MEMORANDUM

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October 3, 2018

Dave Henderson, PE
Roanoke County Engineer
5204 Bernard Drive
Roanoke, VA 24018

RE: Technical Memorandum for Conceptual Stream Restoration of Wolf Creek in Goode Park

Dear Mr. Henderson,

The following technical memorandum presents the observations, methods, analysis and conceptual recommendations resulting from a site visit by Freese & Nichols, Inc. (FNI) for Wolf Creek in Goode Park, located in Roanoke County, VA.

Background

The Stream Restoration of Wolf Creek, in Goode Park, ("Project") consists of the restoration/stabilization of portions of Wolf Creek as it flows alongside the Wolf Creek Greenway through Goode Park in Roanoke County, Virginia. The project extent encompasses the portion of the creek along the Wolf Creek Greenway that flows near the baseball fields in Goode Park to the point where the Greenway crosses over Goode Park Rd. The length of the project is approximately 2,000 feet.

Roanoke County is regulated as a small MS4. The County's MS4 general permit contains requirements for additional stormwater controls to address pollutants where the MS4 has been allocated a wasteload in an approved TMDL. Natural stream restoration of Wolf Creek will, to a certain extent, address the MS4 permit requirements for sediment wasteload allocation for the Roanoke River. (Roanoke County, 2013).

Observations & Field Methods

A site visit was made to Goode Park on December 19th, 2016 by Bryan Dick, Emily Darr, Mackenzie Blum and Stephanie Coffman of Freese & Nichols, Inc. The purpose of the visit was to map the extent of erosion along Wolf Creek, with the intent of being able to use the data to derive estimates of erosion rates along the reach. A summary of the methods is as follows:

- The Bank Erosion Hazard Index (BEHI) method was used to map the susceptibility to erosion of all streambanks from the Blue Ridge Parkway to the intersection of E. Washington Avenue and Goode Park Road. The BEHI method uses several observable indicators of erosion, including bank angle, bank height, rooting depth, root density in the soil and an overall rating of soil protection to assign distinct segments of streambank with a BEHI rating, which can range from “Very Low” to “Extreme”.

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- A 25-ft long survey rod was used to measure the height of all streambanks.
- As the stream was walked, notes were made about the existing condition of the banks, the presence of lateral constraints and possible design solutions at each location.

Erosion Calculation Methods

Following the field effort, estimates of erosion rates were calculated using the BANCS (Bank Assessment of Non-point source Consequences of Sediment) model. The BANCS model uses BEHI and near bank stress (NBS) estimates along a stream reach, along with a developed relationship between streambank erosion rates and BEHI/NBS ("erosion rate curve") in order to estimate erosion rates. The BANCS model is mentioned as one of the possible methods for determining erosion rates and associated nutrient export in the Chesapeake Bay TMDL guidance document "Recommendations of the Expert Panel to Define Removal Rates for Individual Stream Restoration Projects". For this effort, an erosion rate curve developed by the US Fish and Wildlife Service for Hickey's Run in Maryland was used to estimate streambank erosion rates. This curve was selected as it is one of the only regional erosion rate curves available.

Estimates of BEHI as determined in the field, and NBS as determined from planimetric information and field data, were used with the Hickey's Run erosion rate curves to produce estimated erosion rates for each segment of bank that was evaluated along Wolf Creek. Following the guidance provided in "Recommendations of the Expert Panel to Define Removal Rates for Individual Stream Restoration Projects", the restoration of Wolf Creek was assumed to have a 50% sediment/nutrient removal efficiency to conservatively account for the effectiveness of restoration measures. The results of both the existing and post-restoration calculation of erosion rates is presented in the **Tables 1 and 2**.

Nutrient Removal Calculation Methods

Phosphorus removal is used in scoring project eligibility for grant funding from the VA Stormwater Local Assistance Fund (SLAF). To estimate phosphorus and nutrient removal rates, which is ultimately the basis and driver of the Goode Park work, an assumed concentration of TN and TP in each ton of sediment, obtained from the "Recommendations of the Expert Panel to Define Removal Rates for Individual Stream Restoration Projects" guidance document, was applied to the erosion rate estimates from the BANCS model (see Tables 1 and 2). This result was then compared with the default removal rates of TN and TP per linear foot of stream restoration that is contained in the guidance document. As shown in the table, the Hickey's Run curve produces the highest estimates of nutrient removal while the default rate is the lowest. The Hickey's Run curve nutrient reduction estimates were ultimately chosen for the site-specific nature of the curve, which reflects site-specific conditions and site-specific erosion. When used in conjunction with the BANCS methodology, the curve provides more accurate removal rates than predicted with the default rate. As an accepted approach from the expert panel, the removal values from Hickey's Run analysis were the basis for the cost effectiveness per pound of nutrient removed, shown at the bottom of Table 2.

Conceptual Restoration Plan

The restoration approach to Wolf Creek will involve streambank stabilization/restoration on erosive streambanks. Restoration will involve the use of bank stabilization techniques based on bio-engineering

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using slope stabilization technology and deep-rooted woody vegetation to ensure long-term stability of the streambank soil. There are lateral constraints present on both sides of the stream that limit the extent of stream restoration approaches such as re-alignment construction of interior floodplain.

The Wolf Creek Greenway follows the channel for the entire length of the project, crossing the channel several times. The channel is also bordered by several parks and residential developments which must be taken into consideration. While there is room in many places to grade back banks, there are numerous tight spots where grading the banks would be difficult to implement. Because of this, many of the proposed restoration measures involve the use of techniques to narrow the overly-wide channel using rock toe and toe wood or low-height rock walls. Many of these treatments would have one or several lifts of soil wrapped in coir fabric ("geolifts") planted with live stakes at a close enough spacing to allow dense root growth.

A summary of the proposed conceptual restoration approach is as follows:

- Some erosion is evident in the sharper bends and needs stabilization treatment, such as toe wood and rock toe installations. Because the channel follows the Wolf Creek Greenway, the channel is constrained on at least one side for a majority of its length. When there is space, grading is suggested to construct a bankfull bench and reduce bank angle.
- Log vane or rock cross-vanes are suggested periodically throughout the length of the channel to provide in-channel grade control.
- Further downstream, portions of the right and left streambank are relatively stable, with a low-angle slope and vegetation already present and holding bank soil in place. Moderate erosion is present in meanders and could use slope stabilization measures such as a rock toe or toe wood for slope support. In areas where the banks are taller, grading could be implemented to lower bank angle and allow vegetation to take root.
- High levels of sediment deposition have occurred throughout the stream due to the erosive soils and higher flows. In areas where excessive deposition has widened the channel and eroded streambanks, grading would be recommended to re-shape and center the channel to a stable channel form and introduce a stable point-bar where appropriate. Slope stabilization would be encouraged on both sides of areas. Banks should be graded back to include a bankfull bench and lined with coir matting. Vegetation should be planted to help with slope cover.
- The ultimate goal of all these measures is to reduce the bank angle or increase surface protection and install rooted vegetation to increase slope stability and reduce the erosion rates and nutrient export rates.

