PGH2O | PITTSBURGH WATER

MWalaan@pgh2o.com
Direct Dial: 412.255.2289

April 8, 2026

VIA ELECTRONIC FILING
Matt Homsher, Secretary
Pennsylvania Public Utility Commission
Commonwealth Keystone Building, 2nd Floor
Harrisburg, PA 17120

Re: Public Utility Municipal Contract – Contribution Agreement between Baldwin Township and The Pittsburgh Water and Sewer Authority d/b/a Pittsburgh Water related to the Saw Mill Run Watershed Project

Dear Secretary, Homsher:

Please be advised that the above-reference Public Utility Municipal Contract (dated April 8, 2026) ("Agreement") between The Pittsburgh Water and Sewer Authority ("Pittsburgh Water") and Baldwin Township was filed with the Commission by Pittsburgh Water on April 8, 2026.

Should you have any questions regarding the enclosed Public Utility Municipal Contract, please contact me at 412-255-2289.

Very truly yours,

/s/ Monica Walaan
Monica Walaan, Esquire
PA Attorney ID. #318624

Enclosures

cc: Darryl Lawrence, Office of Consumer Advocate
NazAarah Sabree, Office of Small Business Advocate
Allison Kaster, Bureau of Investigation and Enforcement

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

CONTRIBUTION AGREEMENT BETWEEN BALDWIN TOWNSHIP AND THE PITTSBURGH WATER AND SEWER AUTHORITY FOR THE SAW MILL RUN WATERSHED PROJECT

THIS AGREEMENT, made and entered into as of

April 8, 2026,

by and between the

BALDWIN TOWNSHIP, a body corporate and politic organized and existing under the laws of the Commonwealth of Pennsylvania ("Baldwin"),

A

N

D

THE PITTSBURGH WATER AND SEWER AUTHORITY D/B/A PITTSBURGH WATER, a municipal authority organized and existing under the laws of the Commonwealth of Pennsylvania and having a principal place of business located at Penn Liberty Plaza 1, 1200 Penn Avenue, Pittsburgh PA 15222, ("Pittsburgh Water").

WITNESSETH:

WHEREAS, Pittsburgh Water and the Commonwealth of Pennsylvania, acting through its Department of Transportation ("PennDOT") partnered to reduce sediment pollution in the Saw Mill Run Watershed as part of the pollutant reduction plan obligations in the National Pollutant Discharge Elimination System ("NPDES") permits for their respective Municipal Separate Storm Sewer Systems ("MS4"); and

WHEREAS, the project consisted of two stream restoration projects at Crane Avenue and Moore Park in the City of Pittsburgh within the Saw Mill Run Watershed to reduce sediment pollution and implement the Total Maximum Daily Loan ("TMDL") plan ("Project"); and

WHEREAS, the total stream restoration at Moore Park is one thousand nine hundred eighty-one linear feet (1,981ft); and

WHEREAS, Pittsburgh Water is partnering with other municipalities in the Saw Mill Run Watershed to contribute to pollutant reduction; and

WHEREAS, Baldwin desires to participate in the Project located in Moore Park; and

WHEREAS, Baldwin has agreed to restore two hundred linear feet (200ft) of stream in Moore Park and contribute an amount not-to-exceed Forty-Nine Thousand Eight Hundred Seven Dollars and Sixty Cents ($49,807.60) for the design and construction of the restoration; and

WHEREAS, this Agreement outlines the respective duties and entitlements of both Baldwin and Pittsburgh Water.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

NOW THEREFORE, in consideration of the mutual promises and intending to be legally bound, the parties agree as follows:

1. **INCORPORATION:** The above recital clauses are incorporated herein by reference.

2. **ROLES AND RESPONSBILITIES:** Subject to all terms and conditions set forth below:

   a. Baldwin shall:
      i. Restore two hundred linear feet (200ft) of stream for the Project at Moore Park.
      ii. Provide to Pittsburgh Water an amount not to exceed Forty-Nine Thousand Eight Hundred Seven Dollars and Sixty Cents ($49,807.60) within thirty (30) days of the effective date of this Agreement, for the construction and design of its portion of the restoration for the Project.
      iii. Receive Nine Thousand Five Hundred Sixty Pounds (9,560lbs/year) of sediment credit based on its two hundred linear feet (200ft) of restoration with a load reduction calculated consistent with the expert panel protocol averaging 47.8lbs/ft.

   b. Pittsburgh Water shall:
      i. Restore One Thousand Seven Hundred Fifty-one linear feet (1,751ft) of stream at Moore Park as part of the Project.
      ii. As part of the Project, pay for the design and construction at an amount not to exceed One Million Dollars ($1,000,000.00) in order to receive full credit for sediment reduction.
      iii. Provide Baldwin with Nine Thousand Five Hundred Sixty Pounds (9,560 lbs/Year) of sediment credit based on its pro rata share of the stream restoration.
      iv. Receive Two Hundred One Thousand Three Hundred Sixty-Five Pounds (201,365lbs/year) of sediment credit based on its one thousand seven hundred fifty-one linear feet (1,751ft) of restoration with a load sediment reduction calculated using the Mapshed default rate of 115lbs/ft.

   c. Operation and Maintenance
      i. The contractor for the Project shall be responsible for operation and maintenance of the Project for five (5) years following completion thereof as set forth in Exhibit A attached hereto.
      ii. The contractor for the Project will turn over the long-term maintenance to a qualified third party.
      iii. Pittsburgh Water shall be responsible, along with PennDOT, for funding and enforcing the long-term operation and maintenance of the improvements constructed by the Project. In addition, Baldwin, along with other participating municipal entities, shall implement a public education and public participation plan for the Moore Park project.

3. **TERM OF AGREEMENT:** Subject to applicable provisions of the Pennsylvania Public Utility Code, the term of this Agreement will commence on the earliest date allowed under the applicable law and will continue until the work described herein is complete.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

4. **TERMINATION OF AGREEMENT:** Baldwin or Pittsburgh Water may individually terminate this Agreement with thirty (30) days' advance written notice of the intention to terminate, to the other party. In the event of termination, Baldwin or Pittsburgh Water will fully pay any amounts not in dispute for work performed through the date of termination.

5. **MODIFICATION OR AMENDMENT:** This Agreement contains all terms and conditions agreed upon by the parties hereto, and no other agreement, oral or otherwise, regarding the subject matter of this Agreement, will be deemed to exist or to bind any of the parties hereto. Also, this Agreement may not be changed, modified, discharged or extended except by written amendment, duly executed by the parties.

6. **MONITORING AND EVALUATION:** Pittsburgh Water shall provide an opportunity for Baldwin or its authorized representative to monitor and evaluate the work provided pursuant to the Project. Upon request, Pittsburgh Water will endeavor in good faith, subject to applicable law, to provide Baldwin with any additional information and data required by federal authorities or state authorities.

7. **ASSIGNMENT:** This Agreement may not be assigned except by the written consent of both parties.

8. **NOTICES:** All notices required to be given pursuant to the terms and provisions of this Agreement shall be in writing, sent by certified mail, return receipt requested, prepaid, and shall be addressed as follows:

TO BALDWIN:	Baldwin Township 10 Community Park Drive Pittsburgh, PA 15234 ATTENTION: Township Manager
TO PITTSBURGH WATER:	The Pittsburgh Water and Sewer Authority Penn Liberty Plaza 1 1200 Penn Avenue Pittsburgh, PA 15222 ATTENTION: Chief Executive Officer

Or such other address as either party shall subsequently advise the other. Notices shall be deemed delivered two (2) business days following deposit into the mail.

9. **SUCCESSORS AND ASSIGNS:** All covenants and obligations of the parties under this Agreement will bind their successors, whether or not expressly assumed by successors.

10. **GOVERNING LAW:** The validity, interpretation and performance of this Agreement shall be governed by and construed in accordance with the laws of the Commonwealth of Pennsylvania. The provisions of this Agreement shall be deemed severable and if any portion shall be held invalid, illegal or unenforceable for any reason, the remainder of this Agreement shall be effective and binding upon the parties.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

11. LIABILITY OF PITTSBURGH WATER: To the extent permitted by law, each Party hereto (the "Indemnifying Party") agrees to defend, indemnify, and hold harmless the other Party, its directors, officers, partners, agents, employees, and affiliates, (the other "Indemnified Party"), from and against any and all claims, loss, damage, expense and/or liability, arising out of the responsible Indemnifying Party's intentional, negligent acts or omissions under this Agreement, and/or such Party's failure to comply with any provisions of this Agreement. Without waiving its rights thereunder, Pittsburgh Water's indemnity obligations herein apply to the extent permitted under and to the limits of the Political Subdivision Tort Claims Act, 42. Pa.C.S. § 8541, et. seq.

12. AUTHORIZATION BY PITTSBURGH WATER BOARD OF DIRECTORS: This Agreement is entered into by Pittsburgh Water pursuant to the authorization in Resolution No. 80 dated November 17, 2023.

13. BALDWIN AUTHORIZING RESOLUTION: This agreement is entered into by Baldwin pursuant to Resolution No. 2026-9, dated March 30, 2026.

14. PITTSBURGH WATER AUTHORIZATION: Pittsburgh Water's authorization is conditioned upon the approval of this Agreement by the Pennsylvania Public Utilities Commission ("PUC"), if legally required. Pittsburgh Water agrees that it will submit this Agreement for PUC review and/or approval, as the same may be legally required, after execution of this Agreement, and that Pittsburgh Water will take all good-faith actions needed to obtain such approval from the PUC as promptly as possible.

[THE REMAINDER OF THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK.]

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

IN WITNESS WHEREOF, the parties hereto have duly executed this Agreement on the day and year first above written.

THE PITTSBURGH WATER AND SEWER AUTHORITY D/B/A PITTSBURGH WATER

By: William J. Pickering
Name: William J. Pickering
Title: Chief Executive Officer
Date: 4/7/2026

Edward Barca
Edward Barca, Director of Finance for Pittsburgh Water

APPROVED AS TO FORM:

Megan Thiessen
Corporate Counsel for Pittsburgh Water

BALDWIN TOWNSHIP

By: Nick Pellegrino
Name: Nick Pellegrino
Title: President
Date: March 30, 2026

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

EXHIBIT A
SAWMILL RUN WATERSHED POLLUTANT REDUCTION PLAN

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Sawmill Run Watershed Pollutant Reduction Plan

City of Pittsburgh
Allegheny County,
Pennsylvania
February 21, 2023



Prepared for:
Commonwealth of Pennsylvania Department of Transportation

Prepared By:
Land Reclamation Group, LLC
632 Hunt Valley Circle
New Kensington, PA 15068

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Conceptual Pollutant Reduction Plan
Sawmill Run Municipal Separate Storm Sewer System Project
Land Reclamation Group, LLC

Contents

Executive Summary 3
Section A – Pollutants of Concern 3
Section B- Prospective BMP Sites and Eligibility 4
B.1.1. Moore Park 4
B.1.2 Crane Avenue 4
B.1.3 Deer Creek 4
B.2 MS4 Eligibility 5
Section C Determination of Existing Loading for Pollutants of Concern 5
C.1 Data Collection 5
C.2 Data Analysis 6
C.3 Results 7
Section D Selected BMPs to Achieve Reductions 8
Stormwater BMPs 11
Section E Operations and Maintenance 12
E.1 Site Protection 12
E.2 Maintenance and Monitoring 12
E.3 Long Term Operation and Maintenance 13
E.4 Financial Assurances 13
Section F Summary and Conclusion 13

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Tables

Table 1: Average Site Variables

Table 2: Existing Loads

Table 3A: Anticipated Sediment Reductions at Moore Park

Table 3B: Anticipated Sediment Reductions at Crane Avenue

Table 3C: Anticipated Sediment Reductions at Deer Creek

Table 4: Anticipated Stormwater Reductions at Moore Park

Table 5: Anticipated Stormwater Dry Retention BMP Reductions

Graphs

Graph 1: USFW Erosion Rates

Appendices

Appendix A: Figures

- Figure 1: Location Maps
- Figure 2: Soils Maps
- Figure 3: Land Use Maps
- Figure 4: Bank Erosion Hazard Ratings Maps
- Figure 5: Near-Bank Stress Ratings Maps
- Figure 6: Urbanized Area Map

Appendix B: Example Site Instrument

Appendix C: Conceptual Design Plans

Appendix D1: Supporting Sediment Data

Appendix D2: Supporting Stormwater Data

Appendix E: Project Schedule

Appendix F: Soil Bulk Density Lab Results

Appendix G: Summary Credit Sheets

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Executive Summary

Land Reclamation Group, LLC ("LRG") has prepared a Conceptual Best Management Practice Design Plan for the Pittsburgh Sewer and Water Authority ("PWSA") and the Pennsylvania Department of Transportation ("PennDOT") in the Sawmill Run Watershed. Additional work is also being done in the Ohio Watershed for the Pennsylvania Turnpike Commission ("PTC"). These projects will reduce the sediment loading to the watersheds, as obligated by their respective MS4 permits. This design plan provides site-specific BMP data to supplement the Pollutant Reduction Plans for Municipal Separate Strom Sewer System (MS4).

The project proposes the use of stream restoration and floodplain restoration to reduce the sediment loading rates at the selected BMP sites at two locations within the Sawmill Run Watershed (12-Digit HUC 050301010301), and one location in the Deer Creek Watershed (12-Digit HUC 050100090303). LRG has investigated several BMP sites to determine the best possible option for the project. This plan includes a summary of the site conditions and data for the selected BMP sites.

The selected sites contain streams that are impaired due to the impacts of stormwater runoff and land use. The selected restoration projects will be designed with sustainability in mind, along with increasing functionality to reduce sediment loads through the process of stabilizing stream banks and reconnecting the streams to the floodplain. Stream restoration will include channel restoration, floodplain grading and grade control structures to restore the channels and reconnect them with the floodplain. Woody debris will be used as the primary material for the grade control in the form of log grade control structures and floodplain features. The reconstructed streams will be designed to have low bank heights and low erosion rates.

This plan, along with the baseline sediment loadings, reductions, and effectiveness calculations were calculated in accordance to the Pennsylvania Department of Environmental Protection ("PA DEP") guidance document 3800-PM-BCW0100K- National Pollutant Discharges Elimination Systems (NPDES) Stormwater Discharges from Small Municipal Separate Storm Sewer Pollutant Reduction Plan (PRP) Instructions and the Credit Determination Protocol 1 of the "*Recommendations of the Expert Panel to Define Removal Rates for Individual Stream Restoration Projects."*

Results of the investigation show that the restoration of the two selected sites in Sawmill Run and one in Deer Creek will exceed the contracted sediment reduction target of 331,950 lb/yr. These BMPs will also lower the nitrogen and phosphorus loading rates. The calculated reductions for all three sites are provided in Table 3(a, b, c): Anticipated Sediment Reductions at Proposed BMP Sites. These calculations show the relation between the Sawmill Run/Deer Creek Watershed Restoration and the improved water quality of the entire watershed.

Section A – Pollutants of Concern

The proposed BMPs are located within the Sawmill Run and Deer Creek Watersheds. Both watersheds are listed as impaired for siltation and nutrients by the PA DEP. According to the approved PRP

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

instructions, the assumption can be made that meeting the sediment reduction goals for the watersheds will also accomplish nutrient reduction goals.

Section B- Prospective BMP Sites and Eligibility

The selected projects in the Sawmill Run Watershed are all located on property owned by the City of Pittsburgh. One of the sites is owned by two entities, one being the City of Pittsburgh and the other being the Pittsburgh Public School System. All of these sites are located in public parks and reside within the urbanized area of the City of Pittsburgh. Streams located in these parks have been impacted and are severely eroded by urban stormwater runoff. The proposed PTC site is located on private property located 0.15 miles away from the turnpike in Indiana Township. The property is within the one-mile buffer of the Turnpike urbanized area.

The locations of the selected BMPs and data are provided in the appendix. The figures include Figure 1: Location Maps, Figure 2: Soils Map, Figure 3: Land Usage Map, Figure 4: Bank Erosion Hazard Index Ratings Map, and Figure 5: Near-Bank Stress Rating Map. The general approaches to restoration are found in Appendix C: Design Plans and the site-specific loading and reductions are summarized in Sections C and D and in Appendix D: Supporting Calculations.

B.1.1. Moore Park

Moore Park is located on Pioneer Avenue just southwest of the Liberty Tubes. The park is situated between the Pittsburgh South Brook Middle School and Our Lady of Loreto Catholic Parish on the south and the Southcrest Heights Apartments on the north. The property is owned by the City of Pittsburgh and the Public School District of Pittsburgh. LRG is currently in the process of negotiating an agreement with both entities to allow work to be done on the property. The stream is 1,981 LF from the headwaters at the Moore Park Soccer Fields, flowing east towards the west busway terminating in a stormwater basin along the busway. The bank walls reach upwards of 6 feet in some portions of the tributary. Eroded drainage channels are also found along the hillside draining into the stream. LRG is proposing stream and floodplain restoration and the construction of two stormwater basins at the headwater to reduce the sediment load of the stream and increase the stormwater detention volume.

B.1.2 Crane Avenue

The Crane Avenue BMP is located near Vannucci Field just south of Brashear High School. The property is owned by the City of Pittsburgh. LRG is in the process of negotiating an agreement with the city to allow work to be done in the park. Roughly 1,722 LF of stream is located in the park. The stream enters the property from a concrete culvert under Crane Avenue and follows the road downhill to Sawmill Run. A tributary starting from a spring also enters the stream on the property. Both segments of the stream have signs of severe erosion with minimal to no surface cover due to the steep terrain. LRG is proposing stream and floodplain restoration to reduce the sediment load of the stream.

B.1.3 Deer Creek

Deer Creek is located along the turnpike near Dorseyville. The stream lies within property owned by Independence Excavation Inc. LRG is in the process of negotiating an agreement with

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

the Independence Excavation Inc. to allow work to be done on their property. The project would entail working on 830 LF of Deer Creek. This portion of Deer Creek is eroded with minimal bank protection. The creek is listed as impaired for suspended solids, nutrients, siltation, flow alterations, turbidity, and other habitat alterations by the Department of Environmental Protection. LRG is proposing stream restoration to reduce the sediment load of the stream.

B.2 MS4 Eligibility

All of the proposed BMPs meet the criteria for stream restoration projects created in the "*Considerations of Stream Restoration Projects in Pennsylvania for Eligibility as an MS4 Best Management Practice*" document. The required criteria are:

- Documentation of existing and active streambank erosion (Section C, Appendices A and D);
- 100 linear feet minimum of stream channel (Table 2, Appendices A and D);
- Impervious areas upstream of the project must be sufficiently treated to address peak flows that may exceed engineering design thresholds or compromise channel form and function;
    - The first step in the design process is an existing conditions watershed assessment which accounts for the drainage area and differences in land cover within and upstream of the project area. In the modeling, steady-state peak flows are determined from the watershed assessment to design for the worst case scenario 100-year event. By nature, the floodplain restoration designs act in such a way that peak flows are attenuated during storm events relative to the pre-design conditions. Easier access to a wide and hydraulically rough floodplain decreases flow velocity, which in turn increases residence time within the project area. This increased residence time flattens the runoff hydrograph relative to the existing conditions. Model results are also used to design grade and erosion control structures in areas that demonstrate high shear stresses to ensure that the integrity of the channel's form and function is maintained even during strong storm events.
- Addresses both sides of the channel;
- Maximizes floodplain reconnection through the regrading and a combination of approaches to either raise the floodplain and channel elevation through valley fill or to lower them to reconnect the stream to the groundwater table (where appropriate). The restored bank heights are designed to be very low (6"-12") in order to maximize overbank flooding events into the floodplain; and,
- Includes a minimum permanent 35' riparian buffer on all sites.

Section C Determination of Existing Loading for Pollutants of Concern

In order to determine the existing loading of each site, field measurements and data was collected to calculate the erosion rates and sediment loads for each proposed BMP. All data was collected following protocols set in the "*Recommendations of the Expert Panel to Define Removal Rates for Individual Stream Restoration Projects*" document.

C.1 Data Collection

For each proposed BMP, the selected streams were walked to determine the eligibility of the site. The streams potential for restoration was determined through an analysis of the land

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

cover, severity of erosion and vegetation cover. Following the BANCs method, Bank Erosion Hazard Index (BEHI) assessments and Near-Bank Stress (NBS) assessments were used to assess the current conditions of the streams. An assessment was taken whenever a change in any of the measures criteria was observed in the stream. A Trimble Geo7 Handheld GPS unit was used to collected points used to determine the length of each of the banks.

While in the field, soil samples were taken along the bank to test for the soil bulk density of each site. Standard core sampling methods were used for each sample. The samples were analyzed by Ackenheil Engineers Inc. Results from the analysis are in Appendix F. Soil Bulk Density Sampling Results and are summarized in Table 2. Baseline Data Summary. An average of the sites bulk density was used for all sediment load calculations. Soil bulk density testing occurred at or near the bank full elevation as determined in the field.

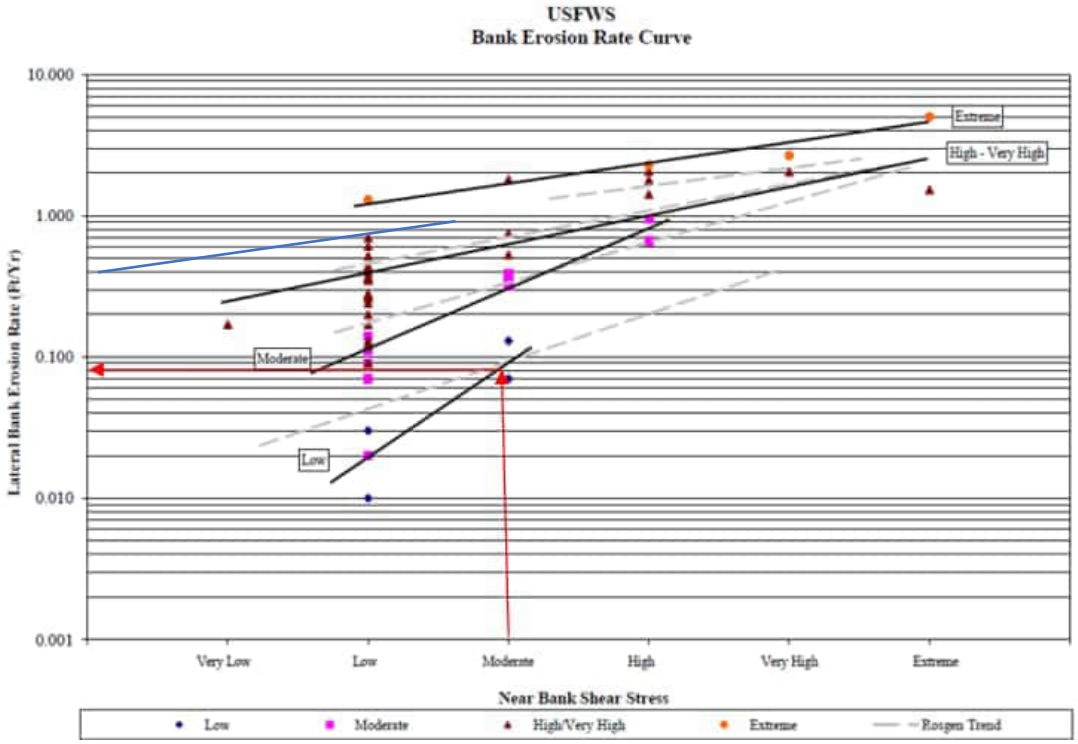
AerdiA was hired to fly each site with a drone to obtain topographic and longitudinal profiles to aid in the design and development of each project.

C.2 Data Analysis

Data collected through field assessments was analyzed using Microsoft Excel and ESRI ArcGIS ArcMap. The BEHI and NBS data collected in the field was put into a spreadsheet created by Stream Mechanics to establish scores for the stream reaches. GPS points were then transferred to ArcMap to calculate the length of the reaches. The results of these calculations were then transferred to another Microsoft Excel Sheet to account for the efficiency factors and Land-River Delivery Factors set by the PADEP in the *"National Pollutant Discharge Elimination System (NPDES) Stormwater Discharges from Small Municipal Separate Storm Sewer Systems Pollutant Reduction Plan (PRP) Instructions".*

The erosion rates for each bank were calculated using the Rosgen's Bank and Nonpoint Source Consequences of Sediment (BANCS) Method and the Bank Erosion Curve Created by U.S. Fish and Wildlife Service below.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D



C.3 Results

Results of the collected field data are summarized in Table 1. The BEHI and NBS scores range from low to extreme with an average rating of high.

Table 1: Average Site Variables			
	BMPs		
	Moore Park	Crane Avenue	Deer Creek
Ave. Bank Height (ft)	2.89	4.81	2.86
Ave. BEHI	38.39	39.51	35.37
Ave. NBS	3.55, Mod-High	3.75, Mod-High	3.86, Mod-High
Ave. Erosion Rate (ft/yr)	1.21	1.23	1.15
Stream Length (ft)	1,981.00	1,722.00	830.00

Using the data collected, the total annual sediment load was calculated for all three sites. The TP and TN loads were calculated using the default concentrations of 1.05 lb TP/ ton TSS and 2.28 lb TN/ton TSS listed in the "*Recommendations of the Expert Panel to Define Removal Rates for Individual Stream Restoration Projects"* document. The land-river sediment delivery factor of 0.181 was used in accordance with the standard set by the PA DEP in the document *"National Pollutant Discharge Elimination System (NPDES) Stormwater Discharges from Small Municipal*

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Separate Storm Sewer Systems Pollutant Reduction Plan (PRP) Instructions". The calculated rates indicate that the selected streams are all highly suspect to erosion.

Table 2: Existing Loads				
Variable		**BMP**		
		Moore Park	**Crane Ave**	**Deer Creek**
total annual loads (lb/yr)		1,046,371.17	2,876,544.56	642,260.84
Land-River Delivery Factor	**TSS**	0.181		
	TP	0.418		
	TN	0.695		
Bulk Density		89.08	99.25	93.64*
Delivered TSS (lb/yr)		189,393.18	520,111.56	116,249.21
Delivered TP (lb/yr)		41.56	114.14	25.51
Delivered TN (lb/yr)		150.06	412.08	92.10

*An assumed bulk density of 93.64 lb/ft^2 was used to calculate the sediment loading based on data from the USDA Natural Resources Conservation Service web soil survey.

Section D Selected BMPs to Achieve Reductions

In addition to the BANCS method, additional methods of sediment load calculations were tested to find the maximum sediment reductions. The Pittsburgh Sewer and Water Authority utilized the modeling software MapShed to calculate the sediment loading for their NPDES permit. This allows them to use a default rate of 115 lb/ft/yr as stated by the Expert Panel Protocols. PennDOT also has an MS4 NPDES permit but used the Simplified Method to calculate their loading rates. Since they did not use MapShed, their default rate of sediment reduction is 44.88 lb/ft/yr. Additional calculations were made to find if more reduction was achieved using the BANCS Method or the default rate.

After the sediment loss was calculated at each site following the BANCS method, efficiency rates of 50%, 75% and 90% were calculated to find the allotted sediment reduction for each BMP. The efficiency rates were chosen with regards to PA DEP guidance that states these rates may be used if there is adequate documentation of a secondary method to validate the BANCS Method assessment, pre-construction monitoring data, a post-construction monitoring plan, and a minimum of one year of post-construction monitoring data.

The results of these calculations will be included in the final PRP Tables 3A-C: Anticipated Sediment Reductions at Proposed BMPs.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Table 3A: Anticipated Sediment Reductions at Moore Park					
Variables		**Sediment Amount**	**Total Reductions (lb/yr)**		
			50% interim	**75% interim**	**90% efficiency**
TSS Loading (lb/yr)		189,393.18	**PennDOT**		
Protocol 1: TSS Reduction (lb/yr)	**50% Efficiency**	94,696.59	**95,166.97**	**142,515.27**	**170,924.24**
	75% Efficiency	142,044.89			
Additional BMPs		470.38	**Municipality***		
Total Annual Reduction (lb/yr)	**50% efficiency**	**95,166.97**	**228,755.76**	**228,755.76**	**228,755.76**
	75% Efficiency	142,044.89	**PTC**		
	115 lb/ft Default	**228,285.38**	-	-	-

* Default Rate of 115lbs/ft was greater than the BANCS Methods at 50%, 75% and 90% efficiency rates

Table 3B: Anticipated Sediment Reductions at Crane Avenue					
Variables		**Sediment Amount**	**Total Reductions (lb/yr)**		
			50% efficiency	**75% efficiency**	**90% efficiency**
TSS Loading (lb/yr)		520,111.56	**PennDOT**		
Protocol 1: TSS Reduction (lb/yr)	**50% Efficiency**	260,055.78	**260,243.59**	390,271.48	468,288.22
	75% Efficiency	390,083.67			
Additional BMPs		187.81	**Municipality**		
Total Annual Reduction (lb/yr)	**50% efficiency**	**260,243.59**	**260,243.59**	390,271.48	468,288.22
	75% Efficiency	390,271.48	**PTC**		
	115 lb/ft Default	203,780.00	-	-	-

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Table 3C: Anticipated Sediment Reductions at Deer Creek					
Variables		**Sediment Amount**	**Total Reductions (lb/yr)**		
			50% interim	**75% interim**	**90% efficiency**
TSS Loading (lb/yr)		116,249.21	**PennDOT**		
Protocol 1: TSS Reduction (lb/yr)	**50% Efficiency**	58,124.61	-	-	-
	75% Efficiency	87,186.91	**Municipality**		
Total Annual Reduction (lb/yr)	**50% efficiency**	58,124.61	-	-	-
	75% Efficiency	87,186.91	**PTC***		
	115 lb/ft Default	**95,450.00**	**95,450.00**	**95,450.00**	**104,624.29**

*Default Rate of 115lbs/ft was greater than the BANCS Methods at 50% and 75% efficiency rates

The efficiency percentages were chosen based on the DEP guidance document *PRP/TMDL Plan*. Under section D. BMP Effectiveness of the PRP/TMDL Plan, the guidance states that "*sediment reduction from streambank restoration projects when existing loads are calculated using modeling at a local scale may be estimated using the Protocols outlined in Section 5 of the report and must then apply the 50% efficiency uncertainty factor*".

At 50% effectiveness the following reductions will be achieved:

PennDOT (2 sites: Moore/Crane) = **355,410.56** lbs/yr (*331,950.00 required*) *
PWSA (2 sites: Moore/Crane) = **488,999.35** lbs/yr*
PTC (1 site: Deer Creek) = **95,450.00** lbs/yr

*Includes additional sediment reductions from the stormwater BMPs below

The statement of work also states that "*If post-construction monitoring is conducted for at least one year after project completion and it can be shown that a higher efficiency is justified, the permittee may request a re-evaluation of the project efficiency (up to 90%). An efficiency higher than 75% will not be considered by DEP until at least one year after the project has been implemented.*" Based on this, there is a potential that the following reduction numbers may be achieved:

PennDOT = 532,786.75 lbs/yr (75%)* up to 639,212.46 lbs/yr (90%)*
PWSA = 619,027.24 lbs/yr (75%)* up to 697,043.98lbs/yr (90%)*
PTC = 95,450.00 lbs/yr (75%) up to 104,624.29 lbs/yr (90%)

*Includes additional sediment reductions from the stormwater BMPs below

These goals will require additional coordination with the DEP to determine the extent of monitoring requiring and the cost effectiveness of obtaining these higher reductions. The 50% reductions will be sufficient to achieve the required reductions at this time.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Stormwater BMPs

Two volume/rate BMPs are also being proposed at the Moore Park Site. Two dry extension basin at the headwaters of the stream. The Moore Park Dry Extension Basin preliminary calculation are below.

The additional capacity required to reduce the twenty-five (25) year twenty-four (24) hour storm event down to the one (1) year twenty-four (24) hour storm event will occur on the reconstructed floodplain. The floodplain restoration that will be completed in conjunction with the stream restoration and basin retrofit will be designed to accommodate the additional capacity necessary. The following table summarizes the stormwater reductions:

Table 4: Anticipated Stormwater Reductions at Moore Park

Moore Park Stormwater Data			25-yr Flow Rate Reduction (CFS)*
Pre-construction Flow Rate(CFS)	1-yr	88.56	33.14
	10-yr	158.45	
	25-yr	187.97	
Pre-construction Volume (CF)	1-yr	221,297	
	10-yr	516,369	
	25-yr	624,104	
Post-construction Flow Rate (CFS)	1-yr	72.9	25-yr Volume Reduction (CF)
	10-yr	130.74	117,154
	25-yr	154.83	
Post-construction Volume (CF)	1-yr	209,351	
	10-yr	442,841	
	25-yr	506,950	

*The targeted rate reductions will be achieved through constructing the new basins.

Table 5: Anticipated Stormwater Dry Retention BMP Reductions

		Crane Avenue	Moore Park 1	Moore Park 2	10-yr Flow Rate Reduction (CFS)*		
					Crane	Moore Park 1	Moore Park 2
Pre-construction Flow Rate(CFS)	10-yr	43.29	5.31	5.32	5.24	2.39	1.99
	100-yr	72.96	10.2	11.57			
Post-construction Flow Rate (CFS)	10-yr	38.05	2.92	3.33			
	100-yr	72.45	9.02	11.42			

Refer to Appendix C for conceptual designs of the Moore Park and Crane Avenue Basins.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Volume Reduction Calculations: Floodplain restoration will achieve increased flood storage through the reestablishment of floodplain as a stormwater BMP. The volume of soils removed as part of the floodplain restoration will be available for storage of flood flows and is capable of conveying flood flows at lower elevations, thus reducing water surface elevations and flooding.

Peak Rate Mitigation Calculations: Peak rate is primarily controlled through the infiltration of runoff and additional storage from runoff and receiving waters in the floodplain. The shallow depth and high floodplain roughness will increase the travel time, reducing downstream peak rates.

Section E Operations and Maintenance

E.1 Site Protection

LRG's property acquisition approach will be to work with prospective landowners (public or private) to establish a site protection instrument. The instrument can be in the form of a conservation easement, deed restrictions, or resources management plan. The instrument will identify and preserve the BMPs; identifying the entity responsible for the long-term operation and maintenance of the BMP; and granting reasonable access for inspection to EPA, PennDOT, PWSA, PADEP, PTC, CCD, and other potential Municipal Partners. The instrument will also identify the entity responsible for long-term maintenance of the BMPs.

The instrument will be recorded at the county courthouse to protect the project site as required. As part of this process, LRG performs due diligence on the property, acquires title insurance, and addresses concerns with the title, such as pre-existing easements, or liens. Any required secondary easements are also negotiated at this time regarding access and construction concerns.

The instrument will be executed after all permits and approvals for the project are received, but prior to the start of any restoration activities at the site. The instrument will restrict activities that conflict with the scope and objectives of the project. An example of an instrument is included in Appendix B: Site Protection Instrument. Any final instruments will be subject to review and approval by all parties prior to finalization.

E.2 Maintenance and Monitoring

Following construction and acceptance of the BMPs by the partners, LRG will begin the required five-year maintenance and monitoring (M&M) period. LRG will inspect the BMPs annually to perform monitoring and maintenance to ensure the viability of the project through the M&M period. The need to perform maintenance will assessed during the visit, and if deemed necessary, appropriate action will be performed to repair any deficient BMPs in part, or whole. Maintenance will include the control of invasive species to promote the success of riparian planting areas. LRG will also perform inspections after major flooding events that have the potential to cause damage to the BMPs.

During the five-year monitoring period, LRG will prepare reports to submit to PennDOT, the PTC, and PWSA by December 31 of each year. At minimum, these reports will include:

- Visual observations of the BMPs, including things such as stream bank and channel stability
- Description of the general conditions of the restoration and stormwater BMPs

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

- Photos taken at ground level, drone aerials, and at fixed monitoring locations
- Assessments of vegetative cover for floodplain restoration BMPs
- BEHI and NBS assessments for stream channel restoration BMPs
- Hydrologic data from stream and floodplain restoration BMPs
- Discussion of maintenance and monitoring activities
- Proposed additional maintenance schedule for following year, if applicable

The anticipated schedule for implementation of the BMPs design plan is included as Appendix E.

E.3 Long Term Operation and Maintenance

Long term operation and maintenance (O&M) will commence once the five-year monitoring is completed. LRG will act as the long-term steward initially until responsibilities can be turned over to another qualified entity. LRG will prepare an Operation and Maintenance Plan that identifies types of maintenance activities, maintenance frequencies, personnel, and equipment requirements, and estimated annual maintenance costs to provide long term O&M of the BMPs. The plan will include provisions that LRG will obtain, and record fully executed instruments in the chain of title for the BMPs that make these obligations legally binding and enforceable by PennDOT, PWSA and PADEP. If the entity is a municipality, then LRG will obtain a fully executed and binding agreement with an appropriate resolution from the municipal entity. This agreement between LRG and the municipality will be enforceable by PennDOT, PADEP, PWSA, and or other potential Municipal Partners.

E.4 Financial Assurances

LRG will maintain a performance bond, a maintenance bond, and/or insurance to protect the BMPs during the construction and five-year M&M periods. Long-term management assurances shall be funded through an endowment and provided to the long-term steward. The long-term management assurances endowment will be fully funded no later than before the five-year M&M period is complete. The amount of the long-term management endowment principal will be calculated utilizing The Nature Conservancy Long-Term Stewardship Calculator. The endowment amount will be based on anticipated long-term management activities broken into component elements.

Section F Summary and Conclusion

According to the calculation results, the three proposed BMPs efficiency will result in 355,410.56 lbs/yr (50%) reduction for PennDOT, this exceeds the reduction goal of 331,950 lbs/yr. Additionally, reductions of 488,999.35 lbs/yr (50%) for PWSA, and 95,450.00 lbs/yr default rate for the PTC will be recognized. Following PA DEP recommendations, an assumed efficiency value of 50% was applied to the loading rates. Higher efficiency may be applied to the calculations after post-restoration conditions are assessed and validated.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Appendix A: Figures

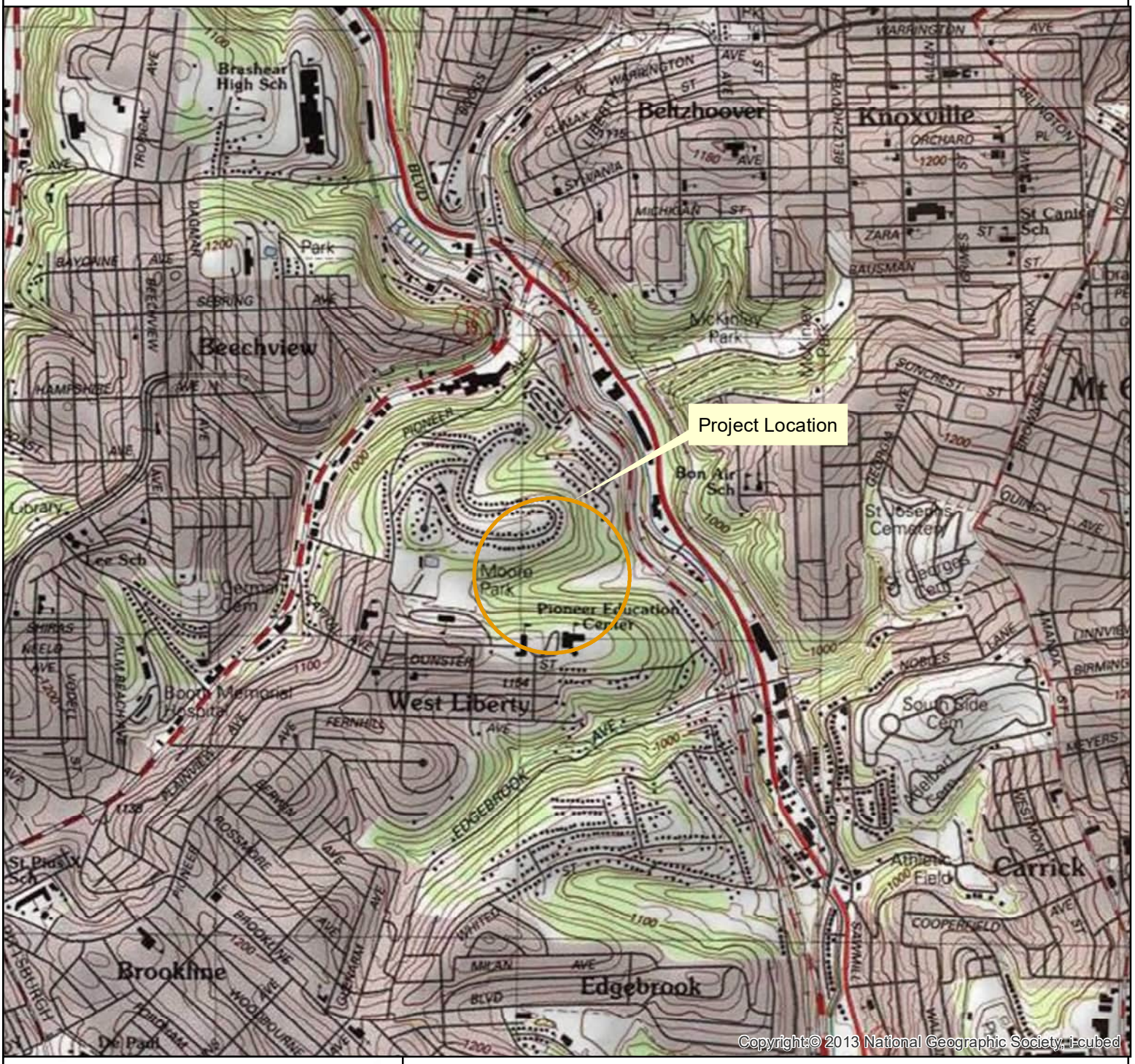
Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

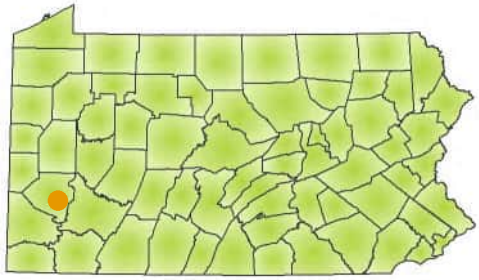
Figure 1 Location Maps

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Figure 1
Project Location

Moore Park Stream Restoration Site
City of Pittsburgh, Allegheny County, Pennsylvania





Project Location

N

0 750 1,500 3,000 Feet

Scale: 1:24,000

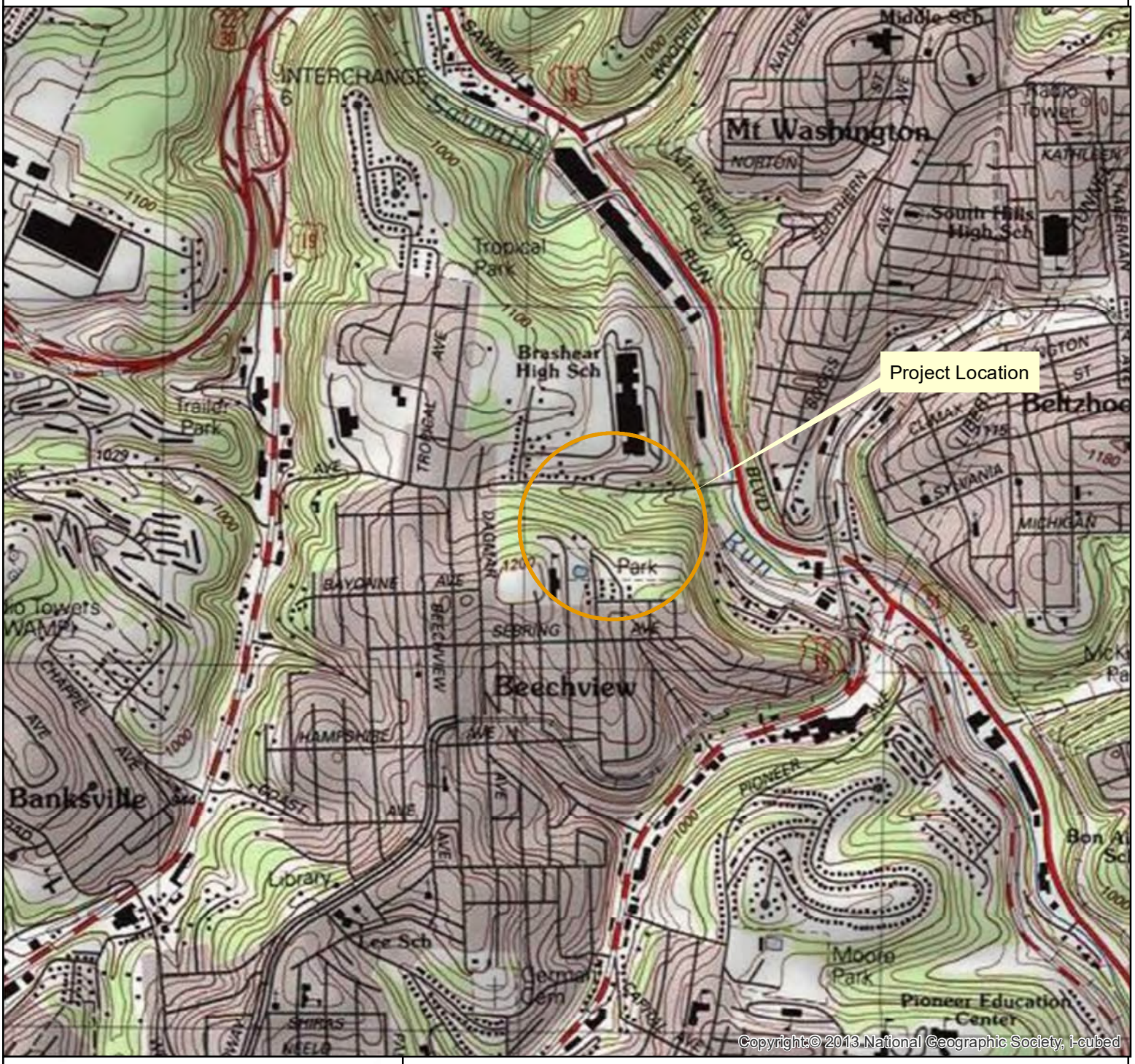
Map Source: USGS Quadrangle

Created by:
Hunt Valley Environmental, LLC

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Figure 1
Project Location

Crane Avenue Stream Restoration Site
City of Pittsburgh, Allegheny County, Pennsylvania





Project Location

N

0 650 1,300 2,600 Feet

Scale: 1:24,000

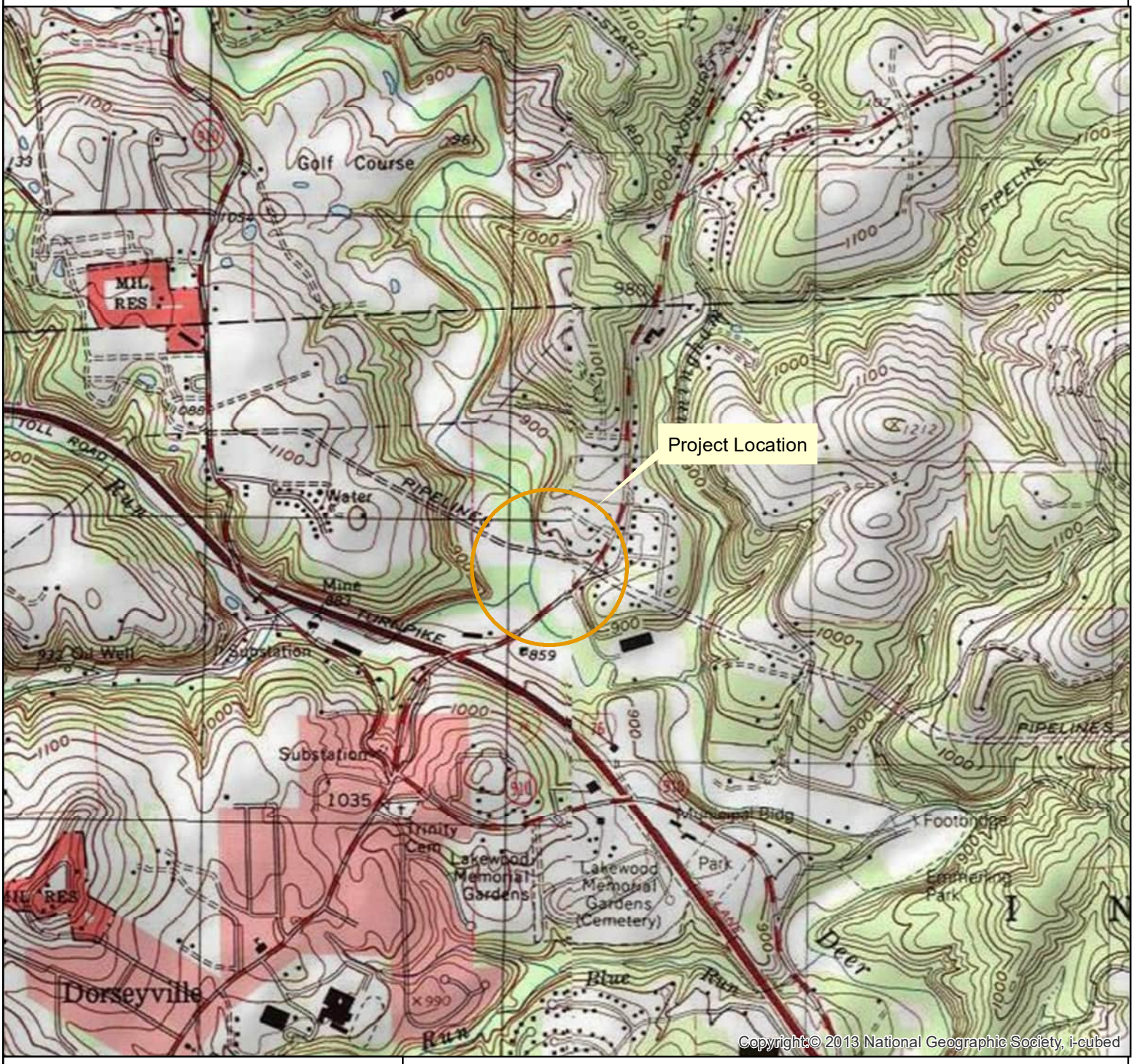
Map Source: USGS Quadrangle

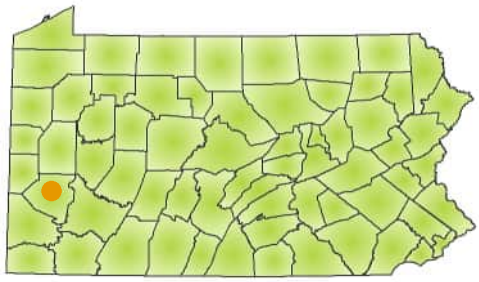
Created by:
Hunt Valley Environmental, LLC

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Figure 1
Project Location

Deer Creek Stream Restoration Site
Indiana Township, Allegheny County, Pennsylvania





Project Location

N

0 750 1,500 3,000 Feet

Scale: 1:24,000

Map Source: USGS Quadrangle

Created by:
Hunt Valley Environmental, LLC

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Figure 2 Soil Maps

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Figure 2
Soils Map

Moore Park Stream RestorationSite
City of Pittsburgh, Allegheny County, Pennsylvania



N

0 220 440 880 Feet

Project Location

Map Source: NRCS Soil Survey
Allegheny County

Created by:
Hunt Valley Environmental, LLC

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Figure 2
Soils Map

Crane Avenue Stream Restoration Site
City of Pittsburgh, Allegheny County, Pennsylvania



N

0 215 430 860 Feet

Project Location

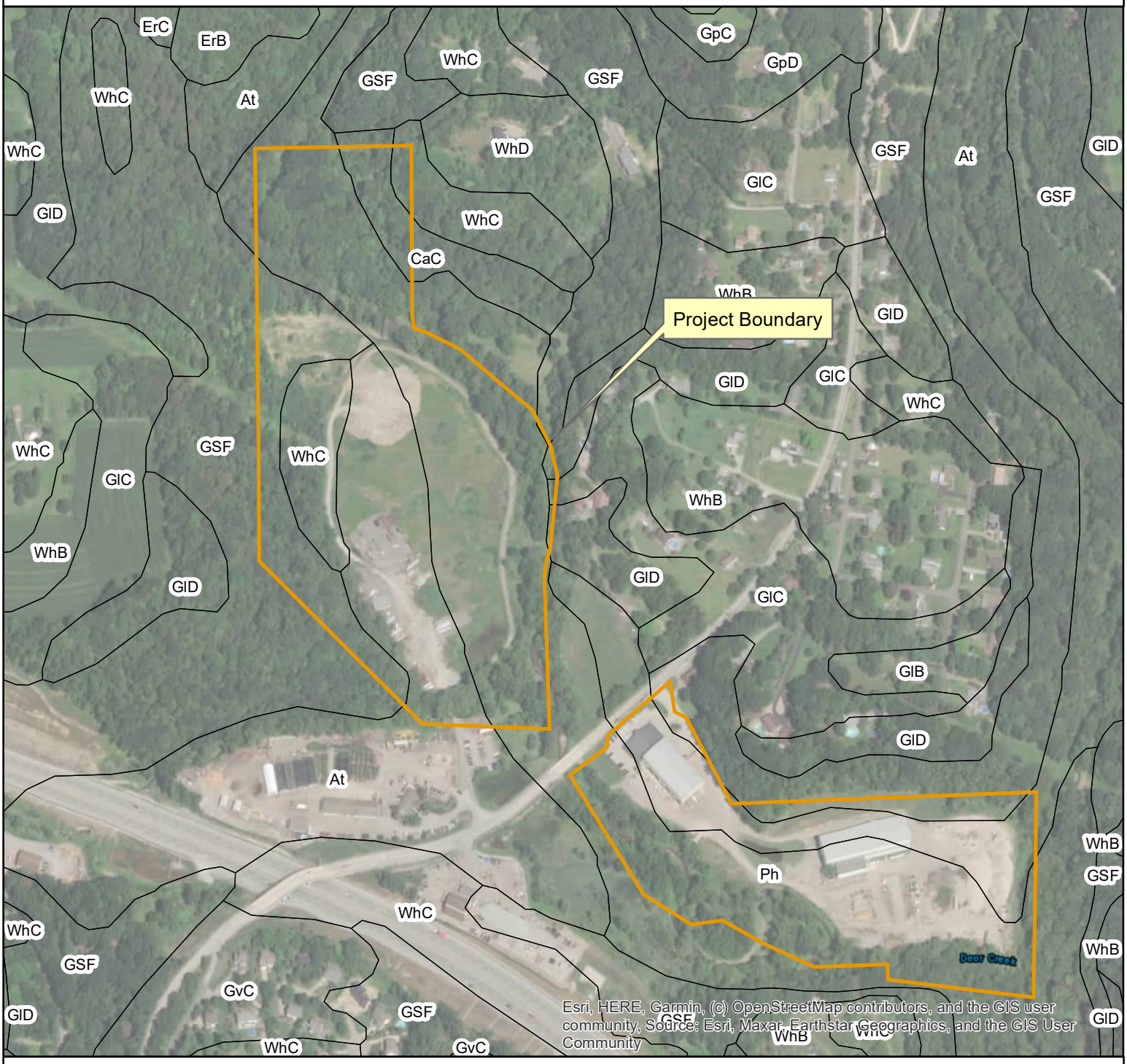
Map Source: NRCS Soil Survey
Allegheny County

Created by:
Hunt Valley Environmental, LLC

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Figure 2
Soils Map

Deer Creek Stream Restoration Site
Indiana Township, Allegheny County, Pennsylvania



N

0 260 520 1,040 Feet

Project Location

Map Source: NRCS Soil Survey
Allegheny County

Created by:
Hunt Valley Environmental, LLC

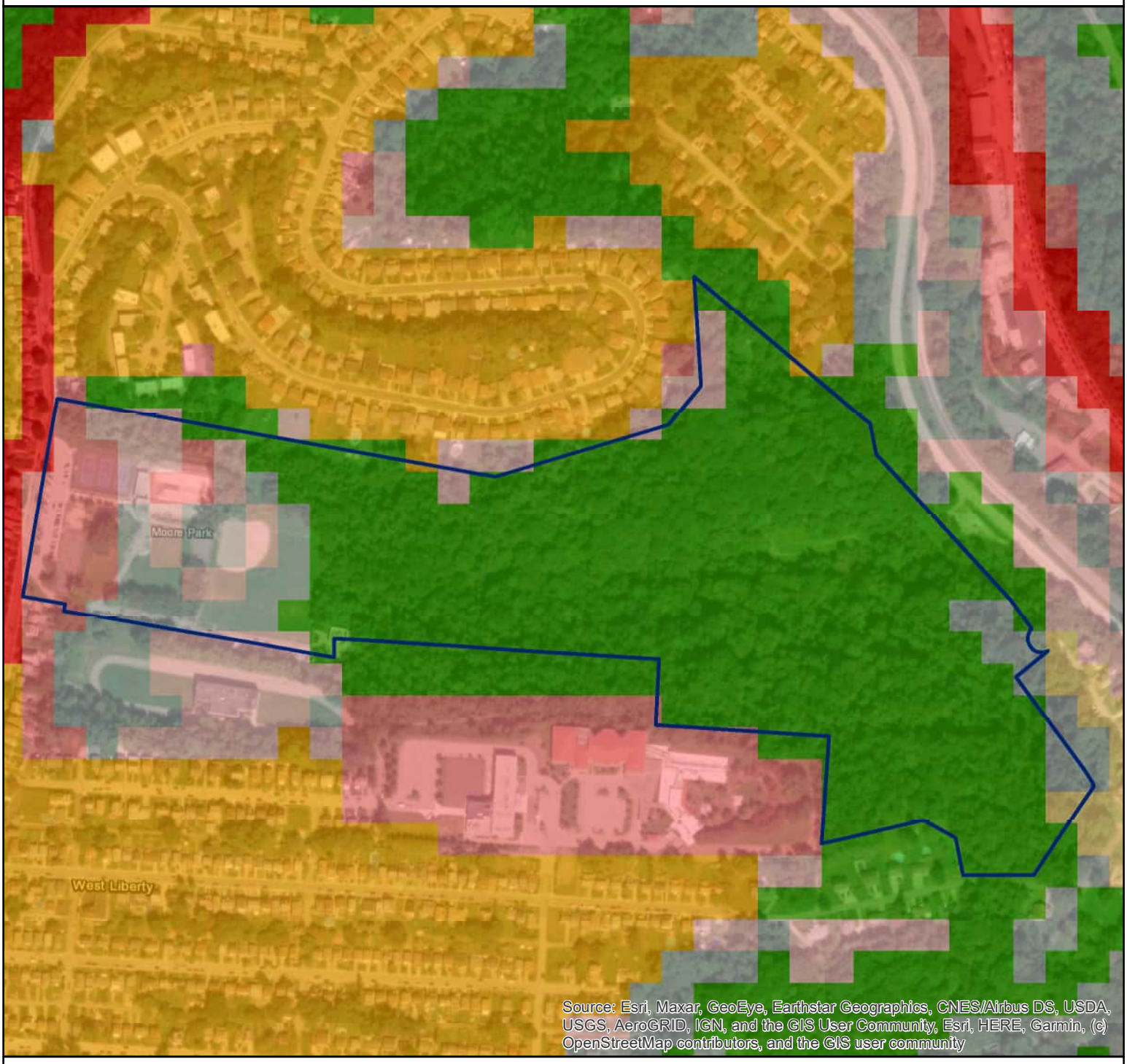
Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Figure 3 Land Use Maps

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Figure 3
Land Use Map

Moore Park Stream Restoration Site
City of Pittsburgh, Allegheny County, Pennsylvania



Legend

- Water
- Low Density Mixed
- High Density Mixed
- Hay/Pasture
- Cropland
- Conif Forest
- Mixed Forest
- Decid Forest
- Wooded Wetland
- Emergent Wetland
- Disturbed
- Turf Grass/Golf courses
- Low Density Residential
- Medium Density Residential
- High Density Residential
- Medium Density Mixed
- Open Land
- Property Boundary

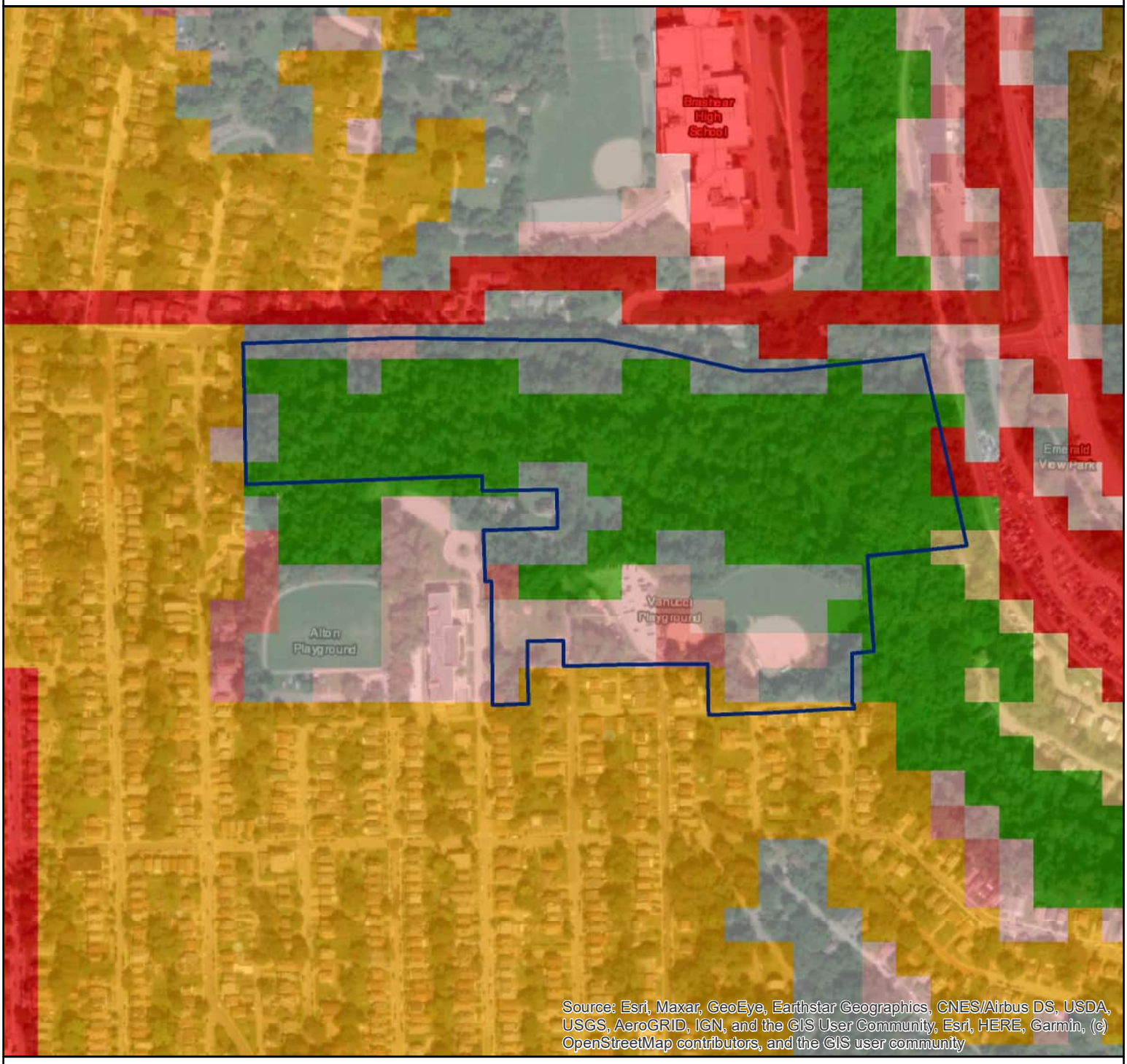
N

0 0.025 0.05 0.1 0.15 0.2 Miles

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Figure 3
Land Use Map

Crane Avenue Stream Restoration Site
City of Pittsburgh, Allegheny County, Pennsylvania



Legend

- Water
- Low Density Mixed
- High Density Mixed
- Hay/Pasture
- Cropland
- Conif Forest
- Mixed Forest
- Decid Forest
- Wooded Wetland
- Emergent Wetland
- Disturbed
- Turf Grass/Golf courses
- Low Density Residential
- Medium Density Residential
- High Density Residential
- Medium Density Mixed
- Open Land

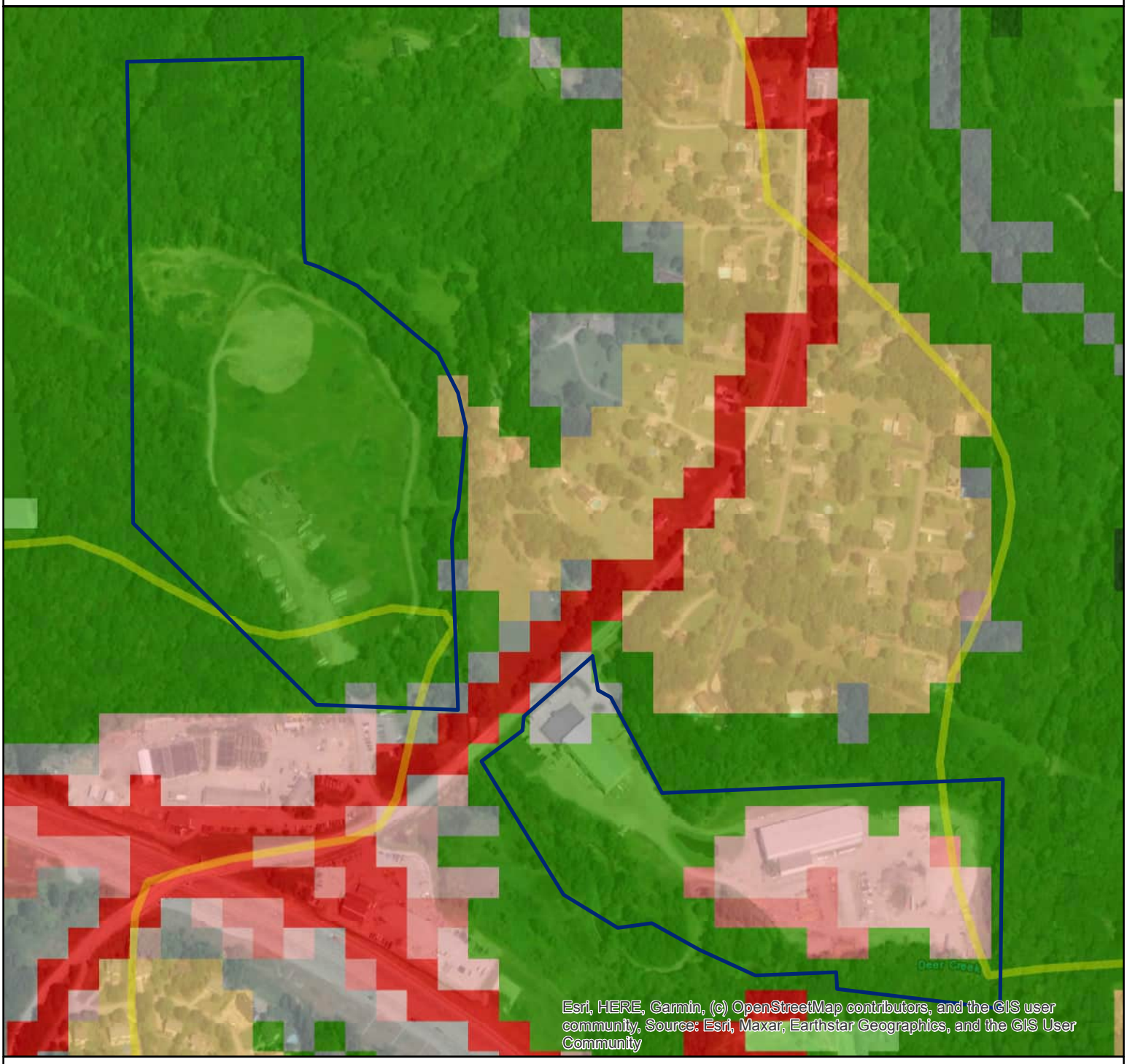
N

0 0.0225 0.045 0.09 0.135 0.18 Miles

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Figure 3
Land Use Map

Deer Creek Stream Restoration Site
Indiana Township, Allegheny County, Pennsylvania



Legend

- Water
- Low Density Mixed
- High Density Mixed
- Hay/Pasture
- Cropland
- Conif Forest
- Mixed Forest
- Decid Forest
- Wooded Wetland
- Emergent Wetland
- Disturbed
- Turf Grass/Golf courses
- Low Density Residential
- Medium Density Residential
- High Density Residential
- Medium Density Mixed
- Open Land
- Project Boundary

N

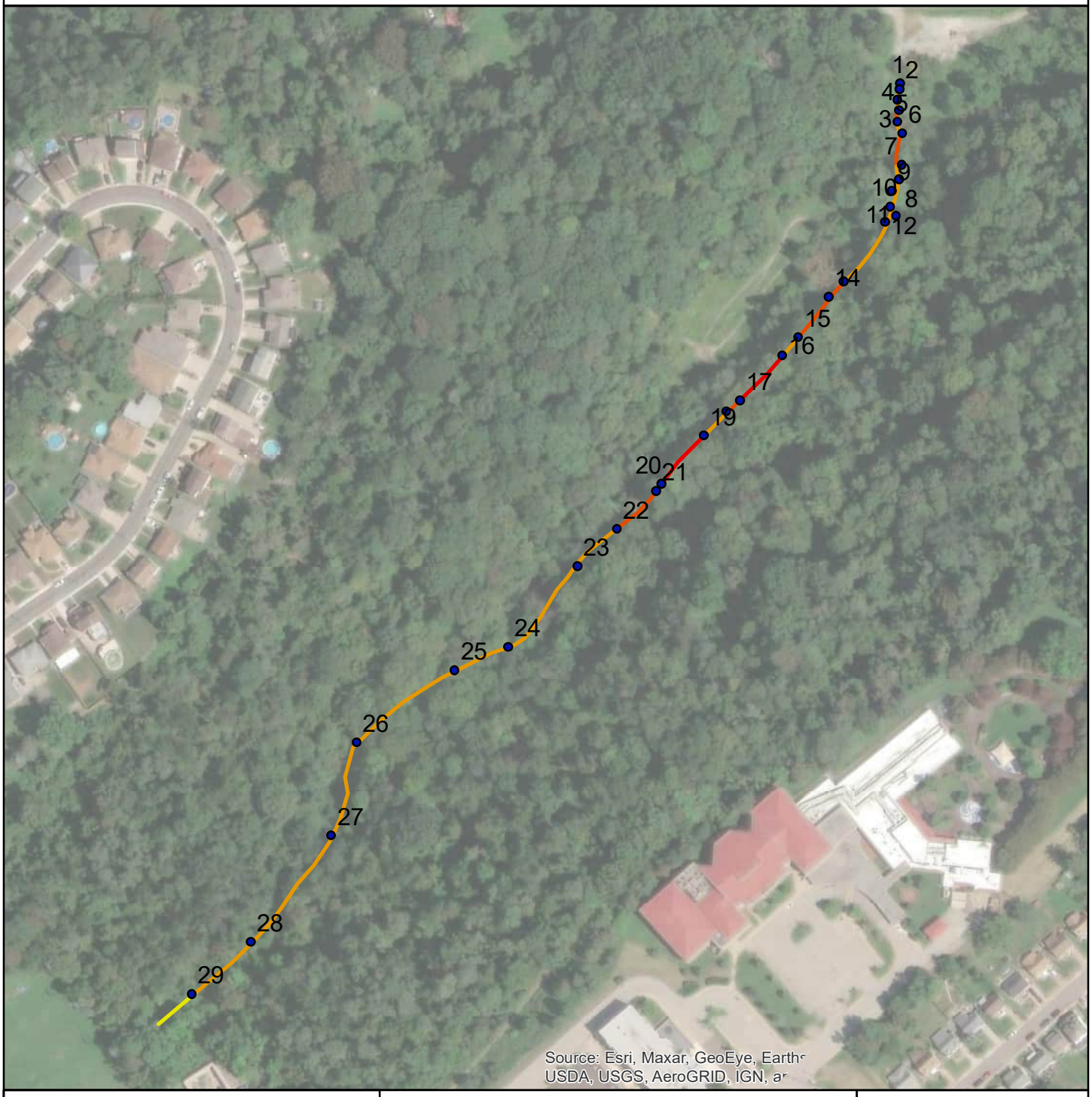
0 0.0250.05 0.1 0.15 0.2 Miles

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Figure 4 Bank Erosion Hazard Index

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Figure 4
Bank Erosion Hazard Index
Moore Park
City of Pittsburgh, Allegheny County, Pennsylvania



Hunt Valley Environmental
632 Hunt Valley Circle
New Kensington, PA 15068

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D



Hunt Valley Environmental
632 Hunt Valley Circle
New Kensington, PA 15068

Legend

Very Low
Low
Moderate
High
Very High
Extreme
Feature ID.

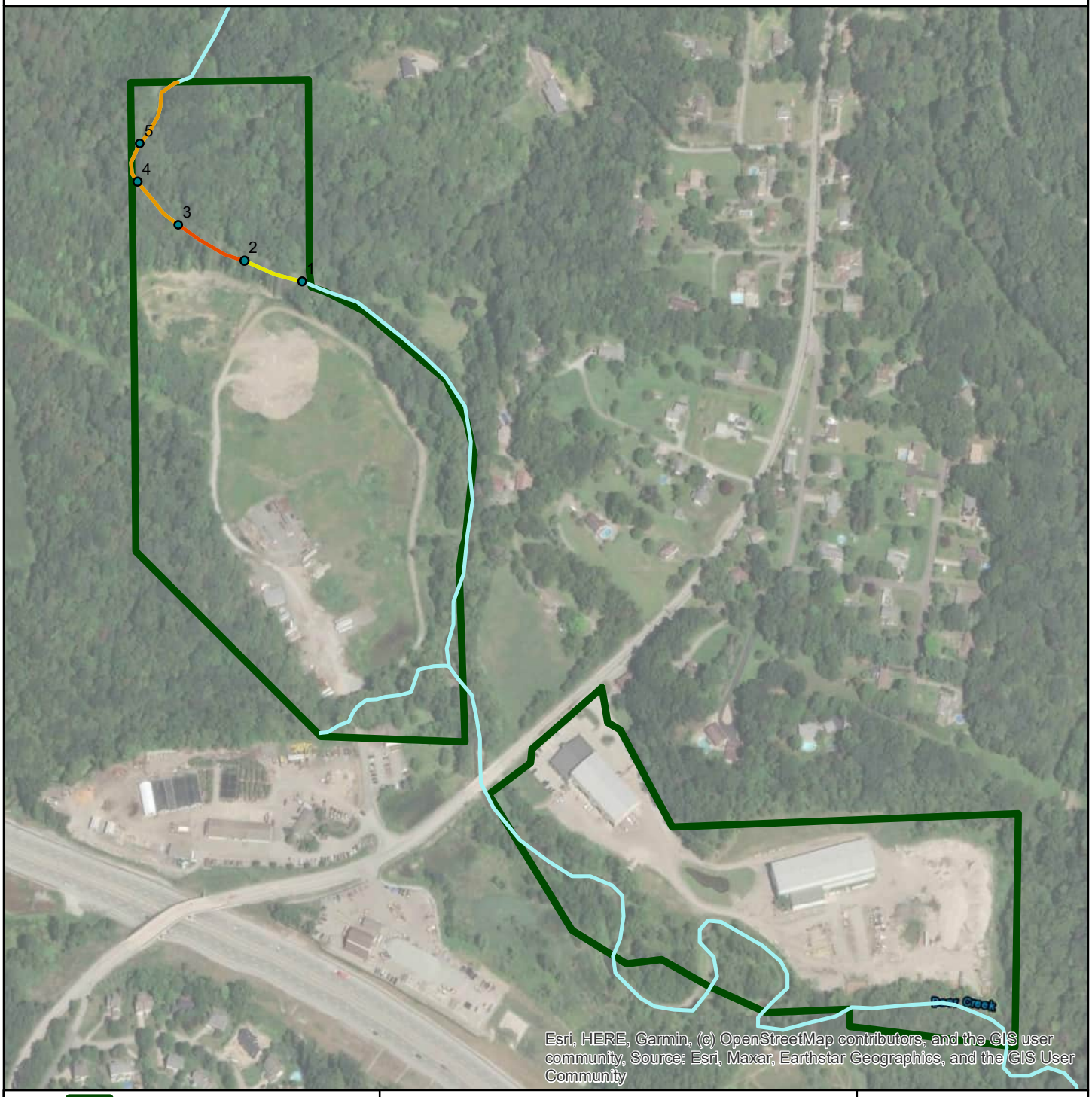
Figure 4
Bank Erosion Hazard Index Map
Crane Avenue Stream Restoration Site
The City of Pittsburgh, Allegheny County

0 50 100 200 Feet

N

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Figure 4
Bank Erosion Hazard Index
Deer Creek
Indiana Township, Allegheny County, Pennsylvania



Project Boundary
Feature ID
Stream
Very Low
Low
Moderate
High
Very High
Extreme

0 225 450 900 Feet

N

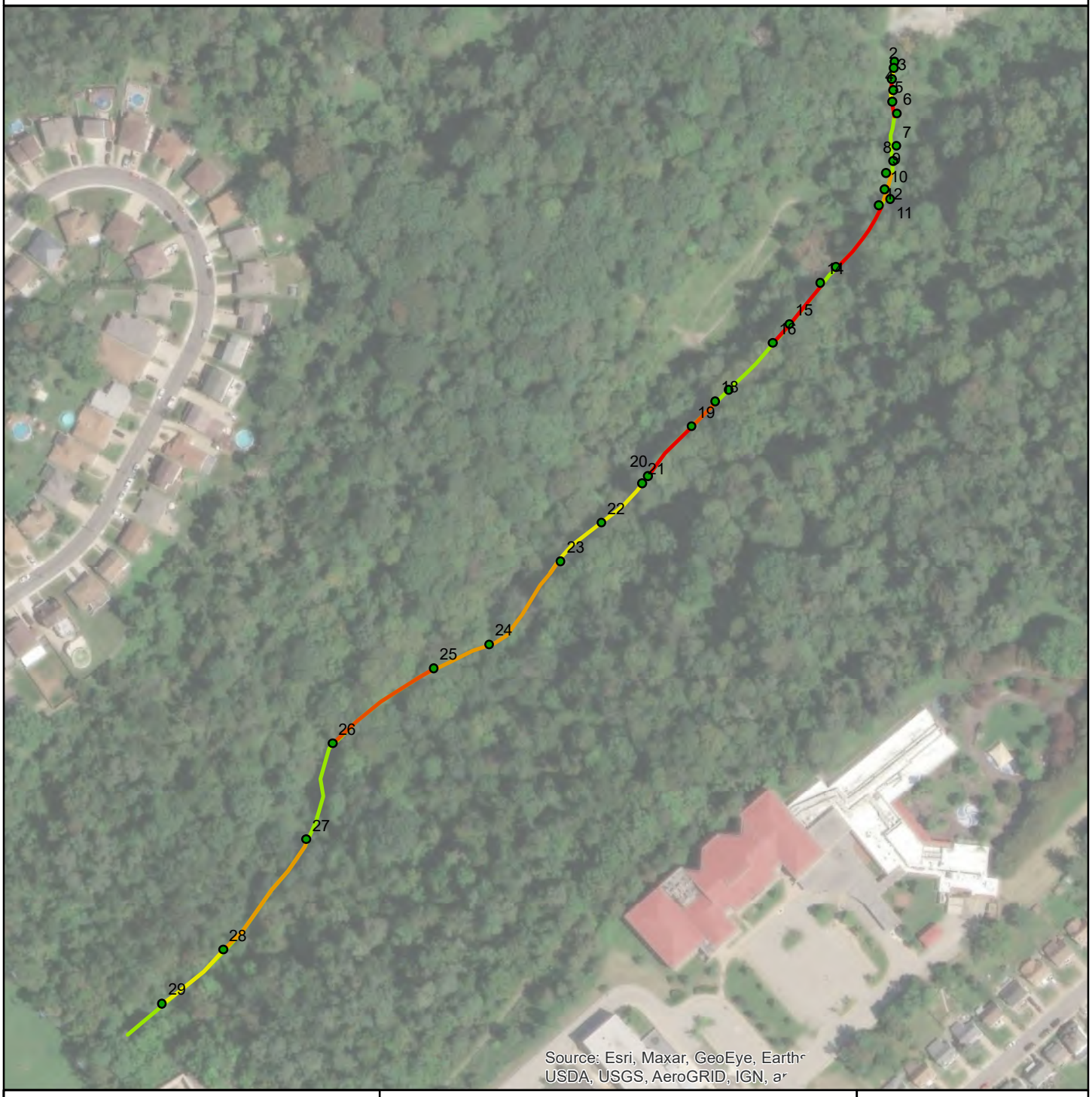
Hunt Valley Environmental
632 Hunt Valley Circle
New Kensington, PA 15068

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Figure 5 Near-Bank Stress Maps

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Figure 5
Near-Bank Stress
Moore Park Restoration Site
City of Pittsburgh, Allegheny County, Pennsylvania



data points
Very Low
Low
Moderate
High
Very High
Extreme

0 105 210 420 Feet

Hunt Valley Environmental
632 Hunt Valley Circle
New Kensington, PA 15068



Hunt Valley Environmental
632 Hunt Valley Circle
New Kensington, PA 15068

Legend

- Data Points
- Low
- Moderate
- High
- Very High
- Extreme

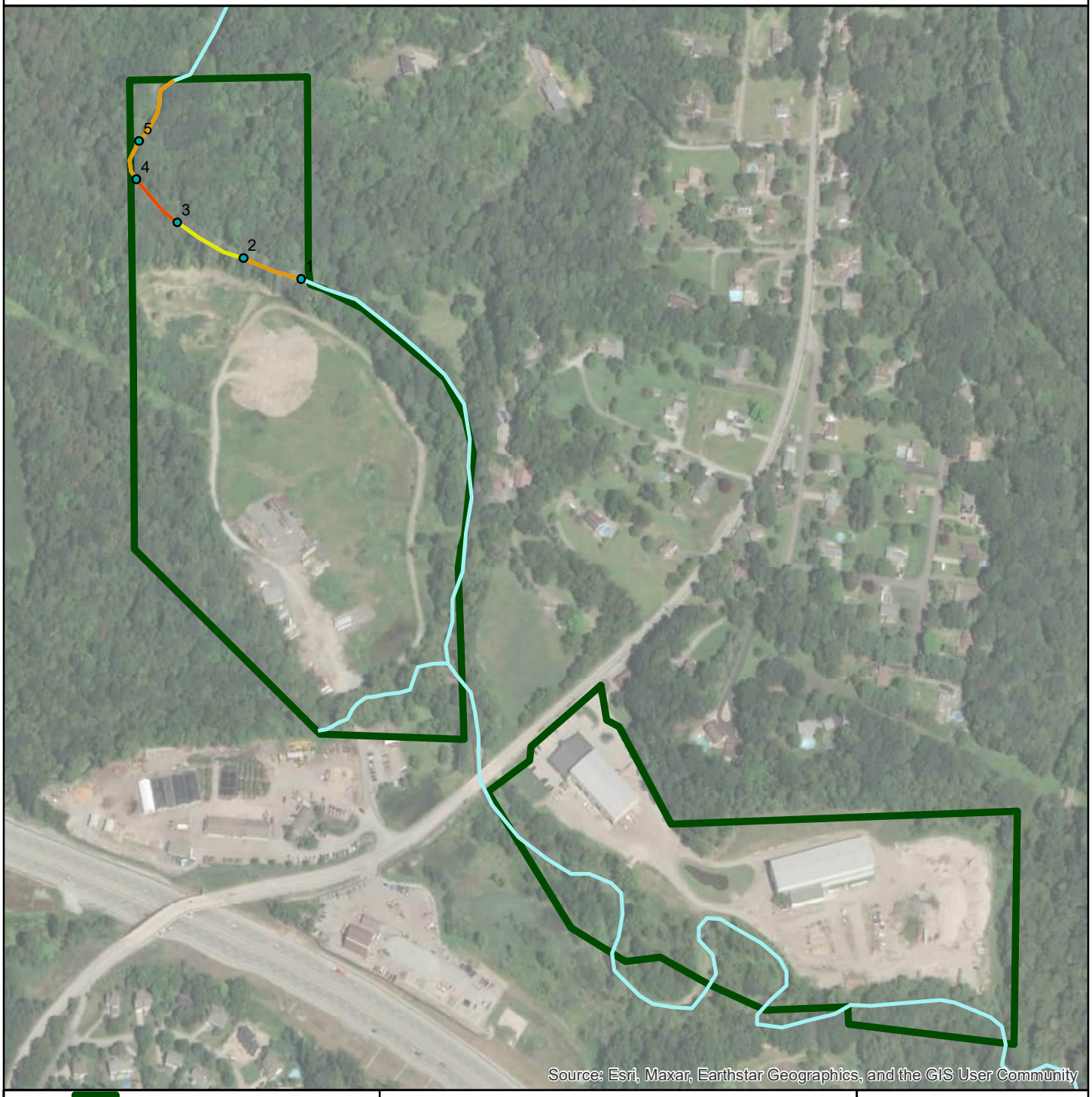
Figure 5
Near-Bank Stress
Crane Avenue Stream Restoration Site
The City of Pittsburgh, Allegheny County

0 55 110 220 Feet

N

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Figure 5
Near-Bank Stress
Deer Creek
Indiana Township, Allegheny County, Pennsylvania



Project Boundary
Feature ID
Stream
Very Low
Low
Moderate
High
Very High
Extreme

0 225 450 900 Feet

N

Hunt Valley Environmental
632 Hunt Valley Circle
New Kensington, PA 15068

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Figure 6 Urbanized Area Map

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Figure 6A
Urbanized Area Map

Sawmill Run

The City of Pittsburgh, Allegheny County, Pennsylvania



Legend

- Property Boundary
- Urbanized Area

N

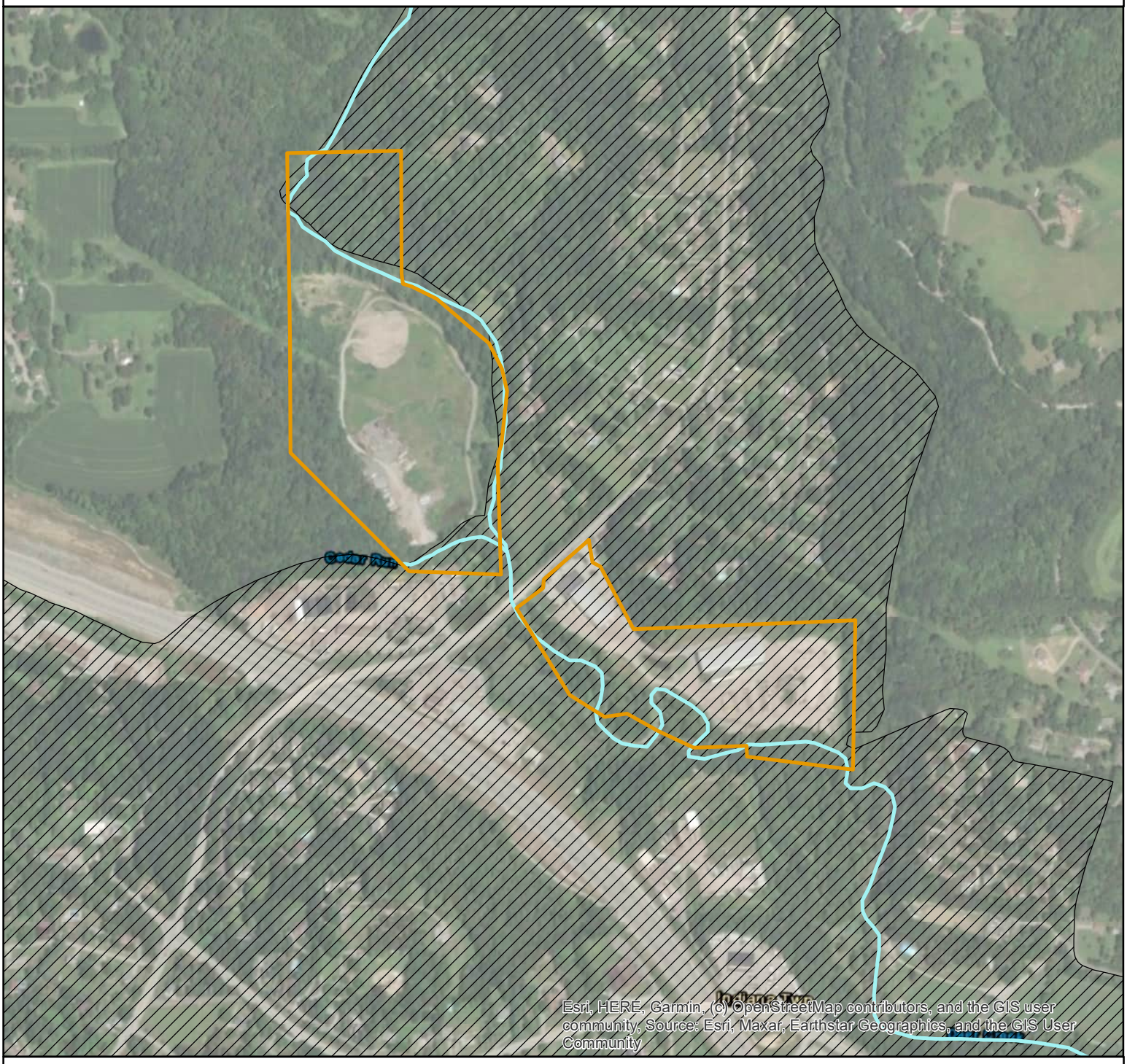
0 800 1,600 3,200 Feet

Created by:
Hunt Valley Environmental, LLC

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Figure 6B
Urbanized Area Map

Deer Creek
Indiana Township, Allegheny County, Pennsylvania



Legend

- Project Boundary
- Streams
- Urbanized Area

N

0 355 710 1,420 Feet

Created by:
Hunt Valley Environmental, LLC

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Appendix B: Example Site Protection Instrument

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Sawmill Run MS4 Projects Land Use Discussion

Date: October 11, 2020
Time: 10:00-10:35
Location: Teams Call

List of Attendees

NAME	ORGANIZATION	TITLE
Michael Barrick	Hunt Valley Environmental	Project Manager
Allision Traynor	Hunt Valley Environmental	Project Engineer
Chris Hornstein	Pittsburgh Public Works	Director
Genesis Martinez	Pittsburgh Public Works	Exe Assist DPW Director
Ana Flores-Bennet	PWSA	Associate Project Manager

General Discussion

Mike B of Hunt Valley Environmental opened the discussion of the project, discussing with the project partners that Land Reclamation Group (LRG) was contracted by PennDOT and PWSA to write the Pollutant Reduction Plan and to construct the Best Management Practices for sediment reduction in Saw Mill Run. LRG has contracted with Hunt Valley Environmental (HVE) to complete this work.

HVE has identified two project areas in Sawmill run to complete the proposed sediment reduction in Sawmill Run. The Project Areas were presented to DPW via the Team's meeting. One area is on a property adjacent to the Moore Park Property. It is a land area owned by the City of Pittsburgh and Pittsburgh School District. This project is refenced as the Moore Park Project. The Second property is the Beechview Greenway at Vannucci Field owned solely by the City of Pittsburgh. At this park, the project area is adjacent Crane Avenue, so it is referenced as the Crane Avenue Project. Mike reviewed the proposed project areas and the concept of the plans being submitted in the PRP for the planned sediment reduction discussing the proposed Best Management Practices. Other items that were discussed included:

- Drainage,
- Property protection
    - A Conservation Easement (CE)
    - A Resource Management Plan (RMP)
- Long-term O&M/ Endowment Funding

Further discussion of property protection continued. Chris H suggested PWSA could hold the long-term property protection CE

HVE Anticipated the property was protected with some type of long-term Protection, as they are parks in the city. Mike explained the RMP and the benefit to the city and operations as the RSM gives them a document in the office that provides O&M needs, and annual inspection requirements. Chris H agreed to the development of the RMP. He requested HVE develop a draft RMP and Conservation Easement.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Other items that were reviewed were drainage findings. The Ana and Chris requested HVE provide information of items identified for further discussion. This includes the drainage from the Pittsburgh Regional Transit Storm Pond, and the storm system along Crane Ave.

Prepared By:

Hunt Valley Environmental, LLC
Michael Barrick

Project Manager

Meeting Minutes prepared by Hunt Valley Environmental, LLC shall be deemed accurate as the record of matters discussed and conclusions reached. Corrections shall be reported to Michael Barrick at Hunt Valley Environmental, LLC within five (5) calendar days of distribution of this document.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Site Protection Instrument

Pittsburgh Sewage and Water Authority was able to provide a deed for the Moore Park Property. LRG will be able to provide a Conservation Easement for Moore Park as the property is owned by the Pittsburgh School District and the City of Pittsburgh. The Conservation Easement will be filed at the County Courthouse.

A deed for Beechview Greenway and Vannucci Park was not available. A specific description for the property including the park is not available. Development of a Conservation Easement could be developed but coordination with the City is ongoing to determine the needed final documents. This property is solely owned and managed by the City of Pittsburgh.

A Resource Management Plan will be developed Land Reclamation Group for both Project properties. This document will be developed the LRG for the day-to-day operations of the Department of Public Works. It will provide the as-built plans of the reestablished waterways on both properties. In addition to as-built plans it will provide operation and maintenance guidance and details of the best management practices used to stabilize the channels. The Beechview Greenway which is owned by the City of Pittsburgh and Moore Park property is Co-owned by the City of Pittsburgh and the Pittsburgh Area School District.

The Deer Creek project will include a conservation easement on the Independence property.

These legal documents are under review with the City Solicitor and LRG's legal representative.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

CONSERVATION EASEMENT MOORE PARK

THIS CONSERVATION EASEMENT is made this _____ day of _____, 20__, by ***The City of Pittsburgh and the School District of Pittsburgh*** (hereinafter "Grantors");

WITNESSETH:

WHEREAS, the Grantor grants an easement to the Grantee/Sponsor for the land developed by the Sponsor into a mitigation bank, the Grantee will monitor the site to the condition listed will be adhered to within the boundary of the said property covered by the easement; and

WHEREAS, Grantor is the fee simple owner of certain tracts of land located in **the City of Pittsburgh**, and being ***a portion of*** the property conveyed to the Grantor by deed recorded in **deed book volume XXXX Deed Page XXXX Instrument number XXXXXXX** in the land records of **Allegheny County**, Pennsylvania, more particularly described on Exhibit A attached hereto and incorporated by reference, hereinafter referred to as the "Property"; and

WHEREAS, **Land Reclamation Group** (the "Sponsor") entered into the Municipal Separate Storm Sewer System Contract with PWSA and PennDOT to reduce sediment discharges to the Sawmill Run Watershed and developer of the Sawmill Run PRP that identifies the Moore Park as a site for Sediment Reduction; and

WHEREAS, Sponsor may serve as the grantee of this Conservation Easement; and

WHEREAS, the Sawmill Run PRP includes Restoration Work governing the area on the Property indicated on Exhibit B attached hereto (the "Scaled Plat"); and

WHEREAS, pursuant to the Sawmill Run PRP, Sponsor proposes to create, maintain, and preserve a self-sustaining natural aquatic system located on the Restoration Work Area; and

WHEREAS, the Sawmill Run PRP requires that this Conservation Easement be executed and recorded in order that the Restoration Work Area shall remain substantially in its natural condition forever; and

WHEREAS, the Grantor has entered into an agreement with the Sponsor. to restore aquatic resources on the land of the proposed Restoration Work Area within the Property; and

WHEREAS, the Restoration Work Area may contain land, functions, values, and services that serve as storm water management best management practices were permitted by one or more of the Agencies; and

WHEREAS, under Federal and State law, the Agencies have issued one or more permits (collectively, the "Permits") for water quality with the expected result of the reduction of sediment loading to Sawmill Run from the Restoration Work located within the Restoration Work Area; and

WHEREAS, pursuant to the Saw Mill Run PRP, the Sponsor proposes to create, maintain, and preserve a high-quality, self-sustaining natural aquatic system and buffer located on the Restoration Work Area described in **Exhibit A** and present on the plat plan attached as **Exhibit B** attached hereto, which contains or will contain land, functions, values, and services that may serve as compensation and mitigation for sediment loading to waters of the United States and/or

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

waters of the Commonwealth that were permitted by the Third Parties; and

WHEREAS, under Federal and State law, the PA DEP has issued a permit, (the "Permits"), for the reduction of sediment loading within the waters of the United States and/or the Commonwealth of Pennsylvania expected to result from the development of the self-sustaining natural aquatic system located on site within the Restoration Work Area; and

WHEREAS, because the Restoration Work Area may serve as mitigation for the reduction of sediment loading, the Agencies are third-party beneficiaries under this Conservation Easement; and

WHEREAS, the Grantor, the Sponsor and grantee agree to the creation of these conservation-based covenants and intend the Restoration Work Area shall be preserved and maintained in a natural condition in perpetuity. The Grantor and Sponsor will follow the Pennsylvania Conservation and Preservation Easements Act, 32 Pa. Cons. Stat. Ann. 5051 et seq.

WHEREAS, the Grantors agree to grant to the Sponsor, PennDOT and the PWSA certain rights with respect to the Property and the creation and monitoring of the Restoration Work Area.

NOW, THEREFORE, in consideration of the mutually-held interests in preservation of the environment, as well as the terms, conditions, and restrictions contained herein, and pursuant to the laws of the Commonwealth, Grantor does agree to the following terms and conditions:

1. PURPOSE.

Pursuant to the Pennsylvania Conservation and Preservation Easements Act, Grantor hereby grants to Grantee an easement over the Restoration Work Area for the following purposes:

To preserve and protect the native flora, fauna, soils, water table and drainage patterns, and other conservation values of the Restoration Work Area.

To preserve the Restoration Work Area in its scenic and open condition; and in general,

To assure that the Restoration Work Area, including its air space and subsurface, will be retained in perpetuity in its natural condition as provided herein and to prevent any use of the Restoration Work Area that will impair or interfere with its natural resource functions and values, Grantor intends that this Conservation Easement will confine the use of the Restoration Work Area to such activities as are consistent with the purpose of this Conservation Easement.

To accomplish the purpose of this Conservation Easement, the following rights are created in accordance with Pennsylvania law:

A. Grantee, Sponsor and the Agencies shall have the right to enter upon the Property to inspect the Conservation Area at reasonable times to monitor the conservation area for compliance with and otherwise enforce the terms of this Conservation Easement; provided that, except in cases where Grantee determines that immediate entry is necessary to prevent, terminate, or mitigate a violation of this Conservation Easement; such entry shall, when practicable, be upon reasonable prior notice to the Grantor, any successor or assign, and Grantee, Sponsor and Agencies shall not unreasonably interfere with the use and quiet enjoyment of the Property by the Grantor, its successors and assigns, in accordance with the terms of this Conservation Easement;

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

B. To allow the Grantee, the Sponsor and the Agencies to enforce the terms of this Conservation Easement by appropriate legal proceedings in accordance with applicable law so as to prevent any activity on or use of the Property that is inconsistent with the purpose of this Conservation Easement and to require the restoration of such areas or features of the Restoration Work Area that may be damaged by any inconsistent activity or use; and

C. To allow the Grantee, the Sponsor, or their authorized representatives, to enter upon the Property and its Restoration Work Area at reasonable times, upon prior notice to the property owner; and upon prior notice and written approval by the applicable Agencies to take any appropriate environmental or conservation management measures consistent with the terms and purposes of this Conservation Easement, including:

1) Planting of native vegetation (i.e. trees, shrubs, grasses and forbs);
2) Restoring, altering or maintaining: the topography; hydrology; drainage; structural integrity; streambed; water quantity; water quality; any relevant feature of any stream, wetland, water body, or vegetative buffer within the Restoration Work Area as provided in the PRP approved by the Agencies; or
3) Performing such other activities as may be required by any Agency to maintain or restore the Restoration Work Area as required by the PRP approved by the Agencies or any related permit issued by any Agency in connection therewith.

2. PERMITTED USES

This Conservation Easement will not prevent the Grantor, any subsequent owner of the Property, and the personal representatives, heirs, successors, and assigns of either the Grantor or any subsequent Property owner, from making use of the area(s) that are not included in the Restoration Work Area, or from using the Restoration Work Area in any way that is not expressly prohibited by, or inconsistent with, the terms of this Conservation Easement.

A. **Maintenance of Existing Utility Facilities**. Existing Utilities lie within the Conservation Easement any required maintenance or repairs due to catastrophic failure of the existing systems are permitted.
   a. **Restoration to as-built conditions will be required** upon completion of said of said maintenance or repairs.

3. RESTRICTIONS

Any activity in or use of the Restoration Work Area inconsistent with the purpose of the Conservation Easement by the Grantor, any subsequent owner of the Property, and the personal representatives, heirs, successors, and assigns of either the Grantor or subsequent Property owner, is prohibited. Without limiting the generality of the foregoing, and except when an approved purpose Section 1 above, or as necessary to accomplish mitigation approved under the aforementioned Mitigation Plan, the following activities and uses are expressly prohibited in, on, over, or under the Restoration Work Area, subject to all of the express terms and conditions below:

A. **Structures.** The construction of new man-made structures, including but not limited to the construction, removal, placement, preservation, maintenance, or alteration of any buildings, roads, utility lines, billboards, or other advertising. This restriction does not include bat boxes, bird nesting boxes, bird feeders, and the placement of signs for safety purposes or boundary demarcation.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

B. **Demolition.** The demolition of fencing structures constructed for the purpose of demarcation of the Restoration Work Area or for public safety.

