best management practices (BMPs) to address Bay cleanup mandates. These grants are competitive and proposed BMPs must be cost efficient and directly address commitments related to reducing water quality pollutant loads to address the Bay cleanup. Grant applications are due October 12, 2018.

DISCUSSION: The Chesapeake Bay Total Maximum Daily Load (TMDL) assigns nutrient and sediment loading reductions to each locality that are enforced through the City's Municipal Separate Storm Sewer System (MS4) general permit. Staff continues to actively pursue SLAF and other grant opportunities to help finance costly stormwater infrastructure to meet these pollutant reductions. Previously, the City has been awarded over $3.9 million in SLAF grant funding for the Lake Cook Retrofit, the Ben Brenman Park Pond Retrofit, and the Lucky Run Stream Restoration project. The Lake Cook Retrofit project is expected to be completed this fall.

For this year's SLAF program, staff proposes two projects. The first project under consideration would be an $800,000 stream restoration for a portion of Strawberry Run located north of Duke Street and west of Fort Williams Parkway. As this is a matching grant, the total project cost is estimated at $1.6 million. A location map is included as part of Attachment 1. The second project under consideration is a $2.23 million stream restoration on Taylor Run, which is located west of King Street near the Chinquapin Recreation Center. The total project cost for this project is $4.51 million. A location map is included as part of Attachment 2.

These streams were initially identified for restoration by T&ES staff in collaboration with RPCA as part of the Phase III Stream Assessment: Stream Restoration and Outfall Rehabilitation Feasibility Study. This Phase III study builds on the City's Phase I work of categorizing streams and the Phase II work that included physical assessment and evaluation of the City's streams. The Phase III study was designed to develop a prioritized list of stream restoration projects and outfall stabilization projects. The Phase III study identified five potential stream restoration projects that were evaluated, assessed, and ranked using a matrix approach that considered bed and bank stability, stream health, feasibility, cost/benefit, and other co-benefits to prioritize the five projects. The Strawberry Run and Taylor Run projects ranked first and second in this scoring. If completed, these restoration projects will provide water quality benefits along approximately 2,700 total linear feet of stream, thereby enhancing the riparian habitats to increase aquatic health for fish and other organisms, protecting infrastructure along the stream, and enhancing the aesthetic enjoyment of these streams.

This request is consistent with City Council's Strategic Plan Goal #2, "Maintain and improve the quality and sustainability of Alexandria's Environment" through initiatives to "enhance the ecological integrity of waterways by maintaining and improving stormwater and sanitary infrastructure and stream system health to minimize environmental impacts." It complies with the City's Bay TMDL Action Plan, which calls for the use of urban stream restoration as a strategy to address Bay cleanup mandates. This request is also consistent with the water goals in the Eco-City Charter and Eco-City Action Plan.

Prior to initiating field work staff sent letters to owners of property immediately adjacent to the potential stream restoration projects. Staff met on-site with these owners to further explain the projects and identify potential concerns. Extensive outreach will be completed as the projects move through the remainder of the grant application process. Initial stakeholder outreach is currently being performed, with extensive stakeholder input expected to begin this fall. If the City receives negative stakeholder feedback, the City may rescind the application. If stakeholders are supportive of the projects allowing them to move forward, continued outreach will occur throughout the life of the project.

FISCAL IMPACT: Staff proposes to request $800,000 or 50% of the estimated $1,600,000 required to plan, design, and construct the Strawberry Run project, and $2,255,000 or 50% of the estimated $4,510,000 for the Taylor Run project. For the required match, $3,055,000 exists in the approved CIP. This includes $500,000 in FY2019 unallocated funds and $2,245,000 in FY2020 in the MS4-TMDL Compliance Water Quality Improvement CIP. The remainder of the required 50% match ($310,000) is available in prior year unallocated funds from the Stream and Channel Maintenance and Environmental Restoration projects. This project funding is intended for matching opportunities of this nature.

ATTACHMENTS:

1. Strawberry Run Stream Restoration SLAF Grant Application Package
2. Taylor Run Stream Restoration SLAF Grant Application Package

STAFF:

Emily A. Baker, P.E., Deputy City Manager
Yon Lambert, AICP, Director, T&ES
Morgan Routt, Director, T&ES
Mitch Bernstein, Director, DPI
William Skrabak, Deputy Director, T&ES
Jesse Maines, Division Chief, Stormwater Management
Megan Cummings, Division Chief, Strategic Management Services

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Attachment D

City's Fiscal Stress Evaluation

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Report on
Comparative Revenue Capacity, Revenue Effort, And Fiscal Stress of Virginia's Cities and Counties

FY 2016

Commission on Local Government

Commonwealth of Virginia

July 2018

2016 Fiscal Stress Scores by Locality

(Alphabetic Order)

Locality	Stress	Rank	Class
York County	96.51	112	Below Average
Alexandria City	94.83	124	Low
Bristol City	106.96	4	High
Buena Vista City	106.11	7	High
Charlottesville City	101.92	39	Above Average
Chesapeake City	99.99	74	Below Average
Colonial Heights City	102.90	28	Above Average
Covington City	105.88	10	High
Danville City	105.06	18	High
Emporia City	108.56	1	High
Fairfax City	93.45	126	Low
Falls Church City	91.16	132	Low
Franklin City	107.02	2	High
Fredericksburg City	100.43	65	Above Average
Galax City	106.13	6	High
Hampton City	105.34	15	High
Harrisonburg City	104.83	19	High
Hopewell City[3]	105.94	8	High
Lexington City	104.60	20	High
Lynchburg City	105.93	9	High
Manassas City	100.18	70	Above Average
Manassas Park City[3]	100.73	61	Above Average
Martinsville City	106.61	5	High
Newport News City	105.13	16	High
Norfolk City	105.39	14	High
Norton City	105.58	12	High
Petersburg City	106.99	3	High
Poquoson City	96.85	109	Below Average
Portsmouth City	105.43	13	High
Radford City	105.80	11	High
Richmond City	103.23	27	Above Average
Roanoke City	105.09	17	High
Salem City	103.48	23	Above Average
Staunton City	103.29	26	Above Average
Suffolk City	101.06	51	Above Average
Virginia Beach City	99.83	77	Below Average
Waynesboro City	104.53	21	High
Williamsburg City	101.36	49	Above Average
Winchester City	102.69	31	Above Average

Rank Scores: 1 = Highest Stress, 133 = Lowest Stress

[3] As of 6/7/2018, the City of Hopewell, and City of Manassas Park did not submit their FY2016 transmittal to the Virginia Auditor of Public Accounts. Therefore, Revenue Effort and Revenue Capacity are calculated based on their FY2015 actual revenues. As a result, their Fiscal Stress score does not reflect their true fiscal conditions for FY2016. However, their Median Household Income scores have been calculated based on the data for FY2016.