Permitting Requirements

The following permits are anticipated:

1. Joint permit- issued by USACE in consultation with other Federal and state agencies.
   It is anticipated that US Fish and Wildlife Service (USFWS) coordination will be necessary as part of the 404-permit process in order to evaluate the potential effects on Threatened and Endangered Species, including the Roanoke Log Perch, Indiana bat and Northern Long-Eared Bat. The Virginia Department of Game and Inland Fisheries (VDGIF) imposes time restrictions on instream construction work for various regulated waters including, for the Roanoke Log Perch, a no-work restriction from March 15 to

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June 30. For the bat species, time restrictions can be imposed on tree clearing if known maternity roost trees or hibernacula are present in the vicinity of the project site.

2.Erosion and sediment control permit issued by Roanoke County.

3.VSMP Permit- issued by VDEQ and administered by Roanoke County.

4.Project will require a Stormwater pollution prevention plan (SWPPP).

5.FEMA No Rise Certification Letter issued by Roanoke County.

6.VMRC Permit

Conceptual Implementation Schedule

October 1, 2018 Submit for SLAF funding

May 1, 2019 Receive Notice of Award of Grant Funding

July 1, 2019 Give Notice to Proceed to Design Consultant

October 15, 2019 Complete Design and Submit for Permits

May 1, 2020 Advertise for Construction Bids

April 15, 2020 Receive Permits

June 1, 2020 Receive Construction Bids

July 1, 2020 Award Construction Contract

August 1, 2020 Permit Time Restrictions Lifted, Construction Notice to Proceed Issued

December 31, 2020 Construction Substantially Completed

February 15, 2021 Construction Final Completion

A photo log illustrates the existing conditions of the site with the Team's proposed solutions, as well as representative BEHI's and their ranking. The conceptual restoration plan described is depicted in "Wolf Creek at Goode Park Stream Restoration Conceptual Plan" sheets. A conceptual construction cost-estimate has also been developed and are attached.

Table 1. Wolf Creek at Goode Park, Protocol 1 BANCS Erosion Evaluation for Existing Streambank Erosion and Nutrient Export Estimate

Stream Bank Side	Bank Length (ft)	BEHI Rating	NBS Rating	Stream Bank Height (ft)	Bulk Density (lb/cf)	Erosion Rate (ft/yr) (Hickey Run Curve)	Erosion Rate (tons/year) (Hickey Run Curve)
Left Bank	31	Moderate	Low	5	125	0.13	**1.2**
Right Bank	36	High	Low	6	125	0.4	**5.4**
Left Bank	76	Extreme	Low	4	125	1.2	**22.8**
Right Bank	32	Moderate	Low	6	125	0.13	**1.5**
Left Bank	85	Moderate	Low	4	125	0.13	**2.7**
Right Bank	90	Moderate	Low	4	125	0.13	**2.9**
Left Bank	56	Very High	Low	6	125	0.4	**8.4**
Right Bank	52	High	Low	5	125	0.4	**6.4**
Left Bank	98	Very High	Low	6	125	0.4	**14.6**
Right Bank	102	Low	Low	4.5	125	0.02	**0.6**
Left Bank	51	Very High	Low	6	125	0.4	**7.7**
Right Bank	49	High	Low	5	125	0.4	**6.2**
Right Bank	61	Moderate	Low	7	125	0.13	**3.5**
Right Bank	86	Extreme	Low	7	125	1.2	**45.0**
Left Bank	73	Moderate	Low	4	125	0.13	**2.4**
Right Bank	56	High	Low	5	125	0.4	**7.0**
Left Bank	63	Very High	Low	5	125	0.4	**7.8**
Right Bank	79	High	Low	5	125	0.4	**9.8**
Left Bank	74	Moderate	Low	5	125	0.13	**3.0**
Right Bank	69	Very High	Low	10	125	0.4	**17.2**
Left Bank	160	High	Low	5	125	0.4	**19.9**
Right Bank	103	Very High	Low	5	125	0.4	**12.8**
Left Bank	56	Extreme	Low	7	125	1.2	**29.4**
Right Bank	82	High	Low	5	125	0.4	**10.2**
Left Bank	53	Moderate	Low	4	125	0.13	**1.7**
Right Bank	57	Extreme	Low	7	125	1.2	**29.8**
Left Bank	63	Moderate	Low	5	125	0.13	**2.6**
Right Bank	68	Low	Low	3.5	125	0.02	**0.3**
Left Bank	78	Very High	Moderate	6	125	0.6	**17.6**
Left Bank	53	Moderate	Low	4	125	0.13	**1.7**
Right Bank	61	Extreme	Low	7	125	1.2	**31.9**
Left Bank	55	Moderate	Low	5	125	0.13	**2.2**
Left Bank	36	Very High	Low	6	125	0.4	**5.4**
Right Bank	59	High	Low	4.5	125	0.4	**6.6**
Right Bank	43	Low	Low	5	126	0.02	**0.3**
						Total	**348.8**

	Hickey Run Erosion Curve
TN Export Rate (lbs/yr)	795
TP Export Rate (lbs/yr)	366
TN 50% Efficiency Protocol 1	**398**
TP 50% Efficiency Protocol 1	**183**

**TN and TP calculation uses default concentrations of 1.05 lbs P/ ton of sediment and 2.28 lbs N /ton of sediment as provided in Recommendations of the Expert Panel to Define Removal Rates for Individual Projects, 2014

Table 2: Wolf Creek at Goode Park, Summary of Removal Rates Using Protocol 1 vs. the Default Rate

Erosion Estimate Method	Total Project Bank Length (ft)	Existing TN Export Rate (lbs/year)	Existing TP Export Rate (lbs/year)	TN Removal Rate @50% Efficiency (lbs/year)	TP Removal Rate at 50% Efficiency (lbs/year)*	Sediment Removal Rate (tons/year)
[(1)] **Hickey Run Erosion Curve***	2342	795	366	**398**	**183**	**349**
Revised Default Rate*	2342			**176**	**159**	**53**

* From Recommendations of the Expert Panel to Define Erosion Removal Rates for Individual Stream Restoration Projects (0.075 lbs N/ft/yr and 0.068 lbs P/ft/yr)

(1) Site specific erosion assessment using the BANCS model

Cost effectiveness:

$	1,932.21	per lb TN/yr	*Based on site-specific assessment using BANCS method with the Hickey Run Erosion Curve TN Removal*
$	4,195.67	per lb TP/ yr	*Based on site-specific assessment using BANCS method with the Hickey Run Erosion Curve TP Removal*

Restoration of Wolf Creek at Goode Park

Photo Log

Example BEHI Classifications

Photo 1A. Eroding bank (right bank) along Wolf Creek - rated as an "Extreme" BEHI.

Photo 2A. Eroding bank (left bank) - rated as a "Very High" BEHI.

Photo 3A. Eroding bank on the left side near Wolf Creek Greenway - rated as a "High" BEHI.

Photo 4A. Looking upstream at bankfull bench both sides of channel – rated as a "Moderate" BEHI.