C. **Soils.** The removal, excavation, disturbance, or dredging of soil, sand, peat, gravel, or aggregate material of any kind; or any change in the topography of the land, including any discharges of dredged or fill material, ditching, extraction, drilling, driving of piles, mining, or excavation of any kind.

D. **Drainage.** The drainage or disturbance of the water level or the water table, except for pre-existing or approved project-related stormwater discharges and any maintenance associated with those stormwater discharges. All pre-existing or approved project-related drainage/stormwater discharge features should be shown on the accompanying plat map or approved plan and attached to this Conservation Easement.

E. **Waste or Debris.** The storage, dumping, depositing, abandoning, discharging, or releasing of any gaseous, liquid, solid, or hazardous waste substance, materials or debris of whatever nature on, in, over, or underground or into surface or ground water.

F. **Non-Native Species.** The planting or introduction of non-native species. Existing non-native species on site are waived of this restriction

G. **Herbicides, Insecticides and Pesticides.** The use of herbicides, insecticides, or pesticides, or other chemicals, except for as may be necessary to control invasive species that threaten the natural character of the Restoration Work Area. State-approved municipal application programs necessary to protect the public health and welfare are not included in this prohibition.

H. **Removal of Vegetation.** The mowing, cutting, pruning, or removal of any kind; disturbance, destruction, or the collection of any trees, shrubs, or other vegetation, except for pruning, cutting or removal for:

1) safety purposes; or
2) control in accordance with accepted scientific forestry management practices for diseased or dead vegetation; or
3) control of non-native species and noxious weeds; or
4) scientific or nature study.

I. **Agricultural Activities.** Conversion of, or expansion into, any portion of the Restoration Work Area for use of agricultural, horticultural, aqua-cultural, livestock production or grazing activities. This prohibition also includes conversion from one type of these activities to another (e.g., from agricultural to silvicultural).

J. **Access by Vehicle.** Unless authorized by the site restoration plan or site maintenance plan. Any temporary crossing or temporary access roads planned for maintenance of the site within the Restoration Work Area must adhere to the site maintenance plan. Due to the terrain the need to access other areas within the property for maintenance will be permitted with the appropriate permit.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

K. **Other.** Other acts, uses, excavation, or discharges that adversely affect fish or wildlife habitat or the preservation of lands, waterways, or other aquatic resources within the Restoration Work Area.

4. INSPECTION, ENFORCEMENT AND ACCESS RIGHTS

The Agencies and their authorized representatives shall have the right to enter and go upon the Property, to inspect the Restoration Work Area and take actions necessary to verify compliance with this Conservation Easement. When practicable, such entry shall be upon prior reasonable notice to the Grantor or the then current owner of the Property. The Grantor grants to the Agencies a discretionary right to enforce this Conservation Easement in a judicial action against any person(s) or other entity(ies) violating or attempting to violate these restrictive covenants: provided, however, that no violation of these restrictive covenants shall result in a forfeiture or reversion of title. In any enforcement action, an enforcing Agency shall be entitled to require a complete restoration for any violation, as well as any other judicial remedy such as civil penalties. Nothing herein shall limit the right of the applicable Agencies to modify, suspend, or revoke any permit.

5. RECORDING AND EXECUTION BY PARTIES

The Grantor agrees that this Conservation Easement shall be recorded within 120 days of the approval of the as-built plans of the Mitigation Bank in the Land Records of the county or counties where the Property is located. Further, if anticipated activities in the Restoration Work Area are agreed upon for future phases of the site, as spelled out in the "Reserved Rights," the Grantor must submit plans to the applicable Agencies for review and approval prior to any work in the Restoration Work Area.

6. NOTICE OF TRANSFER OF PROPERTY INTERESTS

No transfer of the rights of this Conservation Easement, or of any other property interests pertaining to the Restoration Work Area or the underlying property it occupies, shall occur without sixty (60) calendar days prior written notice to the Agencies.

7. MODIFICATIONS

The restrictions contained in this Conservation Easement are required by the attached Mitigation Plan. There shall be no changes or alterations to the provisions in this Conservation Easement without prior written approval from the Agencies. The Agencies shall be provided with a 60-day advance written notice of any legal action concerning this Conservation Easement or of any action to extinguish, void, or modify this Conservation Easement in whole or in part, including transfer of title to, or establishment of any other legal claims over, the Property. This Conservation Easement is intended to survive foreclosure, bankruptcy, condemnation, or judgments affecting the Property.

8. RESERVED RIGHTS

A. The Grantor and any holders of easements or other property rights for the operation and maintenance of pre-existing or project-related structures or infrastructure such as roads, utilities, drainage ditches, or stormwater facilities that are present on, over or under the Restoration Work Area reserve the right, within the terms and conditions of their permits, their agreements, and the law, to continue with such operation and maintenance. All pre-existing or approved project-related structures or infrastructure shall be shown on the accompanying plat map or approved plan and attached to this instrument.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

B. If the authorized project requires any related or unanticipated infrastructure modifications, utility relocation, drainage ditches, or stormwater controls within the identified Restoration Work Area, or if situations require measures to remove threats to life or property within the identified Restoration Work Area, said activities must be approved in writing by the applicable Agencies. Approval is subject to the sole discretion of the applicable Agencies. If approved, said activities must be identified on amended Exhibits A and C and must be recorded and specifically noted as an "amendment" and copies of the recorded amended Exhibits must be provided to the Agencies within 60 days of approval by the Agencies. Approval of said activity by the applicable Agencies is in addition to any Clean Water Act Section 404 permit or other authorization that may be required in order to legally implement said activity. The Grantor accepts the obligation to place any other responsible party on reasonable prior notice of their need to request such Agency approval

9. SEVERABILITY

If any portion of this Conservation Easement, or the application thereof to any person or circumstance, is found to be invalid, the remainder of the provisions of this instrument, or application of such provision to persons or circumstances other that those as to which it is found to be invalid, as the case may be, shall not be affected thereby.

10.
SITE RESTORATION

If the work required by a Restoration plan including maintenance or remedial work, under the Department of Army permit and the Pennsylvania Code Title 25 Environmental Protection Chapter 105 Dam Safety and Waterway Management Permit for the authorized project occurs within the Restoration Work Area, then the Grantor is allowed to construct the Restoration Work Area in accordance with the authorized plan, a copy of which is incorporated by reference.

11. COAL RIGHTS NOTICE.

The following notice is given to and accepted by Grantor for the purpose and with the intention of compliance with the requirements of the Pennsylvania Conservation and Preservation Declarations Act. Nothing herein shall imply the presence or absence of workable coal seams or the severance of coal interests from the Property.

NOTICE: THIS DECLARATION MAY IMPAIR THE DEVELOPMENT OF COAL INTERESTS INCLUDING WORKABLE COAL SEAMS OR COAL INTERESTS WHICH HAVE BEEN SEVERED FROM THE PROPERTY.

12. DURATION; COVENANT RUNNING WITH THE LAND

THIS CONSERVATION EASEMENT VESTS A SERVITUDE RUNNING WITH THE LAND THAT SHALL REMAIN IN EFFECT IN PERPETUITY. THIS CONSERVATION EASEMENT IS BINDING UPON THE UNDERSIGNED GRANTOR AND, UPON RECORDATION IN THE PUBLIC RECORDS, ALL SUBSEQUENT OWNERS OF THE PROPERTY OR ANY PORTION OF THE PROPERTY THAT INCLUDES THE RESTORATION WORK AREA WILL BE BOUND BY ITS TERMS, WHETHER OR NOT SUCH SUBSEQUENT OWNER HAD ACTUAL NOTICE OF THIS CONSERVATION EASEMENT AND WHETHER OR NOT THE DEED OF TRANSFER

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

OF THE PROPERTY SPECIFICALLY REFERS TO THE TRANSFER BEING UNDER AND SUBJECT TO THIS CONSERVATION EASEMENT.

13. MINERAL SUBORDINATION

The Grantor controls the gas and mineral rights of the property. The Grantor agrees to subordinate these rights to the deed restriction for the protection of the area described in Exhibit A and presented on the plan in Exhibit B.

NOTICE TO PARTIES WITH EMINENT DOMAIN AUTHORITY:

14. EMINENT DOMAIN

Exercise of eminent domain by any party ("Condemning Party") to take land held as part of this Bank may remove restrictions that the Sponsor, the Corps, and PADEP intend will protect the Mitigation Bank Site and preserve the land serving as Compensation for other permitted impacts, in perpetuity. Where the Condemning Party (1) intends to take action(s) that will have impacts on Mitigation Bank land associated with Debited Credits; and (2) is required to obtain a Corps and/or PADEP permit for such impacts, the Corps and PADEP have discretion to increase the Condemning Party's wetland and/or stream Compensation requirements, as part of the permitting process, in order to account for the loss of Credits already Debited from this Bank."

IN WITNESS WHEREOF said GRANTOR has executed this Conservation Easement the day and year first above written.

GRANTOR (if entity):

City of Pittsburgh
Name of entity

By: _____

Pittsburgh School District
Name of entity

By: _____

Name: _____

Title:

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Grantee (if entity)

Land Reclamation Group, LLC
Name of entity

By:_____

Name: Andrew Dzurko_____

Title: President

COMMONWEALTH OF PENNSYLVANIA)
) : SS
COUNTY OF _____)

On _____, before me, a Notary Public for the Commonwealth aforesaid, personally appeared _____, who acknowledged himself/herself to be, and that s/he, as member ***City of Pittsburgh*** the Grantor, being authorized to do so, executed, in my presence, the foregoing Conservation Easement for the purposes herein contained

IN WITNESS WHEREOF, I have set my hand and official seal.

_____
Notary Public
My commission expires:

[SEAL]

COMMONWEALTH OF PENNSYLVANIA)
) : SS
COUNTY OF _____)

On _____, before me, a Notary Public for the Commonwealth aforesaid, personally appeared _____, who acknowledged himself/herself to be, XXXXX and that s/he, as member ***Pittsburgh School District*** the Grantor, being authorized to do so, executed, in my presence, the foregoing Conservation Easement for the purposes herein contained

IN WITNESS WHEREOF, I have set my hand and official seal.

_____
Notary Public
My commission expires:

[SEAL]

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

ACCEPTANCE OF CONSERVATION EASEMENT

The undersigned accepts the rights and responsibilities of the Sponsor conferred by this Conservation Easement.

[NAME OF SPONSOR ENTITY]

By:_____
Name:_____
Title:_____

COMMONWEALTH OF PENNSYLVANIA)
) : SS
COUNTY OF _____)

On _____, before me, a Notary Public for the Commonwealth aforesaid, personally appeared _____, who acknowledged himself/herself to be Andrew Dzurko of ***Land Reclamation Group, LLC***, and that s/he, as such officer, being authorized to do so, executed, in my presence, the foregoing Acceptance of Conservation Easement for the purposes herein contained

IN WITNESS WHEREOF, I have set my hand and official seal.

_____
Notary Public
My commission expires:

[SEAL]

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

EXHIBIT A

LEGAL DESCRIPTION OF THE PROPERTY

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

EXHIBIT B

Plan of the Conservation Easement

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

EXHIBIT C

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Natural Resource Management Plan

Sample RMP

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

ACKNOWLEDGEMENTS

Sample RMP

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

EXECUTIVE SUMMARY

This Natural Resource Management Plan (NRMP) coordinates agency efforts to achieve the resource preservation and the mission of the City of Pittsburgh This plan is necessary to clarify and update the City's natural resource management philosophy, vision and direction moving forward and promote the stewardship of natural resources.

The 2022 NRMP is structured around four management themes containing recommended actions:

1) **Inventory and Planning –** ***Knowing what we have***
2) **Protecting Natural Resources –** ***Do no harm***
3) **Managing and Restoring Ecosystems –** ***Helping our land and waters heal***
4) **Fostering Stewardship and Expanding Natural Resources –** ***Spreading the word***

These themes can be tied back to the seven plan elements of the original NRMP: Natural Resource Management Planning, Vegetation, Wildlife, Water Resources, Air Quality, Human Impact on Parklands, and Education.

These management themes embody the key issues facing our natural resources. city parks are isolated natural areas impacted by many stresses. Park staff, volunteers and citizens are charged with protecting these remaining natural areas to preserve the natural resources in biodiversity, natural communities and ecosystems. But the remaining natural areas are not enough. It will be up to many partners to expand natural areas over time in order to sustain our native species and communities and increase the ecological services and quality of life benefits they provide. The City Parks can provide refuge for species, act as a source of locally native species and provide the templates for natural communities for restoration efforts elsewhere.

Sample RMP

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

TABLE OF CONTENTS

INTRODUCTION 1

Purpose and Vision 1

Background 2

Plan Structure 3

Implementation 3

INVENTORY AND PLANNING 4

PROTECTING NATURAL RESOURCES 6

MANAGING WILD POPULATIONS AND RESTORING ECOSYSTEMS 8

FOSTERING STEWARDSHIP AND EXPANDING NATURAL RESOURCES 9

APPENDIX A: City of Pittsburgh Property 12

APPENDIX B: Site-Specific Plans

APPENDIX C: Operations and Maintenance

GLOSSARY OF TERMS .....

Sample RMP

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

INTRODUCTION

Purpose and Vision

The purpose of this Natural Resource Management Plan (NRMP) is to coordinate agency-wide efforts to achieve the resource preservation the mission of the Pittsburgh's Department of Public Works.

> City of Pittsburgh Public Works Mission Statement: P*roviding creative, customer-friendly service while preserving the City's infrastructure by maintaining City streets, preserving park facilities and rehabilitating public facilities*

Much of the responsibility for preserving Pittsburgh's rich natural heritage rests with the City of Pittsburgh. These landholdings include forests at various areas of the city, waterways on parks properties at various areas within the city limits. They also include dozens of community parks and numerous lakefront parks. This plan is structured to support several guiding principles that will inform all aspects of natural resource management on parkland:

- Stewardship of our natural resources
- Preserve biodiversity and sustain wild and healthy ecosystems
- Protect, restore, and expand ecosystem services
- Manage resources adaptively and learn through experience
- Preserve a legacy of natural heritage for present and future generations

Natural resources include living organisms; non-living components, such as air, water, and soil; the ecosystems they form; and the services they provide.

These services include cleaning our air and water, supporting biodiversity, and providing healthy, open spaces to enjoy nature that contribute to a high quality of life for residents. Environmental services provided by City of Pittsburgh parks are invaluable.

Natural resources are assets that requires active management to retain its function and value. In urbanized areas like the City of Pittsburgh, factors such as disturbance from human land uses including development, encroachments and recreation, over-browsing by white-tailed deer and competition from non-native invasive species place tremendous stress on natural areas and impact their ability to function as high-quality ecosystems. Identifying and removing stressors is the first step towards helping the land heal. The City must seek and commit resources for the protection, assessment, monitoring, planning, restoration, and management of natural resources in order to fully achieve its policy vision for natural resource preservation.

Residents expect and rely on natural areas to provide recreational opportunities as well as environmental services and benefits. Many residents may not understand that natural resources is not self-sustaining and requires management in order to provide benefits for future generations. The City must continue to cultivate a broad understanding of the

Sample RMP

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

issues that are impacting natural resources and build support for greater stewardship as outlined in this and other plans. Communication with staff, residents and partners will be a critical factor in the success of preserving natural resources and achieving effective natural resource management.

Background

This plan is necessary to clarify the City's natural resource management philosophy, vision, and direction moving forward. The revised plan is designed to be more strategic in nature and focuses on higher level, evergreen actions that address the stewardship of our natural resources.

Plan Structure

The 2022 NRMP is structured around four management themes containing recommended actions:

1) **Inventory and Planning – *Knowing what we have***
2) **Protecting Natural Resources – *Do no harm***
3) **Managing Wild Populations and Restoring Ecosystems – *Helping our waters heal***
4) **Fostering Stewardship and Expanding Natural Resources – *Spreading the word***

These management themes can be tied back to the seven plan elements of the original NRMP: Natural Resource Management Planning, Vegetation, Wildlife, Water Resources, Air Quality, Human Impact on Parklands, and Education, The management themes are logical groupings of actions that are intended to help staff and partners focus on when and how we manage resources.

The actions are those tasks that staff and partners must undertake to inventory, plan, protect, and manage natural resources and foster stewardship among stakeholders. Underneath many of the actions are nested concepts that provide additional issues that must be considered and addressed in order to comply with this plan.

Implementation

Implementation of the NRMP will be through the annual work plans as well as through the strategic plan goals. Although the Natural Resource Management Protection in the Department of Public Works has the lead role implementing this NRMP, all divisions, sites, and staff are responsible for implementation and for ensuring that policies and practices support natural resource protection. Staff will report on accomplishments and plans annually and also through stewardship updates.

There is broad recognition of the City's obligation and responsibility to protect and manage the natural resources under its care. Implementation of the NRMP requires

Sample RMP

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

resources in both staff and funding. These needs will be defined over time through inventories, site-level resource management plans, periodic agency needs assessments and other processes. Securing the necessary staff and funding to meet NRMP goals and implement the recommended actions of this plan will require the education of numerous stakeholders, access to new and alternative methods of funding (including resources funding streams), and strong advocacy and support from City residents and elected officials. Working collaboratively with partners will also play a key role in accomplishing many aspects of this plan.

This plan's management themes embody the key issues facing our natural resources. City of Pittsburgh's parks are isolated natural areas impacted by many stresses. City staff, volunteers and citizens are charged with protecting these remaining natural areas to preserve the city's natural resources in biodiversity, natural communities, and ecosystems. But the remaining natural areas are not enough. It will be up to many partners to expand natural areas over time in order to sustain our native species and communities and increase the ecological services and quality of life benefits they provide. The parks can provide refuge for species, act as a source of locally native species and provide the templates for natural communities for restoration efforts elsewhere.

INVENTORY AND PLANNING
Knowing what we have

Effective stewardship begins with a fuller understanding of the natural resources under the City's care. The following actions address how the City collects natural resource data and integrates this knowledge into park planning and decision- making. A comprehensive natural resources inventory has not been conducted for all parkland, but the two parks parks have been surveyed and areas of significance have been identified. Consolidating and streamlining this information in a Geographic Information System (GIS) database and communicating the significance of natural areas to staff, partners, elected officials, and citizens is of critical importance to preserving their long- term health.

1. Conduct natural resource inventories of vegetative communities, rare and significant species, habitats and ecological features such as wetlands and their contributing landscapes to identify, map, and monitor biodiversity.
    a. Inventories should be conducted in advance of park acquisition, planning, projects and management activities, with the intent of protecting resources.
    b. Develop a natural resource geodatabase built on the City of Pittsburgh GIS infrastructure to archive natural resource inventory data, ensure uniform data management and allow for a centralized location to access natural resource information.

2. Assess the ecological significance of natural resources on parkland according to federal and state protection status, countywide occurrence, ecological function, ecosystem services and sensitivity to disturbance, and incorporate these

Sample RMP

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

assessments into strategic and long-range planning, general management planning, and operational planning.

a. Identify and protect species and ecosystems that are rare or significant on a local, regional or national scale.

3. Designate Resource Protection Zones and develop a map of parkland defining these areas in which land disturbance shall be limited and access regulated based on the needs of the resources present.

4. Assess the value of natural resources on parkland to include the ecosystem services it provides.
    a. Integrate ecological concepts to include biodiversity, habitat structure, and regeneration into economic valuation studies to develop a more complete picture of ecosystem function and value.
    b. Demonstrate differences in ecosystem and ecological service values between degraded and healthy natural communities.
    c. Develop cost estimates for restoring and managing natural resources.

5. Ensure that natural resource protection is integrated into all aspects of the City's practices to include land acquisition, park planning, development, management, maintenance, and interpretation.
    a. Ensure that natural resource planning takes place and accounts for vegetation, wildlife, water resources, air quality, human impacts and education.
    b. Ensure that park development, management, and interpretation does not conflict with site Natural Resource Management Plans.
    c. Ensure that natural resource specialists are consulted during project planning and prior to activities that impact natural resources.
    d. Base natural resource management decisions on science and best practices, including surveys, monitoring, and adaptive management.
    e. Include natural resource mitigation funding as a part of all projects that impact natural resources.
6. Create site-specific or resource-specific Natural Resource Management Plans and/or Natural Resource Action Plans as appropriate to guide natural resource management and protection and make these plans available to staff and the public.

7. Maintain expertise within park staff, adopt best practices, and seek innovative methods, technology and tools to proactively protect and manage natural resources.

PROTECTING NATURAL RESOURCES
Do no harm

Impacts to parkland degrade the quality and long-term health of the city's natural resources. Some impacts can be addressed locally and internally, such as limiting encroachments from adjoining property owners. Broader impacts, such as watershed degradation, browsing by overabundant white-tailed deer and non-native invasive plant

Sample RMP

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

infestation, are significant, large-scale problems with solutions that lie well beyond park boundaries. The actions within this management theme address some of the most significant impacts to natural resources, including impacts that are countywide in scope and will require the cooperation of citizens and partners to address.

8. Avoid adverse impacts to natural areas, mitigate unavoidable impacts from construction and maintenance projects and require restoration and rehabilitation of impacted natural resources.
    a. Minimize impacts to forests, meadows and other natural areas from human use.
    b. Protect significant natural communities and species.
    c. Require restoration of impacted natural resources when use of parkland causes damage to them.

9. Eliminate encroachments from park neighbors and illegal uses of parkland to prevent, remove or mitigate impacts to natural resources.

10. Protect water resources from impacts of urbanization and development such as stormwater runoff and excessive flows.
    a. Protect water quality by minimizing impacts from park development, as well as development outside of parkland.
    b. Support county, state and regional water quality efforts to include implementation of City of Pittsburgh Watershed Management Plans.
    c. Protect, enhance and restore riparian buffers.
    d. Protect wetlands to include springs, seeps and vernal pools and the buffers that surround them (e.g. the terrestrial habitat zone).
    e. Minimize negative impacts of stormwater facilities per the MS4 Stormwater Management.
    f. Work with partners to protect and restore streams on parkland.
    g. Utilize low impact development practices (such as stormwater management, green buildings and natural landscaping) to reduce impacts to water resources and other natural resources.

11. Prevent net loss of natural resources on or off parkland as a result of granting easements.
    a. Deny requests to place easements on parkland to offset losses elsewhere (except when required by interagency or other pre-existing agreement), when resources on parkland would not be restored to mitigate for those losses.

12. Protect park natural resources from threats of urbanization, development and park operations to include noise and light pollution, degradation of air quality and other sources of pollution.
    a. Prevent excessive light impacts on natural areas.
    b. Prevent or mitigate excessive noise impacts on wildlife.
    c. Reduce air pollution from park management by investing in cleaner equipment, reducing mowing, and incorporating other best practices.

Sample RMP

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

13. Plant only locally common native plant species in natural areas, do not plant any invasive species, and use non-native non-invasive species in formal landscapes only when there are no suitable native plant alternatives.
    a. Use local ecotypes of native species when available.

14. Site trails to minimize natural resource impacts, utilize sustainable trail building principles and avoid placing trails in sensitive natural areas.
    a. Consult and follow the agency's Trail Development Strategy Plan.

15. Increase the City's ownership and buffering of ecologically valuable areas through acquisition of land, easements and other agreements that would serve to protect natural resources on or adjacent to parkland.

MANAGING WILD POPULATIONS AND RESTORING ECOSYSTEMS
Helping our waters heal

The City's natural resources must be adaptively managed to achieve positive ecological outcomes. Natural resource management should begin with clearly defined goals such as improving biodiversity, reducing overabundant or non-native invasive species, or promoting naturally regenerating native plant communities. Natural resource management should be adaptive and experimental. Management actions should include proven as well as novel practices, and staff should incorporate measurable feedback mechanisms, such as biological monitoring, to evaluate their effectiveness and adapt strategies accordingly. The City should embrace a hands-on approach to natural resource management based on the best available science and with clearly defined management goals.

16. Manage natural resources adaptively and holistically on a landscape scale with the goal of having naturally regenerating native plant systems and healthy native wildlife populations.
    a. Manage for landscape mosaics with diverse habitats, including non-forested ecosystems, to foster biodiversity and support different life-cycle stages for species.
    b. Focus on areas with the best, biggest and/or most connected resources.
    c. Protect intact soils with a rich ecological memory and restore degraded soils.
    d. Reintroduce disturbances necessary for system recovery such as fire and canopy gaps.
    e. Focus on removing stresses from systems to include human impacts, white-tailed deer, non-native invasive species, etc. to allow systems to recover.
    f. Restore natural communities to improve ecosystem resilience against large scale and long-term impacts such as climate change, severe weather events, and forest pests.
    g. Consider unique or important natural communities, species and ecological features when establishing management objectives and measuring

Sample RMP

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

management outcomes.

h. Monitor results to determine change and measure success over time.

17. Control overabundant and invasive species that negatively impact natural resources to include, but not limited to, white-tailed deer, non-native invasive species, resident Canada geese, feral animals, and forest pests.
    a. Coordinate response amongst staff and with partner agencies.
    b. Maintain capacity for Early Detection and Rapid Response (EDRR).
    c. Be proactive in preventing new invasions.
    d. Mitigate wildlife conflict.

18. Ensure the health of existing forested areas. Where possible ensure native biodiversity and sustainable regeneration; elsewhere restore to the highest ecosystem function practicable.
    a. Ensure that forested areas are sustainable and promote regeneration.
    b. Expand tree cover and enhance forest health to protect ecosystem services, including improving local air and water quality and sequestering greenhouse gases.

19. Enhance connectivity of parkland to provide natural corridors that allow for the movement of populations over time and preserve ecosystem function and biodiversity.
    a. Focus on buffering sensitive natural resources.

FOSTERING STEWARDSHIP AND EXPANDING NATURAL RESOURCES
Spreading the word

The citizens of the City of Pittsburgh place a significant value on the community parks and greenspaces, with about 80% of the population using and visiting the parks each year. Many visitors participate in recreational activities that allow them to appreciate the parks natural resources, such as walking or biking on trails, birding, and nature study, visiting nature centers, and kayaking or canoeing in the rivers. It is clear, however, that many park visitors lack an understanding of the threats facing the long-term health of these natural resources and the important role that visitors play as stewards and advocates both on and off parkland. The natural resources provide the City with ecosystem services such as clean air and water and quality of life benefits for residents, requires active management and financial commitment to maintain. The actions under this management plan focuses on engaging citizens, staff and regional partners in resource management, with the goal of fostering support for programs and initiatives and raising awareness of the need for active stewardship.

20. Partner with diverse groups to engage and educate residents and staff about their role in natural resource stewardship and increase their awareness of conservation and resource management issues.

21. Maintain and/or enhance effective communication strategies with the public; explore new forms of outreach to engage citizens in natural resource conservation

Sample RMP

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

and management and overcome socioeconomic, language and cultural challenges.

22. Provide high quality interpretive opportunities that enhance awareness of natural resources leading toward the appreciation and conservation of City of Pittsburgh's Natural Resources.
23. Work with adjacent landowners to expand natural areas beyond park boundaries through education, easements and cooperative agreements.
    a. Encourage habitat expansion through native landscaping practices.
24. Partner with diverse groups to conduct resource inventories, formulate plans and manage resources.
    a. Seek and develop partnerships to achieve resource management goals. Support citizen science where appropriate.
    b. Provide opportunities for volunteers to participate in natural resource management.
25. Leverage partnerships with all City agencies and entities having natural resource management responsibilities to optimize alignment of City and park policies as they relate to natural resource management.
    a. Identify and pursue opportunities for natural resource education, protection, restoration and management countywide.
    b. Extend natural resource management actions and benefits across property lines and jurisdictions.
    c. Collaborate with partners to maximize available resources.
    d. Broaden visions and align with regional efforts when possible and appropriate.
26. Participate in and support regional natural resource management planning and management efforts to better identify gaps and opportunities in natural resource protection and management.
    a. Protect and restore ecosystems on a regional and national scale.
    b. Encourage individuals and organizations to expand their vision beyond their own properties, neighborhoods, and counties.
    c. Collaborate and cooperate with partners in order to establish and achieve regional ecological goals.

Sample RMP

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

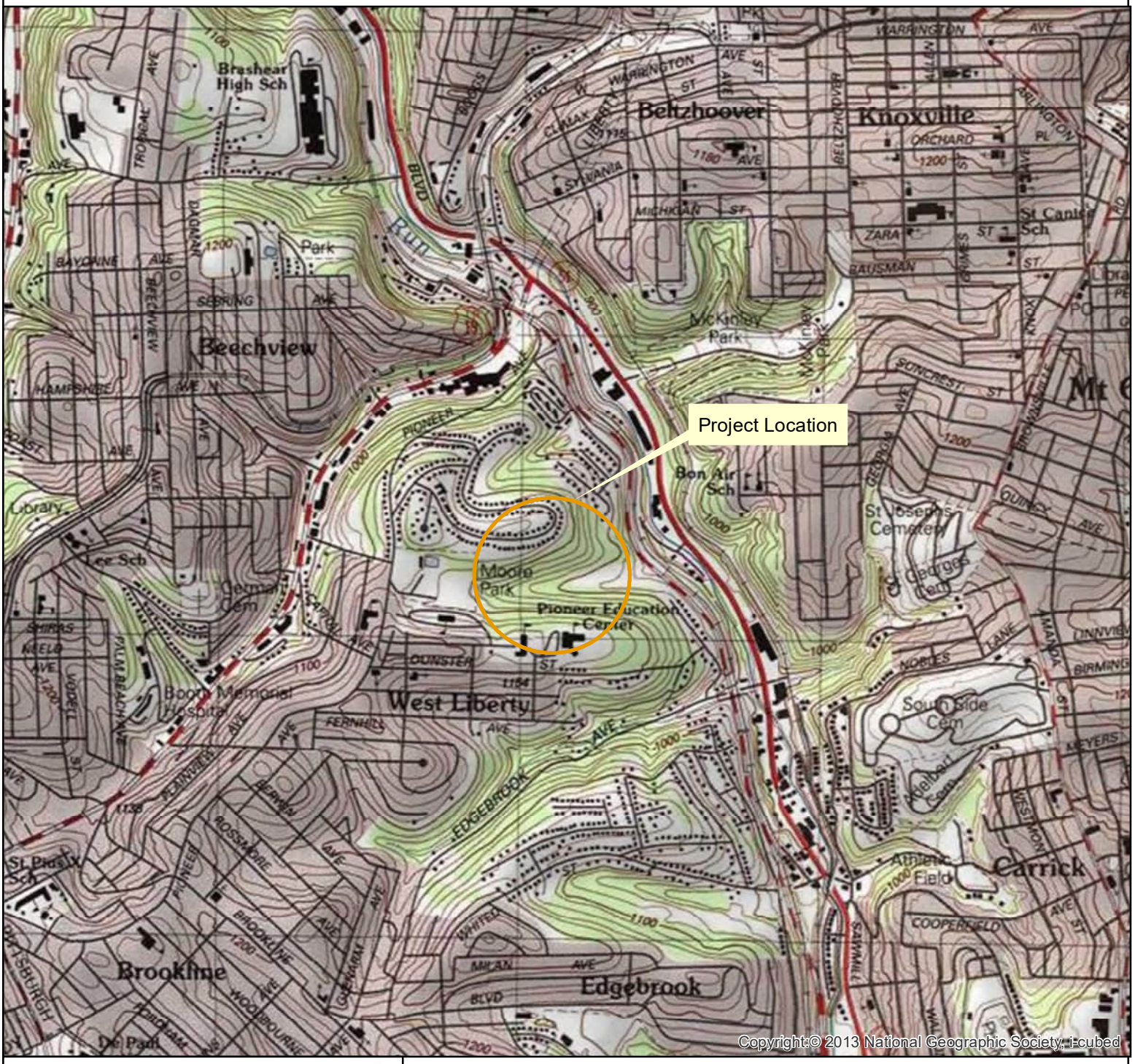
APPENDIX A: City of Pittsburgh Properties

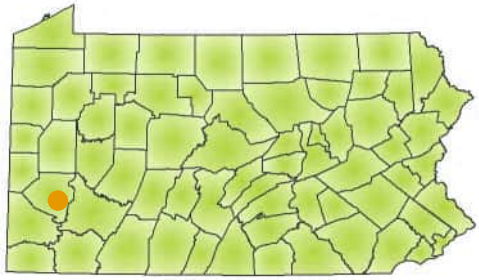
Sample RMP

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Figure 1
Project Location

Moore Park Stream Restoration Site
City of Pittsburgh, Allegheny County, Pennsylvania





Project Location

N

0 750 1,500 3,000 Feet

Scale: 1:24,000

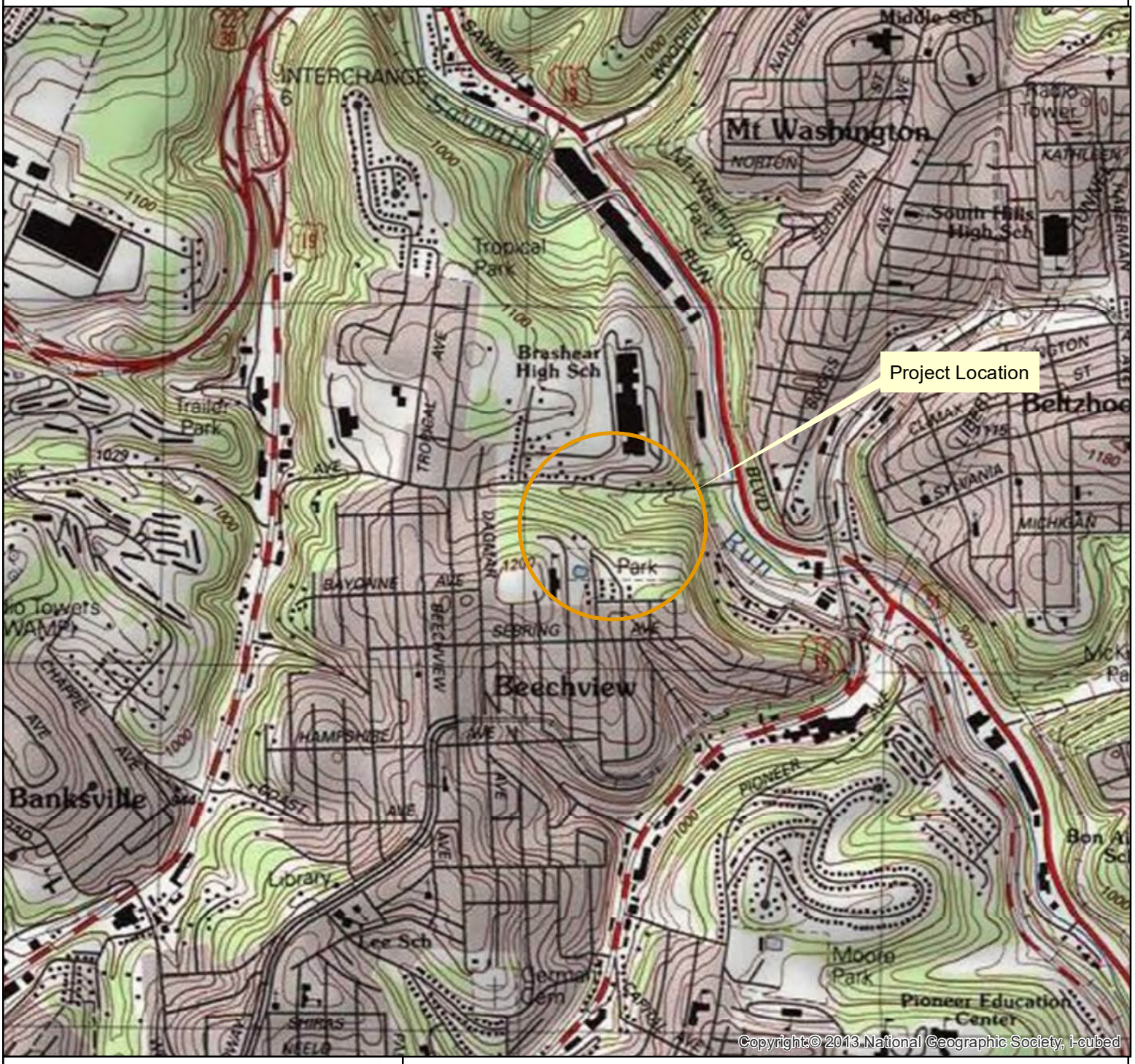
Map Source: USGS Quadrangle

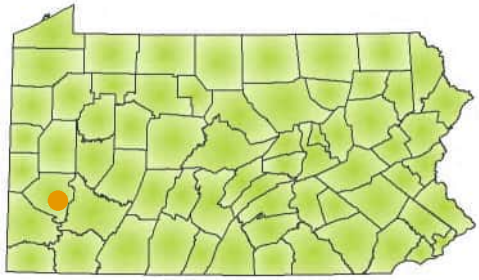
Created by:
Hunt Valley Environmental, LLC

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Figure 1
Project Location

Crane Avenue Stream Restoration Site
City of Pittsburgh, Allegheny County, Pennsylvania





Project Location

N

0 650 1,300 2,600 Feet

Scale: 1:24,000

Map Source: USGS Quadrangle

Created by:
Hunt Valley Environmental, LLC

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

APPENDIX B: Site Plans

Sample RMP

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Site Plans are included under Appendix C. The Resource Management Plan will include the same plans and details of the Moore Park and Crane Avenue- Beechview Greenway.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

APPENDIX C: Operations and Maintenance

Sample RMP

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Operation, Maintenance, and Replacement Plans

The project proposes the use of stream and floodplain restoration to reduce the sediment loading rates at the selected sites at within the Sawmill Run Watershed (12-Digit HUC 050301010301). LRG has investigated several sites to determine the best possible options to provide sediment reduction mitigation.

The selected sites contain streams that are impaired due to urban runoff and sediment due to the impacts of stormwater runoff and land use. The selected restoration projects will be designed with sustainability in mind, along with increasing functionality to reduce sediment loads through the process of stabilizing stream banks and reconnecting the streams to the floodplain. LRG will utilize a method referred as regenerative stream conveyance in the unnamed tributaries to Sawmill Run. This will include channel restoration, floodplain grading and grade control structures to reestablish the stream channels and reconnect them with the floodplain. Woody debris will be used as the primary material for the stabilization of the channel in the form of log grade control structures and floodplain features. The reconstructed streams will be designed to have low bank heights that provide an opportunity for the stormwater to spread out over the floodplain.

Long term O&M is required for the project success. To minimize continual site management needs, Land Reclamation Group has designed Best Management Practices (BMP's) which will not require annual maintenance. The regenerative stream conveyance relies on the opportunities of the flood waters to access the flood plain that has vegetative cover minimizing the shear stress of the water. The Sponsor will need to inspect and monitor the channel. Vegetative success is important. The Sponsor will need to monitor, replace dead shrubs and reseed vegetation when plant success is not apparent. The grade controls need to be inspected. When scour is observed around the grad controls stone or products such as coir log should be used to prevent further scour.

For the Best Management practices proposed the Sponsor shall inspect the banks for further erosion. Vegetative cover is important. Plant success is essential for stabilization and minimization of erosion of sediment. The structures made of wood need to be inspected to make sure they are fixed firmly with no movement during high water events. If the structures are failing, they will require additional pinning or replacement. Where coir logs were utilized, the log must be securely staked/pinned to the streambed. The logs should be backed with material such as soil as presented in the plans. This area must be stabilized with vegetation to hold the material in place. Plugs must be planted in the coir log their success is important as the roots of the vegetation enhance the stability and strength of the log to minimize failure and soil erosion.

At all location success of vegetation is required. Where there are dead shrubs and less than 70% vegetative cover the areas will need to be seeded to prevent erosion and the shrubs will need to be replaced.

The stormwater retention facilities constructed at Moore Park and Beechview Greenway along Crane Avenue will require operations and maintenance for long term success.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Properly designed and installed Bioretention areas require some regular maintenance.

- While vegetation is being established, pruning and weeding may be required.
- Detritus may also need to be removed every year Perennial plantings may be cut down at the end of the growing season.
- Mulch should be re-spread when erosion is evident and be replenished as needed. Once every 2 to 3 years the entire area may require mulch replacement.
- Bioretention areas should be inspected at least two times per year for sediment buildup, erosion vegetative conditions, etc.
- During periods of extended drought, bioretention areas may require watering.
- Trees and shrubs should be inspected twice per year to evaluate health.

General Site Inspection

The reestablished streams shall be inspected for accelerated erosion and BMP failures every 6 months for the first two years. The reestablished streams will be inspected annually. Visual inspection of the grade controls and vegetation establishment will be required.

All sites shall be inspected for accelerated erosion and BMP failures every 6 months for the first two years. The stream bank BMP's will be inspected annually after the first two years.

All sites will be inspected after a significant event. This is a storm greater than a 5 year event.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

GLOSSARY OF TERMS

Adaptive Resource Management – Adaptive management [is a decision process that] promotes flexible decision making that can be adjusted in the face of uncertainties as outcomes from management actions and other events become better understood. Careful monitoring of these outcomes both advances scientific understanding and helps adjust policies or operations as part of an iterative learning process. It is not a 'trial and error' process, but rather emphasizes learning while doing.

Biodiversity – The variety of life in the world or in a particular habitat or ecosystem.

Citizen Science – A project that enables citizen volunteers to gather data that will be analyzed by professional researchers. Citizen volunteers may have no specific scientific training but can perform or manage research-related tasks such as observation, measurement, or computation.

Contributing Landscape – Ecological features which are critical to support species and their lifecycles or the proper functioning of natural systems. For example, field complexes which provide over-wintering habitat for short-eared owls and forested zones around vernal pools which protect hydrology and support breeding populations.

Early Detection and Rapid Response (EDRR) – An approach to preventing new invasive species infestations that requires regular monitoring of managed lands and a prompt and coordinated containment and eradication response. These actions result in lower cost and less resource damage than implementing a long-term control program after a species has become established.

Ecological Memory – The collective genetic biodiversity remaining in a given landscape locked up in living things and their roots, seeds, spores, and eggs. In terrestrial systems, the ecological memory cannot be separated from the soils.

Ecosystem Resilience – The capacity of an ecosystem to absorb disturbance without shifting to an alternative state and losing function and services.

Landscape Mosaic – A metaphor describing the intricate pattern of different habitats or land use types that comprise a geographic region.

Local Ecotype – Plant material and seeds that originate from a defined geographic area and carry genetic adaptations to the environmental conditions of the area.

Natural Resources – Includes living organisms; non-living components such as air, water and soil; the ecosystems they form; and the environmental services they provide, including cleaning air and water, supporting wildlife and contributing to the quality of life

Sample RMP

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

of our citizens. Natural resources is not self-sustaining, but requires deliberate care and investments to enhance, protect and preserve it.

Natural Resource Management Plan(s) – A plan to identify, protect and manage natural resources that can be written to be agency-wide, site-specific, or resource- specific.

Natural Resource Action Plan(s) – An operations plan that summarizes the critical natural resources of a park and sets goals for their management based on available resources. These plans are intended to be brief.

Resource Protection Zone(s) – Areas of natural resource significance in which land disturbance shall be limited and access regulated based on the needs of the resources present. RPZs will generally be defined by the specific resources present.

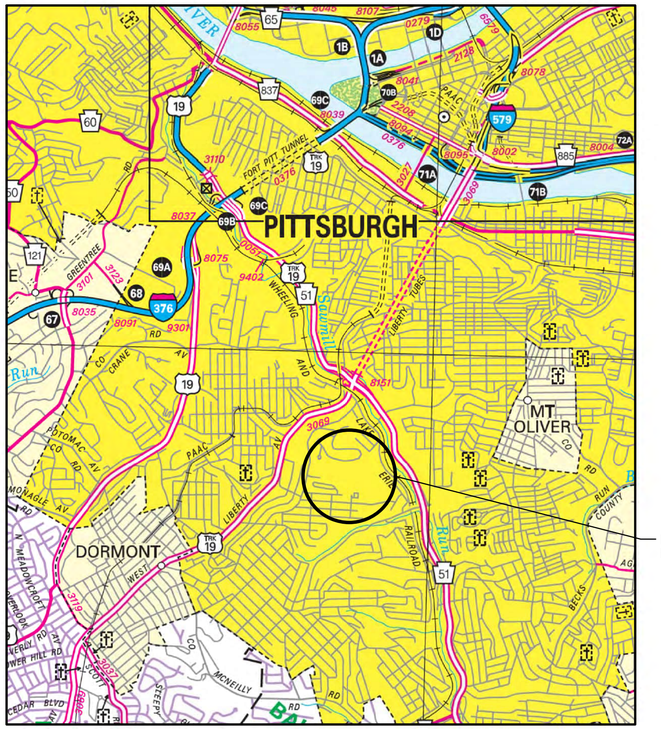
Terrestrial Habitat Zone (for wetlands) – The terrestrial upland areas surrounding a wetland that influence the wetland's hydrology and contain the habitats necessary for various amphibian species to complete their life cycle.

Sample RMP

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Appendix C: Design Plans

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D



LOCATION MAP

0 0.5 1.0 MILES

STREAM RESTORATION FOR MS4 CREDIT

IN THE SAW MILL RUN AND OHIO RIVER WATERSHED

FOR

PENNSYLVANIA DEPARTMENT OF TRANSPOTATION

AND

PITTSBURGH WATER AND SEWER AUTHORITY

POLLUANT REDUCTION PLAN

CALL BEFORE YOU DIG

PENNSYLVANIA LAW REQUIRES 3 WORKING DAYS NOTICE FOR CONSTRUCTION PHASE AND 10 WORKING DAYS IN DESIGN STAGE - STOP CALL 1-800-242-1776

PA ONE CALL System Inc.

DESIGN SERIAL NUMBER - 20222372699

SHEET INDEX BLOCK	
DESCRIPTION	SHEET
TITLE SHEET	1
GENERAL NOTES	2
CONSTRUCTION SEQUENCE	3
EROSION AND SEDIMENT DETAILS	4
STREAM RESTORATION DETAILS	5-6
DETENTION BASIN DETAILS	7-15
PLAN SHEETS	16-18
CROSS SECTIONS	19

SHEET 1 OF 19

STREAM RESTORATION FOR MS4 CREDITS
IN THE THE SAW MILL RUN AND THE OHIO WATERSHED
CITY OF PITTSBURGH
ALLEGHENY COUNTY, PENNSYLVANIA
MOORE PARK RESTORATION PROJECT
TITLE SHEET

PREPARED BY:

HUNT VALLEY ENVIRONMENTAL, LLC
632 HUNT VALLEY ROAD
NEW KENSINGTON, PA 15068

PREPARED FOR:

PENNSYLVANIA
DEPARTMENT OF TRANSPORTATION
KEYSTONE BUILDING
400 NORTHSTREER
HARRISBURG, PA 17120

PITTSBURGH
WATER AND SEWER AUTHORITY
1200 PENN AVE
PITTSBURGH, PA 15222

ENGINEER

ORIGINAL SUBMISSION DATE: 10-19-2022

REVISED SUBMISSION DATE:

COMMONWEALTH OF PENNSYLVANIA
REGISTERED PROFESSIONAL ENGINEER
JAMES H. FLYNN
PE 061647

FILE: S:\Shared Folders\PJF Projects\21-XXX Sawmill Run MS4\CADD\MS4SawMillRunTitleMoorePark.dgn
DATE: 10/24/2022 TIME: 9:05:10 AM

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

EROSION AND SEDIMENT POLLUTION CONTROL GENERAL NOTES

AT LEAST 7 DAYS PRIOR TO STARTING ANY EARTH DISTURBANCE ACTIVITIES, INCLUDING CLEARING AND GRUBBING, THE OWNER AND/OR OPERATOR SHALL INVITE ALL CONTRACTORS, THE LANDOWNER, APPROPRIATE MUNICIPAL OFFICIALS, THE E&S PLAN PREPARER, THE PCSM PLAN PREPARER, THE LICENSED PROFESSIONAL RESPONSIBLE FOR OVERSIGHT OF CRITICAL STAGES OF IMPLEMENTATION OF THE PCSM PLAN, AND A REPRESENTATIVE FROM THE LOCAL CONSERVATION DISTRICT TO AN ON-SITE PRECONSTRUCTION MEETING.

AT LEAST 3 DAYS PRIOR TO STARTING ANY EARTH DISTURBANCE ACTIVITIES, OR EXPANDING INTO AN AREA PREVIOUSLY UNMARKED, THE PENNSYLVANIA ONE CALL SYSTEM INC. SHALL BE NOTIFIED AT 1-800-242-1776 FOR THE LOCATION OF EXISTING UNDERGROUND UTILITIES.

ALL EARTH DISTURBANCE ACTIVITIES SHALL PROCEED IN ACCORDANCE WITH THE SEQUENCE PROVIDED ON THE PLAN DRAWINGS. DEVIATION FROM THAT SEQUENCE MUST BE APPROVED IN WRITING FROM THE LOCAL CONSERVATION DISTRICT OR BY THE DEPARTMENT PRIOR TO IMPLEMENTATION.

AREAS TO BE FILLED ARE TO BE CLEARED, GRUBBED, AND STRIPPED OF TOPSOIL TO REMOVE TREES, VEGETATION, ROOTS AND OTHER OBJECTIONABLE MATERIAL.

CLEARING, GRUBBING, AND TOPSOIL STRIPPING SHALL BE LIMITED TO THOSE AREAS DESCRIBED IN EACH STAGE OF THE CONSTRUCTION SEQUENCE. GENERAL SITE CLEARING, GRUBBING AND TOPSOIL STRIPPING MAY NOT COMMENCE IN ANY STAGE OR PHASE OF THE PROJECT UNTIL THE E&S BMPS SPECIFIED BY THE BMP SEQUENCE FOR THAT STAGE OR PHASE HAVE BEEN INSTALLED AND ARE FUNCTIONING AS DESCRIBED IN THIS E&S PLAN.

AT NO TIME SHALL CONSTRUCTION VEHICLES BE ALLOWED TO ENTER AREAS OUTSIDE THE LIMIT OF DISTURBANCE BOUNDARIES SHOWN ON THE PLAN MAPS. THESE AREAS MUST BE CLEARLY MARKED AND FENCED OFF BEFORE CLEARING AND GRUBBING OPERATIONS BEGIN.

TOPSOIL REQUIRED FOR THE ESTABLISHMENT OF VEGETATION SHALL BE STOCKPILED AT THE LOCATION(S) SHOWN ON THE PLAN MAPS(S) IN THE AMOUNT NECESSARY TO COMPLETE THE FINISH GRADING OF ALL EXPOSED AREAS THAT ARE TO BE STABILIZED BY VEGETATION. EACH STOCKPILE SHALL BE PROTECTED IN THE MANNER SHOWN ON THE PLAN DRAWINGS. STOCKPILE HEIGHTS SHALL NOT EXCEED 35 FEET. STOCKPILE SLOPES SHALL BE 2H:1V OR FLATTER.

IMMEDIATELY UPON DISCOVERING UNFORESEEN CIRCUMSTANCES POSING THE POTENTIAL FOR ACCELERATED EROSION AND/OR SEDIMENT POLLUTION, THE OPERATOR SHALL IMPLEMENT APPROPRIATE BEST MANAGEMENT PRACTICES TO MINIMIZE THE POTENTIAL FOR EROSION AND SEDIMENT POLLUTION AND NOTIFY THE LOCAL CONSERVATION DISTRICT AND/OR DISTRICT ENVIRONMENTAL UNIT.

ALL BUILDING MATERIALS AND WASTES SHALL BE REMOVED FROM THE SITE AND RECYCLED OR DISPOSED OF IN ACCORDANCE WITH THE DEPARTMENT'S SOLID WASTE MANAGEMENT REGULATIONS AT 25 PA. CODE 260.1 ET SEQ., 271.1, AND 287.1 ET. SEQ. NO BUILDING MATERIALS OR WASTES OR UNUSED BUILDING MATERIALS SHALL BE BURNED, BURIED, DUMPED, OR DISCHARGED AT THE SITE.

EROSION AND SEDIMENTATION BEST MANAGEMENT PRACTICES (BMPS) THAT ARE PROPOSED FOR THE PROJECT SHALL BE INSTALLED AND FUNCTIONAL PRIOR TO ANY EARTH MOVING ACTIVITIES WITHIN THEIR CONTRIBUTING AREA.

CONDUCT ALL EARTH MOVING ACTIVITIES AS SPECIFIED IN THE EROSION AND SEDIMENTATION CONTROL PLAN AND IN ACCORDANCE WITH THE RULES AND REGULATION OF CHAPTER 102, TITLE 25 RELATED TO EROSION CONTROL, AND THE CLEAN STREAMS LAW OF PENNSYLVANIA.

UNTIL THE SITE IS STABILIZED, ALL EROSION AND SEDIMENT BMPS SHALL BE MAINTAINED PROPERLY. MAINTENANCE SHALL INCLUDE INSPECTIONS OF ALL EROSION AND SEDIMENT BMPS AFTER EACH RUNOFF EVENT AND ON A WEEKLY BASIS. ALL PREVENTATIVE AND REMEDIAL MAINTENANCE WORK, INCLUDING CLEAN OUT, REPAIR, REPLACEMENT, REGRADING, RESEEDING, REMULCHING AND RENETTING MUST BE PERFORMED IMMEDIATELY. IF THE E&S BMPS FAIL TO PERFORM AS EXPECTED, REPLACEMENT BMPS, OR MODIFICATIONS OF THOSE INSTALLED WILL BE REQUIRED IMMEDIATELY.

SEED AND MULCH ANY DISTURBED AREA THAT WILL REMAIN IDLE FOR MORE THAN 4 DAYS
STABILIZATION IS DEFINED AS A UNIFORM, 70%, PERENNIAL COVER ESTABLISHED OVER THE DISTURBED AREA.

ANY AND ALL ACCUMULATED SILT AND SEDIMENTS THAT ARE FOUND WITHIN AN EROSION CONTROL DEVICE SHALL BE REMOVED FROM THE CONTROL DEVICE AND SPREAD EVENLY ON THE FILL UPSLOPE OF THE EROSION AND SEDIMENTATION CONTROLS, AND THEN SEEDED AND MULCHED TO PROVIDE STABILIZATION.

ANY OFFSITE WASTE AND BORROW AREAS MUST HAVE AN E & S PLAN REVIEWED AND APPROVED BY THE LOCAL CONSERVATION DISTRICT AND THE DISTRICT ENVIRONMENTAL UNIT PRIOR TO BEING ACTIVATED.

CLEAN FILL IS DEFINED AS: UNCONTAMINATED, NON-WATER SOLUBLE, NON-DECOMPOSABLE, INERT, SOLID MATERIAL. THE TERM INCLUDES SOIL, ROCK, STONE, DREDGED MATERIAL, USED ASPHALT, AND BRICK, BLOCK OR CONCRETE, FROM CONSTRUCTION AND DEMOLITION ACTIVITIES THAT IS SEPARATE FROM OTHER WASTE AND IS RECOGNIZABLE AS SUCH. THE TERM DOES NOT INCLUDE MATERIALS PLACED IN OR ON THE WATERS OF THE COMMONWEALTH UNLESS OTHERWISE AUTHORIZED. (THE TERM USED ASPHALT DOES NOT INCLUDE MILLED ASPHALT OR ASPHALT THAT HAS BEEN PROCESSED FOR REUSE).

ENVIRONMENTAL DUE DILIGENCE MUST BE PERFORMED TO DETERMINE IF FILL MATERIALS ASSOCIATED WITH THE PROJECT QUALIFY AS CLEAN FILL. ENVIRONMENTAL DUE DILIGENCE IS DEFINED AS: INVESTIGATION TECHNIQUES, INCLUDING BUT NOT LIMITED TO, VISUAL PROPERTY INSPECTIONS, ELECTRONIC DATA BASE SEARCHES, REVIEW OF THE PROPERTY OWNERSHIP, REVIEW OF THE PROPERTY USE HISTORY, SANBORN MAPS, ENVIRONMENTAL QUESTIONNAIRES, TRANSACTION SCREEN, ANALYTICAL TESTING, ENVIRONMENTAL ASSESSMENTS OR AUDITS. ANALYTICAL TESTING IS NOT A REQUIRED PART OF DUE DILIGENCE UNLESS VISUAL INSPECTION AND/OR REVIEW OF THE PAST LAND USE OF THE PROPERTY INDICATES THAT THE FILL MAY HAVE BEEN COMPROMISED BY A RELEASE OF A REGULATED SUBSTANCE. IF THE FILL IS SUSPECTED TO HAVE BEEN COMPROMISED BY A RELEASE OF A REGULATED SUBSTANCE, IT MUST BE TESTED TO DETERMINE IF IT QUALIFIES AS A CLEAN FILL. TESTING SHOULD BE PERFORMED IN ACCORDANCE WITH APPENDIX A OF THE DEPARTMENT'S POLICY "MANAGEMENT OF CLEAN FILL".

THE CONTRACTOR IS RESPONSIBLE FOR ENSURING THAT ANY MATERIAL BROUGHT ON SITE IS CLEAN FILL. PADEP FORM FP-001 MUST BE RETAINED BY THE PROPERTY OWNER FOR ANY FILL MATERIAL AFFECTED BY A SPILL OR RELEASE OF A REGULATED SUBSTANCE BUT QUALIFYING AS CLEAN FILL DUE TO ANALYTICAL TESTING.

ALL EARTH DISTURBANCES, INCLUDING CLEARING AND GRUBBING AS WELL AS CUTS AND FILLS SHALL BE DONE IN ACCORDANCE WITH THE APPROVED E&S PLAN. A COPY OF THE APPROVED DRAWINGS (STAMPED, SIGNED AND DATED BY THE REVIEWING AGENCY) MUST BE AVAILABLE AT THE PROJECT SITE AT ALL TIMES. THE REVIEWING AGENCY SHALL BE NOTIFIED OF ANY CHANGES TO THE APPROVED PLAN PRIOR TO IMPLEMENTATION OF THOSE CHANGES. THE REVIEWING AGENCY MAY REQUIRE A WRITTEN SUBMITTAL OF THOSE CHANGES FOR REVIEW AND APPROVAL AT ITS DISCRETION.

ALL PUMPING OF WATER FROM ANY WORK AREA SHALL BE DONE ACCORDING TO THE PROCEDURE DESCRIBED IN THIS PLAN, OVER UNDISTURBED VEGETATED AREAS.

A WRITTEN LOG MUST BE COMPLETED ON FORM 3800-FM-BCW0271D (MOST CURRENT FORM) SHOWING DATES THAT E&S BMPS WERE INSPECTED, DEFICIENCIES FOUND AND THE DATE THEY WERE CORRECTED SHALL BE MAINTAINED ON THE SITE AND BE MADE AVAILABLE TO REGULATORY AGENCY OFFICIALS AT THE TIME OF INSPECTION.

SEDIMENT TRACKED ONTO ANY PUBLIC ROADWAY OR SIDEWALK SHALL BE RETURNED TO THE CONSTRUCTION SITE BY THE END OF EACH WORK DAY AND DISPOSED IN THE MANNER DESCRIBED IN THIS PLAN. IN NO CASE SHALL THE SEDIMENT BE WASHED, SHOVELED, OR SWEPT INTO ANY ROADSIDE DITCH, STORM SEWER, OR SURFACE WATER.

AREAS WHICH ARE TO BE TOPSOILED SHALL BE SCARIFIED TO A MINIMUM DEPTH OF 3 TO 5 INCHES 6 TO 12 INCHES ON COMPACTED SOILS PRIOR TO PLACEMENT OF TOPSOIL. AREAS TO BE VEGETATED SHALL HAVE A MINIMUM 4 INCHES OF TOPSOIL IN PLACE PRIOR TO SEEDING AND MULCHING. FILL OUTSLOPES SHALL HAVE A MINIMUM OF 2 INCHES OF TOPSOIL.

BMP INSPECTION, MAINTENANCE AND REPAIR SCHEDULE

BMP	INSPECTION	MAINTENANCE	REPAIR
ROCK CONSTRUCTION ENTRANCE	DAILY	REMOVE SEDIMENT	MAINTAIN THICKNESS AND DIMENSIONS BY ADDING ROCK
SEEDING AND MULCHING	WEEKLY AND AFTER EACH RAINFALL EVENT	N/A	EVALUATE CONDITIONS AND RE-SEED AND STABILIZE
PUMPED WATER FILTER BAG	DAILY	CEASE USE AND FIX PROBLEM	REPAIR IMMEDIATELY
TEMPORARY PUMP BYPASS	DAILY	CEASE USE AND FIX PROBLEM	REPAIR IMMEDIATELY

NOTES:

1. MAINTENANCE AND REPAIR ON BMP'S MUST BE COMPLETED IMMEDIATELY AFTER THE WEEKLY OR RAINFALL INSPECTION.
2. SEDIMENT REMOVED FROM BMP'S SHALL BE PLACED ON THE TOP SOIL STOCK PILE FOR USE LATER IN THE PROJECT.
3. A RUNOFF EVENT IS RAINFALL OR SNOW RUNOFF OF 0.25" OR MORE IN A 24 CONSECUTIVE HOUR PERIOD.
4. WEEKLY OR RAINFALL INSPECTIONS OVER MUST BE COMPLETED ON THE WRITTEN LOG FORM 3800-FM-BCW0271D (OR MOST CURRENT FORM).

STREAM RESTORATION FOR MS4 CREDITS
IN THE THE SAW MILL RUN AND THE OHIO WATERSHED
CITY OF PITTSBURGH
ALLEGHENY COUNTY, PENNSYLVANIA
MOORE PARK RESTORATION PROJECT
GENERAL NOTES

PREPARED BY:
HUNT VALLEY ENVIRONMENTAL, LLC
632 HUNT VALLEY ROAD
NEW KENSINGTON, PA 15068

PREPARED FOR:
PENNSYLVANIA
DEPARTMENT OF TRANSPORTATION
KEYSTONE BUILDING
400 NORTHSTREER
HARRISBURG, PA 17120

PITTSBURGH
WATER AND SEWER AUTHORITY
1200 PENN AVE
PITTSBURGH, PA 15222

ENGINEER

ORIGINAL SUBMISSION DATE: 10-19-2022

REVISED SUBMISSION DATE:

COMMONWEALTH OF PENNSYLVANIA
REGISTERED PROFESSIONAL
JAMES H. FLYNN
ENGINEER
PE 061647

FILE: S:\Shared Folders\P-Drive\21-XXX Sawmill Run MS4\CADD\MS4Sawmill\RunGenNotesMoore.dgn
DATE: 10/20/2022 TIME: 2:54:46 PM

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

EROSION AND SEDIMENT POLLUTION CONTROL GENERAL NOTES (CONT'D)

ALL FILLS SHALL BE COMPACTED AS REQUIRED TO REDUCE EROSION, SLIPPAGE, SETTLEMENT, SUBSIDENCE OR OTHER RELATED PROBLEMS. FILL INTENDED TO SUPPORT BUILDINGS, STRUCTURES AND CONDUITS, ETC. SHALL BE COMPACTED IN ACCORDANCE WITH LOCAL REQUIREMENTS OR CODES.

FILL MATERIALS SHALL BE FREE OF FROZEN PARTICLES, BRUSH, ROOTS, SOD, OR OTHER FOREIGN OR OBJECTIONABLE MATERIALS THAT WOULD INTERFERE WITH OR PREVENT CONSTRUCTION OF SATISFACTORY FILLS.

FROZEN MATERIALS OR SOFT, MUCKY, OR HIGHLY COMPRESSIBLE MATERIALS SHALL NOT BE INCORPORATED INTO FILLS. FILL SHALL NOT BE PLACED ON SATURATED OR FROZEN SURFACES.

SEEPS OR SPRINGS ENCOUNTERED DURING CONSTRUCTION SHALL BE HANDLED IN ACCORDANCE WITH THE STANDARD AND SPECIFICATION FOR SUBSURFACE DRAIN OR OTHER APPROVED METHOD.

ALL GRADED AREAS SHALL BE PERMANENTLY STABILIZED IMMEDIATELY UPON REACHING FINISHED GRADE. CUT SLOPES IN COMPETENT BEDROCK AND ROCK FILLS NEED NOT BE VEGETATED. SEEDED AREAS WITHIN 50 FEET OF A SURFACE WATER, OR AS OTHERWISE SHOWN ON THE PLAN DRAWINGS, SHALL BE BLANKETED ACCORDING TO THE STANDARDS OF THIS PLAN.

IMMEDIATELY AFTER EARTH DISTURBANCE ACTIVITIES CEASE IN ANY AREA OR SUBAREA OF THE PROJECT, THE OPERATOR SHALL STABILIZE ALL DISTURBED AREAS. DURING NON-GERMINATING MONTHS, MULCH OR PROTECTIVE BLANKETING SHALL BE APPLIED AS DESCRIBED IN THE PLAN. AREAS NOT AT FINISHED GRADE, WHICH WILL BE REACTIVATED WITHIN 1 YEAR, MAY BE STABILIZED IN ACCORDANCE WITH THE TEMPORARY STABILIZATION SPECIFICATIONS. THOSE AREAS WHICH WILL NOT BE REACTIVATED WITHIN 1 YEAR SHALL BE STABILIZED IN ACCORDANCE WITH THE PERMANENT STABILIZATION SPECIFICATIONS.

PERMANENT STABILIZATION IS DEFINED AS A MINIMUM UNIFORM, PERENNIAL 70% VEGETATIVE COVER OR OTHER PERMANENT NON-VEGETATIVE COVER WITH A DENSITY SUFFICIENT TO RESIST ACCELERATED EROSION. CUT AND FILL SLOPES SHALL BE CAPABLE OF RESISTING FAILURE DUE TO SLUMPING, SLIDING, OR OTHER MOVEMENTS.

E&S BMPS SHALL REMAIN FUNCTIONAL AS SUCH UNTIL ALL AREAS TRIBUTARY TO THEM ARE PERMANENTLY STABILIZED OR UNTIL THEY ARE REPLACED BY ANOTHER BMP APPROVED BY THE LOCAL CONSERVATION DISTRICT OR DISTRICT ENVIRONMENTAL UNIT.

AFTER FINAL SITE STABILIZATION HAS BEEN ACHIEVED, TEMPORARY EROSION AND SEDIMENT BMPS MUST BE REMOVED OR CONVERTED TO PERMANENT POST CONSTRUCTION STORMWATER MANAGEMENT BMPS. AREAS DISTURBED DURING REMOVAL OR CONVERSION OF THE BMPS SHALL BE STABILIZED IMMEDIATELY. IN ORDER TO ENSURE RAPID REVEGETATION OF DISTURBED AREAS, SUCH REMOVAL/CONVERSIONS ARE TO BE DONE ONLY DURING THE GERMINATING SEASON.

UPON COMPLETION OF ALL EARTH DISTURBANCE ACTIVITIES AND PERMANENT STABILIZATION OF ALL DISTURBED AREAS, THE OWNER AND/OR OPERATOR SHALL CONTACT THE LOCAL CONSERVATION DISTRICT TO SCHEDULE A FINAL INSPECTION.

NOTIFY THE PENNSYLVANIA DEPARTMENT OF ENVIRONMENTAL PROTECTION AND THE ALLEGHENY COUNTY CONSERVATION DISTRICT 10 DAYS IN ADVANCE OF ANY LAND DISTURBANCE ACTIVITIES AT THE FOLLOWING ADDRESS:

PROCEDURES WHICH ENSURE THAT THE PROPER MEASURES FOR THE RECYCLING OR DISPOSAL OF MATERIALS ASSOCIATED WITH OR FROM THE PROJECT SITE WILL BE UNDERTAKEN IN ACCORDANCE WITH DEPARTMENT REGULATIONS. INDIVIDUALS RESPONSIBLE FOR EARTH DISTURBANCE ACTIVITIES MUST ENSURE THAT PROPER MECHANISMS ARE IN PLACE TO CONTROL WASTE MATERIALS. CONSTRUCTION WASTES INCLUDE, BUT ARE NOT LIMITED TO, EXCESS SOIL MATERIALS, BUILDING MATERIALS, CONCRETE WASH WATER, SANITARY WASTES, ETC. THAT COULD ADVERSELY IMPACT WATER QUALITY. MEASURES SHOULD BE PLANNED AND IMPLEMENTED FOR HOUSEKEEPING, MATERIALS MANAGEMENT, AND LITTER CONTROL. WHEREVER POSSIBLE, RECYCLING OF EXCESS MATERIALS IS PREFERRED, RATHER THAN DISPOSAL. A NOTE REQUIRING RECYCLING OF WASTE MATERIALS, WHERE FEASIBLE, SHOULD BE ADDED TO THE DRAWINGS.

ANNE FOX, SENIOR RESOURCE CONSERVATIONIST
ALLEGHENY COUNTY CONSERVATION DISTRICT
312 EAST CARSON STREET, SUITE 119
PITTSBURGH, PA 15219
PHONE: (412) 291-8010

PA DEP REGIONAL OFFICE CONTACT INFORMATION:

PA DEP SOUTHWEST REGIONAL OFFICE
WETLANDS AND WATERWAYS
400 WATERFRONT DRIVE
PITTSBURGH, PA 15222
OFFICE HOURS 8 A.M. - 4 P.M.
PHONE: (412) 422-4000

PLAN PREPARER CONTACT INFORMATION:

MR. JAMES FLYNN, P.E.
HUNT VALLEY ENVIROMENTAL, LLC
632 HUNT VALLEY CIRCLE
NEW KENSINGTON, PA 15068
PHONE: 724-594-0805

	FORMULA AND SPECIES	% BY WEIGHT	MINIMUM % PURITY	MINIMUM % GERMINATION	APPLICATION RATE
FORMULA D	TALL FESCUE (FESTUCA ARUNDINACEA VAR. KENTUCKY 31)	60	96	85	50.0 LBS/ACRE
	CREEPING RED FESCUE OR CHEWINGS FESCUE (FESTUCA RUBRA OR SSP COMMUTATE) (IMPROVED AND CERTIFIED)	30	97	85	
	ANNUAL RYEGRASS (LOLIUM MULTIFLORUM)	10	95	90	
	FERTILIZER APPL. RATE	10-20-20			1000.0 LBS/ACRE
	LIMING RATE	-			6.0 TONS/ACRE
	MULCHING TYPE	HAY			1,200 LBS/1,000 SY
	SEASON SEEDING DATES	MARCH-NOVEMBER			-
FORMULA E	ANNUAL RYEGRASS	100.00	95	90	10.0 LBS/ACRE
	FERTILIZER APPL. RATE	10-20-20			1000.0 LBS/ACRE
	LIMING RATE	-			2.0 TONS/ACRE
	MULCHING TYPE	HAY			3.0 TONS/ACRE
	SEASON SEEDING DATES	MARCH-NOVEMBER			
FORMULA L	HARD FESCUE MIXTURE (FESTUCA LONGIFOLIA), A COMBINATION OF IMPROVED CERTIFIED VARIETIES WITH NO ONE VARIETY EXCEEDING 50% OF THE TOTAL HARD FESCUE COMPONENT	55	97	85	50.0 LBS/ACRE
	CREEPING RED FESCUE (FESTUCA RUBRA) (IMPROVED AND CERTIFIED)	35	97	85	
	ANNUAL RYEGRASS (LOLIUM MULTIFLORUM)	10	95	90	
	FERTILIZER APPL. RATE	10-20-20			1000.0 LBS/ACRE
	LIMING RATE	-			6.0 TONS/ACRE
	MULCHING TYPE	HAY			1,200 LBS/1,000 SY
	SEASON SEEDING DATES	MARCH-NOVEMBER			-

CONSTRUCTION SEQUENCE

ALL CONSTRUCTION ACTIVITIES SHALL PROCEED IN ACCORDANCE WITH THE FOLLOWING CONSTRUCTION SEQUENCE. EACH STEP SHALL BE COMPLETED BEFORE A SUBSEQUENT STEP IS INITIATED. UPON COMPLETION OR TEMPORARY CESSATION OF THE EARTH DISTURBANCE ACTIVITY, OR ANY STAGE THEREOF, THE PROJECT SITE SHALL BE IMMEDIATELY STABILIZED. THE CONTRACTOR CAN PROCEED WITH THE REMAINDER OF CLEARING AND GRUBBING BETWEEN NOVEMBER 16 AND MARCH 31. INSTALL THE REMAINDER BMP'S AND CONTINUE WITH FILL ON THE SITE.

PRE-CONSTRUCTION

1. AT LEAST 7 DAYS PRIOR TO STARTING ANY EARTH DISTURBANCE ACTIVITIES (INCLUDING CLEARING AND GRUBBING), THE OWNER AND/OR OPERATOR SHALL INVITE ALL CONTRACTORS, THE LANDOWNER, APPROPRIATE MUNICIPAL OFFICIALS, THE EROSION AND SEDIMENT POLLUTION CONTROL PLAN PREPARER, A REPRESENTATIVE FROM THE PENNSYLVANIA DEPARTMENT OF ENVIRONMENTAL PROTECTION AND A REPRESENTATIVE FROM THE ALLEGHENY COUNTY CONSERVATION DISTRICT TO AN ON-SITE PRECONSTRUCTION MEETING.
2. AT LEAST 3 DAYS PRIOR TO STARTING ANY EARTH DISTURBANCE ACTIVITIES, OR EXPANDING INTO AN AREA PREVIOUSLY UNMARKED, THE PENNSYLVANIA ONE CALL SYSTEM INC. SHALL BE NOTIFIED AT 1-800-242-1776 FOR THE LOCATION OF EXISTING UNDERGROUND UTILITIES.
3. ALL APPLICABLE PERMITS AND APPROVALS REQUIRED FOR THIS PROJECT SHALL BE SECURED PRIOR TO THE START OF CONSTRUCTION. COPIES OF PERMITS, PLANS AND APPROVALS SHALL BE KEPT ON-SITE AT ALL TIMES.
4. ALL EARTH DISTURBANCE ACTIVITIES SHALL PROCEED IN ACCORDANCE WITH THE SEQUENCE PROVIDED ON THE PLAN DRAWINGS.
5. THE SELECTED CONTRACTOR IS RESPONSIBLE FOR HAVING AN APPROVED EROSION AND SEDIMENTATION CONTROL PLAN FOR ALL OFF-SITE WASTE AND BORROW SITES.
6. CONTRACTOR SHOULD LIMIT STOCKPILING OF WASTE, CONSTRUCTION EQUIPMENT, FUEL TANKS, BORROWED EXCAVATION, ETC. NEAR THE STREAM IN THE EVENT A SIGNIFICANT STORM SHOULD OCCUR.
7. MOBILIZE FOR PROJECT CONSTRUCTION.

CONSTRUCTION

LRG WILL UTILIZE REGENERATIVE STREAM CONVEYANCE/FLOOD PLAIN RESTORATION FOR THE CONSTRUCTION METHOD OF THE REESTABLISHED UNNAMED TRIBUTARY CHANNELS IN SAWMILL RUN. LENGTH OF EACH CONSTRUCTION REACH IS BASED ON THE EXISTING FLOW OF THE CHANNEL.

1. PLACE A ROCK CONSTRUCTION ENTRANCE FOR ACCESS TO THE STREAM.
2. SET UP STREAM DIVERSION/PUMP AROUND APPROXIMATELY 200 FEET MAX IN LENGTH
3. ONLY DISTURB LENGTH OF CHANNEL THAT CAN BE RESTORED IN A DAY.
4. PLACE STONE FILTER IN THE CHANNEL 5-10 FEET UPSTREAM AT THE POINT WHERE THE PUMP DISCHARGES THE WATER INTO THE DOWN-STREAM CHANNEL. DISCHARGE THE WATER THROUGH A DIFFUSER 20 FEET DOWNSTREAM OF THE WORK AREA DO NOT CAUSE A SCOUR ISSUE IN THE CHANNEL OR WETLANDS.
5. GRADE THE CHANNEL CLOSED IN THE REACH.
6. EXCAVATE THE CHANNEL TO PROPOSED GRADE AND DEPTH BY USING THE BACK OF THE BUCKET. IT WILL BE 4" - 6" DEPTH BASED ON THE DETAIL.
7. EXCAVATE AND PLACE GRADE CONTROL STRUCTURES PERPENDICULAR TO CHANNEL SO TOP OF THE LOG STRUCTURE IS AT THE INVERT OF THE CHANNEL. THESE WILL BE SPACED ACCORDING TO CHART IN PLAN.
8. PLACE AASHTO-1 IN BED AS NEEDED
9. SEED FLOODWAY PER SEEDING SPECIFICATION ON DETAIL SHEET, MULCHING WITH A TEMPORARY MULCH BLANKET OR ECMB AS DETAIL RECOMENDS.
10. REMOVE BYPASS PUMP, PROCEED TO NEXT REACH, LEAVE STONE FILTER IN PLACE AT THE DOWNSTREAM END UNTIL THE CHANNEL RESTABLISHMENT PROJECT IS COMPLETED.

REPEAT THE SEQUENCE BASED UPON THE STATIONING OF THE REACH. EACH REACH CAN NOT EXCEED 200 FEET UNLESS THE CHANNEL IS DRY. THE SAME SEQUENCE WILL BE FOLLOWED FOR THE REESTBLISHEMNT OF EACH CHANNEL.

FILE: S:\Shared Folders\Projects\XXX Sawmill Run MS4\CADD\MS4Sawmill\RunGenNotes2Moore.dgn
DATE: 10/27/2022 TIME: 2:55:53 PM

STREAM RESTORATION FOR MS4 CREDITS
IN THE THE SAW MILL RUN AND THE OHIO WATERSHED
CITY OF PITTSBURGH
ALLEGHENY COUNTY, PENNSYLVANIA
MOORE PARK RESTORATION PROJECT
GENERAL NOTES AND CONSTRUCTION SEQUENCE

PREPARED BY:
HUNT VALLEY ENVIRONMENTAL, LLC
632 HUNT VALLEY ROAD
NEW KENSINGTON, PA 15068

PREPARED FOR:
PENNSYLVANIA DEPARTMENT OF TRANSPORTATION
KEYSTONE BUILDING
400 NORTHSTREER
HARRISBURG, PA 17120

PITTSBURGH
WATER AND SEWER AUTHORITY
1200 PENN AVE
PITTSBURGH, PA 15222

ENGINEER

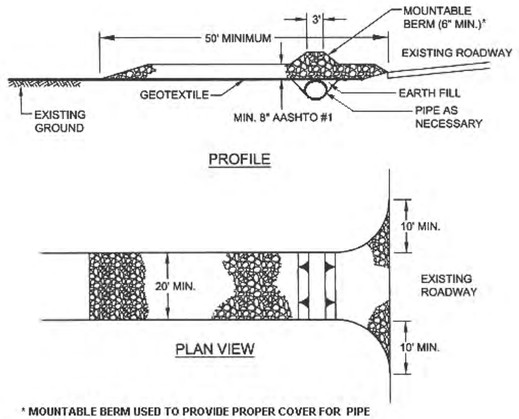
ORIGINAL SUBMISSION DATE: 10-19-2022

REVISED SUBMISSION DATE:

COMMONWEALTH OF PENNSYLVANIA
REGISTERED PROFESSIONAL
JAMES H. FLYNN
ENGINEER
PE 061547

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

STANDARD CONSTRUCTION DETAIL # 3-1
Rock Construction Entrance



* MOUNTABLE BERM USED TO PROVIDE PROPER COVER FOR PIPE

Modified from Maryland DOE

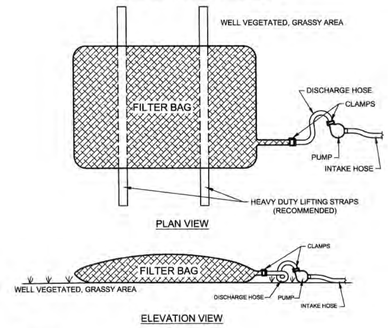
Remove topsoil prior to installation of rock construction entrance. Extend rock over full width of entrance.

Runoff shall be diverted from roadway to a suitable sediment removal BMP prior to entering rock construction entrance.

Mountable berm shall be installed wherever optional culvert pipe is used and proper pipe cover as specified by manufacturer is not otherwise provided. Pipe shall be sized appropriately for size of ditch being crossed.

MAINTENANCE: Rock construction entrance thickness shall be constantly maintained to the specified dimensions by adding rock. A stockpile shall be maintained on site for this purpose. All sediment deposited on paved roadways shall be removed and returned to the construction site immediately. If excessive amounts of sediment are being deposited on roadway, extend length of rock construction entrance by 50 foot increments until condition is alleviated or install wash rack. Washing the roadway or sweeping the deposits into roadway ditches, sewers, culverts, or other drainage courses is not acceptable.

STANDARD CONSTRUCTION DETAIL # 3-16
Pumped Water Filter Bag



PA DEP

Low volume filter bags shall be made from non-woven geotextile material sewn with high strength, double stitched "J" type seams. They shall be capable of trapping particles larger than 150 microns. High volume filter bags shall be made from woven geotextiles that meet the following standards:

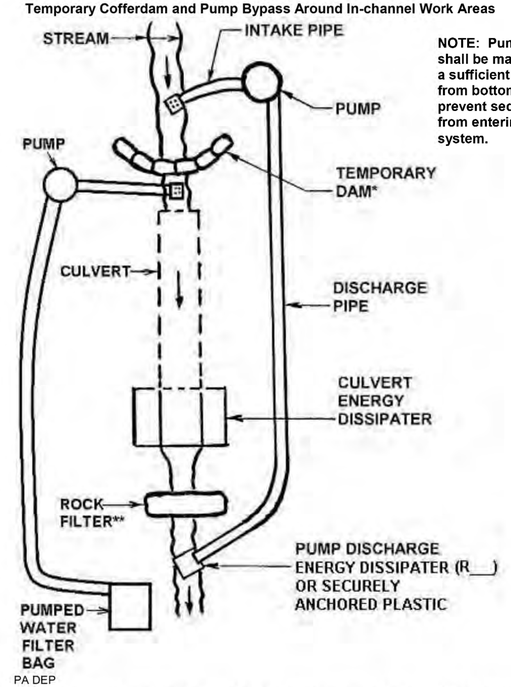
Property	Test Method	Minimum Standard
Avg. Wide Width Strength	ASTM D-4884	60 lb/in
Grab Tensile	ASTM D-4632	205 lb
Puncture	ASTM D-4833	110 lb
Mullen Burst	ASTM D-3786	350 psi
UV Resistance	ASTM D-4355	70%
AOS % Retained	ASTM D-4751	80 Sieve

A suitable means of accessing the bag with machinery required for disposal purposes shall be provided. Filter bags shall be replaced when they become ½ full of sediment. Spare bags shall be kept available for replacement of those that have failed or are filled. Bags shall be placed on straps to facilitate removal unless bags come with lifting straps already attached.

Bags shall be located in well-vegetated (grassy) area, and discharge onto stable, erosion resistant areas. Where this is not possible, a geotextile underlayment and flow path shall be provided. Bags may be placed on filter stone to increase discharge capacity. Bags shall not be placed on slopes greater than 5%. For slopes exceeding 5%, clean rock or other non-erodible and non-polluting material may be placed under the bag to reduce slope steepness.

No downslope sediment barrier is required for most installations. Compost berm or compost filter sock shall be installed below bags located in HQ or EV watersheds, within 50 feet of any receiving surface water or where grassy area is not available.

FIGURE 3.11
Temporary Cofferdam and Pump Bypass Around In-channel Work Areas



PA DEP

NOTE: Pump intake shall be maintained a sufficient distance from bottom to prevent sediment from entering the system.

* **Sandbags (Standard Construction Detail #3-15), Jersey barriers (Figure 3.13) or other non-erosive material, no earth fill. Do not excavate a sump for the pump intake.**

** **See Standard Construction Detail # 4-14. For low gradient channels, the rock filter may be replaced by an impervious cofferdam to prevent backflow into the work area.**

(Additional Notes for Standard Construction Detail # 3-16)

The pump discharge hose shall be inserted into the bags in the manner specified by the manufacturer and securely clamped. A piece of PVC pipe is recommended for this purpose.

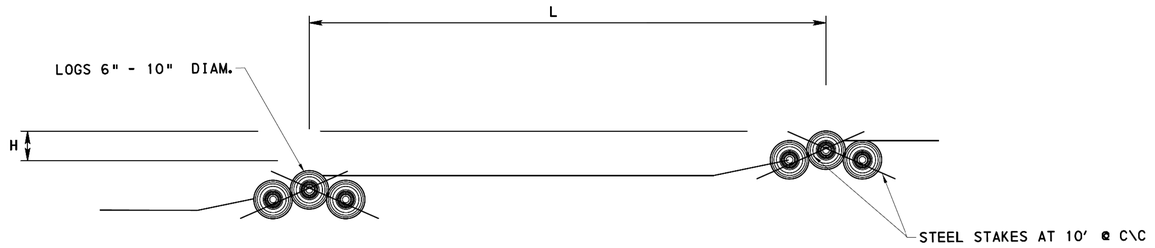
The pumping rate shall be no greater than 750 gpm or ½ the maximum specified by the manufacturer, whichever is less. Pump intakes shall be floating and screened.

Filter bags shall be inspected daily. If any problem is detected, pumping shall cease immediately and not resume until the problem is corrected.

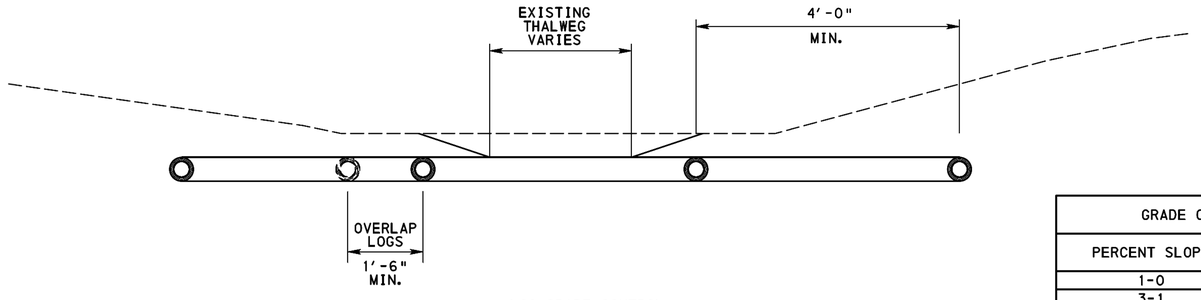
FILE: S:\Shared Folders\Projects\2-XXX Sawmill Run MS4\CADD\MS4Sawmill RunESDetails.dgn
DATE: 10/20/2022 TIME: 2:42:57 PM

SHEET 4 OF 19	STREAM RESTORATION FOR MS4 CREDITS IN THE THE SAW MILL RUN AND THE OHIO WATERSHED CITY OF PITTSBURGH ALLEGHENY COUNTY, PENNSYLVANIA MOORE PARK RESTORATION PROJECT EROSION AND SEDIMENT DETAILS	PREPARED BY: HUNT VALLEY ENVIRONMENTAL, LLC 632 HUNT VALLEY ROAD NEW KENSINGTON, PA 15068	PREPARED FOR: PENNSYLVANIA DEPARTMENT OF TRANSPORTATION KEYSTONE BUILDING 400 NORTHSTREER HARRISBURG, PA 17120 PITTSBURGH WATER AND SEWER AUTHORITY 1200 PENN AVE PITTSBURGH, PA 15222	ENGINEER ORIGINAL SUBMISSION DATE: 10-19-2022 REVISED SUBMISSION DATE:	COMMONWEALTH OF PENNSYLVANIA REGISTERED PROFESSIONAL JAMES H. FLYNN ENGINEER PE 061647

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D



SECTION A-A



LOG GRADE CONTROL

GRADE CONTROL PLACEMENT	
PERCENT SLOPE	SPACING (FT)
1-0	100
3-1	75-100
5-3	60-75
7-5	45-60
9-7	30-45
11-9	20-30
13-11	15-20
15	9-15

GRADE CONTROL NOTES:

1. GRADES GREATER THAN 20% WILL USE REESTABLISHMENT LOG AND ROCK STEP POOL. SEE DETAIL THIS SHEET.

GRADE CONTROL DETAIL
NTS

FILE: S:\Shared Folders\Projects\21-XXX Sawmill Run MS4\CADD\MS4StrMooreResDetails.dgn
DATE: 10/24/2022 TIME: 9:00:14 AM

SHEET 5 OF 19

STREAM RESTORATION FOR MS4 CREDITS
IN THE THE SAW MILL RUN AND THE OHIO WATERSHED
CITY OF PITTSBURGH
ALLEGHENY COUNTY, PENNSYLVANIA
MOORE PARK RESTORATION PROJECT
STREAM RESTORATION DETAILS

PREPARED BY:
HUNT VALLEY ENVIRONMENTAL, LLC
632 HUNT VALLEY ROAD
NEW KENSINGTON, PA 15068

PREPARED FOR:
PENNSYLVANIA
DEPARTMENT OF TRANSPORTATION
KEYSTONE BUILDING
400 NORTHSTREER
HARRISBURG, PA 17120

PITTSBURGH
WATER AND SEWER AUTHORITY
1200 PENN AVE
PITTSBURGH, PA 15222

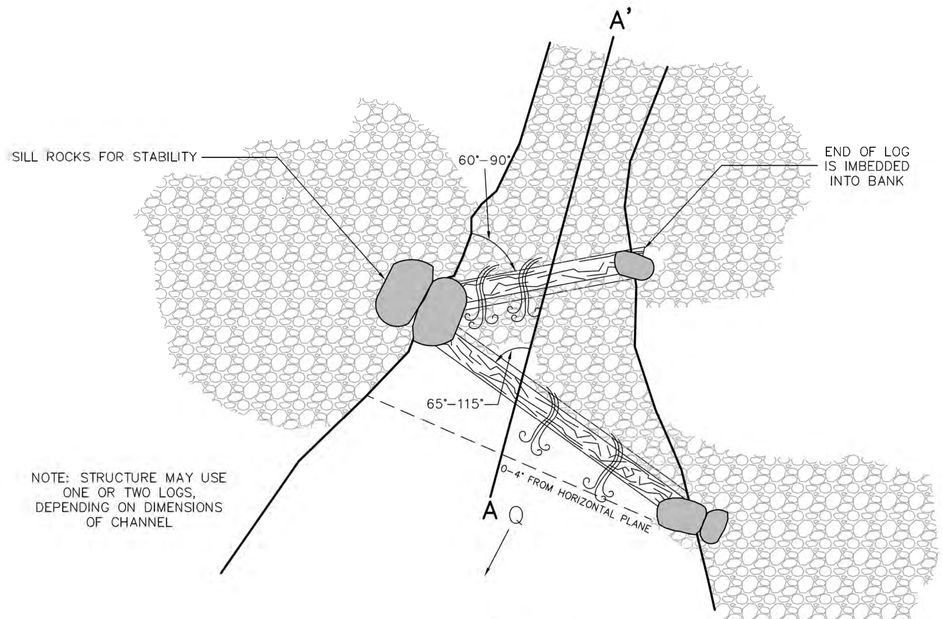
ENGINEER

ORIGINAL
SUBMISSION DATE: 10-19-2022

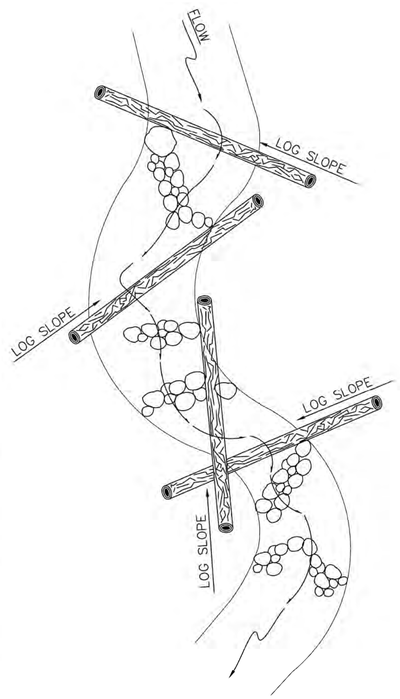
REVISED
SUBMISSION DATE:

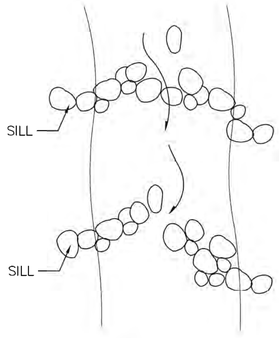
COMMONWEALTH OF PENNSYLVANIA
REGISTERED
A PROFESSIONAL
JAMES H. FLYNN
ENGINEER
PE 061547

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D



PLAN VIEW

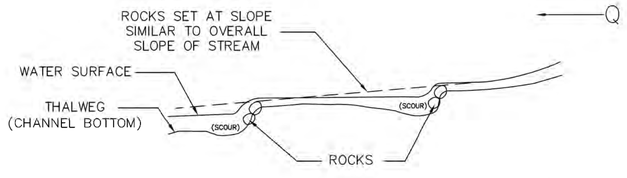


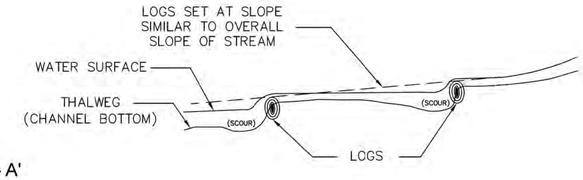


PLAN VIEW

LOG AND ROCK STEP DETAIL

NOT TO SCALE





SECTION A - A'

CONSTRUCTION NOTES:

LOGS SHALL BE HEMLOCK, LOCUST, OR OTHER ONSITE AVAILALE SPECIES AND A MIN 8" IN DIAMETER.

LOG OR ROCK STEP POOL STRUCTURE

NOT TO SCALE

SHEET 6 OF 19

STREAM RESTORATION FOR MS4 CREDITS
IN THE THE SAW MILL RUN AND THE OHIO WATERSHED
CITY OF PITTSBURGH
ALLEGHENY COUNTY, PENNSYLVANIA
MOORE PARK RESTORATION PROJECT
STREAM RESTORATION DETAILS

PREPARED BY:

HUNT VALLEY ENVIRONMENTAL, LLC
632 HUNT VALLEY ROAD
NEW KENSINGTON, PA 15068

PREPARED FOR:

PENNSYLVANIA
DEPARTMENT OF TRANSPORTATION
KEYSTONE BUILDING
400 NORTHSTREER
HARRISBURG, PA 17120

PITTSBURGH
WATER AND SEWER AUTHORITY
1200 PENN AVE
PITTSBURGH, PA 15222

ENGINEER

ORIGINAL SUBMISSION DATE: 10-19-2022

REVISED SUBMISSION DATE:

COMMONWEALTH OF PENNSYLVANIA
REGISTERED PROFESSIONAL ENGINEER
JAMES H. FLYNN
PE 061547

FILE: S:\Shared Folders\Projects\21-XXX Sawmill Run MS4\CADD\MS4StrMooreResRetrolls.dgn
DATE: 10/24/2022 TIME: 9:01:23 AM

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

DETENTION BASIN FLOOR SEED MIXTURE

FORMULA AND SPECIES	% BY WEIGHT	MIN. % PURITY	MIN. % GERMINATION	MAX. % WEED SEED	SEEDING RATE LB PER 1000 SY
					5.2 TOTAL
RED TOP (AGROSTIS ALBA)	20	92	85	0.15	1.04
CREEPING BENTGRASS (AGROSTIS STOLONIFERA)	20	92	85	0.15	1.04
RIVERBANK WILD RYE (ELYMUS RIPARIUS)	20	95	85	0.15	1.04
FOX SEDGE (CAREX VULPINOIDES)	20	94	85	0.10	1.04
ALKALIGRASS (PUCCINELLIA DISTANS)	20	99	90	0.15	1.04

FORMULA L MIXTURE

FORMULA AND SPECIES	% BY WEIGHT	MIN. % PURITY	MIN. % GERMINATION	MAX. % WEED SEED	SEEDING RATE LB PER 1000 SY
					48.0 TOTAL
HARD FESCUE MIXTURE (FESTUCA LONGIFOLIA) A COMBINATION OF IMPROVED CERTIFIED VARIETIES WITH NO ONE VARIETY EXCEEDING 50% OF THE TOTAL HARD FESCUE COMPONENT	55	97	85	0.10	26.0
CREEPING RED FESCUE (FESTUCA RUBRA) (IMPROVED AND CERTIFIED)	35	97	85	0.10	17.0
ANNUAL RYEGRASS (LOLIUM MULTIFLORUM)	10	95	90	0.10	5.0

LIMING RATES

AGRICULTURAL LIME (PERMANENT SEEDING) = 800 LBS / 1000 SY
AGRICULTURAL LIME (TEMPORARY SEEDING) = 800 LBS / 1000 SY

FERTILIZER RATES

APPLY SLOW RELEASE NITROGEN FERTILIZER TO THE SURFACE OF FORMULAS:

PULVERIZED AGRICULTURAL LIMESTONE = 800 LB/ 1000 SY

10-20-20 ANALYSIS COMMERCIAL FERTILIZER = 140 LBS / 1000 SY

38-0-0 UREAFORM FERTILIZER = 50 LBS / 1000 SY OR 32-0-0 TO 38-0-0 SULFUR COATED UREA FERTILIZER = 59 LBS / 1000 SY TO 50 LBS / 1000 SY, AS DIRECTED OR 31-0-0 IBDU FERTILIZER = 61 LBS / 1000 SY

MULCHING RATES

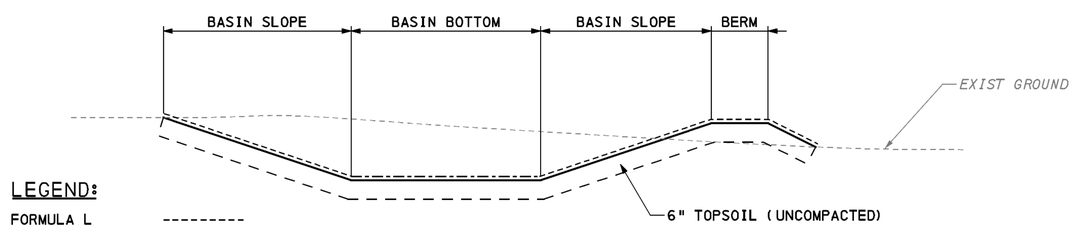
APPLY STRAW AT A RATE OF 1200 LBS / 1000 SY TO THE SURFACE OF FORMULA E.

APPLY ROLLED EROSION CONTROL PRODUCT TO ALL NEWLY SEEDED AREAS ON SLOPES 3:1 OR GREATER.

SEEDING DATES

FORMULA L

DETENTION BASIN FLOOR AND SEASONALLY FLOODED MIXTURE — MARCH 15 TO MAY 15, SEPTEMBER 1 TO OCTOBER 15



LEGEND:
FORMULA L ---------
DETENTION BASIN FLOOR SEED MIX -.-.-.-.-

DRY DETENTION BASIN SEEDING TYPICAL SECTION

NOT TO SCALE

FILE: S:\Shared Folders\Projects\1-XXX Sawmill Run MS4\CADD\MS4StrMooreResDetails.dgn
DATE: 10/27/2022 TIME: 9:02:05 AM

SHEET 7 OF 19

STREAM RESTORATION FOR MS4 CREDITS
IN THE THE SAW MILL RUN AND THE OHIO WATERSHED
CITY OF PITTSBURGH
ALLEGHENY COUNTY, PENNSYLVANIA
MOORE PARK RESTORATION PROJECT
DETENTION BASIN DETAILS

PREPARED BY:
HUNT VALLEY ENVIRONMENTAL, LLC
632 HUNT VALLEY ROAD
NEW KENSINGTON, PA 15068

PREPARED FOR:
PENNSYLVANIA DEPARTMENT OF TRANSPORTATION
KEYSTONE BUILDING
400 NORTHSTREER
HARRISBURG, PA 17120

PITTSBURGH WATER AND SEWER AUTHORITY
1200 PENN AVE
PITTSBURGH, PA 15222

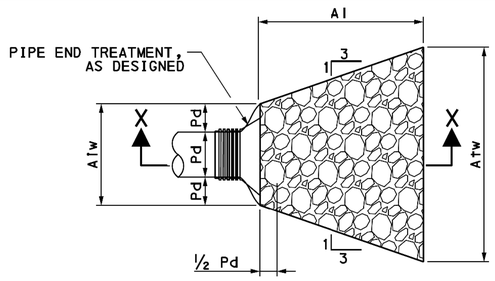
ENGINEER

ORIGINAL SUBMISSION DATE: 10-19-2022

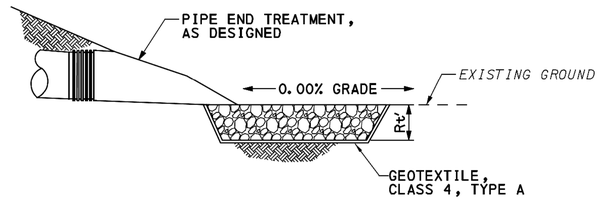
REVISED SUBMISSION DATE:

COMMONWEALTH OF PENNSYLVANIA
REGISTERED PROFESSIONAL
WILLIAM BRUCE McNEAL
ENGINEER
PE074465

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D



PLAN VIEW



SECTION X-X

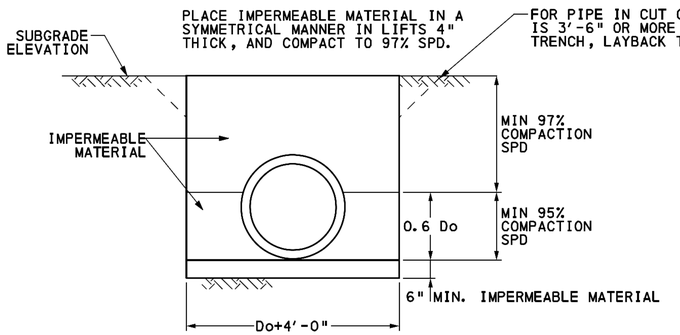
OUTLET PROTECTION NOTES:

1. ALL APRONS SHALL BE CONSTRUCTED TO THE DIMENSIONS SHOWN. TERMINAL WIDTHS SHALL BE ADJUSTED AS NECESSARY TO MATCH RECEIVING CHANNELS.
2. PROVIDE GEOTEXTILE MATERIAL ALONG ALL INTERFACE AREAS WITH GROUND CONTACT.
3. EXTEND RIPRAP ON BACK SIDE OF APRON TO AT LEAST 1/2 DEPTH OF PIPE ON BOTH SIDES TO PREVENT SCOUR AROUND THE PIPE.

APRON NO.	LOCATION	PIPE DIA Pd (IN)	Q (CFS) 10-YR	Q * (CFS) 100-YR	VELOCITY (FPS) 10-YR	VELOCITY (FPS) * 100-YR	RIPRAP SIZE R-_	RIPRAP THICK Rt (IN)	APRON LENGTH Al (FT)	APRON INITIAL WIDTH Alw (FT)	APRON TERMINAL WIDTH Atw (FT)
OP-EW1	MOORE PARK	18	7.09	-	5.25	-	3	9	9	4.50	10.50
OP-EW2	MOORE PARK	18	2.96	9.15	5.29	7.26	4	18	9	4.50	10.50
OP-EW3	MOORE PARK	18	2.40	11.42	5.53	8.93	4	18	10	4.50	11.17
OP-EW4	CRANE AVE	15	10.76	-	10.13	-	5	27	12	3.75	11.75
OP-EW5	CRANE AVE	27	32.87	-	9.73	-	5	27	18	6.75	18.75
OP-EW6	CRANE AVE	18	8.52	14.60	9.17	10.53	5	27	12	4.50	12.50

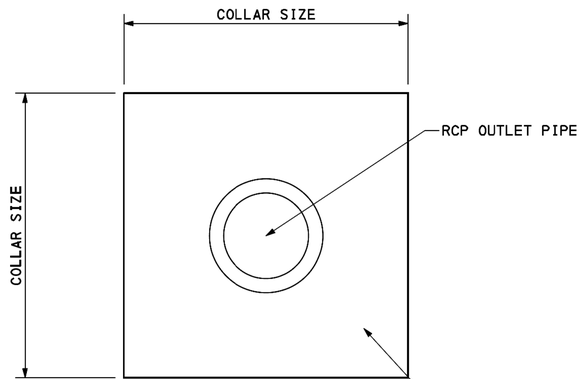
ROCK APRON OUTLET PROTECTION DETAIL

NOT TO SCALE

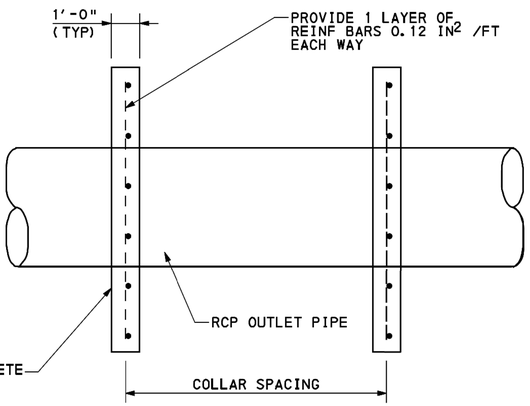


DETENTION BASIN - OUTLET PIPE TRENCH DETAIL

NOT TO SCALE



ELEVATION VIEW



END VIEW

BASIN NUMBER	NO. COLLARS	COLLAR SIZE (FT)	COLLAR SPACING (FT)	DIST TO 1ST COLAR (FT)	OUTLET PIPE DIA (IN)
SCM 001	2	5	7	7	18
SCM 002	3	5	7	7	18
SCM 003	3	5	8	12	18

DISTANCE TO 1ST COLLAR MEASURED FROM OUTSIDE FACE OF THE OUTET STRUCTURE.

REINFORCED CONCRETE ANTI-SEEP COLLAR

NOT TO SCALE

SHEET 8 OF 19

STREAM RESTORATION FOR MS4 CREDITS
IN THE THE SAW MILL RUN AND THE OHIO WATERSHED
CITY OF PITTSBURGH
ALLEGHENY COUNTY, PENNSYLVANIA
MOORE PARK RESTORATION PROJECT
DETENTION BASIN DETAILS

PREPARED BY:

HUNT VALLEY ENVIRONMENTAL, LLC
632 HUNT VALLEY ROAD
NEW KENSINGTON, PA 15068

PREPARED FOR:

PENNSYLVANIA DEPARTMENT OF TRANSPORTATION
KEYSTONE BUILDING
400 NORTHSTREER
HARRISBURG, PA 17120

PITTSBURGH WATER AND SEWER AUTHORITY
1200 PENN AVE
PITTSBURGH, PA 15222

ENGINEER

ORIGINAL SUBMISSION DATE: 10-19-2022

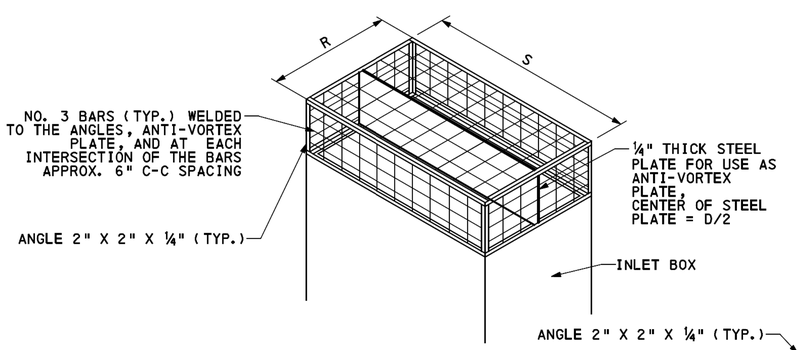
REVISED SUBMISSION DATE:

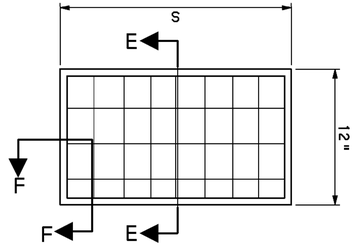
COMMONWEALTH OF PENNSYLVANIA
REGISTERED PROFESSIONAL
WILLIAM BRUCE McNEAL
ENGINEER
PE074465

FILE: S:\Shared Folders\Projects\21-XXX Sawmill Run MS4\CADD\MS4StrMooreReaDetails.dgn
DATE: 10/24/2022 TIME: 9:20:44 AM

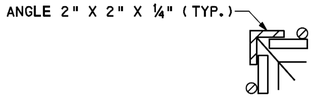
Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

HORIZONTAL TRASH RACK DIMENSIONS		
LOCATION	R	S
MOORE PARK OS-1	3'-0"	4'-9 1/4"
MOORE PARK OS-2	3'-0"	4'-9 1/4"
MOORE PARK OS-3	3'-0"	4'-9 1/4"
MOORE PARK OS-4	3'-0"	4'-9 1/4"
CRANE AVENUE OS-5	5'-0"	5'-0"
CRANE AVENUE OS-6	5'-0"	5'-0"

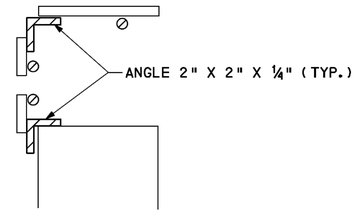




FRONT VIEW



SECTION F-F



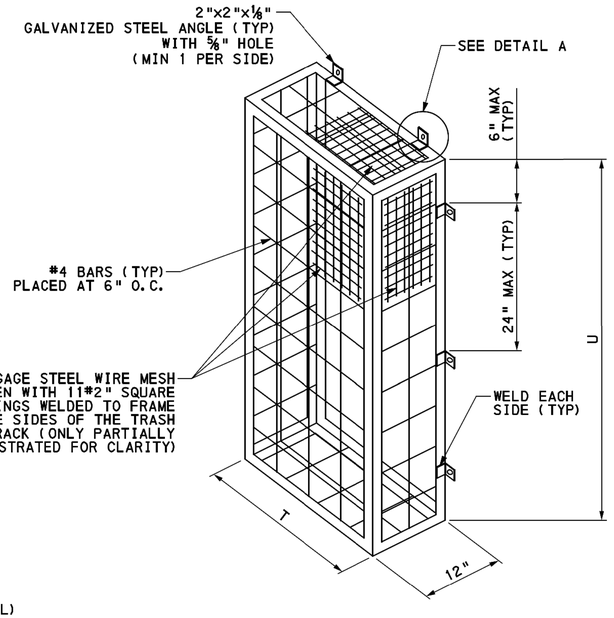
SECTION E-E

NOTES:

1. DIMENSIONS ARE APPROXIMATE, FABRICATE TO FIT OUTSIDE OF INLET BOX.

2. TRASH RACKS TO BE HOT DIPPED GALVANIZED ASSEMBLY PER ASTM A-123; TOUCH UP PER ASTM A-A780.

HORIZONTAL TRASH RACK WITH ANTI-VORTEX PLATE



NOTES:

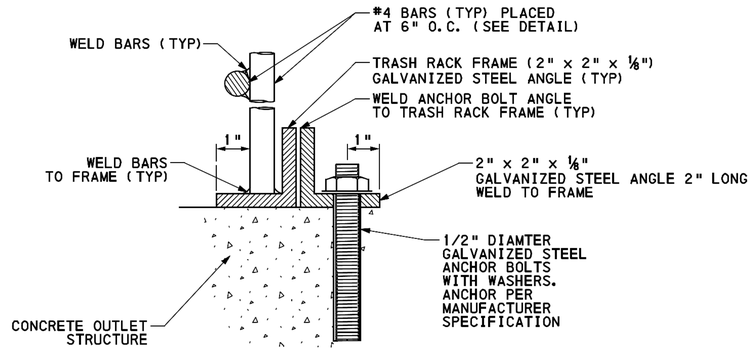
1. WELD #4 TRASH RACK SCREEN SUPPORT BARS TO THE ANGLES AND AT EACH INTERSECTION OF THE BARS.

2. WELD TRASH RACK SCREEN INSIDE OF ANGLE FRAMES ON FIVE SIDES OF RACK.

3. TRASH RACK ASSEMBLIES, BOLTS, AND ATTACHMENTS TO BE GALVANIZED IN ACCORDANCE WITH CS SECTION 1105.

4. REFER TO TABLE FOR OVERALL DIMENSIONS.

5. CENTER TRASH RACK OVER ORIFICES AND SET BOTTOM ELEVATION EQUAL TO BASIN INVERT.



DETAIL A

TRASH RACK DIMENSIONS		
LOCATION	T	U
MOORE PARK OS-1	1'-3"	1'-3"
MOORE PARK OS-3	1'-4"	1'-4"
CRANE AVE OS-5	1'-6"	1'-6"

TRASH RACK

STREAM RESTORATION FOR MS4 CREDITS
IN THE THE SAW MILL RUN AND THE OHIO WATERSHED
CITY OF PITTSBURGH
ALLEGHENY COUNTY, PENNSYLVANIA
MOORE PARK RESTORATION PROJECT
DETENTION BASIN DETAILS

PREPARED BY:
HUNT VALLEY ENVIRONMENTAL, LLC
632 HUNT VALLEY ROAD
NEW KENSINGTON, PA 15068

PREPARED FOR:
PENNSYLVANIA DEPARTMENT OF TRANSPORTATION, KEYSTONE BUILDING, 400 NORTHSTREEN, HARRISBURG, PA 17120
PITTSBURGH WATER AND SEWER AUTHORITY, 1200 PENN AVE, PITTSBURGH, PA 15222

ENGINEER

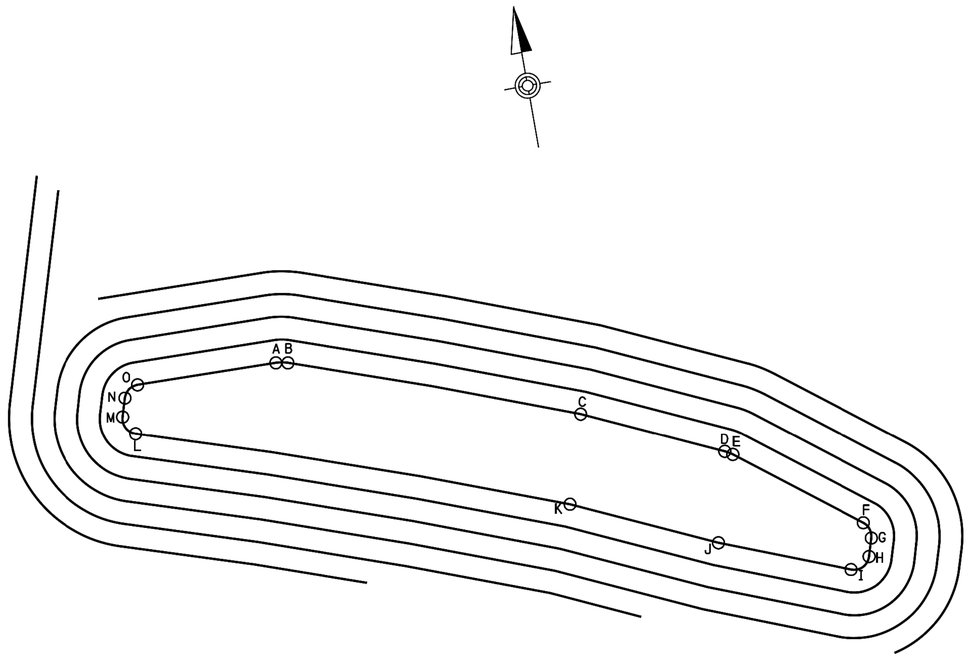
ORIGINAL SUBMISSION DATE: 10-19-2022

REVISED SUBMISSION DATE:

COMMONWEALTH OF PENNSYLVANIA — REGISTERED PROFESSIONAL — WILLIAM BRUCE McNEAL — ENGINEER — PE074465

FILE: S:\Shared Folders\Projects\1-XXX Sawmill Run MS4\CADD\MS4StrMooreResDetrolls.dgn
DATE: 10/24/2022 TIME: 9:10:15 AM

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D



SCM 001 - CONTROL POINTS

POINT	COORDINATES		ELEVATION
	NORTH	EAST	
A	398294.5689	1338656.7187	1095.00
B	398294.2885	1338658.3685	1095.00
C	398280.8454	1338695.1624	1095.00
D	398272.6560	1338712.9854	1095.00
E	398272.0667	1338713.9582	1095.00
F	398260.1605	1338729.3415	1095.00
G	398257.9982	1338730.0312	1095.00
H	398255.6506	1338729.3190	1095.00
I	398254.3705	1338726.6718	1095.00
J	398260.9240	1338710.0432	1095.00
K	398269.3623	1338691.6786	1095.00
L	398288.5997	1338636.8689	1095.00
M	398291.0840	1338635.5681	1095.00
N	398293.4966	1338636.3001	1095.00
O	398294.9156	1338638.2515	1095.00

FOUR PLACE COORDINATES ARE FOR COMPUTATIONAL PURPOSES ONLY AND DO NOT IMPLY A PRECISION BEYOND TWO DECIMAL PLACES

DRY EXTENDED DETENTION BASIN (SCM 001) GEOMETRIC LAYOUT

SCALE

0 10 20 FEET

FILE: S:\Shared Folders\Projects\21-XXX Sawmill Run MS4\CADD\MS4Str\MooreResBetrolls.dgn
DATE: 10/24/2022 TIME: 9:04:13 AM

SHEET 10 OF 19

STREAM RESTORATION FOR MS4 CREDITS
IN THE THE SAW MILL RUN AND THE OHIO WATERSHED
CITY OF PITTSBURGH
ALLEGHENY COUNTY, PENNSYLVANIA
MOORE PARK RESTORATION PROJECT
DETENTION BASIN DETAILS

PREPARED BY:

HUNT VALLEY ENVIRONMENTAL, LLC
632 HUNT VALLEY ROAD
NEW KENSINGTON, PA 15068

PREPARED FOR:

PENNSYLVANIA
DEPARTMENT OF TRANSPORTATION
KEYSTONE BUILDING
400 NORTHSTREER
HARRISBURG, PA 17120

PITTSBURGH
WATER AND SEWER AUTHORITY
1200 PENN AVE
PITTSBURGH, PA 15222

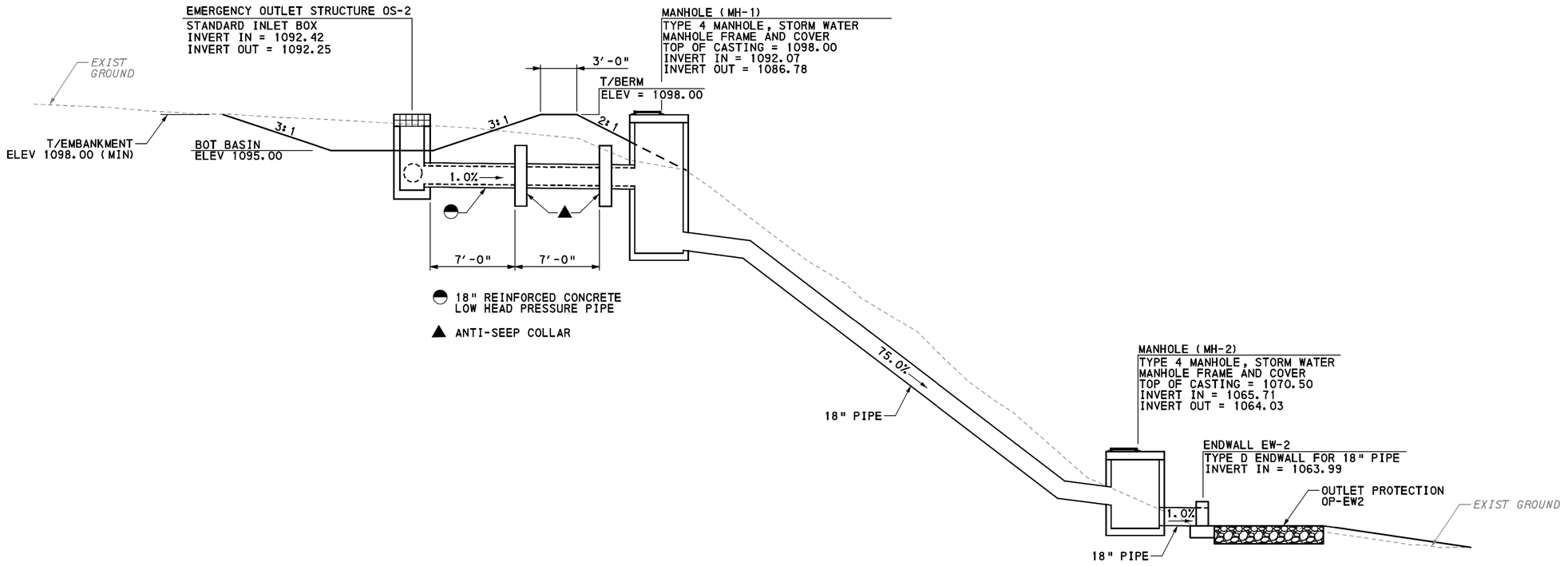
ENGINEER

ORIGINAL SUBMISSION DATE: 10-19-2022

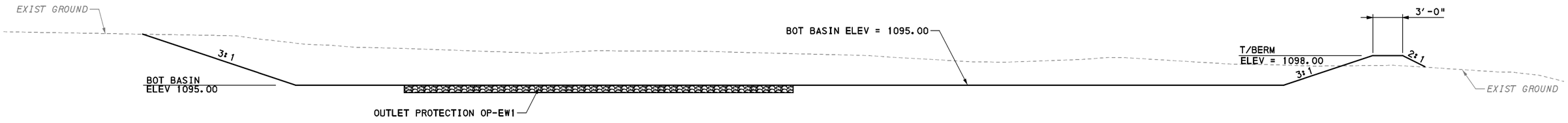
REVISED SUBMISSION DATE:

COMMONWEALTH OF PENNSYLVANIA
REGISTERED PROFESSIONAL ENGINEER
WILLIAM BRUCE McNEAL
PE074465

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D



MOORE PARK SCM-001
SECTION A-A



MOORE PARK SCM-001
SECTION B-B

DATUM 1085

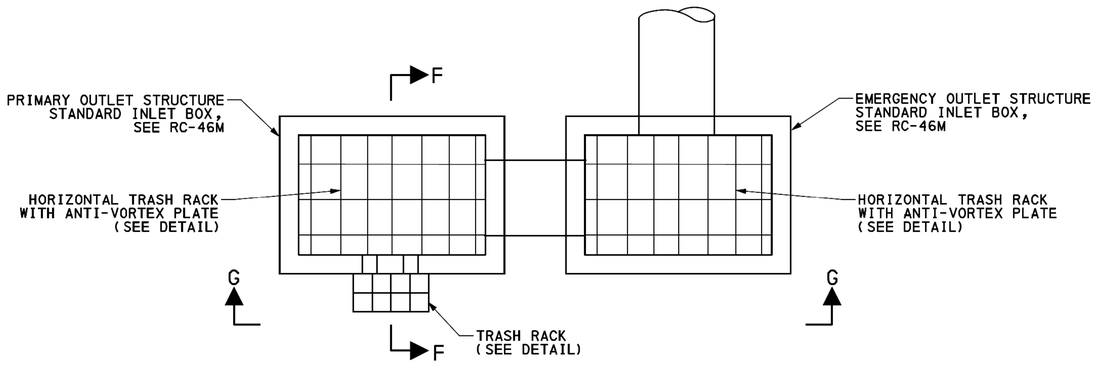
HORIZONTAL 0 5 10 FEET
VERTICAL

SHEET 11 OF 19	STREAM RESTORATION FOR MS4 CREDITS IN THE THE SAW MILL RUN AND THE OHIO WATERSHED CITY OF PITTSBURGH ALLEGHENY COUNTY, PENNSYLVANIA MOORE PARK RESTORATION PROJECT DETENTION BASIN DETAILS	PREPARED BY: HUNT VALLEY ENVIRONMENTAL, LLC 632 HUNT VALLEY ROAD NEW KENSINGTON, PA 15068	PREPARED FOR: PENNSYLVANIA DEPARTMENT OF TRANSPORTATION KEYSTONE BUILDING 400 NORTHSTREER HARRISBURG, PA 17120 PITTSBURGH WATER AND SEWER AUTHORITY 1200 PENN AVE PITTSBURGH, PA 15222	ENGINEER	ORIGINAL SUBMISSION DATE: 10-19-2022 REVISED SUBMISSION DATE:

COMMONWEALTH OF PENNSYLVANIA REGISTERED PROFESSIONAL WILLIAM BRUCE McNEAL ENGINEER PE074465

FILE: G:\Shared Folders\Projects\21-XXX Sawmill Run MS4\CADD\MS4SrMooreResDetails.dgn
DATE: 10/24/2022 TIME: 9:04:41 AM

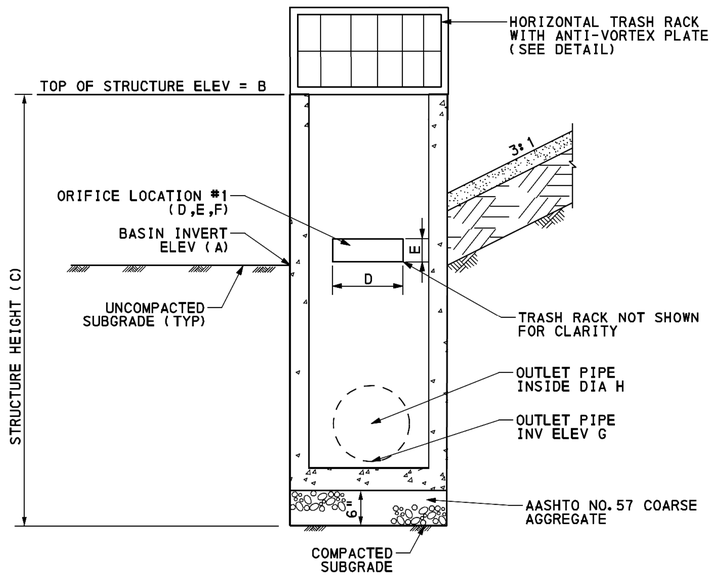
Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D



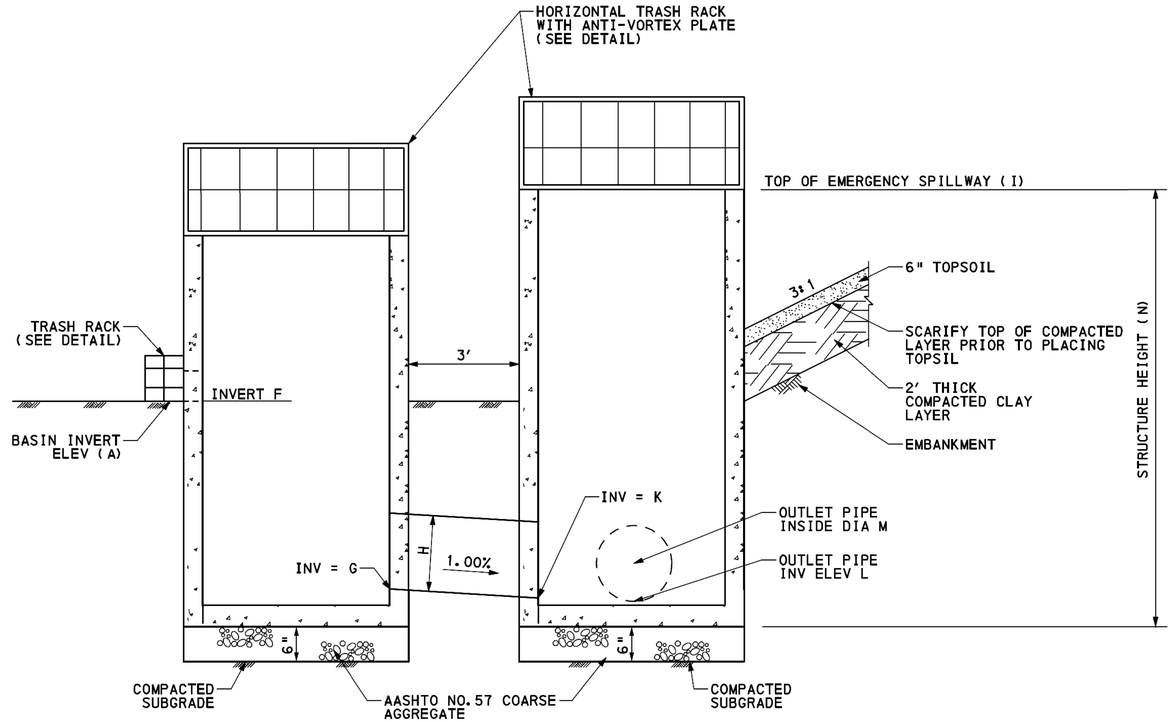
PLAN VIEW
NOT TO SCALE

PRIMARY OUTLET STRUCTURE TABLE (OS-1)						
BASIN INVERT ELEV A	STRUCTURE TOP ELEV B	HEIGHT OF STRUCTURE C (FT)	ORIFICE #1 SIZE D X E (IN)	ORIFICE #1 INV F (FT)	OUTLET PIPE	
					INVERT G (FT)	INSIDE DIA H (IN)
1095.00	1096.70	5	9 X 9	1095.00	1092.45	18

EMERGENCY OUTLET STRUCTURE TABLE (OS-2)				
STRUCTURE TOP ELEV I	HEIGHT OF STRUCTURE J (FT)	OUTLET PIPE		
		INVERT IN K (FT)	INVERT OUT L (FT)	INSIDE DIA M (IN)
1097.00	5.75	1092.41	1092.25	18



PRIMARY OUTLET STRUCTURE (OS-1)



PRIMARY OUTLET STRUCTURE (OS-1)

EMERGENCY OUTLET STRUCTURE (OS-2)

SECTION F-F
NOT TO SCALE

SECTION G-G
NOT TO SCALE

MOORE PARK SCM-001 OUTLET STRUCTURE DETAILS

SHEET 12 OF 19

STREAM RESTORATION FOR MS4 CREDITS
IN THE THE SAW MILL RUN AND THE OHIO WATERSHED
CITY OF PITTSBURGH
ALLEGHENY COUNTY, PENNSYLVANIA
MOORE PARK RESTORATION PROJECT
DETENTION BASIN DETAILS

PREPARED BY:
HUNT VALLEY ENVIRONMENTAL, LLC
632 HUNT VALLEY ROAD
NEW KENSINGTON, PA 15068

PREPARED FOR:
PENNSYLVANIA DEPARTMENT OF TRANSPORTATION
KEYSTONE BUILDING
400 NORTHSTREER
HARRISBURG, PA 17120

PITTSBURGH WATER AND SEWER AUTHORITY
1200 PENN AVE
PITTSBURGH, PA 15222

ENGINEER

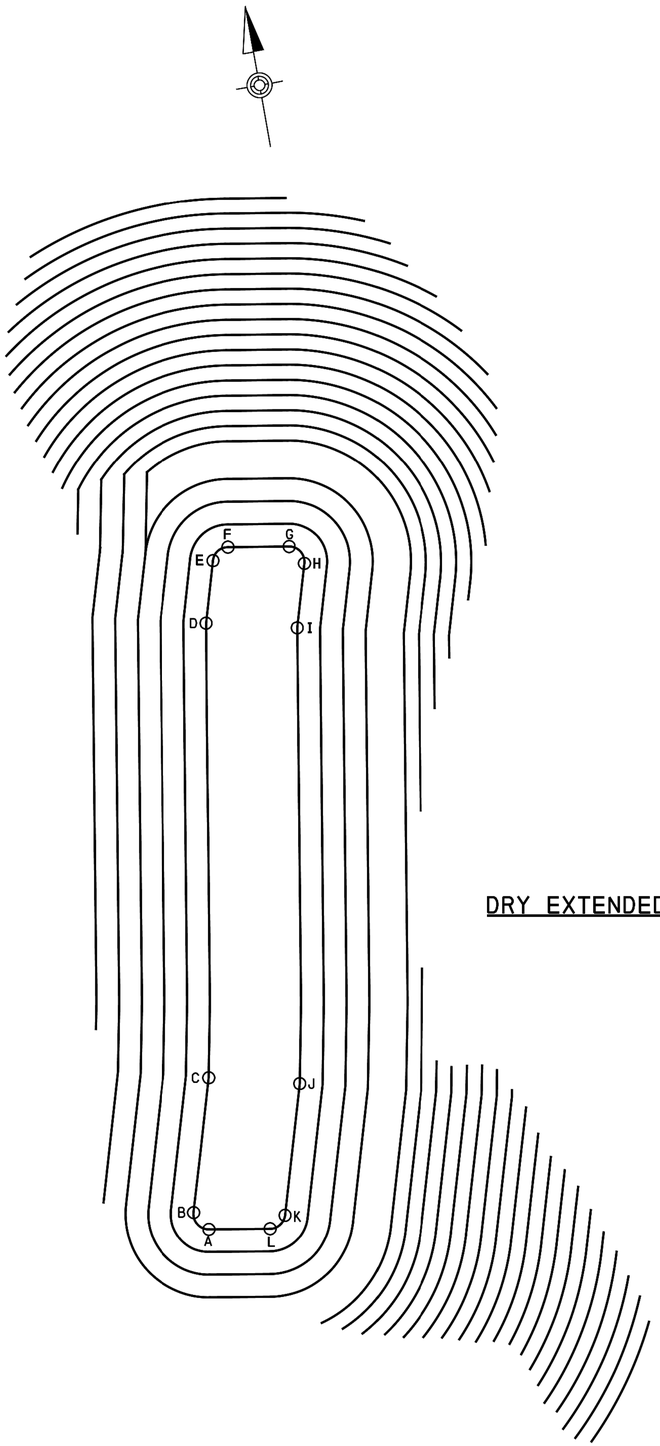
ORIGINAL SUBMISSION DATE: 10-19-2022

REVISED SUBMISSION DATE:

COMMONWEALTH OF PENNSYLVANIA
REGISTERED PROFESSIONAL
WILLIAM BRUCE McNEAL
ENGINEER
PE074465

FILE: S:\Shared Folders\Projects\21-XXX Sawmill Run MS4\CADD\MS4Str-MooreAreaDetails.dgn
DATE: 10/24/2022 TIME: 9:50:10 AM

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D



SCM 002 - CONTROL POINTS

POINT	COORDINATES		ELEVATION
	NORTH	EAST	
A	398434.2590	1338655.2380	1097.00
B	398436.7983	1338653.6510	1097.00
C	398453.9540	1338658.7217	1097.00
D	398513.0834	1338668.9091	1097.00
E	398521.0454	1338671.2615	1097.00
F	398522.4511	1338673.5106	1097.00
G	398521.1174	1338681.4584	1097.00
H	398518.5783	1338683.0454	1097.00
I	398510.3805	1338680.6233	1097.00
J	398451.0997	1338670.3912	1097.00
K	398434.3308	1338665.4349	1097.00
L	398432.9253	1338663.1859	1097.00

FOUR PLACE COORDINATES ARE FOR COMPUTATIONAL PURPOSES ONLY
AND DO NOT IMPLY A PRECISION BEYOND TWO DECIMAL PLACES

DRY EXTENDED DETENTION BASIN (SCM 002) GEOMETRIC LAYOUT

SCALE

0 10 20 FEET

FILE: S:\Shared Folders\Projects\21-XXX Sawmill Run MS4\CADD\MS4StrMooreResDetails.dgn
DATE: 10/24/2022 TIME: 9:00:42 AM

SHEET 13 OF 19

STREAM RESTORATION FOR MS4 CREDITS
IN THE THE SAW MILL RUN AND THE OHIO WATERSHED
CITY OF PITTSBURGH
ALLEGHENY COUNTY, PENNSYLVANIA
MOORE PARK RESTORATION PROJECT
DETENTION BASIN DETAILS

PREPARED BY:

HUNT VALLEY ENVIRONMENTAL, LLC
632 HUNT VALLEY ROAD
NEW KENSINGTON, PA 15068

PREPARED FOR:

PENNSYLVANIA
DEPARTMENT OF TRANSPORTATION
KEYSTONE BUILDING
400 NORTHSTREER
HARRISBURG, PA 17120

PITTSBURGH
WATER AND SEWER AUTHORITY
1200 PENN AVE
PITTSBURGH, PA 15222

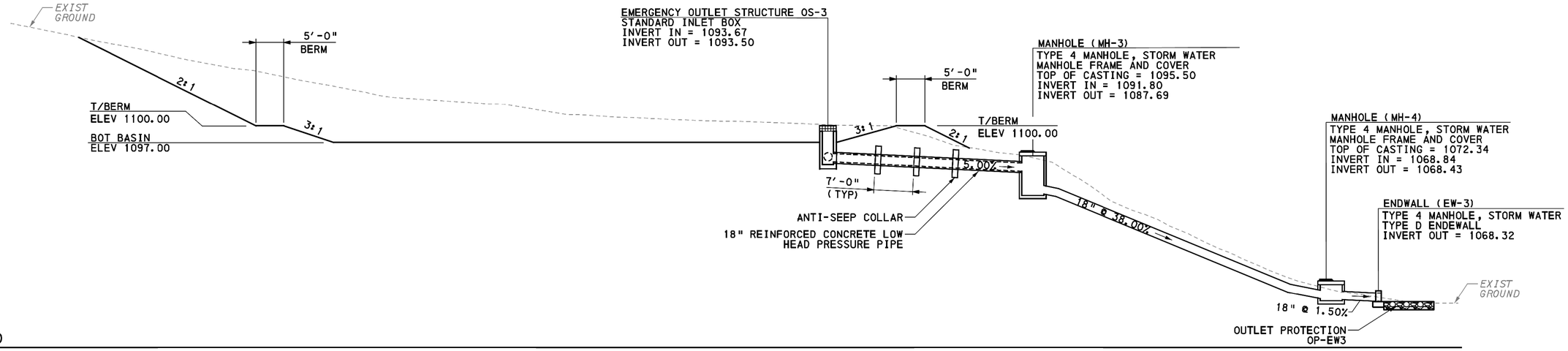
ENGINEER

ORIGINAL
SUBMISSION DATE: 10-19-2022

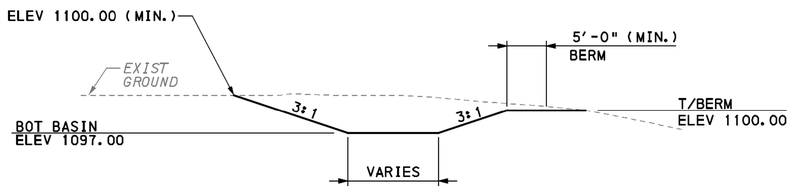
REVISED
SUBMISSION DATE:

COMMONWEALTH OF PENNSYLVANIA
REGISTERED PROFESSIONAL
WILLIAM BRUCE McNEAL
ENGINEER
PE074465

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D



MOORE PARK SCM-002
SECTION C-C



MOORE PARK SCM-002
SECTION D-D

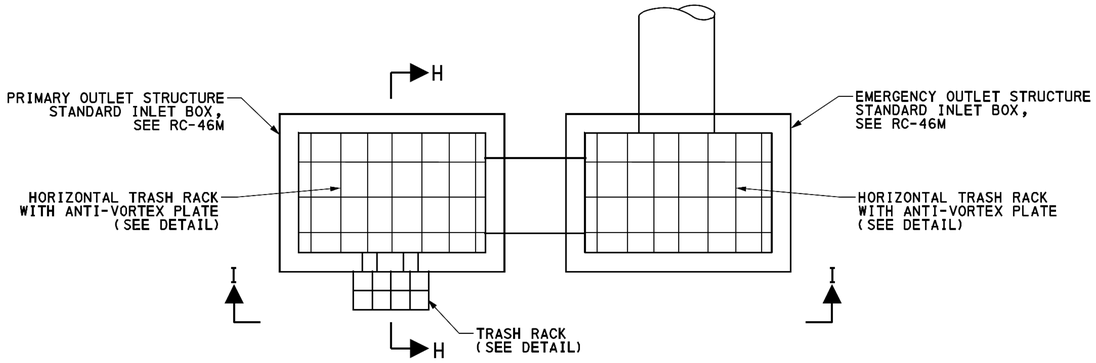
HORIZONTAL 0 10 20 FEET
VERTICAL

SHEET 14 OF 19	STREAM RESTORATION FOR MS4 CREDITS IN THE THE SAW MILL RUN AND THE OHIO WATERSHED CITY OF PITTSBURGH ALLEGHENY COUNTY, PENNSYLVANIA MOORE PARK RESTORATION PROJECT DETENTION BASIN DETAILS	PREPARED BY: HUNT VALLEY ENVIRONMENTAL, LLC 632 HUNT VALLEY ROAD NEW KENSINGTON, PA 15068	PREPARED FOR: PENNSYLVANIA DEPARTMENT OF TRANSPORTATION KEYSTONE BUILDING 400 NORTHSTREEN HARRISBURG, PA 17120 PITTSBURGH WATER AND SEWER AUTHORITY 1200 PENN AVE PITTSBURGH, PA 15222	ENGINEER	ORIGINAL SUBMISSION DATE: 10-19-2022 REVISED SUBMISSION DATE:

COMMONWEALTH OF PENNSYLVANIA
REGISTERED PROFESSIONAL
WILLIAM BRUCE McNEAL
ENGINEER
PE074465

FILE: S:\Shared Folders\Projects\1-XXX Sawmill Run MS4\CADD\MS4Str\MooreResDetails.dgn
DATE: 10/24/2022 TIME: 9:06:08 AM

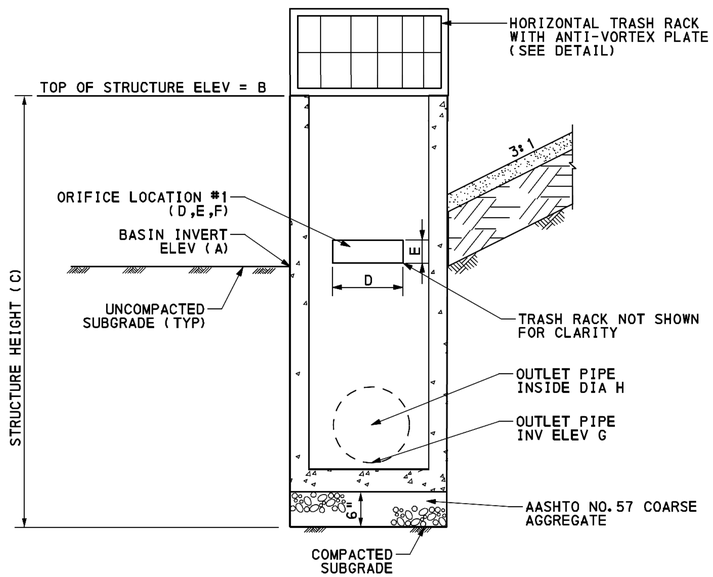
Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D



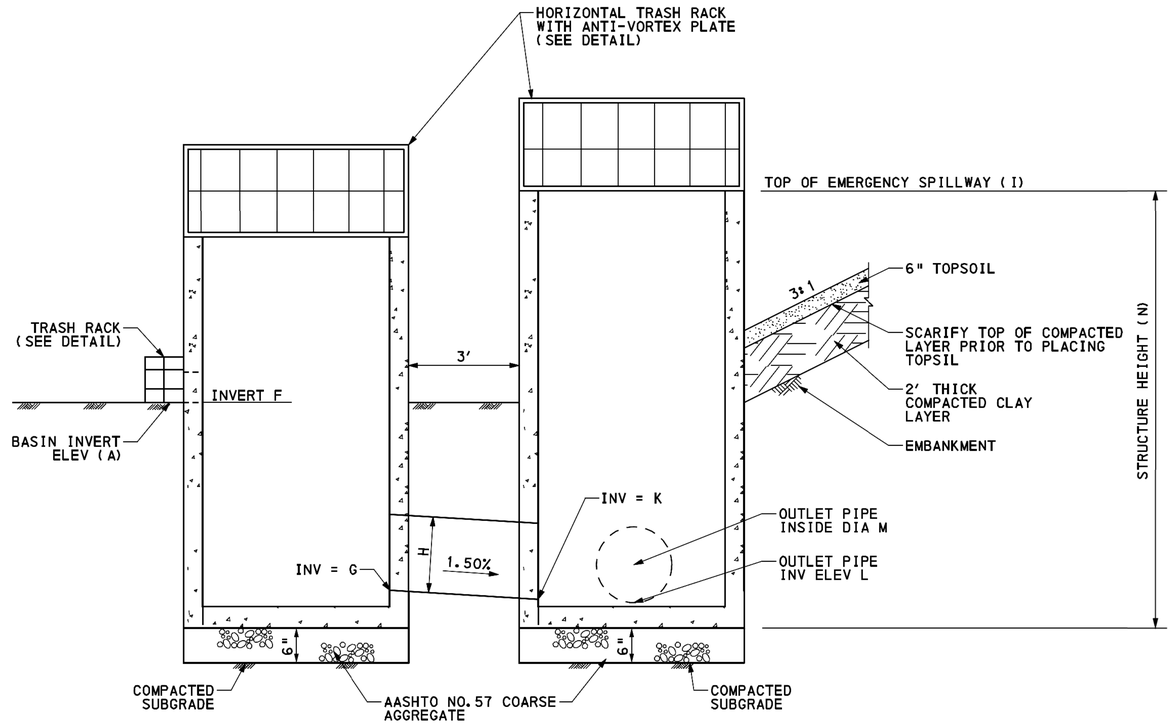
PLAN VIEW
NOT TO SCALE

PRIMARY OUTLET STRUCTURE TABLE (OS-3)						
BASIN INVERT ELEV A	STRUCTURE TOP ELEV B	HEIGHT OF STRUCTURE C (FT)	ORIFICE #1 SIZE D X E (IN)	ORIFICE #1 INV F (FT)	OUTLET PIPE	
					INVERT G (FT)	INSIDE DIA H (IN)
1097.00	1098.60	5.87	8 X 8	1097.00	1093.73	18

EMERGENCY OUTLET STRUCTURE TABLE (OS-4)				
STRUCTURE TOP ELEV I	HEIGHT OF STRUCTURE J (FT)	OUTLET PIPE		
		INVERT IN K (FT)	INVERT OUT L (FT)	INSIDE DIA M (IN)
1099.00	6.50	1093.67	1093.50	18



PRIMARY OUTLET STRUCTURE (OS-3)



PRIMARY OUTLET STRUCTURE (OS-3)

EMERGENCY OUTLET STRUCTURE (OS-4)

SECTION H-H
NOT TO SCALE

SECTION I-I
NOT TO SCALE

MOORE PARK SCM-002 OUTLET STRUCTURE DETAILS

SHEET 15 OF 19

STREAM RESTORATION FOR MS4 CREDITS
IN THE THE SAW MILL RUN AND THE OHIO WATERSHED
CITY OF PITTSBURGH
ALLEGHENY COUNTY, PENNSYLVANIA
MOORE PARK RESTORATION PROJECT
DETENTION BASIN DETAILS

PREPARED BY:

HUNT VALLEY ENVIRONMENTAL, LLC
632 HUNT VALLEY ROAD
NEW KENSINGTON, PA 15068

PREPARED FOR:

PENNSYLVANIA
DEPARTMENT OF TRANSPORTATION
KEYSTONE BUILDING
400 NORTHSTREER
HARRISBURG, PA 17120

PITTSBURGH
WATER AND SEWER AUTHORITY
1200 PENN AVE
PITTSBURGH, PA 15222

ENGINEER

ORIGINAL
SUBMISSION DATE: 10-19-2022

REVISED
SUBMISSION DATE:

COMMONWEALTH OF PENNSYLVANIA
REGISTERED PROFESSIONAL
WILLIAM BRUCE McNEAL
ENGINEER
PE074485

FILE: S:\Shared Folders\Projects\2-XXX Sawmill Run MS4\CADD\MS4StrMooreReaDetails.dgn
DATE: 10/24/2022 TIME: 9:56:53 AM

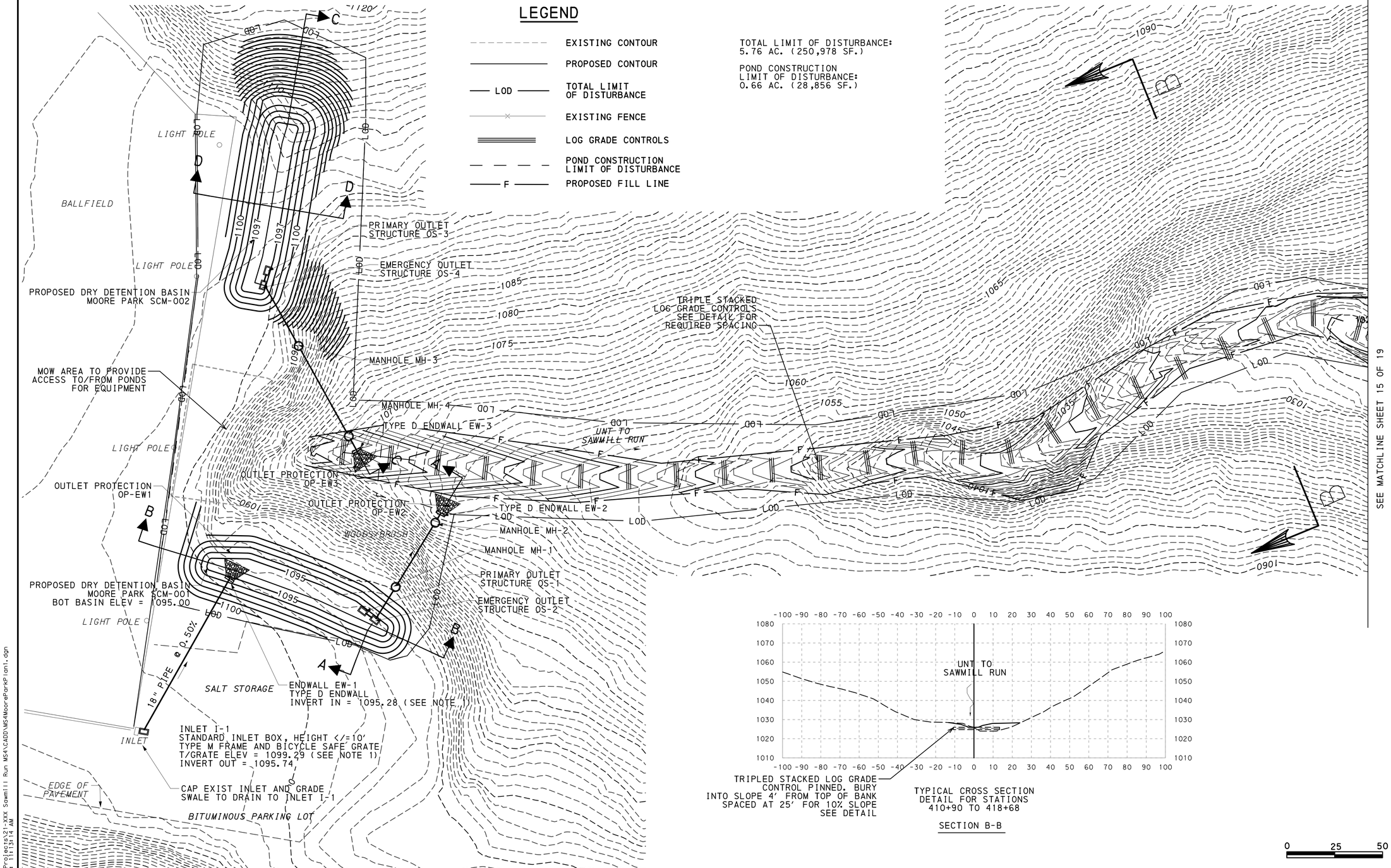
Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

LEGEND

- EXISTING CONTOUR
- PROPOSED CONTOUR
- LOD — TOTAL LIMIT OF DISTURBANCE
- EXISTING FENCE
- LOG GRADE CONTROLS
- POND CONSTRUCTION LIMIT OF DISTURBANCE
- F — PROPOSED FILL LINE

TOTAL LIMIT OF DISTURBANCE:
5.76 AC. (250,978 SF.)

POND CONSTRUCTION
LIMIT OF DISTURBANCE:
0.66 AC. (28,856 SF.)



TRIPLED STACKED LOG GRADE CONTROL PINNED, BURY INTO SLOPE 4' FROM TOP OF BANK SPACED AT 25' FOR 10% SLOPE SEE DETAIL

TYPICAL CROSS SECTION DETAIL FOR STATIONS 410+90 TO 418+68

SECTION B-B

0 25 50 FEET

SHEET 16 OF 19

STREAM RESTORATION FOR MS4 CREDITS
IN THE THE SAW MILL RUN AND THE OHIO WATERSHED
CITY OF PITTSBURGH
ALLEGHENY COUNTY, PENNSYLVANIA
MOORE PARK RESTORATION PROJECT
PLAN SHEET

PREPARED BY:
HUNT VALLEY ENVIRONMENTAL, LLC
632 HUNT VALLEY ROAD
NEW KENSINGTON, PA 15068

PREPARED FOR:
PENNSYLVANIA
DEPARTMENT OF TRANSPORTATION
KEYSTONE BUILDING
400 NORTHSTREER
HARRISBURG, PA 17120

PITTSBURGH
WATER AND SEWER AUTHORITY
1200 PENN AVE
PITTSBURGH, PA 15222

ENGINEER

ORIGINAL SUBMISSION DATE: 10-19-2022

REVISED SUBMISSION DATE:

COMMONWEALTH OF PENNSYLVANIA — REGISTERED PROFESSIONAL — WILLIAM BRUCE McNEAL — ENGINEER — PE074465

COMMONWEALTH OF PENNSYLVANIA — REGISTERED PROFESSIONAL — JAMES H. FLYNN — ENGINEER — PE 06647

FILE: S:\Shared Folders\Projects\1-XYX Sawmill Run MS4\CADD\MS4MooreParkPlan1.dgn
DATE: 10/27/2022 TIME: 11:31:14 AM

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

LEGEND

- EXISTING CONTOUR
- PROPOSED CONTOUR
- LOD — TOTAL LIMIT OF DISTURBANCE
- EXISTING FENCE
- LOG GRADE CONTROLS
- SPILLWAY
- F — PROPOSED FILL LINE

FULLY COVER TRIPLE STACKED LOG GRADE CONTROLS TO ACT AS A BERM TO HOLD WATER IN THE FLOODPLAIN STORAGE AREAS

RELOCATED STREAM TO SAWMILL RUN

SEE MATCHLINE SHEET 16 OF 19

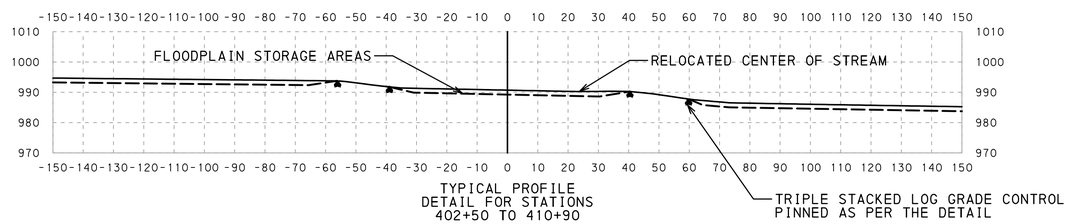
SEE MATCHLINE SHEET 17 OF 19

UNT TO SAWMILL RUN

FLOODPLAIN STORAGE AREAS

BURY GRADE CONTROLS A MINIMUM OF 4' FROM TOP OF BANK AS PER THE DETAIL

EXISTING STREAM TO BE FILLED



TYPICAL PROFILE DETAIL FOR STATIONS 402+50 TO 410+90

0 25 50 FEET

SHEET 17 OF 19

STREAM RESTORATION FOR MS4 CREDITS
IN THE THE SAW MILL RUN AND THE OHIO WATERSHED
CITY OF PITTSBURGH
ALLEGHENY COUNTY, PENNSYLVANIA
MOORE PARK RESTORATION PROJECT
PLAN SHEET

PREPARED BY:

HUNT VALLEY ENVIRONMENTAL, LLC
632 HUNT VALLEY ROAD
NEW KENSINGTON, PA 15068

PREPARED FOR:

PENNSYLVANIA
DEPARTMENT OF TRANSPORTATION
KEYSTONE BUILDING
400 NORTHSTREER
HARRISBURG, PA 17120

PITTSBURGH
WATER AND SEWER AUTHORITY
1200 PENN AVE
PITTSBURGH, PA 15222

ENGINEER

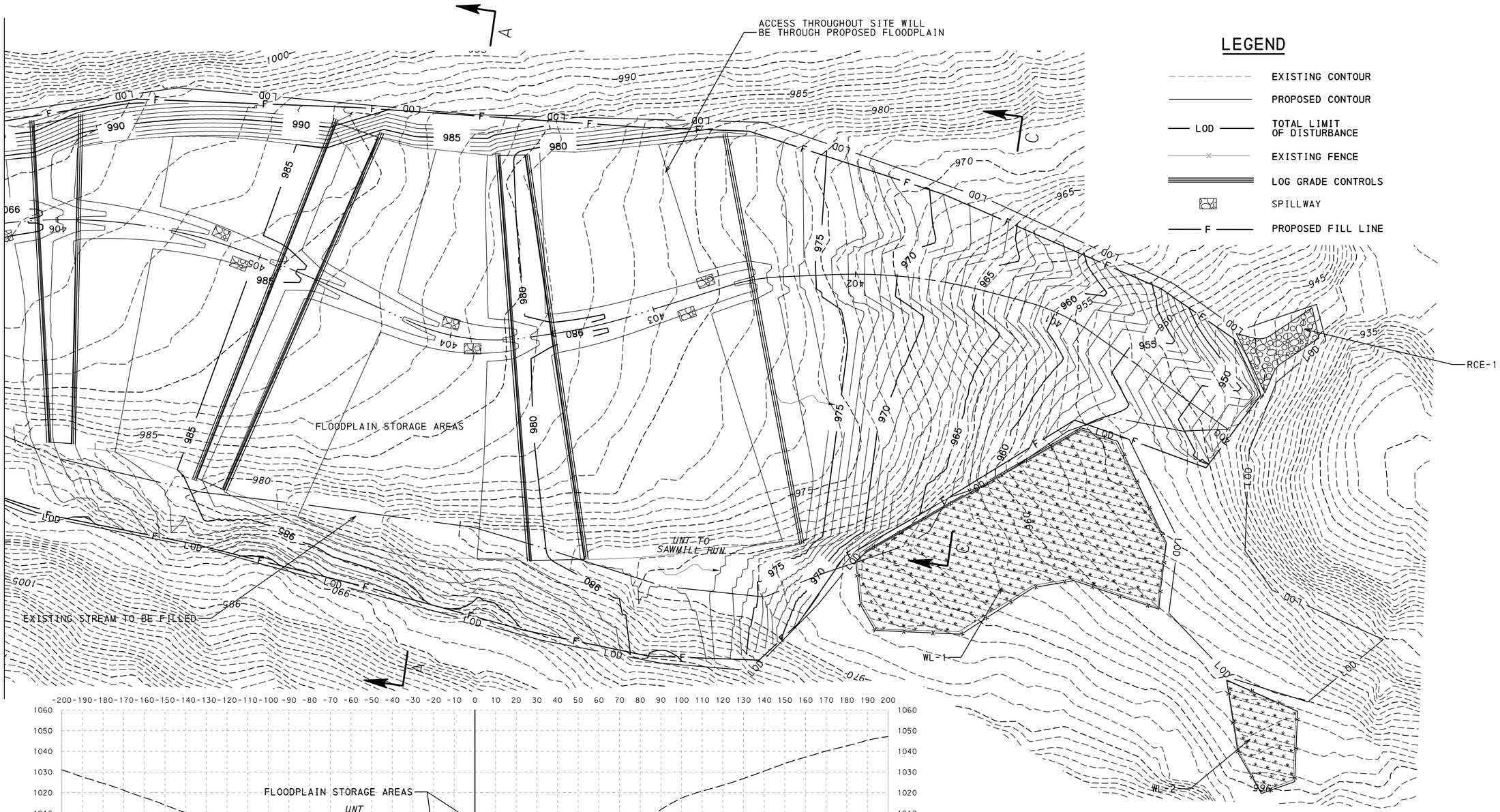
ORIGINAL SUBMISSION DATE: 10-19-2022

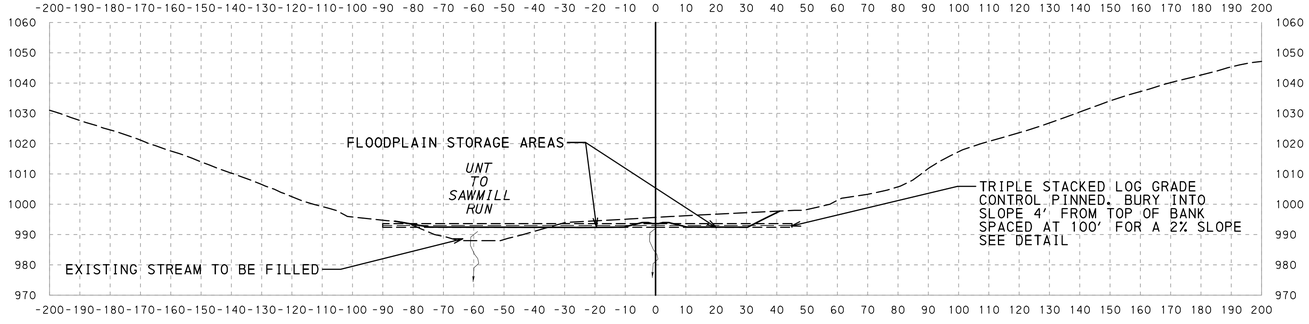
REVISED SUBMISSION DATE:

COMMONWEALTH OF PENNSYLVANIA
REGISTERED PROFESSIONAL
JAMES H. FLYNN
ENGINEER
PE 06647

FILE: S:\Shared Folders\Projects\21-XXX Sawmill Run MS4\CADD\MS4MooreParkPlan2-JHF.dgn
DATE: 10/24/2022 TIME: 10:52:35 AM

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D





TYPICAL CROSS SECTION
DETAIL FOR STATIONS
402+50 TO 410+90

SECTION A-A

0 25 50 FEET

SHEET 18 OF 19

STREAM RESTORATION FOR MS4 CREDITS
IN THE THE SAW MILL RUN AND THE OHIO WATERSHED
CITY OF PITTSBURGH
ALLEGHENY COUNTY, PENNSYLVANIA
MOORE PARK RESTORATION PROJECT
PLAN SHEET

PREPARED BY:

HUNT VALLEY ENVIRONMENTAL, LLC
632 HUNT VALLEY ROAD
NEW KENSINGTON, PA 15068

PREPARED FOR:

PENNSYLVANIA
DEPARTMENT OF TRANSPORTATION
KEYSTONE BUILDING
400 NORTHSTREER
HARRISBURG, PA 17120

PITTSBURGH
WATER AND SEWER AUTHORITY
1200 PENN AVE
PITTSBURGH, PA 15222

ENGINEER

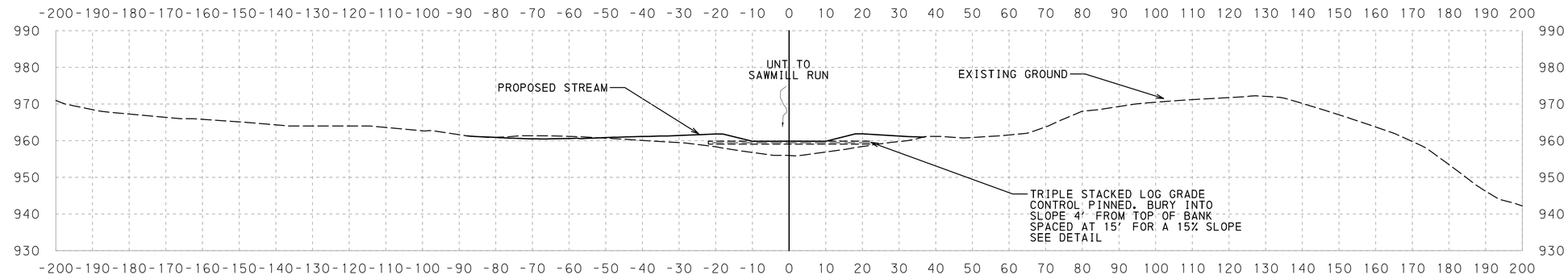
ORIGINAL SUBMISSION DATE: 10-19-2022

REVISED SUBMISSION DATE:

COMMONWEALTH OF PENNSYLVANIA
REGISTERED PROFESSIONAL
JAMES H. FLYNN
ENGINEER
PE 09647

FILE: S:\Shared Folders\Projects\21-XXX Sawmill Run MS4\CADD\MS4MooreParkPlan3.dgn
DATE: 10/27/2022 TIME: 11:11:35 AM

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D



TYPICAL CROSS SECTION
DETAIL FOR STATIONS
400+00 TO 402+50

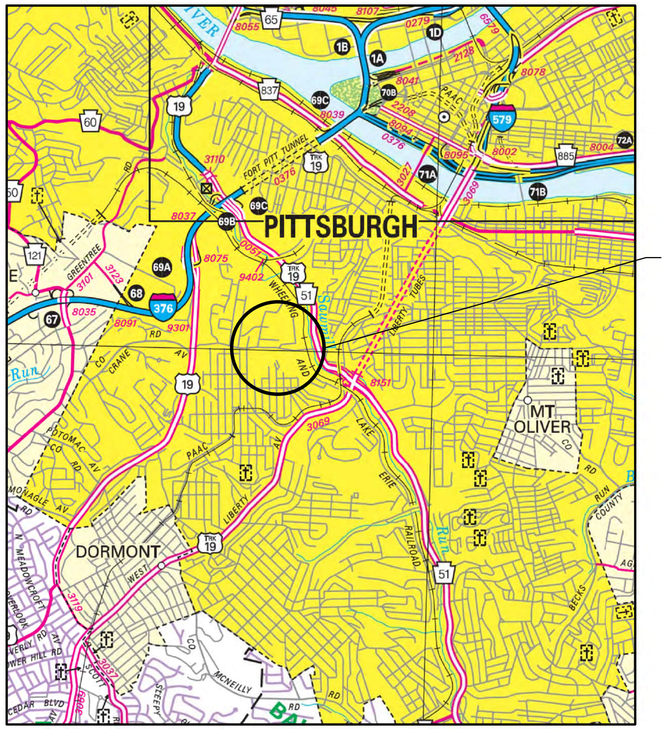
SECTION C-C

FILE: S:\Shared Folders\Projects\21-XXX Sawmill Run MS4\CADD\MS4MoorePark\KSECPlans.dgn
DATE: 10/20/2022 TIME: 5:58:45 PM

SHEET 19 OF 19	STREAM RESTORATION FOR MS4 CREDITS IN THE THE SAW MILL RUN AND THE OHIO WATERSHED CITY OF PITTSBURGH ALLEGHENY COUNTY, PENNSYLVANIA MOORE PARK RESTORATION PROJECT CROSS SECTION	PREPARED BY: HUNT VALLEY ENVIRONMENTAL, LLC 632 HUNT VALLEY ROAD NEW KENSINGTON, PA 15068	PREPARED FOR: PENNSYLVANIA DEPARTMENT OF TRANSPORTATION KEYSTONE BUILDING 400 NORTHSTREER HARRISBURG, PA 17120 PITTSBURGH WATER AND SEWER AUTHORITY 1200 PENN AVE PITTSBURGH, PA 15222	ENGINEER	ORIGINAL SUBMISSION DATE: 10-19-2022 REVISED SUBMISSION DATE:

COMMONWEALTH OF PENNSYLVANIA
REGISTERED PROFESSIONAL
JAMES H. FLYNN
ENGINEER
PE 061647

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D



LOCATION MAP

0 0.5 1.0 MILES

STREAM RESTORATION FOR MS4 CREDIT

IN THE SAW MILL RUN AND OHIO RIVER WATERSHED

FOR

PENNSYLVANIA DEPARTMENT OF TRANSPOTATION

AND

PITTSBURGH WATER AND SEWER AUTHORITY

POLLUANT REDUCTION PLAN

CALL BEFORE YOU DIG

PENNSYLVANIA LAW REQUIRES 3 WORKING DAYS NOTICE FOR CONSTRUCTION PHASE AND 10 WORKING DAYS IN DESIGN STAGE - STOP CALL 1-800-242-1776

PA ONE CALL System Inc.

SHEET INDEX BLOCK	
DESCRIPTION	SHEET
TITLE SHEET	1
GENERAL NOTES	2
CONSTRUCTION SEQUENCE	3
EROSION AND SEDIMENT DETAILS	4
STREAM RESTORATION DETAILS	5-6
DETENTION BASIN DETAILS	7-12
PLAN SHEETS	13-14
CROSS SECTIONS	15

SHEET 1 OF 15

STREAM RESTORATION FOR MS4 CREDITS
IN THE THE SAW MILL RUN AND THE OHIO WATERSHED
CITY OF PITTSBURGH
ALLEGHENY COUNTY, PENNSYLVANIA
CRANE AVE RESTORATION PROJECT
TITLE SHEET

PREPARED BY:

HUNT VALLEY ENVIRONMENTAL, LLC
632 HUNT VALLEY ROAD
NEW KENSINGTON, PA 15068

PREPARED FOR:

PENNSYLVANIA
DEPARTMENT OF TRANSPORTATION
KEYSTONE BUILDING
400 NORTHSTREER
HARRISBURG, PA 17120

PITTSBURGH
WATER AND SEWER AUTHORITY
1200 PENN AVE
PITTSBURGH, PA 15222

ENGINEER

ORIGINAL SUBMISSION DATE: 10-19-2022

REVISED SUBMISSION DATE:

COMMONWEALTH OF PENNSYLVANIA
REGISTERED PROFESSIONAL ENGINEER
JAMES H. FLYNN
PE 061647

FILE: S:\Shared Folders\Projects\2-XXX Sawmill Run MS4\CADD\MS4SawMillRunTitleCraneAve.dgn
DATE: 10/24/2022 TIME: 9:18:11 AM

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

EROSION AND SEDIMENT POLLUTION CONTROL GENERAL NOTES

AT LEAST 7 DAYS PRIOR TO STARTING ANY EARTH DISTURBANCE ACTIVITIES, INCLUDING CLEARING AND GRUBBING, THE OWNER AND/OR OPERATOR SHALL INVITE ALL CONTRACTORS, THE LANDOWNER, APPROPRIATE MUNICIPAL OFFICIALS, THE E&S PLAN PREPARER, THE PCSM PLAN PREPARER, THE LICENSED PROFESSIONAL RESPONSIBLE FOR OVERSIGHT OF CRITICAL STAGES OF IMPLEMENTATION OF THE PCSM PLAN, AND A REPRESENTATIVE FROM THE LOCAL CONSERVATION DISTRICT TO AN ON-SITE PRECONSTRUCTION MEETING.

AT LEAST 3 DAYS PRIOR TO STARTING ANY EARTH DISTURBANCE ACTIVITIES, OR EXPANDING INTO AN AREA PREVIOUSLY UNMARKED, THE PENNSYLVANIA ONE CALL SYSTEM INC. SHALL BE NOTIFIED AT 1-800-242-1776 FOR THE LOCATION OF EXISTING UNDERGROUND UTILITIES.

ALL EARTH DISTURBANCE ACTIVITIES SHALL PROCEED IN ACCORDANCE WITH THE SEQUENCE PROVIDED ON THE PLAN DRAWINGS. DEVIATION FROM THAT SEQUENCE MUST BE APPROVED IN WRITING FROM THE LOCAL CONSERVATION DISTRICT OR BY THE DEPARTMENT PRIOR TO IMPLEMENTATION.

AREAS TO BE FILLED ARE TO BE CLEARED, GRUBBED, AND STRIPPED OF TOPSOIL TO REMOVE TREES, VEGETATION, ROOTS AND OTHER OBJECTIONABLE MATERIAL.

CLEARING, GRUBBING, AND TOPSOIL STRIPPING SHALL BE LIMITED TO THOSE AREAS DESCRIBED IN EACH STAGE OF THE CONSTRUCTION SEQUENCE. GENERAL SITE CLEARING, GRUBBING AND TOPSOIL STRIPPING MAY NOT COMMENCE IN ANY STAGE OR PHASE OF THE PROJECT UNTIL THE E&S BMPS SPECIFIED BY THE BMP SEQUENCE FOR THAT STAGE OR PHASE HAVE BEEN INSTALLED AND ARE FUNCTIONING AS DESCRIBED IN THIS E&S PLAN.

AT NO TIME SHALL CONSTRUCTION VEHICLES BE ALLOWED TO ENTER AREAS OUTSIDE THE LIMIT OF DISTURBANCE BOUNDARIES SHOWN ON THE PLAN MAPS. THESE AREAS MUST BE CLEARLY MARKED AND FENCED OFF BEFORE CLEARING AND GRUBBING OPERATIONS BEGIN.

TOPSOIL REQUIRED FOR THE ESTABLISHMENT OF VEGETATION SHALL BE STOCKPILED AT THE LOCATION(S) SHOWN ON THE PLAN MAPS(S) IN THE AMOUNT NECESSARY TO COMPLETE THE FINISH GRADING OF ALL EXPOSED AREAS THAT ARE TO BE STABILIZED BY VEGETATION. EACH STOCKPILE SHALL BE PROTECTED IN THE MANNER SHOWN ON THE PLAN DRAWINGS. STOCKPILE HEIGHTS SHALL NOT EXCEED 35 FEET. STOCKPILE SLOPES SHALL BE 2H:1V OR FLATTER.

IMMEDIATELY UPON DISCOVERING UNFORESEEN CIRCUMSTANCES POSING THE POTENTIAL FOR ACCELERATED EROSION AND/OR SEDIMENT POLLUTION, THE OPERATOR SHALL IMPLEMENT APPROPRIATE BEST MANAGEMENT PRACTICES TO MINIMIZE THE POTENTIAL FOR EROSION AND SEDIMENT POLLUTION AND NOTIFY THE LOCAL CONSERVATION DISTRICT AND/OR DISTRICT ENVIRONMENTAL UNIT.

ALL BUILDING MATERIALS AND WASTES SHALL BE REMOVED FROM THE SITE AND RECYCLED OR DISPOSED OF IN ACCORDANCE WITH THE DEPARTMENT'S SOLID WASTE MANAGEMENT REGULATIONS AT 25 PA. CODE 260.1 ET SEQ., 271.1, AND 287.1 ET. SEQ. NO BUILDING MATERIALS OR WASTES OR UNUSED BUILDING MATERIALS SHALL BE BURNED, BURIED, DUMPED, OR DISCHARGED AT THE SITE.

EROSION AND SEDIMENTATION BEST MANAGEMENT PRACTICES (BMPS) THAT ARE PROPOSED FOR THE PROJECT SHALL BE INSTALLED AND FUNCTIONAL PRIOR TO ANY EARTH MOVING ACTIVITIES WITHIN THEIR CONTRIBUTING AREA.

CONDUCT ALL EARTH MOVING ACTIVITIES AS SPECIFIED IN THE EROSION AND SEDIMENTATION CONTROL PLAN AND IN ACCORDANCE WITH THE RULES AND REGULATION OF CHAPTER 102, TITLE 25 RELATED TO EROSION CONTROL, AND THE CLEAN STREAMS LAW OF PENNSYLVANIA.

UNTIL THE SITE IS STABILIZED, ALL EROSION AND SEDIMENT BMPS SHALL BE MAINTAINED PROPERLY. MAINTENANCE SHALL INCLUDE INSPECTIONS OF ALL EROSION AND SEDIMENT BMPS AFTER EACH RUNOFF EVENT AND ON A WEEKLY BASIS. ALL PREVENTATIVE AND REMEDIAL MAINTENANCE WORK, INCLUDING CLEAN OUT, REPAIR, REPLACEMENT, REGRADING, RESEEDING, REMULCHING AND RENETTING MUST BE PERFORMED IMMEDIATELY. IF THE E&S BMPS FAIL TO PERFORM AS EXPECTED, REPLACEMENT BMPS, OR MODIFICATIONS OF THOSE INSTALLED WILL BE REQUIRED IMMEDIATELY.

SEED AND MULCH ANY DISTURBED AREA THAT WILL REMAIN IDLE FOR MORE THAN 4 DAYS
STABILIZATION IS DEFINED AS A UNIFORM, 70%, PERENNIAL COVER ESTABLISHED OVER THE DISTURBED AREA.

ANY AND ALL ACCUMULATED SILT AND SEDIMENTS THAT ARE FOUND WITHIN AN EROSION CONTROL DEVICE SHALL BE REMOVED FROM THE CONTROL DEVICE AND SPREAD EVENLY ON THE FILL UPSLOPE OF THE EROSION AND SEDIMENTATION CONTROLS, AND THEN SEEDED AND MULCHED TO PROVIDE STABILIZATION.

ANY OFFSITE WASTE AND BORROW AREAS MUST HAVE AN E & S PLAN REVIEWED AND APPROVED BY THE LOCAL CONSERVATION DISTRICT AND THE DISTRICT ENVIRONMENTAL UNIT PRIOR TO BEING ACTIVATED.

CLEAN FILL IS DEFINED AS: UNCONTAMINATED, NON-WATER SOLUBLE, NON-DECOMPOSABLE, INERT, SOLID MATERIAL. THE TERM INCLUDES SOIL, ROCK, STONE, DREDGED MATERIAL, USED ASPHALT, AND BRICK, BLOCK OR CONCRETE, FROM CONSTRUCTION AND DEMOLITION ACTIVITIES THAT IS SEPARATE FROM OTHER WASTE AND IS RECOGNIZABLE AS SUCH. THE TERM DOES NOT INCLUDE MATERIALS PLACED IN OR ON THE WATERS OF THE COMMONWEALTH UNLESS OTHERWISE AUTHORIZED. (THE TERM USED ASPHALT DOES NOT INCLUDE MILLED ASPHALT OR ASPHALT THAT HAS BEEN PROCESSED FOR REUSE).

ENVIRONMENTAL DUE DILIGENCE MUST BE PERFORMED TO DETERMINE IF FILL MATERIALS ASSOCIATED WITH THE PROJECT QUALIFY AS CLEAN FILL. ENVIRONMENTAL DUE DILIGENCE IS DEFINED AS: INVESTIGATION TECHNIQUES, INCLUDING BUT NOT LIMITED TO, VISUAL PROPERTY INSPECTIONS, ELECTRONIC DATA BASE SEARCHES, REVIEW OF THE PROPERTY OWNERSHIP, REVIEW OF THE PROPERTY USE HISTORY, SANBORN MAPS, ENVIRONMENTAL QUESTIONNAIRES, TRANSACTION SCREEN, ANALYTICAL TESTING, ENVIRONMENTAL ASSESSMENTS OR AUDITS. ANALYTICAL TESTING IS NOT A REQUIRED PART OF DUE DILIGENCE UNLESS VISUAL INSPECTION AND/OR REVIEW OF THE PAST LAND USE OF THE PROPERTY INDICATES THAT THE FILL MAY HAVE BEEN COMPROMISED BY A RELEASE OF A REGULATED SUBSTANCE. IF THE FILL IS SUSPECTED TO HAVE BEEN COMPROMISED BY A RELEASE OF A REGULATED SUBSTANCE, IT MUST BE TESTED TO DETERMINE IF IT QUALIFIES AS A CLEAN FILL. TESTING SHOULD BE PERFORMED IN ACCORDANCE WITH APPENDIX A OF THE DEPARTMENT'S POLICY "MANAGEMENT OF CLEAN FILL".

THE CONTRACTOR IS RESPONSIBLE FOR ENSURING THAT ANY MATERIAL BROUGHT ON SITE IS CLEAN FILL. PADEP FORM FP-001 MUST BE RETAINED BY THE PROPERTY OWNER FOR ANY FILL MATERIAL AFFECTED BY A SPILL OR RELEASE OF A REGULATED SUBSTANCE BUT QUALIFYING AS CLEAN FILL DUE TO ANALYTICAL TESTING.

ALL EARTH DISTURBANCES, INCLUDING CLEARING AND GRUBBING AS WELL AS CUTS AND FILLS SHALL BE DONE IN ACCORDANCE WITH THE APPROVED E&S PLAN. A COPY OF THE APPROVED DRAWINGS (STAMPED, SIGNED AND DATED BY THE REVIEWING AGENCY) MUST BE AVAILABLE AT THE PROJECT SITE AT ALL TIMES. THE REVIEWING AGENCY SHALL BE NOTIFIED OF ANY CHANGES TO THE APPROVED PLAN PRIOR TO IMPLEMENTATION OF THOSE CHANGES. THE REVIEWING AGENCY MAY REQUIRE A WRITTEN SUBMITTAL OF THOSE CHANGES FOR REVIEW AND APPROVAL AT ITS DISCRETION.

ALL PUMPING OF WATER FROM ANY WORK AREA SHALL BE DONE ACCORDING TO THE PROCEDURE DESCRIBED IN THIS PLAN, OVER UNDISTURBED VEGETATED AREAS.

A WRITTEN LOG MUST BE COMPLETED ON FORM 3800-FM-BCW0271D (MOST CURRENT FORM) SHOWING DATES THAT E&S BMPS WERE INSPECTED, DEFICIENCIES FOUND AND THE DATE THEY WERE CORRECTED SHALL BE MAINTAINED ON THE SITE AND BE MADE AVAILABLE TO REGULATORY AGENCY OFFICIALS AT THE TIME OF INSPECTION.

SEDIMENT TRACKED ONTO ANY PUBLIC ROADWAY OR SIDEWALK SHALL BE RETURNED TO THE CONSTRUCTION SITE BY THE END OF EACH WORK DAY AND DISPOSED IN THE MANNER DESCRIBED IN THIS PLAN. IN NO CASE SHALL THE SEDIMENT BE WASHED, SHOVELED, OR SWEPT INTO ANY ROADSIDE DITCH, STORM SEWER, OR SURFACE WATER.

AREAS WHICH ARE TO BE TOPSOILED SHALL BE SCARIFIED TO A MINIMUM DEPTH OF 3 TO 5 INCHES 6 TO 12 INCHES ON COMPACTED SOILS PRIOR TO PLACEMENT OF TOPSOIL. AREAS TO BE VEGETATED SHALL HAVE A MINIMUM 4 INCHES OF TOPSOIL IN PLACE PRIOR TO SEEDING AND MULCHING. FILL OUTSLOPES SHALL HAVE A MINIMUM OF 2 INCHES OF TOPSOIL.

BMP INSPECTION, MAINTENANCE AND REPAIR SCHEDULE

BMP	INSPECTION	MAINTENANCE	REPAIR
ROCK CONSTRUCTION ENTRANCE	DAILY	REMOVE SEDIMENT	MAINTAIN THICKNESS AND DIMENSIONS BY ADDING ROCK
SEEDING AND MULCHING	WEEKLY AND AFTER EACH RAINFALL EVENT	N/A	EVALUATE CONDITIONS AND RE-SEED AND STABILIZE
PUMPED WATER FILTER BAG	DAILY	CEASE USE AND FIX PROBLEM	REPAIR IMMEDIATELY
TEMPORARY PUMP BYPASS	DAILY	CEASE USE AND FIX PROBLEM	REPAIR IMMEDIATELY

NOTES:

1. MAINTENANCE AND REPAIR ON BMP'S MUST BE COMPLETED IMMEDIATELY AFTER THE WEEKLY OR RAINFALL INSPECTION.
2. SEDIMENT REMOVED FROM BMP'S SHALL BE PLACED ON THE TOP SOIL STOCK PILE FOR USE LATER IN THE PROJECT.
3. A RUNOFF EVENT IS RAINFALL OR SNOW RUNOFF OF 0.25" OR MORE IN A 24 CONSECUTIVE HOUR PERIOD.
4. WEEKLY OR RAINFALL INSPECTIONS OVER MUST BE COMPLETED ON THE WRITTEN LOG FORM 3800-FM-BCW0271D (OR MOST CURRENT FORM).

STREAM RESTORATION FOR MS4 CREDITS
IN THE THE SAW MILL RUN AND THE OHIO WATERSHED
CITY OF PITTSBURGH
ALLEGHENY COUNTY, PENNSYLVANIA
CRANE AVE RESTORATION PROJECT
GENERAL NOTES

PREPARED BY:
HUNT VALLEY ENVIRONMENTAL, LLC
632 HUNT VALLEY ROAD
NEW KENSINGTON, PA 15068

PREPARED FOR:
PENNSYLVANIA
DEPARTMENT OF TRANSPORTATION
KEYSTONE BUILDING
400 NORTHSTREER
HARRISBURG, PA 17120

PITTSBURGH
WATER AND SEWER AUTHORITY
1200 PENN AVE
PITTSBURGH, PA 15222

ENGINEER

ORIGINAL SUBMISSION DATE: 10-19-2022

REVISED SUBMISSION DATE:

COMMONWEALTH OF PENNSYLVANIA
REGISTERED PROFESSIONAL
JAMES H. FLYNN
ENGINEER
PE 061647

FILE: S:\Shared Folders\P-Drive\21-XXX Sawmill Run MS4\CADD\MS4Sawmill\RunGenNotes.dgn
DATE: 10/20/2022 TIME: 2:35:47 PM

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

EROSION AND SEDIMENT POLLUTION CONTROL GENERAL NOTES (CONT'D)

ALL FILLS SHALL BE COMPACTED AS REQUIRED TO REDUCE EROSION, SLIPPAGE, SETTLEMENT, SUBSIDENCE OR OTHER RELATED PROBLEMS. FILL INTENDED TO SUPPORT BUILDINGS, STRUCTURES AND CONDUITS, ETC. SHALL BE COMPACTED IN ACCORDANCE WITH LOCAL REQUIREMENTS OR CODES.

FILL MATERIALS SHALL BE FREE OF FROZEN PARTICLES, BRUSH, ROOTS, SOD, OR OTHER FOREIGN OR OBJECTIONABLE MATERIALS THAT WOULD INTERFERE WITH OR PREVENT CONSTRUCTION OF SATISFACTORY FILLS.

FROZEN MATERIALS OR SOFT, MUCKY, OR HIGHLY COMPRESSIBLE MATERIALS SHALL NOT BE INCORPORATED INTO FILLS. FILL SHALL NOT BE PLACED ON SATURATED OR FROZEN SURFACES.

SEEPS OR SPRINGS ENCOUNTERED DURING CONSTRUCTION SHALL BE HANDLED IN ACCORDANCE WITH THE STANDARD AND SPECIFICATION FOR SUBSURFACE DRAIN OR OTHER APPROVED METHOD.

ALL GRADED AREAS SHALL BE PERMANENTLY STABILIZED IMMEDIATELY UPON REACHING FINISHED GRADE. CUT SLOPES IN COMPETENT BEDROCK AND ROCK FILLS NEED NOT BE VEGETATED. SEEDED AREAS WITHIN 50 FEET OF A SURFACE WATER, OR AS OTHERWISE SHOWN ON THE PLAN DRAWINGS, SHALL BE BLANKETED ACCORDING TO THE STANDARDS OF THIS PLAN.

IMMEDIATELY AFTER EARTH DISTURBANCE ACTIVITIES CEASE IN ANY AREA OR SUBAREA OF THE PROJECT, THE OPERATOR SHALL STABILIZE ALL DISTURBED AREAS. DURING NON-GERMINATING MONTHS, MULCH OR PROTECTIVE BLANKETING SHALL BE APPLIED AS DESCRIBED IN THE PLAN. AREAS NOT AT FINISHED GRADE, WHICH WILL BE REACTIVATED WITHIN 1 YEAR, MAY BE STABILIZED IN ACCORDANCE WITH THE TEMPORARY STABILIZATION SPECIFICATIONS. THOSE AREAS WHICH WILL NOT BE REACTIVATED WITHIN 1 YEAR SHALL BE STABILIZED IN ACCORDANCE WITH THE PERMANENT STABILIZATION SPECIFICATIONS.

PERMANENT STABILIZATION IS DEFINED AS A MINIMUM UNIFORM, PERENNIAL 70% VEGETATIVE COVER OR OTHER PERMANENT NON-VEGETATIVE COVER WITH A DENSITY SUFFICIENT TO RESIST ACCELERATED EROSION. CUT AND FILL SLOPES SHALL BE CAPABLE OF RESISTING FAILURE DUE TO SLUMPING, SLIDING, OR OTHER MOVEMENTS.

E&S BMPS SHALL REMAIN FUNCTIONAL AS SUCH UNTIL ALL AREAS TRIBUTARY TO THEM ARE PERMANENTLY STABILIZED OR UNTIL THEY ARE REPLACED BY ANOTHER BMP APPROVED BY THE LOCAL CONSERVATION DISTRICT OR DISTRICT ENVIRONMENTAL UNIT.

AFTER FINAL SITE STABILIZATION HAS BEEN ACHIEVED, TEMPORARY EROSION AND SEDIMENT BMPS MUST BE REMOVED OR CONVERTED TO PERMANENT POST CONSTRUCTION STORMWATER MANAGEMENT BMPS. AREAS DISTURBED DURING REMOVAL OR CONVERSION OF THE BMPS SHALL BE STABILIZED IMMEDIATELY. IN ORDER TO ENSURE RAPID REVEGETATION OF DISTURBED AREAS, SUCH REMOVAL/CONVERSIONS ARE TO BE DONE ONLY DURING THE GERMINATING SEASON.

UPON COMPLETION OF ALL EARTH DISTURBANCE ACTIVITIES AND PERMANENT STABILIZATION OF ALL DISTURBED AREAS, THE OWNER AND/OR OPERATOR SHALL CONTACT THE LOCAL CONSERVATION DISTRICT TO SCHEDULE A FINAL INSPECTION.

NOTIFY THE PENNSYLVANIA DEPARTMENT OF ENVIRONMENTAL PROTECTION AND THE ALLEGHENY COUNTY CONSERVATION DISTRICT 10 DAYS IN ADVANCE OF ANY LAND DISTURBANCE ACTIVITIES AT THE FOLLOWING ADDRESS:

PROCEDURES WHICH ENSURE THAT THE PROPER MEASURES FOR THE RECYCLING OR DISPOSAL OF MATERIALS ASSOCIATED WITH OR FROM THE PROJECT SITE WILL BE UNDERTAKEN IN ACCORDANCE WITH DEPARTMENT REGULATIONS. INDIVIDUALS RESPONSIBLE FOR EARTH DISTURBANCE ACTIVITIES MUST ENSURE THAT PROPER MECHANISMS ARE IN PLACE TO CONTROL WASTE MATERIALS. CONSTRUCTION WASTES INCLUDE, BUT ARE NOT LIMITED TO, EXCESS SOIL MATERIALS, BUILDING MATERIALS, CONCRETE WASH WATER, SANITARY WASTES, ETC. THAT COULD ADVERSELY IMPACT WATER QUALITY. MEASURES SHOULD BE PLANNED AND IMPLEMENTED FOR HOUSEKEEPING, MATERIALS MANAGEMENT, AND LITTER CONTROL. WHEREVER POSSIBLE, RECYCLING OF EXCESS MATERIALS IS PREFERRED, RATHER THAN DISPOSAL. A NOTE REQUIRING RECYCLING OF WASTE MATERIALS, WHERE FEASIBLE, SHOULD BE ADDED TO THE DRAWINGS.

ANNE FOX, SENIOR RESOURCE CONSERVATIONIST
ALLEGHENY COUNTY CONSERVATION DISTRICT
312 EAST CARSON STREET, SUITE 119
PITTSBURGH, PA 15219
PHONE: (412) 291-8010

PA DEP REGIONAL OFFICE CONTACT INFORMATION:

PA DEP SOUTHWEST REGIONAL OFFICE
WETLANDS AND WATERWAYS
400 WATERFRONT DRIVE
PITTSBURGH, PA 15222
OFFICE HOURS 8 A.M. - 4 P.M.
PHONE: (412) 422-4000

PLAN PREPARER CONTACT INFORMATION:

MR. JAMES FLYNN, P.E.
HUNT VALLEY ENVIROMENTAL, LLC
632 HUNT VALLEY CIRCLE
NEW KENSINGTON, PA 15068
PHONE: 724-594-0805

	FORMULA AND SPECIES	% BY WEIGHT	MINIMUM % PURITY	MINIMUM % GERMINATION	APPLICATION RATE
FORMULA D	TALL FESCUE (FESTUCA ARUNDINACEA VAR. KENTUCKY 31)	60	96	85	50.0 LBS/ACRE
	CREEPING RED FESCUE OR CHEWINGS FESCUE (FESTUCA RUBRA OR SSP COMMUTATE) (IMPROVED AND CERTIFIED)	30	97	85	
	ANNUAL RYEGRASS (LOLIUM MULTIFLORUM)	10	95	90	
	FERTILIZER APPL. RATE	10-20-20			1000.0 LBS/ACRE
	LIMING RATE	-			6.0 TONS/ACRE
	MULCHING TYPE	HAY			1,200 LBS/1,000 SY
	SEASON SEEDING DATES	MARCH-NOVEMBER			-
FORMULA E	ANNUAL RYEGRASS	100.00	95	90	10.0 LBS/ACRE
	FERTILIZER APPL. RATE	10-20-20			1000.0 LBS/ACRE
	LIMING RATE	-			2.0 TONS/ACRE
	MULCHING TYPE	HAY			3.0 TONS/ACRE
	SEASON SEEDING DATES	MARCH-NOVEMBER			
FORMULA L	HARD FESCUE MIXTURE (FESTUCA LONGIFOLIA), A COMBINATION OF IMPROVED CERTIFIED VARIETIES WITH NO ONE VARIETY EXCEEDING 50% OF THE TOTAL HARD FESCUE COMPONENT	55	97	85	50.0 LBS/ACRE
	CREEPING RED FESCUE (FESTUCA RUBRA) (IMPROVED AND CERTIFIED)	35	97	85	
	ANNUAL RYEGRASS (LOLIUM MULTIFLORUM)	10	95	90	
	FERTILIZER APPL. RATE	10-20-20			1000.0 LBS/ACRE
	LIMING RATE	-			6.0 TONS/ACRE
	MULCHING TYPE	HAY			1,200 LBS/1,000 SY
	SEASON SEEDING DATES	MARCH-NOVEMBER			-

CONSTRUCTION SEQUENCE

ALL CONSTRUCTION ACTIVITIES SHALL PROCEED IN ACCORDANCE WITH THE FOLLOWING CONSTRUCTION SEQUENCE. EACH STEP SHALL BE COMPLETED BEFORE A SUBSEQUENT STEP IS INITIATED. UPON COMPLETION OR TEMPORARY CESSATION OF THE EARTH DISTURBANCE ACTIVITY, OR ANY STAGE THEREOF, THE PROJECT SITE SHALL BE IMMEDIATELY STABILIZED. THE CONTRACTOR CAN PROCEED WITH THE REMAINDER OF CLEARING AND GRUBBING BETWEEN NOVEMBER 16 AND MARCH 31. INSTALL THE REMAINDER BMP'S AND CONTINUE WITH FILL ON THE SITE.

PRE-CONSTRUCTION

1. AT LEAST 7 DAYS PRIOR TO STARTING ANY EARTH DISTURBANCE ACTIVITIES (INCLUDING CLEARING AND GRUBBING), THE OWNER AND/OR OPERATOR SHALL INVITE ALL CONTRACTORS, THE LANDOWNER, APPROPRIATE MUNICIPAL OFFICIALS, THE EROSION AND SEDIMENT POLLUTION CONTROL PLAN PREPARER, A REPRESENTATIVE FROM THE PENNSYLVANIA DEPARTMENT OF ENVIRONMENTAL PROTECTION AND A REPRESENTATIVE FROM THE ALLEGHENY COUNTY CONSERVATION DISTRICT TO AN ON-SITE PRECONSTRUCTION MEETING.
2. AT LEAST 3 DAYS PRIOR TO STARTING ANY EARTH DISTURBANCE ACTIVITIES, OR EXPANDING INTO AN AREA PREVIOUSLY UNMARKED, THE PENNSYLVANIA ONE CALL SYSTEM INC. SHALL BE NOTIFIED AT 1-800-242-1776 FOR THE LOCATION OF EXISTING UNDERGROUND UTILITIES.
3. ALL APPLICABLE PERMITS AND APPROVALS REQUIRED FOR THIS PROJECT SHALL BE SECURED PRIOR TO THE START OF CONSTRUCTION. COPIES OF PERMITS, PLANS AND APPROVALS SHALL BE KEPT ON-SITE AT ALL TIMES.
4. ALL EARTH DISTURBANCE ACTIVITIES SHALL PROCEED IN ACCORDANCE WITH THE SEQUENCE PROVIDED ON THE PLAN DRAWINGS.
5. THE SELECTED CONTRACTOR IS RESPONSIBLE FOR HAVING AN APPROVED EROSION AND SEDIMENTATION CONTROL PLAN FOR ALL OFF-SITE WASTE AND BORROW SITES.
6. CONTRACTOR SHOULD LIMIT STOCKPILING OF WASTE, CONSTRUCTION EQUIPMENT, FUEL TANKS, BORROWED EXCAVATION, ETC. NEAR THE STREAM IN THE EVENT A SIGNIFICANT STORM SHOULD OCCUR.
7. MOBILIZE FOR PROJECT CONSTRUCTION.

CONSTRUCTION

LRG WILL UTILIZE REGENERATIVE STREAM CONVEYANCE/FLOOD PLAIN RESTORATION FOR THE CONSTRUCTION METHOD OF THE REESTABLISHED UNNAMED TRIBUTARY CHANNELS IN SAWMILL RUN. LENGTH OF EACH CONSTRUCTION REACH IS BASED ON THE EXISTING FLOW OF THE CHANNEL.

1. PLACE A ROCK CONSTRUCTION ENTRANCE FOR ACCESS TO THE STREAM.
2. SET UP STREAM DIVERSION/PUMP AROUND APPROXIMATELY 200 FEET MAX IN LENGTH
3. ONLY DISTURB LENGTH OF CHANNEL THAT CAN BE RESTORED IN A DAY.
4. PLACE STONE FILTER IN THE CHANNEL 5-10 FEET UPSTREAM AT THE POINT WHERE THE PUMP DISCHARGES THE WATER INTO THE DOWN-STREAM CHANNEL. DISCHARGE THE WATER THROUGH A DIFFUSER 20 FEET DOWNSTREAM OF THE WORK AREA DO NOT CAUSE A SCOUR ISSUE IN THE CHANNEL OR WETLANDS.
5. GRADE THE CHANNEL CLOSED IN THE REACH.
6. EXCAVATE THE CHANNEL TO PROPOSED GRADE AND DEPTH BY USING THE BACK OF THE BUCKET. IT WILL BE 4" - 6" DEPTH BASED ON THE DETAIL.
7. EXCAVATE AND PLACE GRADE CONTROL STRUCTURES PERPENDICULAR TO CHANNEL SO TOP OF THE LOG STRUCTURE IS AT THE INVERT OF THE CHANNEL. THESE WILL BE SPACED ACCORDING TO CHART IN PLAN.
8. PLACE AASHTO-1 IN BED AS NEEDED
9. SEED FLOODWAY PER SEEDING SPECIFICATION ON DETAIL SHEET, MULCHING WITH A TEMPORARY MULCH BLANKET OR ECMB AS DETAIL RECOMENDS.
10. REMOVE BYPASS PUMP, PROCEED TO NEXT REACH, LEAVE STONE FILTER IN PLACE AT THE DOWNSTREAM END UNTIL THE CHANNEL RESTABLISHMENT PROJECT IS COMPLETED.

REPEAT THE SEQUENCE BASED UPON THE STATIONING OF THE REACH. EACH REACH CAN NOT EXCEED 200 FEET UNLESS THE CHANNEL IS DRY. THE SAME SEQUENCE WILL BE FOLLOWED FOR THE REESTBLISHEMNT OF EACH CHANNEL.

FILE: S:\Shared Folders\Projects\XXX Sawmill Run MS4\CADD\MS4Sawmill RunGenNotes2crane.dgn
DATE: 10/20/2022 TIME: 2:31:47 PM

SHEET 3 OF 15

STREAM RESTORATION FOR MS4 CREDITS
IN THE THE SAW MILL RUN AND THE OHIO WATERSHED
CITY OF PITTSBURGH
ALLEGHENY COUNTY, PENNSYLVANIA
CRANE AVE RESTORATION PROJECT
GENERAL NOTES AND CONSTRUCTION SEQUENCE

PREPARED BY:
HUNT VALLEY ENVIRONMENTAL, LLC
632 HUNT VALLEY ROAD
NEW KENSINGTON, PA 15068

PREPARED FOR:
PENNSYLVANIA DEPARTMENT OF TRANSPORTATION
KEYSTONE BUILDING
400 NORTHSTREER
HARRISBURG, PA 17120

PITTSBURGH
WATER AND SEWER AUTHORITY
1200 PENN AVE
PITTSBURGH, PA 15222

ENGINEER

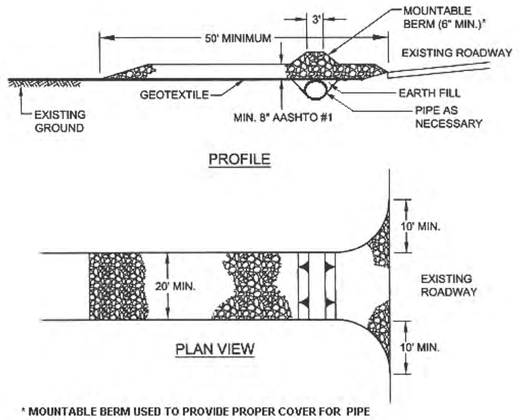
ORIGINAL SUBMISSION DATE: 10-19-2022

REVISED SUBMISSION DATE:

COMMONWEALTH OF PENNSYLVANIA
REGISTERED PROFESSIONAL
JAMES H. FLYNN
ENGINEER
PE 061547

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

STANDARD CONSTRUCTION DETAIL # 3-1
Rock Construction Entrance



* MOUNTABLE BERM USED TO PROVIDE PROPER COVER FOR PIPE

Modified from Maryland DOE

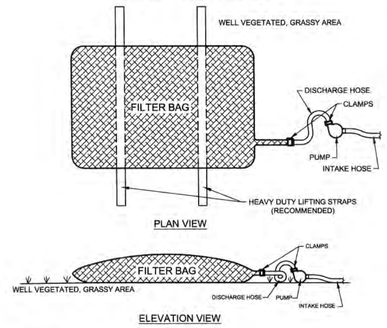
Remove topsoil prior to installation of rock construction entrance. Extend rock over full width of entrance.