Photo 5A. Looking upstream along Wolf Creek - rated as a "Low" BEHI.

Photo 6A. Looking upstream along Wolf Creek – rated as a "Very Low" BEHI.

Existing Conditions – Photo Log

Photo 1. "Moderate" left and right bank from approximately Station 10+00. Minimal work needed, potentially a rock toe along left bank in meander to help stabilize (see Sheet 1 of Conceptual Drawings).

Photo 2. "Very High" erosion along the left bank around Station 14+00. Install toe wood to provide slope stabilization. Grade back right bank and install bankfull bench, line with coir matting and vegetate (see Sheet 1 of Conceptual Drawings).

Photo 3. "Extreme" right bank (looking upstream) with severe sediment deposition at approximately Station 15+50. Grade back bank and install a bankfull bench. Install toe wood and reshape channel to centralize (see Sheet 2 of Conceptual Drawings).

Photo 4. "High" erosion along the right bank and "Very High" along left bank around Station 17+00. Grade back both banks and install bankfull bench. Install toe wood along right bank in the bend to provide slope stabilization (see Sheet 2 of Conceptual Drawings).

Photo 5. "High" left bank at approximately Station 19+00. Grade back bank and install toe wood for slope stabilization. Install rock cross-vane downstream for channel grade control (see Sheet 2 of Conceptual Drawings).

Photo 6. "Extreme" erosion along the right bank around Station 21+50 (looking upstream). Grade back right bank and install bankfull bench, line with coir matting and vegetate (see Sheet 2 of Conceptual Drawings).

Photo 7. "Very High" left bank with severe sediment deposition at approximately Station 23+00. Grade back bank and install a bankfull bench. Install rock toe and reshape channel to centralize (see Sheet 2 of Conceptual Drawings).

Photo 8. "High" erosion along the left bank close to the Wolf Creek Greenway around Station 23+50. Grade back bank and install bankfull bench. Install rock toe along bank in the bend to provide slope stabilization (see Sheet 3 of Conceptual Drawings).

Photo 9. "Extreme" right bank at approximately Station 24+00. Install toe wood for slope stabilization along right bank. Grade back bank on left (see Sheet 3 of Conceptual Drawings).

Photo 10. "Very High" erosion along the left bank and "High" erosion around Station 25+00 (looking downstream). Grade back both banks and install rock toe along the right bank. Use local material when possible (see Sheet 3 of Conceptual Drawings).

Legend

- Station
- Log or Rock Vane
- Toe Wood
- Rock Toe Protection
- Rock Cross-Vane
- Geo-Lift
- Channel Improvements
- Bank Grading
- Slope Stabilization Material

BEHI Rating

- Extreme
- Very High
- High
- Moderate
- Low

BEGIN STREAM RESTORATION

GRADE BACK BANKS AT STABLE SLOPE, LINE WITH COIR MATTING AND PLANT VEGETATION.

10+00

11+00

12+00

13+00

14+00

15+00

TYPICAL SECTION 3 :
GRADE BACK BENCH AND RESHAPE POINT BAR ON LEFT BANK GRADE BACK BENCH AND TIE IN TO TOE WOOD ON RIGHT BANK

TYPICAL SECTION 2 :
GRADE BACK BENCH WITH TOE WOOD ON RIGHT AND LANK BANKS

TOE WOOD (TYP)

GRADE BACK BANKS AT STABLE SLOPE. INSTALL BANKFULL BENCH AND TIE IN TO TOE WOOD.

GOODE PARK

FREESE AND NICHOLS

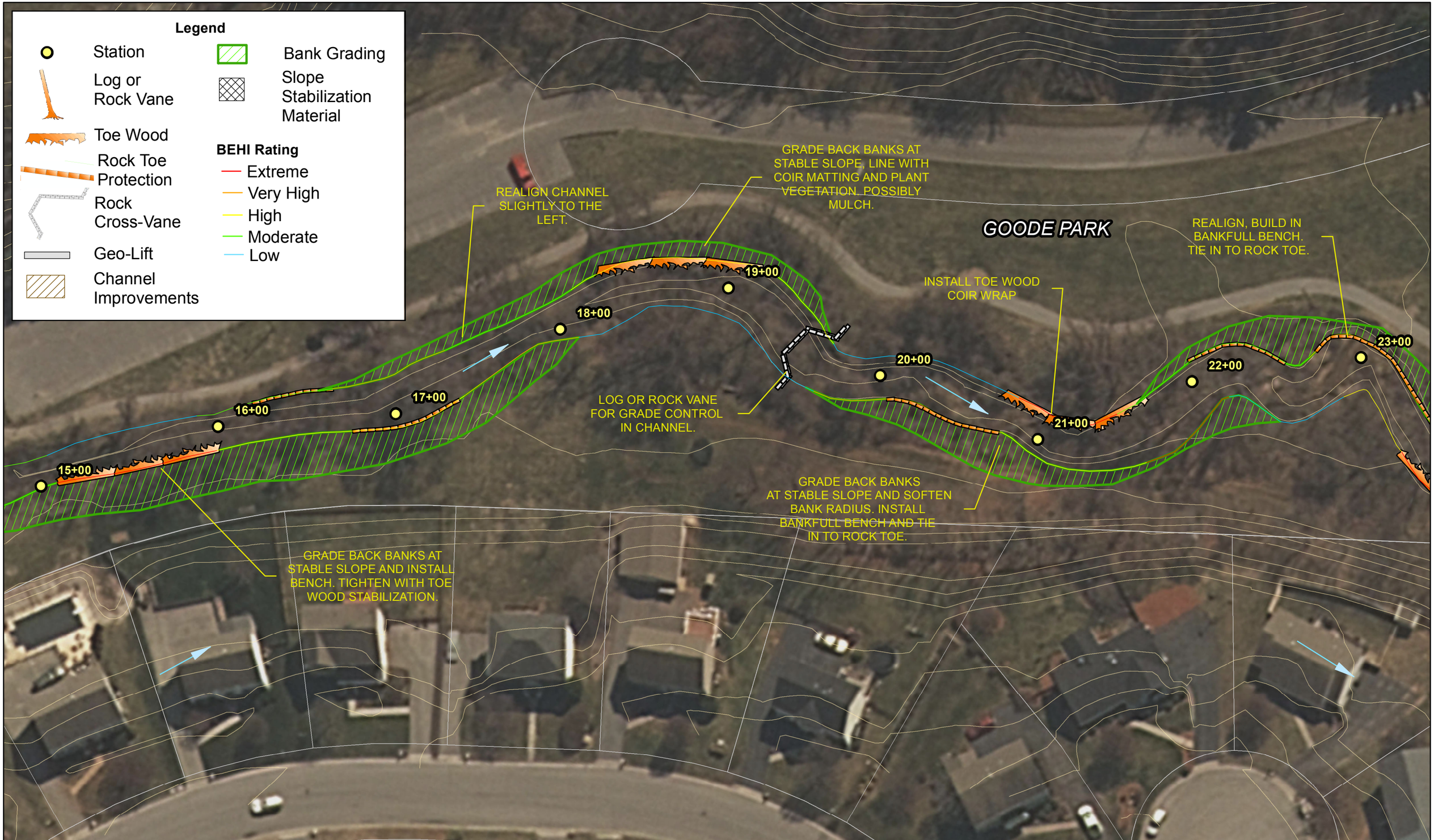
WOLF CREEK AT GOODE PARK STREAM RESTORATION
PRELIMINARY PLAN

SHEET 1

PLAN VIEW

0 22.5 45 90 Feet

1 inch = 45 feet



FREESE AND NICHOLS	WOLF CREEK AT GOODE PARK STREAM RESTORATION PRELIMINARY PLAN	SHEET 2	PLAN VIEW	0 22.5 45 90 Feet 1 inch = 45 feet