Runoff shall be diverted from roadway to a suitable sediment removal BMP prior to entering rock construction entrance.

Mountable berm shall be installed wherever optional culvert pipe is used and proper pipe cover as specified by manufacturer is not otherwise provided. Pipe shall be sized appropriately for size of ditch being crossed.

MAINTENANCE: Rock construction entrance thickness shall be constantly maintained to the specified dimensions by adding rock. A stockpile shall be maintained on site for this purpose. All sediment deposited on paved roadways shall be removed and returned to the construction site immediately. If excessive amounts of sediment are being deposited on roadway, extend length of rock construction entrance by 50 foot increments until condition is alleviated or install wash rack. Washing the roadway or sweeping the deposits into roadway ditches, sewers, culverts, or other drainage courses is not acceptable.

STANDARD CONSTRUCTION DETAIL # 3-16
Pumped Water Filter Bag



PA DEP

Low volume filter bags shall be made from non-woven geotextile material sewn with high strength, double stitched "J" type seams. They shall be capable of trapping particles larger than 150 microns. High volume filter bags shall be made from woven geotextiles that meet the following standards:

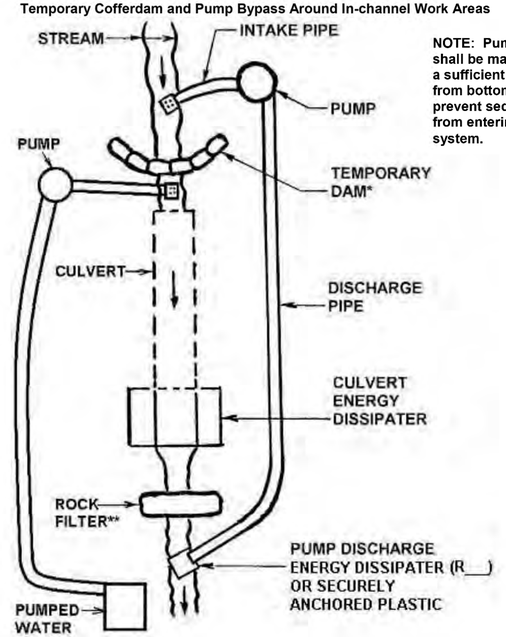
Property	Test Method	Minimum Standard
Avg. Wide Width Strength	ASTM D-4884	60 lb/in
Grab Tensile	ASTM D-4632	205 lb
Puncture	ASTM D-4833	110 lb
Mullen Burst	ASTM D-3786	350 psi
UV Resistance	ASTM D-4355	70%
AOS % Retained	ASTM D-4751	80 Sieve

A suitable means of accessing the bag with machinery required for disposal purposes shall be provided. Filter bags shall be replaced when they become ½ full of sediment. Spare bags shall be kept available for replacement of those that have failed or are filled. Bags shall be placed on straps to facilitate removal unless bags come with lifting straps already attached.

Bags shall be located in well-vegetated (grassy) area, and discharge onto stable, erosion resistant areas. Where this is not possible, a geotextile underlayment and flow path shall be provided. Bags may be placed on filter stone to increase discharge capacity. Bags shall not be placed on slopes greater than 5%. For slopes exceeding 5%, clean rock or other non-erodible and non-polluting material may be placed under the bag to reduce slope steepness.

No downslope sediment barrier is required for most installations. Compost berm or compost filter sock shall be installed below bags located in HQ or EV watersheds, within 50 feet of any receiving surface water or where grassy area is not available.

FIGURE 3.11
Temporary Cofferdam and Pump Bypass Around In-channel Work Areas



PA DEP

NOTE: Pump intake shall be maintained a sufficient distance from bottom to prevent sediment from entering the system.

* **Sandbags (Standard Construction Detail #3-15), Jersey barriers (Figure 3.13) or other non-erosive material, no earth fill. Do not excavate a sump for the pump intake.**

** **See Standard Construction Detail # 4-14. For low gradient channels, the rock filter may be replaced by an impervious cofferdam to prevent backflow into the work area.**

(Additional Notes for Standard Construction Detail # 3-16)

The pump discharge hose shall be inserted into the bags in the manner specified by the manufacturer and securely clamped. A piece of PVC pipe is recommended for this purpose.

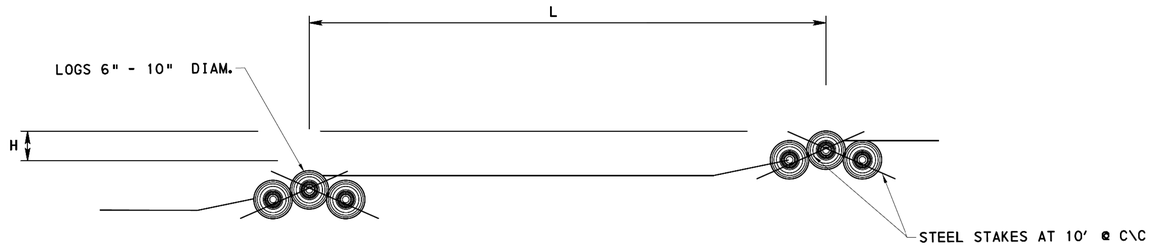
The pumping rate shall be no greater than 750 gpm or ½ the maximum specified by the manufacturer, whichever is less. Pump intakes shall be floating and screened.

Filter bags shall be inspected daily. If any problem is detected, pumping shall cease immediately and not resume until the problem is corrected.

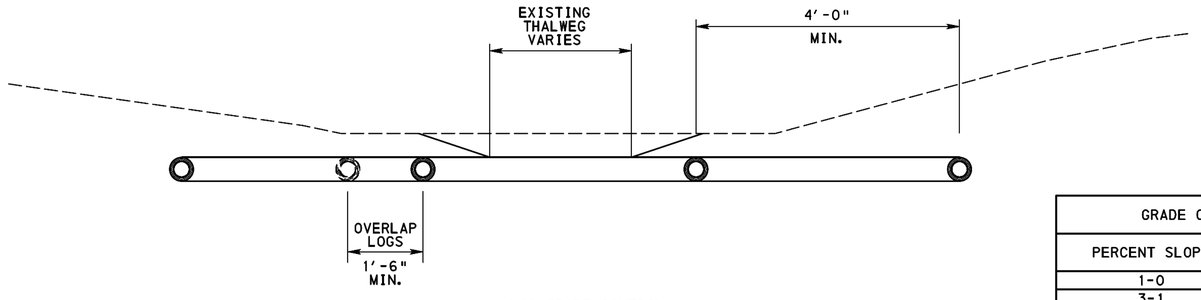
FILE: S:\Shared Folders\Projects\2_XXX Sawmill Run MS4\CADD\MS4Sawmill RunESDdetails.dgn
DATE: 10/20/2022 TIME: 2:41:53 PM

SHEET 4 OF 15	STREAM RESTORATION FOR MS4 CREDITS IN THE THE SAW MILL RUN AND THE OHIO WATERSHED CITY OF PITTSBURGH ALLEGHENY COUNTY, PENNSYLVANIA CRANE AVE RESTORATION PROJECT EROSION AND SEDIMENT DETAILS	PREPARED BY: HUNT VALLEY ENVIRONMENTAL, LLC 632 HUNT VALLEY ROAD NEW KENSINGTON, PA 15068	PREPARED FOR: PENNSYLVANIA DEPARTMENT OF TRANSPORTATION KEYSTONE BUILDING 400 NORTHSTREER HARRISBURG, PA 17120 PITTSBURGH WATER AND SEWER AUTHORITY 1200 PENN AVE PITTSBURGH, PA 15222	ENGINEER ORIGINAL SUBMISSION DATE: 10-19-2022 REVISED SUBMISSION DATE:	COMMONWEALTH OF PENNSYLVANIA REGISTERED PROFESSIONAL JAMES H. FLYNN ENGINEER PE 061647

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D



SECTION A-A



LOG GRADE CONTROL

GRADE CONTROL PLACEMENT	
PERCENT SLOPE	SPACING (FT)
1-0	100
3-1	75-100
5-3	60-75
7-5	45-60
9-7	30-45
11-9	20-30
13-11	15-20
15	9-15

GRADE CONTROL NOTES:

1. GRADES GREATER THAN 20% WILL USE REESTABLISHMENT LOG AND ROCK STEP POOL. SEE DETAIL THIS SHEET.

GRADE CONTROL DETAIL
NTS

FILE: S:\Shared Folders\Projects\21-XXX Sawmill Run MS4\CADD\MS4Str-ResCraneDetails.dgn
DATE: 10/24/2022 TIME: 9:20:54 AM

SHEET 5 OF 15

STREAM RESTORATION FOR MS4 CREDITS
IN THE THE SAW MILL RUN AND THE OHIO WATERSHED
CITY OF PITTSBURGH
ALLEGHENY COUNTY, PENNSYLVANIA
CRANE AVE RESTORATION PROJECT
STREAM RESTORATION DETAILS

PREPARED BY:
HUNT VALLEY ENVIRONMENTAL, LLC
632 HUNT VALLEY ROAD
NEW KENSINGTON, PA 15068

PREPARED FOR:
PENNSYLVANIA
DEPARTMENT OF TRANSPORTATION
KEYSTONE BUILDING
400 NORTHSTREER
HARRISBURG, PA 17120

PITTSBURGH
WATER AND SEWER AUTHORITY
1200 PENN AVE
PITTSBURGH, PA 15222

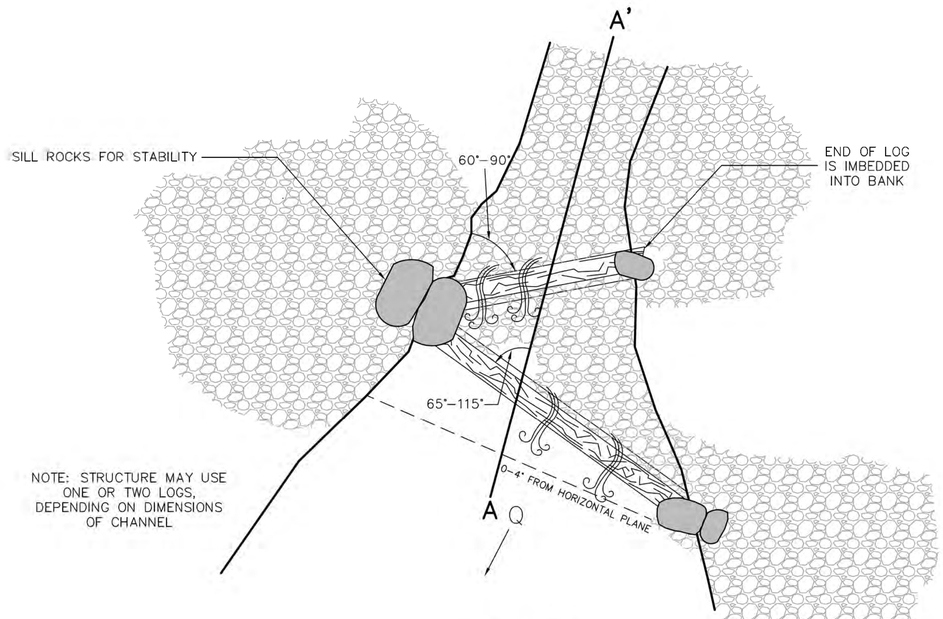
ENGINEER

ORIGINAL
SUBMISSION DATE: 10-19-2022

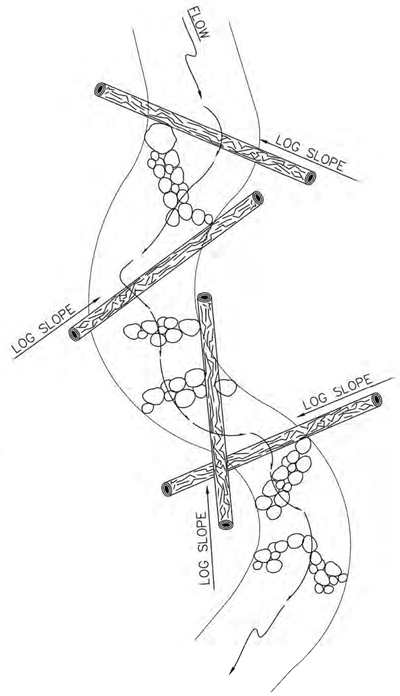
REVISED
SUBMISSION DATE:

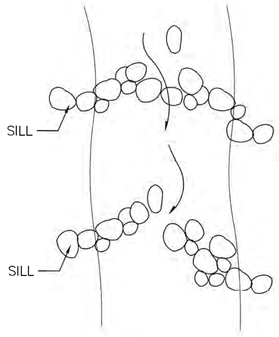
COMMONWEALTH OF PENNSYLVANIA
REGISTERED
A PROFESSIONAL
JAMES H. FLYNN
ENGINEER
PE 061547

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D



PLAN VIEW

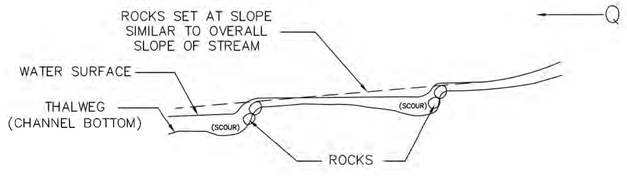




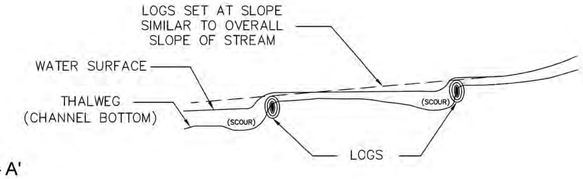
PLAN VIEW

LOG AND ROCK STEP DETAIL

NOT TO SCALE



SECTION A - A'



CONSTRUCTION NOTES:

LOGS SHALL BE HEMLOCK, LOCUST, OR OTHER ONSITE AVAILALE SPECIES AND A MIN 8" IN DIAMETER.

LOG OR ROCK STEP POOL STRUCTURE

NOT TO SCALE

SHEET 6 OF 15

STREAM RESTORATION FOR MS4 CREDITS
IN THE THE SAW MILL RUN AND THE OHIO WATERSHED
CITY OF PITTSBURGH
ALLEGHENY COUNTY, PENNSYLVANIA
CRANE AVE RESTORATION PROJECT
STREAM RESTORATION DETAILS

PREPARED BY:

HUNT VALLEY ENVIRONMENTAL, LLC
632 HUNT VALLEY ROAD
NEW KENSINGTON, PA 15068

PREPARED FOR:

PENNSYLVANIA
DEPARTMENT OF TRANSPORTATION
KEYSTONE BUILDING
400 NORTHSTREER
HARRISBURG, PA 17120

PITTSBURGH
WATER AND SEWER AUTHORITY
1200 PENN AVE
PITTSBURGH, PA 15222

ENGINEER

ORIGINAL SUBMISSION DATE: 10-19-2022

REVISED SUBMISSION DATE:

COMMONWEALTH OF PENNSYLVANIA
REGISTERED PROFESSIONAL ENGINEER
JAMES H. FLYNN
PE 061547

FILE: S:\Shared Folders\Projects\21-XXX Sawmill Run MS4\CADD\MS4StrResCraneDetails.dgn
DATE: 10/24/2022 TIME: 9:27:41 AM

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

DETENTION BASIN FLOOR SEED MIXTURE

FORMULA AND SPECIES	% BY WEIGHT	MIN. % PURITY	MIN. % GERMINATION	MAX. % WEED SEED	SEEDING RATE LB PER 1000 SY
					5.2 TOTAL
RED TOP (AGROSTIS ALBA)	20	92	85	0.15	1.04
CREEPING BENTGRASS (AGROSTIS STOLONIFERA)	20	92	85	0.15	1.04
RIVERBANK WILD RYE (ELYMUS RIPARIUS)	20	95	85	0.15	1.04
FOX SEDGE (CAREX VULPINOIDES)	20	94	85	0.10	1.04
ALKALIGRASS (PUCCINELLIA DISTANS)	20	99	90	0.15	1.04

FORMULA L MIXTURE

FORMULA AND SPECIES	% BY WEIGHT	MIN. % PURITY	MIN. % GERMINATION	MAX. % WEED SEED	SEEDING RATE LB PER 1000 SY
					48.0 TOTAL
HARD FESCUE MIXTURE (FESTUCA LONGIFOLIA) A COMBINATION OF IMPROVED CERTIFIED VARIETIES WITH NO ONE VARIETY EXCEEDING 50% OF THE TOTAL HARD FESCUE COMPONENT	55	97	85	0.10	26.0
CREEPING RED FESCUE (FESTUCA RUBRA) (IMPROVED AND CERTIFIED)	35	97	85	0.10	17.0
ANNUAL RYEGRASS (LOLIUM MULTIFLORUM)	10	95	90	0.10	5.0

LIMING RATES

AGRICULTURAL LIME (PERMANENT SEEDING) = 800 LBS / 1000 SY
AGRICULTURAL LIME (TEMPORARY SEEDING) = 800 LBS / 1000 SY

FERTILIZER RATES

APPLY SLOW RELEASE NITROGEN FERTILIZER TO THE SURFACE OF FORMULAS:

PULVERIZED AGRICULTURAL LIMESTONE = 800 LB/ 1000 SY

10-20-20 ANALYSIS COMMERCIAL FERTILIZER = 140 LBS / 1000 SY

38-0-0 UREAFORM FERTILIZER = 50 LBS / 1000 SY OR 32-0-0 TO 38-0-0 SULFUR COATED UREA FERTILIZER = 59 LBS / 1000 SY TO 50 LBS / 1000 SY, AS DIRECTED OR 31-0-0 IBDU FERTILIZER = 61 LBS / 1000 SY

MULCHING RATES

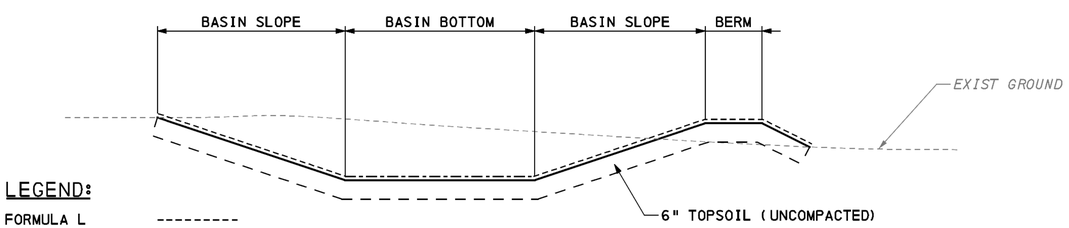
APPLY STRAW AT A RATE OF 1200 LBS / 1000 SY TO THE SURFACE OF FORMULA E.

APPLY ROLLED EROSION CONTROL PRODUCT TO ALL NEWLY SEEDED AREAS ON SLOPES 3:1 OR GREATER.

SEEDING DATES

FORMULA L

DETENTION BASIN FLOOR AND SEASONALLY FLOODED MIXTURE — MARCH 15 TO MAY 15, SEPTEMBER 1 TO OCTOBER 15



LEGEND:
FORMULA L ---------
DETENTION BASIN FLOOR SEED MIX -.-.-.-.-

DRY DETENTION BASIN SEEDING TYPICAL SECTION

NOT TO SCALE

FILE: S:\Shared Folders\Projects\1-XXX Sawmill Run MS4\CADD\MS4Str-ResCraneDetails.dgn
DATE: 10/27/2022 TIME: 9:28:20 AM

SHEET 7 OF 15

STREAM RESTORATION FOR MS4 CREDITS
IN THE THE SAW MILL RUN AND THE OHIO WATERSHED
CITY OF PITTSBURGH
ALLEGHENY COUNTY, PENNSYLVANIA
CRANE AVE RESTORATION PROJECT
DETENTION BASIN DETAILS

PREPARED BY:
HUNT VALLEY ENVIRONMENTAL, LLC
632 HUNT VALLEY ROAD
NEW KENSINGTON, PA 15068

PREPARED FOR:
PENNSYLVANIA DEPARTMENT OF TRANSPORTATION
KEYSTONE BUILDING
400 NORTHSTREER
HARRISBURG, PA 17120

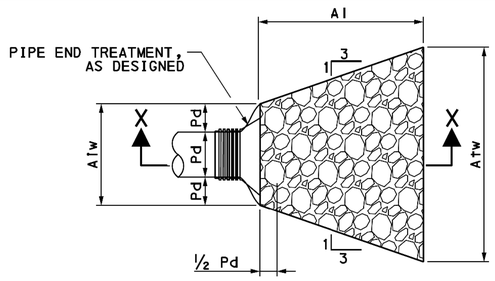
PITTSBURGH WATER AND SEWER AUTHORITY
1200 PENN AVE
PITTSBURGH, PA 15222

ENGINEER

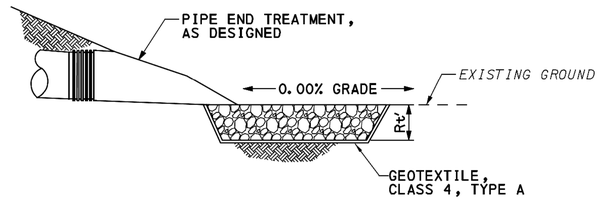
ORIGINAL SUBMISSION DATE: 10-19-2022
REVISED SUBMISSION DATE:

COMMONWEALTH OF PENNSYLVANIA — REGISTERED PROFESSIONAL — WILLIAM BRUCE McNEAL — ENGINEER — PE074465

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D



PLAN VIEW



SECTION X-X

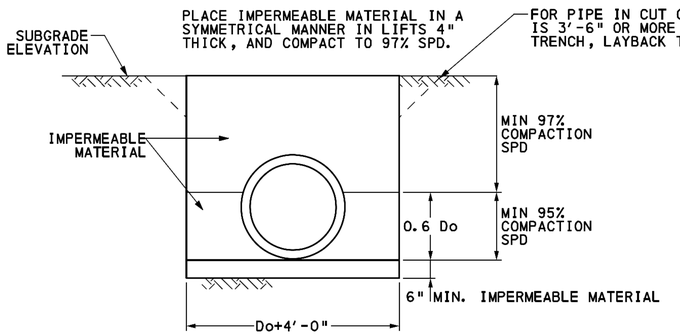
OUTLET PROTECTION NOTES:

1. ALL APRONS SHALL BE CONSTRUCTED TO THE DIMENSIONS SHOWN. TERMINAL WIDTHS SHALL BE ADJUSTED AS NECESSARY TO MATCH RECEIVING CHANNELS.
2. PROVIDE GEOTEXTILE MATERIAL ALONG ALL INTERFACE AREAS WITH GROUND CONTACT.
3. EXTEND RIPRAP ON BACK SIDE OF APRON TO AT LEAST 1/2 DEPTH OF PIPE ON BOTH SIDES TO PREVENT SCOUR AROUND THE PIPE.

APRON NO.	LOCATION	PIPE DIA Pd (IN)	Q (CFS) 10-YR	Q * (CFS) 100-YR	VELOCITY (FPS) 10-YR	VELOCITY (FPS) * 100-YR	RIPRAP SIZE R-_	RIPRAP THICK Rt (IN)	APRON LENGTH Al (FT)	APRON INITIAL WIDTH Alw (FT)	APRON TERMINAL WIDTH Atw (FT)
OP-EW1	MOORE PARK	18	7.09	-	5.25	-	3	9	9	4.50	10.50
OP-EW2	MOORE PARK	18	2.96	9.15	5.29	7.26	4	18	9	4.50	10.50
OP-EW3	MOORE PARK	18	2.40	11.42	5.53	8.93	4	18	10	4.50	11.17
OP-EW4	CRANE AVE	15	10.76	-	10.13	-	5	27	12	3.75	11.75
OP-EW5	CRANE AVE	27	32.87	-	9.73	-	5	27	18	6.75	18.75
OP-EW6	CRANE AVE	18	8.52	14.60	9.17	10.53	5	27	12	4.50	12.50

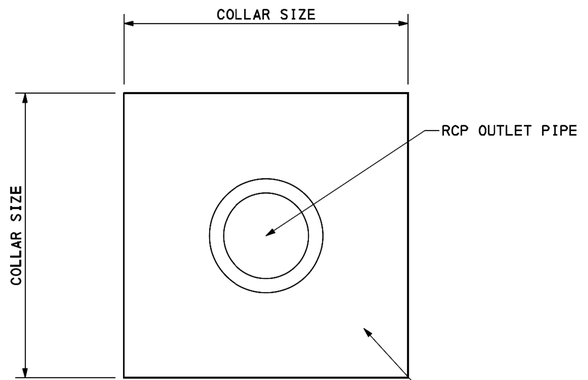
ROCK APRON OUTLET PROTECTION DETAIL

NOT TO SCALE

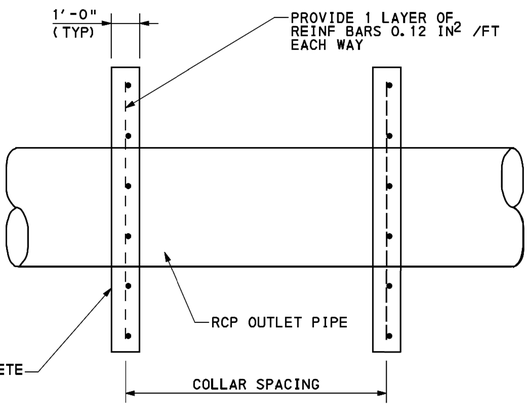


DETENTION BASIN - OUTLET PIPE TRENCH DETAIL

NOT TO SCALE



ELEVATION VIEW



END VIEW

BASIN NUMBER	NO. COLLARS	COLLAR SIZE (FT)	COLLAR SPACING (FT)	DIST TO 1ST COLAR (FT)	OUTLET PIPE DIA (IN)
SCM 001	2	5	7	7	18
SCM 002	3	5	7	7	18
SCM 003	3	5	8	12	18

DISTANCE TO 1ST COLLAR MEASURED FROM OUTSIDE FACE OF THE OUTET STRUCTURE.

REINFORCED CONCRETE ANTI-SEEP COLLAR

NOT TO SCALE

SHEET 8 OF 15

STREAM RESTORATION FOR MS4 CREDITS
IN THE THE SAW MILL RUN AND THE OHIO WATERSHED
CITY OF PITTSBURGH
ALLEGHENY COUNTY, PENNSYLVANIA
CRANE AVE RESTORATION PROJECT
DETENTION BASIN DETAILS

PREPARED BY:

HUNT VALLEY ENVIRONMENTAL, LLC
632 HUNT VALLEY ROAD
NEW KENSINGTON, PA 15068

PREPARED FOR:

PENNSYLVANIA DEPARTMENT OF TRANSPORTATION
KEYSTONE BUILDING
400 NORTHSTREER
HARRISBURG, PA 17120

PITTSBURGH WATER AND SEWER AUTHORITY
1200 PENN AVE
PITTSBURGH, PA 15222

ENGINEER

ORIGINAL SUBMISSION DATE: 10-19-2022

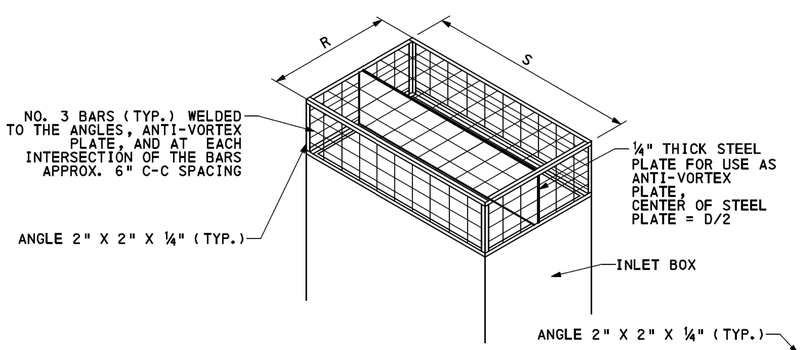
REVISED SUBMISSION DATE:

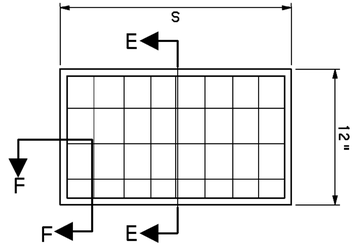
COMMONWEALTH OF PENNSYLVANIA
REGISTERED PROFESSIONAL
WILLIAM BRUCE McNEAL
ENGINEER
PE074465

FILE: S:\Shared Folders\Projects\21-XXX Sawmill Run MS4\CADD\MS4StrResCraneDetails.dgn
DATE: 10/24/2022 TIME: 9:39:06 AM

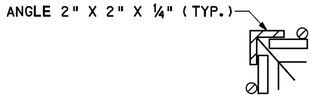
Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

HORIZONTAL TRASH RACK DIMENSIONS		
LOCATION	R	S
MOORE PARK OS-1	3'-0"	4'-9 1/4"
MOORE PARK OS-2	3'-0"	4'-9 1/4"
MOORE PARK OS-3	3'-0"	4'-9 1/4"
MOORE PARK OS-4	3'-0"	4'-9 1/4"
CRANE AVENUE OS-5	5'-0"	5'-0"
CRANE AVENUE OS-6	5'-0"	5'-0"

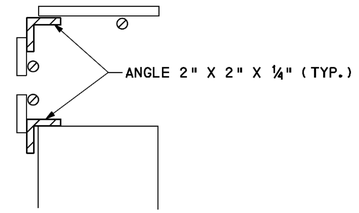




FRONT VIEW



SECTION F-F



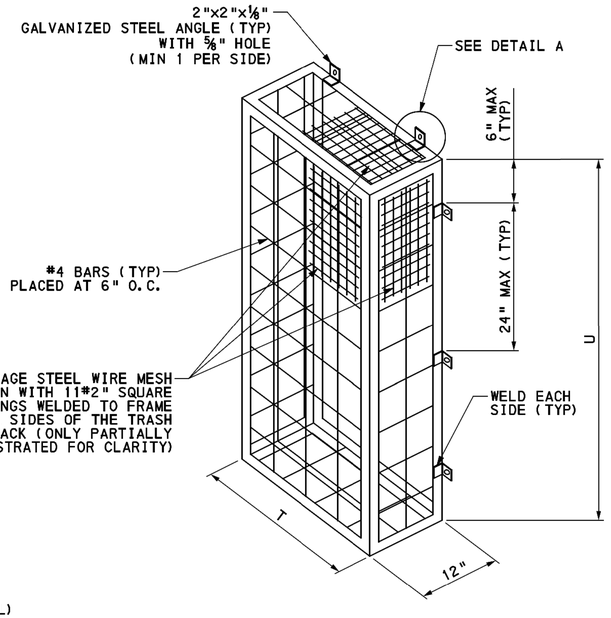
SECTION E-E

NOTES:

1. DIMENSIONS ARE APPROXIMATE, FABRICATE TO FIT OUTSIDE OF INLET BOX.

2. TRASH RACKS TO BE HOT DIPPED GALVANIZED ASSEMBLY PER ASTM A-123; TOUCH UP PER ASTM A-A780.

HORIZONTAL TRASH RACK WITH ANTI-VORTEX PLATE



NOTES:

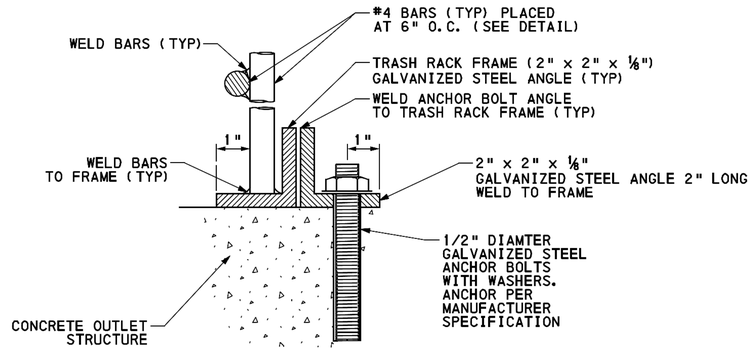
1. WELD #4 TRASH RACK SCREEN SUPPORT BARS TO THE ANGLES AND AT EACH INTERSECTION OF THE BARS.

2. WELD TRASH RACK SCREEN INSIDE OF ANGLE FRAMES ON FIVE SIDES OF RACK.

3. TRASH RACK ASSEMBLIES, BOLTS, AND ATTACHMENTS TO BE GALVANIZED IN ACCORDANCE WITH CS SECTION 1105.

4. REFER TO TABLE FOR OVERALL DIMENSIONS.

5. CENTER TRASH RACK OVER ORIFICES AND SET BOTTOM ELEVATION EQUAL TO BASIN INVERT.



DETAIL A

TRASH RACK DIMENSIONS		
LOCATION	T	U
MOORE PARK OS-1	1'-3"	1'-3"
MOORE PARK OS-3	1'-4"	1'-4"
CRANE AVE OS-5	1'-6"	1'-6"

TRASH RACK

SHEET 9 OF 15

STREAM RESTORATION FOR MS4 CREDITS
IN THE THE SAW MILL RUN AND THE OHIO WATERSHED
CITY OF PITTSBURGH
ALLEGHENY COUNTY, PENNSYLVANIA
CRANE AVE RESTORATION PROJECT
DETENTION BASIN DETAILS

PREPARED BY:
HUNT VALLEY ENVIRONMENTAL, LLC
632 HUNT VALLEY ROAD
NEW KENSINGTON, PA 15068

PREPARED FOR:
PENNSYLVANIA DEPARTMENT OF TRANSPORTATION
KEYSTONE BUILDING
400 NORTHSTREEN
HARRISBURG, PA 17120

PITTSBURGH WATER AND SEWER AUTHORITY
1200 PENN AVE
PITTSBURGH, PA 15222

ENGINEER

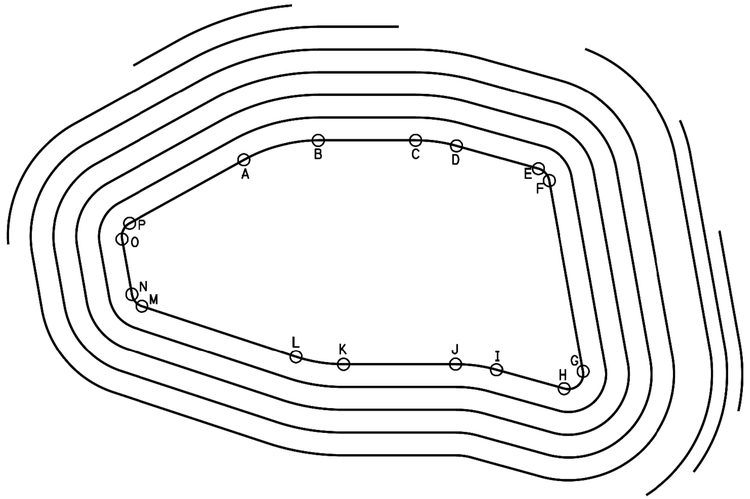
ORIGINAL SUBMISSION DATE: 10-19-2022

REVISED SUBMISSION DATE:

COMMONWEALTH OF PENNSYLVANIA
REGISTERED PROFESSIONAL
WILLIAM BRUCE McNEAL
ENGINEER
PE074465

FILE: S:\Shared Folders\Projects\21-XXX Sawmill Run MS4\CADD\MS4SrRestCraneDetrolls.dgn
DATE: 10/24/2022 TIME: 9:29:14 AM

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D



SCM 003 - CONTROL POINTS

POINT	COORDINATES		ELEVATION
	NORTH	EAST	
A	402824.3882	1336923.7286	956.00
B	402825.1894	1336933.8393	956.00
C	402822.9397	1336946.5299	956.00
D	402821.2681	1336951.7126	956.00
E	402816.4168	1336961.7922	956.00
F	402814.6146	1336962.9248	956.00
G	402789.0538	1336962.9248	956.00
H	402787.2517	1336960.0575	956.00
I	402791.2681	1336951.7126	956.00
J	402792.9397	1336946.5299	956.00
K	402795.5247	1336931.9476	956.00
L	402797.6146	1336925.9449	956.00
M	402807.7876	1336907.0823	956.00
N	402809.5479	1336906.0316	956.00
O	402816.9217	1336906.0316	956.00
P	402818.8153	1336907.3879	956.00

FOUR PLACE COORDINATES ARE FOR COMPUTATIONAL PURPOSES ONLY
AND DO NOT IMPLY A PRECISION BEYOND TWO DECIMAL PLACES

DRY EXTENDED DETENTION BASIN (SCM 003) GEOMETRIC LAYOUT

SCALE

0 10 20 FEET

FILE: S:\Shared Folders\Projects\21-XXX Sawmill Run MS4\CADD\MS4StrRestCraneDetails.dgn
DATE: 10/24/2022 TIME: 9:50:05 AM

SHEET 10 OF 15

STREAM RESTORATION FOR MS4 CREDITS
IN THE THE SAW MILL RUN AND THE OHIO WATERSHED
CITY OF PITTSBURGH
ALLEGHENY COUNTY, PENNSYLVANIA
CRANE AVE RESTORATION PROJECT
DETENTION BASIN DETAILS

PREPARED BY:

HUNT VALLEY ENVIRONMENTAL, LLC
632 HUNT VALLEY ROAD
NEW KENSINGTON, PA 15068

PREPARED FOR:

PENNSYLVANIA
DEPARTMENT OF TRANSPORTATION
KEYSTONE BUILDING
400 NORTHSTREER
HARRISBURG, PA 17120

PITTSBURGH
WATER AND SEWER AUTHORITY
1200 PENN AVE
PITTSBURGH, PA 15222

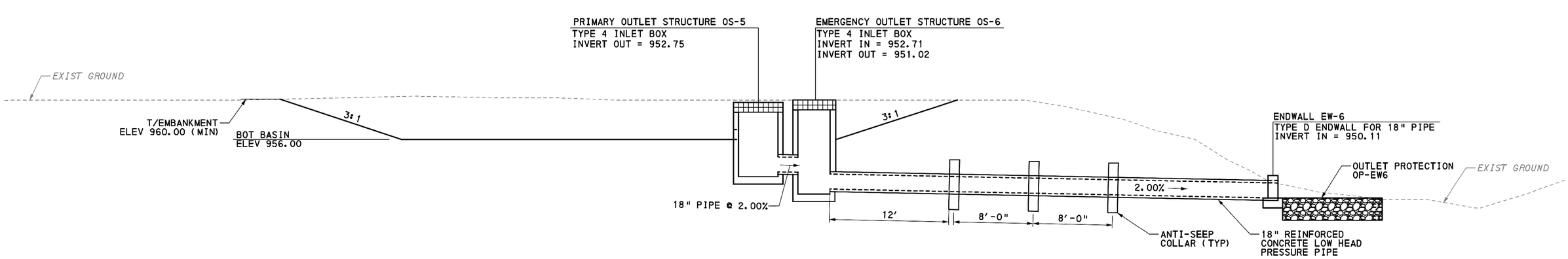
ENGINEER

ORIGINAL
SUBMISSION DATE: 10-19-2022

REVISED
SUBMISSION DATE: _____

COMMONWEALTH OF PENNSYLVANIA
REGISTERED
A PROFESSIONAL
WILLIAM BRUCE McNEAL
ENGINEER
PE074465

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D



DATUM 940

CRANE AVENUE SCM-003
SECTION E-E

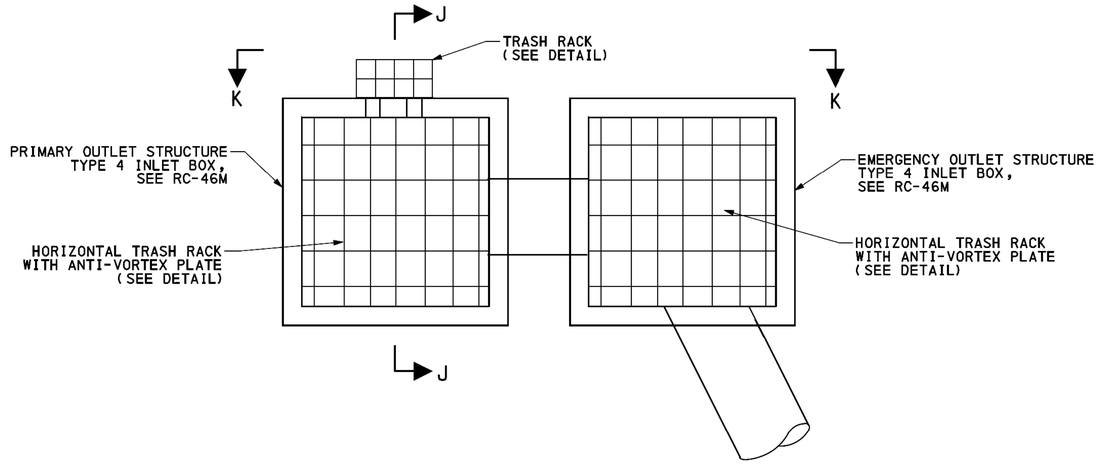
HORIZONTAL 0 5 10 FEET
VERTICAL

SHEET 11 OF 15	STREAM RESTORATION FOR MS4 CREDITS IN THE THE SAW MILL RUN AND THE OHIO WATERSHED CITY OF PITTSBURGH ALLEGHENY COUNTY, PENNSYLVANIA CRANE AVE RESTORATION PROJECT DETENTION BASIN DETAILS	PREPARED BY: HUNT VALLEY ENVIRONMENTAL, LLC 632 HUNT VALLEY ROAD NEW KENSINGTON, PA 15068	PREPARED FOR: PENNSYLVANIA DEPARTMENT OF TRANSPORTATION KEYSTONE BUILDING 400 NORTHSTREER HARRISBURG, PA 17120 PITTSBURGH WATER AND SEWER AUTHORITY 1200 PENN AVE PITTSBURGH, PA 15222	ENGINEER	ORIGINAL SUBMISSION DATE: 10-19-2022 REVISED SUBMISSION DATE:

COMMONWEALTH OF PENNSYLVANIA
REGISTERED PROFESSIONAL
WILLIAM BRUCE McNEAL
ENGINEER
PE074465

FILE: S:\Shared Folders\Projects\1-XXX Sawmill Run MS4\CADD\MS4SrResCraneDetrolls.dgn
DATE: 10/24/2022 TIME: 9:30:51 AM

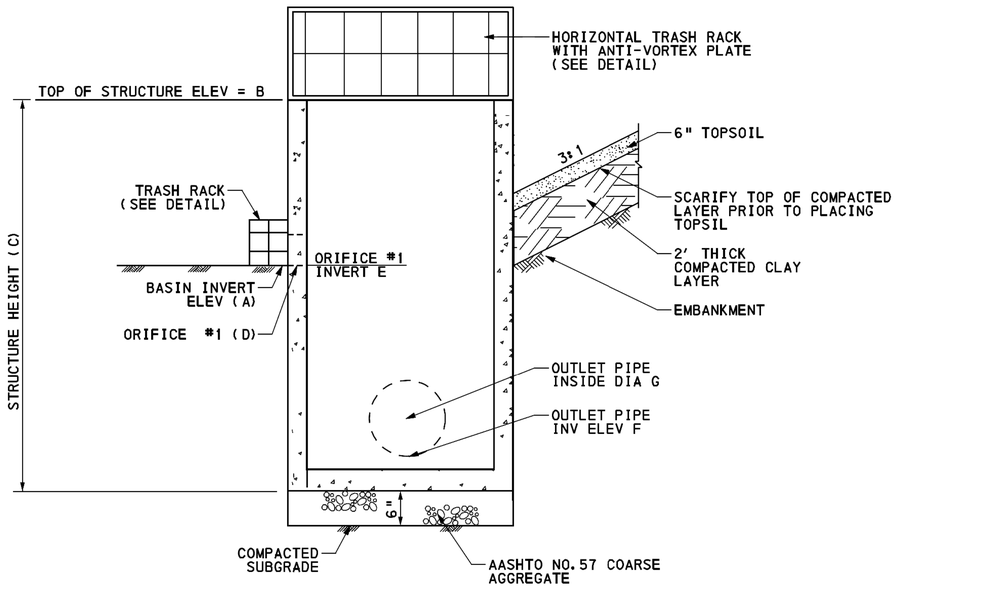
Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D



PLAN VIEW
NOT TO SCALE

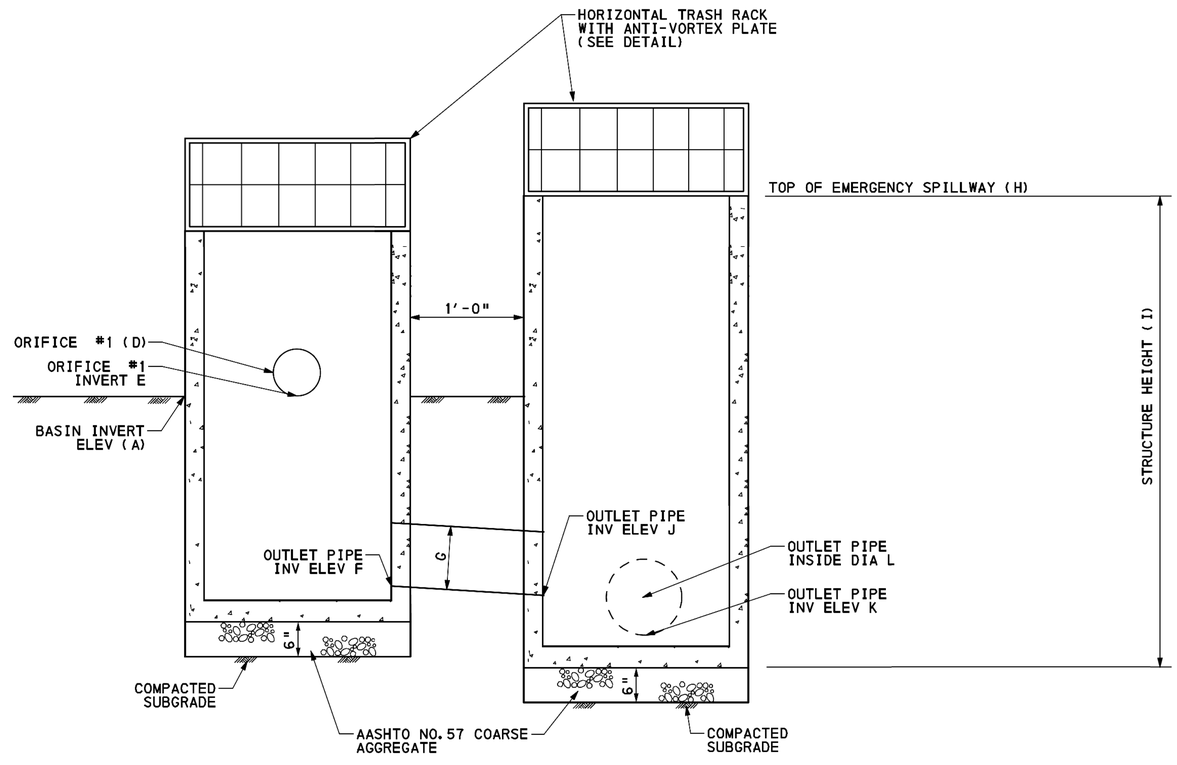
PRIMARY OUTLET STRUCTURE TABLE (OS-5)						
BASIN INVERT ELEV A	STRUCTURE TOP ELEV B	HEIGHT OF STRUCTURE C (FT)	ORIFICE #1 SIZE D (IN)	ORIFICE #1 INV E (FT)	OUTLET PIPE	
					INVERT F (FT)	INSIDE DIA G (IN)
956.00	958.75	7.00	12	956.00	952.75	18

EMERGENCY OUTLET STRUCTURE TABLE (OS-6)				
STRUCTURE TOP ELEV H	HEIGHT OF STRUCTURE I (FT)	OUTLET PIPE		
		INVERT IN J (FT)	INVERT OUT K (FT)	INSIDE DIA L (IN)
959.00	9.00	952.71	951.02	18



PRIMARY OUTLET
STRUCTURE (OS-5)

SECTION J-J
NOT TO SCALE



PRIMARY OUTLET
STRUCTURE (OS-5)

EMERGENCY OUTLET
STRUCTURE (OS-6)

SECTION K-K
NOT TO SCALE

CRANE AVENUE SCM-003 OUTLET STRUCTURE DETAILS

SHEET 12 OF 15

STREAM RESTORATION FOR MS4 CREDITS
IN THE THE SAW MILL RUN AND THE OHIO WATERSHED
CITY OF PITTSBURGH
ALLEGHENY COUNTY, PENNSYLVANIA
CRANE AVE RESTORATION PROJECT
DETENTION BASIN DETAILS

PREPARED BY:
HUNT VALLEY ENVIRONMENTAL, LLC
632 HUNT VALLEY ROAD
NEW KENSINGTON, PA 15068

PREPARED FOR:
PENNSYLVANIA
DEPARTMENT OF TRANSPORTATION
KEYSTONE BUILDING
400 NORTHSTREER
HARRISBURG, PA 17120

PITTSBURGH
WATER AND SEWER AUTHORITY
1200 PENN AVE
PITTSBURGH, PA 15222

ENGINEER

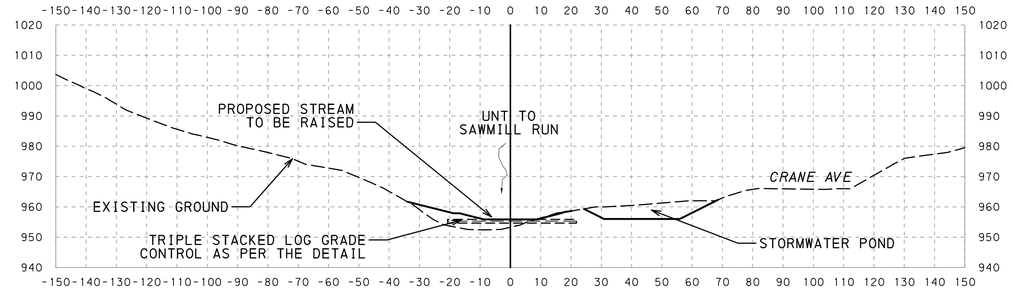
ORIGINAL
SUBMISSION DATE: 10-19-2022

REVISED
SUBMISSION DATE:

COMMONWEALTH OF PENNSYLVANIA
REGISTERED PROFESSIONAL
WILLIAM BRUCE McNEAL
ENGINEER
PE074465

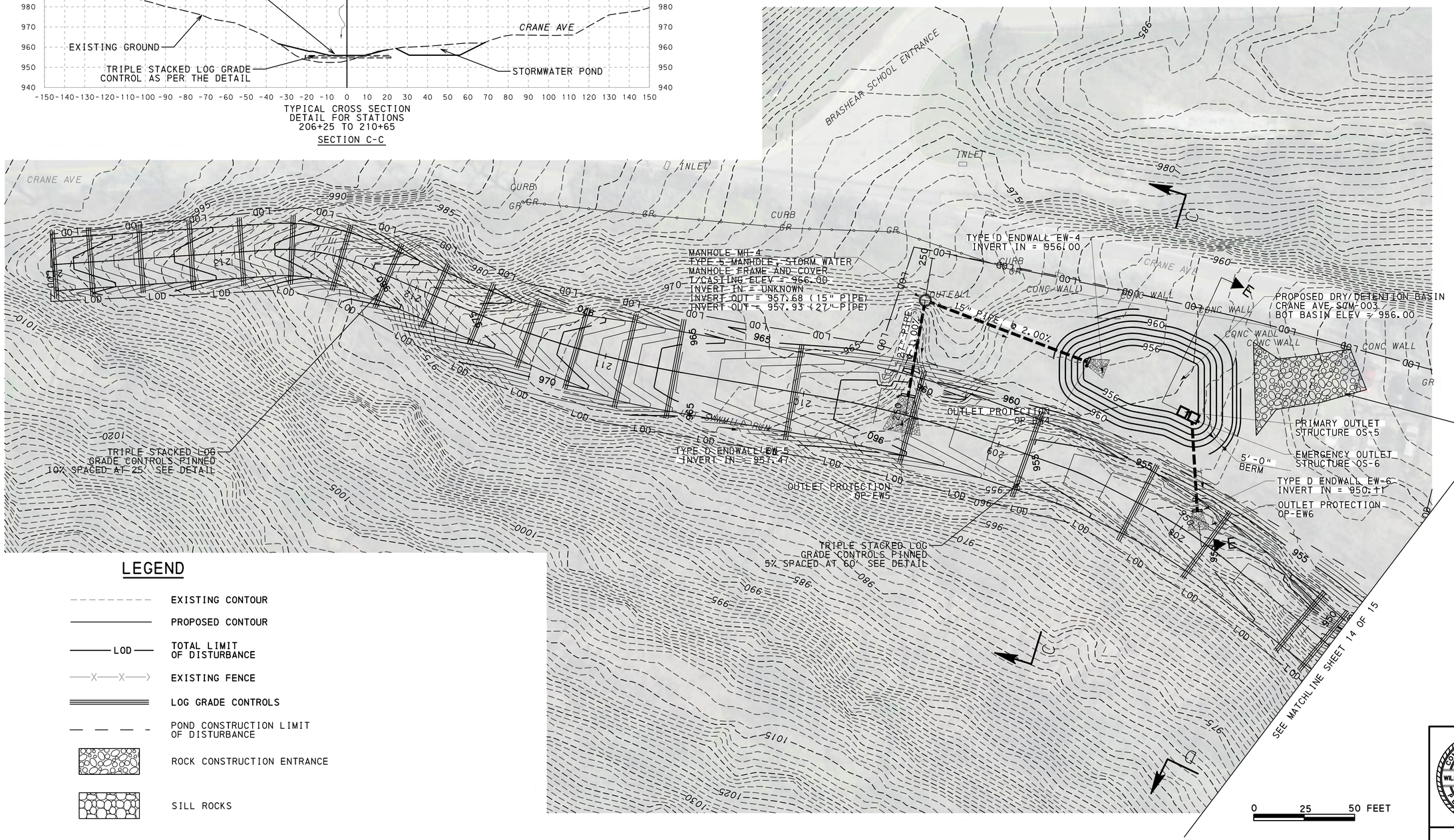
FILE: S:\Shared Folders\Projects\21-XXX Sawmill Run MS4\CADD\MS4SrRestCraneDetRolls.dgn
DATE: 10/24/2022 TIME: 9:31:15 AM

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D



TYPICAL CROSS SECTION
DETAIL FOR STATIONS
206+25 TO 210+65

SECTION C-C



LEGEND

- EXISTING CONTOUR
- PROPOSED CONTOUR
- LOD — TOTAL LIMIT OF DISTURBANCE
- EXISTING FENCE
- LOG GRADE CONTROLS
- POND CONSTRUCTION LIMIT OF DISTURBANCE
- ROCK CONSTRUCTION ENTRANCE
- SILL ROCKS

SHEET 13 OF 15

STREAM RESTORATION FOR MS4 CREDITS
IN THE THE SAW MILL RUN AND THE OHIO WATERSHED
CITY OF PITTSBURGH
ALLEGHENY COUNTY, PENNSYLVANIA
CRANE AVE RESTORATION PROJECT
PLAN SHEET

PREPARED BY:

HUNT VALLEY ENVIRONMENTAL, LLC
632 HUNT VALLEY ROAD
NEW KENSINGTON, PA 15068

PREPARED FOR:

PENNSYLVANIA
DEPARTMENT OF TRANSPORTATION
KEYSTONE BUILDING
400 NORTHSTREER
HARRISBURG, PA 17120

PITTSBURGH
WATER AND SEWER AUTHORITY
1200 PENN AVE
PITTSBURGH, PA 15222

ENGINEER

ORIGINAL SUBMISSION DATE: 10-19-2022

REVISED SUBMISSION DATE:

COMMONWEALTH OF PENNSYLVANIA
REGISTERED PROFESSIONAL ENGINEER
WILLIAM BRUCE McNEAL
PE074465

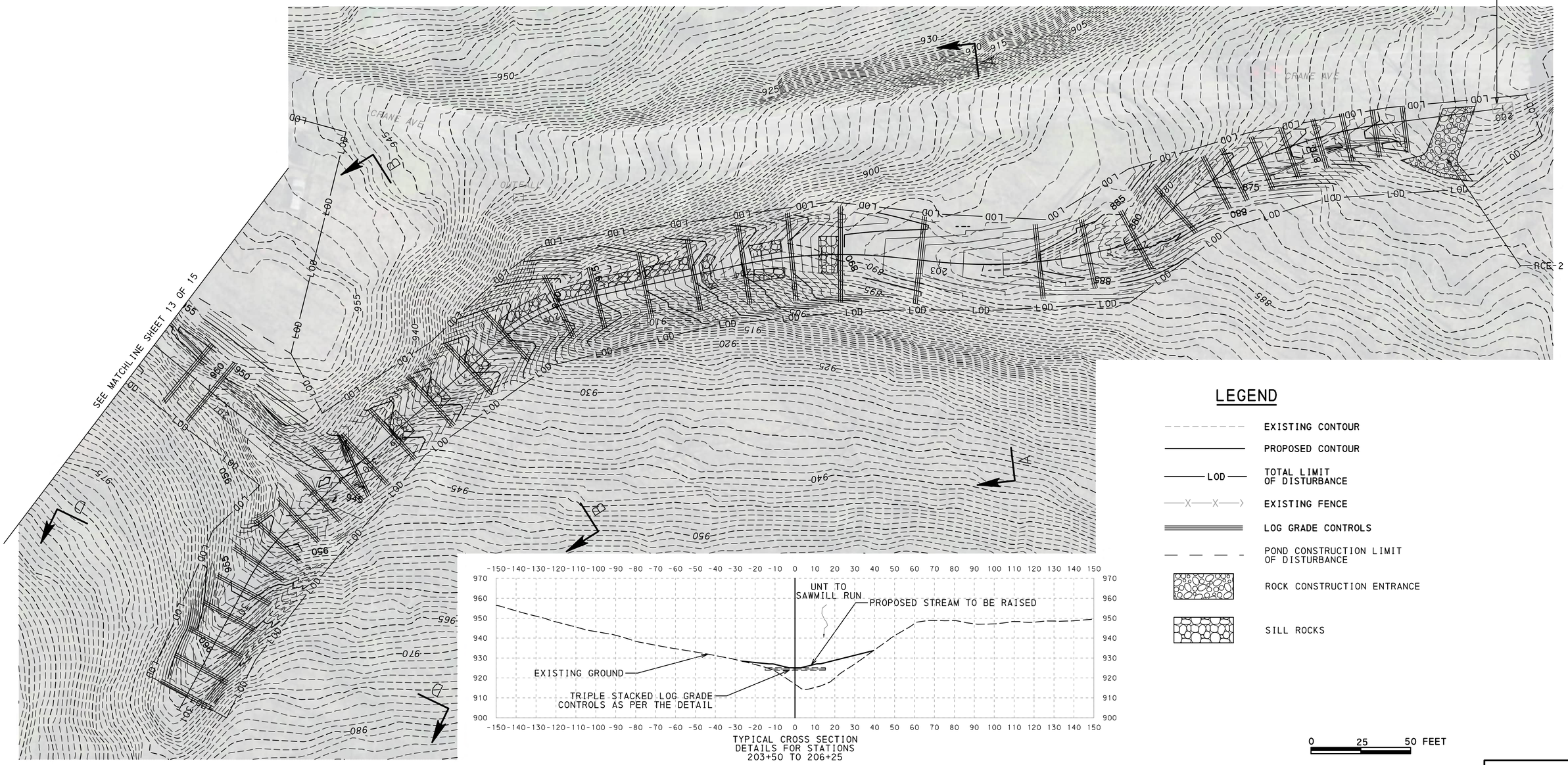
COMMONWEALTH OF PENNSYLVANIA
REGISTERED PROFESSIONAL ENGINEER
JAMES H. FLYNN
PE 061647

FILE: C:\Projects\22-XXX Sawmill Run MS4\Hit&Hit\CraneAveFinal.dgn
DATE: 10/20/2022 TIME: 4:39:37 PM

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

TOTAL LIMIT OF DISTURBANCE:
2.03 AC.

POND CONSTRUCTION LIMIT OF DISTURBANCE:
0.51 AC.



TYPICAL CROSS SECTION
DETAILS FOR STATIONS
203+50 TO 206+25

SECTION B-B

LEGEND

- EXISTING CONTOUR
- PROPOSED CONTOUR
- LOD — TOTAL LIMIT OF DISTURBANCE
- EXISTING FENCE
- LOG GRADE CONTROLS
- POND CONSTRUCTION LIMIT OF DISTURBANCE
- ROCK CONSTRUCTION ENTRANCE
- SILL ROCKS

0 25 50 FEET

SHEET 14 OF 15

STREAM RESTORATION FOR MS4 CREDITS
IN THE THE SAW MILL RUN AND THE OHIO WATERSHED
CITY OF PITTSBURGH
ALLEGHENY COUNTY, PENNSYLVANIA
CRANE AVE RESTORATION PROJECT
PLAN SHEET

PREPARED BY:

HUNT VALLEY ENVIRONMENTAL, LLC
632 HUNT VALLEY ROAD
NEW KENSINGTON, PA 15068

PREPARED FOR:

PENNSYLVANIA
DEPARTMENT OF TRANSPORTATION
KEYSTONE BUILDING
400 NORTHSTREER
HARRISBURG, PA 17120

PITTSBURGH
WATER AND SEWER AUTHORITY
1200 PENN AVE
PITTSBURGH, PA 15222

ENGINEER

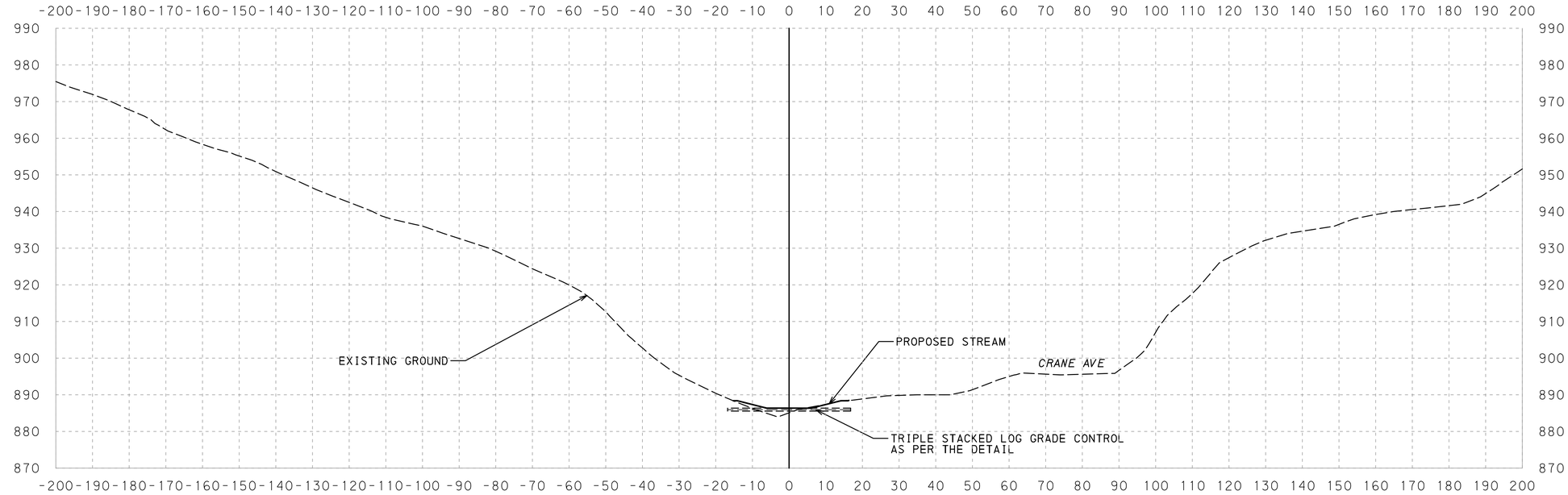
ORIGINAL
SUBMISSION DATE: 10-19-2022

REVISED
SUBMISSION DATE:

COMMONWEALTH OF PENNSYLVANIA
REGISTERED PROFESSIONAL
JAMES H. FLYNN
ENGINEER
PE 061647

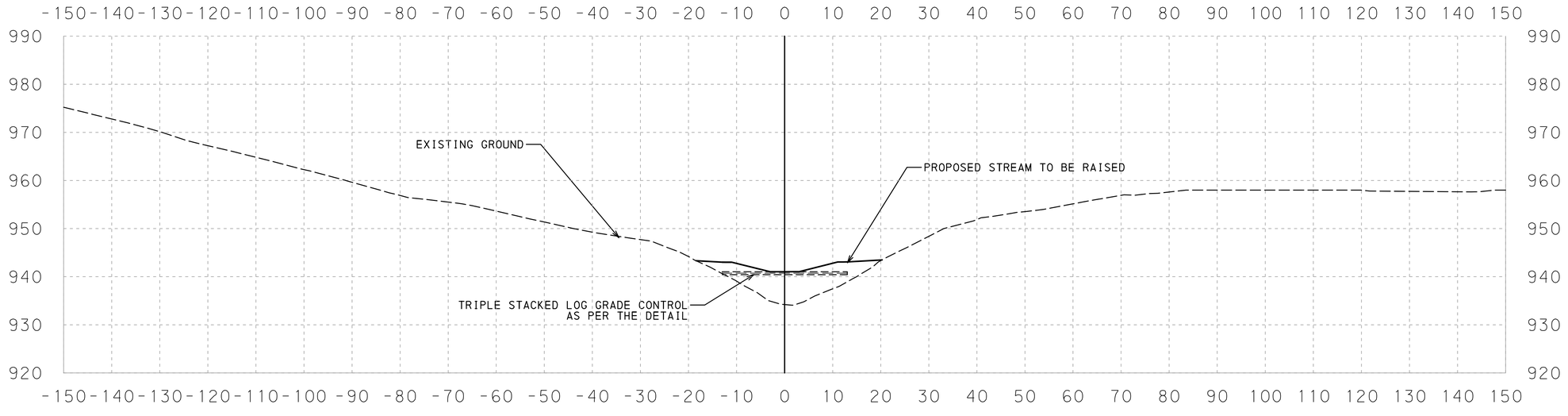
FILE: C:\Projects\22-XXX Sawmill Run MS4\H&H\CraneAvePlan2.dgn
DATE: 10/20/2022 TIME: 5:04:48 PM

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D



TYPICAL CROSS SECTION
DETAIL FOR STATIONS
200+50 TO 203+50

SECTION A-A



TYPICAL CROSS SECTION
DETAIL FOR STATIONS
300+00 TO 301+47

SECTION D-D

SHEET 15 OF 15

STREAM RESTORATION FOR MS4 CREDITS
IN THE THE SAW MILL RUN AND THE OHIO WATERSHED
CITY OF PITTSBURGH
ALLEGHENY COUNTY, PENNSYLVANIA
CRANE AVE RESTORATION PROJECT
CROSS SECTIONS

PREPARED BY:

HUNT VALLEY ENVIRONMENTAL, LLC
632 HUNT VALLEY ROAD
NEW KENSINGTON, PA 15068

PREPARED FOR:

PENNSYLVANIA
DEPARTMENT OF TRANSPORTATION
KEYSTONE BUILDING
400 NORTHSTREEN
HARRISBURG, PA 17120

PITTSBURGH
WATER AND SEWER AUTHORITY
1200 PENN AVE
PITTSBURGH, PA 15222

ENGINEER

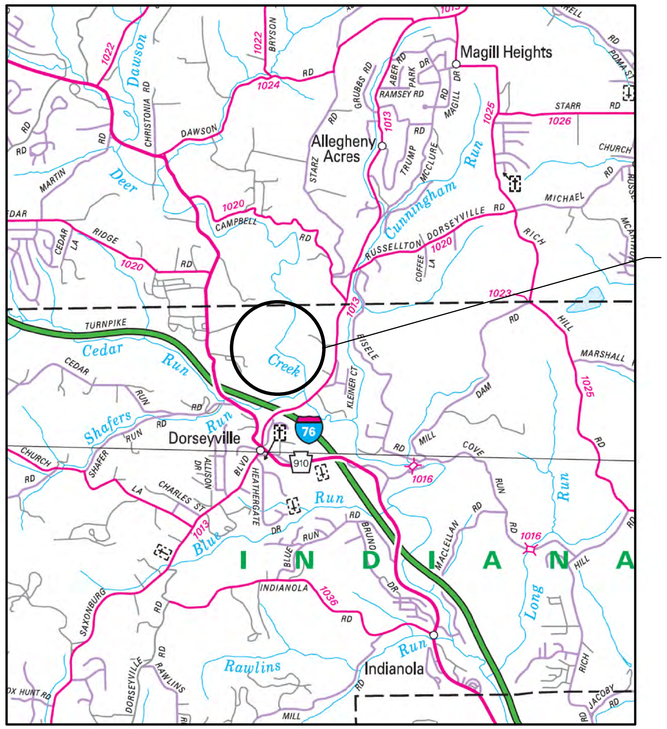
ORIGINAL
SUBMISSION DATE: 10-19-2022

REVISED
SUBMISSION DATE:

COMMONWEALTH OF PENNSYLVANIA
REGISTERED PROFESSIONAL
JAMES H. FLYNN
ENGINEER
PE 061647

FILE: S:\Shared Folders\Projects\21-XXX Sawmill Run MS4\CADD\MS4CraneAveXSECPlans.dgn
DATE: 10/20/2022 TIME: 3:19:32 PM

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D



LOCATION MAP

0 0.5 1.0 MILES

CALL BEFORE YOU DIG

PENNSYLVANIA LAW REQUIRES 3 WORKING DAYS NOTICE FOR CONSTRUCTION PHASE AND 10 WORKING DAYS IN DESIGN STAGE - STOP CALL 1-800-242-1776

PA ONE CALL System Inc.

SHEET INDEX BLOCK	
DESCRIPTION	SHEET
TITLE SHEET	1
GENERAL NOTES	2
CONSTRUCTION SEQUENCE	3
DETAILS	4-6
PLAN SHEETS	7-9
CROSS SECTIONS	10

STREAM RESTORATION FOR MS4 CREDIT

IN THE SAW MILL RUN AND OHIO RIVER WATERSHED

FOR

PENNSYLVANIA DEPARTMENT OF TRANSPOTATION

AND

PITTSBURGH WATER AND SEWER AUTHORITY

POLLUANT REDUCTION PLAN

SHEET 1 OF 10

STREAM RESTORATION FOR MS4 CREDITS
IN THE THE SAW MILL RUN AND THE OHIO WATERSHED
CITY OF PITTSBURGH
ALLEGHENY COUNTY, PENNSYLVANIA
DEER CREEK STREAMBANK STABILIZATION PROJECT
TITLE SHEET

PREPARED BY:

HUNT VALLEY ENVIRONMENTAL, LLC
632 HUNT VALLEY ROAD
NEW KENSINGTON, PA 15068

PREPARED FOR:

PENNSYLVANIA
DEPARTMENT OF TRANSPORTATION
KEYSTONE BUILDING
400 NORTHSTREER
HARRISBURG, PA 17120

PITTSBURGH
WATER AND SEWER AUTHORITY
1200 PENN AVE
PITTSBURGH, PA 15222

ENGINEER

ORIGINAL SUBMISSION DATE: 10-19-2022

REVISED SUBMISSION DATE:

COMMONWEALTH OF PENNSYLVANIA
REGISTERED PROFESSIONAL ENGINEER
JAMES H. FLYNN
PE 061647

FILE: S:\Shared Folders\Projects\21-XXX Sawmill Run MS4\CADD\DeerCreekTitleRev.dgn
DATE: 10/21/2022 TIME: 9:42:51 PM

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

EROSION AND SEDIMENT POLLUTION CONTROL GENERAL NOTES

AT LEAST 7 DAYS PRIOR TO STARTING ANY EARTH DISTURBANCE ACTIVITIES, INCLUDING CLEARING AND GRUBBING, THE OWNER AND/OR OPERATOR SHALL INVITE ALL CONTRACTORS, THE LANDOWNER, APPROPRIATE MUNICIPAL OFFICIALS, THE E&S PLAN PREPARER, THE PCSM PLAN PREPARER, THE LICENSED PROFESSIONAL RESPONSIBLE FOR OVERSIGHT OF CRITICAL STAGES OF IMPLEMENTATION OF THE PCSM PLAN, AND A REPRESENTATIVE FROM THE LOCAL CONSERVATION DISTRICT TO AN ON-SITE PRECONSTRUCTION MEETING.

AT LEAST 3 DAYS PRIOR TO STARTING ANY EARTH DISTURBANCE ACTIVITIES, OR EXPANDING INTO AN AREA PREVIOUSLY UNMARKED, THE PENNSYLVANIA ONE CALL SYSTEM INC. SHALL BE NOTIFIED AT 1-800-242-1776 FOR THE LOCATION OF EXISTING UNDERGROUND UTILITIES.

ALL EARTH DISTURBANCE ACTIVITIES SHALL PROCEED IN ACCORDANCE WITH THE SEQUENCE PROVIDED ON THE PLAN DRAWINGS. DEVIATION FROM THAT SEQUENCE MUST BE APPROVED IN WRITING FROM THE LOCAL CONSERVATION DISTRICT OR BY THE DEPARTMENT PRIOR TO IMPLEMENTATION.

AREAS TO BE FILLED ARE TO BE CLEARED, GRUBBED, AND STRIPPED OF TOPSOIL TO REMOVE TREES, VEGETATION, ROOTS AND OTHER OBJECTIONABLE MATERIAL.

CLEARING, GRUBBING, AND TOPSOIL STRIPPING SHALL BE LIMITED TO THOSE AREAS DESCRIBED IN EACH STAGE OF THE CONSTRUCTION SEQUENCE. GENERAL SITE CLEARING, GRUBBING AND TOPSOIL STRIPPING MAY NOT COMMENCE IN ANY STAGE OR PHASE OF THE PROJECT UNTIL THE E&S BMPS SPECIFIED BY THE BMP SEQUENCE FOR THAT STAGE OR PHASE HAVE BEEN INSTALLED AND ARE FUNCTIONING AS DESCRIBED IN THIS E&S PLAN.

AT NO TIME SHALL CONSTRUCTION VEHICLES BE ALLOWED TO ENTER AREAS OUTSIDE THE LIMIT OF DISTURBANCE BOUNDARIES SHOWN ON THE PLAN MAPS. THESE AREAS MUST BE CLEARLY MARKED AND FENCED OFF BEFORE CLEARING AND GRUBBING OPERATIONS BEGIN.

TOPSOIL REQUIRED FOR THE ESTABLISHMENT OF VEGETATION SHALL BE STOCKPILED AT THE LOCATION(S) SHOWN ON THE PLAN MAPS(S) IN THE AMOUNT NECESSARY TO COMPLETE THE FINISH GRADING OF ALL EXPOSED AREAS THAT ARE TO BE STABILIZED BY VEGETATION. EACH STOCKPILE SHALL BE PROTECTED IN THE MANNER SHOWN ON THE PLAN DRAWINGS. STOCKPILE HEIGHTS SHALL NOT EXCEED 35 FEET. STOCKPILE SLOPES SHALL BE 2H:1V OR FLATTER.

IMMEDIATELY UPON DISCOVERING UNFORESEEN CIRCUMSTANCES POSING THE POTENTIAL FOR ACCELERATED EROSION AND/OR SEDIMENT POLLUTION, THE OPERATOR SHALL IMPLEMENT APPROPRIATE BEST MANAGEMENT PRACTICES TO MINIMIZE THE POTENTIAL FOR EROSION AND SEDIMENT POLLUTION AND NOTIFY THE LOCAL CONSERVATION DISTRICT AND/OR DISTRICT ENVIRONMENTAL UNIT.

ALL BUILDING MATERIALS AND WASTES SHALL BE REMOVED FROM THE SITE AND RECYCLED OR DISPOSED OF IN ACCORDANCE WITH THE DEPARTMENT'S SOLID WASTE MANAGEMENT REGULATIONS AT 25 PA. CODE 260.1 ET SEQ., 271.1, AND 287.1 ET. SEQ. NO BUILDING MATERIALS OR WASTES OR UNUSED BUILDING MATERIALS SHALL BE BURNED, BURIED, DUMPED, OR DISCHARGED AT THE SITE.

EROSION AND SEDIMENTATION BEST MANAGEMENT PRACTICES (BMPS) THAT ARE PROPOSED FOR THE PROJECT SHALL BE INSTALLED AND FUNCTIONAL PRIOR TO ANY EARTH MOVING ACTIVITIES WITHIN THEIR CONTRIBUTING AREA.

CONDUCT ALL EARTH MOVING ACTIVITIES AS SPECIFIED IN THE EROSION AND SEDIMENTATION CONTROL PLAN AND IN ACCORDANCE WITH THE RULES AND REGULATION OF CHAPTER 102, TITLE 25 RELATED TO EROSION CONTROL, AND THE CLEAN STREAMS LAW OF PENNSYLVANIA.

UNTIL THE SITE IS STABILIZED, ALL EROSION AND SEDIMENT BMPS SHALL BE MAINTAINED PROPERLY. MAINTENANCE SHALL INCLUDE INSPECTIONS OF ALL EROSION AND SEDIMENT BMPS AFTER EACH RUNOFF EVENT AND ON A WEEKLY BASIS. ALL PREVENTATIVE AND REMEDIAL MAINTENANCE WORK, INCLUDING CLEAN OUT, REPAIR, REPLACEMENT, REGRADING, RESEEDING, REMULCHING AND RENETTING MUST BE PERFORMED IMMEDIATELY. IF THE E&S BMPS FAIL TO PERFORM AS EXPECTED, REPLACEMENT BMPS, OR MODIFICATIONS OF THOSE INSTALLED WILL BE REQUIRED IMMEDIATELY.

SEED AND MULCH ANY DISTURBED AREA THAT WILL REMAIN IDLE FOR MORE THAN 4 DAYS
STABILIZATION IS DEFINED AS A UNIFORM, 70%, PERENNIAL COVER ESTABLISHED OVER THE DISTURBED AREA.

ANY AND ALL ACCUMULATED SILT AND SEDIMENTS THAT ARE FOUND WITHIN AN EROSION CONTROL DEVICE SHALL BE REMOVED FROM THE CONTROL DEVICE AND SPREAD EVENLY ON THE FILL UPSLOPE OF THE EROSION AND SEDIMENTATION CONTROLS, AND THEN SEEDED AND MULCHED TO PROVIDE STABILIZATION.

ANY OFFSITE WASTE AND BORROW AREAS MUST HAVE AN E & S PLAN REVIEWED AND APPROVED BY THE LOCAL CONSERVATION DISTRICT AND THE DISTRICT ENVIRONMENTAL UNIT PRIOR TO BEING ACTIVATED.

CLEAN FILL IS DEFINED AS: UNCONTAMINATED, NON-WATER SOLUBLE, NON-DECOMPOSABLE, INERT, SOLID MATERIAL. THE TERM INCLUDES SOIL, ROCK, STONE, DREDGED MATERIAL, USED ASPHALT, AND BRICK, BLOCK OR CONCRETE, FROM CONSTRUCTION AND DEMOLITION ACTIVITIES THAT IS SEPARATE FROM OTHER WASTE AND IS RECOGNIZABLE AS SUCH. THE TERM DOES NOT INCLUDE MATERIALS PLACED IN OR ON THE WATERS OF THE COMMONWEALTH UNLESS OTHERWISE AUTHORIZED. (THE TERM USED ASPHALT DOES NOT INCLUDE MILLED ASPHALT OR ASPHALT THAT HAS BEEN PROCESSED FOR REUSE).

ENVIRONMENTAL DUE DILIGENCE MUST BE PERFORMED TO DETERMINE IF FILL MATERIALS ASSOCIATED WITH THE PROJECT QUALIFY AS CLEAN FILL. ENVIRONMENTAL DUE DILIGENCE IS DEFINED AS: INVESTIGATION TECHNIQUES, INCLUDING BUT NOT LIMITED TO, VISUAL PROPERTY INSPECTIONS, ELECTRONIC DATA BASE SEARCHES, REVIEW OF THE PROPERTY OWNERSHIP, REVIEW OF THE PROPERTY USE HISTORY, SANBORN MAPS, ENVIRONMENTAL QUESTIONNAIRES, TRANSACTION SCREEN, ANALYTICAL TESTING, ENVIRONMENTAL ASSESSMENTS OR AUDITS. ANALYTICAL TESTING IS NOT A REQUIRED PART OF DUE DILIGENCE UNLESS VISUAL INSPECTION AND/OR REVIEW OF THE PAST LAND USE OF THE PROPERTY INDICATES THAT THE FILL MAY HAVE BEEN COMPROMISED BY A RELEASE OF A REGULATED SUBSTANCE. IF THE FILL IS SUSPECTED TO HAVE BEEN COMPROMISED BY A RELEASE OF A REGULATED SUBSTANCE, IT MUST BE TESTED TO DETERMINE IF IT QUALIFIES AS A CLEAN FILL. TESTING SHOULD BE PERFORMED IN ACCORDANCE WITH APPENDIX A OF THE DEPARTMENT'S POLICY "MANAGEMENT OF CLEAN FILL".

THE CONTRACTOR IS RESPONSIBLE FOR ENSURING THAT ANY MATERIAL BROUGHT ON SITE IS CLEAN FILL. PADEP FORM FP-001 MUST BE RETAINED BY THE PROPERTY OWNER FOR ANY FILL MATERIAL AFFECTED BY A SPILL OR RELEASE OF A REGULATED SUBSTANCE BUT QUALIFYING AS CLEAN FILL DUE TO ANALYTICAL TESTING.

ALL EARTH DISTURBANCES, INCLUDING CLEARING AND GRUBBING AS WELL AS CUTS AND FILLS SHALL BE DONE IN ACCORDANCE WITH THE APPROVED E&S PLAN. A COPY OF THE APPROVED DRAWINGS (STAMPED, SIGNED AND DATED BY THE REVIEWING AGENCY) MUST BE AVAILABLE AT THE PROJECT SITE AT ALL TIMES. THE REVIEWING AGENCY SHALL BE NOTIFIED OF ANY CHANGES TO THE APPROVED PLAN PRIOR TO IMPLEMENTATION OF THOSE CHANGES. THE REVIEWING AGENCY MAY REQUIRE A WRITTEN SUBMITTAL OF THOSE CHANGES FOR REVIEW AND APPROVAL AT ITS DISCRETION.

ALL PUMPING OF WATER FROM ANY WORK AREA SHALL BE DONE ACCORDING TO THE PROCEDURE DESCRIBED IN THIS PLAN, OVER UNDISTURBED VEGETATED AREAS.

A WRITTEN LOG MUST BE COMPLETED ON FORM 3800-FM-BCW0271D (MOST CURRENT FORM) SHOWING DATES THAT E&S BMPS WERE INSPECTED, DEFICIENCIES FOUND AND THE DATE THEY WERE CORRECTED SHALL BE MAINTAINED ON THE SITE AND BE MADE AVAILABLE TO REGULATORY AGENCY OFFICIALS AT THE TIME OF INSPECTION.

SEDIMENT TRACKED ONTO ANY PUBLIC ROADWAY OR SIDEWALK SHALL BE RETURNED TO THE CONSTRUCTION SITE BY THE END OF EACH WORK DAY AND DISPOSED IN THE MANNER DESCRIBED IN THIS PLAN. IN NO CASE SHALL THE SEDIMENT BE WASHED, SHOVELED, OR SWEPT INTO ANY ROADSIDE DITCH, STORM SEWER, OR SURFACE WATER.

AREAS WHICH ARE TO BE TOPSOILED SHALL BE SCARIFIED TO A MINIMUM DEPTH OF 3 TO 5 INCHES 6 TO 12 INCHES ON COMPACTED SOILS PRIOR TO PLACEMENT OF TOPSOIL. AREAS TO BE VEGETATED SHALL HAVE A MINIMUM 4 INCHES OF TOPSOIL IN PLACE PRIOR TO SEEDING AND MULCHING. FILL OUTSLOPES SHALL HAVE A MINIMUM OF 2 INCHES OF TOPSOIL.

BMP INSPECTION, MAINTENANCE AND REPAIR SCHEDULE

BMP	INSPECTION	MAINTENANCE	REPAIR
ROCK CONSTRUCTION ENTRANCE	DAILY	REMOVE SEDIMENT	MAINTAIN THICKNESS AND DIMENSIONS BY ADDING ROCK
SEEDING AND MULCHING	WEEKLY AND AFTER EACH RAINFALL EVENT	N/A	EVALUATE CONDITIONS AND RE-SEED AND STABILIZE
TEMPORARY STREAM CROSSING	DAILY	SEDIMENT ACCUMULATION SHALL BE REMOVED WITHIN 24 HOURS	DAMAGED CROSSING SHALL BE REPAIRED WITHIN 24 HOURS

NOTES:

1. MAINTENANCE AND REPAIR ON BMP'S MUST BE COMPLETED IMMEDIATELY AFTER THE WEEKLY OR RAINFALL INSPECTION.
2. SEDIMENT REMOVED FROM BMP'S SHALL BE PLACED ON THE TOP SOIL STOCK PILE FOR USE LATER IN THE PROJECT.
3. A RUNOFF EVENT IS RAINFALL OR SNOW RUNOFF OF 0.25" OR MORE IN A 24 CONSECUTIVE HOUR PERIOD.
4. WEEKLY OR RAINFALL INSPECTIONS OVER MUST BE COMPLETED ON THE WRITTEN LOG FORM 3800-FM-BCW0271D (OR MOST CURRENT FORM).

FILE: S:\Shared Folders\Projects\21-XXX Sawmill Run MS4\CADD\MS4GenNotesDeerCreek.dgn
DATE: 10/21/2022 TIME: 3:56:46 PM

STREAM RESTORATION FOR MS4 CREDITS
IN THE THE SAW MILL RUN AND THE OHIO WATERSHED
CITY OF PITTSBURGH
ALLEGHENY COUNTY, PENNSYLVANIA
DEER CREEK STREAMBANK STABILIZATION PROJECT
GENERAL NOTES

PREPARED BY:

HUNT VALLEY ENVIRONMENTAL, LLC
632 HUNT VALLEY ROAD
NEW KENSINGTON, PA 15068

PREPARED FOR:

PENNSYLVANIA
DEPARTMENT OF TRANSPORTATION
KEYSTONE BUILDING
400 NORTHSTREER
HARRISBURG, PA 17120

PITTSBURGH
WATER AND SEWER AUTHORITY
1200 PENN AVE
PITTSBURGH, PA 15222

ENGINEER

ORIGINAL SUBMISSION DATE: 10-19-2022

REVISED SUBMISSION DATE:

COMMONWEALTH OF PENNSYLVANIA
REGISTERED PROFESSIONAL
JAMES H. FLYNN
ENGINEER
PE 061647

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

EROSION AND SEDIMENT POLLUTION CONTROL GENERAL NOTES (CONT'D)

ALL FILLS SHALL BE COMPACTED AS REQUIRED TO REDUCE EROSION, SLIPPAGE, SETTLEMENT, SUBSIDENCE OR OTHER RELATED PROBLEMS. FILL INTENDED TO SUPPORT BUILDINGS, STRUCTURES AND CONDUITS, ETC. SHALL BE COMPACTED IN ACCORDANCE WITH LOCAL REQUIREMENTS OR CODES.

FILL MATERIALS SHALL BE FREE OF FROZEN PARTICLES, BRUSH, ROOTS, SOD, OR OTHER FOREIGN OR OBJECTIONABLE MATERIALS THAT WOULD INTERFERE WITH OR PREVENT CONSTRUCTION OF SATISFACTORY FILLS.

FROZEN MATERIALS OR SOFT, MUCKY, OR HIGHLY COMPRESSIBLE MATERIALS SHALL NOT BE INCORPORATED INTO FILLS. FILL SHALL NOT BE PLACED ON SATURATED OR FROZEN SURFACES.

SEEPS OR SPRINGS ENCOUNTERED DURING CONSTRUCTION SHALL BE HANDLED IN ACCORDANCE WITH THE STANDARD AND SPECIFICATION FOR SUBSURFACE DRAIN OR OTHER APPROVED METHOD.

ALL GRADED AREAS SHALL BE PERMANENTLY STABILIZED IMMEDIATELY UPON REACHING FINISHED GRADE. CUT SLOPES IN COMPETENT BEDROCK AND ROCK FILLS NEED NOT BE VEGETATED. SEEDED AREAS WITHIN 50 FEET OF A SURFACE WATER, OR AS OTHERWISE SHOWN ON THE PLAN DRAWINGS, SHALL BE BLANKETED ACCORDING TO THE STANDARDS OF THIS PLAN.

IMMEDIATELY AFTER EARTH DISTURBANCE ACTIVITIES CEASE IN ANY AREA OR SUBAREA OF THE PROJECT, THE OPERATOR SHALL STABILIZE ALL DISTURBED AREAS. DURING NON-GERMINATING MONTHS, MULCH OR PROTECTIVE BLANKETING SHALL BE APPLIED AS DESCRIBED IN THE PLAN. AREAS NOT AT FINISHED GRADE, WHICH WILL BE REACTIVATED WITHIN 1 YEAR, MAY BE STABILIZED IN ACCORDANCE WITH THE TEMPORARY STABILIZATION SPECIFICATIONS. THOSE AREAS WHICH WILL NOT BE REACTIVATED WITHIN 1 YEAR SHALL BE STABILIZED IN ACCORDANCE WITH THE PERMANENT STABILIZATION SPECIFICATIONS.

PERMANENT STABILIZATION IS DEFINED AS A MINIMUM UNIFORM, PERENNIAL 70% VEGETATIVE COVER OR OTHER PERMANENT NON-VEGETATIVE COVER WITH A DENSITY SUFFICIENT TO RESIST ACCELERATED EROSION. CUT AND FILL SLOPES SHALL BE CAPABLE OF RESISTING FAILURE DUE TO SLUMPING, SLIDING, OR OTHER MOVEMENTS.

E&S BMPS SHALL REMAIN FUNCTIONAL AS SUCH UNTIL ALL AREAS TRIBUTARY TO THEM ARE PERMANENTLY STABILIZED OR UNTIL THEY ARE REPLACED BY ANOTHER BMP APPROVED BY THE LOCAL CONSERVATION DISTRICT OR DISTRICT ENVIRONMENTAL UNIT.

AFTER FINAL SITE STABILIZATION HAS BEEN ACHIEVED, TEMPORARY EROSION AND SEDIMENT BMPS MUST BE REMOVED OR CONVERTED TO PERMANENT POST CONSTRUCTION STORMWATER MANAGEMENT BMPS. AREAS DISTURBED DURING REMOVAL OR CONVERSION OF THE BMPS SHALL BE STABILIZED IMMEDIATELY. IN ORDER TO ENSURE RAPID REVEGETATION OF DISTURBED AREAS, SUCH REMOVAL/CONVERSIONS ARE TO BE DONE ONLY DURING THE GERMINATING SEASON.

UPON COMPLETION OF ALL EARTH DISTURBANCE ACTIVITIES AND PERMANENT STABILIZATION OF ALL DISTURBED AREAS, THE OWNER AND/OR OPERATOR SHALL CONTACT THE LOCAL CONSERVATION DISTRICT TO SCHEDULE A FINAL INSPECTION.

NOTIFY THE PENNSYLVANIA DEPARTMENT OF ENVIRONMENTAL PROTECTION AND THE ALLEGHENY COUNTY CONSERVATION DISTRICT 10 DAYS IN ADVANCE OF ANY LAND DISTURBANCE ACTIVITIES AT THE FOLLOWING ADDRESS:

PROCEDURES WHICH ENSURE THAT THE PROPER MEASURES FOR THE RECYCLING OR DISPOSAL OF MATERIALS ASSOCIATED WITH OR FROM THE PROJECT SITE WILL BE UNDERTAKEN IN ACCORDANCE WITH DEPARTMENT REGULATIONS. INDIVIDUALS RESPONSIBLE FOR EARTH DISTURBANCE ACTIVITIES MUST ENSURE THAT PROPER MECHANISMS ARE IN PLACE TO CONTROL WASTE MATERIALS. CONSTRUCTION WASTES INCLUDE, BUT ARE NOT LIMITED TO, EXCESS SOIL MATERIALS, BUILDING MATERIALS, CONCRETE WASH WATER, SANITARY WASTES, ETC. THAT COULD ADVERSELY IMPACT WATER QUALITY. MEASURES SHOULD BE PLANNED AND IMPLEMENTED FOR HOUSEKEEPING, MATERIALS MANAGEMENT, AND LITTER CONTROL. WHEREVER POSSIBLE, RECYCLING OF EXCESS MATERIALS IS PREFERRED, RATHER THAN DISPOSAL. A NOTE REQUIRING RECYCLING OF WASTE MATERIALS, WHERE FEASIBLE, SHOULD BE ADDED TO THE DRAWINGS.

ANNE FOX, SENIOR RESOURCE CONSERVATIONIST
ALLEGHENY COUNTY CONSERVATION DISTRICT
312 EAST CARSON STREET, SUITE 119
PITTSBURGH, PA 15219
PHONE: (412) 291-8010

PA DEP REGIONAL OFFICE CONTACT INFORMATION:

PA DEP SOUTHWEST REGIONAL OFFICE
WETLANDS AND WATERWAYS
400 WATERFRONT DRIVE
PITTSBURGH, PA 15222
OFFICE HOURS 8 A.M. - 4 P.M.
PHONE: (412) 422-4000

PLAN PREPARER CONTACT INFORMATION:

MR. JAMES FLYNN, P.E.
HUNT VALLEY ENVIROMENTAL, LLC
632 HUNT VALLEY CIRCLE
NEW KENSINGTON, PA 15068
PHONE: 724-594-0805

	FORMULA AND SPECIES	% BY WEIGHT	MINIMUM % PURITY	MINIMUM % GERMINATION	APPLICATION RATE
FORMULA D	TALL FESCUE (FESTUCA ARUNDINACEA VAR. KENTUCKY 31)	60	96	85	50.0 LBS/ACRE
	CREEPING RED FESCUE OR CHEWINGS FESCUE (FESTUCA RUBRA OR SSP COMMUTATE) (IMPROVED AND CERTIFIED)	30	97	85	
	ANNUAL RYEGRASS (LOLIUM MULTIFLORUM)	10	95	90	
	FERTILIZER APPL. RATE	10-20-20			1000.0 LBS/ACRE
	LIMING RATE	-			6.0 TONS/ACRE
	MULCHING TYPE	HAY			1,200 LBS/1,000 SY
	SEASON SEEDING DATES	MARCH-NOVEMBER			-
FORMULA E	ANNUAL RYEGRASS	100.00	95	90	10.0 LBS/ACRE
	FERTILIZER APPL. RATE	10-20-20			1000.0 LBS/ACRE
	LIMING RATE	-			2.0 TONS/ACRE
	MULCHING TYPE	HAY			3.0 TONS/ACRE
	SEASON SEEDING DATES	MARCH-NOVEMBER			
FORMULA L	HARD FESCUE MIXTURE (FESTUCA LONGIFOLIA), A COMBINATION OF IMPROVED CERTIFIED VARIETIES WITH NO ONE VARIETY EXCEEDING 50% OF THE TOTAL HARD FESCUE COMPONENT	55	97	85	50.0 LBS/ACRE
	CREEPING RED FESCUE (FESTUCA RUBRA) (IMPROVED AND CERTIFIED)	35	97	85	
	ANNUAL RYEGRASS (LOLIUM MULTIFLORUM)	10	95	90	
	FERTILIZER APPL. RATE	10-20-20			1000.0 LBS/ACRE
	LIMING RATE	-			6.0 TONS/ACRE
	MULCHING TYPE	HAY			1,200 LBS/1,000 SY
	SEASON SEEDING DATES	MARCH-NOVEMBER			-

CONSTRUCTION SEQUENCE

ALL CONSTRUCTION ACTIVITIES SHALL PROCEED IN ACCORDANCE WITH THE FOLLOWING CONSTRUCTION SEQUENCE. EACH STEP SHALL BE COMPLETED BEFORE A SUBSEQUENT STEP IS INITIATED. UPON COMPLETION OR TEMPORARY CESSATION OF THE EARTH DISTURBANCE ACTIVITY, OR ANY STAGE THEREOF, THE PROJECT SITE SHALL BE IMMEDIATELY STABILIZED. THE CONTRACTOR CAN PROCEED WITH THE REMAINDER OF CLEARING AND GRUBBING BETWEEN NOVEMBER 16 AND MARCH 31. INSTALL THE REMAINDER BMP'S AND CONTINUE WITH FILL ON THE SITE.

PRE-CONSTRUCTION

1. AT LEAST 7 DAYS PRIOR TO STARTING ANY EARTH DISTURBANCE ACTIVITIES (INCLUDING CLEARING AND GRUBBING), THE OWNER AND/OR OPERATOR SHALL INVITE ALL CONTRACTORS, THE LANDOWNER, APPROPRIATE MUNICIPAL OFFICIALS, THE EROSION AND SEDIMENT POLLUTION CONTROL PLAN PREPARER, A REPRESENTATIVE FROM THE PENNSYLVANIA DEPARTMENT OF ENVIRONMENTAL PROTECTION AND A REPRESENTATIVE FROM THE ALLEGHENY COUNTY CONSERVATION DISTRICT TO AN ON-SITE PRECONSTRUCTION MEETING.
2. AT LEAST 3 DAYS PRIOR TO STARTING ANY EARTH DISTURBANCE ACTIVITIES, OR EXPANDING INTO AN AREA PREVIOUSLY UNMARKED, THE PENNSYLVANIA ONE CALL SYSTEM INC. SHALL BE NOTIFIED AT 1-800-242-1776 FOR THE LOCATION OF EXISTING UNDERGROUND UTILITIES.
3. ALL APPLICABLE PERMITS AND APPROVALS REQUIRED FOR THIS PROJECT SHALL BE SECURED PRIOR TO THE START OF CONSTRUCTION. COPIES OF PERMITS, PLANS AND APPROVALS SHALL BE KEPT ON-SITE AT ALL TIMES.
4. ALL EARTH DISTURBANCE ACTIVITIES SHALL PROCEED IN ACCORDANCE WITH THE SEQUENCE PROVIDED ON THE PLAN DRAWINGS.
5. THE SELECTED CONTRACTOR IS RESPONSIBLE FOR HAVING AN APPROVED EROSION AND SEDIMENTATION CONTROL PLAN FOR ALL OFF-SITE WASTE AND BORROW SITES.
6. CONTRACTOR SHOULD LIMIT STOCKPILING OF WASTE, CONSTRUCTION EQUIPMENT, FUEL TANKS, BORROWED EXCAVATION, ETC. NEAR THE STREAM IN THE EVENT A SIGNIFICANT STORM SHOULD OCCUR.
7. MOBILIZE FOR PROJECT CONSTRUCTION.

CONSTRUCTION

LRG WILL UTILIZE REGENERATIVE STREAM CONVEYANCE/FLOOD PLAIN RESTORATION FOR THE CONSTRUCTION METHOD OF THE REESTABLISHED UNNAMED TRIBUTARY CHANNELS IN SAWMILL RUN. LENGTH OF EACH CONSTRUCTION REACH IS BASED ON THE EXISTING FLOW OF THE CHANNEL.

1. PLACE A ROCK CONSTRUCTION ENTRANCE AND STREAM CROSSWING FOR ACCESS TO THE STREAM AT STATION 106+40
2. ESTABLISH HAUL ROAD TO UPSTREAM PROJECT AREA.
3. BEGINNING AT STATION 114+75 SET UP STREAM DIVERSION AND TEMPORARY CROSSING. USE SANDBAGS DIVERTING WATER AROUND WORK AREA APPROXIMATELY 200 FEET MAX IN LENGTH. ONLY DISTURB LENGTH OF CHANNEL BANK THAT CAN BE RESTORED IN A DAY.
4. PUMP WORK AREA TO SEDIMENT FILTER BAG
5. CONSTRUCT BANK STABILIZATION BEST MANAGEMENT PRACTICES AS PLANNED ACCORDING TO DETAIL IN THE REACH.
6. REDIVERT STREAM FLOW AWAY FROM WORK AREA REMOVE TEMPORARY CROSSING.
7. PUMP WORK AREA TO SEDIMENT FILTER BAG
8. CONSTRUCT BMP'S ACCORDING TO DETAILS ON OPPOSITE BANK.
9. STABILIZE LOOSE SOIL AREAS WITH RECOMMENDED SEED MIX AND ECMB OR APPROPRIATE BLANKETING PRODUCT.
10. RESTORE ACCESS ROADS TO THE STREAM CHANNEL AND ALONG STREAM CHANNEL SEED AND MULCH.
11. PUMP WORK AREA TO SEDIMENT FILTER BAG
12. CONSTRUCT BMP'S ACCORDING TO DETAILS BANK.
13. STABILIZE LOOSE SOIL AREAS WITH RECOMMENDED SEED MIX AND ECMB OR APPROPRIATE BLANKETING PRODUCT.
14. REDIVERT STREAM FLOW AWAY FROM WORK AREA REMOVE TEMPORARY CROSSING.
15. PUMP WORK AREA TO SEDIMENT FILTER BAG
16. CONSTRUCT BMP'S ACCORDING TO DETAILS ON OPPOSITE BANK.

REPEAT THE SEQUENCE COMPLETING CONSTRUCTION OF EACH REACH. EACH REACH CAN NOT EXCEED 200 FEET UNLESS THE CHANNEL IS DRY.

17. RESTORE ACCESS ROADS TO THE STREAM CHANNEL AND ALONG STREAM CHANNEL SEED AND MULCH REMOVE CROSSING AT STATION 106+40

FILE: S:\Shared Folders\Projects\1-XXX Sawmill Run MS4\CADD\MS4GenNotesBeerCreek2.dgn
DATE: 10/27/2022 TIME: 8:03:37 PM

SHEET 3 OF 10

STREAM RESTORATION FOR MS4 CREDITS
IN THE THE SAW MILL RUN AND THE OHIO WATERSHED
CITY OF PITTSBURGH
ALLEGHENY COUNTY, PENNSYLVANIA
DEER CREEK STREAMBANK STABILIZATION PROJECT
GENERAL NOTES AND CONSTRUCTION SEQUENCE

PREPARED BY:
HUNT VALLEY ENVIRONMENTAL, LLC
632 HUNT VALLEY ROAD
NEW KENSINGTON, PA 15068

PREPARED FOR:
PENNSYLVANIA DEPARTMENT OF TRANSPORTATION
KEYSTONE BUILDING
400 NORTHSTREER
HARRISBURG, PA 17120

PITTSBURGH WATER AND SEWER AUTHORITY
1200 PENN AVE
PITTSBURGH, PA 15222

ENGINEER

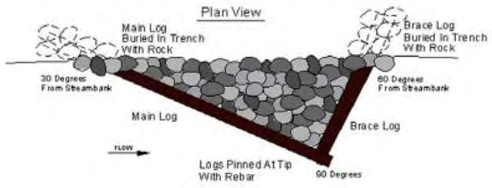
ORIGINAL SUBMISSION DATE: 10-19-2022

REVISED SUBMISSION DATE:

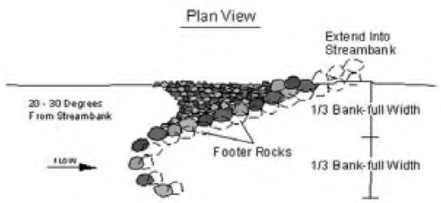
COMMONWEALTH OF PENNSYLVANIA
REGISTERED PROFESSIONAL
JAMES H. FLYNN
ENGINEER
PE 061547

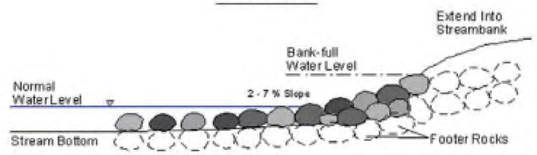
Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

LOG FRAMED STONE DEFLECTOR

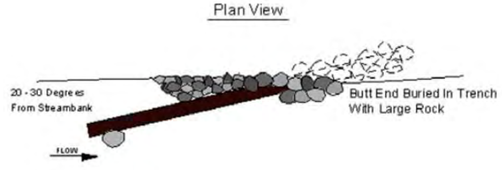


J-HOOK ROCK VANE DEFLECTOR

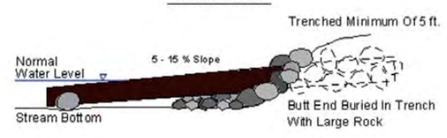




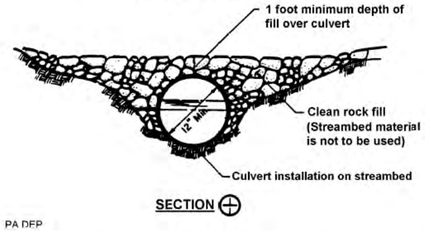
SINGLE LOG VANE DEFLECTOR



NOTE: Can place a large rock at tip as a brace.



STANDARD CONSTRUCTION DETAIL # 3-13
Temporary Stream Crossing



SECTION ⊕

PA DEP

Provide 50' stabilized access to crossing on both sides of stream channel (see Standard Construction Detail #3-12).

Pipes shall extend beyond the toe of the roadway.

Runoff from the roadway shall be diverted off the roadway and into a sediment removal BMP before it reaches the rock approach to the crossing.

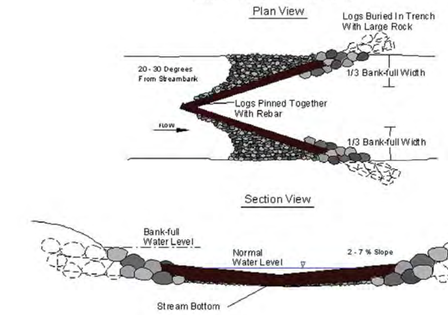
MAINTENANCE

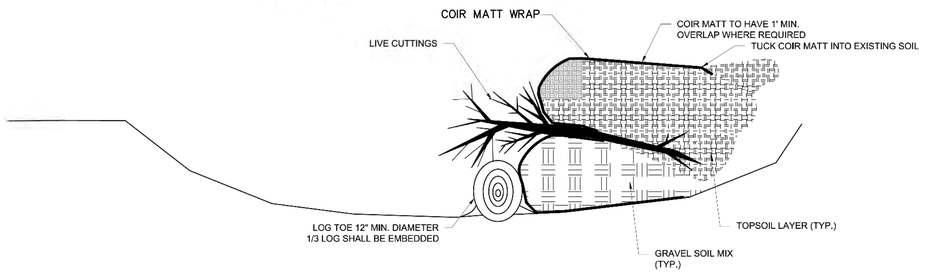
1. **Temporary stream crossings shall be inspected on a daily basis.**
2. **Damaged crossings shall be repaired within 24 hours of the inspection and before any subsequent use.**
3. **Sediment deposits on the crossing or its approaches shall be removed within 24 hours of the inspection**

As soon as the temporary crossing is no longer needed, it shall be removed. All materials shall be disposed of properly and disturbed areas stabilized.

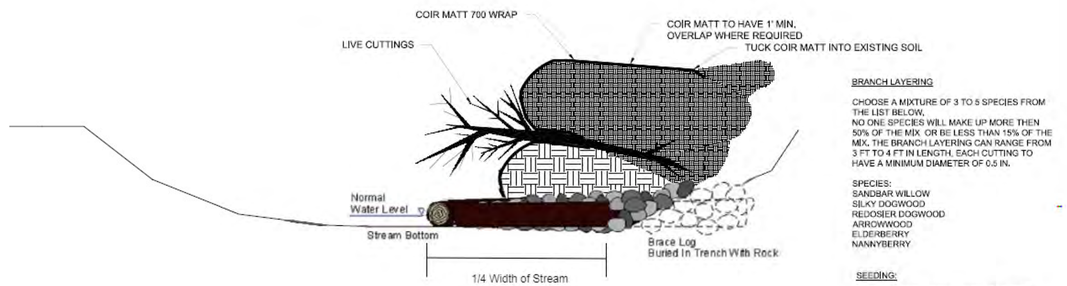
STREAM CROSSING
NOT TO SCALE

LOG CROSS VANE
(LOW FLOW CHANNEL STRUCTURE)





SINGLE LIFT BRANCH LAYERING WITH LOG TOE



BRANCH LAYERING

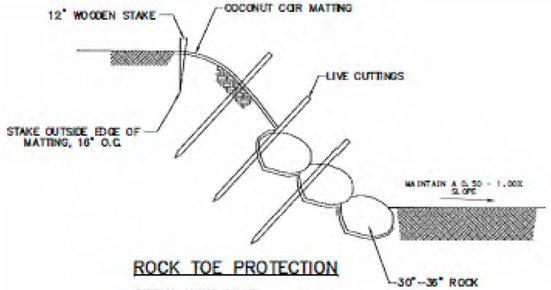
CHOOSE A MIXTURE OF 3 TO 5 SPECIES FROM THE LIST BELOW. NO ONE SPECIES WILL MAKE UP MORE THEN 50% OF THE MIX OR BE LESS THAN 15% OF THE MIX. THE BRANCH LAYERING CAN RANGE FROM 3 FT TO 4 FT IN LENGTH. EACH CUTTING TO HAVE A MINIMUM DIAMETER OF 0.5 IN.

SPECIES:
SANDBAR WILLOW
SILKY DOGWOOD
REDOSIER DOGWOOD
ARROWWOOD
ELDERBERRY
NANNYBERRY

SEEDING:

ALL DISTURBED AREAS MUST BE SEEDED. RIPARIAN BUFFER MIX, APPLY AT A RATE OF 0.5 LB PER 1,000 S.F.

SINGLE LIFT BRANCH LAYERING WITH STONE TOE DEFLECTOR



ROCK TOE PROTECTION

INSTALL ALONG BANKS WHERE STREAMBANK IS PROPOSED TO BE 2:1 AND 3:1.

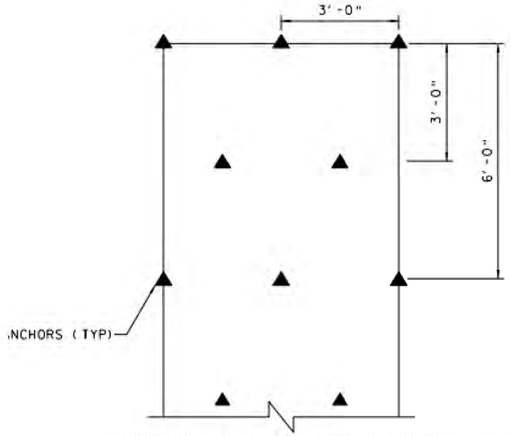
ROCK TOE PROTECTION DETAIL
NOT TO SCALE

SHEET 4 OF 10	STREAM RESTORATION FOR MS4 CREDITS IN THE THE SAW MILL RUN AND THE OHIO WATERSHED CITY OF PITTSBURGH ALLEGHENY COUNTY, PENNSYLVANIA DEER CREEK STREAMBANK STABILIZATION PROJECT DETAILS	PREPARED BY: HUNT VALLEY ENVIRONMENTAL, LLC 632 HUNT VALLEY ROAD NEW KENSINGTON, PA 15068	PREPARED FOR: PENNSYLVANIA DEPARTMENT OF TRANSPORTATION KEYSTONE BUILDING 400 NORTHSTREER HARRISBURG, PA 17120 PITTSBURGH WATER AND SEWER AUTHORITY 1200 PENN AVE PITTSBURGH, PA 15222	ENGINEER	ORIGINAL SUBMISSION DATE: 10-19-2022 REVISED SUBMISSION DATE:

COMMONWEALTH OF PENNSYLVANIA REGISTERED PROFESSIONAL ENGINEER JAMES H. FLYNN PE 061647

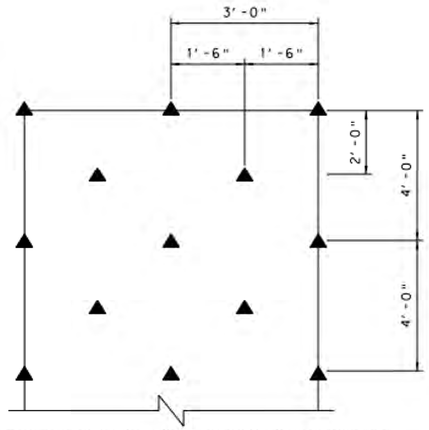
FILE: S:\Shared Folders\Projects\XXX Sawmill Run MS4\CADD\DeerCreekDetails.dgn
DATE: 10/24/2022 TIME: 11:25:05 AM

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D



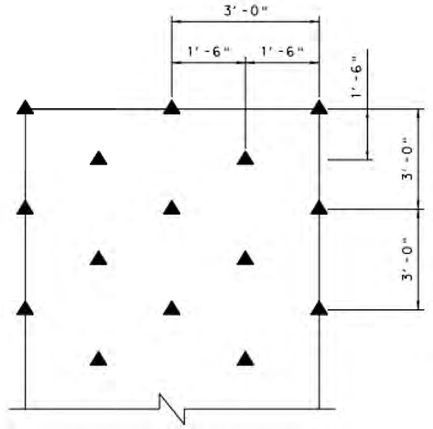
ANCHOR PATTERN FOR SLOPES BETWEEN 3:1 AND 2:1 (INCLUDING 3:1)

PLACE 1.8 ANCHORS/SY



ANCHOR PATTERN FOR SLOPES BETWEEN 2:1 AND 1:1 (INCLUDING 2:1)

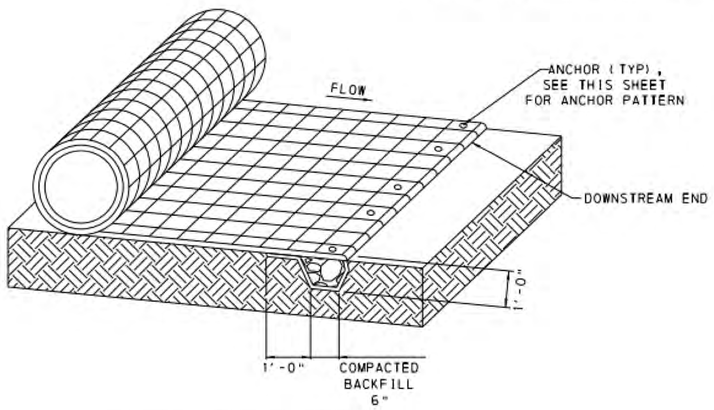
PLACE 2 ANCHORS/SY



ANCHOR PATTERN FOR SLOPES 1:1 OR STEEPER

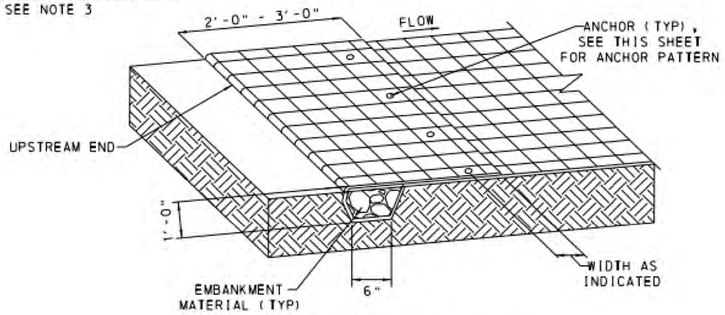
PLACE 2 1/2 ANCHORS/SY

ANCHOR PATTERNS FOR SLOPES

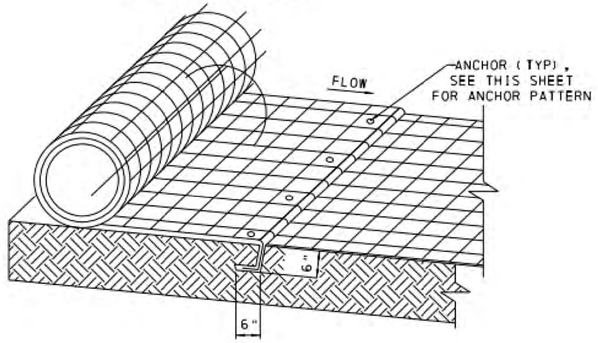


INITIAL ANCHOR TRENCH

SEE NOTE 3

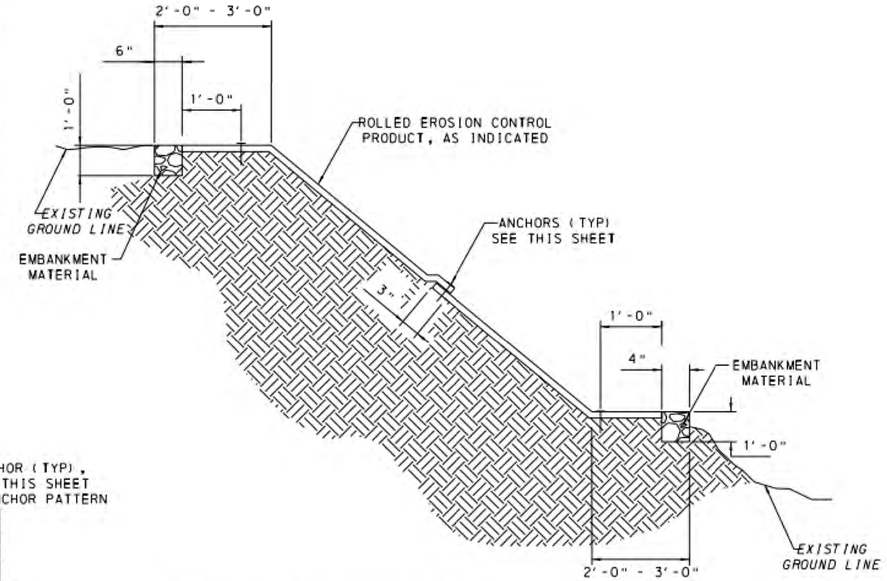


TERMINAL ANCHOR TRENCH SEE NOTE %



INTERMITTENT CHECK SLOT

SEE NOTE 4



TYPICAL SLOPE CROSS SECTION

NOTES

1. ESTABLISH AND MAINTAIN CONTINUOUS CONTACT BETWEEN THE ROLLED EROSION CONTROL PRODUCTS AND THE SOIL.
2. PROVIDE ANCHORING DEVICES IN ACCORDANCE WITH PUBLICATION 408/2016, SECTION 806.2(d).
3. EXCAVATE INITIAL ANCHOR TRENCH 1'-0" DEEP AND 6" WIDE ACROSS THE WIDTH OF THE CHANNEL TO PREVENT UNDERMINING OF THE ROLLED EROSION CONTROL PRODUCTS.
4. EXCAVATE INTERMITTENT CHECK SLOT 6" DEEP AND 6" WIDE ACROSS THE WIDTH OF THE CHANNEL AT 25'-0" TO 30'-0" ALONG THE LENGTH OF THE ROLLED EROSION CONTROL PRODUCTS TO PREVENT LOOSE SOIL FROM BEING TRANSPORTED DOWNSTREAM BENEATH THE ROLLED EROSION CONTROL PRODUCTS.
5. EXCAVATE TERMINAL ANCHOR TRENCH 1'-0" DEEP AND 6" WIDE ACROSS THE WIDTH OF THE CHANNEL TO ENSURE WATER FLOW TRANSITIONS SMOOTHLY ONTO THE ROLLED EROSION CONTROL PRODUCTS WITHOUT SEPARATION FROM THE SOIL.
6. PERMANENT ROLLED EROSION CONTROL PRODUCT SHALL BE USED IN EROSION CONTROL CHANNELS OR WITHIN 50' OF WATERWAYS IN ACCORDANCE WITH ITEM 0806-0140.
7. THE PREFERRED MATERIAL FOR ROLLED PRODUCTS ARE JUTE OR COCONUT FIBER MATS.
8. ROLLED PRODUCTS ARE NOT TO BE PLACED ON BEDROCK.
9. COMPLY WITH RC-73M

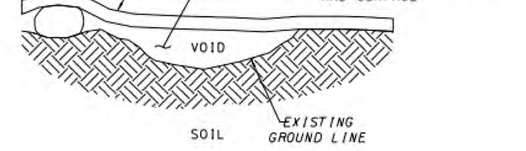


FIGURE 1

LACK OF CONTINUOUS CONTACT

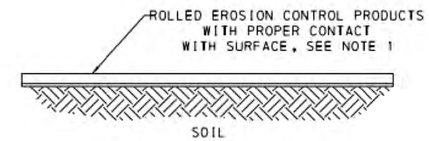


FIGURE 2

CONTINUOUS CONTACT

SHEET 5 OF 10

STREAM RESTORATION FOR MS4 CREDITS
IN THE THE SAW MILL RUN AND THE OHIO WATERSHED
CITY OF PITTSBURGH
ALLEGHENY COUNTY, PENNSYLVANIA
DEER CREEK STREAMBANK STABILIZATION PROJECT
DETAILS

PREPARED BY:

HUNT VALLEY ENVIRONMENTAL, LLC
632 HUNT VALLEY ROAD
NEW KENSINGTON, PA 15068

PREPARED FOR:

PENNSYLVANIA DEPARTMENT OF TRANSPORTATION
KEYSTONE BUILDING
400 NORTHSTREER
HARRISBURG, PA 17120

PITTSBURGH WATER AND SEWER AUTHORITY
1200 PENN AVE
PITTSBURGH, PA 15222

ENGINEER

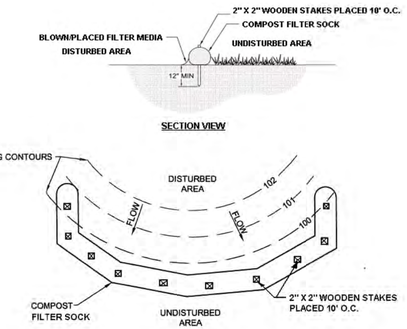
ORIGINAL SUBMISSION DATE: 10-19-2022

REVISED SUBMISSION DATE:

COMMONWEALTH OF PENNSYLVANIA REGISTERED PROFESSIONAL ENGINEER JAMES H. FLYNN PE 061647

FILE: S:\Shared Folders\Projects\21-XXX Sawmill Run MS4\CADD\DeerCreekDetails.dgn
DATE: 10/21/2022 TIME: 6:22:25 PM

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D



COMPOST FILTER SOCK SHALL BE PLACED AT EXISTING LEVEL GRADE. BOTH ENDS OF THE SOCK SHALL BE AT LEAST 8 FEET UPSLOPE AT 45 DEGREES TO THE MAIN SOCK ALIGNMENT.

STAKES MAY BE INSTALLED IMMEDIATELY DOWN SLOPE OF THE SOCK IF SO SPECIFIED BY THE MANUFACTURER

TRAFFIC SHALL NOT BE PERMITTED TO CROSS FILTER SOCKS

ACCUMULATED SEDIMENT SHALL BE REMOVED WHEN IT REACHES HALF THE ABOVE GROUND HEIGHT OF THE SOCK AND DISPOSED OF IN THE MANNER DESCRIBED ELSEWHERE IN THE PLAN

SOCKS SHALL BE INSPECTED WEEKLY AND AFTER EACH RUNOFF EVENT. DAMAGED SOCKS SHALL BE REPAIRED ACCORDING TO MANUFACTURES SPECIFICATIONS OR REPLACED WITHIN 24 HOURS OF INSPECTION

BIODEGRADABLE FILTER SOCKS SHALL BE REPLACED AFTER 6 MONTHS; PHOTODEGRADABLE SOCKS AFTER 1 YEAR. POLYPROPYLENE SOCKS SHALL BE REPLACED ACCORDING TO MANUFACTURERS RECOMMENDATIONS

Compost Standards

Organic Matter Content	80% - 100% (dry weight basis)
Organic Portion	Fibrous and elongated
pH	5.5 - 8.0
Moisture Content	35% - 55%
Particle Size	98% pass through 1" screen
Soluble Salt Concentration	5.0 dS/m (mmhos /cm) Maximum

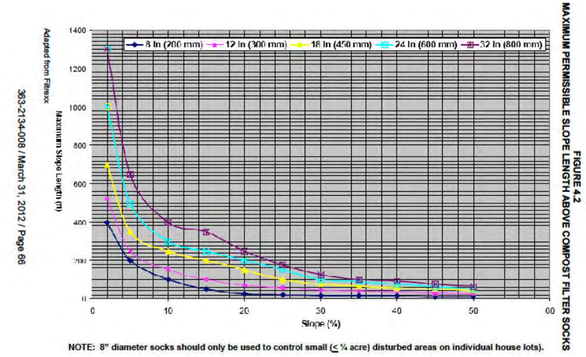


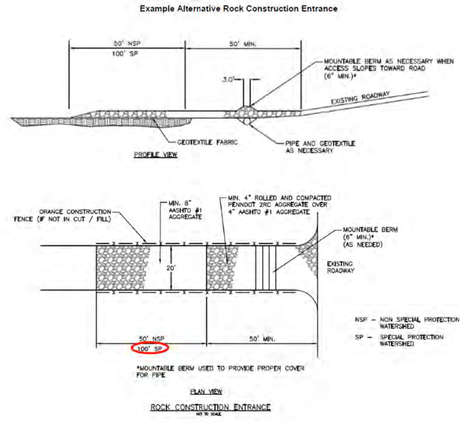
FIGURE 4.2
MAXIMUM PERMISSIBLE SLOPE LENGTH ABOVE COMPOST FILTER SOCKS

NOTE: 8" diameter socks should only be used to control small (≤ ¼ acre) disturbed areas on individual house lots).

Compost Sock Fabric Minimum Specifications Material Type	**3 mil HDPE**	**5 mil HDPE**	**5 mil HDPE**	**Multi - Filament Polypropylene (MFPP)**	**Heavy Duty Multi -Filament Polypropylene (HDMFPP)**
Material Characteristics	Photo - degradable	Photo - degradable	Bio - degradable	Photo - degradable	Photo -degradable
Sock Diameters	12" 18"	12" 18" 24" 32"	12" 18" 24" 32"	12" 18" 24" 32"	12" 18" 24" 32"
Mesh Opening	3/8"	3/8"	3/8"	3/8"	1/8"
Tensile Strength	26 psi	26 psi	44 psi	202 psi	
Ultraviolet Stability % Original Strength (ASTMG - 155)	23% at 1000 hr.	23% at 1000 hr.	100% at 1000 hr.	100% at 1000 hr.	
Minimum Functional Longevity Two - ply systems	6 months	9 months	6 months	1 year	2 years
Inner Containment Netting			**HDPE biaxial net Continuously wound Fusion - welded junctions ¾" X ¾" Max. aperture size**		
Outer Filtration Mesh			**Composite Polypropylene Fabric (Woven layer and non - woven fleece mechanically fused via needle punch) 3/16" Max. aperture size**		

Sock fabrics composed of burlap may be used on projects lasting 6 months or less.

ROCK CONSTRUCTION ENTRENCE



TOPSOIL SHOULD BE REMOVED PRIOR TO INSTALLATION OF ACCESS

RUNOFF SHALL BE DIVERTED FROM ACCESS TO A SUITABLE SEDIMENT REMOVAL BMP

MOUNTABLE BERM SHOULD BE INSTALLED WHEREVER OPTIONAL CULVERT PIPE IS USED

PIPE TO BE SIZED APPROPRIATELY FOR SIZE OF DITCH BEING CROSSED

TOP OF SLOPE BERM (IF UTILIZED)

TEMPORARY BERMS TO BE PLACED, MAINTAINED, AND ADJUSTED CONTINUOUSLY UNTIL 90% VEGETATIVE GROWTH IS ESTABLISHED ON THE EXTERIOR SLOPES WITH PERMANENT STORM DRAINAGE FACILITIES FUNCTIONING

BERMS MUST OUTLET TO SLOPE PIPES OR COLLECTION CHANNELS

CHANNELS BEHIND BERM SHALL HAVE POSITIVE GRADE TO OUTLET AND AN APPROPRIATE LINING

BERMS SHALL BE ADEQUATELY COMPACTED TO PREVENT FAILURE

SPECIES: SEEDING AND SOIL SUPPLEMENTS, ERNMX-183	26% DEER TONGUE, 25% SWITCHGRASS, 20% FOX SEDGE, 20 %VIRGINIA WILDRYE, 4%AUTUMN BENTGRASS, 3% SOFT RUSH, 1% PATH RUSH, 1% REDTOP PANIC GRASS
% PURE LIVE SEED: (1%)	88
APPLICATION RATE: (LBS/ACRE)	20
FERTILIZER TYPE: (X-X-X)	10-20-20 COMMERCIAL FERTILIZER
FERTILIZER APPLICATION RATE: (LBS/ACRE)	677
LIMING RATE: (TONS/ACRE)	6
MULCH TYPE:	HAY
MULCHING RATE: (TONS/ACRE)	3.0
SEEDING SEASON DATES:	9/1 TO 4/30 AND 5/31 TO 8/10

SPECIES: SEEDING AND SOIL SUPPLEMENTS, ERNMX-178	20% VIRGINIA WILD RYE, 20% DEERTONGUE, 18% BIG BLUESTEM, 18% INDIANGRASS, 10% SWITCHGRASS, 3% BLACKEYED SUSAN, 3% BLUE VERVAIN, 2.5% SWAMP MILKWEED, 2% NEW ENGLAND ASTER, 1.5% GOLDEN ALEXANDERS 0.8% WRINKLELEAF GOLDENROD, 0.5% WILD BERGAMOT, 0.3% BONESET, 0.3% COMMON SNEEZEWEED, 0.1% ZIGZAG ASTER
% PURE LIVE SEED: (1%)	83
APPLICATION RATE: (LBS/ACRE)	102
FERTILIZER TYPE: (X-X-X)	10-20-20 COMMERCIAL FERTILIZER
FERTILIZER APPLICATION RATE: (LBS/ACRE)	677
FERTILIZER TYPE: (X-X-X)	38-0-0
FERTILIZER APPLICATION RATE: (LBS/ACRE)	242
LIMING RATE: (TONS/ACRE)	6
MULCH TYPE:	STRAW
MULCHING RATE: (TONS/ACRE)	3.0
ANCHOR MATERIAL:	RECYCLED CELLULOSE FIBER
ANCHOR METHOD:	MECHANICAL BLOWER
RATE OF ANCHOR MATERIAL APPL: (LB/ACRE)	774
SEEDING SEASON DATES:	1/1 TO 8/1 AND 8/1 TO 1/1

EROSION CONTROL SLOPE TREATMENT

DESCRIPTION –
This work is furnishing and placing of an Erosion Control Slope Treatment on all slopes 3h: 1v and steeper consisting of a hydraulically-applied bonded fiber matrix erosion control system (hydro matting).

MATERIAL –
Hydro matting – Hydraulically-applied hydro mulch composed of 100% biodegradable long strand organic fibers which forms a continuous 3-dimensional erosion control blanket which:

Retains its form with the fibers remaining bonded upon rewetting.

Has no holes or gaps greater than 0.04 inches in any dimension.

When applied leaves no voids between the soil surface and the matting.

Has a water holding capacity of 1.2 gallons per pound of matrix.

Has no germination or growth inhibiting factors.

Does not form a water insensitive crust.

Matting shall meet the following minimum requirements:
Fibers – No less than 70% (by weight) long strand wood or cellulose fiber.

Bonding agent – High-strength natural bonding agent that does not dissolve or disperse upon rewetting.

CONSTRUCTION –
Hydro matting – Apply hydro matting where indicated, together with the seed and soil supplements to the finished prepared soil surface only after topsoil has been placed and seeding and soil supplements have been applied as indicated.
Do not use hydro matting on slopes located around high-priority areas.
Do not apply hydro matting where:

Water is standing on the surface.

Over saturated soils.

When there is insufficient drying time (a 24-hour drying window is required).

Prior to application of hydro matting, allow all slopes with lateral seeps to dry, provided there is no risk of slope failure. Apply, maintain and repair hydro matting in accordance with the manufacturer's recommendations. Satisfactorily repair or replace hydro matting

FILE: S:\Shared Folders\Projects\21-XXX Sawmill Run MS4\CADD\DeerCreekDetails.dgn
DATE: 10/21/2022 TIME: 01:23:32 PM

SHEET 6 OF 10

STREAM RESTORATION FOR MS4 CREDITS
IN THE THE SAW MILL RUN AND THE OHIO WATERSHED
CITY OF PITTSBURGH
ALLEGHENY COUNTY, PENNSYLVANIA
DEER CREEK STREAMBANK STABILIZATION PROJECT
DETAILS

PREPARED BY:
HUNT VALLEY ENVIRONMENTAL, LLC
632 HUNT VALLEY ROAD
NEW KENSINGTON, PA 15068

PREPARED FOR:
PENNSYLVANIA DEPARTMENT OF TRANSPORTATION KEYSTONE BUILDING 400 NORTHSTREER HARRISBURG, PA 17120
PITTSBURGH WATER AND SEWER AUTHORITY 1200 PENN AVE PITTSBURGH, PA 15222

ENGINEER

ORIGINAL SUBMISSION DATE: 10-19-2022

REVISED SUBMISSION DATE:

COMMONWEALTH OF PENNSYLVANIA REGISTERED PROFESSIONAL JAMES H. FLYNN ENGINEER PE 061647

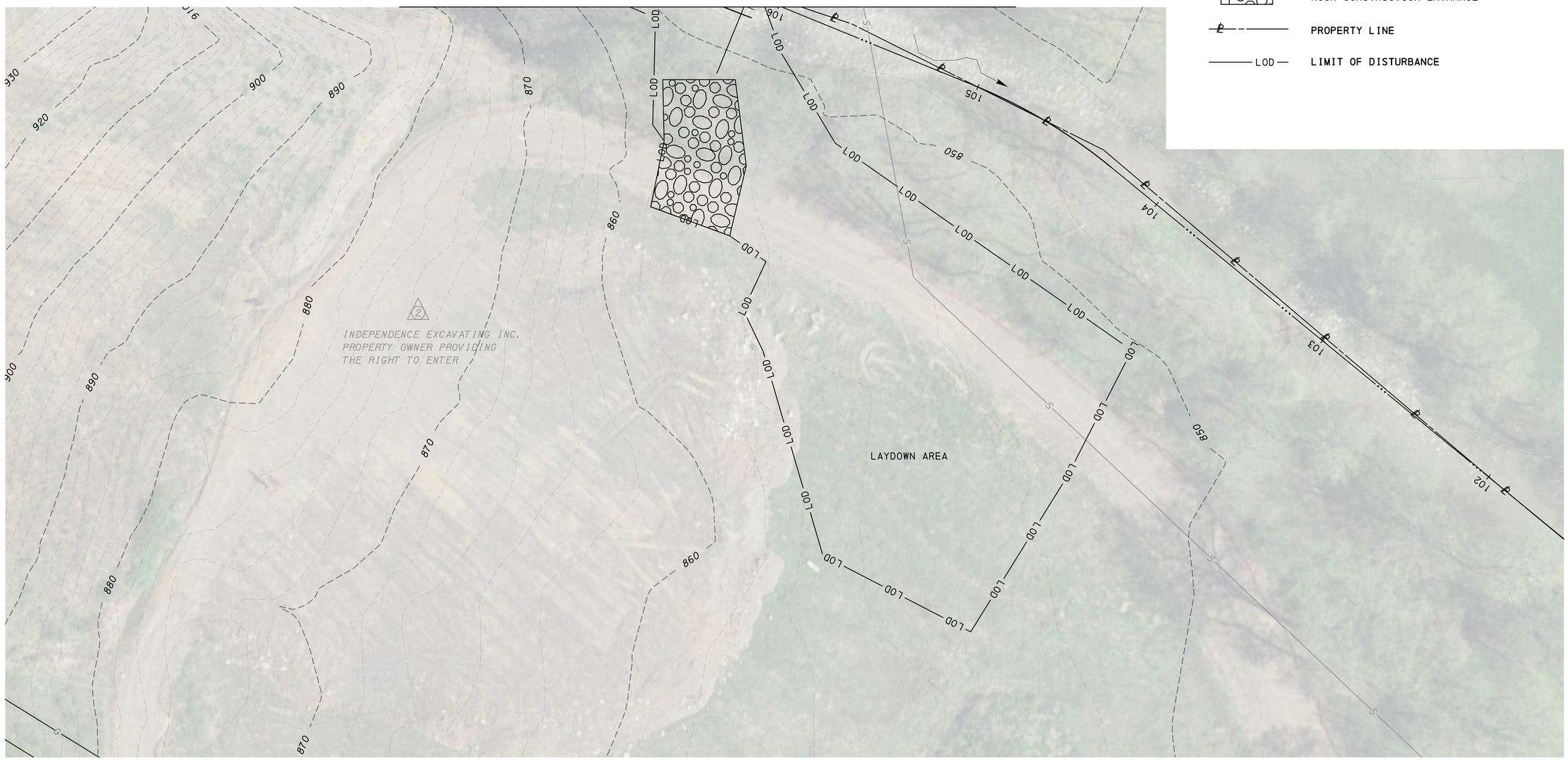
Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

TOTAL LIMIT OF DISTURBANCE:
2.60 AC.

NO NPDES PERMIT IS REQUIRED.
THE AREA OF DISTURBANCE IS COVERED
UNDER 401 WATER QUALITY CERTIFICATION

LEGEND

- EXISTING CONTOUR
- PROPOSED CONTOURS
- ROLLED EROSION CONTROL PRODUCT
- S — EXISTING SANITARY SEWER
- G — EXISTING GAS LINE
- ROCK CONSTRUCTION ENTRANCE
- ℄ — PROPERTY LINE
- LOD — LIMIT OF DISTURBANCE



0 25 50 FEET

SHEET 7 OF 10

STREAM RESTORATION FOR MS4 CREDITS
IN THE THE SAW MILL RUN AND THE OHIO WATERSHED
CITY OF PITTSBURGH
ALLEGHENY COUNTY, PENNSYLVANIA
DEER CREEK STREAMBANK STABILIZATION PROJECT
PLAN SHEET

PREPARED BY:
HUNT VALLEY ENVIRONMENTAL, LLC
632 HUNT VALLEY ROAD
NEW KENSINGTON, PA 15068

PREPARED FOR:
PENNSYLVANIA
DEPARTMENT OF TRANSPORTATION
KEYSTONE BUILDING
400 NORTHSTREER
HARRISBURG, PA 17120

PITTSBURGH
WATER AND SEWER AUTHORITY
1200 PENN AVE
PITTSBURGH, PA 15222

ENGINEER

ORIGINAL
SUBMISSION DATE: 10-19-2022

REVISED
SUBMISSION DATE:

COMMONWEALTH OF PENNSYLVANIA
REGISTERED PROFESSIONAL ENGINEER
JAMES H. FLYNN
PE 061647

FILE: S:\Shared Folders\Projects\21-XXX Sawmill Run MS4\CADD\DeerCreekPlan1.dgn
DATE: 10/24/2022 TIME: 9:48:31 AM

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

SEE MATCHLINE SHEET 9 OF 10

TOE WOOD WITH BRANCH LAYERING AND COIR MATT, SEE TYPICAL

TOE WOOD WITH BRANCH LAYERING (TYP.)

ACCESS ROAD

COIR LOGS

LOG CROSS VANE

LOG FRAMED STONE DEFLECTOR (TYP.)

TOTAL LIMIT OF DISTURBANCE:
2.60 AC.

NO NPDES PERMIT IS REQUIRED.
THE AREA OF DISTURBANCE IS COVERED
UNDER 401 WATER QUALITY CERTIFICATION

LEGEND

- EXISTING CONTOUR
- PROPOSED CONTOURS
- ROLLED EROSION CONTROL PRODUCT
- LOD — EXISTING SANITARY SEWER
- S — EXISTING SANITARY SEWER
- G — EXISTING GAS LINE
- ROCK CONSTRUCTION ENTRANCE
- PROPERTY LINE
- COIR LOGS
- SINGLE LIFT BRANCH WITH LOG TOE
- LOG FRAMED STONE DEFLECTOR
- LOG CROSS VANE

TEMPORARY STREAM CROSSING
SEE SHEET 10 FOR CROSS SECTION

BEGIN WORK STA. 106+15

RCE-1

SEE MATCHLINE SHEET 7 OF 10

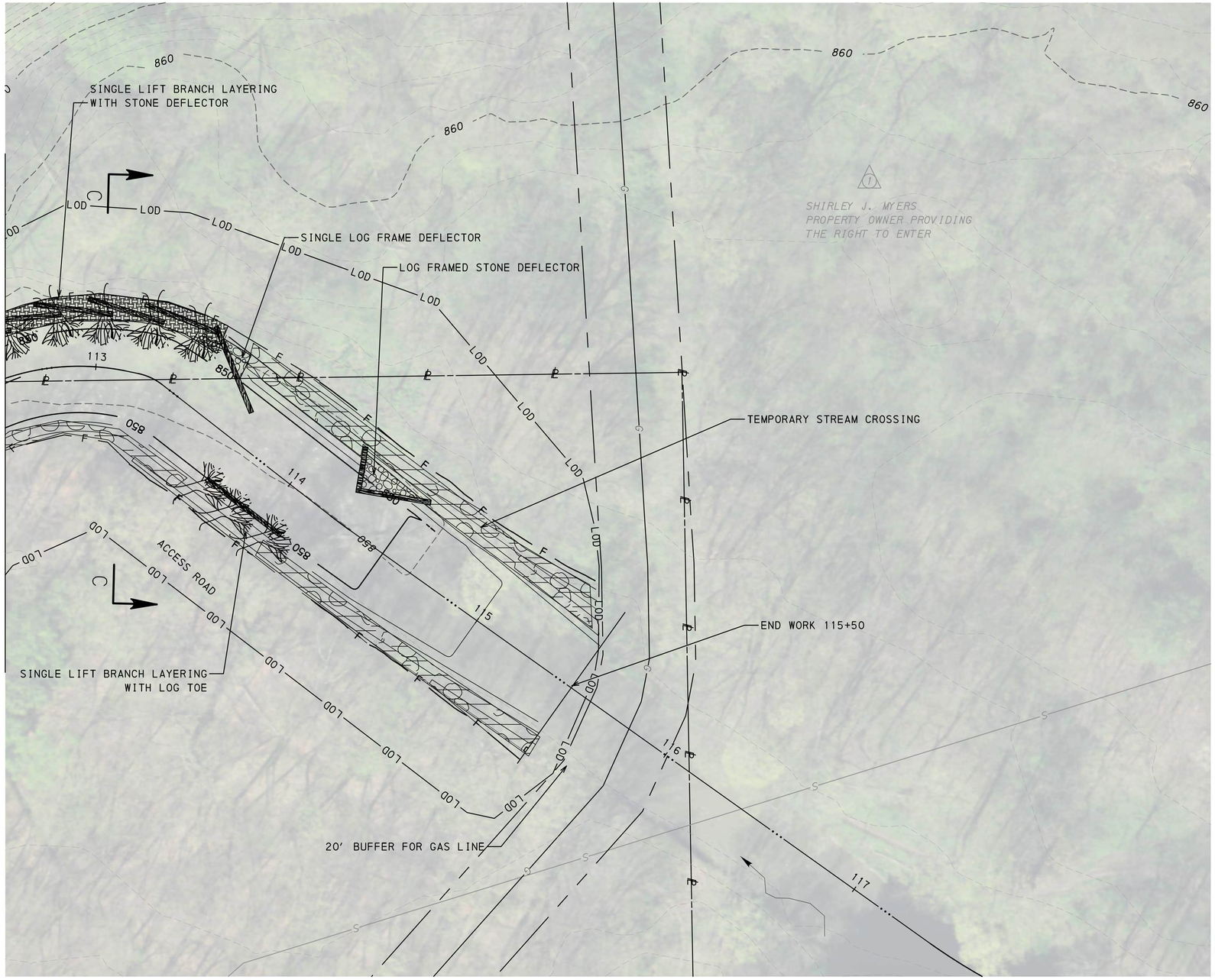
0 25 50 FEET

FILE: S:\Shared Folders\Projects\XXX Sawmill Run MS4\CADD\DeerCreekPlan2.dgn
DATE: 10/21/2022 TIME: 9:58:26 AM

SHEET 8 OF 10	STREAM RESTORATION FOR MS4 CREDITS IN THE THE SAW MILL RUN AND THE OHIO WATERSHED CITY OF PITTSBURGH ALLEGHENY COUNTY, PENNSYLVANIA DEER CREEK STREAMBANK STABILIZATION PROJECT PLAN SHEET	PREPARED BY: HUNT VALLEY ENVIRONMENTAL, LLC 632 HUNT VALLEY ROAD NEW KENSINGTON, PA 15068	PREPARED FOR: PENNSYLVANIA DEPARTMENT OF TRANSPORTATION KEYSTONE BUILDING 400 NORTHSTREER HARRISBURG, PA 17120 PITTSBURGH WATER AND SEWER AUTHORITY 1200 PENN AVE PITTSBURGH, PA 15222	ENGINEER	ORIGINAL SUBMISSION DATE: 10-19-2022 REVISED SUBMISSION DATE:

COMMONWEALTH OF PENNSYLVANIA
REGISTERED PROFESSIONAL
JAMES H. FLYNN
ENGINEER
PE 061647

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D



TOTAL LIMIT OF DISTURBANCE:
2.60 AC.

NO NPDES PERMIT IS REQUIRED.
THE AREA OF DISTURBANCE IS COVERED
UNDER 401 WATER QUALITY CERTIFICATION

LEGEND

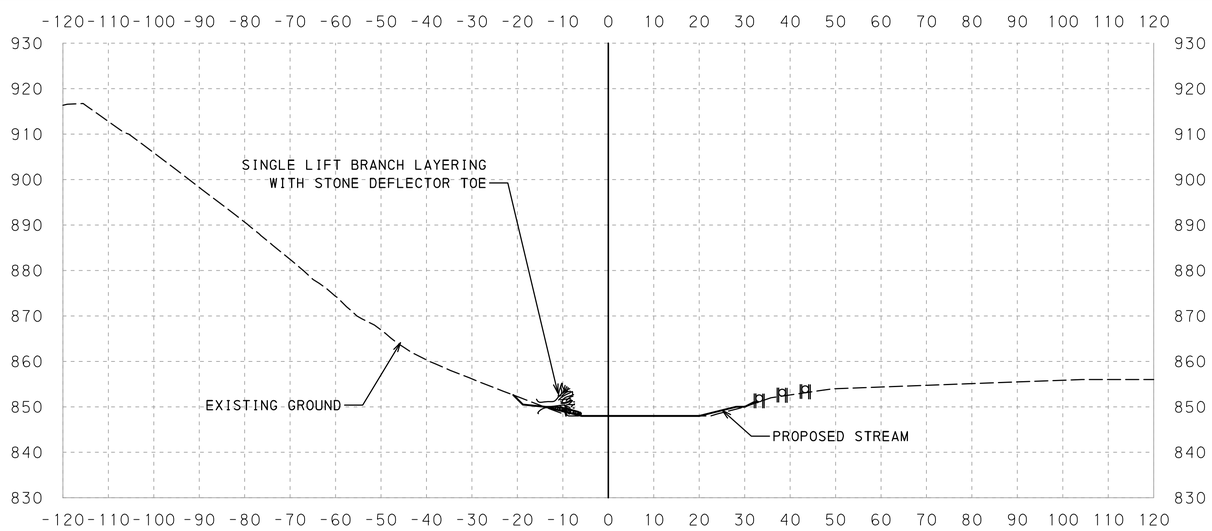
- EXISTING CONTOUR
- PROPOSED CONTOURS
- ROLLED EROSION CONTROL PRODUCT
- LOD — LIMIT OF DISTURBANCE
- S — EXISTING SANITARY SEWER
- G — EXISTING GAS LINE
- ROCK CONSTRUCTION ENTRANCE
- PROPERTY LINE
- COIR LOGS
- SINGLE LIFT BRANCH WITH LOG TOE
- LOG FRAMED STONE DEFLECTOR
- LOG CROSS VANE

0 25 50 FEET

FILE: S:\Shared Folders\Projects\2_XXX Sawmill Run MS4\CADD\DeerCreekPlan3.dgn
DATE: 10/24/2022 TIME: 9:56:46 AM

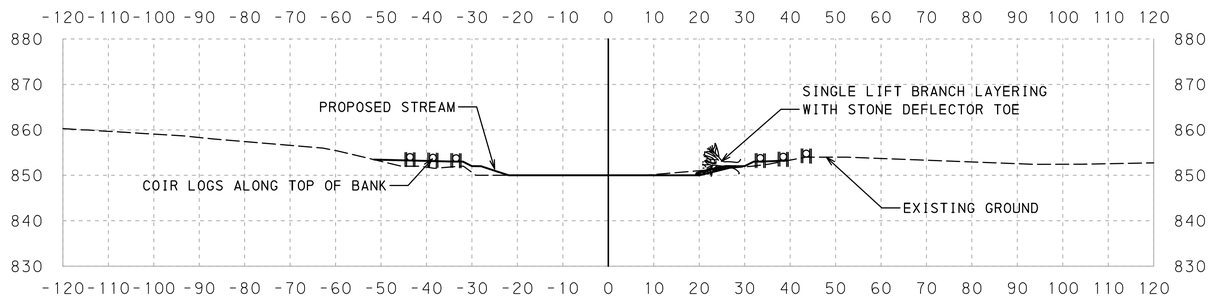
SHEET 9 OF 10	STREAM RESTORATION FOR MS4 CREDITS IN THE THE SAW MILL RUN AND THE OHIO WATERSHED CITY OF PITTSBURGH ALLEGHENY COUNTY, PENNSYLVANIA DEER CREEK STREAMBANK STABILIZATION PROJECT PLAN SHEET	PREPARED BY: HUNT VALLEY ENVIRONMENTAL, LLC 632 HUNT VALLEY ROAD NEW KENSINGTON, PA 15068	PREPARED FOR: PENNSYLVANIA DEPARTMENT OF TRANSPORTATION KEYSTONE BUILDING 400 NORTHSTREER HARRISBURG, PA 17120 PITTSBURGH WATER AND SEWER AUTHORITY 1200 PENN AVE PITTSBURGH, PA 15222	ENGINEER ORIGINAL SUBMISSION DATE: 10-19-2022 REVISED SUBMISSION DATE:	COMMONWEALTH OF PENNSYLVANIA REGISTERED PROFESSIONAL JAMES H. FLYNN ENGINEER PE 061647

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D



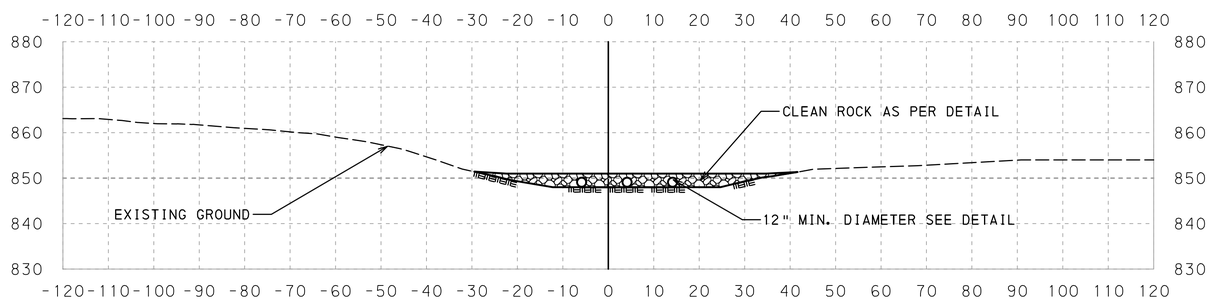
TYPICAL CROSS SECTION
DETAIL FOR STATIONS
106+10 TO 112+00

SECTION B-B



TYPICAL CROSS SECTION
DETAIL FOR STATIONS
112+00 TO 115+50

SECTION C-C



TYPICAL CROSS SECTION
FOR TEMPORARY STREAM CROSSINGS

SECTION A-A

FILE: S:\Shared Folders\Projects\1-XXX Sawmill Run MS4\CADD\DeerCreekXSECPlan.dgn
DATE: 10/27/2022 TIME: 9:17:13 AM

SHEET 10 OF 10

STREAM RESTORATION FOR MS4 CREDITS
IN THE THE SAW MILL RUN AND THE OHIO WATERSHED
CITY OF PITTSBURGH
ALLEGHENY COUNTY, PENNSYLVANIA
DEER CREEK STREAMBANK STABILIZATION PROJECT
CROSS SECTIONS

PREPARED BY:

HUNT VALLEY ENVIRONMENTAL, LLC
632 HUNT VALLEY ROAD
NEW KENSINGTON, PA 15068

PREPARED FOR:

PENNSYLVANIA
DEPARTMENT OF TRANSPORTATION
KEYSTONE BUILDING
400 NORTHSTREER
HARRISBURG, PA 17120

PITTSBURGH
WATER AND SEWER AUTHORITY
1200 PENN AVE
PITTSBURGH, PA 15222

ENGINEER

ORIGINAL
SUBMISSION DATE: 10-19-2022

REVISED
SUBMISSION DATE:

COMMONWEALTH OF PENNSYLVANIA
REGISTERED PROFESSIONAL
JAMES H. FLYNN
ENGINEER
PE 061647

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Appendix D1: Supporting Sediment Data

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

MARKOSKY
3689 Route 711 • Ligonier, PA 15658
724.238.4138 • www.markosky.com
COLLABORATIVE ENGINEERING

Subject: Sawmill Run - MS4
BMP Load Calcs

Calc By: WBM
Date: 10/18/2022

Chk'd By
Date:

MOORE PARK (SCM 001) - PROPOSED BMP LOAD CALCULATIONS

Source	Area (Ac)	Sediment		Nitrogen		Phosphorus	
		Total Load (lb)	Loading Rate (lb/ac)	Total Load (lb)	Loading Rate (lb/ac)	Total Load (lb)	Loading Rate (lb/ac)
Forest	0.66	16.50	25	0.059	0.09	0.007	0.01
Open Land	1.25	402.13	321.7	1.363	1.09	0.088	0.07
HD Residential	0.53	74.73	141	1.622	3.06	0.186	0.35
TOTALS	**2.44**	**493.36**		**3.0437**		**0.280**	

Note: Loading Rates obtained from MapShed Modeling

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

MARKOSKY
3689 Route 711 • Ligonier, PA 15658
724.238.4138 • www.markosky.com
COLLABORATIVE ENGINEERING

Subject: Sawmill Run - MS4
BMP Load Calcs

Calc By: WBM
Date: 10/18/2022

Chk'd By
Date:

MOORE PARK (SCM 002) - PROPOSED BMP LOAD CALCULATIONS

Source	Area (Ac)	Sediment		Nitrogen		Phosphorus	
		Total Load (lb)	Loading Rate (lb/ac)	Total Load (lb)	Loading Rate (lb/ac)	Total Load (lb)	Loading Rate (lb/ac)
Forest	2.45	61.25	25.00	0.221	0.090	0.025	0.010
Open Land	0.71	229.37	321.70	0.777	1.090	0.050	0.070
HD Residential	0.00	0.00	141.00	0.000	3.060	0.000	0.350
TOTALS	**3.163**	**290.62**		**0.998**		**0.074**	

Note: Loading Rates obtained from MapShed Modeling

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

MARKOSKY
3689 Route 711 • Ligonier, PA 15658
724.238.4138 • www.markosky.com
COLLABORATIVE ENGINEERING

Subject: Sawmill Run - MS4
BMP Load Calcs

Calc By: WBM
Date: 10/18/2022

Chk'd By
Date:

CRANE AVENUE (SCM 003) - PROPOSED BMP LOAD CALCULATIONS

Source	Area (Ac)	Sediment		Nitrogen		Phosphorus	
		Total Load (lb)	Loading Rate (lb/ac)	Total Load (lb)	Loading Rate (lb/ac)	Total Load (lb)	Loading Rate (lb/ac)
Forest	0.00	0.00	25.00	0.000	0.090	0.000	0.010
Open Land	0.00	0.00	321.70	0.000	1.090	0.000	0.070
HD Residential	2.22	313.02	141.00	6.793	3.060	0.777	0.350
TOTALS	**2.22**	**313.02**		**6.793**		**0.777**	

1. Loading Rates obtained from MapShed Modeling.
2. Drainage Area to the existing outfall is 11.66 acres. The computed flow from the drainage area exceeds the overall capacity of the proposed detention basin. Flow is split at a proposed manhole sending Q_{10} = 9.71 cfs to the basin and 31.27 cfs to UNT to Sawmill Run. The equivalent impervious area (Q_{10} = 9.71 cfs) is 2.22 acres which will be used to compute proposed BMP Load Calculations.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

MARKOSKY
3689 Route 711 • Ligonier, PA 15658
724.238.4138 • www.markosky.com
COLLABORATIVE ENGINEERING

Subject: Sawmill Run - MS4
BMP Load Reduction

Calc By: WBM
Date: 10/18/2022

Chk'd By
Date:

PROPOSED BMP LOAD REDUCTION TABLE

BMP ID	BMP Type	Removal Efficiency Determination Method	Existing Sediment Load (lb/yr)	Existing TP Load (lb/yr)	Sediment Removal Efficiency	TP Removal Efficiency	Sediment Load Reduction (lb/yr)	TP Load Reduction (lb/yr)
Moore Park-SCM 001	Dry Extended Detention Basin	PADEP Effectiveness	493.36	0.28	60.00%	20.00%	296.01	0.056
Moore Park - SCM 002	Dry Extended Detention Basin	PADEP Effectiveness	290.62	0.07	60.00%	20.00%	174.37	0.015
Crane Ave - SCM 003	Dry Extended Detention Basin	PADEP Effectiveness	313.02	0.78	60.00%	20.00%	187.81	0.155
TOTALS							**658.19**	**0.226**

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Project Name	Moore Park								
Feature Feature I.D. (Bank., Headcut or Deposition I.D.)	Length, ft (Bank or deposition)	Height, ft (Bank or Headcut)	BEHI Rating	NBS Rating	Predicted Rate of Bank Erosion (ft/year)	Predicted Erosion Amount (ft^3/year)	Predicted Erosion Amount (tons/year)	Predicted Erosion Rate (tons/year/ft)	Comments
1	32.0	2.5	Very High	Extreme	2.50	200.00	8.91	0.30	Right Bank
2 R	12.0	1.5	High	Moderate	0.64	11.52	0.51	0.05	Right Bank
2 L	12.0	3.3	Very High	Moderate	0.64	25.60	1.14	0.10	Left Bank
3 (Right and Left Banks)	32.0	3.2	Very High	Extreme	2.50	253.33	11.28	0.38	Right and Left Bank
4 (Right and Left Banks)	34.0	1.5	Very High	Moderate	0.64	32.64	1.45	0.05	Right and Left Bank
5 (Right and Left Banks)	42.0	2.5	Very High	Extreme	2.50	262.50	11.69	0.30	Right and Left Bank
6 R	46.0	3.7	Very High	Low	0.40	67.47	3.00	0.07	Right Bank
6 L	46.0	2.0	High	Low	0.40	36.80	1.64	0.04	Left Bank
7 (Right and Left Banks)	42.0	2.7	High	Low	0.40	44.80	2.00	0.05	Right and Left Bank
8 (Right and Left Banks)	34.0	3.3	High	Low	0.40	45.33	2.02	0.06	Right and Left Bank
9 (Right and Left Banks)	44.0	3.6	High	High	1.00	157.67	7.02	0.17	Right and Left Bank
10 (Right and Left Banks)	24.0	4.1	Extreme	High	2.50	245.00	10.91	0.49	Right and Left Bank
11 (Right and Left Banks)	24.0	1.7	High	Low	0.40	16.00	0.71	0.03	Right and Left Bank
12 (Right and Left Banks)	224.0	1.3	High	Extreme	2.50	700.00	31.18	0.15	Right and Left Bank
13 (Right and Left Banks)	68.0	1.2	Very High	Low	0.40	31.73	1.41	0.02	Right and Left Bank
14 (Right and Left Banks)	168.0	2.6	Very High	Extreme	2.50	1085.00	48.33	0.31	Right and Left Bank
15 (Right and Left Banks)	76.0	3.1	High	Extreme	2.50	585.83	26.09	0.37	Right and Left Bank
16 R	90.0	2.4	Extreme	Low	1.30	282.75	12.59	0.15	Right Bank
16 L	90.0	2.4	High	Low	0.40	87.00	3.87	0.05	Left Bank
17 (Right and Left Banks)	66.0	3.6	Very High	Low	0.25	59.13	2.63	0.04	Right and Left Bank
18 (Right and Left Banks)	98.0	2.5	High	Very High	1.75	428.75	19.10	0.21	Right and Left Bank
19 (Right and Left Banks)	206.0	2.0	Extreme	Extreme	4.50	1854.00	82.58	0.43	Right and Left Bank
20 (Right and Left Bank)	22.0	0.9	Very High	Moderate	0.64	12.91	0.57	0.03	Right Bank
21 (Right and Left Banks)	164.0	2.5	Very High	Moderate	0.64	262.40	11.69	0.08	Right and Left Bank
22 (Right and Left Banks)	160.0	0.8	High	Moderate	0.64	76.80	3.42	0.02	Right and Left Bank
23 (Right and Left Banks)	328.0	3.0	High	High	1.00	984.00	43.83	0.14	Right and Left Bank
24 (Right and Left Banks)	194.0	0.9	High	High	1.00	169.75	7.56	0.04	Right and Left Bank
25 (Right and Left Banks)	342.0	4.0	Moderate	Very High	0.70	957.60	42.65	0.13	Right and Left Bank
26 (Right and Left Banks)	292.0	3.0	High	Low	0.40	350.40	15.61	0.06	Right and Left Bank
27 (Right and Left Banks)	428.0	6.0	Moderate	High	0.80	2054.40	91.50	0.23	Right and Left Bank
28 (Right and Left Banks)	210.0	2.5	High	Moderate	0.64	336.00	14.97	0.08	Right and Left Bank
29 (Right and Left Banks)	134.0	1.8	Moderate	Low	0.13	29.31	1.31	0.01	Right and Left Bank
TOTAL OF ALL GRIDS	**3784.0**	**N/A**	**N/A**	**N/A**	**37.6**	**11,746.42**	**523.2**	**4.7**	

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

USFWS - SHARP
STREAM NAME - REACH IDENTIFICATION

BANK EROSION HAZARD INDEX

Stream:	Moore Park	**Observer(s):**	AT, JR, MM	**Data:**	AT	**QA/QC:**		**Total Score:**		**44.08**		
Reach:		**Comments:**								**Very High**		
Location:	1	**Bank Length**	32					**Total Score Values:**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**	**Extreme**
Date:	5/12/2022								5-10	10-20	20-30	30-40	40-45	45-50

Erodibility Variables

Bank Height / Bankfull Height Ratio

Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
2.50	0.29	8.57	10.00	Extreme	

Root Depth / Bank Height Ratio

Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
0.33	2.50	0.13	8.07	Very High	

Weighted Root Density

Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
30.00	0.13	4.00	10.00	Extreme	

Bank Angle

Bank Angle (°)		Index	Bank Erosion Potental	Notes
80.00		5.90	Moderate	

Surface Protection

Surface Protection (%)		Index	Bank Erosion Potental	Notes
40.00		5.11	Moderate	

	Adjustment		Notes
Bank Materials			
	Adjustment		Notes
Bank Stratification	5.00		undercutting
TOTAL SCORE	**44.08**		

Bank Erosion Potential

		Very Low	Low	Moderate	High	Very High	Extreme
Erodibility Variables							
Bank Height / Bankfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Root Depth / Bank Height	Value	1.00-0.90	0.89-0.50	0.49-0.30	0.29-0.15	0.14-0.05	<0.05
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Surface Protection	Value	100-80	79-55	54-30	29-15	14-10	<10
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10

Adjustments

Bank Material	
Bedrock	Bedrock banks have a very low erosion potential.
Boulders	Boulder banks have a low erosion potential.
Cobble	Substract 10 points. No adjustment if sand/gravel compose greater than 50% of bank.
Clay/Silt Loam	Add 5 points.
Gravel	Add 5-10 points depending on percentage of bank material composed of sand.
Sand	Add 10 points.
Silt / Clay	No adjustment.

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

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

Estimating Near-Bank Stress (NBS)

Stream: Location: **Moore Park**

Station: Stream Type: Valley Type: **Confined**

Observers: **AT, AD** Date: **5-25-22**

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)

Method	1
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**	

Copyright © 2008 Wildland Hydrology

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

USFWS - SHARP
STREAM NAME - REACH IDENTIFICATION

BANK EROSION HAZARD INDEX

Stream:	Moore Park	**Observer(s):**	AT, JR, MM	**Data:**	AT	**QA/QC:**		**Total Score:**		**36.69**		
Reach:		**Comments:**								**High**		
Location:	2 R	**Bank Length**	12					**Total Score Values:**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**	**Extreme**
Date:	5/12/2022								5-10	10-20	20-30	30-40	40-45	45-50

Erodibility Variables

Bank Height / Bankfull Height Ratio

Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
1.50	0.29	5.14	10.00	Extreme	

Root Depth / Bank Height Ratio

Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
0.50	1.50	0.33	5.57	Moderate	

Weighted Root Density

Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
15.00	0.33	5.00	9.00	Very High	

Bank Angle

Bank Angle (°)		Index	Bank Erosion Potental	Notes
70.00		4.90	Moderate	

Surface Protection

Surface Protection (%)		Index	Bank Erosion Potental	Notes
20.00		7.22	High	

	Adjustment		Notes
Bank Materials			
	Adjustment		Notes
Bank Stratification			
TOTAL SCORE	**36.69**		

Bank Erosion Potential

Erodibility Variables

		Very Low	Low	Moderate	High	Very High	Extreme
Bank Height / Bankfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Root Depth / Bank Height	Value	1.00-0.90	0.89-0.50	0.49-0.30	0.29-0.15	0.14-0.05	<0.05
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Surface Protection	Value	100-80	79-55	54-30	29-15	14-10	<10
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10

Adjustments

Bank Material

Bedrock	Bedrock banks have a very low erosion potential.
Boulders	Boulder banks have a low erosion potential.
Cobble	Substract 10 points. No adjustment if sand/gravel compose greater than 50% of bank.
Clay/Silt Loam	Add 5 points.
Gravel	Add 5-10 points depending on percentage of bank material composed of sand.
Sand	Add 10 points.
Silt / Clay	No adjustment.

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

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

Estimating Near-Bank Stress (NBS)

Stream: | Location: **Moore Park**

Station: | Stream Type: | Valley Type: **Confined**

Observers: **AT, AD** | Date: **5-25-22**

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)

Method	5
Dominant Near-Bank Stress	
Moderate	

Level III

(5)

Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkf} (ft)	*Ratio* d_{nb} / d_{bkf}	Near-Bank Stress (NBS)
1.1666667	**0.7**	**1.6666667**	**Moderate**

(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					**Moderate**	

Copyright © 2008 Wildland Hydrology

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

USFWS - SHARP
STREAM NAME - REACH IDENTIFICATION

BANK EROSION HAZARD INDEX

Stream:	Moore Park	**Observer(s):**	AT, JR, MM	**Data:**	AT	**QA/QC:**		**Total Score:**		**40.02**			
Reach:		**Comments:**								**Very High**			
Location:	2 L	**Bank Length**	12					**Total Score Values:**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**	**Extreme**
Date:	5/12/2022								5-10	10-20	20-30	30-40	40-45	45-50

Erodibility Variables

Bank Height / Bankfull Height Ratio

Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
3.33	0.29	11.43	10.00	Extreme	

Root Depth / Bank Height Ratio

Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
0.50	3.33	0.15	7.90	High	

Weighted Root Density

Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
15.00	0.15	2.25	10.00	Extreme	

Bank Angle

Bank Angle (°)		Index	Bank Erosion Potental	Notes
70.00		4.90	Moderate	

Surface Protection

Surface Protection (%)		Index	Bank Erosion Potental	Notes
20.00		7.22	High	

	Adjustment		Notes
Bank Materials			
	Adjustment		Notes
Bank Stratification			
TOTAL SCORE	**40.02**		

Bank Erosion Potential

		Very Low	Low	Moderate	High	Very High	Extreme
Erodibility Variables							
Bank Height / Bankfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Root Depth / Bank Height	Value	1.00-0.90	0.89-0.50	0.49-0.30	0.29-0.15	0.14-0.05	<0.05
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Surface Protection	Value	100-80	79-55	54-30	29-15	14-10	<10
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10

Adjustments

Bank Material	
Bedrock	Bedrock banks have a very low erosion potential.
Boulders	Boulder banks have a low erosion potential.
Cobble	Substract 10 points. No adjustment if sand/gravel compose greater than 50% of bank.
Clay/Silt Loam	Add 5 points.
Gravel	Add 5-10 points depending on percentage of bank material composed of sand.
Sand	Add 10 points.
Silt / Clay	No adjustment.

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

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

Estimating Near-Bank Stress (NBS)

Stream: | Location: **Moore Park**

Station: | Stream Type: | Valley Type: **Confined**

Observers: **AT, AD** | Date: **5-25-22**

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)

Method	5
Dominant Near-Bank Stress	
Moderate	

Level III

(5)

Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkf} (ft)	*Ratio* d_{nb} / d_{bkf}	Near-Bank Stress (NBS)
1.1666667	**0.7**	**1.6666667**	**Moderate**

(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					**Moderate**	

Copyright © 2008 Wildland Hydrology

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

USFWS - SHARP
STREAM NAME - REACH IDENTIFICATION

BANK EROSION HAZARD INDEX

Stream:	Moore Park	**Observer(s):**	AT, JR, MM	**Data:**	AT	**QA/QC:**		**Total Score:**		**43.64**		
Reach:		**Comments:**								**Very High**		
Location:	3 (Right and Left Banks)	**Bank Length**	32					**Total Score Values:**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**	**Extreme**
Date:	5/12/2022								5-10	10-20	20-30	30-40	40-45	45-50

Erodibility Variables					
Bank Height / Bankfull Height Ratio					
Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
3.17	0.29	10.86	10.00	Extreme	
Root Depth / Bank Height Ratio					
Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
1.00	3.17	0.32	5.74	Moderate	
Weighted Root Density					
Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
5.00	0.32	1.58	10.00	Extreme	
Bank Angle					
Bank Angle (°)			Index	Bank Erosion Potental	Notes
90.00			7.90	High	
Surface Protection					
Surface Protection (%)			Index	Bank Erosion Potental	Notes
2.00			10.00	Extreme	
			Adjustment		Notes
Bank Materials					
			Adjustment		Notes
Bank Stratification					
		TOTAL SCORE	**43.64**		

Bank Erosion Potential

		Very Low	Low	Moderate	High	Very High	Extreme
Erodibility Variables							
Bank Height / Bankfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Root Depth / Bank Height	Value	1.00-0.90	0.89-0.50	0.49-0.30	0.29-0.15	0.14-0.05	<0.05
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Surface Protection	Value	100-80	79-55	54-30	29-15	14-10	<10
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10

Adjustments

Bank Material	
Bedrock	Bedrock banks have a very low erosion potential.
Boulders	Boulder banks have a low erosion potential.
Cobble	Substract 10 points. No adjustment if sand/gravel compose greater than 50% of bank.
Clay/Silt Loam	Add 5 points.
Gravel	Add 5-10 points depending on percentage of bank material composed of sand.
Sand	Add 10 points.
Silt / Clay	No adjustment.

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

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

Estimating Near-Bank Stress (NBS)

Stream: Location: **Moore Park**

Station: Stream Type: Valley Type: **Confined**

Observers: **AT, AD** Date: **5-25-22**

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)

Method	1
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**	

Copyright © 2008 Wildland Hydrology

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

USFWS - SHARP
STREAM NAME - REACH IDENTIFICATION

BANK EROSION HAZARD INDEX

Stream:	Moore Park	**Observer(s):**	AT, JR, MM	**Data:**	AT	**QA/QC:**		**Total Score:**		**41.33**		
Reach:		**Comments:**								**Very High**		
Location:	4 (Right and Left Banks)	**Bank Length**	34					**Total Score Values:**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**	**Extreme**
Date:	5/12/2022								5-10	10-20	20-30	30-40	40-45	45-50

Erodibility Variables					
Bank Height / Bankfull Height Ratio					
Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
1.50	0.29	5.14	10.00	Extreme	
Root Depth / Bank Height Ratio					
Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
0.21	1.50	0.14	8.01	Very High	
Weighted Root Density					
Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
10.00	0.14	1.39	10.00	Extreme	
Bank Angle					
Bank Angle (°)			Index	Bank Erosion Potental	Notes
48.00			3.32	Low	
Surface Protection					
Surface Protection (%)			Index	Bank Erosion Potental	Notes
5.00			10.00	Extreme	
			Adjustment		Notes
Bank Materials					
			Adjustment		Notes
Bank Stratification					
		TOTAL SCORE	**41.33**		

Bank Erosion Potential

		Very Low	Low	Moderate	High	Very High	Extreme
Erodibility Variables							
Bank Height / Bankfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Root Depth / Bank Height	Value	1.00-0.90	0.89-0.50	0.49-0.30	0.29-0.15	0.14-0.05	<0.05
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Surface Protection	Value	100-80	79-55	54-30	29-15	14-10	<10
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10

Adjustments

Bedrock	Bedrock banks have a very low erosion potential.
Boulders	Boulder banks have a low erosion potential.
Cobble	Substract 10 points. No adjustment if sand/gravel compose greater than 50% of bank.
Clay/Silt Loam	Add 5 points.
Gravel	Add 5-10 points depending on percentage of bank material composed of sand.
Sand	Add 10 points.
Silt / Clay	No adjustment.

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

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

Estimating Near-Bank Stress (NBS)

Stream: Location: **Moore Park**

Station: Stream Type: Valley Type: **Confined**

Observers: **AT, AD** Date: **5-25-22**

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)

Method	1
Dominant Near-Bank Stress	
Moderate	

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					**Moderate**	

Copyright © 2008 Wildland Hydrology

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

USFWS - SHARP
STREAM NAME - REACH IDENTIFICATION

BANK EROSION HAZARD INDEX

Stream:	Moore Park	**Observer(s):**	AT, JR, MM	**Data:**	AT	**QA/QC:**		**Total Score:**		**40.03**			
Reach:		**Comments:**								**Very High**			
Location:	5 (Right and Left Banks)	**Bank Length**	42					**Total Score Values:**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**	**Extreme**
Date:	5/12/2022								5-10	10-20	20-30	30-40	40-45	45-50

Erodibility Variables

Bank Height / Bankfull Height Ratio

Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
2.50	0.29	8.57	10.00	Extreme	

Root Depth / Bank Height Ratio

Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
0.33	2.50	0.13	8.07	Very High	

Weighted Root Density

Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
30.00	0.13	4.00	10.00	Extreme	

Bank Angle

Bank Angle (°)		Index	Bank Erosion Potental	Notes
85.00		6.84	High	

Surface Protection

Surface Protection (%)		Index	Bank Erosion Potental	Notes
40.00		5.11	Moderate	

	Adjustment		Notes
Bank Materials			
	Adjustment		Notes
Bank Stratification			
TOTAL SCORE	**40.03**		

Bank Erosion Potential

		Very Low	Low	Moderate	High	Very High	Extreme
Erodibility Variables							
Bank Height / Bankfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Root Depth / Bank Height	Value	1.00-0.90	0.89-0.50	0.49-0.30	0.29-0.15	0.14-0.05	<0.05
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Surface Protection	Value	100-80	79-55	54-30	29-15	14-10	<10
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10

Adjustments

Bank Material	
Bedrock	Bedrock banks have a very low erosion potential.
Boulders	Boulder banks have a low erosion potential.
Cobble	Substract 10 points. No adjustment if sand/gravel compose greater than 50% of bank.
Clay/Silt Loam	Add 5 points.
Gravel	Add 5-10 points depending on percentage of bank material composed of sand.
Sand	Add 10 points.
Silt / Clay	No adjustment.

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

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

Estimating Near-Bank Stress (NBS)

Stream: Location: **Moore Park**

Station: Stream Type: Valley Type: **Confined**

Observers: **AT, AD** Date: **5-25-22**

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)

Method	1
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**	

Copyright © 2008 Wildland Hydrology

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

USFWS - SHARP
STREAM NAME - REACH IDENTIFICATION

BANK EROSION HAZARD INDEX

Stream:	Moore Park	**Observer(s):**	AT, JR, MM	**Data:**	AT	**QA/QC:**		**Total Score:**		**40.97**			
Reach:		**Comments:**								**Very High**			
Location:	6 R	**Bank Length**	46					**Total Score Values:**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**	**Extreme**
Date:	5/12/2022								5-10	10-20	20-30	30-40	40-45	45-50

Erodibility Variables

Bank Height / Bankfull Height Ratio

Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
3.67	0.29	12.57	10.00	Extreme	

Root Depth / Bank Height Ratio

Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
0.50	3.67	0.14	8.04	Very High	

Weighted Root Density

Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
35.00	0.14	4.77	10.00	Extreme	

Bank Angle

Bank Angle (°)		Index	Bank Erosion Potental	Notes
40.00		2.93	Low	

Surface Protection

Surface Protection (%)		Index	Bank Erosion Potental	Notes
5.00		10.00	Extreme	

	Adjustment		Notes
Bank Materials			
	Adjustment		Notes
Bank Stratification			
TOTAL SCORE	**40.97**		

Bank Erosion Potential

		Very Low	Low	Moderate	High	Very High	Extreme
Erodibility Variables							
Bank Height / Bankfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Root Depth / Bank Height	Value	1.00-0.90	0.89-0.50	0.49-0.30	0.29-0.15	0.14-0.05	<0.05
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Surface Protection	Value	100-80	79-55	54-30	29-15	14-10	<10
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10

Adjustments

Bank Material	
Bedrock	Bedrock banks have a very low erosion potential.
Boulders	Boulder banks have a low erosion potential.
Cobble	Substract 10 points. No adjustment if sand/gravel compose greater than 50% of bank.
Clay/Silt Loam	Add 5 points.
Gravel	Add 5-10 points depending on percentage of bank material composed of sand.
Sand	Add 10 points.
Silt / Clay	No adjustment.

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

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

Estimating Near-Bank Stress (NBS)

Stream: | Location: **Moore Park**

Station: | Stream Type: | Valley Type: **Confined**

Observers: **AT, AD** | Date: **5-25-22**

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)

Method	5
Dominant Near-Bank Stress	
Low	

Level III

(5)

Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkf} (ft)	*Ratio* d_{nb} / d_{bkf}	Near-Bank Stress (NBS)
1.75	**1.2833333**	**1.3636364**	**Low**

(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					**Low**	

Copyright © 2008 Wildland Hydrology

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

USFWS - SHARP
STREAM NAME - REACH IDENTIFICATION

BANK EROSION HAZARD INDEX

Stream:	Moore Park	**Observer(s):**	AT, JR, MM	**Data:**	AT	**QA/QC:**		**Total Score:**		**38.05**		
Reach:		**Comments:**								**High**		
Location:	6 L	**Bank Length**	46					**Total Score Values:**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**	**Extreme**
Date:	5/12/2022								5-10	10-20	20-30	30-40	40-45	45-50

Erodibility Variables

Bank Height / Bankfull Height Ratio

Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
2.00	0.29	6.86	10.00	Extreme	

Root Depth / Bank Height Ratio

Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
0.50	2.00	0.25	6.54	High	

Weighted Root Density

Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
35.00	0.25	8.75	8.58	Very High	

Bank Angle

Bank Angle (°)		Index	Bank Erosion Potental	Notes
40.00		2.93	Low	

Surface Protection

Surface Protection (%)		Index	Bank Erosion Potental	Notes
5.00		10.00	Extreme	

	Adjustment		Notes
Bank Materials			
	Adjustment		Notes
Bank Stratification			
TOTAL SCORE	**38.05**		

Bank Erosion Potential

		Very Low	Low	Moderate	High	Very High	Extreme
Erodibility Variables							
Bank Height / Bankfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Root Depth / Bank Height	Value	1.00-0.90	0.89-0.50	0.49-0.30	0.29-0.15	0.14-0.05	<0.05
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Surface Protection	Value	100-80	79-55	54-30	29-15	14-10	<10
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10

Adjustments

Bank Material	
Bedrock	Bedrock banks have a very low erosion potential.
Boulders	Boulder banks have a low erosion potential.
Cobble	Substract 10 points. No adjustment if sand/gravel compose greater than 50% of bank.
Clay/Silt Loam	Add 5 points.
Gravel	Add 5-10 points depending on percentage of bank material composed of sand.
Sand	Add 10 points.
Silt / Clay	No adjustment.

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

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

Estimating Near-Bank Stress (NBS)

Stream: | Location: **Moore Park**

Station: | Stream Type: | Valley Type: **Confined**

Observers: **AT, AD** | Date: **5-25-22**

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)

Method	5
Dominant Near-Bank Stress	
Low	

Level III

(5)

Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkf} (ft)	*Ratio* d_{nb} / d_{bkf}	Near-Bank Stress (NBS)
1.75	**1.2833333**	**1.3636364**	**Low**

(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					**Low**	

Copyright © 2008 Wildland Hydrology

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

USFWS - SHARP
STREAM NAME - REACH IDENTIFICATION

BANK EROSION HAZARD INDEX

Stream:	Moore Park	**Observer(s):**	AT, JR, MM	**Data:**	AT	**QA/QC:**		**Total Score:**		**38.37**		
Reach:		**Comments:**								**High**		
Location:	7 (Right and Left Banks)	**Bank Length**	42					**Total Score Values:**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**	**Extreme**
Date:	5/12/2022								5-10	10-20	20-30	30-40	40-45	45-50

Erodibility Variables

Bank Height / Bankfull Height Ratio

Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
2.67	0.29	9.14	10.00	Extreme	

Root Depth / Bank Height Ratio

Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
1.25	2.67	0.47	4.21	Moderate	

Weighted Root Density

Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
25.00	0.47	11.72	8.25	Very High	

Bank Angle

Bank Angle (°)		Index	Bank Erosion Potental	Notes
80.00		5.90	Moderate	

Surface Protection

Surface Protection (%)		Index	Bank Erosion Potental	Notes
2.00		10.00	Extreme	

	Adjustment		Notes
Bank Materials			
	Adjustment		Notes
Bank Stratification			
TOTAL SCORE	**38.37**		

Bank Erosion Potential

		Very Low	Low	Moderate	High	Very High	Extreme
Erodibility Variables							
Bank Height / Bankfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Root Depth / Bank Height	Value	1.00-0.90	0.89-0.50	0.49-0.30	0.29-0.15	0.14-0.05	<0.05
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Surface Protection	Value	100-80	79-55	54-30	29-15	14-10	<10
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10

Adjustments

Bank Material	
Bedrock	Bedrock banks have a very low erosion potential.
Boulders	Boulder banks have a low erosion potential.
Cobble	Substract 10 points. No adjustment if sand/gravel compose greater than 50% of bank.
Clay/Silt Loam	Add 5 points.
Gravel	Add 5-10 points depending on percentage of bank material composed of sand.
Sand	Add 10 points.
Silt / Clay	No adjustment.

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

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

Estimating Near-Bank Stress (NBS)

Stream: | Location: **Moore Park**

Station: | Stream Type: | Valley Type: **Confined**

Observers: **AT, AD** | Date: **5-25-22**

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)

Method	5
Dominant Near-Bank Stress	
Low	

Level III

(5)

Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkf} (ft)	*Ratio* d_{nb} / d_{bkf}	Near-Bank Stress (NBS)
1.75	**1.2833333**	**1.3636364**	**Low**

(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					**Low**	

Copyright © 2008 Wildland Hydrology

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

USFWS - SHARP
STREAM NAME - REACH IDENTIFICATION

BANK EROSION HAZARD INDEX

Stream:	Moore Park	**Observer(s):**	AT, JR, MM	**Data:**	AT	**QA/QC:**		**Total Score:**		**39.21**		
Reach:		**Comments:**								**High**		
Location:	8 (Right and Left Banks)	**Bank Length**	34					**Total Score Values:**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**	**Extreme**
Date:	5/12/2022								5-10	10-20	20-30	30-40	40-45	45-50

Erodibility Variables

Bank Height / Bankfull Height Ratio

Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
3.33	0.29	11.43	10.00	Extreme	

Root Depth / Bank Height Ratio

Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
2.00	3.33	0.60	3.41	Low	

Weighted Root Density

Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
25.00	0.60	15.00	7.90	High	

Bank Angle

Bank Angle (°)		Index	Bank Erosion Potental	Notes
90.00		7.90	High	

Surface Protection

Surface Protection (%)		Index	Bank Erosion Potental	Notes
5.00		10.00	Extreme	

	Adjustment		Notes
Bank Materials			
	Adjustment		Notes
Bank Stratification			
TOTAL SCORE	**39.21**		

Bank Erosion Potential

		Very Low	Low	Moderate	High	Very High	Extreme
Erodibility Variables							
Bank Height / Bankfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Root Depth / Bank Height	Value	1.00-0.90	0.89-0.50	0.49-0.30	0.29-0.15	0.14-0.05	<0.05
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Surface Protection	Value	100-80	79-55	54-30	29-15	14-10	<10
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10

Adjustments

Bank Material	
Bedrock	Bedrock banks have a very low erosion potential.
Boulders	Boulder banks have a low erosion potential.
Cobble	Substract 10 points. No adjustment if sand/gravel compose greater than 50% of bank.
Clay/Silt Loam	Add 5 points.
Gravel	Add 5-10 points depending on percentage of bank material composed of sand.
Sand	Add 10 points.
Silt / Clay	No adjustment.

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

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

Estimating Near-Bank Stress (NBS)

Stream: | Location: **Moore Park**

Station: | Stream Type: | Valley Type: **Confined**

Observers: **AT, AD** | Date: **5-25-22**

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)

Method	5
Dominant Near-Bank Stress	
Low	

Level III

(5)

Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkf} (ft)	*Ratio* d_{nb} / d_{bkf}	Near-Bank Stress (NBS)
1.75	**1.2833333**	**1.3636364**	**Low**

(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					**Low**	

Copyright © 2008 Wildland Hydrology

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

USFWS - SHARP
STREAM NAME - REACH IDENTIFICATION

BANK EROSION HAZARD INDEX

Stream:	Moore Park	**Observer(s):**	AT, JR, MM	**Data:**	AT	**QA/QC:**		**Total Score:**		**39.44**		
Reach:		**Comments:**								**High**		
Location:	9 (Right and Left Banks)	**Bank Length**	44					**Total Score Values:**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**	**Extreme**
Date:	5/12/2022								5-10	10-20	20-30	30-40	40-45	45-50

Erodibility Variables

Bank Height / Bankfull Height Ratio

Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
3.58	0.29	12.29	10.00	Extreme	

Root Depth / Bank Height Ratio

Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
1.17	3.58	0.33	5.64	Moderate	

Weighted Root Density

Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
10.00	0.33	3.26	10.00	Extreme	

Bank Angle

Bank Angle (°)		Index	Bank Erosion Potental	Notes
90.00		7.90	High	

Surface Protection

Surface Protection (%)		Index	Bank Erosion Potental	Notes
30.00		5.90	Moderate	

	Adjustment		Notes
Bank Materials			
	Adjustment		Notes
Bank Stratification			
TOTAL SCORE	**39.44**		

Bank Erosion Potential

		Very Low	Low	Moderate	High	Very High	Extreme
Erodibility Variables							
Bank Height / Bankfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Root Depth / Bank Height	Value	1.00-0.90	0.89-0.50	0.49-0.30	0.29-0.15	0.14-0.05	<0.05
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Surface Protection	Value	100-80	79-55	54-30	29-15	14-10	<10
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10

Adjustments

Bedrock	Bedrock banks have a very low erosion potential.
Boulders	Boulder banks have a low erosion potential.
Cobble	Substract 10 points. No adjustment if sand/gravel compose greater than 50% of bank.
Clay/Silt Loam	Add 5 points.
Gravel	Add 5-10 points depending on percentage of bank material composed of sand.
Sand	Add 10 points.
Silt / Clay	No adjustment.

Bank Material

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

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

Estimating Near-Bank Stress (NBS)

Stream: Location: **Moore Park**

Station: Stream Type: Valley Type: **Confined**

Observers: **AT, AD** Date: **5-25-22**

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)

Method	1
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**	

Copyright © 2008 Wildland Hydrology

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

USFWS - SHARP
STREAM NAME - REACH IDENTIFICATION

BANK EROSION HAZARD INDEX

Stream:	Moore Park	**Observer(s):**	AT, JR, MM	**Data:**	AT	**QA/QC:**		**Total Score:**		**50.62**		
Reach:		**Comments:**								**Extreme**		
Location:	10 (Right and Left Banks)	**Bank Length**	24					**Total Score Values:**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**	**Extreme**
Date:	5/12/2022								5-10	10-20	20-30	30-40	40-45	45-50

Erodibility Variables

Bank Height / Bankfull Height Ratio

Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
4.08	0.29	14.00	10.00	Extreme	

Root Depth / Bank Height Ratio

Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
0.67	4.08	0.16	7.72	High	

Weighted Root Density

Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
10.00	0.16	1.63	10.00	Extreme	

Bank Angle

Bank Angle (°)		Index	Bank Erosion Potental	Notes
90.00		7.90	High	

Surface Protection

Surface Protection (%)		Index	Bank Erosion Potental	Notes
5.00		10.00	Extreme	

	Adjustment		Notes
Bank Materials			
	Adjustment		Notes
Bank Stratification	5.00		Undercutting
TOTAL SCORE	**50.62**		

Bank Erosion Potential

		Very Low	Low	Moderate	High	Very High	Extreme
Erodibility Variables							
Bank Height / Bankfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Root Depth / Bank Height	Value	1.00-0.90	0.89-0.50	0.49-0.30	0.29-0.15	0.14-0.05	<0.05
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Surface Protection	Value	100-80	79-55	54-30	29-15	14-10	<10
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10

Adjustments

Bank Material	
Bedrock	Bedrock banks have a very low erosion potential.
Boulders	Boulder banks have a low erosion potential.
Cobble	Substract 10 points. No adjustment if sand/gravel compose greater than 50% of bank.
Clay/Silt Loam	Add 5 points.
Gravel	Add 5-10 points depending on percentage of bank material composed of sand.
Sand	Add 10 points.
Silt / Clay	No adjustment.

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

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

Estimating Near-Bank Stress (NBS)

Stream: Location: **Moore Park**

Station: Stream Type: Valley Type: **Confined**

Observers: **AT, AD** Date: **5-25-22**

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)

Method	1
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**	

Copyright © 2008 Wildland Hydrology

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

USFWS - SHARP
STREAM NAME - REACH IDENTIFICATION

BANK EROSION HAZARD INDEX

Stream:	Moore Park	**Observer(s):**	AT, JR, MM	**Data:**	AT	**QA/QC:**		**Total Score:**		**35.50**		
Reach:		**Comments:**								**High**		
Location:	11 (Right and Left Banks)	**Bank Length**	24					**Total Score Values:**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**	**Extreme**
Date:	5/12/2022								5-10	10-20	20-30	30-40	40-45	45-50

Erodibility Variables

Bank Height / Bankfull Height Ratio

Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
1.67	0.29	5.71	10.00	Extreme	

Root Depth / Bank Height Ratio

Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
0.33	1.67	0.20	7.22	High	

Weighted Root Density

Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
15.00	0.20	3.00	10.00	Extreme	

Bank Angle

Bank Angle (°)		Index	Bank Erosion Potental	Notes
45.00		3.17	Low	

Surface Protection

Surface Protection (%)		Index	Bank Erosion Potental	Notes
40.00		5.11	Moderate	

	Adjustment		Notes
Bank Materials			
	Adjustment		Notes
Bank Stratification			
TOTAL SCORE	**35.50**		

Bank Erosion Potential

		Very Low	Low	Moderate	High	Very High	Extreme
Erodibility Variables							
Bank Height / Bankfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Root Depth / Bank Height	Value	1.00-0.90	0.89-0.50	0.49-0.30	0.29-0.15	0.14-0.05	<0.05
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Surface Protection	Value	100-80	79-55	54-30	29-15	14-10	<10
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10

Adjustments

Bank Material	
Bedrock	Bedrock banks have a very low erosion potential.
Boulders	Boulder banks have a low erosion potential.
Cobble	Substract 10 points. No adjustment if sand/gravel compose greater than 50% of bank.
Clay/Silt Loam	Add 5 points.
Gravel	Add 5-10 points depending on percentage of bank material composed of sand.
Sand	Add 10 points.
Silt / Clay	No adjustment.

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

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

Estimating Near-Bank Stress (NBS)

Stream: | Location: **Moore Park**

Station: | Stream Type: | Valley Type: **Confined**

Observers: **AT, AD** | Date: **5-25-22**

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)

Method	5
Dominant Near-Bank Stress	
Low	

Level III

(5)

Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkf} (ft)	*Ratio* d_{nb} / d_{bkf}	Near-Bank Stress (NBS)
1.75	**1.2833333**	**1.3636364**	**Low**

(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					**Low**	

Copyright © 2008 Wildland Hydrology

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

USFWS - SHARP
STREAM NAME - REACH IDENTIFICATION

BANK EROSION HAZARD INDEX

Stream:	Moore Park	**Observer(s):**	AT, JR, MM	**Data:**	AT	**QA/QC:**		**Total Score:**		**34.98**		
Reach:		**Comments:**								**High**		
Location:	12 (Right and Left Banks)	**Bank Length**	224					**Total Score Values:**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**	**Extreme**
Date:	5/12/2022								5-10	10-20	20-30	30-40	40-45	45-50

Erodibility Variables

Bank Height / Bankfull Height Ratio

Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
1.25	0.29	4.29	10.00	Extreme	

Root Depth / Bank Height Ratio

Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
0.17	1.25	0.13	8.07	Very High	

Weighted Root Density

Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
10.00	0.13	1.33	10.00	Extreme	

Bank Angle

Bank Angle (°)		Index	Bank Erosion Potental	Notes
25.00		2.19	Low	

Surface Protection

Surface Protection (%)		Index	Bank Erosion Potental	Notes
45.00		4.71	Moderate	

	Adjustment		Notes
Bank Materials			
	Adjustment		Notes
Bank Stratification			
TOTAL SCORE	**34.98**		

Bank Erosion Potential

		Very Low	Low	Moderate	High	Very High	Extreme
Erodibility Variables							
Bank Height / Bankfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Root Depth / Bank Height	Value	1.00-0.90	0.89-0.50	0.49-0.30	0.29-0.15	0.14-0.05	<0.05
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Surface Protection	Value	100-80	79-55	54-30	29-15	14-10	<10
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10

Adjustments

Bedrock	Bedrock banks have a very low erosion potential.
Boulders	Boulder banks have a low erosion potential.
Cobble	Substract 10 points. No adjustment if sand/gravel compose greater than 50% of bank.
Clay/Silt Loam	Add 5 points.
Gravel	Add 5-10 points depending on percentage of bank material composed of sand.
Sand	Add 10 points.
Silt / Clay	No adjustment.

Bank Material

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

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

Estimating Near-Bank Stress (NBS)

Stream: Location: **Moore Park**

Station: Stream Type: Valley Type: **Confined**

Observers: **AT, AD** Date: **5-25-22**

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)

Method	1
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**	

Copyright © 2008 Wildland Hydrology

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

USFWS - SHARP
STREAM NAME - REACH IDENTIFICATION

BANK EROSION HAZARD INDEX

Stream:	Moore Park	**Observer(s):**	AT, JR, MM	**Data:**	AT	**QA/QC:**		**Total Score:**		**41.87**		
Reach:		**Comments:**								**Very High**		
Location:	13 (Right and Left Banks)	**Bank Length**	68					**Total Score Values:**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**	**Extreme**
Date:	5/12/2022								5-10	10-20	20-30	30-40	40-45	45-50

Erodibility Variables

Bank Height / Bankfull Height Ratio

Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
1.17	0.29	4.00	10.00	Extreme	

Root Depth / Bank Height Ratio

Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
0.46	1.17	0.39	4.97	Moderate	

Weighted Root Density

Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
5.00	0.39	1.96	10.00	Extreme	

Bank Angle

Bank Angle (°)		Index	Bank Erosion Potental	Notes
90.00		7.90	High	

Surface Protection

Surface Protection (%)		Index	Bank Erosion Potental	Notes
10.00		9.00	Very High	

	Adjustment		Notes
Bank Materials			
	Adjustment		Notes
Bank Stratification			
TOTAL SCORE	**41.87**		

Bank Erosion Potential

		Very Low	Low	Moderate	High	Very High	Extreme
Erodibility Variables							
Bank Height / Bankfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Root Depth / Bank Height	Value	1.00-0.90	0.89-0.50	0.49-0.30	0.29-0.15	0.14-0.05	<0.05
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Surface Protection	Value	100-80	79-55	54-30	29-15	14-10	<10
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10

Adjustments

Bedrock	Bedrock banks have a very low erosion potential.
Boulders	Boulder banks have a low erosion potential.
Cobble	Substract 10 points. No adjustment if sand/gravel compose greater than 50% of bank.
Clay/Silt Loam	Add 5 points.
Gravel	Add 5-10 points depending on percentage of bank material composed of sand.
Sand	Add 10 points.
Silt / Clay	No adjustment.

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

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

Estimating Near-Bank Stress (NBS)

Stream: | Location: **Moore Park**

Station: | Stream Type: | Valley Type: **Confined**

Observers: **AT, AD** | Date: **5-25-22**

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)

Method	5
Dominant Near-Bank Stress	
Low	

Level III

(5)

Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkf} (ft)	*Ratio* d_{nb} / d_{bkf}	Near-Bank Stress (NBS)
1.75	**1.2833333**	**1.3636364**	**Low**

(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					**Low**	

Copyright © 2008 Wildland Hydrology

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

USFWS - SHARP
STREAM NAME - REACH IDENTIFICATION

BANK EROSION HAZARD INDEX

Stream:	Moore Park	**Observer(s):**	AT, JR, MM	**Data:**	AT	**QA/QC:**		**Total Score:**		**41.00**		
Reach:		**Comments:**								**Very High**		
Location:	14 (Right and Left Banks)	**Bank Length**	168					**Total Score Values:**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**	**Extreme**
Date:	5/12/2022								5-10	10-20	20-30	30-40	40-45	45-50

Erodibility Variables

Bank Height / Bankfull Height Ratio

Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
2.58	0.29	8.86	10.00	Extreme	

Root Depth / Bank Height Ratio

Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
1.08	2.58	0.42	4.71	Moderate	

Weighted Root Density

Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
25.00	0.42	10.48	8.39	Very High	

Bank Angle

Bank Angle (°)		Index	Bank Erosion Potental	Notes
90.00		7.90	High	

Surface Protection

Surface Protection (%)		Index	Bank Erosion Potental	Notes
1.00		10.00	Extreme	

	Adjustment		Notes
Bank Materials			
	Adjustment		Notes
Bank Stratification			
TOTAL SCORE	**41.00**		

Bank Erosion Potential

		Very Low	Low	Moderate	High	Very High	Extreme
Erodibility Variables							
Bank Height / Bankfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Root Depth / Bank Height	Value	1.00-0.90	0.89-0.50	0.49-0.30	0.29-0.15	0.14-0.05	<0.05
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Surface Protection	Value	100-80	79-55	54-30	29-15	14-10	<10
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10

Adjustments

Bedrock	Bedrock banks have a very low erosion potential.
Boulders	Boulder banks have a low erosion potential.
Cobble	Substract 10 points. No adjustment if sand/gravel compose greater than 50% of bank.
Clay/Silt Loam	Add 5 points.
Gravel	Add 5-10 points depending on percentage of bank material composed of sand.
Sand	Add 10 points.
Silt / Clay	No adjustment.

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

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

Estimating Near-Bank Stress (NBS)

Stream: Location: **Moore Park**

Station: Stream Type: Valley Type: **Confined**

Observers: **AT, AD** Date: **5-25-22**

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)

Method	**1**
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**	

Copyright © 2008 Wildland Hydrology

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

USFWS - SHARP
STREAM NAME - REACH IDENTIFICATION

BANK EROSION HAZARD INDEX

Stream:	Moore Park	**Observer(s):**	AT, JR, MM	**Data:**	AT	**QA/QC:**		**Total Score:**		**38.92**		
Reach:		**Comments:**								**High**		
Location:	15 (Right and Left Banks)	**Bank Length**	76					**Total Score Values:**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**	**Extreme**
Date:	5/12/2022								5-10	10-20	20-30	30-40	40-45	45-50

Erodibility Variables

Bank Height / Bankfull Height Ratio

Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
3.08	0.29	10.57	10.00	Extreme	

Root Depth / Bank Height Ratio

Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
0.83	3.08	0.27	6.27	High	

Weighted Root Density

Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
15.00	0.27	4.05	10.00	Extreme	

Bank Angle

Bank Angle (°)		Index	Bank Erosion Potental	Notes
55.00		3.66	Low	

Surface Protection

Surface Protection (%)		Index	Bank Erosion Potental	Notes
10.00		9.00	Very High	

	Adjustment		Notes
Bank Materials			
	Adjustment		Notes
Bank Stratification			
TOTAL SCORE	**38.92**		

Bank Erosion Potential

		Very Low	Low	Moderate	High	Very High	Extreme
Erodibility Variables							
Bank Height / Bankfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Root Depth / Bank Height	Value	1.00-0.90	0.89-0.50	0.49-0.30	0.29-0.15	0.14-0.05	<0.05
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Surface Protection	Value	100-80	79-55	54-30	29-15	14-10	<10
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10

Adjustments

Bedrock	Bedrock banks have a very low erosion potential.
Boulders	Boulder banks have a low erosion potential.
Cobble	Substract 10 points. No adjustment if sand/gravel compose greater than 50% of bank.
Clay/Silt Loam	Add 5 points.
Gravel	Add 5-10 points depending on percentage of bank material composed of sand.
Sand	Add 10 points.
Silt / Clay	No adjustment.

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

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

Estimating Near-Bank Stress (NBS)

Stream: Location: **Moore Park**

Station: Stream Type: Valley Type: **Confined**

Observers: **AT, AD** Date: **5-25-22**

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)

Method	1
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**	

Copyright © 2008 Wildland Hydrology

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

USFWS - SHARP
STREAM NAME - REACH IDENTIFICATION

BANK EROSION HAZARD INDEX

Stream:	Moore Park	**Observer(s):**	AT, JR, MM	**Data:**	AT	**QA/QC:**		**Total Score:**		**52.11**		
Reach:		**Comments:**								**Extreme**		
Location:	16 R	**Bank Length**	90					**Total Score Values:**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**	**Extreme**
Date:	5/12/2022								5-10	10-20	20-30	30-40	40-45	45-50

Erodibility Variables

Bank Height / Bankfull Height Ratio

Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
2.42	0.29	8.29	10.00	Extreme	

Root Depth / Bank Height Ratio

Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
0.67	2.42	0.28	6.19	High	

Weighted Root Density

Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
50.00	0.28	13.79	8.02	Very High	

Bank Angle

Bank Angle (°)		Index	Bank Erosion Potental	Notes
90.00		7.90	High	

Surface Protection

Surface Protection (%)		Index	Bank Erosion Potental	Notes
2.00		10.00	Extreme	

	Adjustment		Notes
Bank Materials			
	Adjustment		Notes
Bank Stratification	10.00		
TOTAL SCORE	**52.11**		

Bank Erosion Potential

		Very Low	Low	Moderate	High	Very High	Extreme
Erodibility Variables							
Bank Height / Bankfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Root Depth / Bank Height	Value	1.00-0.90	0.89-0.50	0.49-0.30	0.29-0.15	0.14-0.05	<0.05
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Surface Protection	Value	100-80	79-55	54-30	29-15	14-10	<10
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10

Adjustments

Bedrock	Bedrock banks have a very low erosion potential.
Boulders	Boulder banks have a low erosion potential.
Cobble	Substract 10 points. No adjustment if sand/gravel compose greater than 50% of bank.
Clay/Silt Loam	Add 5 points.
Gravel	Add 5-10 points depending on percentage of bank material composed of sand.
Sand	Add 10 points.
Silt / Clay	No adjustment.