Legend

- Station
- Log or Rock Vane
- Toe Wood
- Rock Toe Protection
- Rock Cross-Vane
- Geo-Lift
- Channel Improvements
- Bank Grading
- Slope Stabilization Material

BEHI Rating

- Extreme
- Very High
- High
- Moderate
- Low

GOODE PARK

GRADE BACK BANK AT STABLE SLOPE

TYPICAL SECTION 1 :
ROCK TOE ON LEFT BANK
GRADE BACK BENCH WITH
TOE WOOD ON RIGHT BANK

END BANK STABLIZATION WORK

23+00

24+00

25+00

GRADE BACK BANKS AT STABLE SLOPE AND SOFTEN BANK RADIUS. INSTALL BANKFULL BENCH AND TIE IN TO ROCK TOE.

FREESE AND NICHOLS

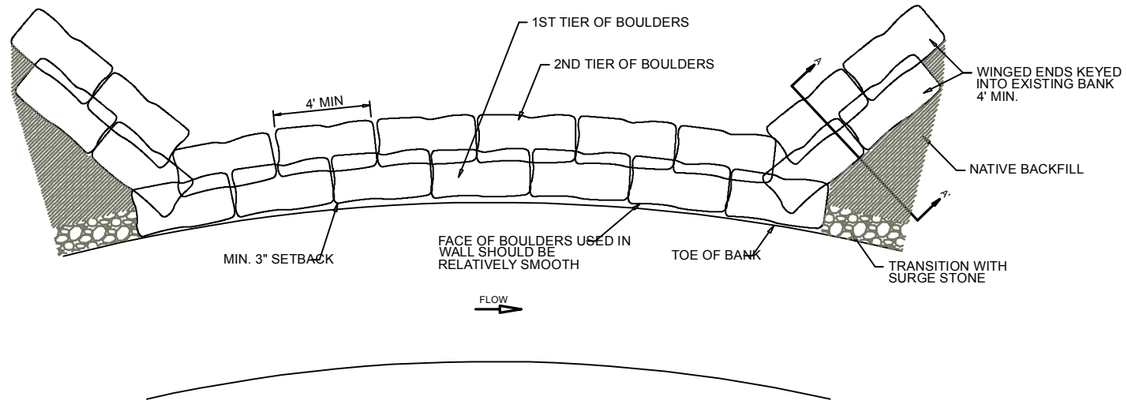
WOLF CREEK AT GOODE PARK STREAM RESTORATION
PRELIMINARY PLAN

SHEET 3

PLAN VIEW

0 22.5 45 90 Feet

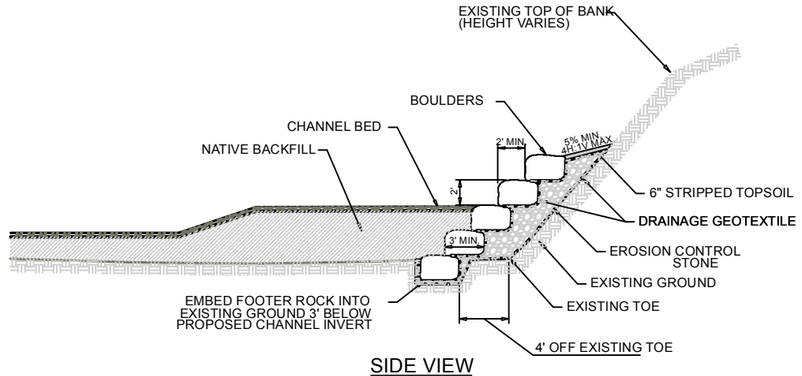
1 inch = 46 feet



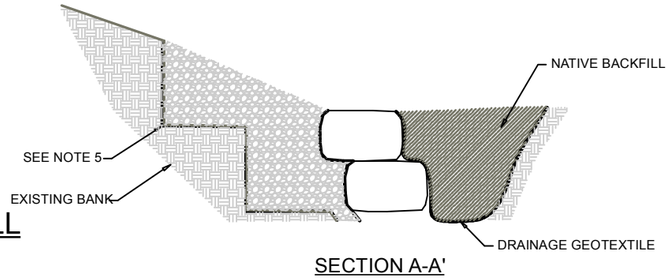
PLAN VIEW

NOTE

1. SEE SECTIONS FOR WALL LOCATIONS. EXISTING GROUND TIE-IN ELEVATIONS AND SLOPES VARY BASED ON SECTION LOCATIONS.
2. NUMBER OF BOULDERS WILL VARY DEPENDING ON ELEVATION OF EXISTING SLOPE TIE-IN POINT AND PROPOSED BANKFULL ELEVATION.
3. CONTRACTOR SHALL NOT REMOVE ANY OF THE EXISTING SLOPE WHEN CONSTRUCTING BOULDER WALL
4. ALL ROCKS SHALL BE BOULDERS
5. WHERE EXCAVATION INTO EXISTING SLOPE IS REQUIRED, CUT INTO EXISTING MATERIAL IN A BENCHING OR STAIR STEP FASHION. EACH BENCH SHALL FORM A HORIZONTAL SURFACE AND CORRESPONDING NEARLY VERTICAL SURFACE. THE HEIGHT DIFFERENCE BETWEEN ADJACENT HORIZONTAL SURFACES SHALL BE A MINIMUM OF 3'

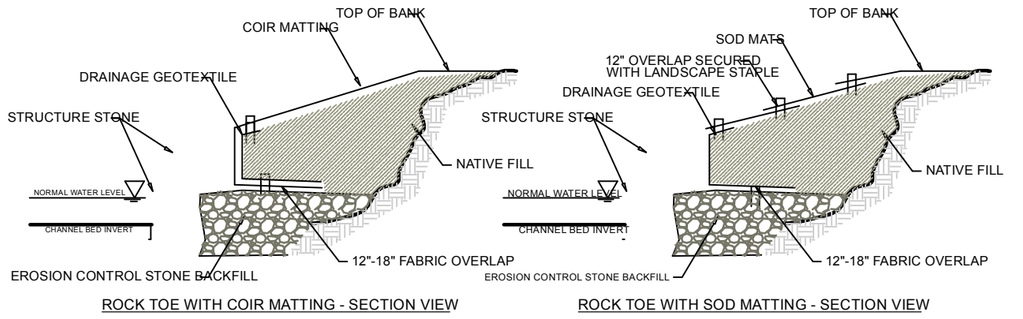


SIDE VIEW



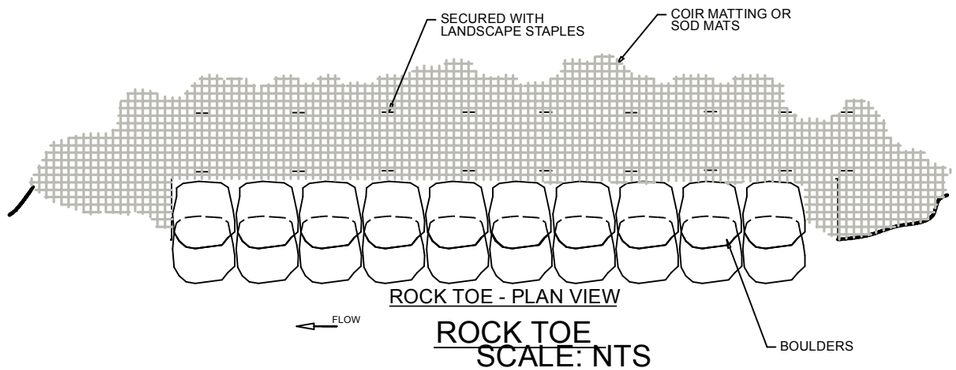
SECTION A-A'

STACKED ROCK WALL
SCALE: NTS



ROCK TOE WITH COIR MATTING - SECTION VIEW

ROCK TOE WITH SOD MATTING - SECTION VIEW

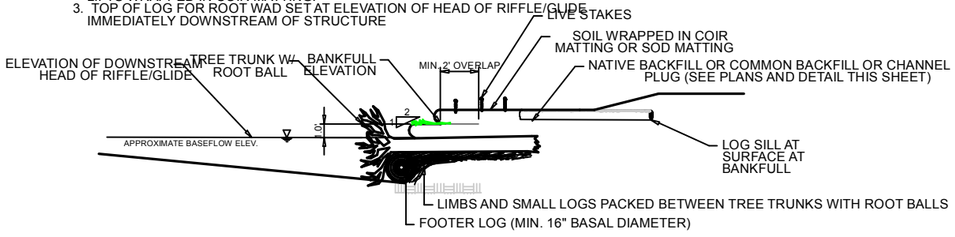


ROCK TOE - PLAN VIEW

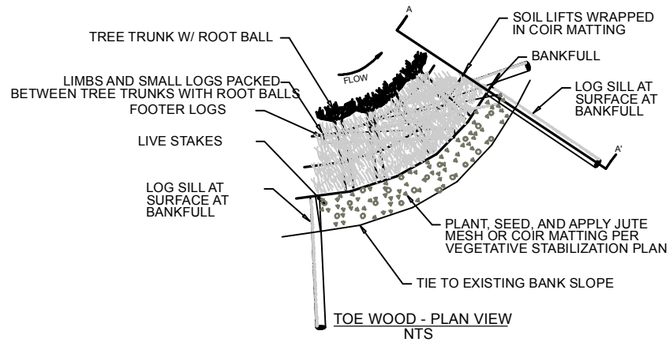
ROCK TOE
SCALE: NTS

NOTES:

1. THE CONTRACTOR SHALL USE LOGS, TRUNKS WITH ROOTS, AND BRANCHES TO FORM THE "TOE WOOD" STREAMBANK TOE PROTECTION.
2. THE STREAMBANKS ABOVE THE TOE WOOD SHALL BE FORMED FROM SOIL LIFTS WRAPPED IN COIR MATTING.
3. TOP OF LOG FOR ROOT WAD SET AT ELEVATION OF HEAD OF RIFFLE/GLIDE IMMEDIATELY DOWNSTREAM OF STRUCTURE



TOE WOOD - SECTION VIEW A-A'
NTS



TOE WOOD - PLAN VIEW
NTS

TOE WOOD
SCALE: NTS

FREESE AND NICHOLS

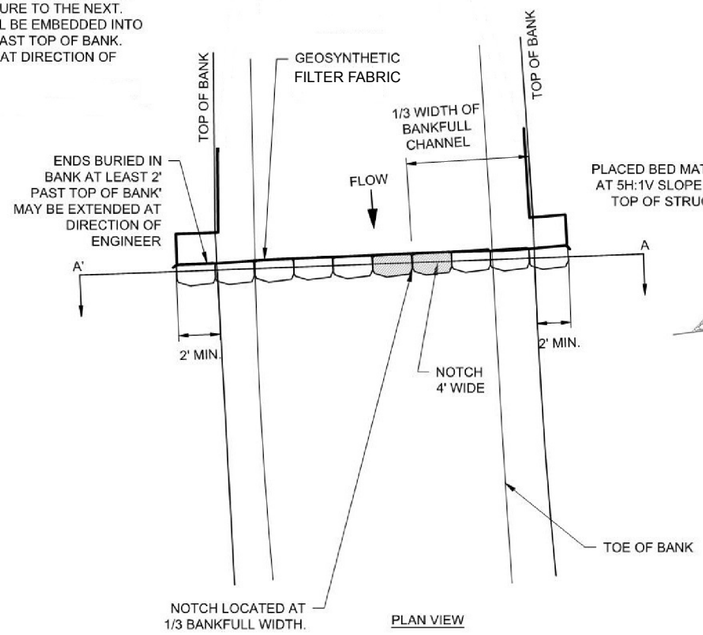
WOLF CREEK AT GOODE PARK STREAM RESTORATION
PRELIMINARY PLAN

SHEET 4

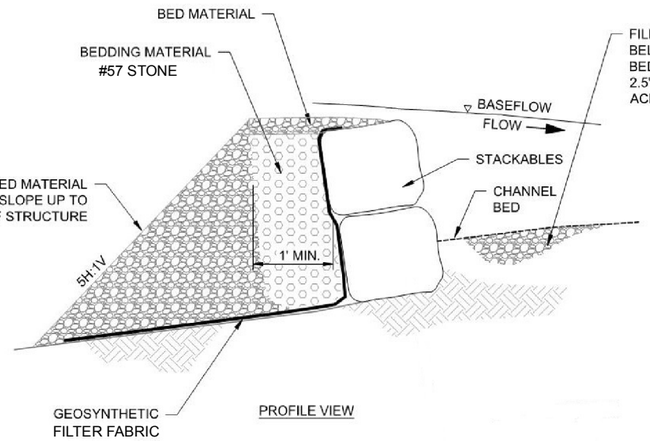
GENERAL DETAILS

NOTE:

1. SILL ROCKS TO BE STACKABLES.
2. CREATE LOW-FLOW NOTCH OF AT LEAST 6" DEPTH USING THINNER ROCK, LOCATE AT 1/3 BANKFULL WIDTH, ALTERNATING FROM ONE STRUCTURE TO THE NEXT.
3. ENDS OF SILL SHALL BE EMBEDDED INTO BANK AT LEAST 2' PAST TOP OF BANK. MAY BE EXTENDED AT DIRECTION OF ENGINEER.