Bank Material

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

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

Estimating Near-Bank Stress (NBS)

Stream: | Location: **Moore Park**

Station: | Stream Type: | Valley Type: **Confined**

Observers: **AT, AD** | Date: **5-25-22**

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)

Method	5
Dominant Near-Bank Stress	
Low	

Level III

(5)

Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkf} (ft)	*Ratio* d_{nb} / d_{bkf}	Near-Bank Stress (NBS)
1.4583333	**0.9916667**	**1.4705882**	**Low**

(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					**Low**	

Copyright © 2008 Wildland Hydrology

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

USFWS - SHARP
STREAM NAME - REACH IDENTIFICATION

BANK EROSION HAZARD INDEX

Stream:	Moore Park	**Observer(s):**	AT, JR, MM	**Data:**	AT	**QA/QC:**		**Total Score:**		**33.87**		
Reach:		**Comments:**								**High**		
Location:	16 L	**Bank Length**	90					**Total Score Values:**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**	**Extreme**
Date:	5/12/2022								5-10	10-20	20-30	30-40	40-45	45-50

Erodibility Variables

Bank Height / Bankfull Height Ratio

Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
2.42	0.29	8.29	10.00	Extreme	

Root Depth / Bank Height Ratio

Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
0.67	2.42	0.28	6.19	High	

Weighted Root Density

Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
50.00	0.28	13.79	8.02	Very High	

Bank Angle

Bank Angle (°)		Index	Bank Erosion Potental	Notes
30.00		2.44	Low	

Surface Protection

Surface Protection (%)		Index	Bank Erosion Potental	Notes
20.00		7.22	High	

	Adjustment		Notes
Bank Materials			
	Adjustment		Notes
Bank Stratification			
TOTAL SCORE	**33.87**		

Bank Erosion Potential

		Very Low	Low	Moderate	High	Very High	Extreme
Erodibility Variables							
Bank Height / Bankfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Root Depth / Bank Height	Value	1.00-0.90	0.89-0.50	0.49-0.30	0.29-0.15	0.14-0.05	<0.05
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Surface Protection	Value	100-80	79-55	54-30	29-15	14-10	<10
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10

Adjustments

Bedrock	Bedrock banks have a very low erosion potential.
Boulders	Boulder banks have a low erosion potential.
Cobble	Substract 10 points. No adjustment if sand/gravel compose greater than 50% of bank.
Clay/Silt Loam	Add 5 points.
Gravel	Add 5-10 points depending on percentage of bank material composed of sand.
Sand	Add 10 points.
Silt / Clay	No adjustment.

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

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

Estimating Near-Bank Stress (NBS)

Stream: | Location: **Moore Park**

Station: | Stream Type: | Valley Type: **Confined**

Observers: **AT, AD** | Date: **5-25-22**

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)

Method	5
Dominant Near-Bank Stress	
Low	

Level III

(5)

Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkf} (ft)	*Ratio* d_{nb} / d_{bkf}	Near-Bank Stress (NBS)
1.4583333	**0.9916667**	**1.4705882**	**Low**

(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					**Low**	

Copyright © 2008 Wildland Hydrology

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

USFWS - SHARP
STREAM NAME - REACH IDENTIFICATION

BANK EROSION HAZARD INDEX

Stream:	Moore Park	**Observer(s):**	AT, JR, MM	**Data:**	AT	**QA/QC:**		**Total Score:**		**43.35**		
Reach:		**Comments:**								**Very High**		
Location:	17 (Right and Left Banks)	**Bank Length**	66					**Total Score Values:**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**	**Extreme**
Date:	5/12/2022								5-10	10-20	20-30	30-40	40-45	45-50

Erodibility Variables

Bank Height / Bankfull Height Ratio

Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
3.58	0.29	12.29	10.00	Extreme	

Root Depth / Bank Height Ratio

Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
0.92	3.58	0.26	6.46	High	

Weighted Root Density

Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
20.00	0.26	5.12	8.99	Very High	

Bank Angle

Bank Angle (°)		Index	Bank Erosion Potental	Notes
90.00		7.90	High	

Surface Protection

Surface Protection (%)		Index	Bank Erosion Potental	Notes
2.00		10.00	Extreme	

	Adjustment		Notes
Bank Materials			
	Adjustment		Notes
Bank Stratification			
TOTAL SCORE	**43.35**		

Bank Erosion Potential

		Very Low	Low	Moderate	High	Very High	Extreme
Erodibility Variables							
Bank Height / Bankfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Root Depth / Bank Height	Value	1.00-0.90	0.89-0.50	0.49-0.30	0.29-0.15	0.14-0.05	<0.05
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Surface Protection	Value	100-80	79-55	54-30	29-15	14-10	<10
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10

Adjustments

Bank Material	
Bedrock	Bedrock banks have a very low erosion potential.
Boulders	Boulder banks have a low erosion potential.
Cobble	Substract 10 points. No adjustment if sand/gravel compose greater than 50% of bank.
Clay/Silt Loam	Add 5 points.
Gravel	Add 5-10 points depending on percentage of bank material composed of sand.
Sand	Add 10 points.
Silt / Clay	No adjustment.

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

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

Estimating Near-Bank Stress (NBS)

Stream: | Location: **Moore Park**

Station: | Stream Type: | Valley Type: **Confined**

Observers: **AT, AD** | Date: **5-25-22**

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)

Method	5
Dominant Near-Bank Stress	
Low	

Level III

(5)

Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkf} (ft)	*Ratio* d_{nb} / d_{bkf}	Near-Bank Stress (NBS)
1.4583333	**0.9916667**	**1.4705882**	**Low**

(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					**Low**	

Copyright © 2008 Wildland Hydrology

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

USFWS - SHARP
STREAM NAME - REACH IDENTIFICATION

BANK EROSION HAZARD INDEX

Stream:	Moore Park	**Observer(s):**	AT, JR, MM	**Data:**	AT	**QA/QC:**		**Total Score:**		**39.30**		
Reach:		**Comments:**								**High**		
Location:	18 (Right and Left Banks)	**Bank Length**	98					**Total Score Values:**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**	**Extreme**
Date:	5/12/2022								5-10	10-20	20-30	30-40	40-45	45-50

Erodibility Variables

Bank Height / Bankfull Height Ratio

Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
2.50	0.29	8.57	10.00	Extreme	

Root Depth / Bank Height Ratio

Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
0.75	2.50	0.30	5.90	Moderate	

Weighted Root Density

Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
15.00	0.30	4.50	10.00	Extreme	

Bank Angle

Bank Angle (°)		Index	Bank Erosion Potental	Notes
65.00		4.40	Moderate	

Surface Protection

Surface Protection (%)		Index	Bank Erosion Potental	Notes
10.00		9.00	Very High	

	Adjustment		Notes
Bank Materials			
	Adjustment		Notes
Bank Stratification			
TOTAL SCORE	**39.30**		

Bank Erosion Potential

		Very Low	Low	Moderate	High	Very High	Extreme
Erodibility Variables							
Bank Height / Bankfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Root Depth / Bank Height	Value	1.00-0.90	0.89-0.50	0.49-0.30	0.29-0.15	0.14-0.05	<0.05
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Surface Protection	Value	100-80	79-55	54-30	29-15	14-10	<10
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10

Adjustments

Bank Material	
Bedrock	Bedrock banks have a very low erosion potential.
Boulders	Boulder banks have a low erosion potential.
Cobble	Substract 10 points. No adjustment if sand/gravel compose greater than 50% of bank.
Clay/Silt Loam	Add 5 points.
Gravel	Add 5-10 points depending on percentage of bank material composed of sand.
Sand	Add 10 points.
Silt / Clay	No adjustment.

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

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

Estimating Near-Bank Stress (NBS)

Stream: Location: **Moore Park**

Station: Stream Type: Valley Type: **Confined**

Observers: **AT, AD** Date: **5-25-22**

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)

Method	1
Dominant Near-Bank Stress	**Very 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				**Very High**	

Copyright © 2008 Wildland Hydrology

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

USFWS - SHARP
STREAM NAME - REACH IDENTIFICATION

BANK EROSION HAZARD INDEX

Stream:	Moore Park	**Observer(s):**	AT, JR, MM	**Data:**	AT	**QA/QC:**		**Total Score:**		**46.04**		
Reach:		**Comments:**								**Extreme**		
Location:	19 (Right and Left Banks)	**Bank Length**	206					**Total Score Values:**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**	**Extreme**
Date:	5/12/2022								5-10	10-20	20-30	30-40	40-45	45-50

Erodibility Variables					
Bank Height / Bankfull Height Ratio					
Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
2.00	0.29	6.86	10.00	Extreme	
Root Depth / Bank Height Ratio					
Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
0.17	2.00	0.08	8.63	Very High	
Weighted Root Density					
Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
5.00	0.08	0.42	10.00	Extreme	
Bank Angle					
Bank Angle (°)			Index	Bank Erosion Potental	Notes
50.00			3.41	Low	
Surface Protection					
Surface Protection (%)			Index	Bank Erosion Potental	Notes
15.00			8.00	Very High	
			Adjustment		Notes
Bank Materials			6.00		red dog
			Adjustment		Notes
Bank Stratification					
		TOTAL SCORE	**46.04**		

Bank Erosion Potential

		Very Low	Low	Moderate	High	Very High	Extreme
Erodibility Variables							
Bank Height / Bankfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Root Depth / Bank Height	Value	1.00-0.90	0.89-0.50	0.49-0.30	0.29-0.15	0.14-0.05	<0.05
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Surface Protection	Value	100-80	79-55	54-30	29-15	14-10	<10
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10

Adjustments

Bank Material	
Bedrock	Bedrock banks have a very low erosion potential.
Boulders	Boulder banks have a low erosion potential.
Cobble	Substract 10 points. No adjustment if sand/gravel compose greater than 50% of bank.
Clay/Silt Loam	Add 5 points.
Gravel	Add 5-10 points depending on percentage of bank material composed of sand.
Sand	Add 10 points.
Silt / Clay	No adjustment.

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

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

Estimating Near-Bank Stress (NBS)

Stream: | Location: **Moore Park**

Station: | Stream Type: | Valley Type: **Confined**

Observers: **AT, AD** | Date: **5-25-22**

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)

Method	1
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**	

Copyright © 2008 Wildland Hydrology

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

USFWS - SHARP
STREAM NAME - REACH IDENTIFICATION

BANK EROSION HAZARD INDEX

Stream:	Moore Park	**Observer(s):**	AT, JR, MM	**Data:**	AT	**QA/QC:**		**Total Score:**		**40.15**		
Reach:		**Comments:**								**Very High**		
Location:	20 (Right and Left Bank)	**Bank Length**	22					**Total Score Values:**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**	**Extreme**
Date:	5/12/2022								5-10	10-20	20-30	30-40	40-45	45-50

Erodibility Variables

Bank Height / Bankfull Height Ratio

Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
0.92	0.29	3.14	10.00	Extreme	

Root Depth / Bank Height Ratio

Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
0.17	0.92	0.18	7.47	High	

Weighted Root Density

Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
15.00	0.18	2.73	10.00	Extreme	

Bank Angle

Bank Angle (°)		Index	Bank Erosion Potental	Notes
35.00		2.68	Low	

Surface Protection

Surface Protection (%)		Index	Bank Erosion Potental	Notes
5.00		10.00	Extreme	

	Adjustment		Notes
Bank Materials			
	Adjustment		Notes
Bank Stratification			
TOTAL SCORE	**40.15**		

Bank Erosion Potential

		Very Low	Low	Moderate	High	Very High	Extreme
Erodibility Variables							
Bank Height / Bankfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Root Depth / Bank Height	Value	1.00-0.90	0.89-0.50	0.49-0.30	0.29-0.15	0.14-0.05	<0.05
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Surface Protection	Value	100-80	79-55	54-30	29-15	14-10	<10
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10

Adjustments

Bedrock	Bedrock banks have a very low erosion potential.
Boulders	Boulder banks have a low erosion potential.
Cobble	Substract 10 points. No adjustment if sand/gravel compose greater than 50% of bank.
Clay/Silt Loam	Add 5 points.
Gravel	Add 5-10 points depending on percentage of bank material composed of sand.
Sand	Add 10 points.
Silt / Clay	No adjustment.

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

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

Estimating Near-Bank Stress (NBS)

Stream: | Location: **Moore Park**

Station: | Stream Type: | Valley Type: **Confined**

Observers: **AT, AD** | Date: **5-25-22**

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)

Method	5
Dominant Near-Bank Stress	
Moderate	

Level III

(5)

Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkf} (ft)	*Ratio* d_{nb} / d_{bkf}	Near-Bank Stress (NBS)
0.9166667	**0.5166667**	**1.7741935**	**Moderate**

(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					**Moderate**	

Copyright © 2008 Wildland Hydrology

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

USFWS - SHARP
STREAM NAME - REACH IDENTIFICATION

BANK EROSION HAZARD INDEX

Stream:	Moore Park	**Observer(s):**	AT, JR, MM	**Data:**	AT	**QA/QC:**		**Total Score:**		**41.61**		
Reach:		**Comments:**								**Very High**		
Location:	21 (Right and Left Banks)	**Bank Length**	164					**Total Score Values:**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**	**Extreme**
Date:	5/12/2022								5-10	10-20	20-30	30-40	40-45	45-50

Erodibility Variables					
Bank Height / Bankfull Height Ratio					
Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
2.50	0.29	8.57	10.00	Extreme	
Root Depth / Bank Height Ratio					
Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
0.25	2.50	0.10	8.44	Very High	
Weighted Root Density					
Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
40.00	0.10	4.00	10.00	Extreme	
Bank Angle					
Bank Angle (°)			Index	Bank Erosion Potental	Notes
45.00			3.17	Low	
Surface Protection					
Surface Protection (%)			Index	Bank Erosion Potental	Notes
5.00			10.00	Extreme	
			Adjustment		Notes
Bank Materials					
			Adjustment		Notes
Bank Stratification					
		TOTAL SCORE	**41.61**		

Bank Erosion Potential

		Very Low	Low	Moderate	High	Very High	Extreme
Erodibility Variables							
Bank Height / Bankfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Root Depth / Bank Height	Value	1.00-0.90	0.89-0.50	0.49-0.30	0.29-0.15	0.14-0.05	<0.05
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Surface Protection	Value	100-80	79-55	54-30	29-15	14-10	<10
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10

Adjustments

Bedrock	Bedrock banks have a very low erosion potential.
Boulders	Boulder banks have a low erosion potential.
Cobble	Substract 10 points. No adjustment if sand/gravel compose greater than 50% of bank.
Clay/Silt Loam	Add 5 points.
Gravel	Add 5-10 points depending on percentage of bank material composed of sand.
Sand	Add 10 points.
Silt / Clay	No adjustment.

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

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

Estimating Near-Bank Stress (NBS)

Stream: | Location: **Moore Park**

Station: | Stream Type: | Valley Type: **Confined**

Observers: **AT, AD** | Date: **5-25-22**

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)

Method	5
Dominant Near-Bank Stress	
Moderate	

Level III

(5)

Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkf} (ft)	*Ratio* d_{nb} / d_{bkf}	Near-Bank Stress (NBS)
0.9166667	**0.5166667**	**1.7741935**	**Moderate**

(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					**Moderate**	

Copyright © 2008 Wildland Hydrology

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

USFWS - SHARP
STREAM NAME - REACH IDENTIFICATION

BANK EROSION HAZARD INDEX

Stream:	Moore Park	**Observer(s):**	AT, JR, MM	**Data:**	AT	**QA/QC:**		**Total Score:**		**31.15**		
Reach:		**Comments:**								**High**		
Location:	22 (Right and Left Banks)	**Bank Length**	160					**Total Score Values:**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**	**Extreme**
Date:	5/12/2022								5-10	10-20	20-30	30-40	40-45	45-50

Erodibility Variables					
Bank Height / Bankfull Height Ratio					
Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
0.75	0.33	2.25	8.21	Very High	
Root Depth / Bank Height Ratio					
Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
0.42	0.75	0.56	3.63	Low	
Weighted Root Density					
Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
15.00	0.56	8.33	8.63	Very High	
Bank Angle					
Bank Angle (°)			Index	Bank Erosion Potental	Notes
15.00			1.68	Very Low	
Surface Protection					
Surface Protection (%)			Index	Bank Erosion Potental	Notes
10.00			9.00	Very High	
			Adjustment		Notes
Bank Materials					
			Adjustment		Notes
Bank Stratification					
		TOTAL SCORE	**31.15**		

Bank Erosion Potential

		Very Low	Low	Moderate	High	Very High	Extreme
Erodibility Variables							
Bank Height / Bankfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Root Depth / Bank Height	Value	1.00-0.90	0.89-0.50	0.49-0.30	0.29-0.15	0.14-0.05	<0.05
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Surface Protection	Value	100-80	79-55	54-30	29-15	14-10	<10
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10

Adjustments

Bank Material	
Bedrock	Bedrock banks have a very low erosion potential.
Boulders	Boulder banks have a low erosion potential.
Cobble	Substract 10 points. No adjustment if sand/gravel compose greater than 50% of bank.
Clay/Silt Loam	Add 5 points.
Gravel	Add 5-10 points depending on percentage of bank material composed of sand.
Sand	Add 10 points.
Silt / Clay	No adjustment.

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

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

Estimating Near-Bank Stress (NBS)

Stream: Location: **Moore Park**

Station: Stream Type: Valley Type: **Confined**

Observers: **AT, AD** Date: **5-25-22**

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)

Method	5
Dominant Near-Bank Stress	
Moderate	

Level III

(5)

Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkf} (ft)	*Ratio* d_{nb} / d_{bkf}	Near-Bank Stress (NBS)
0.9166667	**0.5166667**	**1.7741935**	**Moderate**

(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					**Moderate**	

Copyright © 2008 Wildland Hydrology

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

USFWS - SHARP
STREAM NAME - REACH IDENTIFICATION

BANK EROSION HAZARD INDEX

Stream:	Moore Park	**Observer(s):**	AT, JR, MM	**Data:**	AT	**QA/QC:**		**Total Score:**		**32.70**		
Reach:		**Comments:**								**High**		
Location:	23 (Right and Left Banks)	**Bank Length**	328					**Total Score Values:**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**	**Extreme**
Date:	5/12/2022								5-10	10-20	20-30	30-40	40-45	45-50

Erodibility Variables

Bank Height / Bankfull Height Ratio

Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
3.00	0.29	10.29	10.00	Extreme	

Root Depth / Bank Height Ratio

Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
2.67	3.00	0.89	2.01	Low	

Weighted Root Density

Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
20.00	0.89	17.78	7.52	High	

Bank Angle

Bank Angle (°)		Index	Bank Erosion Potental	Notes
45.00		3.17	Low	

Surface Protection

Surface Protection (%)		Index	Bank Erosion Potental	Notes
5.00		10.00	Extreme	

	Adjustment		Notes
Bank Materials			
	Adjustment		Notes
Bank Stratification			
TOTAL SCORE	**32.70**		

Bank Erosion Potential

		Very Low	Low	Moderate	High	Very High	Extreme
Erodibility Variables							
Bank Height / Bankfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Root Depth / Bank Height	Value	1.00-0.90	0.89-0.50	0.49-0.30	0.29-0.15	0.14-0.05	<0.05
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Surface Protection	Value	100-80	79-55	54-30	29-15	14-10	<10
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10

Adjustments

Bank Material	
Bedrock	Bedrock banks have a very low erosion potential.
Boulders	Boulder banks have a low erosion potential.
Cobble	Substract 10 points. No adjustment if sand/gravel compose greater than 50% of bank.
Clay/Silt Loam	Add 5 points.
Gravel	Add 5-10 points depending on percentage of bank material composed of sand.
Sand	Add 10 points.
Silt / Clay	No adjustment.

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

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

Estimating Near-Bank Stress (NBS)

Stream: Location: **Moore Park**

Station: Stream Type: Valley Type: **Confined**

Observers: **AT, AD** Date: **5-25-22**

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)

Method	**5**
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)
0.75	**0.3166667**	**2.3684211**	**High**

(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**	

Copyright © 2008 Wildland Hydrology

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

USFWS - SHARP
STREAM NAME - REACH IDENTIFICATION

BANK EROSION HAZARD INDEX

Stream:	Moore Park	**Observer(s):**	AT, JR, MM	**Data:**	AT	**QA/QC:**		**Total Score:**		**35.69**		
Reach:		**Comments:**								**High**		
Location:	24 (Right and Left Banks)	**Bank Length**	194					**Total Score Values:**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**	**Extreme**
Date:	5/12/2022								5-10	10-20	20-30	30-40	40-45	45-50

Erodibility Variables

Bank Height / Bankfull Height Ratio

Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
0.88	0.29	3.00	10.00	Extreme	

Root Depth / Bank Height Ratio

Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
0.42	0.88	0.48	4.14	Moderate	

Weighted Root Density

Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
50.00	0.48	23.81	6.70	High	

Bank Angle

Bank Angle (°)		Index	Bank Erosion Potental	Notes
85.00		6.84	High	

Surface Protection

Surface Protection (%)		Index	Bank Erosion Potental	Notes
15.00		8.00	Very High	

	Adjustment		Notes
Bank Materials			
	Adjustment		Notes
Bank Stratification			
TOTAL SCORE	**35.69**		

Bank Erosion Potential

		Very Low	Low	Moderate	High	Very High	Extreme
Erodibility Variables							
Bank Height / Bankfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Root Depth / Bank Height	Value	1.00-0.90	0.89-0.50	0.49-0.30	0.29-0.15	0.14-0.05	<0.05
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Surface Protection	Value	100-80	79-55	54-30	29-15	14-10	<10
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10

Adjustments

Bedrock	Bedrock banks have a very low erosion potential.
Boulders	Boulder banks have a low erosion potential.
Cobble	Substract 10 points. No adjustment if sand/gravel compose greater than 50% of bank.
Clay/Silt Loam	Add 5 points.
Gravel	Add 5-10 points depending on percentage of bank material composed of sand.
Sand	Add 10 points.
Silt / Clay	No adjustment.

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

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

Estimating Near-Bank Stress (NBS)

Stream: | Location: **Moore Park**

Station: | Stream Type: | Valley Type: **Confined**

Observers: **AT, AD** | Date: **5-25-22**

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)

Method	5
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)
0.75	**0.3166667**	**2.3684211**	**High**

(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**	

Copyright © 2008 Wildland Hydrology

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

USFWS - SHARP
STREAM NAME - REACH IDENTIFICATION

BANK EROSION HAZARD INDEX

Stream:	Moore Park	**Observer(s):**	AT, JR, MM	**Data:**	AT	**QA/QC:**		**Total Score:**		**23.99**		
Reach:		**Comments:**								**Moderate**		
Location:	25 (Right and Left Banks)	**Bank Length**	342					**Total Score Values:**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**	**Extreme**
Date:	5/12/2022								5-10	10-20	20-30	30-40	40-45	45-50

Erodibility Variables

Bank Height / Bankfull Height Ratio

Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
4.00	0.29	13.71	10.00	Extreme	

Root Depth / Bank Height Ratio

Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
6.00	4.00	1.50	1.00	Very Low	

Weighted Root Density

Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
30.00	1.50	45.00	4.71	Moderate	

Bank Angle

Bank Angle (°)		Index	Bank Erosion Potental	Notes
45.00		3.17	Low	

Surface Protection

Surface Protection (%)		Index	Bank Erosion Potental	Notes
40.00		5.11	Moderate	

	Adjustment		Notes
Bank Materials			
	Adjustment		Notes
Bank Stratification			
TOTAL SCORE	**23.99**		

Bank Erosion Potential

		Very Low	Low	Moderate	High	Very High	Extreme
Erodibility Variables							
Bank Height / Bankfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Root Depth / Bank Height	Value	1.00-0.90	0.89-0.50	0.49-0.30	0.29-0.15	0.14-0.05	<0.05
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Surface Protection	Value	100-80	79-55	54-30	29-15	14-10	<10
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10

Adjustments

Bank Material	
Bedrock	Bedrock banks have a very low erosion potential.
Boulders	Boulder banks have a low erosion potential.
Cobble	Substract 10 points. No adjustment if sand/gravel compose greater than 50% of bank.
Clay/Silt Loam	Add 5 points.
Gravel	Add 5-10 points depending on percentage of bank material composed of sand.
Sand	Add 10 points.
Silt / Clay	No adjustment.

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

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

Estimating Near-Bank Stress (NBS)

Stream: Location: **Moore Park**

Station: Stream Type: Valley Type: **Confined**

Observers: **AT, AD** Date: **5-25-22**

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)

Method	1
Dominant Near-Bank Stress	
Very 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					**Very High**	

Copyright © 2008 Wildland Hydrology

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

USFWS - SHARP
STREAM NAME - REACH IDENTIFICATION

BANK EROSION HAZARD INDEX

Stream:	Moore Park	**Observer(s):**	AT, JR, MM	**Data:**	AT	**QA/QC:**		**Total Score:**		**38.54**		
Reach:		**Comments:**								**High**		
Location:	26 (Right and Left Banks)	**Bank Length**	292					**Total Score Values:**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**	**Extreme**
Date:	5/12/2022								5-10	10-20	20-30	30-40	40-45	45-50

Erodibility Variables

Bank Height / Bankfull Height Ratio

Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
3.00	0.29	10.29	10.00	Extreme	

Root Depth / Bank Height Ratio

Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
0.75	3.00	0.25	6.54	High	

Weighted Root Density

Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
35.00	0.25	8.75	8.58	Very High	

Bank Angle

Bank Angle (°)		Index	Bank Erosion Potental	Notes
50.00		3.41	Low	

Surface Protection

Surface Protection (%)		Index	Bank Erosion Potental	Notes
5.00		10.00	Extreme	

	Adjustment		Notes
Bank Materials			
	Adjustment		Notes
Bank Stratification			
TOTAL SCORE	**38.54**		

Bank Erosion Potential

		Very Low	Low	Moderate	High	Very High	Extreme
Erodibility Variables							
Bank Height / Bankfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Root Depth / Bank Height	Value	1.00-0.90	0.89-0.50	0.49-0.30	0.29-0.15	0.14-0.05	<0.05
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Surface Protection	Value	100-80	79-55	54-30	29-15	14-10	<10
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10

Adjustments

Bank Material	
Bedrock	Bedrock banks have a very low erosion potential.
Boulders	Boulder banks have a low erosion potential.
Cobble	Substract 10 points. No adjustment if sand/gravel compose greater than 50% of bank.
Clay/Silt Loam	Add 5 points.
Gravel	Add 5-10 points depending on percentage of bank material composed of sand.
Sand	Add 10 points.
Silt / Clay	No adjustment.

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

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

Estimating Near-Bank Stress (NBS)

Stream: | Location: **Moore Park**

Station: | Stream Type: | Valley Type: **Confined**

Observers: **AT, AD** | Date: **5-25-22**

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)

Method	5
Dominant Near-Bank Stress	
Low	

Level III

(5)

Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkf} (ft)	*Ratio* d_{nb} / d_{bkf}	Near-Bank Stress (NBS)
0.4166667	**0.3888889**	**1.0714286**	**Low**

(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					**Low**	

Copyright © 2008 Wildland Hydrology

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

USFWS - SHARP
STREAM NAME - REACH IDENTIFICATION

BANK EROSION HAZARD INDEX

Stream:	Moore Park	**Observer(s):**	AT, JR, MM	**Data:**	AT	**QA/QC:**		**Total Score:**		**25.18**		
Reach:		**Comments:**								**Moderate**		
Location:	27 (Right and Left Banks)	**Bank Length**	428					**Total Score Values:**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**	**Extreme**
Date:	5/12/2022								5-10	10-20	20-30	30-40	40-45	45-50

Erodibility Variables					
Bank Height / Bankfull Height Ratio					
Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
6.00	0.29	20.57	10.00	Extreme	
Root Depth / Bank Height Ratio					
Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
6.00	6.00	1.00	1.00	Very Low	
Weighted Root Density					
Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
35.00	1.00	35.00	5.50	Moderate	
Bank Angle					
Bank Angle (°)			Index	Bank Erosion Potental	Notes
45.00			3.17	Low	
Surface Protection					
Surface Protection (%)			Index	Bank Erosion Potental	Notes
35.00			5.50	Moderate	
			Adjustment		Notes
Bank Materials					
			Adjustment		Notes
Bank Stratification					
		TOTAL SCORE	**25.18**		

Bank Erosion Potential

		Very Low	Low	Moderate	High	Very High	Extreme
Erodibility Variables							
Bank Height / Bankfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Root Depth / Bank Height	Value	1.00-0.90	0.89-0.50	0.49-0.30	0.29-0.15	0.14-0.05	<0.05
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Surface Protection	Value	100-80	79-55	54-30	29-15	14-10	<10
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10

Adjustments

Bank Material	
Bedrock	Bedrock banks have a very low erosion potential.
Boulders	Boulder banks have a low erosion potential.
Cobble	Substract 10 points. No adjustment if sand/gravel compose greater than 50% of bank.
Clay/Silt Loam	Add 5 points.
Gravel	Add 5-10 points depending on percentage of bank material composed of sand.
Sand	Add 10 points.
Silt / Clay	No adjustment.

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

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

Estimating Near-Bank Stress (NBS)

Stream: Location: **Moore Park**

Station: Stream Type: Valley Type: **Confined**

Observers: **AT, AD** Date: **5-25-22**

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)

Method	1
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**	

Copyright © 2008 Wildland Hydrology

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

USFWS - SHARP
STREAM NAME - REACH IDENTIFICATION

BANK EROSION HAZARD INDEX

Stream:	Moore Park	**Observer(s):**	AT, JR, MM	**Data:**	AT	**QA/QC:**		**Total Score:**		**35.71**		
Reach:		**Comments:**								**High**		
Location:	28 (Right and Left Banks)	**Bank Length**	210					**Total Score Values:**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**	**Extreme**
Date:	5/12/2022								5-10	10-20	20-30	30-40	40-45	45-50

Erodibility Variables

Bank Height / Bankfull Height Ratio

Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
2.50	0.29	8.57	10.00	Extreme	

Root Depth / Bank Height Ratio

Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
0.83	2.50	0.33	5.57	Moderate	

Weighted Root Density

Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
0.83	0.33	0.28	10.00	Extreme	

Bank Angle

Bank Angle (°)		Index	Bank Erosion Potental	Notes
40.00		2.93	Low	

Surface Protection

Surface Protection (%)		Index	Bank Erosion Potental	Notes
20.00		7.22	High	

	Adjustment		Notes
Bank Materials			
	Adjustment		Notes
Bank Stratification			
TOTAL SCORE	**35.71**		

Bank Erosion Potential

		Very Low	Low	Moderate	High	Very High	Extreme
Erodibility Variables							
Bank Height / Bankfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Root Depth / Bank Height	Value	1.00-0.90	0.89-0.50	0.49-0.30	0.29-0.15	0.14-0.05	<0.05
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Surface Protection	Value	100-80	79-55	54-30	29-15	14-10	<10
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10

Adjustments

Bedrock	Bedrock banks have a very low erosion potential.
Boulders	Boulder banks have a low erosion potential.
Cobble	Substract 10 points. No adjustment if sand/gravel compose greater than 50% of bank.
Clay/Silt Loam	Add 5 points.
Gravel	Add 5-10 points depending on percentage of bank material composed of sand.
Sand	Add 10 points.
Silt / Clay	No adjustment.

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

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

Estimating Near-Bank Stress (NBS)

Stream: Location: **Moore Park**

Station: Stream Type: Valley Type: **Confined**

Observers: **AT, AD** Date: **5-25-22**

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)

Method	1
Dominant Near-Bank Stress	
Moderate	

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					**Moderate**	

Copyright © 2008 Wildland Hydrology

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

USFWS - SHARP
STREAM NAME - REACH IDENTIFICATION

BANK EROSION HAZARD INDEX

Stream:	Moore Park	**Observer(s):**	AT, JR, MM	**Data:**	AT	**QA/QC:**		**Total Score:**		**24.30**		
Reach:		**Comments:**								**Moderate**		
Location:	29 (Right and Left Banks)	**Bank Length**	134					**Total Score Values:**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**	**Extreme**
Date:	5/12/2022								5-10	10-20	20-30	30-40	40-45	45-50

Erodibility Variables					
Bank Height / Bankfull Height Ratio					
Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
1.75	0.29	6.00	10.00	Extreme	
Root Depth / Bank Height Ratio					
Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
1.75	1.75	1.00	1.00	Very Low	
Weighted Root Density					
Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
80.00	1.00	80.00	1.90	Very Low	
Bank Angle					
Bank Angle (°)			Index	Bank Erosion Potental	Notes
90.00			7.90	High	
Surface Protection					
Surface Protection (%)			Index	Bank Erosion Potental	Notes
60.00			3.50	Low	
			Adjustment		Notes
Bank Materials					
			Adjustment		Notes
Bank Stratification					
		TOTAL SCORE	**24.30**		

Bank Erosion Potential

		Very Low	Low	Moderate	High	Very High	Extreme
Erodibility Variables							
Bank Height / Bankfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Root Depth / Bank Height	Value	1.00-0.90	0.89-0.50	0.49-0.30	0.29-0.15	0.14-0.05	<0.05
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Surface Protection	Value	100-80	79-55	54-30	29-15	14-10	<10
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10

Adjustments

Bedrock	Bedrock banks have a very low erosion potential.
Boulders	Boulder banks have a low erosion potential.
Cobble	Substract 10 points. No adjustment if sand/gravel compose greater than 50% of bank.
Clay/Silt Loam	Add 5 points.
Gravel	Add 5-10 points depending on percentage of bank material composed of sand.
Sand	Add 10 points.
Silt / Clay	No adjustment.

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

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

Estimating Near-Bank Stress (NBS)

Stream: | Location: **Moore Park**

Station: | Stream Type: | Valley Type: **Confined**

Observers: **AT, AD** | Date: **5-25-22**

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)

Level III

(5)

Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkf} (ft)	*Ratio* d_{nb} / d_{bkf}	Near-Bank Stress (NBS)
0.4166667	**0.35**	**1.1904762**	**Low**

Method	
Dominant Near-Bank Stress	

(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					**Low**	

Copyright © 2008 Wildland Hydrology

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

BEHI	NBS	Rate
low	very low	0.017
low	low	0.020
low	moderate	0.090
low	high	0.160
low	very high	0.325
low	extreme	0.6
moderate	very low	0.09
moderate	low	0.125
moderate	moderate	0.300
moderate	high	0.800
moderate	very high	0.700
moderate	extreme	1.200
high	very low	0.250
high	low	0.400
high	moderate	0.640
high	high	1.000
high	very high	1.750
high	extreme	2.500
very high	very low	0.250
very high	low	0.400
very high	moderate	0.640
very high	high	1.000
very high	very high	1.750
very high	extreme	2.500
extreme	very low	0.15
extreme	low	1.300
extreme	moderate	1.750
extreme	high	2.500
extreme	very high	3.500
extreme	extreme	4.500

Non-highlighted rates from USFWS Bank Erosion Rate Curve
Yellow Highlighted rates from Rosgen Colorado Bank Erosion Rate Blue Highlighted rates are interpolated from Rosgen Colorado Bank Erosion Rate

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D



Photo location 1 facing northwest



Photo location 2 facing west

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D



Photo location 3 facing south



Photo location 4 facing Northeast

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D



Photo Location 5 facing Northeast



Photo location 6 facing northeast

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D



Photo location 7 facing South



Photo location 8 facing South

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D



Photo Location 9 facing South



Photo Location 10 Facing South

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D



Photo location 11 facing southeast



Photo Location 12 Facing South

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D



Photo Location 13 facing North



Photo location 14 facing northeast

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D



Photo location 15 facing Southwest



Photo location 16 facing Northeast

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D



Photo location 17 facing west



Photo Location 18 Facing East

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D



Photo Location 19 facing Northeast



Photo Location 20 facing Southwest

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D



Photo location 21 facing southwest



Photo location 22 facing Southwest

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D



Photo location 23 facing South



Photo location 24 facing southwest

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D



Photo location 25 facing South



Photo location 26 facing south

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D



Photo Location 27 facing North



Photo Location 28 facing Northeast

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D



Photo location 29 facing Southwest



Photo location 30 facing Northeast

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D



Photo location 31 facing Southwest



Photo location 32 facing Southwest

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D



Photo location 33 facing Northeast



Photo location 34 facing South

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D



Photo location 35 facing Northeast



Photo location 36 facing Southwest

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D



Photo location 37 Facing Southeast



Photo location 38 facing Southwest

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D



Photo location 39 facing Southeast



Photo location 40 facing Northeast

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Project Name									
Feature Feature I.D. (Bank., Headcut or Deposition I.D.)	Length, ft (Bank or deposition)	Height, ft (Bank or Headcut)	BEHI Rating	NBS Rating	Predicted Rate of Bank Erosion (ft/year)	Predicted Erosion Amount (ft^2/year)	Predicted Erosion Amount (tons/year)	Predicted Erosion Rate (tons/year/ft)	Comments
1 L	85.0	2.0	Very High	Moderate	0.64	108.80	5.40	0.06	left bank
1 R	85.0	1.3	High	Moderate	0.64	72.53	3.60	0.04	right bank
2 R	34.0	6.0	High	Low	0.40	81.60	4.05	0.12	right bank
2 L	34.0	4.8	High	Low	0.40	65.73	3.26	0.09	left bank
3	54.0	5.0	High	Low	0.40	108.00	5.36	0.10	left and right bank
4	56.0	7.0	High	Extreme	2.50	980.00	48.63	0.84	left and right bank
5	74.0	6.0	High	Moderate	0.64	284.16	14.10	0.18	left and right bank
6	26.0	5.0	Very High	Extreme	2.50	325.00	16.13	0.60	left and right bank
7 R	14.0	7.0	Extreme	Extreme	4.50	441.00	21.88	1.52	right bank
7 L	14.0	2.0	Moderate	Extreme	1.20	33.60	1.67	0.12	left bank
8	50.0	2.2	High	Moderate	0.64	69.33	3.44	0.07	left and right bank
9	24.0	3.2	Very High	Low	0.25	19.00	0.94	0.04	left and right bank
10	64.0	2.2	High	Low	0.40	55.47	2.75	0.04	left and right bank
11	32.0	2.7	Very High	Extreme	2.50	213.33	10.59	0.32	left and right bank
12	70.0	2.5	Extreme	Moderate	1.75	306.25	15.20	0.21	left and right bank
13	164.0	2.0	Very High	Moderate	0.64	209.92	10.42	0.06	left and right bank
14	398.0	8.0	Extreme	Extreme	4.50	14328.00	711.03	1.73	left and right bank
15	138.0	12.0	Extreme	Very High	3.50	5796.00	287.63	2.02	left and right bank
16	72.0	8.0	Extreme	Low	1.30	748.80	37.16	0.50	left and right bank
17	60.0	4.5	Extreme	Low	1.30	351.00	17.42	0.28	left and right bank
18	74.0	7.0	Very High	Low	0.25	129.50	6.43	0.08	left and right bank
19	10.0	7.0	Very High	Moderate	0.64	44.80	2.22	0.22	left and right bank
20	24.0	4.0	Moderate	Low	0.13	12.00	0.60	0.02	left and right bank
21	48.0	2.0	Moderate	Low	0.13	12.00	0.60	0.01	left and right bank
22	120.0	3.3	Very High	High	1.00	400.00	19.85	0.16	left and right bank
23	86.0	2.7	High	Moderate	0.64	146.77	7.28	0.08	left and right bank
24	130.0	2.3	Very High	Moderate	0.64	194.13	9.63	0.07	left and right bank
25	50.0	6.4	Very High	Moderate	0.64	205.33	10.19	0.20	left and right bank
26	40.0	2.0	Extreme	Moderate	1.75	140.00	6.95	0.17	left and right bank
27	76.0	4.0	High	Very High	1.75	532.00	26.40	0.34	left and right bank
28	132.0	1.7	High	Low	0.40	88.00	4.37	0.03	left and right bank
29	40.0	0.5	High	Moderate	0.64	12.80	0.64	0.02	left and right bank
30	100.0	2.5	Very High	Moderate	0.64	160.00	7.94	0.08	left and right bank
31	482.0	1.5	Very High	Moderate	0.64	462.72	22.96	0.05	left and right bank
32	484.0	1.5	Very High	Extreme	2.50	1815.00	90.07	0.18	left and right bank
TOTAL OF ALL GRIDS	**3444.0**	**N/A**	**N/A**	**N/A**	**43.0**	**28,952.59**	**1436.8**	**10.7**	

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

USFWS - SHARP
STREAM NAME - REACH IDENTIFICATION

BANK EROSION HAZARD INDEX

Stream:	UNT to Sawmill Run	**Observer(s):**	AT,MB,MM	**Data:**	AT	**QA/QC:**		**Total Score:**		**44.01**		
Reach:		**Comments:**	left bank							**Very High**		
Location:	1 L	**Bank Length**	85					**Total Score Values:**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**	**Extreme**
Date:	5/11/2022								5-10	10-20	20-30	30-40	40-45	45-50

Erodibility Variables

Bank Height / Bankfull Height Ratio

Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
2.00	0.25	8.00	10.00	Extreme	

Root Depth / Bank Height Ratio

Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
0.42	2.00	0.21	7.11	High	

Weighted Root Density

Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
20.00	0.21	4.17	10.00	Extreme	

Bank Angle

Bank Angle (°)		Index	Bank Erosion Potental	Notes
60.00		3.90	Low	

Surface Protection

Surface Protection (%)		Index	Bank Erosion Potental	Notes
15.00		8.00	Very High	

	Adjustment		Notes
Bank Materials	5.00		silt loam
	Adjustment		Notes
Bank Stratification			
TOTAL SCORE	**44.01**		

Bank Erosion Potential

		Very Low	Low	Moderate	High	Very High	Extreme
Bank Height / Bankfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Root Depth / Bank Height	Value	1.00-0.90	0.89-0.50	0.49-0.30	0.29-0.15	0.14-0.05	<0.05
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Surface Protection	Value	100-80	79-55	54-30	29-15	14-10	<10
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10

Erodibility Variables

Bank Material

Adjustments

Bedrock	Bedrock banks have a very low erosion potential.
Boulders	Boulder banks have a low erosion potential.
Cobble	Substract 10 points. No adjustment if sand/gravel compose greater than 50% of bank.
Clay/Silt Loam	Add 5 points.
Gravel	Add 5-10 points depending on percentage of bank material composed of sand.
Sand	Add 10 points.
Silt / Clay	No adjustment.

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

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

Estimating Near-Bank Stress (NBS)

Stream: **UNT to Sawmill Run** Location: **Crane Avenue**

Station: Stream Type: Valley Type:

Observers: **AT, MB, MM** Date: **5/11/22**

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)

Method	
Dominant Near-Bank Stress	

Level III

(5)

Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkf} (ft)	*Ratio* d_{nb} / d_{bkf}	Near-Bank Stress (NBS)
0.75	**0.4583333**	**1.6363636**	**Moderate**

(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 **Moderate**

Copyright © 2008 Wildland Hydrology

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

USFWS - SHARP
STREAM NAME - REACH IDENTIFICATION

BANK EROSION HAZARD INDEX

Stream:	UNT to Sawmill Run	**Observer(s):**	AT,MB,MM	**Data:**	AT	**QA/QC:**		**Total Score:**		**37.85**		
Reach:		**Comments:**	right bank							**High**		
Location:	1 R	**Bank Length**	85					**Total Score Values:**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**	**Extreme**
Date:	5/11/2022								5-10	10-20	20-30	30-40	40-45	45-50

Erodibility Variables

Bank Height / Bankfull Height Ratio

Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
1.33	0.25	5.33	10.00	Extreme	

Root Depth / Bank Height Ratio

Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
0.50	1.33	0.38	5.15	Moderate	

Weighted Root Density

Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
20.00	0.38	7.50	8.72	Very High	

Bank Angle

Bank Angle (°)		Index	Bank Erosion Potental	Notes
30.00		2.44	Low	

Surface Protection

Surface Protection (%)		Index	Bank Erosion Potental	Notes
25.00		6.54	High	

	Adjustment		Notes
Bank Materials	5.00		silt loam
	Adjustment		Notes
Bank Stratification			
TOTAL SCORE	**37.85**		

Bank Erosion Potential

		Very Low	Low	Moderate	High	Very High	Extreme
Erodibility Variables							
Bank Height / Bankfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Root Depth / Bank Height	Value	1.00-0.90	0.89-0.50	0.49-0.30	0.29-0.15	0.14-0.05	<0.05
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Surface Protection	Value	100-80	79-55	54-30	29-15	14-10	<10
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10

Adjustments

Bank Material	
Bedrock	Bedrock banks have a very low erosion potential.
Boulders	Boulder banks have a low erosion potential.
Cobble	Substract 10 points. No adjustment if sand/gravel compose greater than 50% of bank.
Clay/Silt Loam	Add 5 points.
Gravel	Add 5-10 points depending on percentage of bank material composed of sand.
Sand	Add 10 points.
Silt / Clay	No adjustment.

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

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

Estimating Near-Bank Stress (NBS)

Stream: **UNT to Sawmill Run** Location: **Crane Avenue**

Station: Stream Type: Valley Type:

Observers: **AT, MB, MM** Date: **5/11/22**

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)

Method	
Dominant Near-Bank Stress	

Level III

(5)

Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkf} (ft)	*Ratio* d_{nb} / d_{bkf}	Near-Bank Stress (NBS)
0.75	**0.4583333**	**1.6363636**	**Moderate**

(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					**Moderate**	

Copyright © 2008 Wildland Hydrology

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

USFWS - SHARP
STREAM NAME - REACH IDENTIFICATION

BANK EROSION HAZARD INDEX

Stream:	UNT to Sawmill Run	**Observer(s):**	AT,MB,MM	**Data:**	AT	**QA/QC:**		**Total Score:**		**38.18**		
Reach:		**Comments:**	right bank							**High**		
Location:	2 R	**Bank Length**	34					**Total Score Values:**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**	**Extreme**
Date:	5/11/2022								5-10	10-20	20-30	30-40	40-45	45-50

Erodibility Variables

Bank Height / Bankfull Height Ratio

Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
6.00	0.46	13.09	10.00	Extreme	

Root Depth / Bank Height Ratio

Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
6.00	6.00	1.00	1.00	Very Low	

Weighted Root Density

Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
35.00	1.00	35.00	5.50	Moderate	

Bank Angle

Bank Angle (°)		Index	Bank Erosion Potental	Notes
110.00		8.68	Very High	

Surface Protection

Surface Protection (%)		Index	Bank Erosion Potental	Notes
15.00		8.00	Very High	

	Adjustment		Notes
Bank Materials	5.00		silt loam
	Adjustment		Notes
Bank Stratification			
TOTAL SCORE	**38.18**		

Bank Erosion Potential

		Very Low	Low	Moderate	High	Very High	Extreme
Erodibility Variables							
Bank Height / Bankfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Root Depth / Bank Height	Value	1.00-0.90	0.89-0.50	0.49-0.30	0.29-0.15	0.14-0.05	<0.05
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Surface Protection	Value	100-80	79-55	54-30	29-15	14-10	<10
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10

Adjustments

Bank Material	
Bedrock	Bedrock banks have a very low erosion potential.
Boulders	Boulder banks have a low erosion potential.
Cobble	Substract 10 points. No adjustment if sand/gravel compose greater than 50% of bank.
Clay/Silt Loam	Add 5 points.
Gravel	Add 5-10 points depending on percentage of bank material composed of sand.
Sand	Add 10 points.
Silt / Clay	No adjustment.

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

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

Estimating Near-Bank Stress (NBS)

Stream: **UNT to Sawmill Run** Location: **Crane Avenue**

Station: Stream Type: Valley Type:

Observers: **AT, MB, MM** Date: **5/11/22**

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)

Method	
Dominant Near-Bank Stress	

Level III

(5)

Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkf} (ft)	*Ratio* d_{nb} / d_{bkf}	Near-Bank Stress (NBS)
0.5833333	**0.4583333**	**1.2727273**	**Low**

(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					**Low**	

Copyright © 2008 Wildland Hydrology

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

USFWS - SHARP
STREAM NAME - REACH IDENTIFICATION

BANK EROSION HAZARD INDEX

Stream:	UNT to Sawmill Run	**Observer(s):**	AT,MB,MM	**Data:**	AT	**QA/QC:**		**Total Score:**		**35.30**		
Reach:		**Comments:**	left bank							**High**		
Location:	2 L	**Bank Length**	34					**Total Score Values:**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**	**Extreme**
Date:	5/11/2022								5-10	10-20	20-30	30-40	40-45	45-50

Erodibility Variables

Bank Height / Bankfull Height Ratio

Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
4.83	0.46	10.55	10.00	Extreme	

Root Depth / Bank Height Ratio

Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
4.83	4.83	1.00	1.00	Very Low	

Weighted Root Density

Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
35.00	1.00	35.00	5.50	Moderate	

Bank Angle

Bank Angle (°)		Index	Bank Erosion Potental	Notes
90.00		7.90	High	

Surface Protection

Surface Protection (%)		Index	Bank Erosion Potental	Notes
30.00		5.90	Moderate	

	Adjustment		Notes
Bank Materials	5.00		silt loam
	Adjustment		Notes
Bank Stratification			
TOTAL SCORE	**35.30**		

Bank Erosion Potential

		Very Low	Low	Moderate	High	Very High	Extreme
Erodibility Variables							
Bank Height / Bankfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Root Depth / Bank Height	Value	1.00-0.90	0.89-0.50	0.49-0.30	0.29-0.15	0.14-0.05	<0.05
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Surface Protection	Value	100-80	79-55	54-30	29-15	14-10	<10
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10

Adjustments

Bedrock	Bedrock banks have a very low erosion potential.
Boulders	Boulder banks have a low erosion potential.
Cobble	Substract 10 points. No adjustment if sand/gravel compose greater than 50% of bank.
Clay/Silt Loam	Add 5 points.
Gravel	Add 5-10 points depending on percentage of bank material composed of sand.
Sand	Add 10 points.
Silt / Clay	No adjustment.

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

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

Estimating Near-Bank Stress (NBS)

Stream: **UNT to Sawmill Run** Location: **Crane Avenue**

Station: Stream Type: Valley Type:

Observers: **AT, MB, MM** Date: **5/11/22**

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)

Method	
Dominant Near-Bank Stress	

Level III

(5)

Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkf} (ft)	*Ratio* d_{nb} / d_{bkf}	Near-Bank Stress (NBS)
0.5833333	**0.4583333**	**1.2727273**	**Low**

(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				**Low**	

Copyright © 2008 Wildland Hydrology

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

USFWS - SHARP
STREAM NAME - REACH IDENTIFICATION

BANK EROSION HAZARD INDEX

Stream:	UNT to Sawmill Run	**Observer(s):**	AT,MB,MM	**Data:**	AT	**QA/QC:**		**Total Score:**		**31.70**		
Reach:		**Comments:**								**High**		
Location:	3	**Bank Length**	54					**Total Score Values:**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**	**Extreme**
Date:	5/11/2022								5-10	10-20	20-30	30-40	40-45	45-50

Erodibility Variables

Bank Height / Bankfull Height Ratio

Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
5.00	0.83	6.00	10.00	Extreme	

Root Depth / Bank Height Ratio

Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
4.00	5.00	0.80	2.44	Low	

Weighted Root Density

Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
40.00	0.80	32.00	5.74	Moderate	

Bank Angle

Bank Angle (°)		Index	Bank Erosion Potental	Notes
50.00		3.41	Low	

Surface Protection

Surface Protection (%)		Index	Bank Erosion Potental	Notes
40.00		5.11	Moderate	

	Adjustment		Notes
Bank Materials	5.00		silt loam
	Adjustment		Notes
Bank Stratification			
TOTAL SCORE	**31.70**		

Bank Erosion Potential

		Very Low	Low	Moderate	High	Very High	Extreme
Erodibility Variables							
Bank Height / Bankfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Root Depth / Bank Height	Value	1.00-0.90	0.89-0.50	0.49-0.30	0.29-0.15	0.14-0.05	<0.05
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Surface Protection	Value	100-80	79-55	54-30	29-15	14-10	<10
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10

Adjustments

Bedrock	Bedrock banks have a very low erosion potential.
Boulders	Boulder banks have a low erosion potential.
Cobble	Substract 10 points. No adjustment if sand/gravel compose greater than 50% of bank.
Clay/Silt Loam	Add 5 points.
Gravel	Add 5-10 points depending on percentage of bank material composed of sand.
Sand	Add 10 points.
Silt / Clay	No adjustment.

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

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

Estimating Near-Bank Stress (NBS)

Stream: **UNT to Sawmill Run** Location: **Crane Avenue**

Station: Stream Type: Valley Type:

Observers: **AT, MB, MM** Date: **5/11/22**

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)

Method	
Dominant Near-Bank Stress	

Level III

(5)

Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkf} (ft)	*Ratio* d_{nb} / d_{bkf}	Near-Bank Stress (NBS)
0.6666667	**0.4583333**	**1.4545455**	**Low**

(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				**Low**	

Copyright © 2008 Wildland Hydrology

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

USFWS - SHARP
STREAM NAME - REACH IDENTIFICATION

BANK EROSION HAZARD INDEX

Stream:	UNT to Sawmill Run	**Observer(s):**	AT,MB,MM	**Data:**	AT	**QA/QC:**		**Total Score:**		**39.89**		
Reach:		**Comments:**								**High**		
Location:	4	**Bank Length**	56					**Total Score Values:**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**	**Extreme**
Date:	5/11/2022								5-10	10-20	20-30	30-40	40-45	45-50

Erodibility Variables					
Bank Height / Bankfull Height Ratio					
Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
7.00	1.83	3.82	10.00	Extreme	
Root Depth / Bank Height Ratio					
Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
6.00	7.00	0.86	2.16	Low	
Weighted Root Density					
Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
20.00	0.86	17.14	7.61	High	
Bank Angle					
Bank Angle (°)			Index	Bank Erosion Potental	Notes
90.00			7.90	High	
Surface Protection					
Surface Protection (%)			Index	Bank Erosion Potental	Notes
20.00			7.22	High	
			Adjustment		Notes
Bank Materials			5.00		silt loam
			Adjustment		Notes
Bank Stratification					
		TOTAL SCORE	**39.89**		

Bank Erosion Potential

		Very Low	Low	Moderate	High	Very High	Extreme
Erodibility Variables							
Bank Height / Bankfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Root Depth / Bank Height	Value	1.00-0.90	0.89-0.50	0.49-0.30	0.29-0.15	0.14-0.05	<0.05
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Surface Protection	Value	100-80	79-55	54-30	29-15	14-10	<10
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10

Adjustments

Bank Material	
Bedrock	Bedrock banks have a very low erosion potential.
Boulders	Boulder banks have a low erosion potential.
Cobble	Substract 10 points. No adjustment if sand/gravel compose greater than 50% of bank.
Clay/Silt Loam	Add 5 points.
Gravel	Add 5-10 points depending on percentage of bank material composed of sand.
Sand	Add 10 points.
Silt / Clay	No adjustment.

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

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

Estimating Near-Bank Stress (NBS)

Stream: **UNT to Sawmill Run** Location: **Crane Avenue**

Station: Stream Type: Valley Type:

Observers: **AT, MB, MM** Date: **5/11/22**

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)

Method	1
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**	

Copyright © 2008 Wildland Hydrology

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

USFWS - SHARP
STREAM NAME - REACH IDENTIFICATION

BANK EROSION HAZARD INDEX

Stream:	UNT to Sawmill Run	**Observer(s):**	AT,MB,MM	**Data:**	AT	**QA/QC:**		**Total Score:**		**38.49**		
Reach:		**Comments:**								**High**		
Location:	5	**Bank Length**	74					**Total Score Values:**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**	**Extreme**
Date:	5/11/2022								5-10	10-20	20-30	30-40	40-45	45-50

Erodibility Variables

Bank Height / Bankfull Height Ratio

Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
6.00	1.67	3.60	10.00	Extreme	

Root Depth / Bank Height Ratio

Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
5.00	6.00	0.83	2.28	Low	

Weighted Root Density

Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
60.00	0.83	50.00	4.32	Moderate	

Bank Angle

Bank Angle (°)		Index	Bank Erosion Potental	Notes
90.00		7.90	High	

Surface Protection

Surface Protection (%)		Index	Bank Erosion Potental	Notes
10.00		9.00	Very High	

	Adjustment		Notes
Bank Materials	5.00		silt loam
	Adjustment		Notes
Bank Stratification			
TOTAL SCORE	**38.49**		

Bank Erosion Potential

		Very Low	Low	Moderate	High	Very High	Extreme
Erodibility Variables							
Bank Height / Bankfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Root Depth / Bank Height	Value	1.00-0.90	0.89-0.50	0.49-0.30	0.29-0.15	0.14-0.05	<0.05
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Surface Protection	Value	100-80	79-55	54-30	29-15	14-10	<10
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10

Adjustments

Bedrock	Bedrock banks have a very low erosion potential.
Boulders	Boulder banks have a low erosion potential.
Cobble	Substract 10 points. No adjustment if sand/gravel compose greater than 50% of bank.
Clay/Silt Loam	Add 5 points.
Gravel	Add 5-10 points depending on percentage of bank material composed of sand.
Sand	Add 10 points.
Silt / Clay	No adjustment.

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

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

Estimating Near-Bank Stress (NBS)

Stream: **UNT to Sawmill Run** Location: **Crane Avenue**

Station: Stream Type: Valley Type:

Observers: **AT, MB, MM** Date: **5/11/22**

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)

Method	
Dominant Near-Bank Stress	

Level III

(5)

Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkf} (ft)	*Ratio* d_{nb} / d_{bkf}	Near-Bank Stress (NBS)
0.75	**0.4583333**	**1.6363636**	**Moderate**

(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				**Moderate**	

Copyright © 2008 Wildland Hydrology

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

USFWS - SHARP
STREAM NAME - REACH IDENTIFICATION

BANK EROSION HAZARD INDEX

Stream:	UNT to Sawmill Run	**Observer(s):**	AT,MB,MM	**Data:**	AT	**QA/QC:**		**Total Score:**		**43.43**		
Reach:		**Comments:**								**Very High**		
Location:	6	**Bank Length**	26					**Total Score Values:**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**	**Extreme**
Date:	5/11/2022								5-10	10-20	20-30	30-40	40-45	45-50

Erodibility Variables

Bank Height / Bankfull Height Ratio

Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
5.00	1.33	3.75	10.00	Extreme	

Root Depth / Bank Height Ratio

Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
3.50	5.00	0.70	2.93	Low	

Weighted Root Density

Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
50.00	0.70	35.00	5.50	Moderate	

Bank Angle

Bank Angle (°)		Index	Bank Erosion Potental	Notes
160.00		10.00	Extreme	

Surface Protection

Surface Protection (%)		Index	Bank Erosion Potental	Notes
5.00		10.00	Extreme	

	Adjustment		Notes
Bank Materials	5.00		silt loam
	Adjustment		Notes
Bank Stratification			
TOTAL SCORE	**43.43**		

Bank Erosion Potential

		Very Low	Low	Moderate	High	Very High	Extreme
Bank Height / Bankfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Root Depth / Bank Height	Value	1.00-0.90	0.89-0.50	0.49-0.30	0.29-0.15	0.14-0.05	<0.05
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Surface Protection	Value	100-80	79-55	54-30	29-15	14-10	<10
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10

Erodibility Variables

Adjustments

Bank Material

Bedrock	Bedrock banks have a very low erosion potential.
Boulders	Boulder banks have a low erosion potential.
Cobble	Substract 10 points. No adjustment if sand/gravel compose greater than 50% of bank.
Clay/Silt Loam	Add 5 points.
Gravel	Add 5-10 points depending on percentage of bank material composed of sand.
Sand	Add 10 points.
Silt / Clay	No adjustment.

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

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

Estimating Near-Bank Stress (NBS)

Stream: **UNT to Sawmill Run** Location: **Crane Avenue**

Station: Stream Type: Valley Type:

Observers: **AT, MB, MM** Date: **5/11/22**

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)

Method	1
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**	

Copyright © 2008 Wildland Hydrology

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

USFWS - SHARP
STREAM NAME - REACH IDENTIFICATION

BANK EROSION HAZARD INDEX

Stream:	UNT to Sawmill Run	**Observer(s):**	AT,MB,MM	**Data:**	AT	**QA/QC:**		**Total Score:**		**46.40**		
Reach:		**Comments:**	right bank							**Extreme**		
Location:	7 R	**Bank Length**	14					**Total Score Values:**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**	**Extreme**
Date:	5/11/2022								5-10	10-20	20-30	30-40	40-45	45-50

Erodibility Variables

Bank Height / Bankfull Height Ratio

Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
7.00	1.83	3.82	10.00	Extreme	

Root Depth / Bank Height Ratio

Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
2.00	7.00	0.29	6.06	High	

Weighted Root Density

Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
35.00	0.29	10.00	8.44	Very High	

Bank Angle

Bank Angle (°)		Index	Bank Erosion Potental	Notes
90.00		7.90	High	

Surface Protection

Surface Protection (%)		Index	Bank Erosion Potental	Notes
10.00		9.00	Very High	

	Adjustment		Notes
Bank Materials	5.00		silt loam
	Adjustment		Notes
Bank Stratification			
TOTAL SCORE	**46.40**		

Bank Erosion Potential

		Very Low	Low	Moderate	High	Very High	Extreme
Erodibility Variables							
Bank Height / Bankfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Root Depth / Bank Height	Value	1.00-0.90	0.89-0.50	0.49-0.30	0.29-0.15	0.14-0.05	<0.05
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Surface Protection	Value	100-80	79-55	54-30	29-15	14-10	<10
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10

Adjustments

Bedrock	Bedrock banks have a very low erosion potential.
Boulders	Boulder banks have a low erosion potential.
Cobble	Substract 10 points. No adjustment if sand/gravel compose greater than 50% of bank.
Clay/Silt Loam	Add 5 points.
Gravel	Add 5-10 points depending on percentage of bank material composed of sand.
Sand	Add 10 points.
Silt / Clay	No adjustment.

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

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

Estimating Near-Bank Stress (NBS)

Stream: **UNT to Sawmill Run** Location: **Crane Avenue**

Station: Stream Type: Valley Type:

Observers: **AT, MB, MM** Date: **5/11/22**

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)
4.5	**6.5**	**0.6923077**	**Extreme**

(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)

Method	**2**
Dominant Near-Bank Stress	

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**	

Copyright © 2008 Wildland Hydrology

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

USFWS - SHARP
STREAM NAME - REACH IDENTIFICATION

BANK EROSION HAZARD INDEX

Stream:	UNT to Sawmill Run	**Observer(s):**	AT,MB,MM	**Data:**	AT	**QA/QC:**		**Total Score:**		**29.79**		
Reach:		**Comments:**	left bank							**Moderate**		
Location:	7 L	**Bank Length**	14					**Total Score Values:**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**	**Extreme**
Date:	5/11/2022								5-10	10-20	20-30	30-40	40-45	45-50

Erodibility Variables

Bank Height / Bankfull Height Ratio

Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
2.00	1.83	1.09	1.82	Very Low	

Root Depth / Bank Height Ratio

Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
1.00	2.00	0.50	3.90	Low	

Weighted Root Density

Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
0.50	0.50	0.25	10.00	Extreme	

Bank Angle

Bank Angle (°)		Index	Bank Erosion Potental	Notes
45.00		3.17	Low	

Surface Protection

Surface Protection (%)		Index	Bank Erosion Potental	Notes
30.00		5.90	Moderate	

	Adjustment		Notes
Bank Materials	5.00		silt loam
	Adjustment		Notes
Bank Stratification			
TOTAL SCORE	**29.79**		

Bank Erosion Potential

		Very Low	Low	Moderate	High	Very High	Extreme
Erodibility Variables							
Bank Height / Bankfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Root Depth / Bank Height	Value	1.00-0.90	0.89-0.50	0.49-0.30	0.29-0.15	0.14-0.05	<0.05
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Surface Protection	Value	100-80	79-55	54-30	29-15	14-10	<10
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10

Adjustments

Bedrock	Bedrock banks have a very low erosion potential.
Boulders	Boulder banks have a low erosion potential.
Cobble	Substract 10 points. No adjustment if sand/gravel compose greater than 50% of bank.
Clay/Silt Loam	Add 5 points.
Gravel	Add 5-10 points depending on percentage of bank material composed of sand.
Sand	Add 10 points.
Silt / Clay	No adjustment.

Bank Material

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

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

Estimating Near-Bank Stress (NBS)

Stream: **UNT to Sawmill Run** Location: **Crane Avenue**

Station: Stream Type: Valley Type:

Observers: **AT, MB, MM** Date: **5/11/22**

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)
4.5	**6.5**	**0.6923077**	**Extreme**

(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)

Method	2
Dominant Near-Bank Stress	

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**	

Copyright © 2008 Wildland Hydrology

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

USFWS - SHARP
STREAM NAME - REACH IDENTIFICATION

BANK EROSION HAZARD INDEX

Stream:	UNT to Sawmill Run	**Observer(s):**	AT,MB,MM	**Data:**	AT	**QA/QC:**		**Total Score:**		**35.42**		
Reach:		**Comments:**								**High**		
Location:	8	**Bank Length**	50					**Total Score Values:**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**	**Extreme**
Date:	5/11/2022								5-10	10-20	20-30	30-40	40-45	45-50

Erodibility Variables

Bank Height / Bankfull Height Ratio

Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
2.17	0.67	3.25	10.00	Extreme	

Root Depth / Bank Height Ratio

Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
1.67	2.17	0.77	2.59	Low	

Weighted Root Density

Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
30.00	0.77	23.08	6.80	High	

Bank Angle

Bank Angle (°)		Index	Bank Erosion Potental	Notes
58.00		3.80	Low	

Surface Protection

Surface Protection (%)		Index	Bank Erosion Potental	Notes
20.00		7.22	High	

	Adjustment		Notes
Bank Materials	5.00		silt loam
	Adjustment		Notes
Bank Stratification			
TOTAL SCORE	**35.42**		

Bank Erosion Potential

		Very Low	Low	Moderate	High	Very High	Extreme
Erodibility Variables							
Bank Height / Bankfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Root Depth / Bank Height	Value	1.00-0.90	0.89-0.50	0.49-0.30	0.29-0.15	0.14-0.05	<0.05
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Surface Protection	Value	100-80	79-55	54-30	29-15	14-10	<10
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10

Adjustments

Bedrock	Bedrock banks have a very low erosion potential.
Boulders	Boulder banks have a low erosion potential.
Cobble	Substract 10 points. No adjustment if sand/gravel compose greater than 50% of bank.
Clay/Silt Loam	Add 5 points.
Gravel	Add 5-10 points depending on percentage of bank material composed of sand.
Sand	Add 10 points.
Silt / Clay	No adjustment.

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

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

Estimating Near-Bank Stress (NBS)

Stream: **UNT to Sawmill Run** Location: **Crane Avenue**

Station: Stream Type: Valley Type:

Observers: **AT, MB, MM** Date: **5/11/22**

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)

Method	
Dominant Near-Bank Stress	

Level III

(5)

Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkf} (ft)	*Ratio* d_{nb} / d_{bkf}	Near-Bank Stress (NBS)
0.7083333	**0.4583333**	**1.5454545**	**Moderate**

(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				**Moderate**	

Copyright © 2008 Wildland Hydrology

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

USFWS - SHARP
STREAM NAME - REACH IDENTIFICATION

BANK EROSION HAZARD INDEX

Stream:	UNT to Sawmill Run	**Observer(s):**	AT,MB,MM	**Data:**	AT	**QA/QC:**		**Total Score:**		**40.30**		
Reach:		**Comments:**								**Very High**		
Location:	9	**Bank Length**	24					**Total Score Values:**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**	**Extreme**
Date:	5/11/2022								5-10	10-20	20-30	30-40	40-45	45-50

Erodibility Variables					
Bank Height / Bankfull Height Ratio					
Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
3.17	1.00	3.17	10.00	Extreme	
Root Depth / Bank Height Ratio					
Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
1.50	3.17	0.47	4.16	Moderate	
Weighted Root Density					
Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
25.00	0.47	11.84	8.24	Very High	
Bank Angle					
Bank Angle (°)			Index	Bank Erosion Potental	Notes
60.00			3.90	Low	
Surface Protection					
Surface Protection (%)			Index	Bank Erosion Potental	Notes
10.00			9.00	Very High	
			Adjustment		Notes
Bank Materials			5.00		silt loam
			Adjustment		Notes
Bank Stratification					
		TOTAL SCORE	**40.30**		

Bank Erosion Potential

		Very Low	Low	Moderate	High	Very High	Extreme
Erodibility Variables							
Bank Height / Bankfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Root Depth / Bank Height	Value	1.00-0.90	0.89-0.50	0.49-0.30	0.29-0.15	0.14-0.05	<0.05
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Surface Protection	Value	100-80	79-55	54-30	29-15	14-10	<10
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10

Adjustments

Bedrock	Bedrock banks have a very low erosion potential.
Boulders	Boulder banks have a low erosion potential.
Cobble	Substract 10 points. No adjustment if sand/gravel compose greater than 50% of bank.
Clay/Silt Loam	Add 5 points.
Gravel	Add 5-10 points depending on percentage of bank material composed of sand.
Sand	Add 10 points.
Silt / Clay	No adjustment.

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

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

Estimating Near-Bank Stress (NBS)

Stream: **UNT to Sawmill Run** Location: **Crane Avenue**

Station: Stream Type: Valley Type:

Observers: **AT, MB, MM** Date: **5/11/22**

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)

Method	
Dominant Near-Bank Stress	

Level III

(5)

Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkf} (ft)	*Ratio* d_{nb} / d_{bkf}	Near-Bank Stress (NBS)
0.6666667	**0.4583333**	**1.4545455**	**Low**

(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				**Low**	

Copyright © 2008 Wildland Hydrology

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

USFWS - SHARP
STREAM NAME - REACH IDENTIFICATION

BANK EROSION HAZARD INDEX

Stream:	UNT to Sawmill Run	**Observer(s):**	AT,MB,MM	**Data:**	AT	**QA/QC:**		**Total Score:**		**37.19**		
Reach:		**Comments:**								**High**		
Location:	10	**Bank Length**	64					**Total Score Values:**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**	**Extreme**
Date:	5/11/2022								5-10	10-20	20-30	30-40	40-45	45-50

Erodibility Variables

Bank Height / Bankfull Height Ratio

Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
2.17	0.67	3.25	10.00	Extreme	

Root Depth / Bank Height Ratio

Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
1.67	2.17	0.77	2.59	Low	

Weighted Root Density

Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
30.00	0.77	23.08	6.80	High	

Bank Angle

Bank Angle (°)		Index	Bank Erosion Potental	Notes
58.00		3.80	Low	

Surface Protection

Surface Protection (%)		Index	Bank Erosion Potental	Notes
10.00		9.00	Very High	

	Adjustment		Notes
Bank Materials	5.00		silt loam
	Adjustment		Notes
Bank Stratification			
TOTAL SCORE	**37.19**		

Bank Erosion Potential

		Very Low	Low	Moderate	High	Very High	Extreme
Erodibility Variables							
Bank Height / Bankfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Root Depth / Bank Height	Value	1.00-0.90	0.89-0.50	0.49-0.30	0.29-0.15	0.14-0.05	<0.05
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Surface Protection	Value	100-80	79-55	54-30	29-15	14-10	<10
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10

Adjustments

Bedrock	Bedrock banks have a very low erosion potential.
Boulders	Boulder banks have a low erosion potential.
Cobble	Substract 10 points. No adjustment if sand/gravel compose greater than 50% of bank.
Clay/Silt Loam	Add 5 points.
Gravel	Add 5-10 points depending on percentage of bank material composed of sand.
Sand	Add 10 points.
Silt / Clay	No adjustment.

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

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

Estimating Near-Bank Stress (NBS)

Stream: **UNT to Sawmill Run** Location: **Crane Avenue**

Station: Stream Type: Valley Type:

Observers: **AT, MB, MM** Date: **5/11/22**

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)

Method	
Dominant Near-Bank Stress	

Level III

(5)

Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkf} (ft)	*Ratio* d_{nb} / d_{bkf}	Near-Bank Stress (NBS)
0.5833333	**0.4583333**	**1.2727273**	**Low**

(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					**Low**	

Copyright © 2008 Wildland Hydrology

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

USFWS - SHARP
STREAM NAME - REACH IDENTIFICATION

BANK EROSION HAZARD INDEX

Stream:	UNT to Sawmill Run	**Observer(s):**	AT,MB,MM	**Data:**	AT	**QA/QC:**		**Total Score:**		**40.11**		
Reach:		**Comments:**								**Very High**		
Location:	11	**Bank Length**	32					**Total Score Values:**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**	**Extreme**
Date:	5/11/2022								5-10	10-20	20-30	30-40	40-45	45-50

Erodibility Variables					
Bank Height / Bankfull Height Ratio					
Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
2.67	1.00	2.67	8.81	Very High	
Root Depth / Bank Height Ratio					
Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
1.67	2.67	0.63	3.29	Low	
Weighted Root Density					
Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
20.00	0.63	12.50	8.17	Very High	
Bank Angle					
Bank Angle (°)			Index	Bank Erosion Potental	Notes
85.00			6.84	High	
Surface Protection					
Surface Protection (%)			Index	Bank Erosion Potental	Notes
15.00			8.00	Very High	
			Adjustment		Notes
Bank Materials			5.00		silt loam
			Adjustment		Notes
Bank Stratification					
		TOTAL SCORE	**40.11**		

Bank Erosion Potential

		Very Low	Low	Moderate	High	Very High	Extreme
Erodibility Variables							
Bank Height / Bankfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Root Depth / Bank Height	Value	1.00-0.90	0.89-0.50	0.49-0.30	0.29-0.15	0.14-0.05	<0.05
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Surface Protection	Value	100-80	79-55	54-30	29-15	14-10	<10
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10

Adjustments

Bedrock	Bedrock banks have a very low erosion potential.
Boulders	Boulder banks have a low erosion potential.
Cobble	Substract 10 points. No adjustment if sand/gravel compose greater than 50% of bank.
Clay/Silt Loam	Add 5 points.
Gravel	Add 5-10 points depending on percentage of bank material composed of sand.
Sand	Add 10 points.
Silt / Clay	No adjustment.

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

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

Estimating Near-Bank Stress (NBS)

Stream: **UNT to Sawmill Run** Location: **Crane Avenue**

Station: Stream Type: Valley Type:

Observers: **AT, MB, MM** Date: **5/11/22**

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)

Method	1
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**	

Copyright © 2008 Wildland Hydrology

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

USFWS - SHARP
STREAM NAME - REACH IDENTIFICATION

BANK EROSION HAZARD INDEX

Stream:	UNT to Sawmill Run	**Observer(s):**	AT,MB,MM	**Data:**	AT	**QA/QC:**		**Total Score:**		**49.92**		
Reach:		**Comments:**								**Extreme**		
Location:	12	**Bank Length**	70					**Total Score Values:**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**	**Extreme**
Date:	5/11/2022								5-10	10-20	20-30	30-40	40-45	45-50

Erodibility Variables

Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
Bank Height / Bankfull Height Ratio					
2.50	0.46	5.45	10.00	Extreme	
Root Depth / Bank Height Ratio					
Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
0.33	2.50	0.13	8.07	Very High	
Weighted Root Density					
Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
10.00	0.13	1.33	10.00	Extreme	
Bank Angle					
Bank Angle (°)			Index	Bank Erosion Potental	Notes
85.00			6.84	High	
Surface Protection					
Surface Protection (%)			Index	Bank Erosion Potental	Notes
5.00			10.00	Extreme	
			Adjustment		Notes
Bank Materials			5.00		silt loam
			Adjustment		Notes
Bank Stratification					
		TOTAL SCORE	**49.92**		

Bank Erosion Potential

		Very Low	Low	Moderate	High	Very High	Extreme
Erodibility Variables							
Bank Height / Bankfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Root Depth / Bank Height	Value	1.00-0.90	0.89-0.50	0.49-0.30	0.29-0.15	0.14-0.05	<0.05
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Surface Protection	Value	100-80	79-55	54-30	29-15	14-10	<10
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10

Adjustments

Bedrock	Bedrock banks have a very low erosion potential.
Boulders	Boulder banks have a low erosion potential.
Cobble	Substract 10 points. No adjustment if sand/gravel compose greater than 50% of bank.
Clay/Silt Loam	Add 5 points.
Gravel	Add 5-10 points depending on percentage of bank material composed of sand.
Sand	Add 10 points.
Silt / Clay	No adjustment.

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

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

Estimating Near-Bank Stress (NBS)

Stream: **UNT to Sawmill Run** Location: **Crane Avenue**

Station: Stream Type: Valley Type:

Observers: **AT, MB, MM** Date: **5/11/22**

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)

Method	
Dominant Near-Bank Stress	

Level III

(5)

Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkf} (ft)	*Ratio* d_{nb} / d_{bkf}	Near-Bank Stress (NBS)
0.75	**0.4583333**	**1.6363636**	**Moderate**

(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				**Moderate**	

Copyright © 2008 Wildland Hydrology

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

USFWS - SHARP
STREAM NAME - REACH IDENTIFICATION

BANK EROSION HAZARD INDEX

Stream:	UNT to Sawmill Run	**Observer(s):**	AT,MB,MM	**Data:**	AT	**QA/QC:**		**Total Score:**		**40.04**		
Reach:		**Comments:**								**Very High**		
Location:	13	**Bank Length**	164					**Total Score Values:**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**	**Extreme**
Date:	5/11/2022								5-10	10-20	20-30	30-40	40-45	45-50

Erodibility Variables

Bank Height / Bankfull Height Ratio

Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
2.00	0.67	3.00	10.00	Extreme	

Root Depth / Bank Height Ratio

Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
0.67	2.00	0.33	5.57	Moderate	

Weighted Root Density

Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
40.00	0.33	13.33	8.07	Very High	

Bank Angle

Bank Angle (°)		Index	Bank Erosion Potental	Notes
90.00		7.90	High	

Surface Protection

Surface Protection (%)		Index	Bank Erosion Potental	Notes
60.00		3.50	Low	

	Adjustment		Notes
Bank Materials	5.00		silt loam
	Adjustment		Notes
Bank Stratification			
TOTAL SCORE	**40.04**		

Bank Erosion Potential

		Very Low	Low	Moderate	High	Very High	Extreme
Erodibility Variables							
Bank Height / Bankfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Root Depth / Bank Height	Value	1.00-0.90	0.89-0.50	0.49-0.30	0.29-0.15	0.14-0.05	<0.05
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Surface Protection	Value	100-80	79-55	54-30	29-15	14-10	<10
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10

Adjustments

Bedrock	Bedrock banks have a very low erosion potential.
Boulders	Boulder banks have a low erosion potential.
Cobble	Substract 10 points. No adjustment if sand/gravel compose greater than 50% of bank.
Clay/Silt Loam	Add 5 points.
Gravel	Add 5-10 points depending on percentage of bank material composed of sand.
Sand	Add 10 points.
Silt / Clay	No adjustment.

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

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

Estimating Near-Bank Stress (NBS)

Stream: **UNT to Sawmill Run** Location: **Crane Avenue**

Station: Stream Type: Valley Type:

Observers: **AT, MB, MM** Date: **5/11/22**

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)

Method	
Dominant Near-Bank Stress	

Level III

(5)

Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkf} (ft)	*Ratio* d_{nb} / d_{bkf}	Near-Bank Stress (NBS)
0.75	**0.4166667**	**1.8**	**Moderate**

(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				**Moderate**	

Copyright © 2008 Wildland Hydrology

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

USFWS - SHARP
STREAM NAME - REACH IDENTIFICATION

BANK EROSION HAZARD INDEX

Stream:	UNT to Sawmill Run	**Observer(s):**	AT,MB,MM	**Data:**	AT	**QA/QC:**		**Total Score:**		**46.04**		
Reach:		**Comments:**								**Extreme**		
Location:	14	**Bank Length**	398					**Total Score Values:**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**	**Extreme**
Date:	12/8/2022								5-10	10-20	20-30	30-40	40-45	45-50

Erodibility Variables					
Bank Height / Bankfull Height Ratio					
Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
8.00	1.08	7.38	10.00	Extreme	
Root Depth / Bank Height Ratio					
Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
1.25	8.00	0.16	7.82	High	
Weighted Root Density					
Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
35.00	0.16	5.47	8.95	Very High	
Bank Angle					
Bank Angle (°)			Index	Bank Erosion Potental	Notes
95.00			8.14	Very High	
Surface Protection					
Surface Protection (%)			Index	Bank Erosion Potental	Notes
28.00			6.14	High	
			Adjustment		Notes
Bank Materials			5.00		silt loam
			Adjustment		Notes
Bank Stratification					
		TOTAL SCORE	**46.04**		

Bank Erosion Potential

		Very Low	Low	Moderate	High	Very High	Extreme
Erodibility Variables							
Bank Height / Bankfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Root Depth / Bank Height	Value	1.00-0.90	0.89-0.50	0.49-0.30	0.29-0.15	0.14-0.05	<0.05
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Surface Protection	Value	100-80	79-55	54-30	29-15	14-10	<10
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10

Adjustments

Bedrock	Bedrock banks have a very low erosion potential.
Boulders	Boulder banks have a low erosion potential.
Cobble	Substract 10 points. No adjustment if sand/gravel compose greater than 50% of bank.
Clay/Silt Loam	Add 5 points.
Gravel	Add 5-10 points depending on percentage of bank material composed of sand.
Sand	Add 10 points.
Silt / Clay	No adjustment.

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

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

Estimating Near-Bank Stress (NBS)

Stream: **UNT to Sawmill Run** Location: **Crane Avenue**

Station: Stream Type: Valley Type:

Observers: **AT, MB, MM** Date: **5/11/22**

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)

Method	1
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)
0.8333333	**0.4583333**	**1.8181818**	**High**

(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**	

Copyright © 2008 Wildland Hydrology

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

USFWS - SHARP
STREAM NAME - REACH IDENTIFICATION

BANK EROSION HAZARD INDEX

Stream:	UNT to Sawmill Run	**Observer(s):**	AT,MB,MM	**Data:**	AT	**QA/QC:**		**Total Score:**		**47.50**		
Reach:		**Comments:**								**Extreme**		
Location:	15	**Bank Length**	138					**Total Score Values:**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**	**Extreme**
Date:	12/8/2022								5-10	10-20	20-30	30-40	40-45	45-50

Erodibility Variables

Bank Height / Bankfull Height Ratio

Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
12.00	0.75	16.00	10.00	Extreme	

Root Depth / Bank Height Ratio

Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
2.08	12.00	0.17	7.58	High	

Weighted Root Density

Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
80.00	0.17	13.87	8.01	Very High	

Bank Angle

Bank Angle (°)		Index	Bank Erosion Potental	Notes
90.00		7.90	High	

Surface Protection

Surface Protection (%)		Index	Bank Erosion Potental	Notes
10.00		9.00	Very High	

	Adjustment		Notes
Bank Materials	5.00		silt loam
	Adjustment		Notes
Bank Stratification			
TOTAL SCORE	**47.50**		

Bank Erosion Potential

		Very Low	Low	Moderate	High	Very High	Extreme
Erodibility Variables							
Bank Height / Bankfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Root Depth / Bank Height	Value	1.00-0.90	0.89-0.50	0.49-0.30	0.29-0.15	0.14-0.05	<0.05
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Surface Protection	Value	100-80	79-55	54-30	29-15	14-10	<10
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10

Adjustments

Bedrock	Bedrock banks have a very low erosion potential.
Boulders	Boulder banks have a low erosion potential.
Cobble	Substract 10 points. No adjustment if sand/gravel compose greater than 50% of bank.
Clay/Silt Loam	Add 5 points.
Gravel	Add 5-10 points depending on percentage of bank material composed of sand.
Sand	Add 10 points.
Silt / Clay	No adjustment.

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

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

Estimating Near-Bank Stress (NBS)

Stream: **UNT to Sawmill Run** Location: **Crane Avenue**

Station: Stream Type: Valley Type:

Observers: **AT, MB, MM** Date: **5/11/22**

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)

Method	1
Dominant Near-Bank Stress	
Very 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				**Very High**	

Copyright © 2008 Wildland Hydrology

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

USFWS - SHARP
STREAM NAME - REACH IDENTIFICATION

BANK EROSION HAZARD INDEX

Stream:	UNT to Sawmill Run	**Observer(s):**	AT,MB,MM	**Data:**	AT	**QA/QC:**		**Total Score:**		**47.00**		
Reach:		**Comments:**								**Extreme**		
Location:	16	**Bank Length**	72					**Total Score Values:**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**	**Extreme**
Date:	5/11/2022								5-10	10-20	20-30	30-40	40-45	45-50

Erodibility Variables

Bank Height / Bankfull Height Ratio

Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
8.00	1.00	8.00	10.00	Extreme	

Root Depth / Bank Height Ratio

Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
2.00	8.00	0.25	6.54	High	

Weighted Root Density

Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
70.00	0.25	17.50	7.56	High	

Bank Angle

Bank Angle (°)		Index	Bank Erosion Potental	Notes
90.00		7.90	High	

Surface Protection

Surface Protection (%)		Index	Bank Erosion Potental	Notes
5.00		10.00	Extreme	

	Adjustment		Notes
Bank Materials	5.00		silt loam
	Adjustment		Notes
Bank Stratification			
TOTAL SCORE	**47.00**		

Bank Erosion Potential

		Very Low	Low	Moderate	High	Very High	Extreme
Erodibility Variables							
Bank Height / Bankfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Root Depth / Bank Height	Value	1.00-0.90	0.89-0.50	0.49-0.30	0.29-0.15	0.14-0.05	<0.05
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Surface Protection	Value	100-80	79-55	54-30	29-15	14-10	<10
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10

Adjustments

Bedrock	Bedrock banks have a very low erosion potential.
Boulders	Boulder banks have a low erosion potential.
Cobble	Substract 10 points. No adjustment if sand/gravel compose greater than 50% of bank.
Clay/Silt Loam	Add 5 points.
Gravel	Add 5-10 points depending on percentage of bank material composed of sand.
Sand	Add 10 points.
Silt / Clay	No adjustment.

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

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

Estimating Near-Bank Stress (NBS)

Stream: **UNT to Sawmill Run** Location: **Crane Avenue**

Station: Stream Type: Valley Type:

Observers: **AT, MB, MM** Date: **5/11/22**

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)

Method	
Dominant Near-Bank Stress	

Level III

(5)

Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkf} (ft)	*Ratio* d_{nb} / d_{bkf}	Near-Bank Stress (NBS)
0.6666667	**0.4583333**	**1.4545455**	**Low**

(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					**Low**	

Copyright © 2008 Wildland Hydrology

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

USFWS - SHARP
STREAM NAME - REACH IDENTIFICATION

BANK EROSION HAZARD INDEX

Stream:	UNT to Sawmill Run	**Observer(s):**	AT,MB,MM	**Data:**	AT	**QA/QC:**		**Total Score:**		**46.32**		
Reach:		**Comments:**								**Extreme**		
Location:	17	**Bank Length**	60					**Total Score Values:**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**	**Extreme**
Date:	5/11/2022								5-10	10-20	20-30	30-40	40-45	45-50

Erodibility Variables

Bank Height / Bankfull Height Ratio

Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
4.50	1.00	4.50	10.00	Extreme	

Root Depth / Bank Height Ratio

Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
1.00	4.50	0.22	6.92	High	

Weighted Root Density

Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
15.00	0.22	3.33	10.00	Extreme	

Bank Angle

Bank Angle (°)		Index	Bank Erosion Potental	Notes
65.00		4.40	Moderate	

Surface Protection

Surface Protection (%)		Index	Bank Erosion Potental	Notes
5.00		10.00	Extreme	

	Adjustment		Notes
Bank Materials	5.00		silt loam
	Adjustment		Notes
Bank Stratification			
TOTAL SCORE	**46.32**		

Bank Erosion Potential

		Very Low	Low	Moderate	High	Very High	Extreme
Erodibility Variables							
Bank Height / Bankfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Root Depth / Bank Height	Value	1.00-0.90	0.89-0.50	0.49-0.30	0.29-0.15	0.14-0.05	<0.05
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Surface Protection	Value	100-80	79-55	54-30	29-15	14-10	<10
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10

Adjustments

Bedrock	Bedrock banks have a very low erosion potential.
Boulders	Boulder banks have a low erosion potential.
Cobble	Substract 10 points. No adjustment if sand/gravel compose greater than 50% of bank.
Clay/Silt Loam	Add 5 points.
Gravel	Add 5-10 points depending on percentage of bank material composed of sand.
Sand	Add 10 points.
Silt / Clay	No adjustment.

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

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

Estimating Near-Bank Stress (NBS)

Stream: **UNT to Sawmill Run** Location: **Crane Avenue**

Station: Stream Type: Valley Type:

Observers: **AT, MB, MM** Date: **5/11/22**

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)

Method	
Dominant Near-Bank Stress	

Level III

(5)

Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkf} (ft)	*Ratio* d_{nb} / d_{bkf}	Near-Bank Stress (NBS)
0.58	**0.4583333**	**1.2727273**	**Low**

(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				**Low**	

Copyright © 2008 Wildland Hydrology

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

USFWS - SHARP
STREAM NAME - REACH IDENTIFICATION

BANK EROSION HAZARD INDEX

Stream:	UNT to Sawmill Run	**Observer(s):**	AT,MB,MM	**Data:**	AT	**QA/QC:**		**Total Score:**		**41.62**		
Reach:		**Comments:**								**Very High**		
Location:	18	**Bank Length**	74					**Total Score Values:**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**	**Extreme**
Date:	5/11/2022								5-10	10-20	20-30	30-40	40-45	45-50

Erodibility Variables

Bank Height / Bankfull Height Ratio

Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
7.00	0.50	14.00	10.00	Extreme	

Root Depth / Bank Height Ratio

Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
4.00	7.00	0.57	3.55	Low	

Weighted Root Density

Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
21.00	0.57	12.00	8.22	Very High	

Bank Angle

Bank Angle (°)		Index	Bank Erosion Potental	Notes
85.00		6.84	High	

Surface Protection

Surface Protection (%)		Index	Bank Erosion Potental	Notes
15.00		8.00	Very High	

	Adjustment		Notes
Bank Materials	5.00		silt loam
	Adjustment		Notes
Bank Stratification			
TOTAL SCORE	**41.62**		

Bank Erosion Potential

		Very Low	Low	Moderate	High	Very High	Extreme
Erodibility Variables							
Bank Height / Bankfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Root Depth / Bank Height	Value	1.00-0.90	0.89-0.50	0.49-0.30	0.29-0.15	0.14-0.05	<0.05
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Surface Protection	Value	100-80	79-55	54-30	29-15	14-10	<10
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10

Adjustments

Bedrock	Bedrock banks have a very low erosion potential.
Boulders	Boulder banks have a low erosion potential.
Cobble	Substract 10 points. No adjustment if sand/gravel compose greater than 50% of bank.
Clay/Silt Loam	Add 5 points.
Gravel	Add 5-10 points depending on percentage of bank material composed of sand.
Sand	Add 10 points.
Silt / Clay	No adjustment.

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

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

Estimating Near-Bank Stress (NBS)

Stream: **UNT to Sawmill Run** Location: **Crane Avenue**

Station: Stream Type: Valley Type:

Observers: **AT, MB, MM** Date: **5/11/22**

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)

Method	
Dominant Near-Bank Stress	

Level III

(5)

Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkf} (ft)	*Ratio* d_{nb} / d_{bkf}	Near-Bank Stress (NBS)
0.5833333	**0.5**	**1.1666667**	**Low**

(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				**Low**	

Copyright © 2008 Wildland Hydrology

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

USFWS - SHARP
STREAM NAME - REACH IDENTIFICATION

BANK EROSION HAZARD INDEX

Stream:	UNT to Sawmill Run	**Observer(s):**	AT,MB,MM	**Data:**	AT	**QA/QC:**		**Total Score:**		**40.06**		
Reach:		**Comments:**								**Very High**		
Location:	19	**Bank Length**	10					**Total Score Values:**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**	**Extreme**
Date:	5/11/2022								5-10	10-20	20-30	30-40	40-45	45-50

Erodibility Variables					
Bank Height / Bankfull Height Ratio					
Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
7.00	1.00	7.00	10.00	Extreme	
Root Depth / Bank Height Ratio					
Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
4.50	7.00	0.64	3.20	Low	
Weighted Root Density					
Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
45.00	0.64	28.93	6.01	High	
Bank Angle					
Bank Angle (°)			Index	Bank Erosion Potental	Notes
85.00			6.84	High	
Surface Protection					
Surface Protection (%)			Index	Bank Erosion Potental	Notes
10.00			9.00	Very High	
			Adjustment		Notes
Bank Materials			5.00		silt loam
			Adjustment		Notes
Bank Stratification					
		TOTAL SCORE	**40.06**		

Bank Erosion Potential

		Very Low	Low	Moderate	High	Very High	Extreme
Erodibility Variables							
Bank Height / Bankfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Root Depth / Bank Height	Value	1.00-0.90	0.89-0.50	0.49-0.30	0.29-0.15	0.14-0.05	<0.05
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Surface Protection	Value	100-80	79-55	54-30	29-15	14-10	<10
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10

Adjustments

Bedrock	Bedrock banks have a very low erosion potential.
Boulders	Boulder banks have a low erosion potential.
Cobble	Substract 10 points. No adjustment if sand/gravel compose greater than 50% of bank.
Clay/Silt Loam	Add 5 points.
Gravel	Add 5-10 points depending on percentage of bank material composed of sand.
Sand	Add 10 points.
Silt / Clay	No adjustment.

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

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

Estimating Near-Bank Stress (NBS)

Stream: **UNT to Sawmill Run** Location: **Crane Avenue**

Station: Stream Type: Valley Type:

Observers: **AT, MB, MM** Date: **5/11/22**

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)

Method	
Dominant Near-Bank Stress	

Level III

(5)

Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkf} (ft)	*Ratio* d_{nb} / d_{bkf}	Near-Bank Stress (NBS)
0.75	**0.4583333**	**1.6363636**	**Moderate**

(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				**Moderate**	

Copyright © 2008 Wildland Hydrology

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

USFWS - SHARP
STREAM NAME - REACH IDENTIFICATION

BANK EROSION HAZARD INDEX

Stream:	UNT to Sawmill Run	**Observer(s):**	AT,MB,MM	**Data:**	AT	**QA/QC:**		**Total Score:**		**22.76**		
Reach:		**Comments:**								**Moderate**		
Location:	20	**Bank Length**	24					**Total Score Values:**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**	**Extreme**
Date:	5/11/2022								5-10	10-20	20-30	30-40	40-45	45-50

Erodibility Variables					
Bank Height / Bankfull Height Ratio					
Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
4.00	0.83	4.80	10.00	Extreme	
Root Depth / Bank Height Ratio					
Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
4.00	4.00	1.00	1.00	Very Low	
Weighted Root Density					
Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
85.00	1.00	85.00	1.68	Very Low	
Bank Angle					
Bank Angle (°)			Index	Bank Erosion Potental	Notes
50.00			3.41	Low	
Surface Protection					
Surface Protection (%)			Index	Bank Erosion Potental	Notes
85.00			1.68	Very Low	
			Adjustment		Notes
Bank Materials			5.00		silt loam
			Adjustment		Notes
Bank Stratification					
		TOTAL SCORE	**22.76**		

Bank Erosion Potential

		Very Low	Low	Moderate	High	Very High	Extreme
Erodibility Variables							
Bank Height / Bankfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Root Depth / Bank Height	Value	1.00-0.90	0.89-0.50	0.49-0.30	0.29-0.15	0.14-0.05	<0.05
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Surface Protection	Value	100-80	79-55	54-30	29-15	14-10	<10
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10

Adjustments

Bank Material	
Bedrock	Bedrock banks have a very low erosion potential.
Boulders	Boulder banks have a low erosion potential.
Cobble	Substract 10 points. No adjustment if sand/gravel compose greater than 50% of bank.
Clay/Silt Loam	Add 5 points.
Gravel	Add 5-10 points depending on percentage of bank material composed of sand.
Sand	Add 10 points.
Silt / Clay	No adjustment.

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

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

Estimating Near-Bank Stress (NBS)

Stream: **UNT to Sawmill Run** Location: **Crane Avenue**

Station: Stream Type: Valley Type:

Observers: **AT, MB, MM** Date: **5/11/22**

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)

Method	
Dominant Near-Bank Stress	

Level III

(5)

Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkf} (ft)	*Ratio* d_{nb} / d_{bkf}	Near-Bank Stress (NBS)
0.5833333	**0.4583333**	**1.2727273**	**Low**

(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				**Low**	

Copyright © 2008 Wildland Hydrology

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

USFWS - SHARP
STREAM NAME - REACH IDENTIFICATION

BANK EROSION HAZARD INDEX

Stream:	UNT to Sawmill Run	**Observer(s):**	AT,MB,MM	**Data:**	AT	**QA/QC:**		**Total Score:**		**21.19**		
Reach:		**Comments:**								**Moderate**		
Location:	21	**Bank Length**	48					**Total Score Values:**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**	**Extreme**
Date:	5/11/2022								5-10	10-20	20-30	30-40	40-45	45-50

Erodibility Variables

Bank Height / Bankfull Height Ratio					
Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
2.00	0.83	2.40	8.43	Very High	
Root Depth / Bank Height Ratio					
Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
2.00	2.00	1.00	1.00	Very Low	
Weighted Root Density					
Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
85.00	1.00	85.00	1.68	Very Low	
Bank Angle					
Bank Angle (°)			Index	Bank Erosion Potental	Notes
50.00			3.41	Low	
Surface Protection					
Surface Protection (%)			Index	Bank Erosion Potental	Notes
85.00			1.68	Very Low	
			Adjustment		Notes
Bank Materials			5.00		silt loam
			Adjustment		Notes
Bank Stratification					
		TOTAL SCORE	**21.19**		

Bank Erosion Potential

		Very Low	Low	Moderate	High	Very High	Extreme
Erodibility Variables							
Bank Height / Bankfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Root Depth / Bank Height	Value	1.00-0.90	0.89-0.50	0.49-0.30	0.29-0.15	0.14-0.05	<0.05
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Surface Protection	Value	100-80	79-55	54-30	29-15	14-10	<10
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10

Adjustments

Bedrock	Bedrock banks have a very low erosion potential.
Boulders	Boulder banks have a low erosion potential.
Cobble	Substract 10 points. No adjustment if sand/gravel compose greater than 50% of bank.
Clay/Silt Loam	Add 5 points.
Gravel	Add 5-10 points depending on percentage of bank material composed of sand.
Sand	Add 10 points.
Silt / Clay	No adjustment.

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

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

Estimating Near-Bank Stress (NBS)

Stream: **UNT to Sawmill Run** Location: **Crane Avenue**

Station: Stream Type: Valley Type:

Observers: **AT, MB, MM** Date: **5/11/22**

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)

Method	
Dominant Near-Bank Stress	

Level III

(5)

Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkf} (ft)	*Ratio* d_{nb} / d_{bkf}	Near-Bank Stress (NBS)
0.5833333	**0.4583333**	**1.2727273**	**Low**

(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					**Low**	

Copyright © 2008 Wildland Hydrology

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

USFWS - SHARP
STREAM NAME - REACH IDENTIFICATION

BANK EROSION HAZARD INDEX

Stream:	UNT to Sawmill Run	**Observer(s):**	AT,MB,MM	**Data:**	AT	**QA/QC:**		**Total Score:**		**43.04**		
Reach:		**Comments:**								**Very High**		
Location:	22	**Bank Length**	120					**Total Score Values:**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**	**Extreme**
Date:	5/11/2022								5-10	10-20	20-30	30-40	40-45	45-50

Erodibility Variables

Bank Height / Bankfull Height Ratio

Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
3.33	0.67	5.00	10.00	Extreme	

Root Depth / Bank Height Ratio

Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
0.83	3.33	0.25	6.54	High	

Weighted Root Density

Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
20.00	0.25	5.00	9.00	Very High	

Bank Angle

Bank Angle (°)		Index	Bank Erosion Potental	Notes
66.00		4.50	Moderate	

Surface Protection

Surface Protection (%)		Index	Bank Erosion Potental	Notes
15.00		8.00	Very High	

	Adjustment		Notes
Bank Materials	5.00		silt loam
	Adjustment		Notes
Bank Stratification			
TOTAL SCORE	**43.04**		

Bank Erosion Potential

		Very Low	Low	Moderate	High	Very High	Extreme
Erodibility Variables							
Bank Height / Bankfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Root Depth / Bank Height	Value	1.00-0.90	0.89-0.50	0.49-0.30	0.29-0.15	0.14-0.05	<0.05
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Surface Protection	Value	100-80	79-55	54-30	29-15	14-10	<10
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10

Adjustments

Bedrock	Bedrock banks have a very low erosion potential.
Boulders	Boulder banks have a low erosion potential.
Cobble	Substract 10 points. No adjustment if sand/gravel compose greater than 50% of bank.
Clay/Silt Loam	Add 5 points.
Gravel	Add 5-10 points depending on percentage of bank material composed of sand.
Sand	Add 10 points.
Silt / Clay	No adjustment.

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

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

Estimating Near-Bank Stress (NBS)

Stream: **UNT to Sawmill Run** Location: **Crane Avenue**

Station: Stream Type: Valley Type:

Observers: **AT, MB, MM** Date: **5/11/22**

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)

Method	
Dominant Near-Bank Stress	

Level III

(5)

Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkf} (ft)	*Ratio* d_{nb} / d_{bkf}	Near-Bank Stress (NBS)
0.8333333	**0.4583333**	**1.8181818**	**High**

(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**	

Copyright © 2008 Wildland Hydrology

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

USFWS - SHARP
STREAM NAME - REACH IDENTIFICATION

BANK EROSION HAZARD INDEX

Stream:	UNT to Sawmill Run	**Observer(s):**	AT,MB,MM	**Data:**	AT	**QA/QC:**		**Total Score:**		**36.35**		
Reach:		**Comments:**								**High**		
Location:	23	**Bank Length**	86					**Total Score Values:**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**	**Extreme**
Date:	5/11/2022								5-10	10-20	20-30	30-40	40-45	45-50

Erodibility Variables

Bank Height / Bankfull Height Ratio

Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
2.67	0.58	4.57	10.00	Extreme	

Root Depth / Bank Height Ratio

Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
2.67	2.67	1.00	1.00	Very Low	

Weighted Root Density

Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
60.00	1.00	60.00	3.50	Low	

Bank Angle

Bank Angle (°)		Index	Bank Erosion Potental	Notes
85.00		6.84	High	

Surface Protection

Surface Protection (%)		Index	Bank Erosion Potental	Notes
5.00		10.00	Extreme	

	Adjustment		Notes
Bank Materials	5.00		silt loam
	Adjustment		Notes
Bank Stratification			
TOTAL SCORE	**36.35**		

Bank Erosion Potential

		Very Low	Low	Moderate	High	Very High	Extreme
Erodibility Variables							
Bank Height / Bankfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Root Depth / Bank Height	Value	1.00-0.90	0.89-0.50	0.49-0.30	0.29-0.15	0.14-0.05	<0.05
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Surface Protection	Value	100-80	79-55	54-30	29-15	14-10	<10
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10

Adjustments

Bedrock	Bedrock banks have a very low erosion potential.
Boulders	Boulder banks have a low erosion potential.
Cobble	Substract 10 points. No adjustment if sand/gravel compose greater than 50% of bank.
Clay/Silt Loam	Add 5 points.
Gravel	Add 5-10 points depending on percentage of bank material composed of sand.
Sand	Add 10 points.
Silt / Clay	No adjustment.

Bank Material

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

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

Estimating Near-Bank Stress (NBS)

Stream: **UNT to Sawmill Run** Location: **Crane Avenue**

Station: Stream Type: Valley Type:

Observers: **AT, MB, MM** Date: **5/11/22**

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)

Method	
Dominant Near-Bank Stress	

Level III

(5)

Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkf} (ft)	*Ratio* d_{nb} / d_{bkf}	Near-Bank Stress (NBS)
0.75	**0.4583333**	**1.6363636**	**Moderate**

(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				**Moderate**	

Copyright © 2008 Wildland Hydrology

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

USFWS - SHARP
STREAM NAME - REACH IDENTIFICATION

BANK EROSION HAZARD INDEX

Stream:	UNT to Sawmill Run	**Observer(s):**	AT,MB,MM	**Data:**	AT	**QA/QC:**		**Total Score:**		**42.02**		
Reach:		**Comments:**								**Very High**		
Location:	24	**Bank Length**	130					**Total Score Values:**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**	**Extreme**
Date:	5/11/2022								5-10	10-20	20-30	30-40	40-45	45-50

Erodibility Variables

Bank Height / Bankfull Height Ratio

Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
2.33	0.50	4.67	10.00	Extreme	

Root Depth / Bank Height Ratio

Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
1.67	2.33	0.71	2.86	Low	

Weighted Root Density

Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
10.00	0.71	7.14	8.76	Very High	

Bank Angle

Bank Angle (°)		Index	Bank Erosion Potental	Notes
75.00		5.40	Moderate	

Surface Protection

Surface Protection (%)		Index	Bank Erosion Potental	Notes
1.00		10.00	Extreme	

	Adjustment		Notes
Bank Materials	5.00		silt loam
	Adjustment		Notes
Bank Stratification			
TOTAL SCORE	**42.02**		

Bank Erosion Potential

		Very Low	Low	Moderate	High	Very High	Extreme
Erodibility Variables							
Bank Height / Bankfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Root Depth / Bank Height	Value	1.00-0.90	0.89-0.50	0.49-0.30	0.29-0.15	0.14-0.05	<0.05
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Surface Protection	Value	100-80	79-55	54-30	29-15	14-10	<10
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10

Adjustments

Bedrock	Bedrock banks have a very low erosion potential.
Boulders	Boulder banks have a low erosion potential.
Cobble	Substract 10 points. No adjustment if sand/gravel compose greater than 50% of bank.
Clay/Silt Loam	Add 5 points.
Gravel	Add 5-10 points depending on percentage of bank material composed of sand.
Sand	Add 10 points.
Silt / Clay	No adjustment.

Bank Material

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

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

Estimating Near-Bank Stress (NBS)

Stream: **UNT to Sawmill Run** Location: **Crane Avenue**

Station: Stream Type: Valley Type:

Observers: **AT, MB, MM** Date: **5/11/22**

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)

Method	
Dominant Near-Bank Stress	

Level III

(5)

Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkf} (ft)	*Ratio* d_{nb} / d_{bkf}	Near-Bank Stress (NBS)
0.75	**0.4583333**	**1.6363636**	**Moderate**

(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				**Moderate**	

Copyright © 2008 Wildland Hydrology

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

USFWS - SHARP
STREAM NAME - REACH IDENTIFICATION

BANK EROSION HAZARD INDEX

Stream:	UNT to Sawmill Run	**Observer(s):**	AT,MB,MM	**Data:**	AT	**QA/QC:**		**Total Score:**		**41.74**		
Reach:		**Comments:**								**Very High**		
Location:	25	**Bank Length**	50					**Total Score Values:**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**	**Extreme**
Date:	5/11/2022								5-10	10-20	20-30	30-40	40-45	45-50

Erodibility Variables

Bank Height / Bankfull Height Ratio

Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
6.42	0.50	12.83	10.00	Extreme	

Root Depth / Bank Height Ratio

Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
3.00	6.42	0.47	4.22	Moderate	

Weighted Root Density

Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
40.00	0.47	18.70	7.40	High	

Bank Angle

Bank Angle (°)		Index	Bank Erosion Potental	Notes
90.00		7.90	High	

Surface Protection

Surface Protection (%)		Index	Bank Erosion Potental	Notes
20.00		7.22	High	

	Adjustment		Notes
Bank Materials	5.00		silt loam
	Adjustment		Notes
Bank Stratification			
TOTAL SCORE	**41.74**		

Bank Erosion Potential

		Very Low	Low	Moderate	High	Very High	Extreme
Erodibility Variables							
Bank Height / Bankfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Root Depth / Bank Height	Value	1.00-0.90	0.89-0.50	0.49-0.30	0.29-0.15	0.14-0.05	<0.05
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Surface Protection	Value	100-80	79-55	54-30	29-15	14-10	<10
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10

Adjustments

Bedrock	Bedrock banks have a very low erosion potential.
Boulders	Boulder banks have a low erosion potential.
Cobble	Substract 10 points. No adjustment if sand/gravel compose greater than 50% of bank.
Clay/Silt Loam	Add 5 points.
Gravel	Add 5-10 points depending on percentage of bank material composed of sand.
Sand	Add 10 points.
Silt / Clay	No adjustment.

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

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

Estimating Near-Bank Stress (NBS)

Stream: **UNT to Sawmill Run** Location: **Crane Avenue**

Station: Stream Type: Valley Type:

Observers: **AT, MB, MM** Date: **5/11/22**

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)

Method	1
Dominant Near-Bank Stress	
Moderate	

Level III

(5)

Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkf} (ft)	*Ratio* d_{nb} / d_{bkf}	Near-Bank Stress (NBS)
0.5833333	**0.4583333**	**1.2727273**	**Low**

(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					**Moderate**	

Copyright © 2008 Wildland Hydrology

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

USFWS - SHARP
STREAM NAME - REACH IDENTIFICATION

BANK EROSION HAZARD INDEX

Stream:	UNT to Sawmill Run	**Observer(s):**	AT,MB,MM	**Data:**	AT	**QA/QC:**		**Total Score:**		**47.44**		
Reach:		**Comments:**								**Extreme**		
Location:	26	**Bank Length**	40					**Total Score Values:**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**	**Extreme**
Date:	5/11/2022								5-10	10-20	20-30	30-40	40-45	45-50

Erodibility Variables

Bank Height / Bankfull Height Ratio

Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
2.00	0.50	4.00	10.00	Extreme	

Root Depth / Bank Height Ratio

Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
0.01	2.00	0.01	10.00	Extreme	

Weighted Root Density

Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
1.00	0.01	0.01	10.00	Extreme	

Bank Angle

Bank Angle (°)		Index	Bank Erosion Potental	Notes
30.00		2.44	Low	

Surface Protection

Surface Protection (%)		Index	Bank Erosion Potental	Notes
1.00		10.00	Extreme	

	Adjustment		Notes
Bank Materials	5.00		silt loam
	Adjustment		Notes
Bank Stratification			
TOTAL SCORE	**47.44**		

Bank Erosion Potential

		Very Low	Low	Moderate	High	Very High	Extreme
Bank Height / Bankfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Root Depth / Bank Height	Value	1.00-0.90	0.89-0.50	0.49-0.30	0.29-0.15	0.14-0.05	<0.05
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Surface Protection	Value	100-80	79-55	54-30	29-15	14-10	<10
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10

Erodibility Variables

Bank Material

Adjustments

Bedrock	Bedrock banks have a very low erosion potential.
Boulders	Boulder banks have a low erosion potential.
Cobble	Substract 10 points. No adjustment if sand/gravel compose greater than 50% of bank.
Clay/Silt Loam	Add 5 points.
Gravel	Add 5-10 points depending on percentage of bank material composed of sand.
Sand	Add 10 points.
Silt / Clay	No adjustment.

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

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

Estimating Near-Bank Stress (NBS)

Stream: **UNT to Sawmill Run** Location: **Crane Avenue**

Station: Stream Type: Valley Type:

Observers: **AT, MB, MM** Date: **5/11/22**

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)

Method	1
Dominant Near-Bank Stress	
Moderate	

Level III

(5)

Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkf} (ft)	*Ratio* d_{nb} / d_{bkf}	Near-Bank Stress (NBS)
0.5	**0.4583333**	**1.0909091**	**Low**

(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				**Moderate**	

Copyright © 2008 Wildland Hydrology

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

USFWS - SHARP
STREAM NAME - REACH IDENTIFICATION

BANK EROSION HAZARD INDEX

Stream:	UNT to Sawmill Run	**Observer(s):**	AT,MB,MM	**Data:**	AT	**QA/QC:**		**Total Score:**		**32.47**		
Reach:		**Comments:**								**High**		
Location:	27	**Bank Length**	76					**Total Score Values:**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**	**Extreme**
Date:	5/11/2022								5-10	10-20	20-30	30-40	40-45	45-50

Erodibility Variables

Bank Height / Bankfull Height Ratio

Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
4.00	0.50	8.00	10.00	Extreme	

Root Depth / Bank Height Ratio

Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
3.00	4.00	0.75	2.68	Low	

Weighted Root Density

Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
30.00	0.75	22.50	6.88	High	

Bank Angle

Bank Angle (°)		Index	Bank Erosion Potental	Notes
65.00		4.40	Moderate	

Surface Protection

Surface Protection (%)		Index	Bank Erosion Potental	Notes
60.00		3.50	Low	

	Adjustment		Notes
Bank Materials	5.00		silt loam
	Adjustment		Notes
Bank Stratification			
TOTAL SCORE	**32.47**		

Bank Erosion Potential

		Very Low	Low	Moderate	High	Very High	Extreme
Bank Height / Bankfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Root Depth / Bank Height	Value	1.00-0.90	0.89-0.50	0.49-0.30	0.29-0.15	0.14-0.05	<0.05
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Surface Protection	Value	100-80	79-55	54-30	29-15	14-10	<10
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10

Erodibility Variables

Bank Material

Adjustments

Bedrock	Bedrock banks have a very low erosion potential.
Boulders	Boulder banks have a low erosion potential.
Cobble	Substract 10 points. No adjustment if sand/gravel compose greater than 50% of bank.
Clay/Silt Loam	Add 5 points.
Gravel	Add 5-10 points depending on percentage of bank material composed of sand.
Sand	Add 10 points.
Silt / Clay	No adjustment.

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

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

Estimating Near-Bank Stress (NBS)

Stream: **UNT to Sawmill Run** Location: **Crane Avenue**

Station: Stream Type: Valley Type:

Observers: **AT, MB, MM** Date: **5/11/22**

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)

Method	1
Dominant Near-Bank Stress	**Very 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)
0.6666667	**0.4583333**	**1.4545455**	**Low**

(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					**Very High**	

Copyright © 2008 Wildland Hydrology

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

USFWS - SHARP
STREAM NAME - REACH IDENTIFICATION

BANK EROSION HAZARD INDEX

Stream:	UNT to Sawmill Run	**Observer(s):**	AT,MB,MM	**Data:**	AT	**QA/QC:**		**Total Score:**		**37.59**		
Reach:		**Comments:**								**High**		
Location:	28	**Bank Length**	132					**Total Score Values:**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**	**Extreme**
Date:	5/11/2022								5-10	10-20	20-30	30-40	40-45	45-50

Erodibility Variables

Bank Height / Bankfull Height Ratio

Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
1.67	0.83	2.00	7.90	High	

Root Depth / Bank Height Ratio

Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
0.42	1.67	0.25	6.54	High	

Weighted Root Density

Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
10.00	0.25	2.50	10.00	Extreme	

Bank Angle

Bank Angle (°)		Index	Bank Erosion Potental	Notes
26.00		2.24	Low	

Surface Protection

Surface Protection (%)		Index	Bank Erosion Potental	Notes
30.00		5.90	Moderate	

	Adjustment		Notes
Bank Materials	5.00		silt loam
	Adjustment		Notes
Bank Stratification			
TOTAL SCORE	**37.59**		

Bank Erosion Potential

		Very Low	Low	Moderate	High	Very High	Extreme
Erodibility Variables							
Bank Height / Bankfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Root Depth / Bank Height	Value	1.00-0.90	0.89-0.50	0.49-0.30	0.29-0.15	0.14-0.05	<0.05
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Surface Protection	Value	100-80	79-55	54-30	29-15	14-10	<10
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10

Adjustments

Bedrock	Bedrock banks have a very low erosion potential.
Boulders	Boulder banks have a low erosion potential.
Cobble	Substract 10 points. No adjustment if sand/gravel compose greater than 50% of bank.
Clay/Silt Loam	Add 5 points.
Gravel	Add 5-10 points depending on percentage of bank material composed of sand.
Sand	Add 10 points.
Silt / Clay	No adjustment.

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

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

Estimating Near-Bank Stress (NBS)

Stream: **UNT to Sawmill Run** Location: **Crane Avenue**

Station: Stream Type: Valley Type:

Observers: **AT, MB, MM** Date: **5/11/22**

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)

Method	
Dominant Near-Bank Stress	

Level III

(5)

Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkf} (ft)	*Ratio* d_{nb} / d_{bkf}	Near-Bank Stress (NBS)
0.5	**0.4583333**	**1.0909091**	**Low**

(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					**Low**	

Copyright © 2008 Wildland Hydrology

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

USFWS - SHARP
STREAM NAME - REACH IDENTIFICATION

BANK EROSION HAZARD INDEX

Stream:	UNT to Sawmill Run	**Observer(s):**	AT, MB	**Data:**	AT	**QA/QC:**		**Total Score:**		**34.47**		
Reach:		**Comments:**								**High**		
Location:	29	**Bank Length**	40					**Total Score Values:**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**	**Extreme**
Date:	12/8/2022								5-10	10-20	20-30	30-40	40-45	45-50

Erodibility Variables					
Bank Height / Bankfull Height Ratio					
Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
0.50	0.50	1.00	1.00	Very Low	
Root Depth / Bank Height Ratio					
Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
0.17	0.50	0.33	5.57	Moderate	
Weighted Root Density					
Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
10.00	0.33	3.33	10.00	Extreme	
Bank Angle					
Bank Angle (°)			Index	Bank Erosion Potental	Notes
60.00			3.90	Low	
Surface Protection					
Surface Protection (%)			Index	Bank Erosion Potental	Notes
10.00			9.00	Very High	
			Adjustment		Notes
Bank Materials			5.00		silt loam
			Adjustment		Notes
Bank Stratification					
		TOTAL SCORE	**34.47**		

Bank Erosion Potential

		Very Low	Low	Moderate	High	Very High	Extreme
Erodibility Variables							
Bank Height / Bankfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Root Depth / Bank Height	Value	1.00-0.90	0.89-0.50	0.49-0.30	0.29-0.15	0.14-0.05	<0.05
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Surface Protection	Value	100-80	79-55	54-30	29-15	14-10	<10
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10

Adjustments

Bank Material	
Bedrock	Bedrock banks have a very low erosion potential.
Boulders	Boulder banks have a low erosion potential.
Cobble	Substract 10 points. No adjustment if sand/gravel compose greater than 50% of bank.
Clay/Silt Loam	Add 5 points.
Gravel	Add 5-10 points depending on percentage of bank material composed of sand.
Sand	Add 10 points.
Silt / Clay	No adjustment.

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

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

Estimating Near-Bank Stress (NBS)

Stream: **UNT to Sawmill Run** Location: **Crane Avenue**

Station: Stream Type: Valley Type:

Observers: **AT, MB** Date: **12/8/22**

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)

Method	**1**
Dominant Near-Bank Stress	
Moderate	

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				**Moderate**	

Copyright © 2008 Wildland Hydrology

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

USFWS - SHARP
STREAM NAME - REACH IDENTIFICATION

BANK EROSION HAZARD INDEX

Stream:	UNT to Sawmill Run	**Observer(s):**	AT, MB	**Data:**	AT	**QA/QC:**		**Total Score:**	**45.12**			
Reach:		**Comments:**							**Very High**			
Location:	30	**Bank Length**	100					**Total Score Values:**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**	**Extreme**
Date:	12/8/2022								5-10	10-20	20-30	30-40	40-45	45-50

Erodibility Variables

Bank Height / Bankfull Height Ratio

Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
2.50	0.50	5.00	10.00	Extreme	

Root Depth / Bank Height Ratio

Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
0.50	2.50	0.20	7.22	High	

Weighted Root Density

Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
5.00	0.20	1.00	10.00	Extreme	

Bank Angle

Bank Angle (°)		Index	Bank Erosion Potental	Notes
60.00		3.90	Low	

Surface Protection

Surface Protection (%)		Index	Bank Erosion Potental	Notes
10.00		9.00	Very High	

	Adjustment		Notes
Bank Materials	5.00		silt loam
	Adjustment		Notes
Bank Stratification			
TOTAL SCORE	**45.12**		

Bank Erosion Potential

		Very Low	Low	Moderate	High	Very High	Extreme
Erodibility Variables							
Bank Height / Bankfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Root Depth / Bank Height	Value	1.00-0.90	0.89-0.50	0.49-0.30	0.29-0.15	0.14-0.05	<0.05
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Surface Protection	Value	100-80	79-55	54-30	29-15	14-10	<10
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10

Adjustments

Bank Material	
Bedrock	Bedrock banks have a very low erosion potential.
Boulders	Boulder banks have a low erosion potential.
Cobble	Substract 10 points. No adjustment if sand/gravel compose greater than 50% of bank.
Clay/Silt Loam	Add 5 points.
Gravel	Add 5-10 points depending on percentage of bank material composed of sand.
Sand	Add 10 points.
Silt / Clay	No adjustment.

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

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

Estimating Near-Bank Stress (NBS)

Stream: **UNT to Sawmill Run** Location: **Crane Avenue**

Station: Stream Type: Valley Type:

Observers: **AT, MB** Date: **12/8/22**

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)

Method	1
Dominant Near-Bank Stress	
Moderate	

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					**Moderate**	

Copyright © 2008 Wildland Hydrology

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

USFWS - SHARP
STREAM NAME - REACH IDENTIFICATION

BANK EROSION HAZARD INDEX

Stream:	UNT to Sawmill Run	**Observer(s):**	AT, MB	**Data:**	AT	**QA/QC:**		**Total Score:**		**40.96**		
Reach:		**Comments:**								**Very High**		
Location:	31	**Bank Length**	482					**Total Score Values:**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**	**Extreme**
Date:	12/8/2022								5-10	10-20	20-30	30-40	40-45	45-50

Erodibility Variables					
Bank Height / Bankfull Height Ratio					
Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
1.50	0.50	3.00	10.00	Extreme	
Root Depth / Bank Height Ratio					
Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
0.50	1.50	0.33	5.57	Moderate	
Weighted Root Density					
Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
5.00	0.33	1.67	10.00	Extreme	
Bank Angle					
Bank Angle (°)			Index	Bank Erosion Potental	Notes
45.00			3.17	Low	
Surface Protection					
Surface Protection (%)			Index	Bank Erosion Potental	Notes
20.00			7.22	High	
			Adjustment		Notes
Bank Materials			5.00		silt loam
			Adjustment		Notes
Bank Stratification					
		TOTAL SCORE	**40.96**		

Bank Erosion Potential

		Very Low	Low	Moderate	High	Very High	Extreme
Erodibility Variables							
Bank Height / Bankfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Root Depth / Bank Height	Value	1.00-0.90	0.89-0.50	0.49-0.30	0.29-0.15	0.14-0.05	<0.05
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Surface Protection	Value	100-80	79-55	54-30	29-15	14-10	<10
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10

Adjustments

Bank Material	
Bedrock	Bedrock banks have a very low erosion potential.
Boulders	Boulder banks have a low erosion potential.
Cobble	Substract 10 points. No adjustment if sand/gravel compose greater than 50% of bank.
Clay/Silt Loam	Add 5 points.
Gravel	Add 5-10 points depending on percentage of bank material composed of sand.
Sand	Add 10 points.
Silt / Clay	No adjustment.

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

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

Estimating Near-Bank Stress (NBS)

Stream: **UNT to Sawmill Run** Location: **Crane Avenue**

Station: Stream Type: Valley Type:

Observers: **AT, MB** Date: **12/8/22**

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)

Method	1
Dominant Near-Bank Stress	
Moderate	

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					**Moderate**	

Copyright © 2008 Wildland Hydrology

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

USFWS - SHARP
STREAM NAME - REACH IDENTIFICATION

BANK EROSION HAZARD INDEX

Stream:	UNT to Sawmill Run	**Observer(s):**	AT, MB	**Data:**	AT	**QA/QC:**		**Total Score:**		**40.96**		
Reach:		**Comments:**								**Very High**		
Location:	32	**Bank Length**	484					**Total Score Values:**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**	**Extreme**
Date:	12/8/2022								5-10	10-20	20-30	30-40	40-45	45-50

Erodibility Variables

Bank Height / Bankfull Height Ratio

Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
1.50	0.50	3.00	10.00	Extreme	

Root Depth / Bank Height Ratio

Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
0.50	1.50	0.33	5.57	Moderate	

Weighted Root Density

Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
5.00	0.33	1.67	10.00	Extreme	

Bank Angle

Bank Angle (°)		Index	Bank Erosion Potental	Notes
45.00		3.17	Low	

Surface Protection

Surface Protection (%)		Index	Bank Erosion Potental	Notes
20.00		7.22	High	

	Adjustment		Notes
Bank Materials	5.00		silt loam
	Adjustment		Notes
Bank Stratification			
TOTAL SCORE	**40.96**		

Bank Erosion Potential

		Very Low	Low	Moderate	High	Very High	Extreme
Erodibility Variables							
Bank Height / Bankfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Root Depth / Bank Height	Value	1.00-0.90	0.89-0.50	0.49-0.30	0.29-0.15	0.14-0.05	<0.05
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Surface Protection	Value	100-80	79-55	54-30	29-15	14-10	<10
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10

Adjustments

Bank Material	
Bedrock	Bedrock banks have a very low erosion potential.
Boulders	Boulder banks have a low erosion potential.
Cobble	Substract 10 points. No adjustment if sand/gravel compose greater than 50% of bank.
Clay/Silt Loam	Add 5 points.
Gravel	Add 5-10 points depending on percentage of bank material composed of sand.
Sand	Add 10 points.
Silt / Clay	No adjustment.

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

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

Estimating Near-Bank Stress (NBS)

Stream: **UNT to Sawmill Run** Location: **Crane Avenue**

Station: Stream Type: Valley Type:

Observers: **AT, MB** Date: **12/8/22**

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)

Method	**1**
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**	

Copyright © 2008 Wildland Hydrology

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

BEHI	NBS	Rate
low	very low	0.017
low	low	0.020
low	moderate	0.090
low	high	0.160
low	very high	0.325
low	extreme	0.6
moderate	very low	0.09
moderate	low	0.125
moderate	moderate	0.300
moderate	high	0.800
moderate	very high	0.700
moderate	extreme	1.200
high	very low	0.250
high	low	0.400
high	moderate	0.640
high	high	1.000
high	very high	1.750
high	extreme	2.500
very high	very low	0.250
very high	low	0.400
very high	moderate	0.640
very high	high	1.000
very high	very high	1.750
very high	extreme	2.500
extreme	very low	0.15
extreme	low	1.300
extreme	moderate	1.750
extreme	high	2.500
extreme	very high	3.500
extreme	extreme	4.500

Non-highlighted rates from USFWS Bank Erosion Rate Curve
Yellow Highlighted rates from Rosgen Colorado Bank Erosion Rate Blue Highlighted rates are interpolated from Rosgen Colorado Bank Erosion Rate

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D



Photo location 3 facing west



Photo location 4 facing Northeast

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D



Photo location 5 facing Southwest



Photo location 6 facing Southeast

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D



Photo location 7 facing North



Photo location 8 facing West

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D



Photo location 9 facing West



Photo location 10 facing North

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D



Photo location 11 facing Northwest

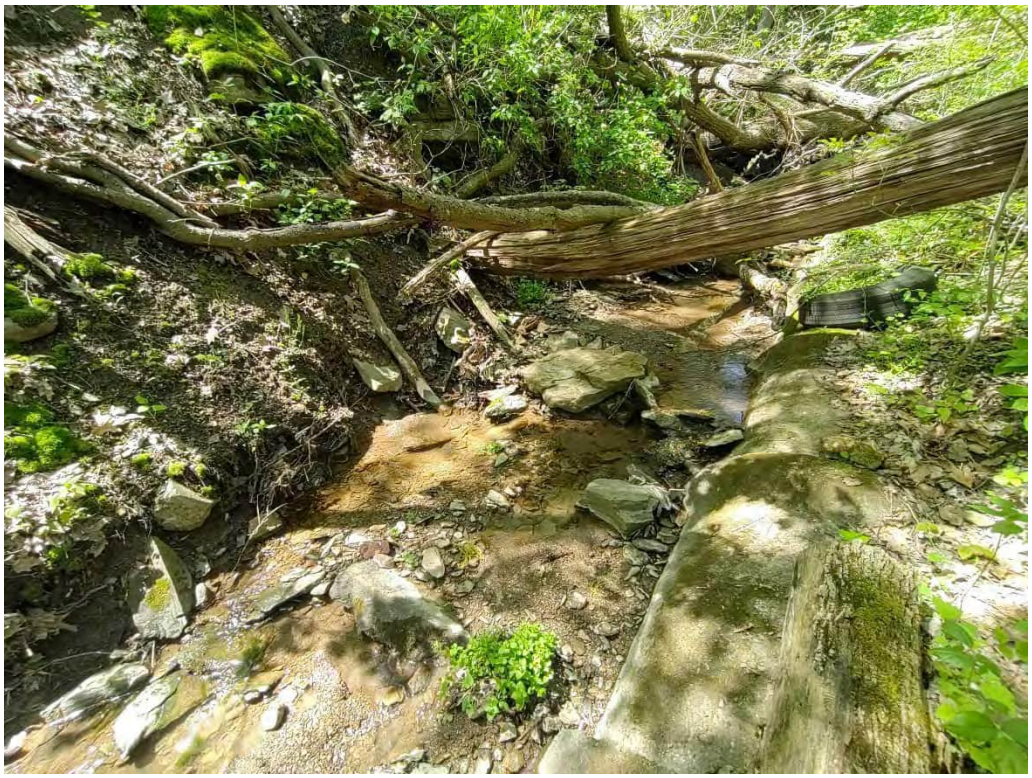


Photo location 12 facing East

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D



Photo location 13 facing Southwest



Photo location 14 facing West

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D



Photo location 15 facing North



Photo location 16 facing South

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D



Photo location 17 facing Northwest

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D



Photo location 18 facing Southwest



Photo location 19 facing Northwest

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D



Photo location 20 facing Northeast



Photo location 21 facing Northeast

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D



Photo Location 22 facing East



Photo location 25 facing Southwest

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D



Photo location 27 facing Northwest



Photo location 28 facing South

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D



Photo location 30 facing Northeast



Photo location 31 facing North

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D



Photo location 32 facing South

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Project Name	Deer Creek								
Feature Feature I.D. (Bank., Headcut or Deposition I.D.)	Length, ft (Bank or deposition)	Height, ft (Bank or Headcut)	BEHI Rating	NBS Rating	Predicted Rate of Bank Erosion (ft/year)	Predicted Erosion Amount (ft^3/year)	Predicted Erosion Amount (tons/year)	Predicted Erosion Rate (tons/year/ft)	Comments
1	216.0	0.8	Moderate	High	0.80	144.00	6.74	0.03	Right Bank
1	216.0	0.5	Low	High	0.16	17.28	0.81	0.00	Left Bank
2	230.0	6.5	Very High	Moderate	0.64	956.80	44.80	0.20	Left Bank
2	230.0	0.8	Moderate	Moderate	0.30	57.50	2.69	0.01	Right Bank
3	182.0	2.5	High	Very High	1.75	796.25	37.28	0.21	Left Bank
3	182.0	8.0	High	Very High	1.75	2548.00	119.30	0.67	Right Bank
4	129.0	2.5	High	High	1.00	322.50	15.10	0.12	Right Bank
4	129.0	2.5	High	High	1.00	322.50	15.10	0.12	Left Bank
5	231.0	3.7	High	High	1.00	847.00	39.66	0.18	Right Bank
5	231.0	3.7	High	High	1.00	847.00	39.66	0.18	Left Bank
TOTAL OF ALL GRIDS	**1976.0**	**N/A**	**N/A**	**N/A**	**9.4**	**6858.8**	**321.1**	**1.7**	

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

USFWS - SHARP
STREAM NAME - REACH IDENTIFICATION

BANK EROSION HAZARD INDEX

Stream:	Deer Creek	**Observer(s):**	AT, MM	**Data:**	AT	**QA/QC:**		**Total Score:**		**25.95**		
Reach:		**Comments:**	R							**Moderate**		
Location:	1	**Bank Length**	216					**Total Score Values:**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**	**Extreme**
Date:	8/16/2022								5-10	10-20	20-30	30-40	40-45	45-50

Erodibility Variables

Bank Height / Bankfull Height Ratio

Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
0.83	0.33	2.50	8.57	Very High	

Root Depth / Bank Height Ratio

Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
0.42	0.83	0.50	3.90	Low	

Weighted Root Density

Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
60.00	0.50	30.00	5.90	Moderate	

Bank Angle

Bank Angle (°)		Index	Bank Erosion Potental	Notes
15.00		1.68	Very Low	

Surface Protection

Surface Protection (%)		Index	Bank Erosion Potental	Notes
30.00		5.90	Moderate	

	Adjustment		Notes
Bank Materials			
	Adjustment		Notes
Bank Stratification			
TOTAL SCORE	**25.95**		

Bank Erosion Potential

		Very Low	Low	Moderate	High	Very High	Extreme
Erodibility Variables							
Bank Height / Bankfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Root Depth / Bank Height	Value	1.00-0.90	0.89-0.50	0.49-0.30	0.29-0.15	0.14-0.05	<0.05
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Surface Protection	Value	100-80	79-55	54-30	29-15	14-10	<10
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10

Adjustments

Bank Material	
Bedrock	Bedrock banks have a very low erosion potential.
Boulders	Boulder banks have a low erosion potential.
Cobble	Substract 10 points. No adjustment if sand/gravel compose greater than 50% of bank.
Clay/Silt Loam	Add 5 points.
Gravel	Add 5-10 points depending on percentage of bank material composed of sand.
Sand	Add 10 points.
Silt / Clay	No adjustment.

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

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

Estimating Near-Bank Stress (NBS)

Stream: **Deer Creek** Location: **Independence Excavation**

Station: Stream Type: Valley Type:

Observers: **AT, MM** Date: **8-16-22**

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)

Method	1
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**	

Copyright © 2008 Wildland Hydrology

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

USFWS - SHARP
STREAM NAME - REACH IDENTIFICATION

BANK EROSION HAZARD INDEX

Stream:	Deer Creek	**Observer(s):**	AT, MM	**Data:**	AT	**QA/QC:**		**Total Score:**		**19.21**			
Reach:		**Comments:**	1							**Low**			
Location:	1	**Bank Length**	216					**Total Score Values:**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**	**Extreme**
Date:	8/16/2022								5-10	10-20	20-30	30-40	40-45	45-50

Erodibility Variables					
Bank Height / Bankfull Height Ratio					
Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
0.50	0.33	1.50	5.90	Moderate	
Root Depth / Bank Height Ratio					
Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
5.00	0.50	10.00	1.00	Very Low	
Weighted Root Density					
Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
5.00	10.00	50.00	4.32	Moderate	
Bank Angle					
Bank Angle (°)			Index	Bank Erosion Potental	Notes
10.00			1.45	Very Low	
Surface Protection					
Surface Protection (%)			Index	Bank Erosion Potental	Notes
25.00			6.54	High	
			Adjustment		Notes
Bank Materials					
			Adjustment		Notes
Bank Stratification					
		TOTAL SCORE	**19.21**		

Bank Erosion Potential

		Very Low	Low	Moderate	High	Very High	Extreme
Erodibility Variables							
Bank Height / Bankfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Root Depth / Bank Height	Value	1.00-0.90	0.89-0.50	0.49-0.30	0.29-0.15	0.14-0.05	<0.05
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Surface Protection	Value	100-80	79-55	54-30	29-15	14-10	<10
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10

Adjustments

Bedrock	Bedrock banks have a very low erosion potential.
Boulders	Boulder banks have a low erosion potential.
Cobble	Substract 10 points. No adjustment if sand/gravel compose greater than 50% of bank.
Clay/Silt Loam	Add 5 points.
Gravel	Add 5-10 points depending on percentage of bank material composed of sand.
Sand	Add 10 points.
Silt / Clay	No adjustment.

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

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

Estimating Near-Bank Stress (NBS)

Stream: **Deer Creek** Location: **Independence Excavation**

Station: Stream Type: Valley Type:

Observers: **AT, MM** Date: **8-16-22**

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)

Method	**1**
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**	

Copyright © 2008 Wildland Hydrology

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

USFWS - SHARP
STREAM NAME - REACH IDENTIFICATION

BANK EROSION HAZARD INDEX

Stream:	Deer Creek	**Observer(s):**	AT, MM	**Data:**	AT	**QA/QC:**		**Total Score:**		**43.15**		
Reach:		**Comments:**	1							**Very High**		
Location:	2	**Bank Length**	230					**Total Score Values:**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**	**Extreme**
Date:	8/16/2022								5-10	10-20	20-30	30-40	40-45	45-50

Erodibility Variables

Bank Height / Bankfull Height Ratio

Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
6.50	0.33	19.50	10.00	Extreme	

Root Depth / Bank Height Ratio

Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
2.00	6.50	0.31	5.82	Moderate	

Weighted Root Density

Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
30.00	0.31	9.23	8.53	Very High	

Bank Angle

Bank Angle (°)		Index	Bank Erosion Potental	Notes
90.00		7.90	High	

Surface Protection

Surface Protection (%)		Index	Bank Erosion Potental	Notes
30.00		5.90	Moderate	

	Adjustment		Notes
Bank Materials			
	Adjustment		Notes
Bank Stratification	5.00		undercutting
TOTAL SCORE	**43.15**		

Bank Erosion Potential

		Very Low	Low	Moderate	High	Very High	Extreme
Erodibility Variables							
Bank Height / Bankfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Root Depth / Bank Height	Value	1.00-0.90	0.89-0.50	0.49-0.30	0.29-0.15	0.14-0.05	<0.05
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Surface Protection	Value	100-80	79-55	54-30	29-15	14-10	<10
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10

Adjustments

Bedrock	Bedrock banks have a very low erosion potential.
Boulders	Boulder banks have a low erosion potential.
Cobble	Substract 10 points. No adjustment if sand/gravel compose greater than 50% of bank.
Clay/Silt Loam	Add 5 points.
Gravel	Add 5-10 points depending on percentage of bank material composed of sand.
Sand	Add 10 points.
Silt / Clay	No adjustment.

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

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

Estimating Near-Bank Stress (NBS)

Stream: **Deer Creek** Location: **Independence Excavation**

Station: Stream Type: Valley Type:

Observers: **AT, MM** Date: **8-16-22**

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)

Method	1
Dominant Near-Bank Stress	**Moderate**

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				**Moderate**	

Copyright © 2008 Wildland Hydrology

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

USFWS - SHARP
STREAM NAME - REACH IDENTIFICATION

BANK EROSION HAZARD INDEX

Stream:	Deer Creek	**Observer(s):**	AT, MM	**Data:**	AT	**QA/QC:**		**Total Score:**		**25.95**		
Reach:		**Comments:**	r							**Moderate**		
Location:	2	**Bank Length**	230					**Total Score Values:**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**	**Extreme**
Date:	8/16/2022								5-10	10-20	20-30	30-40	40-45	45-50

Erodibility Variables					
Bank Height / Bankfull Height Ratio					
Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
0.83	0.33	2.50	8.57	Very High	
Root Depth / Bank Height Ratio					
Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
0.42	0.83	0.50	3.90	Low	
Weighted Root Density					
Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
60.00	0.50	30.00	5.90	Moderate	
Bank Angle					
Bank Angle (°)			Index	Bank Erosion Potental	Notes
15.00			1.68	Very Low	
Surface Protection					
Surface Protection (%)			Index	Bank Erosion Potental	Notes
30.00			5.90	Moderate	
			Adjustment		Notes
Bank Materials					
			Adjustment		Notes
Bank Stratification					
		TOTAL SCORE	**25.95**		

Erodibility Variables

Bank Erosion Potential							
		Very Low	Low	Moderate	High	Very High	Extreme
Bank Height / Bankfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Root Depth / Bank Height	Value	1.00-0.90	0.89-0.50	0.49-0.30	0.29-0.15	0.14-0.05	<0.05
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Surface Protection	Value	100-80	79-55	54-30	29-15	14-10	<10
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10

Bank Material

Adjustments	
Bedrock	Bedrock banks have a very low erosion potential.
Boulders	Boulder banks have a low erosion potential.
Cobble	Substract 10 points. No adjustment if sand/gravel compose greater than 50% of bank.
Clay/Silt Loam	Add 5 points.
Gravel	Add 5-10 points depending on percentage of bank material composed of sand.
Sand	Add 10 points.
Silt / Clay	No adjustment.
Stratification	
Add 5-10 points depending on position of unstable layers in relation to bankfull stage.	

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

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

Estimating Near-Bank Stress (NBS)

Stream: **Deer Creek** Location: **Independence Excavation**

Station: Stream Type: Valley Type:

Observers: **AT, MM** Date: **8-16-22**

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)

Method	1
Dominant Near-Bank Stress	
Moderate	

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					**Moderate**	

Copyright © 2008 Wildland Hydrology

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

USFWS - SHARP
STREAM NAME - REACH IDENTIFICATION

BANK EROSION HAZARD INDEX

Stream:	Deer Creek	**Observer(s):**	AT, MM	**Data:**	AT	**QA/QC:**		**Total Score:**		**37.52**		
Reach:		**Comments:**	1							**High**		
Location:	3	**Bank Length**	182					**Total Score Values:**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**	**Extreme**
Date:	8/16/2022								5-10	10-20	20-30	30-40	40-45	45-50

Erodibility Variables

Bank Height / Bankfull Height Ratio

Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
2.50	0.33	7.50	10.00	Extreme	

Root Depth / Bank Height Ratio

Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
0.67	2.50	0.27	6.32	High	

Weighted Root Density

Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
70.00	0.27	18.67	7.40	High	

Bank Angle

Bank Angle (°)		Index	Bank Erosion Potental	Notes
90.00		7.90	High	

Surface Protection

Surface Protection (%)		Index	Bank Erosion Potental	Notes
30.00		5.90	Moderate	

	Adjustment		Notes
Bank Materials			
	Adjustment		Notes
Bank Stratification			
TOTAL SCORE	**37.52**		

Bank Erosion Potential

		Very Low	Low	Moderate	High	Very High	Extreme
Erodibility Variables							
Bank Height / Bankfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Root Depth / Bank Height	Value	1.00-0.90	0.89-0.50	0.49-0.30	0.29-0.15	0.14-0.05	<0.05
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Surface Protection	Value	100-80	79-55	54-30	29-15	14-10	<10
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10

Adjustments

Bedrock	Bedrock banks have a very low erosion potential.
Boulders	Boulder banks have a low erosion potential.
Cobble	Substract 10 points. No adjustment if sand/gravel compose greater than 50% of bank.
Clay/Silt Loam	Add 5 points.
Gravel	Add 5-10 points depending on percentage of bank material composed of sand.
Sand	Add 10 points.
Silt / Clay	No adjustment.

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

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

Estimating Near-Bank Stress (NBS)

Stream: **Deer Creek** Location: **Independence Excavation**

Station: Stream Type: Valley Type:

Observers: **AT, MM** Date: **8-16-22**

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)

Method	1
Dominant Near-Bank Stress	**Very 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					**Very High**	

Copyright © 2008 Wildland Hydrology

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

USFWS - SHARP
STREAM NAME - REACH IDENTIFICATION

BANK EROSION HAZARD INDEX

Stream:	Deer Creek	**Observer(s):**	AT, MM	**Data:**	AT	**QA/QC:**		**Total Score:**		**34.25**		
Reach:		**Comments:**	r							**High**		
Location:	3	**Bank Length**	182					**Total Score Values:**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**	**Extreme**
Date:	8/16/2022								5-10	10-20	20-30	30-40	40-45	45-50

Erodibility Variables

Bank Height / Bankfull Height Ratio

Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
8.00	0.33	24.00	10.00	Extreme	

Root Depth / Bank Height Ratio

Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
4.50	8.00	0.56	3.60	Low	

Weighted Root Density

Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
30.00	0.56	16.88	7.65	High	

Bank Angle

Bank Angle (°)		Index	Bank Erosion Potental	Notes
90.00		7.90	High	

Surface Protection

Surface Protection (%)		Index	Bank Erosion Potental	Notes
40.00		5.11	Moderate	

	Adjustment		Notes
Bank Materials			
	Adjustment		Notes
Bank Stratification			
TOTAL SCORE	**34.25**		

Bank Erosion Potential

		Very Low	Low	Moderate	High	Very High	Extreme
Erodibility Variables							
Bank Height / Bankfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Root Depth / Bank Height	Value	1.00-0.90	0.89-0.50	0.49-0.30	0.29-0.15	0.14-0.05	<0.05
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Surface Protection	Value	100-80	79-55	54-30	29-15	14-10	<10
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10

Adjustments

Bedrock	Bedrock banks have a very low erosion potential.
Boulders	Boulder banks have a low erosion potential.
Cobble	Substract 10 points. No adjustment if sand/gravel compose greater than 50% of bank.
Clay/Silt Loam	Add 5 points.
Gravel	Add 5-10 points depending on percentage of bank material composed of sand.
Sand	Add 10 points.
Silt / Clay	No adjustment.

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

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

Estimating Near-Bank Stress (NBS)

Stream: **Deer Creek** Location: **Independence Excavation**

Station: Stream Type: Valley Type:

Observers: **AT, MM** Date: **8-16-22**

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)

Method	1
Dominant Near-Bank Stress	**Very 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				**Very High**	

Copyright © 2008 Wildland Hydrology

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

USFWS - SHARP
STREAM NAME - REACH IDENTIFICATION

BANK EROSION HAZARD INDEX

Stream:	Deer Creek	**Observer(s):**	AT, MM	**Data:**	AT	**QA/QC:**		**Total Score:**		**32.24**		
Reach:		**Comments:**	r							**High**		
Location:	4	**Bank Length**	129					**Total Score Values:**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**	**Extreme**
Date:	8/16/2022								5-10	10-20	20-30	30-40	40-45	45-50

Erodibility Variables

Bank Height / Bankfull Height Ratio

Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
2.50	0.33	7.50	10.00	Extreme	

Root Depth / Bank Height Ratio

Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
1.00	2.50	0.40	4.90	Moderate	

Weighted Root Density

Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
30.00	0.40	12.00	8.22	Very High	

Bank Angle

Bank Angle (°)		Index	Bank Erosion Potental	Notes
20.00		1.90	Very Low	

Surface Protection

Surface Protection (%)		Index	Bank Erosion Potental	Notes
20.00		7.22	High	

	Adjustment		Notes
Bank Materials			
	Adjustment		Notes
Bank Stratification			
TOTAL SCORE	**32.24**		

Bank Erosion Potential

		Very Low	Low	Moderate	High	Very High	Extreme
Erodibility Variables							
Bank Height / Bankfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Root Depth / Bank Height	Value	1.00-0.90	0.89-0.50	0.49-0.30	0.29-0.15	0.14-0.05	<0.05
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Surface Protection	Value	100-80	79-55	54-30	29-15	14-10	<10
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10

Adjustments

Bank Material	
Bedrock	Bedrock banks have a very low erosion potential.
Boulders	Boulder banks have a low erosion potential.
Cobble	Substract 10 points. No adjustment if sand/gravel compose greater than 50% of bank.
Clay/Silt Loam	Add 5 points.
Gravel	Add 5-10 points depending on percentage of bank material composed of sand.
Sand	Add 10 points.
Silt / Clay	No adjustment.

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

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

Estimating Near-Bank Stress (NBS)

Stream: **Deer Creek** Location: **Independence Excavation**

Station: Stream Type: Valley Type:

Observers: **AT, MM** Date: **8-16-22**

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)

Method	1
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**	

Copyright © 2008 Wildland Hydrology

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

USFWS - SHARP
STREAM NAME - REACH IDENTIFICATION

BANK EROSION HAZARD INDEX

Stream:	Deer Creek	**Observer(s):**	AT, MM	**Data:**	AT	**QA/QC:**		**Total Score:**		**35.67**		
Reach:		**Comments:**	1							**High**		
Location:	4	**Bank Length**	129					**Total Score Values:**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**	**Extreme**
Date:	8/16/2022								5-10	10-20	20-30	30-40	40-45	45-50

Erodibility Variables					
Bank Height / Bankfull Height Ratio					
Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
2.50	0.33	7.50	10.00	Extreme	
Root Depth / Bank Height Ratio					
Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
1.00	2.50	0.40	4.90	Moderate	
Weighted Root Density					
Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
40.00	0.40	16.00	7.76	High	
Bank Angle					
Bank Angle (°)			Index	Bank Erosion Potental	Notes
90.00			7.90	High	
Surface Protection					
Surface Protection (%)			Index	Bank Erosion Potental	Notes
40.00			5.11	Moderate	
			Adjustment		Notes
Bank Materials					
			Adjustment		Notes
Bank Stratification					
		TOTAL SCORE	**35.67**		

Bank Erosion Potential

		Very Low	Low	Moderate	High	Very High	Extreme
Erodibility Variables							
Bank Height / Bankfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Root Depth / Bank Height	Value	1.00-0.90	0.89-0.50	0.49-0.30	0.29-0.15	0.14-0.05	<0.05
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Surface Protection	Value	100-80	79-55	54-30	29-15	14-10	<10
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10

Adjustments

Bedrock	Bedrock banks have a very low erosion potential.
Boulders	Boulder banks have a low erosion potential.
Cobble	Substract 10 points. No adjustment if sand/gravel compose greater than 50% of bank.
Clay/Silt Loam	Add 5 points.
Gravel	Add 5-10 points depending on percentage of bank material composed of sand.
Sand	Add 10 points.
Silt / Clay	No adjustment.

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

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

Estimating Near-Bank Stress (NBS)

Stream: **Deer Creek** Location: **Independence Excavation**

Station: Stream Type: Valley Type:

Observers: **AT, MM** Date: **8-16-22**

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)

Method	1
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**	

Copyright © 2008 Wildland Hydrology

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

USFWS - SHARP
STREAM NAME - REACH IDENTIFICATION

BANK EROSION HAZARD INDEX

Stream:	Deer Creek	**Observer(s):**	AT, MM	**Data:**	AT	**QA/QC:**		**Total Score:**		**34.40**			
Reach:		**Comments:**	r							**High**			
Location:	5	**Bank Length**	231					**Total Score Values:**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**	**Extreme**
Date:	8/16/2022								5-10	10-20	20-30	30-40	40-45	45-50

Erodibility Variables

Bank Height / Bankfull Height Ratio

Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
3.67	0.33	11.00	10.00	Extreme	

Root Depth / Bank Height Ratio

Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
2.00	3.67	0.55	3.68	Low	

Weighted Root Density

Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
30.00	0.55	16.36	7.71	High	

Bank Angle

Bank Angle (°)		Index	Bank Erosion Potental	Notes
90.00		7.90	High	

Surface Protection

Surface Protection (%)		Index	Bank Erosion Potental	Notes
40.00		5.11	Moderate	

	Adjustment		Notes
Bank Materials			
	Adjustment		Notes
Bank Stratification			
TOTAL SCORE	**34.40**		

Bank Erosion Potential

		Very Low	Low	Moderate	High	Very High	Extreme
Erodibility Variables							
Bank Height / Bankfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Root Depth / Bank Height	Value	1.00-0.90	0.89-0.50	0.49-0.30	0.29-0.15	0.14-0.05	<0.05
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Surface Protection	Value	100-80	79-55	54-30	29-15	14-10	<10
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10

Adjustments

Bank Material	
Bedrock	Bedrock banks have a very low erosion potential.
Boulders	Boulder banks have a low erosion potential.
Cobble	Substract 10 points. No adjustment if sand/gravel compose greater than 50% of bank.
Clay/Silt Loam	Add 5 points.
Gravel	Add 5-10 points depending on percentage of bank material composed of sand.
Sand	Add 10 points.
Silt / Clay	No adjustment.

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

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

Estimating Near-Bank Stress (NBS)

Stream: **Deer Creek** Location: **Independence Excavation**

Station: Stream Type: Valley Type:

Observers: **AT, MM** Date: **8-16-22**

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)

Method	1
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**	

Copyright © 2008 Wildland Hydrology

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

USFWS - SHARP
STREAM NAME - REACH IDENTIFICATION

BANK EROSION HAZARD INDEX

Stream:	Deer Creek	**Observer(s):**	AT, MM	**Data:**	AT	**QA/QC:**		**Total Score:**		**34.40**		
Reach:		**Comments:**	1							**High**		
Location:	5	**Bank Length**	231					**Total Score Values:**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**	**Extreme**
Date:	8/16/2022								5-10	10-20	20-30	30-40	40-45	45-50

Erodibility Variables

Bank Height / Bankfull Height Ratio

Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
3.67	0.33	11.00	10.00	Extreme	

Root Depth / Bank Height Ratio

Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
2.00	3.67	0.55	3.68	Low	

Weighted Root Density

Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
30.00	0.55	16.36	7.71	High	

Bank Angle

Bank Angle (°)		Index	Bank Erosion Potental	Notes
90.00		7.90	High	

Surface Protection

Surface Protection (%)		Index	Bank Erosion Potental	Notes
40.00		5.11	Moderate	

	Adjustment		Notes
Bank Materials			
	Adjustment		Notes
Bank Stratification			
TOTAL SCORE	**34.40**		

Bank Erosion Potential

		Very Low	Low	Moderate	High	Very High	Extreme
Erodibility Variables							
Bank Height / Bankfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Root Depth / Bank Height	Value	1.00-0.90	0.89-0.50	0.49-0.30	0.29-0.15	0.14-0.05	<0.05
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Surface Protection	Value	100-80	79-55	54-30	29-15	14-10	<10
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10

Adjustments

Bank Material	
Bedrock	Bedrock banks have a very low erosion potential.
Boulders	Boulder banks have a low erosion potential.
Cobble	Substract 10 points. No adjustment if sand/gravel compose greater than 50% of bank.
Clay/Silt Loam	Add 5 points.
Gravel	Add 5-10 points depending on percentage of bank material composed of sand.
Sand	Add 10 points.
Silt / Clay	No adjustment.

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

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

Estimating Near-Bank Stress (NBS)

Stream: **Deer Creek** Location: **Independence Excavation**

Station: Stream Type: Valley Type:

Observers: **AT, MM** Date: **8-16-22**

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)

Method	1
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**	

Copyright © 2008 Wildland Hydrology

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D



Photo 1



Photo 2

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D



Photo 3



Photo 4

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D



Photo 5



Photo 6

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D



Photo Location 7



Photo 8

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D



Photo 9



Photo Location 10

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

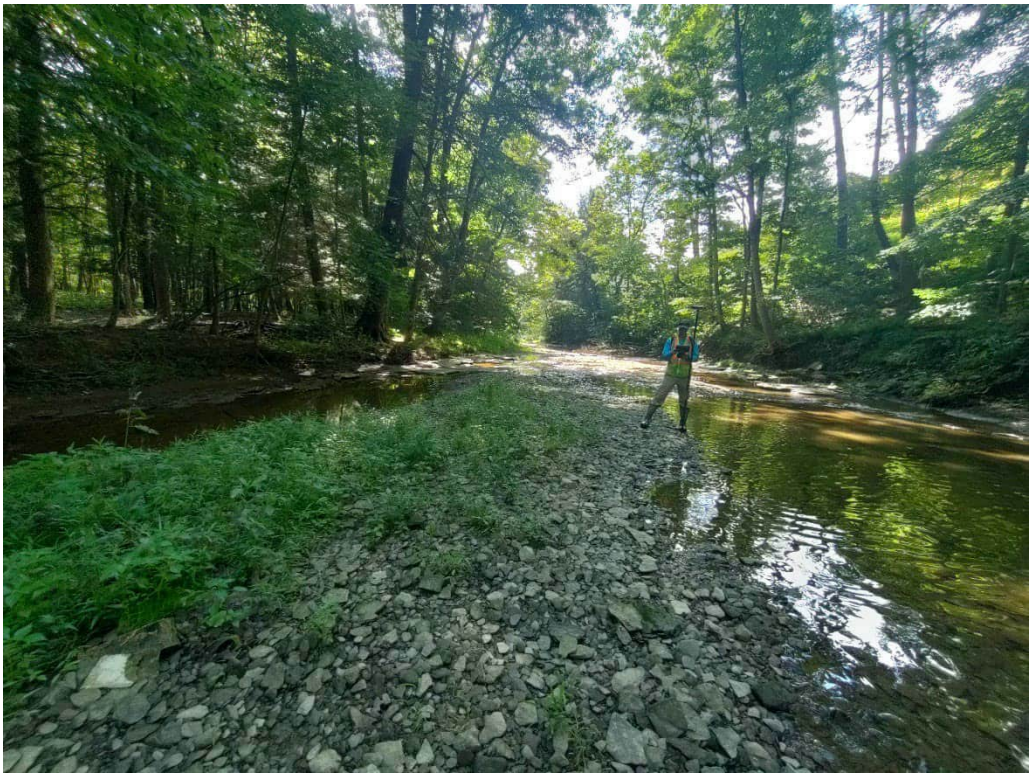


Photo Location 11



Photo 12

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D



Photo Location 13



Photo Location 14

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D



Photo 15



Photo Location 16

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

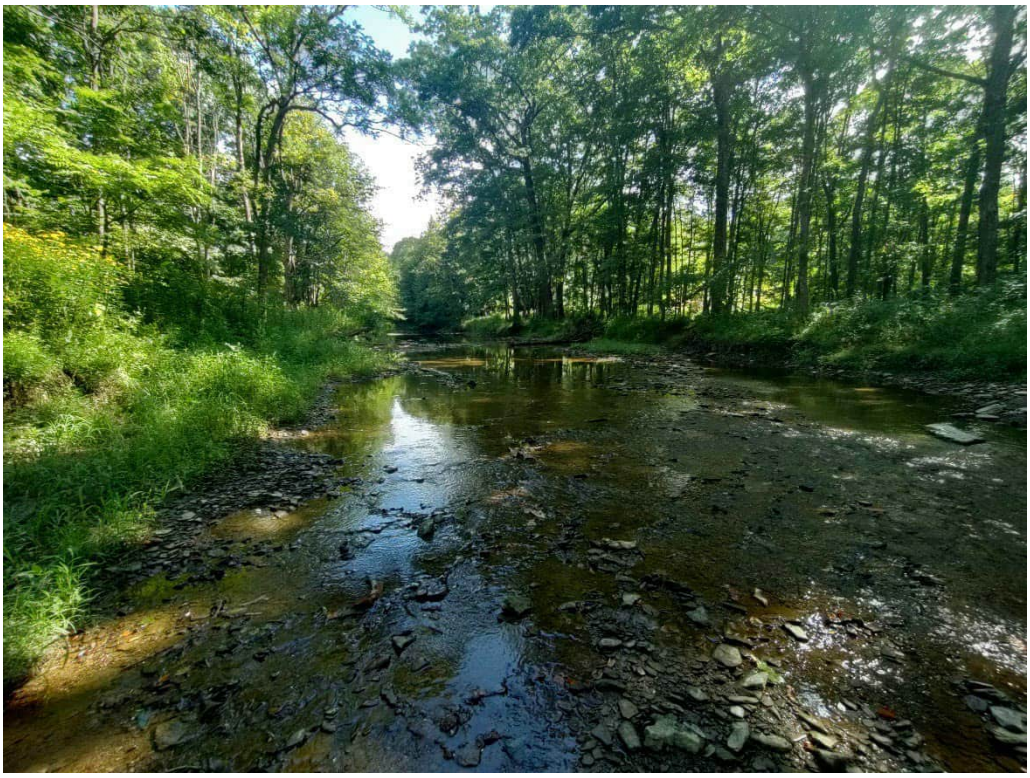


Photo 17



Photo Location 18

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Appendix D2: Supporting Stormwater Data

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

PCSM SUPORTING CALCULATIONS - BMP DESIGN

1. BASIN SUMMARY
2. DRAINAGE AREA / LAND COVER MAPS
3. LAND COVER AREA CALCULATIONS
4. BASIN CALCULATIONS
5. ANTI-SEEP COLLAR CALCULATIONS
6. PIPE CAPACITY CALCULATIONS
7. RIPRAP APRONG OUTLET PROTECTION CALCULATIONS
8. PA RAINFALL INTENSITY CHARTS (PENNDOT PUB 584)

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

MARKOSKY
3689 Route 711 • Ligonier, PA 15658
724.238.4138 • www.markosky.com
COLLABORATIVE ENGINEERING

Subject : Subject : Sawmill Run - MS4
Basin Summary

Calculated By: WBM Date: 10/20/2022
Checked By: Date:

Purpose:

Install BMP's throughout the Sawmill Run Watershed to reduce 10-year storm event peak flows to maximum extent feasible.

Existing Conditions:

SCM 001 and SCM 002

SCM 001 and SCM 002 are proposed to be placed at the low end of Moore Park and at the headwaters of UNT to Sawmill Run. Each location are flat wood/brush areas that sit directly above the deep valley that carries UNT to Sawmill run. SCM 001 is to be placed adjacent to an existing paved parking area along the Southwest corner of the park. SCM 002 will be located to the north of SCM 001 adjacent to an existing ball field perimeter fence. Moore Park runoff is mostly collected by inlets and conveyed by means of storm sewer system. The discharge points of the existing system could not be located.

SCM 003

SCM 003 will be located adjacent to Crane Avenue across from the entrance to Brashear Public School. The location of the basin is a flat area consisting mostly of brush and trees and located near UNT to Sawmill Run channel banks. The basin will be placed adjacent to an existing pipe outfall. The source of the outfall is primarilly runoff from the Brashear Public School Property. A portion of the flow from this outfall will be directed to SCM 003.

Proposed Conditions:

Each SCM will be Dry Detention type BMP consisting of a Primary Outlet Structure, Emergency Outlet Structure, and associated piping with Anti-Seep Collars. Each Primary Outlet Structure will be a PennDOT inlet box that includes a low flow vertical orifice that controls 10-year storm event. The top of the box will remain open and will serve as a horizontal orifice/weir controlling the 100-year storm event. The Primary Outlet Structure has been designed to provide a minimum of 1' of freeboard. The Emergency Outlet Structure will be a PennDOT inlet box with the top of box serving as an emergency spillway in the event the Primary Outlet Structure is clogged or not functioning as designed. The Emergency Spillway is designed to convey the 100-year storm event without overtopping of the basin.

Capacity calculations have been computed for proposed inflow and outflow pipes. Inflow pipes entering the basin have been designed to convey 10-year storm event. Outflow pipes from the Primary and Emergency Outlet structures have been designed to convey 100-year storm event. Outflow pipes for each basin will discharge to UNT's to Sawmill Run.

SCM 001 will collect runoff from approximately 2.44 acres of Moore Park. The drainage area currently drains to an existing brick lined swale which is then collected by an existing inlet and pipe with an unknow discharge point. It is assumed that the existing inlet/pipe is part of a larger conveyance system that drains the uper reaches of Moore Park. It is proposed that the existing conveyance system will remain in-place and the inlet that currently collects 2.44 acre drainage area be capped and and runoff be directed to a new separate system that conveys flow to proposed SCM-001.

SCM 002 will collect sheet flow runoff from the existing ball field and adjacent wooded hillside/ and residential grass area located above Moore Park. Runoff is currently collected along the perimeter of the ball field and conveyed overland to UNT to Sawmill Run.

SCM 003 will collect a portion of runoff that originates from the Brashear school property located above the proposed basin location. Currently, Brashear School runoff is collected and discharged to an existing outfall located adjacent to the proposed basin which Calculated flow from the drainage area exceeds the capacity of the proposed basin. The existing endwall at the outfall will be replaced with a manhole that is designed to split flow sending a portion of flow to the proposed basin and remaining flow to UNT to Sawmill Run.

Basin Calculations:

Basin calculations were computed using HydroCAD Software (See attached output). Input for HydroCAD model includes the following:

Drainage Area:

Drainage areas delineated using Lidar Contours, existing storm sewer mapping, and field visits.

Land Cover:

Land Cover areas were computed using aerial imagery and verified during field views.

Time of Concentration:

Time of Concentration segments were determined using Lidar Contours, Aerial Imagery, and field views. Total Tc value was computed in HydroCAD.

Rainfall Data:

Rainfall data for the 10-year and 100-year events was obtained from Publication 584, Chapter 7, Appendix A 'Field manual for Pennsylvania

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Pre to Post Comparison

SCM-001		
Design Year Storm	Pre-Constr (cfs)	Post-Constr (cfs)
10	5.31	2.96
100	10.2	9.02

SCM-002		
Design Year Storm	Pre-Constr (cfs)	Post-Constr (cfs)
10	5.32	3.33
100	11.57	11.42

SCM-003		
Design Year Storm	Pre-Constr (cfs)	Post-Constr (cfs)
10	43.29	38.05
100	72.96	72.45

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

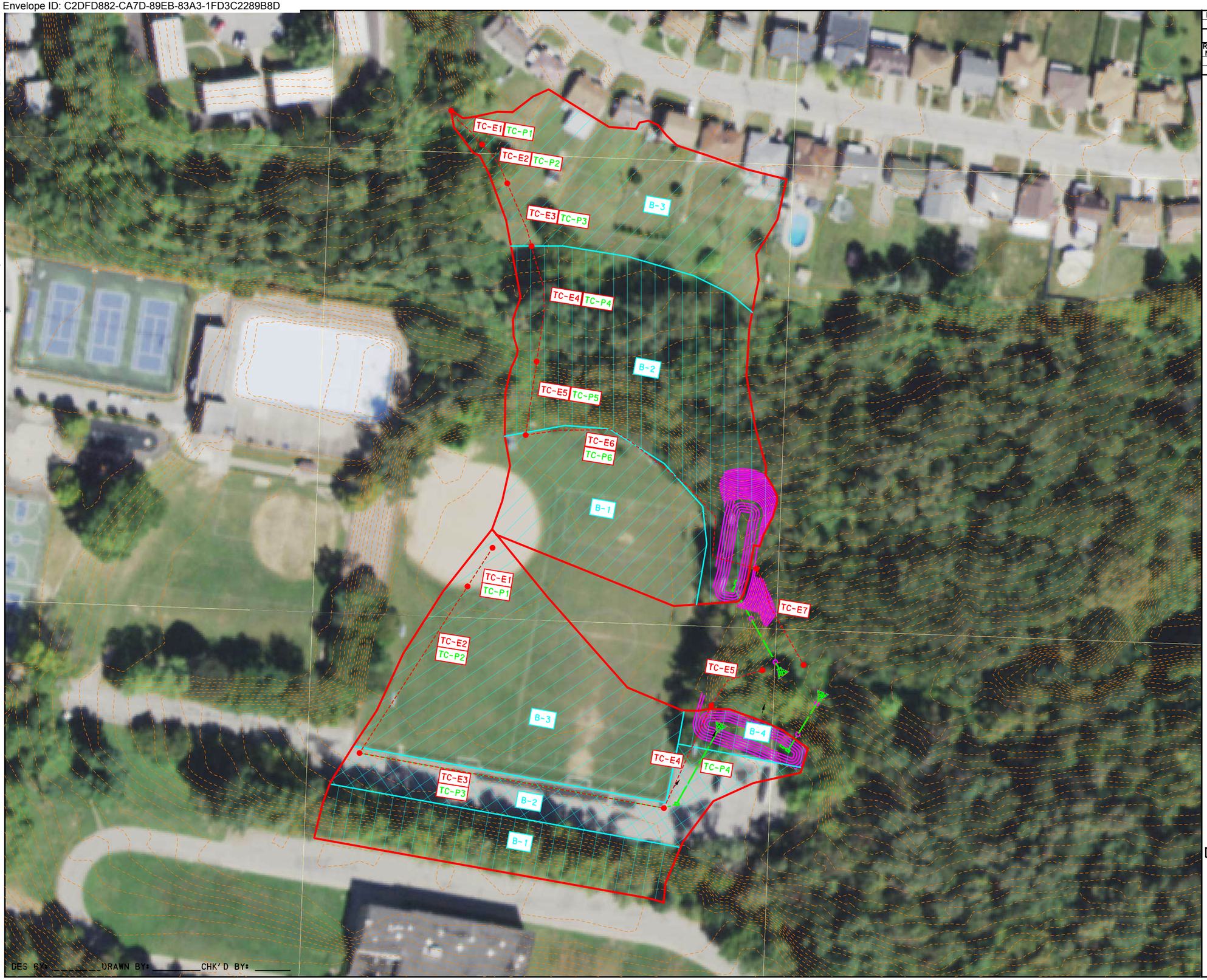
DRAINAGE AREA / LAND COVER MAPS

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

PLOTTED: 10/19/2022 10:57:51 PM
FILE NAME: G:\21-068 Stream Restoration MS4 Sawmill Run_Ohio Watershed\CADD\Exhibits\Moore Park_SCM 001 Drainage Areas.dgn

DISTRICT	COUNTY	ROUTE	SECTION	SHEET
11-0	ALLEGHENY	SAWMILL RUN		OF 15
CITY OF PITTSBURGH				

REV NO	REVISIONS	DATE	BY	APPD



LEGEND:

- LIDAR EXISTING CONTOUR
- PROPOSED DRAINAGE AREA
- PROPOSED PIPE
- PROPOSED CONTOUR
- TC-E1 — EXIST Tc PATH / SEGMENT
- TC-P1 — PROPOSED Tc PATH / SEGMENT
- PAVED PARKING, HSG C
- WOODS, FAIR, HSG C
- 50-75% GRASS COVER, FAIR, HSG C
- B-1 — LAND USE AREA LABEL

MOORE PARK
SCM 001 & SCM 002
DRAINAGE AREA / LAND COVER MAP

0 50 100 FEET

DES BY: _____ DRAWN BY: _____ CHK'D BY: _____

D2-6

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

PLOTTED: 10/19/2022 11:05:02 PM

FILE NAME: G:\21-068 Stream Restoration MS4 Sawmill Run_Ohio Watershed\CADD\Env\Exhibits\Crane Avenue_SCM 003 Drainage Areas.dgn

DISTRICT	COUNTY	ROUTE	SECTION	SHEET
11-0	ALLEGHENY	SAWMILL RUN		OF 15
CITY OF PITTSBURGH				

REV NO	REVISIONS	DATE	BY	APPD

TC-E1
TC-E2
TC-E3
TC-E4
TC-E5
TC-E6
TC-E7
TC-E8
TC-E9
B-1
B-2
B-3
B-4
B-5
B-6
SCM 003

LEGEND:

- LIDAR EXISTING CONTOUR
- DRAINAGE AREA
- PROPOSED CONTOUR
- EXIST/PROP Tc PATH / SEGMENT (TC-E1)
- PAVED ROADS WITH CURBS, HSG C
- OPEN SPACE, FAIR CONDITION, HSG C
- WOODS, FAIR, HSG-C
- 1/2 ACRE RESIDENTIAL LOTS, HSG-C
- B-1 LAND USE AREA LABEL

CRANE AVE
SCM 003
DRAINAGE AREA/LAND COVER MAP

0 50 100 FEET

DES BY: _____ DRAWN BY: _____ CHK'D BY: _____

D2-7

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

LAND COVER AREA CALCULATIONS

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

MARKOSKY
3689 Route 711 • Ligonier, PA 15658
724.238.4138 • www.markosky.com
COLLABORATIVE ENGINEERING

Subjext: Sawmill Run - MS4
Land Cover Calcs - SCM 001

Area	Woods, Fair, HSG C		50-75% Grass cover, Fair, HSG C		Paved parking, HSG C	
	SF	Acre	SF	Acre	SF	Acre
B-1	23393.0106	0.537029628				
B-2					23010.4272	0.528
B-3			54637.4905	1.25430419		
B-4	5470	0.125573921				
Totals	28863.0106	0.663	54637.4905	1.254	23010.4272	0.528

TOTAL AREA **2.445 ACRES**

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

MARKOSKY
3689 Route 711 • Ligonier, PA 15658
724.238.4138 • www.markosky.com
COLLABORATIVE ENGINEERING

Subjext: Sawmill Run - MS4
Land Cover Calcs - SCM 002

Area	Woods, Fair, HSG C		50-75% Grass cover, Fair, HSG C		Paved parking, HSG C	
	SF	Acre	SF	Acre	SF	Acre
B-1			31036.9126	0.71		
B-2	61925.7392	1.42				
B-3			44905.3018	1.03		
Totals	61925.7392	1.422	75942.2144	1.743	0	0.000

TOTAL AREA **3.165 ACRES**

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

MARKOSKY
3689 Route 711 • Ligonier, PA 15658
724.238.4138 • www.markosky.com
COLLABORATIVE ENGINEERING

Subjext: Sawmill Run - MS4
Land Cover Calcs - SCM 003

Area	Impervious Areas, HSG C		1/2 Acre Residential Lot, HSG C		Open Space, Fair Condtion, HSG C		Woods , Fair Condtion, HSG C	
	SF	Acre	SF	Acre	SF	Acre	SF	Acre
B-1	292864.9724	6.72						
B-2					108110.7478	2.48		
B-3							25766.9792	0.59
B-4			4260.0728	0.10				
B-5							68933.3266	1.58
B-6							8056.4819	0.18
Totals	292864.9724	6.723	4260.0728	0.098	108110.7478	2.482	102756.7877	2.359

TOTAL AREA **11.662 ACRES**

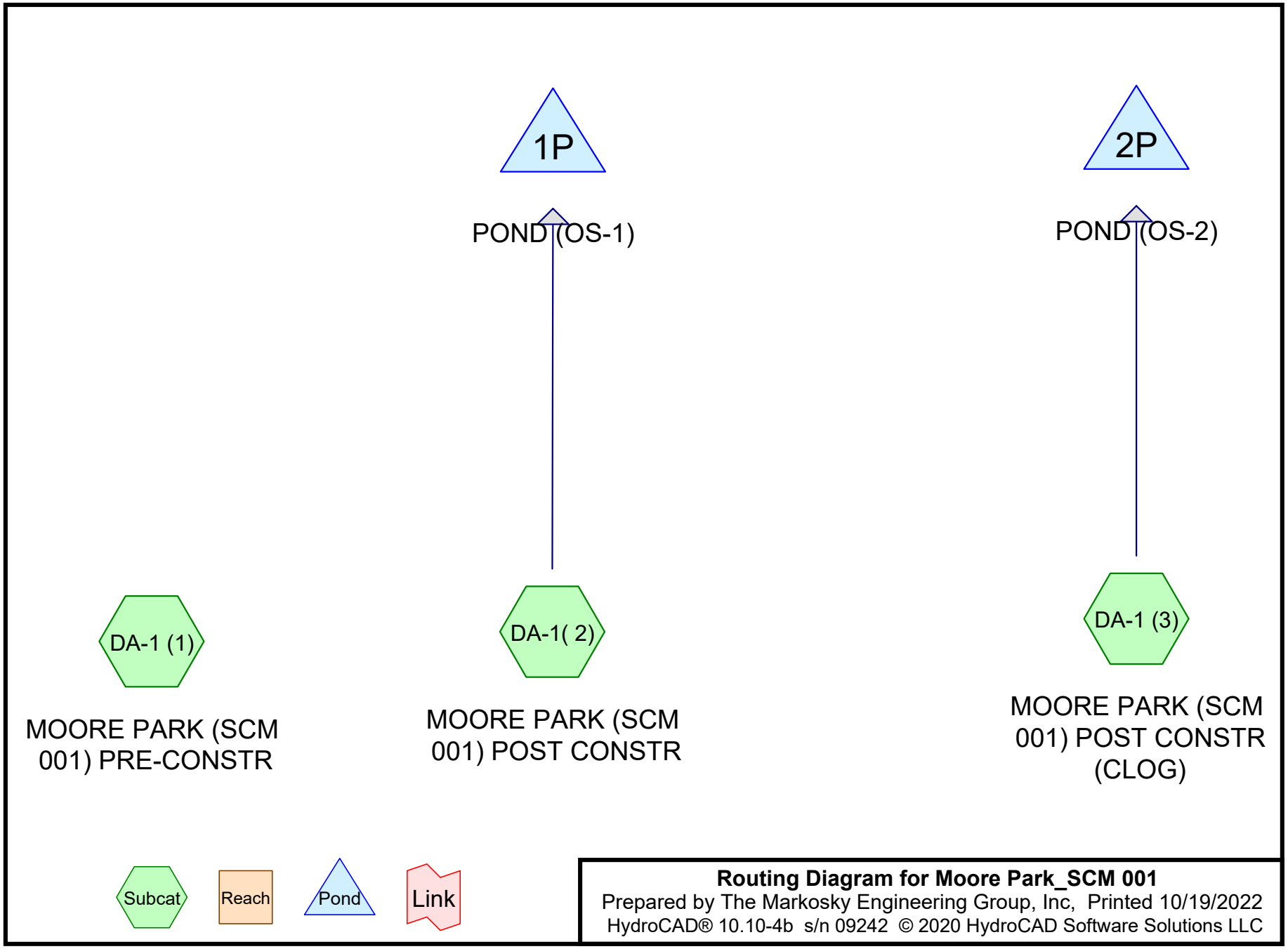
Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

BASIN CALCULATIONS

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

SCM-001 (10-YEAR)

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D



Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Summary for Subcatchment DA-1 (1): MOORE PARK (SCM 001) PRE-CONSTR

Runoff = 5.31 cfs @ 12.07 hrs, Volume= 14,734 cf, Depth= 1.66"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 10 year Rainfall=3.44"

Area (ac)	CN	Description
0.663	73	Woods, Fair, HSG C
1.254	79	50-75% Grass cover, Fair, HSG C
0.528	98	Paved parking, HSG C
2.445	81	Weighted Average
1.917		78.40% Pervious Area
0.528		21.60% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.6	50	0.0100	0.10		**Sheet Flow, TC-E1** Grass: Short n= 0.150 P2= 2.40"
5.1	215	0.0100	0.70		**Shallow Concentrated Flow, TC-E2** Short Grass Pasture Kv= 7.0 fps
0.2	336	0.0050	22.90	297.65	**Channel Flow, TC-E3** Area= 13.0 sf Perim= 2.2' r= 5.91' n= 0.015 Brickwork
0.5	124	0.0100	4.56	5.60	**Pipe Channel, TC-E4** 15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.015 Concrete sewer w/manholes & inlets
0.0	40	0.5000	51.55	5,155.34	**Channel Flow, TC-E5** Area= 100.0 sf Perim= 56.0' r= 1.79' n= 0.030 Stream, clean & straight
14.4	765	Total			

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Summary for Subcatchment DA-1(2): MOORE PARK (SCM 001) POST CONSTR

[47] Hint: Peak is 121% of capacity of segment #4

Runoff = 4.79 cfs @ 12.10 hrs, Volume= 14,734 cf, Depth= 1.66"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 10 year Rainfall=3.44"

Area (ac)	CN	Description
0.663	73	Woods, Fair, HSG C
1.254	79	50-75% Grass cover, Fair, HSG C
0.528	98	Paved parking, HSG C
2.445	81	Weighted Average
1.917		78.40% Pervious Area
0.528		21.60% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.6	50	0.0100	0.10		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.40"
5.1	215	0.0100	0.70		**Shallow Concentrated Flow, TC-P2** Short Grass Pasture Kv= 7.0 fps
3.4	336	0.0050	1.64	6.55	**Channel Flow, TC-P3** Area= 4.0 sf Perim= 12.5' r= 0.32' n= 0.030
0.6	110	0.0050	3.23	3.96	**Pipe Channel, TC-E4** 15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.015 Concrete sewer w/manholes & inlets
17.7	711	Total			

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Summary for Pond 1P: POND (OS-1)

Inflow Area = 106,504 sf, 21.60% Impervious, Inflow Depth = 1.66" for 10 year event
Inflow = 4.79 cfs @ 12.10 hrs, Volume= 14,734 cf
Outflow = 2.96 cfs @ 12.26 hrs, Volume= 14,734 cf, Atten= 38%, Lag= 9.1 min
Primary = 2.96 cfs @ 12.26 hrs, Volume= 14,734 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 1,096.58' @ 12.26 hrs Surf.Area= 2,174 sf Storage= 2,541 cf

Plug-Flow detention time= 15.7 min calculated for 14,724 cf (100% of inflow)
Center-of-Mass det. time= 15.9 min (859.5 - 843.6)

Volume	Invert	Avail.Storage	Storage Description
#1	1,095.00'	6,429 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
1,095.00	1,080	213.0	0	0	1,080
1,096.00	1,758	235.0	1,405	1,405	1,896
1,097.00	2,505	258.0	2,121	3,526	2,831
1,098.00	3,320	280.0	2,903	6,429	3,811

Device	Routing	Invert	Outlet Devices
#1	Primary	1,092.45'	**18.0" Round Culvert** L= 4.0' RCP, groove end w/headwall, Ke= 0.200 Inlet / Outlet Invert= 1,092.45' / 1,092.41' S= 0.0100 '/' Cc= 0.900 n= 0.012, Flow Area= 1.77 sf
#2	Device 1	1,095.00'	**9.0" W x 9.0" H Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Device 1	1,096.70'	**45.0" x 24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=2.96 cfs @ 12.26 hrs HW=1,096.58' (Free Discharge)
└**1=Culvert** (Passes 2.96 cfs of 19.54 cfs potential flow)
  ├**2=Orifice/Grate** (Orifice Controls 2.96 cfs @ 5.25 fps)
  └**3=Orifice/Grate** (Controls 0.00 cfs)

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

SCM-001 (100-YEAR)

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Summary for Subcatchment DA-1 (1): MOORE PARK (SCM 001) PRE-CONSTR

[47] Hint: Peak is 182% of capacity of segment #4

Runoff = 10.20 cfs @ 12.06 hrs, Volume= 28,386 cf, Depth= 3.20"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 100 year Rainfall=5.24"

Area (ac)	CN	Description
0.663	73	Woods, Fair, HSG C
1.254	79	50-75% Grass cover, Fair, HSG C
0.528	98	Paved parking, HSG C
2.445	81	Weighted Average
1.917		78.40% Pervious Area
0.528		21.60% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.6	50	0.0100	0.10		**Sheet Flow, TC-E1** Grass: Short n= 0.150 P2= 2.40"
5.1	215	0.0100	0.70		**Shallow Concentrated Flow, TC-E2** Short Grass Pasture Kv= 7.0 fps
0.2	336	0.0050	22.90	297.65	**Channel Flow, TC-E3** Area= 13.0 sf Perim= 2.2' r= 5.91' n= 0.015 Brickwork
0.5	124	0.0100	4.56	5.60	**Pipe Channel, TC-E4** 15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.015 Concrete sewer w/manholes & inlets
0.0	40	0.5000	51.55	5,155.34	**Channel Flow, TC-E5** Area= 100.0 sf Perim= 56.0' r= 1.79' n= 0.030 Stream, clean & straight
14.4	765	Total			

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Summary for Subcatchment DA-1(2): MOORE PARK (SCM 001) POST CONSTR

[47] Hint: Peak is 141% of capacity of segment #3
[47] Hint: Peak is 233% of capacity of segment #4

Runoff = 9.23 cfs @ 12.10 hrs, Volume= 28,386 cf, Depth= 3.20"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 100 year Rainfall=5.24"

Area (ac)	CN	Description
0.663	73	Woods, Fair, HSG C
1.254	79	50-75% Grass cover, Fair, HSG C
0.528	98	Paved parking, HSG C
2.445	81	Weighted Average
1.917		78.40% Pervious Area
0.528		21.60% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.6	50	0.0100	0.10		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.40"
5.1	215	0.0100	0.70		**Shallow Concentrated Flow, TC-P2** Short Grass Pasture Kv= 7.0 fps
3.4	336	0.0050	1.64	6.55	**Channel Flow, TC-P3** Area= 4.0 sf Perim= 12.5' r= 0.32' n= 0.030
0.6	110	0.0050	3.23	3.96	**Pipe Channel, TC-E4** 15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.015 Concrete sewer w/manholes & inlets
17.7	711	Total			

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Summary for Pond 1P: POND (OS-1)

Inflow Area = 106,504 sf, 21.60% Impervious, Inflow Depth = 3.20" for 100 year event
Inflow = 9.23 cfs @ 12.10 hrs, Volume= 28,386 cf
Outflow = 9.02 cfs @ 12.13 hrs, Volume= 28,386 cf, Atten= 2%, Lag= 1.9 min
Primary = 9.02 cfs @ 12.13 hrs, Volume= 28,386 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 1,096.98' @ 12.13 hrs Surf.Area= 2,489 sf Storage= 3,478 cf

Plug-Flow detention time= 13.2 min calculated for 28,367 cf (100% of inflow)
Center-of-Mass det. time= 13.3 min (838.2 - 824.9)

Volume	Invert	Avail.Storage	Storage Description
#1	1,095.00'	6,429 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
1,095.00	1,080	213.0	0	0	1,080
1,096.00	1,758	235.0	1,405	1,405	1,896
1,097.00	2,505	258.0	2,121	3,526	2,831
1,098.00	3,320	280.0	2,903	6,429	3,811

Device	Routing	Invert	Outlet Devices
#1	Primary	1,092.45'	**18.0" Round Culvert** L= 4.0' RCP, groove end w/headwall, Ke= 0.200 Inlet / Outlet Invert= 1,092.45' / 1,092.41' S= 0.0100 '/' Cc= 0.900 n= 0.012, Flow Area= 1.77 sf
#2	Device 1	1,095.00'	**9.0" W x 9.0" H Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Device 1	1,096.70'	**45.0" x 24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=8.87 cfs @ 12.13 hrs HW=1,096.98' (Free Discharge)
└**1=Culvert** (Passes 8.87 cfs of 20.67 cfs potential flow)
  ├**2=Orifice/Grate** (Orifice Controls 3.42 cfs @ 6.08 fps)
  └**3=Orifice/Grate** (Weir Controls 5.46 cfs @ 1.72 fps)

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

SCM-001 (100-YEAR)
CLOGGED CONDITION

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Summary for Subcatchment DA-1 (3): MOORE PARK (SCM 001) POST CONSTR (CLOG)

[47] Hint: Peak is 142% of capacity of segment #3
[47] Hint: Peak is 166% of capacity of segment #4

Runoff = 9.28 cfs @ 12.10 hrs, Volume= 28,386 cf, Depth= 3.20"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 100 year Rainfall=5.24"

Area (ac)	CN	Description
0.663	73	Woods, Fair, HSG C
1.254	79	50-75% Grass cover, Fair, HSG C
0.528	98	Paved parking, HSG C
2.445	81	Weighted Average
1.917		78.40% Pervious Area
0.528		21.60% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.6	50	0.0100	0.10		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.40"
5.1	215	0.0100	0.70		**Shallow Concentrated Flow, TC-P2** Short Grass Pasture Kv= 7.0 fps
3.4	336	0.0050	1.64	6.55	**Channel Flow, TC-P3** Area= 4.0 sf Perim= 12.5' r= 0.32' n= 0.030
0.4	110	0.0100	4.56	5.60	**Pipe Channel, TC-P4** 15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.015 Concrete sewer w/manholes & inlets
17.5	711	Total			

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Summary for Pond 2P: POND (OS-2)

Inflow Area = 106,504 sf, 21.60% Impervious, Inflow Depth = 3.20" for 100 year event
Inflow = 9.28 cfs @ 12.10 hrs, Volume= 28,386 cf
Outflow = 9.15 cfs @ 12.12 hrs, Volume= 24,861 cf, Atten= 1%, Lag= 1.3 min
Primary = 9.15 cfs @ 12.12 hrs, Volume= 24,861 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 1,097.39' @ 12.12 hrs Surf.Area= 2,809 sf Storage= 4,561 cf

Plug-Flow detention time= 87.4 min calculated for 24,843 cf (88% of inflow)
Center-of-Mass det. time= 27.6 min (852.3 - 824.7)

Volume	Invert	Avail.Storage	Storage Description
#1	1,095.00'	6,429 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
1,095.00	1,080	213.0	0	0	1,080
1,096.00	1,758	235.0	1,405	1,405	1,896
1,097.00	2,505	258.0	2,121	3,526	2,831
1,098.00	3,320	280.0	2,903	6,429	3,811

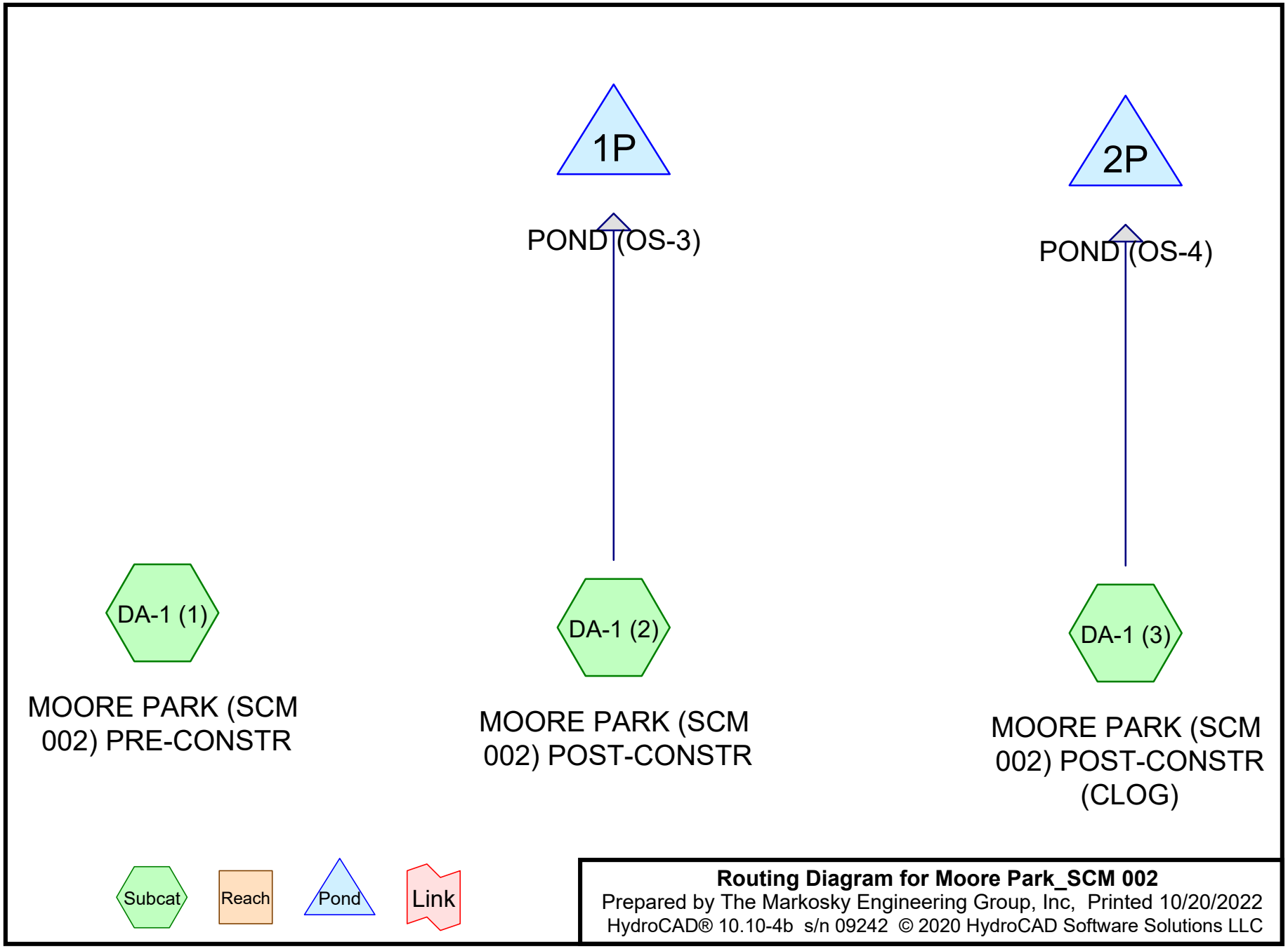
Device	Routing	Invert	Outlet Devices
#1	Primary	1,086.78'	**18.0" Round Culvert** L= 28.0' RCP, groove end w/headwall, Ke= 0.200 Inlet / Outlet Invert= 1,086.78' / 1,065.71' S= 0.7525 '/' Cc= 0.900 n= 0.012, Flow Area= 1.77 sf
#2	Device 1	1,097.00'	**45.0" x 24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=9.00 cfs @ 12.12 hrs HW=1,097.39' (Free Discharge)
↑**1=Culvert** (Passes 9.00 cfs of 33.39 cfs potential flow)
↑**2=Orifice/Grate** (Weir Controls 9.00 cfs @ 2.03 fps)

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

SCM-002 (10-YEAR)

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D



Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Summary for Subcatchment DA-1 (1): MOORE PARK (SCM 002) PRE-CONSTR

Runoff = 4.87 cfs @ 12.05 hrs, Volume= 12,687 cf, Depth= 1.10"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type II 24-hr 10 year Rainfall=3.30"

Area (ac)	CN	Description
2.453	73	Woods, Fair, HSG C
0.713	79	50-75% Grass cover, Fair, HSG C
0.000	98	Paved parking, HSG C
3.166	74	Weighted Average
3.166		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.8	50	0.1700	0.30		**Sheet Flow, TC-E1** Grass: Short n= 0.150 P2= 2.40"
0.3	52	0.2000	3.13		**Shallow Concentrated Flow, TC-E2** Short Grass Pasture Kv= 7.0 fps
0.5	74	0.1351	2.57		**Shallow Concentrated Flow, TC-E3** Short Grass Pasture Kv= 7.0 fps
1.4	128	0.0900	1.50		**Shallow Concentrated Flow, TC-E4** Woodland Kv= 5.0 fps
0.4	80	0.4000	3.16		**Shallow Concentrated Flow, TC-E5** Woodland Kv= 5.0 fps
5.6	334	0.0200	0.99		**Shallow Concentrated Flow, TC-E6** Short Grass Pasture Kv= 7.0 fps
0.8	117	0.2700	2.60		**Shallow Concentrated Flow, TC-E7** Woodland Kv= 5.0 fps
11.8	835	Total			

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Summary for Subcatchment DA-1 (2): MOORE PARK (SCM 002) POST-CONSTR

Runoff = 4.87 cfs @ 12.05 hrs, Volume= 12,687 cf, Depth= 1.10"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type II 24-hr 10 year Rainfall=3.30"

Area (ac)	CN	Description
2.453	73	Woods, Fair, HSG C
0.713	79	50-75% Grass cover, Fair, HSG C
0.000	98	Paved parking, HSG C
3.166	74	Weighted Average
3.166		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.8	50	0.1700	0.30		**Sheet Flow, TC-E1** Grass: Short n= 0.150 P2= 2.40"
0.3	52	0.2000	3.13		**Shallow Concentrated Flow, TC-E2** Short Grass Pasture Kv= 7.0 fps
0.5	74	0.1351	2.57		**Shallow Concentrated Flow, TC-E3** Short Grass Pasture Kv= 7.0 fps
1.4	128	0.0900	1.50		**Shallow Concentrated Flow, TC-E4** Woodland Kv= 5.0 fps
0.4	80	0.4000	3.16		**Shallow Concentrated Flow, TC-E5** Woodland Kv= 5.0 fps
5.6	334	0.0200	0.99		**Shallow Concentrated Flow, TC-E6** Short Grass Pasture Kv= 7.0 fps
0.8	117	0.2700	2.60		**Shallow Concentrated Flow, TC-E7** Woodland Kv= 5.0 fps
11.8	835	Total			

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Summary for Pond 1P: POND (OS-3)

Inflow Area = 137,911 sf, 0.00% Impervious, Inflow Depth = 1.10" for 10 year event
Inflow = 4.87 cfs @ 12.05 hrs, Volume= 12,687 cf
Outflow = 2.40 cfs @ 12.19 hrs, Volume= 12,687 cf, Atten= 51%, Lag= 8.5 min
Primary = 2.40 cfs @ 12.19 hrs, Volume= 12,687 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 1,098.59' @ 12.19 hrs Surf.Area= 2,106 sf Storage= 2,514 cf

Plug-Flow detention time= 18.3 min calculated for 12,687 cf (100% of inflow)
Center-of-Mass det. time= 18.0 min (880.2 - 862.2)

Volume	Invert	Avail.Storage	Storage Description
#1	1,097.00'	6,192 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
1,097.00	1,079	200.0	0	0	1,079
1,098.00	1,711	219.0	1,383	1,383	1,746
1,099.00	2,400	238.0	2,046	3,429	2,474
1,100.00	3,143	256.0	2,763	6,192	3,224

Device	Routing	Invert	Outlet Devices
#1	Primary	1,093.73'	**18.0" Round Culvert** L= 4.0' RCP, groove end w/headwall, Ke= 0.200 Inlet / Outlet Invert= 1,093.73' / 1,093.67' S= 0.0150 '/' Cc= 0.900 n= 0.012, Flow Area= 1.77 sf
#2	Device 1	1,097.00'	**8.0" W x 8.0" H Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Device 1	1,098.60'	**45.2" x 24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=2.39 cfs @ 12.19 hrs HW=1,098.59' (Free Discharge)
└**1=Culvert** (Passes 2.39 cfs of 21.56 cfs potential flow)
  ├**2=Orifice/Grate** (Orifice Controls 2.39 cfs @ 5.38 fps)
  └**3=Orifice/Grate** (Controls 0.00 cfs)

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

SCM-002 (100-YEAR)

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Summary for Subcatchment DA-1 (1): MOORE PARK (SCM 002) PRE-CONSTR

Runoff = 11.57 cfs @ 12.04 hrs, Volume= 29,388 cf, Depth= 2.56"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type II 24-hr 100 year Rainfall=5.24"

Area (ac)	CN	Description
2.453	73	Woods, Fair, HSG C
0.713	79	50-75% Grass cover, Fair, HSG C
0.000	98	Paved parking, HSG C
3.166	74	Weighted Average
3.166		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.8	50	0.1700	0.30		**Sheet Flow, TC-E1** Grass: Short n= 0.150 P2= 2.40"
0.3	52	0.2000	3.13		**Shallow Concentrated Flow, TC-E2** Short Grass Pasture Kv= 7.0 fps
0.5	74	0.1351	2.57		**Shallow Concentrated Flow, TC-E3** Short Grass Pasture Kv= 7.0 fps
1.4	128	0.0900	1.50		**Shallow Concentrated Flow, TC-E4** Woodland Kv= 5.0 fps
0.4	80	0.4000	3.16		**Shallow Concentrated Flow, TC-E5** Woodland Kv= 5.0 fps
5.6	334	0.0200	0.99		**Shallow Concentrated Flow, TC-E6** Short Grass Pasture Kv= 7.0 fps
0.8	117	0.2700	2.60		**Shallow Concentrated Flow, TC-E7** Woodland Kv= 5.0 fps
11.8	835	Total			

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Summary for Subcatchment DA-1 (2): MOORE PARK (SCM 002) POST-CONSTR

Runoff = 11.57 cfs @ 12.04 hrs, Volume= 29,388 cf, Depth= 2.56"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type II 24-hr 100 year Rainfall=5.24"

Area (ac)	CN	Description
2.453	73	Woods, Fair, HSG C
0.713	79	50-75% Grass cover, Fair, HSG C
0.000	98	Paved parking, HSG C
3.166	74	Weighted Average
3.166		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.8	50	0.1700	0.30		**Sheet Flow, TC-E1** Grass: Short n= 0.150 P2= 2.40"
0.3	52	0.2000	3.13		**Shallow Concentrated Flow, TC-E2** Short Grass Pasture Kv= 7.0 fps
0.5	74	0.1351	2.57		**Shallow Concentrated Flow, TC-E3** Short Grass Pasture Kv= 7.0 fps
1.4	128	0.0900	1.50		**Shallow Concentrated Flow, TC-E4** Woodland Kv= 5.0 fps
0.4	80	0.4000	3.16		**Shallow Concentrated Flow, TC-E5** Woodland Kv= 5.0 fps
5.6	334	0.0200	0.99		**Shallow Concentrated Flow, TC-E6** Short Grass Pasture Kv= 7.0 fps
0.8	117	0.2700	2.60		**Shallow Concentrated Flow, TC-E7** Woodland Kv= 5.0 fps
11.8	835	Total			

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Summary for Pond 1P: POND (OS-3)

Inflow Area = 137,911 sf, 0.00% Impervious, Inflow Depth = 2.56" for 100 year event
Inflow = 11.57 cfs @ 12.04 hrs, Volume= 29,388 cf
Outflow = 11.42 cfs @ 12.06 hrs, Volume= 29,388 cf, Atten= 1%, Lag= 1.2 min
Primary = 11.42 cfs @ 12.06 hrs, Volume= 29,388 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 1,098.98' @ 12.06 hrs Surf.Area= 2,382 sf Storage= 3,370 cf

Plug-Flow detention time= 13.8 min calculated for 29,388 cf (100% of inflow)
Center-of-Mass det. time= 13.5 min (850.8 - 837.3)

Volume	Invert	Avail.Storage	Storage Description
#1	1,097.00'	6,192 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
1,097.00	1,079	200.0	0	0	1,079
1,098.00	1,711	219.0	1,383	1,383	1,746
1,099.00	2,400	238.0	2,046	3,429	2,474
1,100.00	3,143	256.0	2,763	6,192	3,224

Device	Routing	Invert	Outlet Devices
#1	Primary	1,093.73'	**18.0" Round Culvert** L= 4.0' RCP, groove end w/headwall, Ke= 0.200 Inlet / Outlet Invert= 1,093.73' / 1,093.67' S= 0.0150 '/' Cc= 0.900 n= 0.012, Flow Area= 1.77 sf
#2	Device 1	1,097.00'	**8.0" W x 8.0" H Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Device 1	1,098.60'	**45.2" x 24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=11.21 cfs @ 12.06 hrs HW=1,098.97' (Free Discharge)
└**1=Culvert** (Passes 11.21 cfs of 22.54 cfs potential flow)
  ├**2=Orifice/Grate** (Orifice Controls 2.73 cfs @ 6.15 fps)
  └**3=Orifice/Grate** (Weir Controls 8.48 cfs @ 1.99 fps)

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

SCM-002 (100-YEAR)
CLOGGED CONDITION

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Summary for Subcatchment DA-1 (3): MOORE PARK (SCM 002) POST-CONSTR (CLOG)