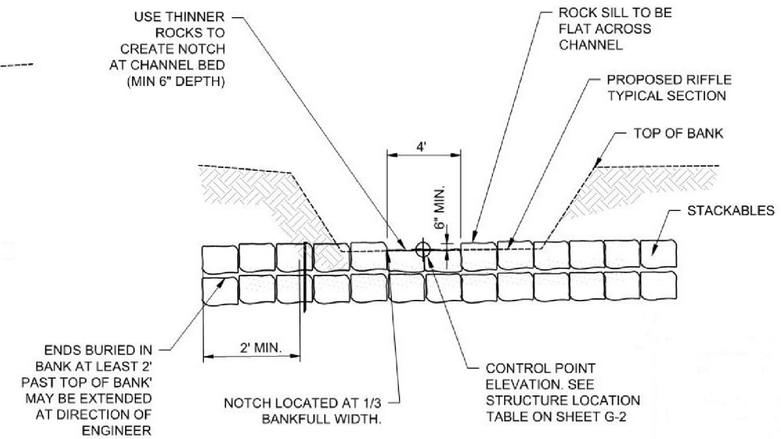


PLAN VIEW

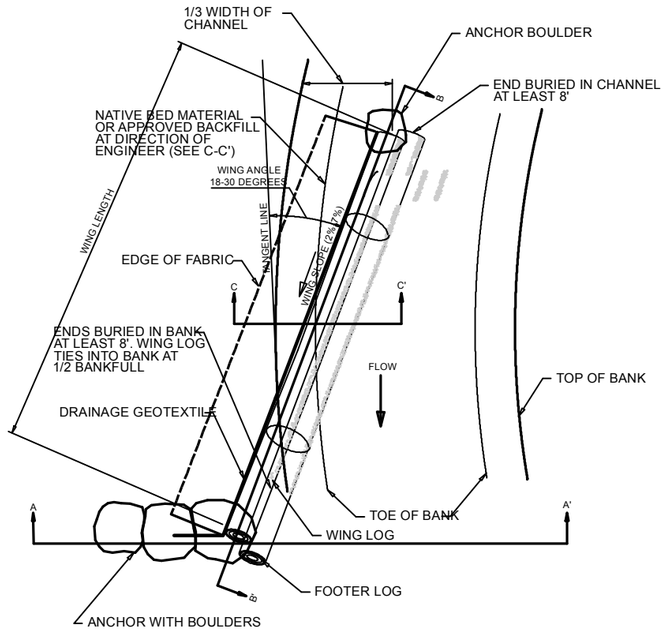


PROFILE VIEW

ROCK SILL
SCALE: NTS



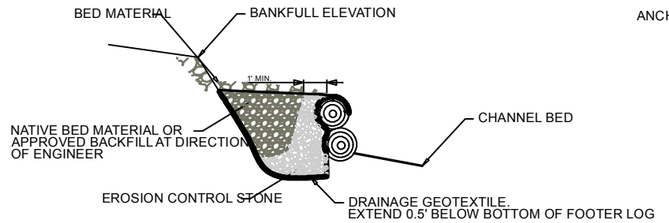
ROCK SILL SECTION A - A' LOOKING DOWNSTREAM



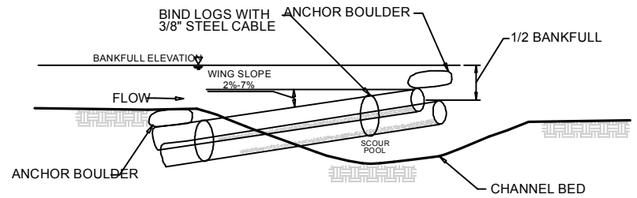
PLAN VIEW

NOTES

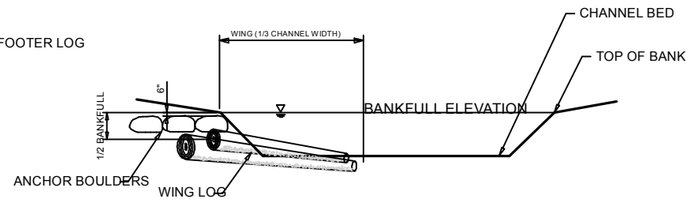
1) VANE ARMS BACKFILLED WITH NATIVE BED MATERIAL OR APPROVED BACKFILL AT DIRECTION OF ENGINEER.
2) BANKFULL CHANNEL WIDTH INDICATES THE WIDTH OF THE PROPOSED CHANNEL AT THE SPECIFIC STRUCTURE LOCATION. THIS WIDTH MAY NOT NECESSARILY BE THE SAME AS THE TYPICAL CROSS-SECTION WIDTH SHOWN IN THE DETAILS.



SECTION C-C'



SECTION B-B' (PROFILE VIEW)

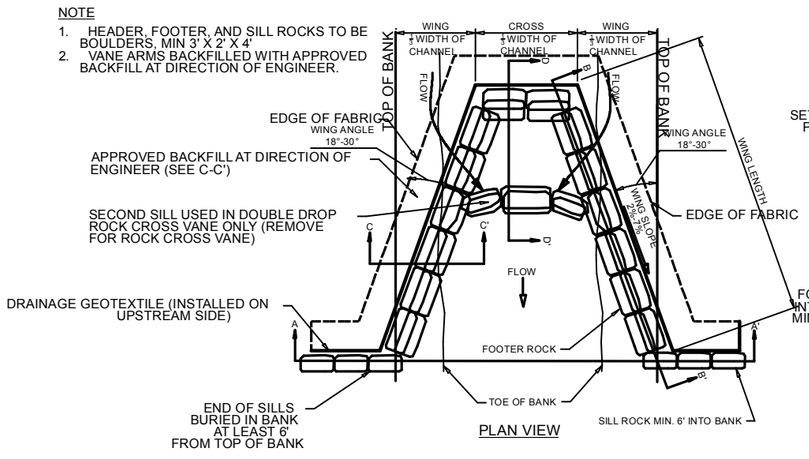


SECTION A'-A (UPSTREAM VIEW)

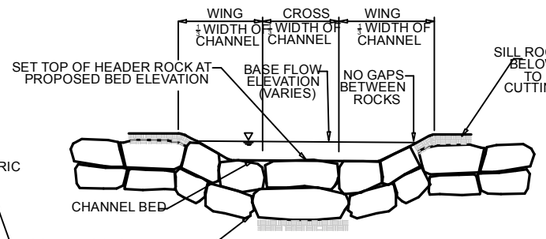
LOG VANE
SCALE: NTS

NOTE

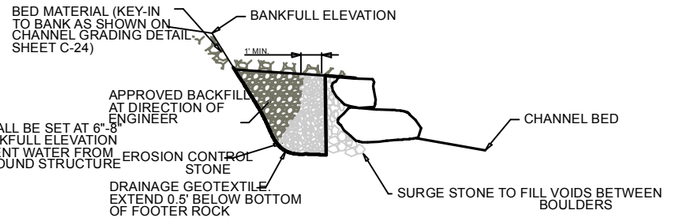
1. HEADER, FOOTER, AND SILL ROCKS TO BE BOULDERS, MIN 3' X 2' X 4'
2. VANE ARMS BACKFILLED WITH APPROVED BACKFILL AT DIRECTION OF ENGINEER.



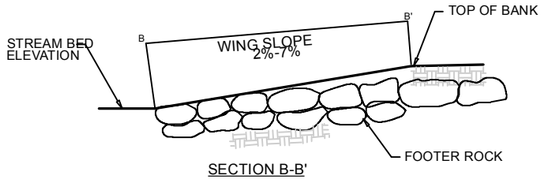
PLAN VIEW



SECTION A-A' (UPSTREAM VIEW)

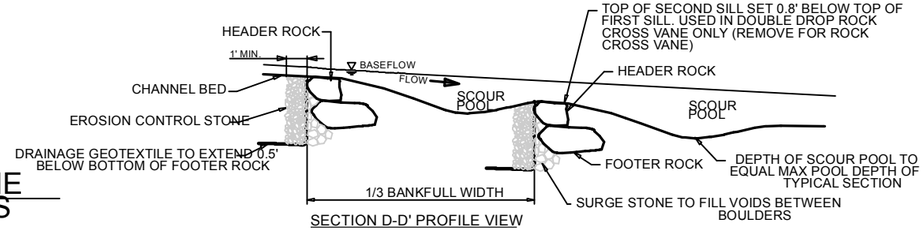


SECTION C-C'



SECTION B-B'

ROCK CROSS VANE
SCALE: NTS



SECTION D-D' PROFILE VIEW

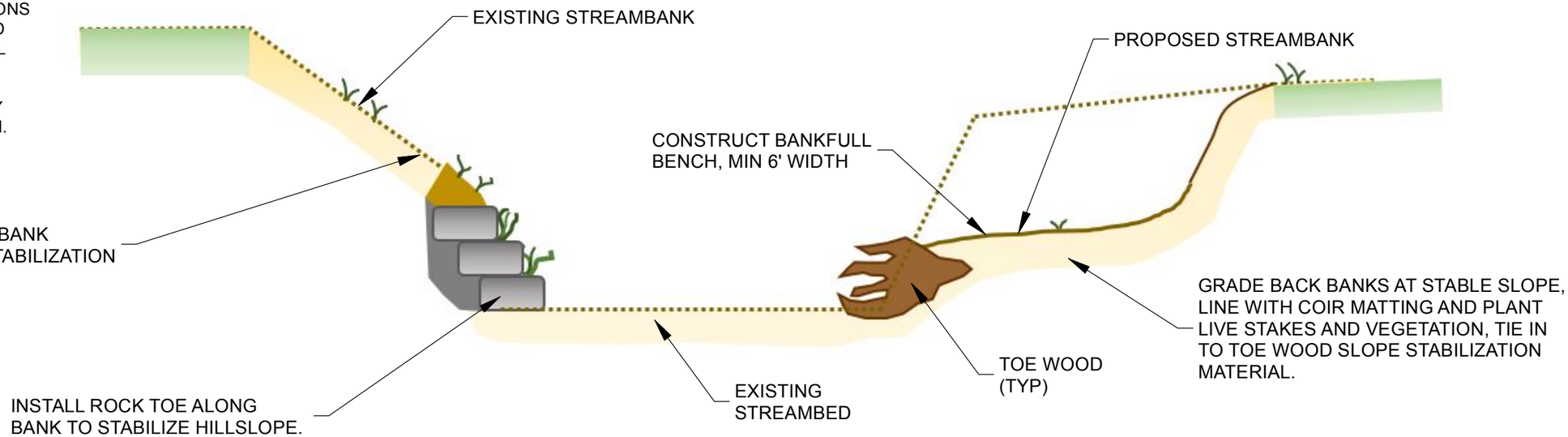
FREESE AND NICHOLS

WOLF CREEK AT GOODE PARK STREAM RESTORATION
PRELIMINARY PLAN

SHEET 6

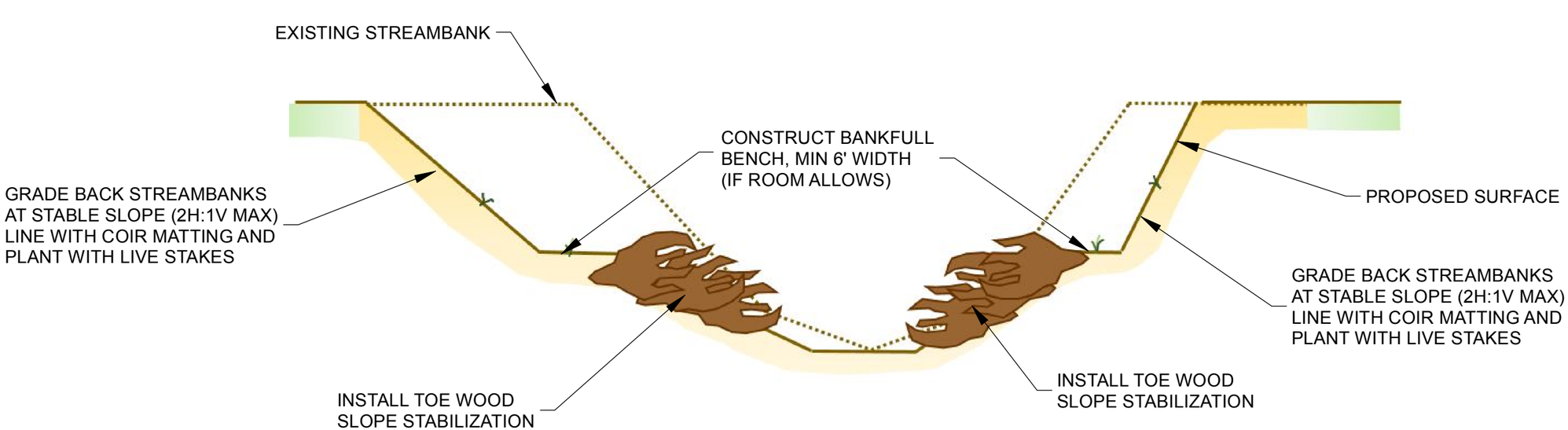
GENERAL DETAILS

NOTE: THE RESTORATION SOLUTIONS VARY ALONG THE RIGHT BANK AND THE LEFT BANK. THE CONCEPTUAL CROSS-SECTIONS ARE MEANT TO PROVIDE A GENERAL IDEA OF THE DESIGN CONCEPTS BUT MAY VARY DEPENDING ON THE FINAL DESIGN.



TYPICAL SECTION 1- ROCK TOE ON LEFT BANK AND GRADE BACK BENCH WITH TOE WOOD ON RIGHT BANK

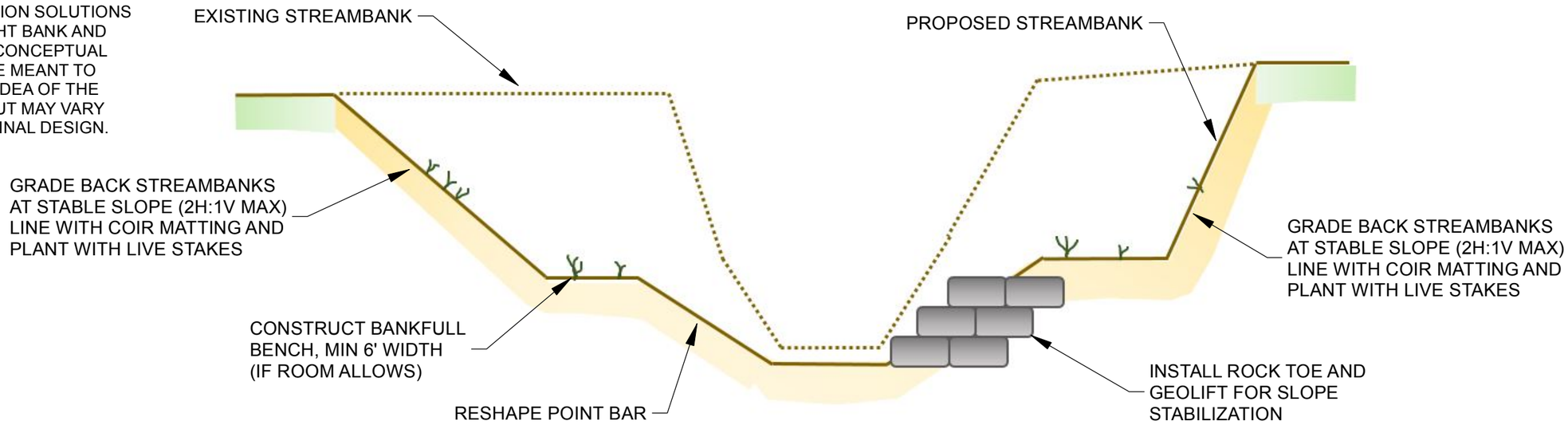
(LOOKING DOWNSTREAM)



TYPICAL SECTION 2- GRADE BACK BENCH WITH TOE WOOD ON RIGHT AND LEFT BANK

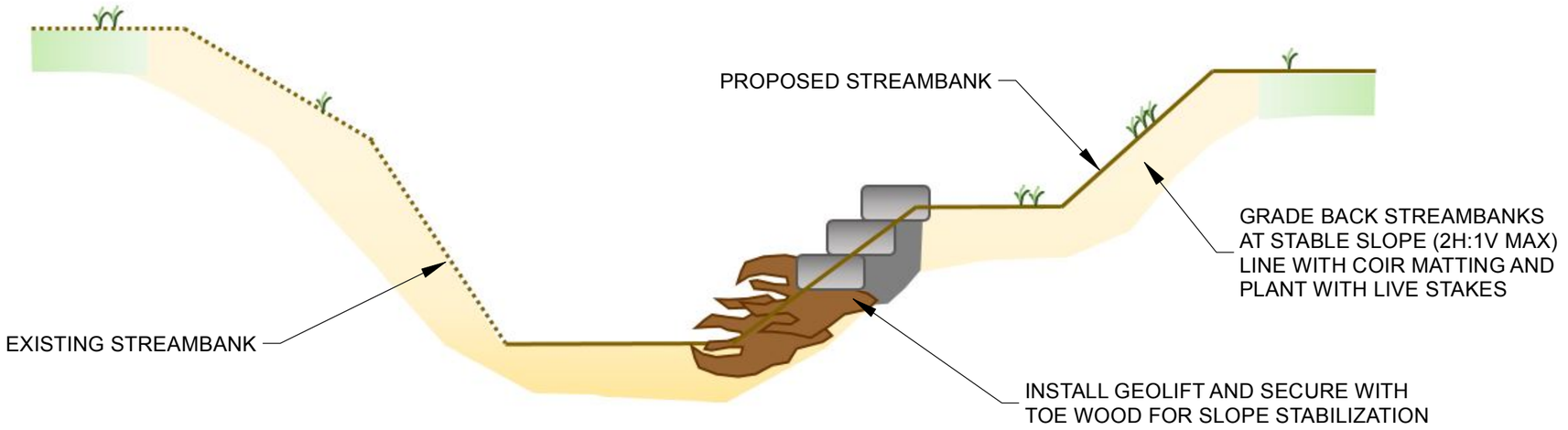
(LOOKING DOWNSTREAM)

NOTE: THE RESTORATION SOLUTIONS VARY ALONG THE RIGHT BANK AND THE LEFT BANK. THE CONCEPTUAL CROSS-SECTIONS ARE MEANT TO PROVIDE A GENERAL IDEA OF THE DESIGN CONCEPTS BUT MAY VARY DEPENDING ON THE FINAL DESIGN.



TYPICAL SECTION 3- GRADE BACK BENCH AND RESHAPE POINT BAR ON LEFT BANK, GRADE BACK BENCH AND TIE IN TO TOE WOOD ON RIGHT BANK

(LOOKING DOWNSTREAM)



ALTERNATIVE SECTION - INSTALL GEOLIFT ON RIGHT BANK AND SUPPORT WITH TOE WOOD

GOODE PARK STREAM RESTORATION
CONCEPTUAL CONSTRUCTION COST ESTIMATE

ITEM NO.	Pay Item Description	Unit	Estimated Quantity	Unit Price	Item Amount
1	Mobilization/Demobilization	LS	1	$ 35,023.57	$ 35,023.57
2	Clearing and Grubbing Approximated 2/3 Acreage of Temp. Seeding	AC	3.1	$ 750.00	$ 2,350.00
3	Construction Entrance	EA	2	$ 2,800.00	$ 5,600.00
4	Construction Safety Fence	LF	4,000	$ 3.00	$ 12,000.00
5	Silt Fence	LF	3,000	$ 3.50	$ 10,500.00
6	Pump Around Diversion	LS	1	$ 24,000.00	$ 24,000.00
7	Sediment Bag/Special Stilling Basin	EA	2	$ 2,000.00	$ 4,000.00
8	Grading (excavation)	CY	5,000	$ 27.00	$ 135,000.00
9	Turbidity Curtain	LF	60	$ 25.00	$ 1,500.00
10	Coir Matting/Sod Matting	SY	4,000	$ 7.10	$ 28,400.00
11	Log/Rock Vane	EA	4	$ 5,000.00	$ 20,000.00
12	Rock Toe	LF	800	$ 122.00	$ 97,600.00
13	Toe Wood	LF	800	$ 50.00	$ 40,000.00
14	Permanent Seeding	AC	3.1	$ 1,800.00	$ 5,580.00
15	Temporary Seeding	AC	3.1	$ 1000.00	$ 3,100.00
16	Temporary Stream Crossing	EA	2	$ 2,400.00	$ 4,800.00
17	Live Stakes	EA	2,000	$ 3.50	$ 7,000.00
18	Bare root seedlings	EA	2,000	$ 3.50	$ 57000.00
	Subtotal				$ 443,428.57
	5% Construction Contingency				$ 22,171.43
				Total Cost	**$ 465,600**