Runoff = 11.57 cfs @ 12.04 hrs, Volume= 29,388 cf, Depth= 2.56"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type II 24-hr 100 year Rainfall=5.24"

Area (ac)	CN	Description
2.453	73	Woods, Fair, HSG C
0.713	79	50-75% Grass cover, Fair, HSG C
0.000	98	Paved parking, HSG C
3.166	74	Weighted Average
3.166		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.8	50	0.1700	0.30		**Sheet Flow, TC-E1** Grass: Short n= 0.150 P2= 2.40"
0.3	52	0.2000	3.13		**Shallow Concentrated Flow, TC-E2** Short Grass Pasture Kv= 7.0 fps
0.5	74	0.1351	2.57		**Shallow Concentrated Flow, TC-E3** Short Grass Pasture Kv= 7.0 fps
1.4	128	0.0900	1.50		**Shallow Concentrated Flow, TC-E4** Woodland Kv= 5.0 fps
0.4	80	0.4000	3.16		**Shallow Concentrated Flow, TC-E5** Woodland Kv= 5.0 fps
5.6	334	0.0200	0.99		**Shallow Concentrated Flow, TC-E6** Short Grass Pasture Kv= 7.0 fps
0.8	117	0.2700	2.60		**Shallow Concentrated Flow, TC-E7** Woodland Kv= 5.0 fps
11.8	835	Total			

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Summary for Pond 2P: POND (OS-4)

Inflow Area = 137,911 sf, 0.00% Impervious, Inflow Depth = 2.56" for 100 year event
Inflow = 11.57 cfs @ 12.04 hrs, Volume= 29,388 cf
Outflow = 11.34 cfs @ 12.06 hrs, Volume= 25,959 cf, Atten= 2%, Lag= 1.2 min
Primary = 11.34 cfs @ 12.06 hrs, Volume= 25,959 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 1,099.45' @ 12.06 hrs Surf.Area= 2,721 sf Storage= 4,577 cf

Plug-Flow detention time= 81.8 min calculated for 25,959 cf (88% of inflow)
Center-of-Mass det. time= 23.7 min (861.0 - 837.3)

Volume	Invert	Avail.Storage	Storage Description
#1	1,097.00'	6,192 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

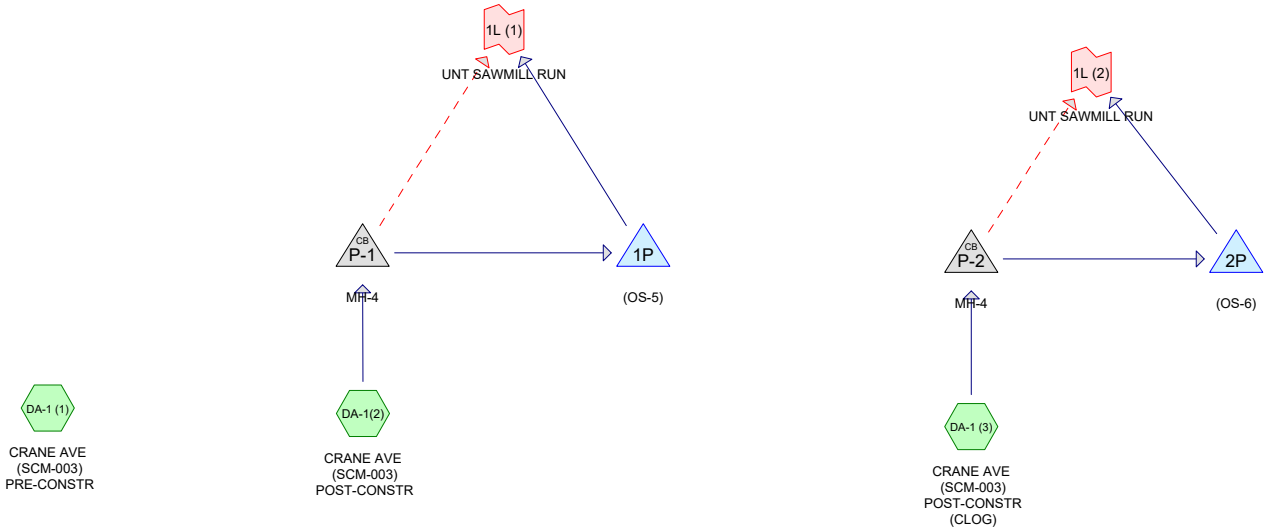
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
1,097.00	1,079	200.0	0	0	1,079
1,098.00	1,711	219.0	1,383	1,383	1,746
1,099.00	2,400	238.0	2,046	3,429	2,474
1,100.00	3,143	256.0	2,763	6,192	3,224

Device	Routing	Invert	Outlet Devices
#1	Primary	1,093.50'	**18.0" Round Culvert** L= 34.0' RCP, groove end w/headwall, Ke= 0.200 Inlet / Outlet Invert= 1,093.50' / 1,091.80' S= 0.0500 '/' Cc= 0.900 n= 0.012, Flow Area= 1.77 sf
#2	Device 1	1,099.00'	**45.2" x 24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=11.17 cfs @ 12.06 hrs HW=1,099.44' (Free Discharge)
↑**1=Culvert** (Passes 11.17 cfs of 24.24 cfs potential flow)
↑**2=Orifice/Grate** (Weir Controls 11.17 cfs @ 2.18 fps)

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

SCM-003 (10-YEAR)



Subcat Reach Pond Link

Routing Diagram for Crane Avenue_Existing
Prepared by The Markosky Engineering Group, Inc, Printed 10/20/2022
HydroCAD® 10.10-4b s/n 09242 © 2020 HydroCAD Software Solutions LLC

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Summary for Subcatchment DA-1 (1): CRANE AVE (SCM-003) PRE-CONSTR

Runoff = 43.29 cfs @ 11.99 hrs, Volume= 97,433 cf, Depth= 2.30"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type II 24-hr 10 year Rainfall=3.44"

Area (ac)	CN	Description
6.723	98	Paved roads w/curbs & sewers, HSG C
0.098	80	1/2 acre lots, 25% imp, HSG C
2.480	79	50-75% Grass cover, Fair, HSG C
2.360	73	Woods, Fair, HSG C
11.661	89	Weighted Average
4.913		42.14% Pervious Area
6.747		57.86% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.4	50	0.1000	0.24		**Sheet Flow, TC-E1** Grass: Short n= 0.150 P2= 2.40"
0.5	60	0.0700	1.85		**Shallow Concentrated Flow, TC-E2** Short Grass Pasture Kv= 7.0 fps
1.4	212	0.1300	2.52		**Shallow Concentrated Flow, TC-E3** Short Grass Pasture Kv= 7.0 fps
0.1	22	0.5000	4.95		**Shallow Concentrated Flow, TC-E4** Short Grass Pasture Kv= 7.0 fps
1.7	174	0.0600	1.71		**Shallow Concentrated Flow, TC-E5** Short Grass Pasture Kv= 7.0 fps
0.3	200	0.0300	11.15	19.71	**Pipe Channel, TC-E6** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.012
0.1	190	0.3100	35.85	63.36	**Pipe Channel, TC-E7** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.012
0.1	132	0.0740	17.52	30.96	**Pipe Channel, TC-E8** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.012
0.0	55	0.1500	24.94	44.07	**Pipe Channel, TC-E9** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.012
7.6	1,095	Total			

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Summary for Subcatchment DA-1(2): CRANE AVE (SCM-003) POST-CONSTR

Runoff = 43.29 cfs @ 11.99 hrs, Volume= 97,433 cf, Depth= 2.30"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type II 24-hr 10 year Rainfall=3.44"

Area (ac)	CN	Description
6.723	98	Paved roads w/curbs & sewers, HSG C
0.098	80	1/2 acre lots, 25% imp, HSG C
2.480	79	50-75% Grass cover, Fair, HSG C
2.360	73	Woods, Fair, HSG C
11.661	89	Weighted Average
4.913		42.14% Pervious Area
6.747		57.86% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.4	50	0.1000	0.24		**Sheet Flow, TC-E1** Grass: Short n= 0.150 P2= 2.40"
0.5	60	0.0700	1.85		**Shallow Concentrated Flow, TC-E2** Short Grass Pasture Kv= 7.0 fps
1.4	212	0.1300	2.52		**Shallow Concentrated Flow, TC-E3** Short Grass Pasture Kv= 7.0 fps
0.1	22	0.5000	4.95		**Shallow Concentrated Flow, TC-E4** Short Grass Pasture Kv= 7.0 fps
1.7	174	0.0600	1.71		**Shallow Concentrated Flow, TC-E5** Short Grass Pasture Kv= 7.0 fps
0.3	200	0.0300	11.15	19.71	**Pipe Channel, TC-E6** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.012
0.1	190	0.3100	35.85	63.36	**Pipe Channel, TC-E7** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.012
0.1	132	0.0740	17.52	30.96	**Pipe Channel, TC-E8** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.012
0.0	55	0.1500	24.94	44.07	**Pipe Channel, TC-E9** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.012
7.6	1,095	Total			

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Summary for Pond 1P: (OS-5)

Inflow Area = 507,953 sf, 57.86% Impervious, Inflow Depth = 1.38" for 10 year event
Inflow = 10.76 cfs @ 11.97 hrs, Volume= 58,217 cf
Outflow = 8.52 cfs @ 12.06 hrs, Volume= 58,205 cf, Atten= 21%, Lag= 5.2 min
Primary = 8.52 cfs @ 12.06 hrs, Volume= 58,205 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 958.84' @ 12.06 hrs Surf.Area= 3,048 sf Storage= 6,306 cf

Plug-Flow detention time= 15.5 min calculated for 58,205 cf (100% of inflow)
Center-of-Mass det. time= 15.1 min (870.5 - 855.3)

Volume	Invert	Avail.Storage	Storage Description
#1	956.00'	10,290 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
956.00	1,473	157.0	0	0	1,473
957.00	1,976	177.0	1,718	1,718	2,030
958.00	2,536	195.0	2,250	3,969	2,595
959.00	3,152	215.0	2,838	6,807	3,279
960.00	3,825	233.0	3,483	10,290	3,958

Device	Routing	Invert	Outlet Devices
#1	Primary	952.75'	**18.0" Round Culvert** L= 2.0' RCP, groove end w/headwall, Ke= 0.200 Inlet / Outlet Invert= 952.75' / 952.71' S= 0.0200 '/' Cc= 0.900 n= 0.012, Flow Area= 1.77 sf
#2	Device 1	956.00'	**12.2" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Device 1	958.70'	**48.0" x 48.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=8.19 cfs @ 12.06 hrs HW=958.82' TW=0.00' (Dynamic Tailwater)
└─**1=Culvert** (Passes 8.19 cfs of 24.54 cfs potential flow)
  ├─**2=Orifice/Grate** (Orifice Controls 5.95 cfs @ 7.32 fps)
  └─**3=Orifice/Grate** (Weir Controls 2.25 cfs @ 1.15 fps)

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Summary for Pond P-1: MH-4

Inflow Area = 507,953 sf, 57.86% Impervious, Inflow Depth = 2.30" for 10 year event
Inflow = 43.29 cfs @ 11.99 hrs, Volume= 97,433 cf
Outflow = 43.29 cfs @ 11.99 hrs, Volume= 97,433 cf, Atten= 0%, Lag= 0.0 min
Primary = 10.76 cfs @ 11.97 hrs, Volume= 58,217 cf
Secondary = 32.48 cfs @ 11.99 hrs, Volume= 39,216 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 961.73' @ 11.99 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	958.00'	**15.0" Round Culvert** L= 84.0' RCP, groove end w/headwall, Ke= 0.200 Inlet / Outlet Invert= 958.00' / 956.00' S= 0.0238 '/' Cc= 0.900 n= 0.012, Flow Area= 1.23 sf
#2	Secondary	958.25'	**27.0" Round Culvert** L= 46.0' RCP, groove end w/headwall, Ke= 0.200 Inlet / Outlet Invert= 958.25' / 957.79' S= 0.0100 '/' Cc= 0.900 n= 0.012, Flow Area= 3.98 sf

Primary OutFlow Max=10.08 cfs @ 11.97 hrs HW=961.52' TW=958.52' (Dynamic Tailwater)
└**1=Culvert** (Outlet Controls 10.08 cfs @ 8.21 fps)

Secondary OutFlow Max=31.61 cfs @ 11.99 hrs HW=961.63' TW=0.00' (Dynamic Tailwater)
└**2=Culvert** (Barrel Controls 31.61 cfs @ 7.95 fps)

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Summary for Link 1L (1): UNT SAWMILL RUN

Inflow Area = 507,953 sf, 57.86% Impervious, Inflow Depth = 2.30" for 10 year event
Inflow = 38.05 cfs @ 12.00 hrs, Volume= 97,422 cf
Primary = 38.05 cfs @ 12.00 hrs, Volume= 97,422 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

SCM-003 (100-YEAR)

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Summary for Subcatchment DA-1 (1): CRANE AVE (SCM-003) PRE-CONSTR

Runoff = 72.96 cfs @ 11.99 hrs, Volume= 169,407 cf, Depth= 4.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type II 24-hr 100 year Rainfall=5.24"

Area (ac)	CN	Description
6.723	98	Paved roads w/curbs & sewers, HSG C
0.098	80	1/2 acre lots, 25% imp, HSG C
2.480	79	50-75% Grass cover, Fair, HSG C
2.360	73	Woods, Fair, HSG C
11.661	89	Weighted Average
4.913		42.14% Pervious Area
6.747		57.86% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.4	50	0.1000	0.24		**Sheet Flow, TC-E1** Grass: Short n= 0.150 P2= 2.40"
0.5	60	0.0700	1.85		**Shallow Concentrated Flow, TC-E2** Short Grass Pasture Kv= 7.0 fps
1.4	212	0.1300	2.52		**Shallow Concentrated Flow, TC-E3** Short Grass Pasture Kv= 7.0 fps
0.1	22	0.5000	4.95		**Shallow Concentrated Flow, TC-E4** Short Grass Pasture Kv= 7.0 fps
1.7	174	0.0600	1.71		**Shallow Concentrated Flow, TC-E5** Short Grass Pasture Kv= 7.0 fps
0.3	200	0.0300	11.15	19.71	**Pipe Channel, TC-E6** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.012
0.1	190	0.3100	35.85	63.36	**Pipe Channel, TC-E7** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.012
0.1	132	0.0740	17.52	30.96	**Pipe Channel, TC-E8** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.012
0.0	55	0.1500	24.94	44.07	**Pipe Channel, TC-E9** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.012
7.6	1,095	Total			

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Summary for Subcatchment DA-1(2): CRANE AVE (SCM-003) POST-CONSTR

Runoff = 72.96 cfs @ 11.99 hrs, Volume= 169,407 cf, Depth= 4.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type II 24-hr 100 year Rainfall=5.24"

Area (ac)	CN	Description
6.723	98	Paved roads w/curbs & sewers, HSG C
0.098	80	1/2 acre lots, 25% imp, HSG C
2.480	79	50-75% Grass cover, Fair, HSG C
2.360	73	Woods, Fair, HSG C
11.661	89	Weighted Average
4.913		42.14% Pervious Area
6.747		57.86% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.4	50	0.1000	0.24		**Sheet Flow, TC-E1** Grass: Short n= 0.150 P2= 2.40"
0.5	60	0.0700	1.85		**Shallow Concentrated Flow, TC-E2** Short Grass Pasture Kv= 7.0 fps
1.4	212	0.1300	2.52		**Shallow Concentrated Flow, TC-E3** Short Grass Pasture Kv= 7.0 fps
0.1	22	0.5000	4.95		**Shallow Concentrated Flow, TC-E4** Short Grass Pasture Kv= 7.0 fps
1.7	174	0.0600	1.71		**Shallow Concentrated Flow, TC-E5** Short Grass Pasture Kv= 7.0 fps
0.3	200	0.0300	11.15	19.71	**Pipe Channel, TC-E6** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.012
0.1	190	0.3100	35.85	63.36	**Pipe Channel, TC-E7** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.012
0.1	132	0.0740	17.52	30.96	**Pipe Channel, TC-E8** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.012
0.0	55	0.1500	24.94	44.07	**Pipe Channel, TC-E9** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.012
7.6	1,095	Total			

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Summary for Pond P-1: MH-4

Inflow Area = 507,953 sf, 57.86% Impervious, Inflow Depth = 4.00" for 100 year event
Inflow = 72.96 cfs @ 11.99 hrs, Volume= 169,407 cf
Outflow = 72.96 cfs @ 11.99 hrs, Volume= 169,407 cf, Atten= 0%, Lag= 0.0 min
Primary = 14.85 cfs @ 11.98 hrs, Volume= 89,411 cf
Secondary = 58.11 cfs @ 11.99 hrs, Volume= 79,995 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 965.38' @ 11.99 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	958.00'	**15.0" Round Culvert** L= 84.0' RCP, groove end w/headwall, Ke= 0.200 Inlet / Outlet Invert= 958.00' / 956.00' S= 0.0238 '/' Cc= 0.900 n= 0.012, Flow Area= 1.23 sf
#2	Secondary	958.25'	**27.0" Round Culvert** L= 46.0' RCP, groove end w/headwall, Ke= 0.200 Inlet / Outlet Invert= 958.25' / 957.79' S= 0.0100 '/' Cc= 0.900 n= 0.012, Flow Area= 3.98 sf

Primary OutFlow Max=14.31 cfs @ 11.98 hrs HW=965.03' TW=958.97' (Dynamic Tailwater)
└**1=Culvert** (Outlet Controls 14.31 cfs @ 11.66 fps)

Secondary OutFlow Max=56.30 cfs @ 11.99 hrs HW=965.08' TW=0.00' (Dynamic Tailwater)
└**2=Culvert** (Barrel Controls 56.30 cfs @ 14.16 fps)

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Summary for Pond 1P: (OS-5)

Inflow Area = 507,953 sf, 57.86% Impervious, Inflow Depth = 2.11" for 100 year event
Inflow = 14.85 cfs @ 11.98 hrs, Volume= 89,411 cf
Outflow = 14.60 cfs @ 12.01 hrs, Volume= 89,400 cf, Atten= 2%, Lag= 1.4 min
Primary = 14.60 cfs @ 12.01 hrs, Volume= 89,400 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 959.00' @ 12.01 hrs Surf.Area= 3,150 sf Storage= 6,795 cf

Plug-Flow detention time= 13.8 min calculated for 89,400 cf (100% of inflow)
Center-of-Mass det. time= 13.4 min (848.8 - 835.3)

Volume	Invert	Avail.Storage	Storage Description
#1	956.00'	10,290 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
956.00	1,473	157.0	0	0	1,473
957.00	1,976	177.0	1,718	1,718	2,030
958.00	2,536	195.0	2,250	3,969	2,595
959.00	3,152	215.0	2,838	6,807	3,279
960.00	3,825	233.0	3,483	10,290	3,958

Device	Routing	Invert	Outlet Devices
#1	Primary	952.75'	**18.0" Round Culvert** L= 2.0' RCP, groove end w/headwall, Ke= 0.200 Inlet / Outlet Invert= 952.75' / 952.71' S= 0.0200 '/' Cc= 0.900 n= 0.012, Flow Area= 1.77 sf
#2	Device 1	956.00'	**12.2" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Device 1	958.70'	**48.0" x 48.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=14.39 cfs @ 12.01 hrs HW=958.99' TW=0.00' (Dynamic Tailwater)
└─**1=Culvert** (Passes 14.39 cfs of 24.92 cfs potential flow)
  ├─**2=Orifice/Grate** (Orifice Controls 6.16 cfs @ 7.59 fps)
  └─**3=Orifice/Grate** (Weir Controls 8.23 cfs @ 1.77 fps)

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Summary for Link 1L (1): UNT SAWMILL RUN

Inflow Area = 507,953 sf, 57.86% Impervious, Inflow Depth = 4.00" for 100 year event
Inflow = 72.45 cfs @ 11.99 hrs, Volume= 169,396 cf
Primary = 72.45 cfs @ 11.99 hrs, Volume= 169,396 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

SCM-003 (100-YEAR)
CLOGGED CONDITION

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Summary for Subcatchment DA-1 (3): CRANE AVE (SCM-003) POST-CONSTR (CLOG)

Runoff = 72.96 cfs @ 11.99 hrs, Volume= 169,407 cf, Depth= 4.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type II 24-hr 100 year Rainfall=5.24"

Area (ac)	CN	Description
6.723	98	Paved roads w/curbs & sewers, HSG C
0.098	80	1/2 acre lots, 25% imp, HSG C
2.480	79	50-75% Grass cover, Fair, HSG C
2.360	73	Woods, Fair, HSG C
11.661	89	Weighted Average
4.913		42.14% Pervious Area
6.747		57.86% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.4	50	0.1000	0.24		**Sheet Flow, TC-E1** Grass: Short n= 0.150 P2= 2.40"
0.5	60	0.0700	1.85		**Shallow Concentrated Flow, TC-E2** Short Grass Pasture Kv= 7.0 fps
1.4	212	0.1300	2.52		**Shallow Concentrated Flow, TC-E3** Short Grass Pasture Kv= 7.0 fps
0.1	22	0.5000	4.95		**Shallow Concentrated Flow, TC-E4** Short Grass Pasture Kv= 7.0 fps
1.7	174	0.0600	1.71		**Shallow Concentrated Flow, TC-E5** Short Grass Pasture Kv= 7.0 fps
0.3	200	0.0300	11.15	19.71	**Pipe Channel, TC-E6** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.012
0.1	190	0.3100	35.85	63.36	**Pipe Channel, TC-E7** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.012
0.1	132	0.0740	17.52	30.96	**Pipe Channel, TC-E8** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.012
0.0	55	0.1500	24.94	44.07	**Pipe Channel, TC-E9** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.012
7.6	1,095	Total			

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Summary for Pond P-2: MH-4

Inflow Area = 507,953 sf, 57.86% Impervious, Inflow Depth = 4.00" for 100 year event
Inflow = 72.96 cfs @ 11.99 hrs, Volume= 169,407 cf
Outflow = 72.96 cfs @ 11.99 hrs, Volume= 169,407 cf, Atten= 0%, Lag= 0.0 min
Primary = 14.38 cfs @ 11.98 hrs, Volume= 27,678 cf
Secondary = 58.57 cfs @ 11.99 hrs, Volume= 141,729 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 965.46' @ 11.99 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	958.00'	**15.0" Round Culvert** L= 84.0' RCP, groove end w/headwall, Ke= 0.200 Inlet / Outlet Invert= 958.00' / 956.00' S= 0.0238 '/' Cc= 0.900 n= 0.012, Flow Area= 1.23 sf
#2	Secondary	958.25'	**27.0" Round Culvert** L= 46.0' RCP, groove end w/headwall, Ke= 0.200 Inlet / Outlet Invert= 958.25' / 957.79' S= 0.0100 '/' Cc= 0.900 n= 0.012, Flow Area= 3.98 sf

Primary OutFlow Max=13.93 cfs @ 11.98 hrs HW=965.15' TW=959.41' (Dynamic Tailwater)
└**1=Culvert** (Outlet Controls 13.93 cfs @ 11.35 fps)

Secondary OutFlow Max=56.75 cfs @ 11.99 hrs HW=965.16' TW=0.00' (Dynamic Tailwater)
└**2=Culvert** (Barrel Controls 56.75 cfs @ 14.27 fps)

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Summary for Pond 2P: (OS-6)

Inflow Area = 507,953 sf, 57.86% Impervious, Inflow Depth = 0.65" for 100 year event
Inflow = 14.38 cfs @ 11.98 hrs, Volume= 27,678 cf
Outflow = 14.03 cfs @ 12.00 hrs, Volume= 20,871 cf, Atten= 2%, Lag= 1.0 min
Primary = 14.03 cfs @ 12.00 hrs, Volume= 20,871 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 959.42' @ 12.00 hrs Surf.Area= 3,424 sf Storage= 8,174 cf

Plug-Flow detention time= 86.0 min calculated for 20,842 cf (75% of inflow)
Center-of-Mass det. time= 61.5 min (722.1 - 660.6)

Volume	Invert	Avail.Storage	Storage Description
#1	956.00'	10,290 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
956.00	1,473	157.0	0	0	1,473
957.00	1,976	177.0	1,718	1,718	2,030
958.00	2,536	195.0	2,250	3,969	2,595
959.00	3,152	215.0	2,838	6,807	3,279
960.00	3,825	233.0	3,483	10,290	3,958

Device	Routing	Invert	Outlet Devices
#1	Primary	951.02'	**18.0" Round Culvert** L= 45.0' RCP, groove end w/headwall, Ke= 0.200 Inlet / Outlet Invert= 951.02' / 950.11' S= 0.0202 '/' Cc= 0.900 n= 0.012, Flow Area= 1.77 sf
#2	Device 1	959.00'	**48.0" x 48.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=13.99 cfs @ 12.00 hrs HW=959.42' TW=0.00' (Dynamic Tailwater)
↑**1=Culvert** (Passes 13.99 cfs of 28.73 cfs potential flow)
↑**2=Orifice/Grate** (Weir Controls 13.99 cfs @ 2.11 fps)

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Summary for Link 1L (2): UNT SAWMILL RUN

Inflow Area = 507,953 sf, 57.86% Impervious, Inflow Depth = 3.84" for 100 year event
Inflow = 72.47 cfs @ 11.99 hrs, Volume= 162,600 cf
Primary = 72.47 cfs @ 11.99 hrs, Volume= 162,600 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

ANTI-SEEP COLLAR CALCULATIONS

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

MARKOSKY
3689 Route 711 • Ligonier, PA 15658
724.238.4138 • www.markosky.com
COLLABORATIVE ENGINEERING

Subject : Subject : Sawmill Run - MS4
Crane Avenue SCM-003

Calculated By: WBM Date: 10/13/2022
Checked By: Date:

DRY EXTENDED DETENTION BASIN (SCM 001) - ANTI-SEEP COLLAR

Length of Pipe in Saturated Zone (Ls)

Ls = y(z+4) [1+(Pipe Slope / 0.25-pipe slope)

y = Distance from upstream invert of principal spillway riser to top of dewatering volume

T/ Dewatering Volume Elev =	959.31	FT	(Top of WSE under Clogged Conditions)
Invert Elev. =	951.02	FT	(Invert Out - Emergency Spillway)
y =	8.29	FT	

z = Horizontal component of upstream embankment slope

z = 3.00

Pipe Slope = 0.0200 FT/FT

Ls = **63.08** **FT**

Required Increase in Flow Path (Lf)

Lf = 1.15Ls (FT)

Lf = **72.54** **FT**

Minimum Collar Project (Vmin)

Vmin = (Lf - Ls) / 2 x N

Lf - Ls = 9.46 FT

N = Number of Collars

N = 3.00 EA

Vmin = **1.58** **FT** USE **2** **FT**

Maximum Collar Spacing (Smax)

Smax = Ls (N-1)

Smax = **31.54** **FT** USE **32** **FT**

Minimum Collar Spacing (Smin)

Smin = 5 x V

Smin = **7.88** **FT** USE **8** **FT**

SUMMARY

Collar Height and Width = PIPE OD + (V x 2)

Pipe OD = 24.00 IN

Colllar Height & Width = **5** **FT**

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

MARKOSKY
3689 Route 711 • Ligonier, PA 15658
724.238.4138 • www.markosky.com
COLLABORATIVE ENGINEERING

Subject : Subject : Sawmill Run - MS4
Moore Park SCM 002

Calculated By: WBM Date: 10/10/2022
Checked By: Date:

DRY EXTENDED DETENTION BASIN (SCM 002) - ANTI-SEEP COLLAR

Length of Pipe in Saturated Zone (Ls)

Ls = y(z+4) [1+(Pipe Slope / 0.25-pipe slope)

y = Distance from upstream invert of principal spillway riser to top of dewatering volume

T/ Dewatering Volume Elev =	1099.45	FT	(Top of WSE under Clogged Conditions)
Invert Elev. =	1093.50	FT	(Invert Out - Emergency Spillway)
y =	5.95	FT	

z = Horizontal component of upstream embankment slope

z = 3.00

Pipe Slope = 0.0500 FT/FT

Ls = **52.06** **FT**

Required Increase in Flow Path (Lf)

Lf = 1.15Ls (FT)

Lf = **59.87** **FT**

Minimum Collar Project (Vmin)

Vmin = (Lf - Ls) / 2 x N

Lf - Ls = 7.81 FT

N = Number of Collars

N = 3.00 EA

Vmin = **1.30** **FT** USE **1** **FT**

Maximum Collar Spacing (Smax)

Smax = Ls (N-1)

Smax = **26.03** **FT** USE **26** **FT**

Minimum Collar Spacing (Smin)

Smin = 5 x V

Smin = **6.51** **FT** USE **7** **FT**

SUMMARY

Collar Height and Width = PIPE OD + (V x 2)

Pipe OD = 24.00 IN

Colllar Height & Width = **5** **FT**

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

MARKOSKY
3689 Route 711 • Ligonier, PA 15658
724.238.4138 • www.markosky.com
COLLABORATIVE ENGINEERING

Subject : Subject : Sawmill Run - MS4
Crane Avenue SCM-003

Calculated By: WBM Date: 10/13/2022
Checked By: Date:

DRY EXTENDED DETENTION BASIN (SCM 003) - ANTI-SEEP COLLAR

Length of Pipe in Saturated Zone (Ls)

Ls = y(z+4) [1+(Pipe Slope / 0.25-pipe slope)

y = Distance from upstream invert of principal spillway riser to top of dewatering volume

T/ Dewatering Volume Elev =	959.31	FT	(Top of WSE under Clogged Conditions)
Invert Elev. =	951.02	FT	(Invert Out - Emergency Spillway)
y =	8.29	FT	

z = Horizontal component of upstream embankment slope

z =	3.00	
Pipe Slope =	0.0200	FT/FT

Ls = **63.08** **FT**

Required Increase in Flow Path (Lf)

Lf = 1.15Ls (FT)

Lf = **72.54** **FT**

Minimum Collar Project (Vmin)

Vmin = (Lf - Ls) / 2 x N

Lf - Ls = 9.46 FT

N = Number of Collars

N = 3.00 EA

Vmin = **1.58** **FT** USE **2** **FT**

Maximum Collar Spacing (Smax)

Smax = Ls (N-1)

Smax = **31.54** **FT** USE **32** **FT**

Minimum Collar Spacing (Smin)

Smin = 5 x V

Smin = **7.88** **FT** USE **8** **FT**

SUMMARY

Collar Height and Width = PIPE OD + (V x 2)

Pipe OD = 24.00 IN

Colllar Height & Width = **5** **FT**

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

PIPE CAPACITY CALCULATIONS

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

DRAINAGE COMPUTATION FORM **PROJECT NAME** MS4 Sawmill Run **DESIGNER** WBM **DATE** 10/18/2022
STORM SEWER, HYDRAULIC DESIGN **PROJECT NUMBER** **REVIEWER** **DATE** **SHEET** 1 **OF** 1

						GRATE		PIPE DEPTH ANALYSIS				HYDRAULIC DESIGN														REMARKS
FROM INLET	TO INLET	ROUTE	STATION OF INLET	SIDE OFFSET	INCREMENTAL RUNOFF	BYPASS FROM UPSTREAM INLET	GRATE CAPACITY	DISTANCE FROM TOP RIM TO INSIDE TOP PIPE	FILL ABOVE TOP OF PIPE	MIN REQ'D FILL BASED ON PIPE STRENGTH AND LOCATION	MIN REQ'D FILL BASED ON INLET BOX CONFIGURATION	FLOW IN PIPE	TOP OF RIM (GROUND)	PIPE INVERT OUT	PIPE INVERT IN	LENGTH OF PIPE	SLOPE OF PIPE	TYPE OF PIPE	MANNING'S n VALUE	SIZE OF PIPE	phi (assumed)	AREA OF PARTIALLY FULL PIPE	DESIGN FLOW	MEAN VELOCITY	PIPE CAPACITY FLOWING FULL	
					(cfs)	(cfs)	(cfs)	(ft)	(ft)	(ft)	(ft)	(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)			(in)	(Degree)	(ft^2)	(cfs)	(fps)	(cfs)	
SCM-001																										
I-1	EW-1	Moore	-	-	-	0.00	16.00	1.52	1.50	1.50	1.42	7.09	1099.29	1095.74	1095.28	91.00	0.0051	TP	0.012	18			7.09	5.25	8.09	10-YR STORM EVENT
OS-1	OS-2	Moore	-	-	-	0.00	-	-	-	-	-	9.02	-	1092.45	1092.41	4.00	0.0100	RCP	0.012	18			9.02	7.23	11.38	100-YR STORM EVENT - SCM 001 OS-1
OS-2	MH-1	Moore	-	-	-	0.00	-	-	-	-	-	9.15	-	1092.25	1092.07	17.50	0.0103	TP	0.012	18			9.15	7.33	11.54	100-YR STORM EVENT - SCM 001 OS-2 Governs
MH-1	MH-2	Moore	-	-	-	0.00	-	-	-	-	-	9.15	-	1086.78	1065.71	28.00	0.7525	TP	0.012	18			9.15	31.06	98.68	100-YR STORM EVENT - SCM 001 OS-2 Governs
MH-2	EW-2	Moore	-	-	-	0.00	-	-	-	-	-	2.96	-	1064.03	1063.99	4.00	0.0100	TP	0.012	18			2.96	5.29	11.38	10-YR STORM EVENT - SCM 001 OS-1
MH-2	EW-2	Moore	-	-	-	0.00	-	-	-	-	-	9.15	-	1064.03	1063.99	4.00	0.0100	TP	0.012	18			9.15	7.26	11.38	100-YR STORM EVENT - SCM 001 OS-2 Governs
SCM-002																										
OS-3	OS-4	Moore				0.00	-	-	-	-	-	11.42	-	1093.73	1093.67	4.00	0.0150	TP	0.012	18			11.42	8.93	13.93	100-YR STORM EVENT - SCM 002 OS-3 Normal Function
OS-4	MH-3	Moore				0.00						11.42		1093.50	1091.80	34.00	0.0500	TP	0.012	18			11.42	13.78	25.44	100-YR STORM EVENT - SCM 002 OS-3 Governs
MH-3	MH-4	Moore				0.00						11.42		1087.69	1068.84	50.00	0.3770	TP	0.012	18			11.42	27.33	69.85	100-YR STORM EVENT - SCM 002 OS-3 Governs
MH-4	EW-3	Moore				0.00						2.40		1068.43	1068.32	7.00	0.0150	TP	0.012	18			2.40	5.53	13.93	10-YR STORM EVENT - SCM 002 OS-3
MH-4	EW-3	Moore				0.00						11.42		1068.43	1068.32	7.00	0.0150	TP	0.012	18			11.42	8.93	13.93	100-YR STORM EVENT - SCM 002 OS-3 Governs
SCM-003																										
MH-4	EW-4	Crane				0.00						10.76		958.00	956.00	84.00	0.0238	TP	0.012	15			10.76	10.13	10.79	10-YR STORM EVENT - SCM 003
MH-4	EW-5	Crane				0.00						32.87		958.25	957.79	46.00	0.0100	TP	0.012	27			32.87	9.73	33.54	10-YR STORM EVENT - SCM 003
OS-5	OS-6	Crane				0.00						14.60		952.75	952.71	2.00	0.0200	TP	0.012	18			14.60	10.47	16.09	100-YR STORM EVENT - SCM 003 OS-5 Governs
OS-6	EW-6	Crane				0.00						8.52		951.02	950.11	45.00	0.0202	TP	0.012	18			8.52	9.17	16.18	100-YR STORM EVENT - SCM 003 OS-5 Normal Function
OS-6	EW-6	Crane				0.00						14.60		951.02	950.11	45.00	0.0202	TP	0.012	18			14.60	10.53	16.18	100-YR STORM EVENT - SCM 003 OS-5 Normal Function

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

RIPRAP APRON OUTLET PROTECTION

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Moore Park
OP - EW1

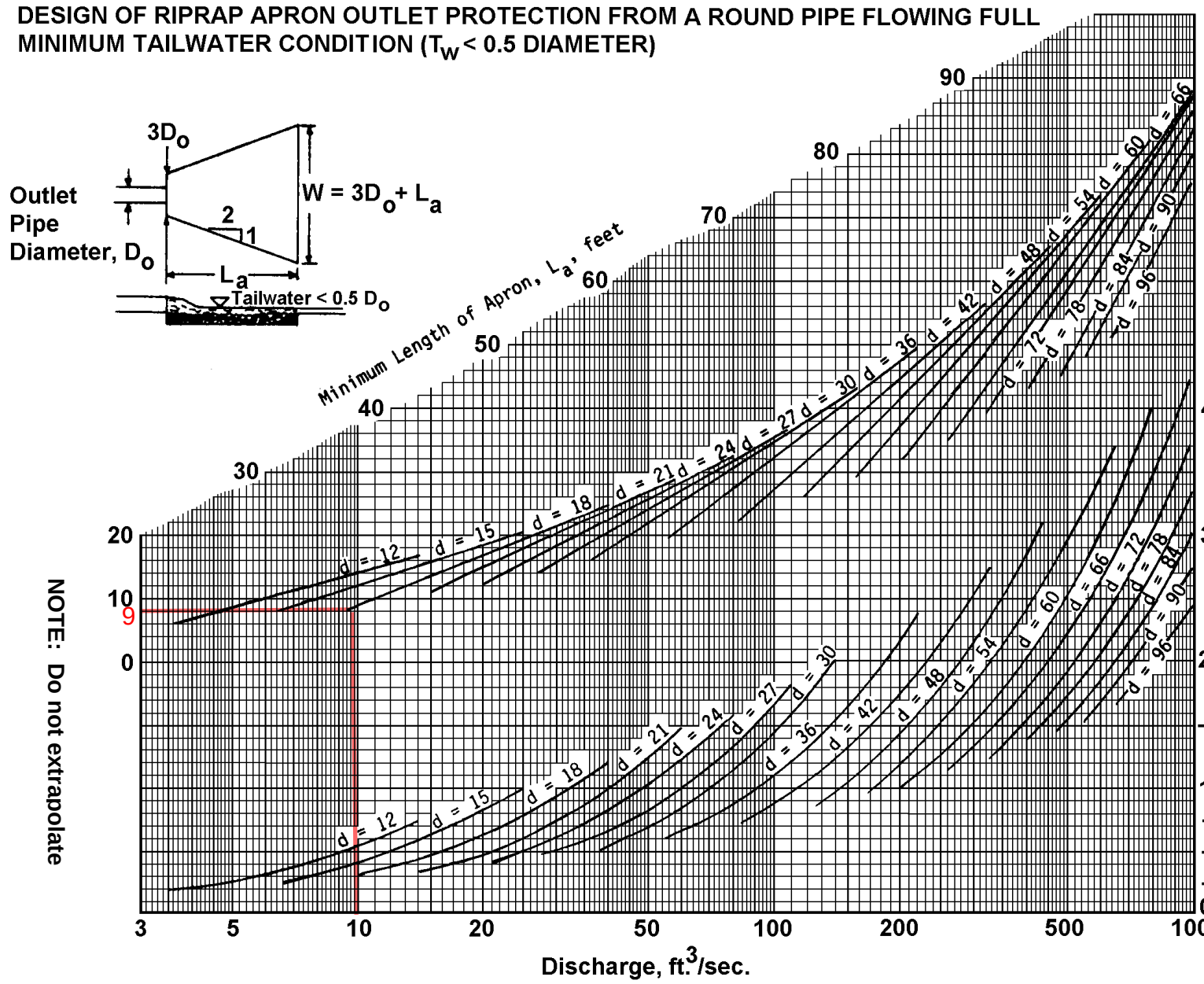


FIGURE 9.3
Riprap Apron Design, Minimum Tailwater Condition

* For discharge velocities exceeding Maximum Allowable for Riprap indicated, increase d_{50} stone size and/or provide velocity reduction device.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Moore Park
OP - EW1

TABLE 6.6
Riprap Gradation, Filter Blanket Requirements, Maximum Velocities

Percent Passing (Square Openings)						
Class, Size NO. / **Rock Size (Inches)**	**R-8**	**R-7**	**R-6**	**R-5**	**R-4**	**R-3**
42	100					
30		100				
24	15-50		100			
18		15-50		100		
15	0-15					
12		0-15	15-50		100	
9				15-50		
6			0-15		15-50	100
4				0-15		
3					0-15	15-50
2						0-15
Nominal Placement Thickness (inches)	63	45	36	27	18	9
Filter Stone[1]	AASHTO #1	AASHTO #1	AASHTO #1	AASHTO #3	AASHTO #3	AASHTO #57
V_{max} (ft/sec)	17.0	14.5	13.0	11.5	9.0	6.5

Adapted from PennDOT Pub. 408, Section 703.2(c), Table C

V @ EW-1 = 5.25 fps

1 This is a general standard. Soil conditions at each site should be analyzed to determine actual filter size. A suitable woven or non-woven geotextile underlayment, used according to the manufacturer's recommendations, may be substituted for the filter stone for gradients < 10%.

TABLE 6.7
Comparison of Various Gradations of Coarse Aggregates

Total Percent Passing															
AASHTO NUMBER	**6 ½**	**4"**	**3 ½"**	**2 ½**	**2"**	**1 ½ "**	**1"**	**3/4 "**	**1/2"**	**3/8"**	**#4**	**#8**	**#16**	**#30**	**#100**
1		100	90-100	25-60		0-15		0-5							
3				100	90-100	35-70	0-15		0-5						
5						100	90-100	20-55	0-10	0-5					
57						100	90-100		25-60		0-10	0-5			
67							100	90-100		20-55	0-10	0-5			
7								100	90-100	40-70	0-15	0-5			
8									100	85-100	10-30	0-10	0-5		
10										100	75-100				10-30

PennDOT Publication 408, Section 703.2(c), Table C

Tables 6.6 and 6.7 should be placed on the plan drawings of all sites where riprap channel linings are proposed.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Moore Park
OP - EW2

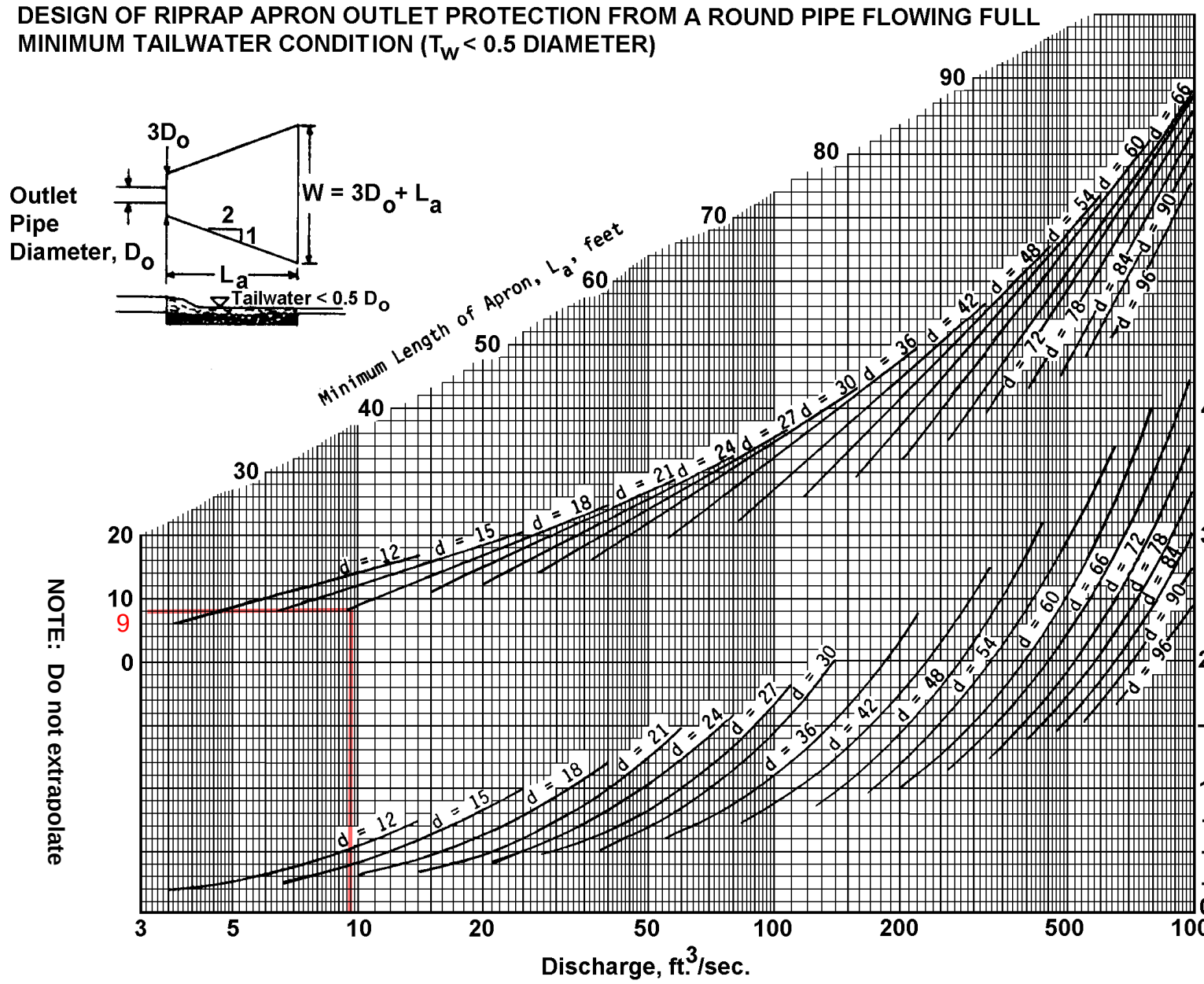


FIGURE 9.3
Riprap Apron Design, Minimum Tailwater Condition

* For discharge velocities exceeding Maximum Allowable for Riprap indicated, increase d_{50} stone size and/or provide velocity reduction device.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Moore Park
OP - EW2

TABLE 6.6
Riprap Gradation, Filter Blanket Requirements, Maximum Velocities

Percent Passing (Square Openings)						
Class, Size NO. / **Rock Size (Inches)**	**R-8**	**R-7**	**R-6**	**R-5**	**R-4**	**R-3**
42	100					
30		100				
24	15-50		100			
18		15-50		100		
15	0-15					
12		0-15	15-50		100	
9				15-50		
6			0-15		15-50	100
4				0-15		
3					0-15	15-50
2						0-15
Nominal Placement Thickness (inches)	63	45	36	27	18	9
Filter Stone[1]	AASHTO #1	AASHTO #1	AASHTO #1	AASHTO #3	AASHTO #3	AASHTO #57
V_{max} (ft/sec)	17.0	14.5	13.0	11.5	9.0	6.5

Adapted from PennDOT Pub. 408, Section 703.2(c), Table C

V @ EW-2 = 7.26 fps

1 This is a general standard. Soil conditions at each site should be analyzed to determine actual filter size. A suitable woven or non-woven geotextile underlayment, used according to the manufacturer's recommendations, may be substituted for the filter stone for gradients < 10%.

TABLE 6.7
Comparison of Various Gradations of Coarse Aggregates

Total Percent Passing															
AASHTO NUMBER	**6 ½**	**4"**	**3 ½"**	**2 ½**	**2"**	**1 ½ "**	**1"**	**3/4 "**	**1/2"**	**3/8"**	**#4**	**#8**	**#16**	**#30**	**#100**
1		100	90-100	25-60		0-15		0-5							
3				100	90-100	35-70	0-15		0-5						
5						100	90-100	20-55	0-10	0-5					
57						100	90-100		25-60		0-10	0-5			
67							100	90-100		20-55	0-10	0-5			
7								100	90-100	40-70	0-15	0-5			
8									100	85-100	10-30	0-10	0-5		
10										100	75-100				10-30

PennDOT Publication 408, Section 703.2(c), Table C

Tables 6.6 and 6.7 should be placed on the plan drawings of all sites where riprap channel linings are proposed.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Moore Park
OP - EW3

TABLE 6.6
Riprap Gradation, Filter Blanket Requirements, Maximum Velocities

Percent Passing (Square Openings)						
Class, Size NO. / **Rock Size (Inches)**	**R-8**	**R-7**	**R-6**	**R-5**	**R-4**	**R-3**
42	100					
30		100				
24	15-50		100			
18		15-50		100		
15	0-15					
12		0-15	15-50		100	
9				15-50		
6			0-15		15-50	100
4				0-15		
3					0-15	15-50
2						0-15
Nominal Placement Thickness (inches)	63	45	36	27	18	9
Filter Stone[1]	AASHTO #1	AASHTO #1	AASHTO #1	AASHTO #3	AASHTO #3	AASHTO #57
V_{max} (ft/sec)	17.0	14.5	13.0	11.5	9.0	6.5

Adapted from PennDOT Pub. 408, Section 703.2(c), Table C

V @ EW-3 = 8.93 fps

1 This is a general standard. Soil conditions at each site should be analyzed to determine actual filter size. A suitable woven or non-woven geotextile underlayment, used according to the manufacturer's recommendations, may be substituted for the filter stone for gradients < 10%.

TABLE 6.7
Comparison of Various Gradations of Coarse Aggregates

Total Percent Passing															
AASHTO NUMBER	**6 ½**	**4"**	**3 ½"**	**2 ½**	**2"**	**1 ½ "**	**1"**	**3/4 "**	**1/2"**	**3/8"**	**#4**	**#8**	**#16**	**#30**	**#100**
1		100	90-100	25-60		0-15		0-5							
3				100	90-100	35-70	0-15		0-5						
5						100	90-100	20-55	0-10	0-5					
57						100	90-100		25-60		0-10	0-5			
67							100	90-100		20-55	0-10	0-5			
7								100	90-100	40-70	0-15	0-5			
8									100	85-100	10-30	0-10	0-5		
10										100	75-100				10-30

PennDOT Publication 408, Section 703.2(c), Table C

Tables 6.6 and 6.7 should be placed on the plan drawings of all sites where riprap channel linings are proposed.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Moore Park
OP - EW3

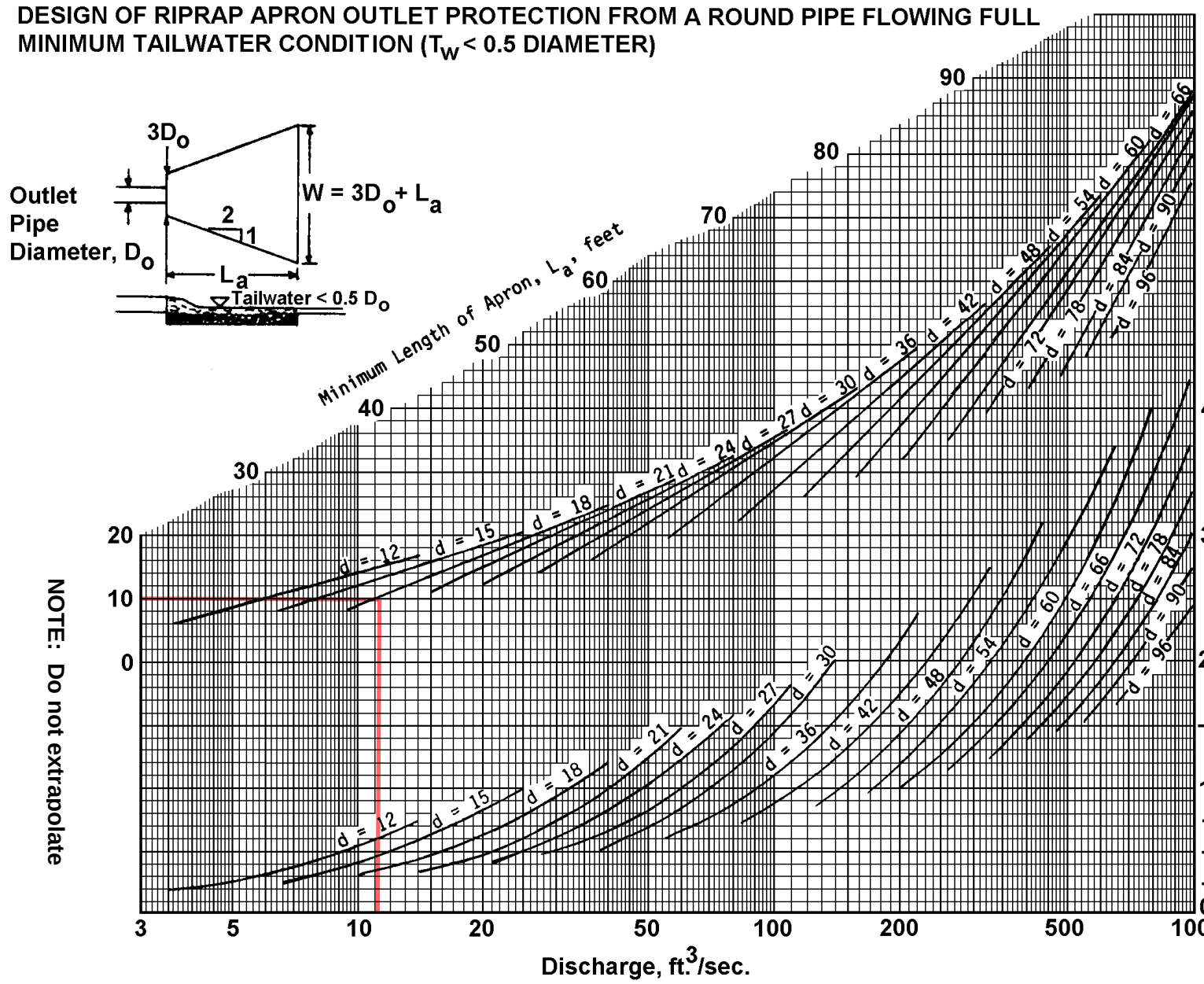


FIGURE 9.3
Riprap Apron Design, Minimum Tailwater Condition

* For discharge velocities exceeding Maximum Allowable for Riprap indicated, increase d_{50} stone size and/or provide velocity reduction device.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Moore Park
OP - EW4

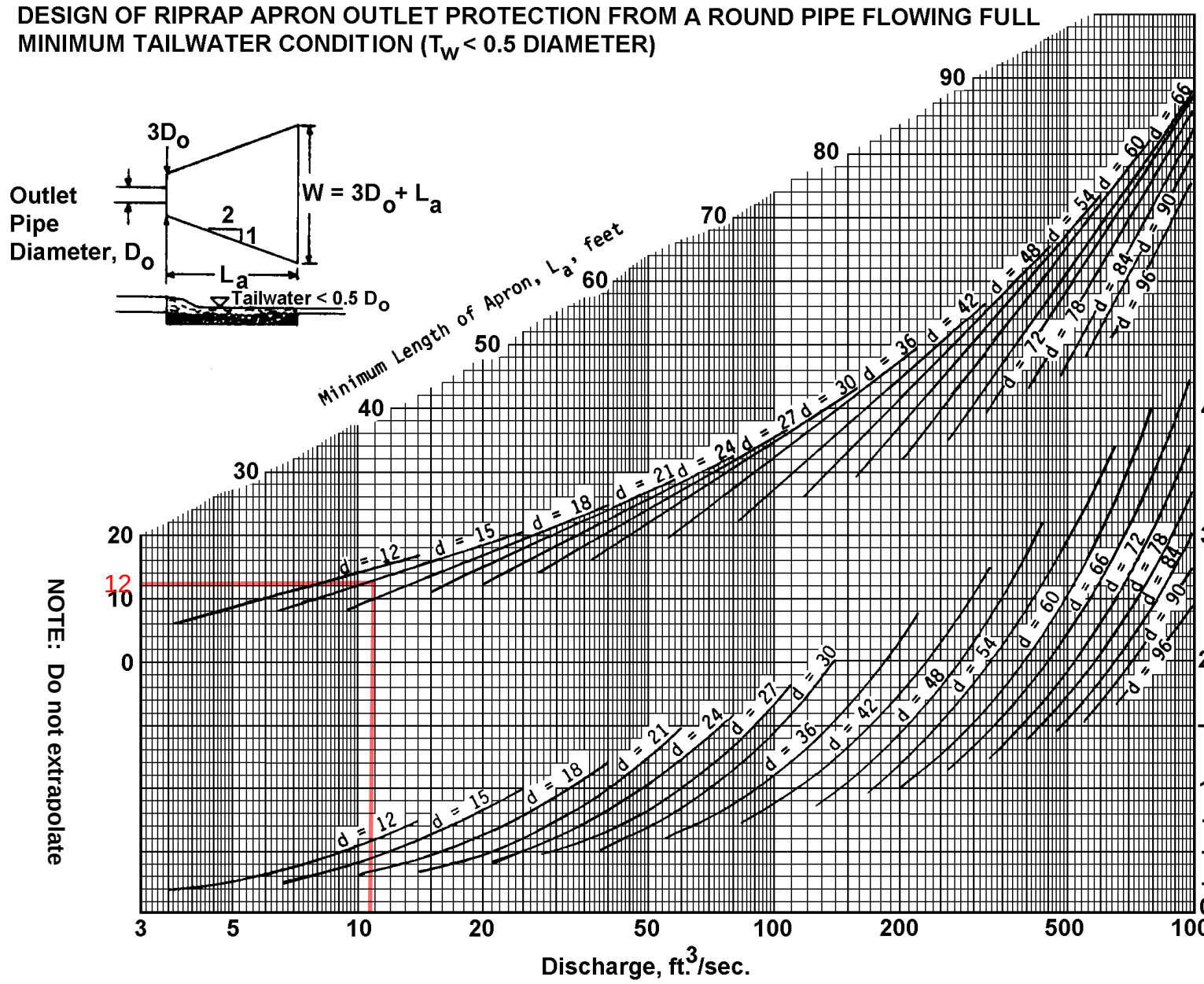


FIGURE 9.3
Riprap Apron Design, Minimum Tailwater Condition

* For discharge velocities exceeding Maximum Allowable for Riprap indicated, increase d_{50} stone size and/or provide velocity reduction device.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Moore Park
OP - EW4

TABLE 6.6
Riprap Gradation, Filter Blanket Requirements, Maximum Velocities

Percent Passing (Square Openings)						
Class, Size NO. / **Rock Size (Inches)**	**R-8**	**R-7**	**R-6**	**R-5**	**R-4**	**R-3**
42	100					
30		100				
24	15-50		100			
18		15-50		100		
15	0-15					
12		0-15	15-50		100	
9				15-50		
6			0-15		15-50	100
4				0-15		
3					0-15	15-50
2						0-15
Nominal Placement Thickness (inches)	63	45	36	27	18	9
Filter Stone[1]	AASHTO #1	AASHTO #1	AASHTO #1	AASHTO #3	AASHTO #3	AASHTO #57
V_{max} (ft/sec)	17.0	14.5	13.0	11.5	9.0	6.5

Adapted from PennDOT Pub. 408, Section 703.2(c), Table C

V @ EW-4 = 10.13 fps

1 This is a general standard. Soil conditions at each site should be analyzed to determine actual filter size. A suitable woven or non-woven geotextile underlayment, used according to the manufacturer's recommendations, may be substituted for the filter stone for gradients < 10%.

TABLE 6.7
Comparison of Various Gradations of Coarse Aggregates

Total Percent Passing															
AASHTO NUMBER	**6 ½**	**4"**	**3 ½"**	**2 ½**	**2"**	**1 ½ "**	**1"**	**3/4 "**	**1/2"**	**3/8"**	**#4**	**#8**	**#16**	**#30**	**#100**
1		100	90-100	25-60		0-15		0-5							
3				100	90-100	35-70	0-15		0-5						
5						100	90-100	20-55	0-10	0-5					
57						100	90-100		25-60		0-10	0-5			
67							100	90-100		20-55	0-10	0-5			
7								100	90-100	40-70	0-15	0-5			
8									100	85-100	10-30	0-10	0-5		
10										100	75-100				10-30

PennDOT Publication 408, Section 703.2(c), Table C

Tables 6.6 and 6.7 should be placed on the plan drawings of all sites where riprap channel linings are proposed.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Moore Park
OP - EW5

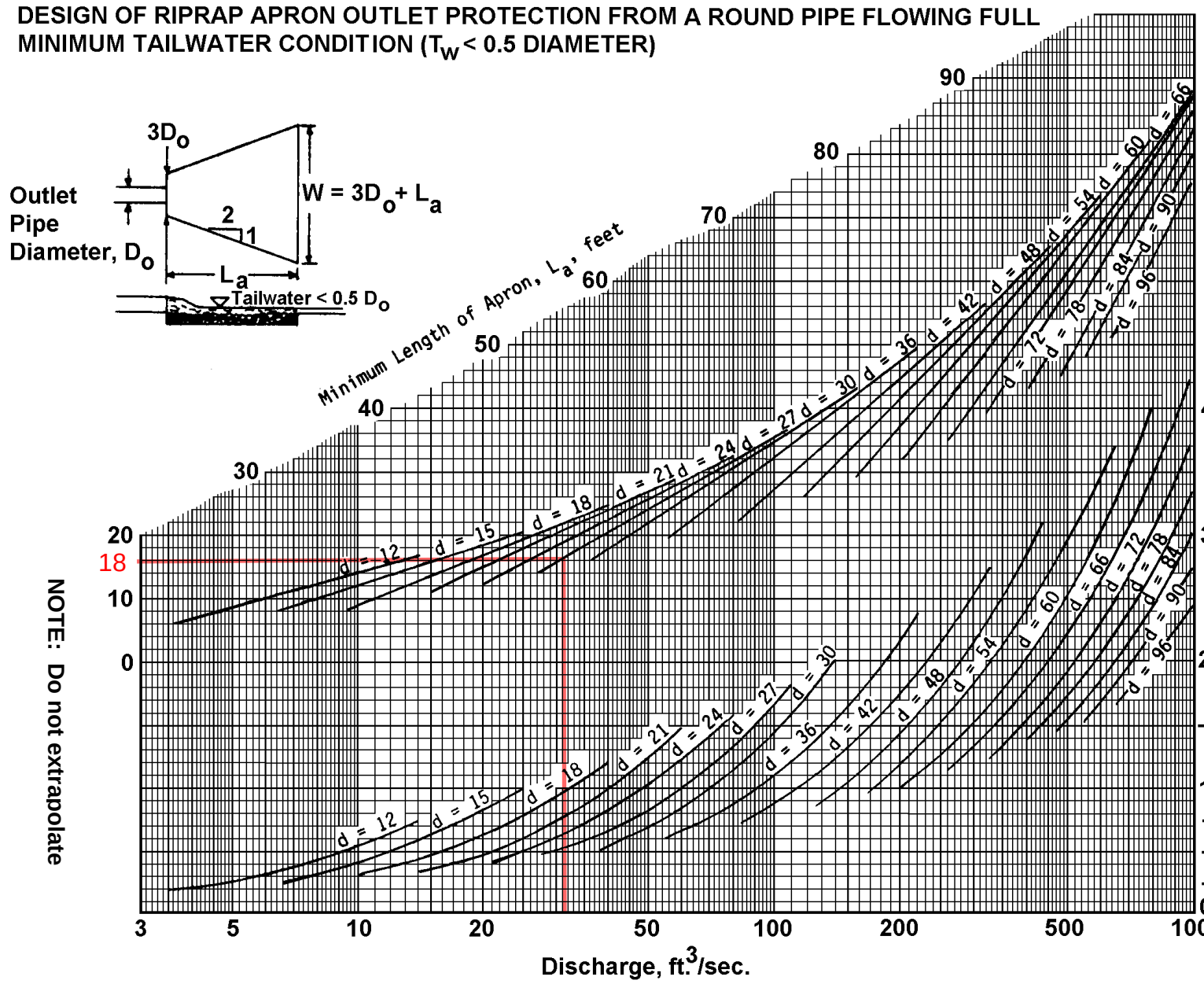


FIGURE 9.3
Riprap Apron Design, Minimum Tailwater Condition

* For discharge velocities exceeding Maximum Allowable for Riprap indicated, increase d_{50} stone size and/or provide velocity reduction device.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Moore Park
OP - EW5

TABLE 6.6
Riprap Gradation, Filter Blanket Requirements, Maximum Velocities

Percent Passing (Square Openings)						
Class, Size NO. / **Rock Size (Inches)**	**R-8**	**R-7**	**R-6**	**R-5**	**R-4**	**R-3**
42	100					
30		100				
24	15-50		100			
18		15-50		100		
15	0-15					
12		0-15	15-50		100	
9				15-50		
6			0-15		15-50	100
4				0-15		
3					0-15	15-50
2						0-15
Nominal Placement Thickness (inches)	63	45	36	27	18	9
Filter Stone[1]	AASHTO #1	AASHTO #1	AASHTO #1	AASHTO #3	AASHTO #3	AASHTO #57
V_{max} (ft/sec)	17.0	14.5	13.0	11.5	9.0	6.5

Adapted from PennDOT Pub. 408, Section 703.2(c), Table C

V @ EW-5 = 9.73 fps

1 This is a general standard. Soil conditions at each site should be analyzed to determine actual filter size. A suitable woven or non-woven geotextile underlayment, used according to the manufacturer's recommendations, may be substituted for the filter stone for gradients < 10%.

TABLE 6.7
Comparison of Various Gradations of Coarse Aggregates

Total Percent Passing															
AASHTO NUMBER	**6 ½**	**4"**	**3 ½"**	**2 ½**	**2"**	**1 ½ "**	**1"**	**3/4 "**	**1/2"**	**3/8"**	**#4**	**#8**	**#16**	**#30**	**#100**
1		100	90-100	25-60		0-15		0-5							
3				100	90-100	35-70	0-15		0-5						
5						100	90-100	20-55	0-10	0-5					
57						100	90-100		25-60		0-10	0-5			
67							100	90-100		20-55	0-10	0-5			
7								100	90-100	40-70	0-15	0-5			
8									100	85-100	10-30	0-10	0-5		
10										100	75-100				10-30

PennDOT Publication 408, Section 703.2(c), Table C

Tables 6.6 and 6.7 should be placed on the plan drawings of all sites where riprap channel linings are proposed.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Moore Park
OP - EW6

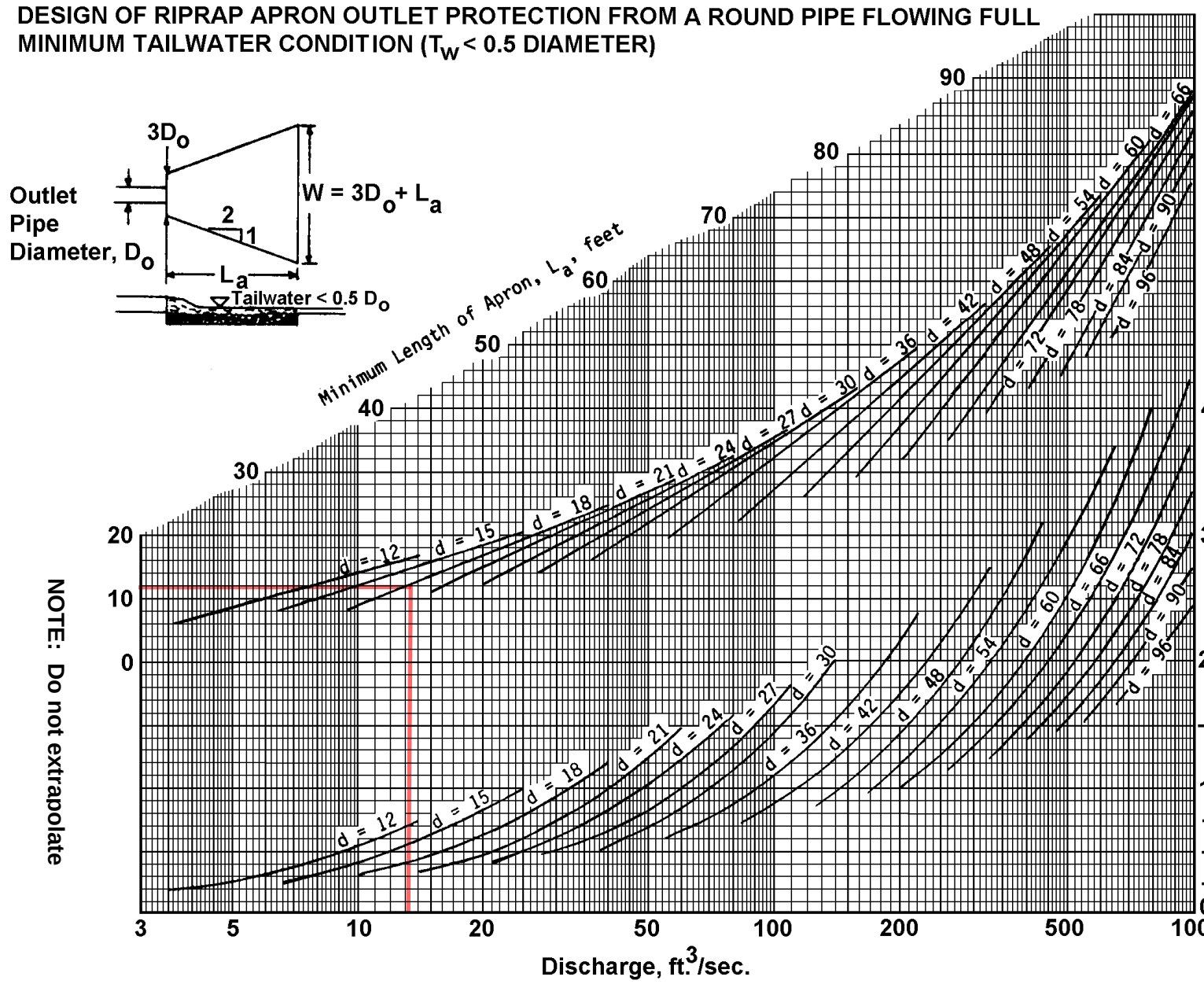


FIGURE 9.3
Riprap Apron Design, Minimum Tailwater Condition

* For discharge velocities exceeding Maximum Allowable for Riprap indicated, increase d_{50} stone size and/or provide velocity reduction device.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Moore Park
OP - EW3

TABLE 6.6
Riprap Gradation, Filter Blanket Requirements, Maximum Velocities

Percent Passing (Square Openings)						
Class, Size NO. / **Rock Size (Inches)**	**R-8**	**R-7**	**R-6**	**R-5**	**R-4**	**R-3**
42	100					
30		100				
24	15-50		100			
18		15-50		100		
15	0-15					
12		0-15	15-50		100	
9				15-50		
6			0-15		15-50	100
4				0-15		
3					0-15	15-50
2						0-15
Nominal Placement Thickness (inches)	63	45	36	27	18	9
Filter Stone[1]	AASHTO #1	AASHTO #1	AASHTO #1	AASHTO #3	AASHTO #3	AASHTO #57
V_{max} (ft/sec)	17.0	14.5	13.0	11.5	9.0	6.5

Adapted from PennDOT Pub. 408, Section 703.2(c), Table C

V @ EW-6 = 10.53 fps

1 This is a general standard. Soil conditions at each site should be analyzed to determine actual filter size. A suitable woven or non-woven geotextile underlayment, used according to the manufacturer's recommendations, may be substituted for the filter stone for gradients < 10%.

TABLE 6.7
Comparison of Various Gradations of Coarse Aggregates

Total Percent Passing															
AASHTO NUMBER	**6 ½**	**4"**	**3 ½"**	**2 ½**	**2"**	**1 ½ "**	**1"**	**3/4 "**	**1/2"**	**3/8"**	**#4**	**#8**	**#16**	**#30**	**#100**
1		100	90-100	25-60		0-15		0-5							
3				100	90-100	35-70	0-15		0-5						
5						100	90-100	20-55	0-10	0-5					
57						100	90-100		25-60		0-10	0-5			
67							100	90-100		20-55	0-10	0-5			
7								100	90-100	40-70	0-15	0-5			
8									100	85-100	10-30	0-10	0-5		
10										100	75-100				10-30

PennDOT Publication 408, Section 703.2(c), Table C

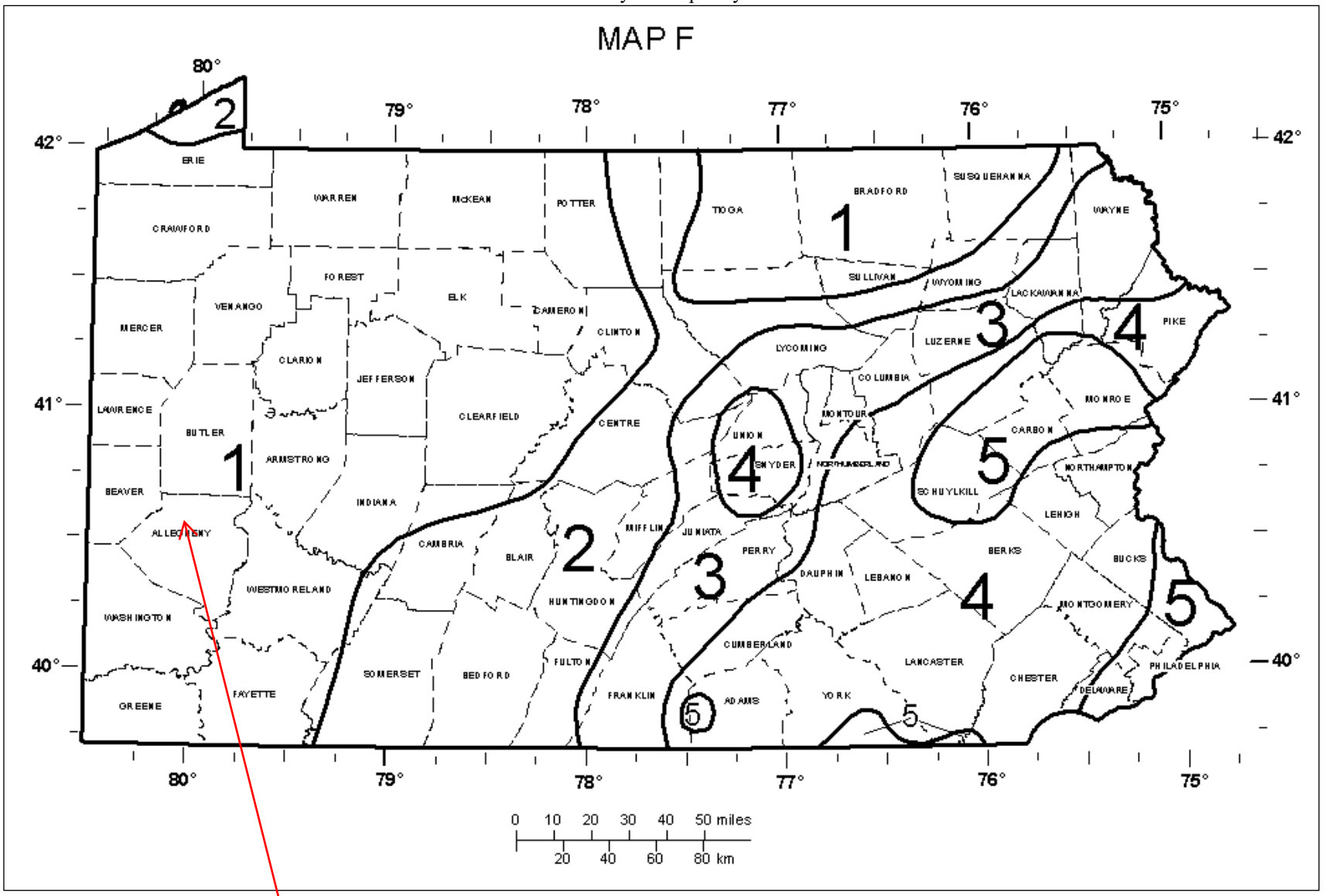
Tables 6.6 and 6.7 should be placed on the plan drawings of all sites where riprap channel linings are proposed.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

PA DESIGN RAINFALL INTENSITY

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Figure 7A.6 Map F. 12- and 24-hour durations for storms occurring with an average recurrence interval (ARI) of 1-, 2-, 5-, 10-, 25-, 50-, and 100-years and the 24-hour duration for the 500-year frequency storm.



Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

If a basin should be found to lie on the boundary between two regions, the intensities should be obtained from the two corresponding regional graphs and averaged. In the case that the basin is large enough to be divided into areas A_i and A_j of measurable size in the adjacent regions i and j, a weighted average intensity may be used.

$$I = \frac{I_i A_{i+} I_j A_j}{A_{i+} A_j}$$

Step 4 From the PDT-IDF curves for that region, determine the rainfall intensity.

The rainfall values for the five-minute through six (6) hour storms can be obtained directly from Tables 7A.2(a/b) through 7A.6(a/b) for each of the five regions or from interpolation from the PDT-IDF curves, Figures 7A.7(a/b) through 7A.16(a/b). For the twelve (12) and twenty-four (24) hour storms, the rainfall values can only be obtained directly from Tables 7A.2(a/b) through 7A.6(a/b) for each of the five regions.

Table 7A.2(a) Five (5) minute through twenty-four (24) hour storm totals for Region 1 (Metric).

Region 1								
Rainfall Total								
	1-Yr Storm	2-Yr Storm	5-Yr Storm	10-Yr Storm	25-Yr Storm	50-Yr Storm	100-Yr Storm	500-Yr Storm
Duration (Min)	cm	cm	cm	cm	cm	cm	cm	cm
5	0.70	0.83	1.00	1.13	1.29	1.39	1.47	
10	1.09	1.30	1.56	1.75	1.97	2.11	2.22	
15	1.34	1.59	1.91	2.15	2.44	2.61	2.76	
30	1.77	2.13	2.63	2.99	3.45	3.73	3.99	
60	2.16	2.62	3.30	3.81	4.48	4.92	5.33	
120	2.52	3.03	3.79	4.41	5.28	5.98	6.64	
180	2.77	3.32	4.15	4.82	5.80	6.55	7.34	
360	3.49	4.17	5.17	6.02	7.22	8.11	9.04	
720	4.30	5.14	6.33	7.38	8.93	10.09	11.32	
1440	5.18	6.19	7.59	8.74	10.40	11.80	13.30	17.11

Table 7A.2(b) Five (5) minute through twenty-four (24) hour storm totals for Region 1 (U.S. Customary).

Region 1								
Rainfall Total								
	1-Yr Storm	2-Yr Storm	5-Yr Storm	10-Yr Storm	25-Yr Storm	50-Yr Storm	100-Yr Storm	500-Yr Storm
Duration (Min)	in	in	in	in	in	in	in	in
5	0.28	0.33	0.39	0.45	0.51	0.55	0.58	
10	0.43	0.51	0.61	0.69	0.78	0.83	0.87	
15	0.53	0.63	0.75	0.85	0.96	1.03	1.09	
30	0.70	0.84	1.03	1.18	1.36	1.47	1.57	
60	0.85	1.03	1.30	1.50	1.76	1.94	2.10	
120	0.99	1.19	1.49	1.74	2.08	2.35	2.62	
180	1.09	1.31	1.63	1.90	2.28	2.58	2.89	
360	1.37	1.64	2.04	2.37	2.84	3.19	3.56	
720	1.69	2.02	2.49	2.91	3.52	3.97	4.46	
1440	2.04	2.44	2.99	3.44	4.09	4.65	5.24	6.74

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

Volume Management

Project: Moore Park MS4

Instructions | General | *Volume* | Rate | Quality

2-Year / 24-Hour Storm Event (NOAA Atlas 14): **3.9** inches

Alternative 2-Year / 24-Hour Storm Event _____ inches

Alternative Source: _____

Pre-Construction Conditions: *No. Rows:* **2** ▪ *Exempt from Meadow in Good Condition* ▪ *Automatically Calculate CN, Ia, Runoff and Volume*

Land Cover	Area (acres)	Soil Group	CN	Ia (in)	Q Runoff (in)	Runoff Volume (cf)
Open Space (Lawns, Parks, Golf Courses, Cemeteries, Etc.) - Good Condition (Grass Cover > 75%)	4.94	D	80	0.500	1.96	35,135
Woods (Good Condition)	46.06	B	55	1.636	0.49	82,019
TOTAL (ACRES):	**51.00**				**TOTAL (CF):**	**117,154**

Post-Construction Conditions: *No. Rows:* _____

Land Cover	Area (acres)	Soil Group	CN	Ia (in)	Q Runoff (in)	Runoff Volume (cf)
TOTAL (ACRES):	**0.00**				**TOTAL (CF):**	**0**

NET CHANGE IN VOLUME TO MANAGE (CF): **-117,154**

Non-Structural BMP Volume Credits:

- ▪ Tree Planting Credit
- ▪ Other (attach calculations):

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Structural BMP Volume Credits: *No. Structural BMPs:* *Start BMP Numbering at:*

DP No.	BMP No.	BMP Name	MRC?	Discharge	Incremental BMP DA (acres)	Volume Routed to BMP (CF)	Infiltration / Vegetated Area (SF)	Infiltration Rate (in/hr)	Infiltration Period (hrs)	Vegeta-ted?	Media Depth (ft)	Storage Volume (CF)	Infiltration Credit (CF)	ET Credit (CF)
												Totals:		

INFILTRATION & ET CREDITS (CF):	
NET CHANGE IN VOLUME TO MANAGE (CF):	**-117,154**
TOTAL CREDITS (CF):	

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

Volume Management

Project: Moore Park MS4

Instructions | General | *Volume* | Rate | Quality

2-Year / 24-Hour Storm Event (NOAA Atlas 14): **3.3** inches

Alternative 2-Year / 24-Hour Storm Event _____ inches

Alternative Source: _____

Pre-Construction Conditions: *No. Rows:* **2** ▪ *Exempt from Meadow in Good Condition* ▪ *Automatically Calculate CN, Ia, Runoff and Volume*

Land Cover	Area (acres)	Soil Group	CN	Ia (in)	Q Runoff (in)	Runoff Volume (cf)
Open Space (Lawns, Parks, Golf Courses, Cemeteries, Etc.) - Good Condition (Grass Cover > 75%)	4.94	D	80	0.500	1.48	26,526
Woods (Good Condition)	46.06	B	55	1.636	0.28	47,001
TOTAL (ACRES):	**51.00**				**TOTAL (CF):**	**73,528**

Post-Construction Conditions: *No. Rows:* _____

Land Cover	Area (acres)	Soil Group	CN	Ia (in)	Q Runoff (in)	Runoff Volume (cf)
TOTAL (ACRES):	**0.00**				**TOTAL (CF):**	**0**

NET CHANGE IN VOLUME TO MANAGE (CF): **-73,528**

Non-Structural BMP Volume Credits:

- ▪ Tree Planting Credit
- ▪ Other (attach calculations):

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Structural BMP Volume Credits: *No. Structural BMPs:* *Start BMP Numbering at:*

DP No.	BMP No.	BMP Name	MRC?	Discharge	Incremental BMP DA (acres)	Volume Routed to BMP (CF)	Infiltration / Vegetated Area (SF)	Infiltration Rate (in/hr)	Infiltration Period (hrs)	Vegeta-ted?	Media Depth (ft)	Storage Volume (CF)	Infiltration Credit (CF)	ET Credit (CF)
												Totals:		

INFILTRATION & ET CREDITS (CF):	
NET CHANGE IN VOLUME TO MANAGE (CF):	**-73,528**
TOTAL CREDITS (CF):	

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

Volume Management

Project: Moore Park MS4

Instructions | General | *Volume* | Rate | Quality

2-Year / 24-Hour Storm Event (NOAA Atlas 14): **1.97** inches

Alternative 2-Year / 24-Hour Storm Event _____ inches

Alternative Source: _____

Pre-Construction Conditions: *No. Rows:* **2** ▪ *Exempt from Meadow in Good Condition* ▪ *Automatically Calculate CN, Ia, Runoff and Volume*

Land Cover	Area (acres)	Soil Group	CN	Ia (in)	Q Runoff (in)	Runoff Volume (cf)
Open Space (Lawns, Parks, Golf Courses, Cemeteries, Etc.) - Good Condition (Grass Cover > 75%)	4.94	D	80	0.500	0.54	9,761
Woods (Good Condition)	46.06	B	55	1.636	0.01	2,186
TOTAL (ACRES):	**51.00**				**TOTAL (CF):**	**11,946**

Post-Construction Conditions: *No. Rows:* **1**

Land Cover	Area (acres)	Soil Group	CN	Ia (in)	Q Runoff (in)	Runoff Volume (cf)
TOTAL (ACRES):	**0.00**				**TOTAL (CF):**	**0**

NET CHANGE IN VOLUME TO MANAGE (CF): **-11,946**

Non-Structural BMP Volume Credits:

- ▪ Tree Planting Credit
- ▪ Other (attach calculations):

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Structural BMP Volume Credits: *No. Structural BMPs:* *Start BMP Numbering at:*

DP No.	BMP No.	BMP Name	MRC?	Discharge	Incremental BMP DA (acres)	Volume Routed to BMP (CF)	Infiltration / Vegetated Area (SF)	Infiltration Rate (in/hr)	Infiltration Period (hrs)	Vegeta-ted?	Media Depth (ft)	Storage Volume (CF)	Infiltration Credit (CF)	ET Credit (CF)
												Totals:		

INFILTRATION & ET CREDITS (CF):	
NET CHANGE IN VOLUME TO MANAGE (CF):	**-11,946**
TOTAL CREDITS (CF):	

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Appendix E: Anticipated Project Schedule

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Sawmill Run/ Deer Creek MS4 Schedule:

	Milestone Activity	**Milestone Date (on or before)**
1.	Conceptual PRP submitted to PennDOT	August, 2022
2.	Final PRP submitted to PennDOT	December 15, 2022
3.	Federal, State, and Local permits submission	January 2023
4.	Begin BMP construction	May 2023
5.	25% construction complete	August 2023
6.	50% construction complete	September 2023
7.	100% construction complete	December 2023
8.	As-built Plans	January 2024
9.	Post-Construction monitoring begins	January 2024
10.	Post-Construction Monitoring	July 1, 2024
11.	Required Sediment Reduction Approval	January 2025
12.	Post-Construction Monitoring	July 1, 2025
13.	Post-Construction Monitoring	July 1, 2026
14.	Post-Construction Monitoring	July 1, 2027
15.	Post-Construction Monitoring	July 1, 2028
16.	Post-Construction Monitoring Ends	November 2028
17.	End of Post-Construction	December 2028

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Appendix F: Soil Bulk Density Lab Results

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

ACKENHEIL ENGINEERS, INC.
GEOTECHNICAL · CIVIL · INSPECTION · TESTING
1000 Banksville Road, Pittsburgh, Pennsylvania 15216
Phone 412-531-7111 · Fax 412-531-4334 · www.ackenheil.com

Unit Weight of Density

ASTM D 7263 (Method B)

Project: Moore Park **Date:** 5/16/2022

AE Client: Hunt Valley Environmental **Project No.:** 22501

Boring	Sample Number	Depth	USCS	Moisture Content	Average Length (in)	Average Diameter (in)	Volume (ft^3)	Weight (lb)	Wet Unit Weight (pcf)	Dry Unit Weight (pcf)
SP-1	S-1	16"		39.8%	6.025	2.050	0.0115	1.158	100.7	72.0
SP-2	S-1	24"		19.1%	6.025	2.050	0.0115	1.404	122.1	102.5
SP-3	S-1	50"		22.2%	6.025	2.050	0.0115	1.160	100.8	82.5
SP-4	S-1	48"		20.6%	6.025	2.050	0.0115	1.370	119.1	98.8
SP-5	S-1	20"		27.6%	6.025	2.050	0.0115	1.322	114.9	90.1

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

ACKENHEIL ENGINEERS, INC.
GEOTECHNICAL · CIVIL · INSPECTION · TESTING
1000 Banksville Road, Pittsburgh, Pennsylvania 15216
Phone 412-531-7111 · Fax 412-531-4334 · www.ackenheil.com

Unit Weight of Density

ASTM D 7263 (Method B)

Project: Crane Avenue **Date:** 5/16/2022

AE Client: Hunt Valley Environmental **Project No.:** 22501

Boring	Sample Number	Depth	USCS	Moisture Content	Average Length (in)	Average Diameter (in)	Volume (ft^3)	Weight (lb)	Wet Unit Weight (pcf)	Dry Unit Weight (pcf)
CA-Sp1	S-1			22.2%	6.025	2.050	0.0115	1.514	131.6	107.7
CA-Sp2	S-1			29.8%	6.025	2.050	0.0115	1.222	106.2	81.8
CA-Sp3	S-1			13.7%	6.025	2.050	0.0115	1.530	133.0	117.0
CA-Sp4	S-1			30.1%	6.025	2.050	0.0115	1.354	117.7	90.5

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

United States Department of Agriculture

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for Allegheny County, Pennsylvania



October 13, 2022

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD). To file a complaint of discrimination, write to USDA, Director, Office of Civil Rights, 1400 Independence Avenue, S.W., Washington, D.C. 20250-9410 or call (800) 795-3272 (voice) or (202) 720-6382 (TDD). USDA is an equal opportunity provider and employer.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Contents

Preface.....2
Soil Map.....5
Soil Map.....6
Legend.....7
Map Unit Legend.....8
Map Unit Descriptions.....8
Allegheny County, Pennsylvania.....10
At—Atkins silt loam, 0 to 3 percent slopes, frequently flooded.....10
CaC—Cavode silt loam, 8 to 15 percent slopes.....11
ErB—Ernest silt loam, 3 to 8 percent slopes.....12
GlD—Gilpin silt loam, 15 to 25 percent slopes.....14
GSF—Gilpin, Weikert, Culleoka channery silt loams and 25 to 80 percent slopes.....15
Ph—Philo silt loam, 0 to 3 percent slopes, occasionally flooded.....18
WhC—Wharton silt loam, 8 to 15 percent slopes.....19
WhD—Wharton silt loam, 15 to 25 percent slopes.....21
Soil Information for All Uses.....23
Soil Properties and Qualities.....23
Soil Physical Properties.....23
Bulk Density, One-Third Bar.....23
References.....27

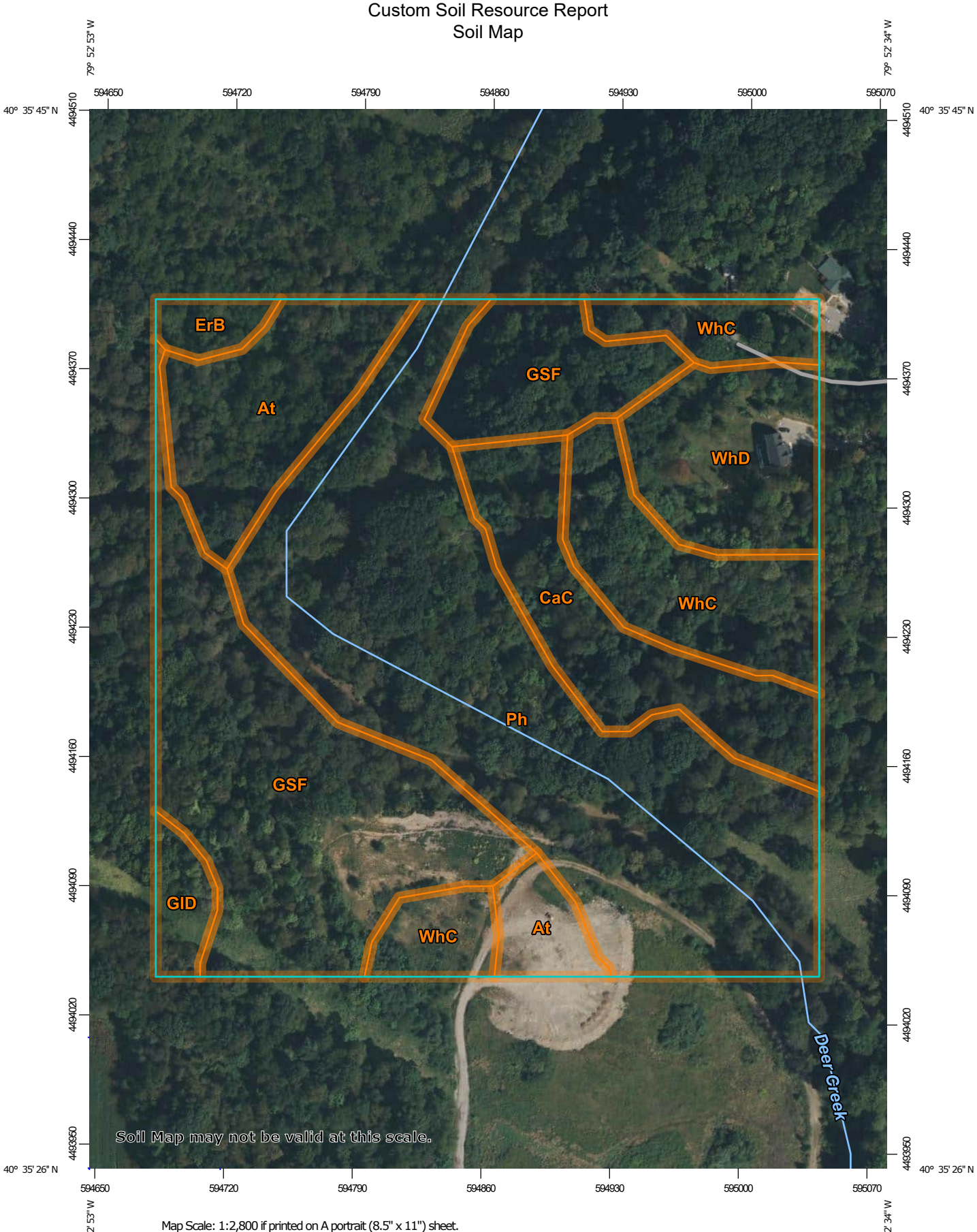
Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Custom Soil Resource Report
Soil Map



Map Scale: 1:2,800 if printed on A portrait (8.5" x 11") sheet.

N

Meters: 0 40 80 160 240

Feet: 0 100 200 400 600

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 17N WGS84

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:15,800.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Allegheny County, Pennsylvania
Survey Area Data: Version 18, Sep 6, 2022

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Sep 11, 2021—Nov 16, 2021

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
At	Atkins silt loam, 0 to 3 percent slopes, frequently flooded	3.2	9.9%
CaC	Cavode silt loam, 8 to 15 percent slopes	2.9	8.8%
ErB	Ernest silt loam, 3 to 8 percent slopes	0.4	1.3%
GlD	Gilpin silt loam, 15 to 25 percent slopes	0.6	1.7%
GSF	Gilpin, Weikert, Culleoka channery silt loams and 25 to 80 percent slopes	8.2	24.8%
Ph	Philo silt loam, 0 to 3 percent slopes, occasionally flooded	11.1	33.6%
WhC	Wharton silt loam, 8 to 15 percent slopes	4.1	12.5%
WhD	Wharton silt loam, 15 to 25 percent slopes	2.4	7.3%
Totals for Area of Interest		**32.9**	**100.0%**

Map Unit Descriptions

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

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

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Allegheny County, Pennsylvania

At—Atkins silt loam, 0 to 3 percent slopes, frequently flooded

Map Unit Setting

National map unit symbol: 2t328
Elevation: 680 to 2,110 feet
Mean annual precipitation: 37 to 58 inches
Mean annual air temperature: 46 to 52 degrees F
Frost-free period: 155 to 204 days
Farmland classification: Not prime farmland

Map Unit Composition

Atkins and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Atkins

Setting

Landform: Flood plains
Landform position (three-dimensional): Talf
Down-slope shape: Concave
Across-slope shape: Concave
Parent material: Recent fine-loamy alluvium derived from sandstone and shale over old fine-silty alluvium derived from sedimentary rock

Typical profile

Ap - 0 to 8 inches: silt loam
Bg1 - 8 to 12 inches: silt loam
Bg2 - 12 to 20 inches: silt loam
Bg3 - 20 to 34 inches: loam
Cg1 - 34 to 44 inches: loam
2Cg2 - 44 to 60 inches: silty clay loam

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.57 in/hr)
Depth to water table: About 5 to 8 inches
Frequency of flooding: NoneFrequent
Frequency of ponding: Frequent
Available water supply, 0 to 60 inches: Very high (about 12.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3w
Hydrologic Soil Group: B/D
Ecological site: F124XY008OH - Wet Floodplain and Drainageway
Hydric soil rating: Yes

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Minor Components

Philo

Percent of map unit: 10 percent
Landform: Flood plains
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

Ernest

Percent of map unit: 5 percent
Landform: Hillslopes
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Head slope
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: No

CaC—Cavode silt loam, 8 to 15 percent slopes

Map Unit Setting

National map unit symbol: 2wdpd
Elevation: 770 to 1,990 feet
Mean annual precipitation: 38 to 50 inches
Mean annual air temperature: 46 to 51 degrees F
Frost-free period: 110 to 195 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Cavode and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Cavode

Setting

Landform: Hillslopes
Landform position (two-dimensional): Summit, shoulder, backslope
Landform position (three-dimensional): Interfluve, side slope
Down-slope shape: Concave, convex, linear
Across-slope shape: Concave, linear
Parent material: Acid clayey residuum weathered from clayey shale

Typical profile

Ap - 0 to 10 inches: silt loam
Btg - 10 to 47 inches: silty clay loam
BCg - 47 to 57 inches: channery silt loam
R - 57 to 67 inches: bedrock

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Properties and qualities

Slope: 8 to 15 percent
Depth to restrictive feature: 40 to 80 inches to lithic bedrock
Drainage class: Somewhat poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 6 to 18 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: High (about 9.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: C/D
Ecological site: F124XY002OH - Acid Mixed Sedimentary Upland
Hydric soil rating: No

Minor Components

Gilpin

Percent of map unit: 10 percent
Landform: Hillslopes
Landform position (two-dimensional): Summit, shoulder, backslope
Landform position (three-dimensional): Interfluve, side slope
Down-slope shape: Convex
Across-slope shape: Linear, convex
Hydric soil rating: No

Brinkerton

Percent of map unit: 5 percent
Landform: Hillslopes
Landform position (two-dimensional): Footslope, toeslope
Landform position (three-dimensional): Base slope, head slope
Down-slope shape: Concave, linear
Across-slope shape: Concave, linear
Hydric soil rating: Yes

ErB—Ernest silt loam, 3 to 8 percent slopes

Map Unit Setting

National map unit symbol: 2t32b
Elevation: 690 to 2,230 feet
Mean annual precipitation: 37 to 55 inches
Mean annual air temperature: 47 to 52 degrees F
Frost-free period: 155 to 191 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Ernest and similar soils: 85 percent

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Ernest

Setting

Landform: Hillslopes
Landform position (two-dimensional): Footslope, toeslope
Landform position (three-dimensional): Head slope, base slope
Down-slope shape: Concave, linear
Across-slope shape: Concave
Parent material: Fine-loamy colluvium derived from sedimentary rock

Typical profile

Ap - 0 to 8 inches: silt loam
Bt1 - 8 to 15 inches: silt loam
Bt2 - 15 to 24 inches: silt loam
Btx1 - 24 to 36 inches: channery silt loam
Btx2 - 36 to 50 inches: channery silt loam
C - 50 to 74 inches: channery silt loam

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: 23 to 28 inches to fragipan
Drainage class: Moderately well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.60 in/hr)
Depth to water table: About 15 to 22 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 4.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: C/D
Ecological site: F124XY002OH - Acid Mixed Sedimentary Upland
Hydric soil rating: No

Minor Components

Gilpin

Percent of map unit: 5 percent
Landform: Hillslopes
Landform position (two-dimensional): Backslope, footslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Linear, convex
Hydric soil rating: No

Buchanan

Percent of map unit: 5 percent
Landform: Hillslopes
Landform position (two-dimensional): Footslope, toeslope
Landform position (three-dimensional): Head slope, base slope
Down-slope shape: Concave, linear
Across-slope shape: Concave

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Hydric soil rating: No

Brinkerton

Percent of map unit: 5 percent
Landform: Hillslopes
Landform position (two-dimensional): Footslope, toeslope
Landform position (three-dimensional): Head slope, base slope
Down-slope shape: Concave
Across-slope shape: Concave
Other vegetative classification: Wetlands (W3)
Hydric soil rating: Yes

GID—Gilpin silt loam, 15 to 25 percent slopes

Map Unit Setting

National map unit symbol: 2t1ky
Elevation: 570 to 3,590 feet
Mean annual precipitation: 37 to 57 inches
Mean annual air temperature: 46 to 56 degrees F
Frost-free period: 162 to 201 days
Farmland classification: Not prime farmland

Map Unit Composition

Gilpin and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Gilpin

Setting

Landform: Hillslopes
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Linear, convex
Parent material: Residuum weathered from sandstone and siltstone

Typical profile

A - 0 to 3 inches: silt loam
BA - 3 to 5 inches: silt loam
Bt - 5 to 30 inches: channery silty clay loam
Cr - 30 to 40 inches: bedrock

Properties and qualities

Slope: 15 to 25 percent
Depth to restrictive feature: 25 to 37 inches to paralithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.20 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 4.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: C
Ecological site: F126XY004OH - Side Slope
Forage suitability group: Unnamed (G126XYF-1OH)
Other vegetative classification: Unnamed (G126XYF-1OH)
Hydric soil rating: No

Minor Components

Berks

Percent of map unit: 5 percent
Landform: Hillslopes
Landform position (two-dimensional): Shoulder, backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex, linear
Across-slope shape: Linear, concave, convex
Hydric soil rating: No

Coolville

Percent of map unit: 5 percent
Landform: Hillslopes
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Convex
Other vegetative classification: Fertile Loams (FL3)
Hydric soil rating: No

Coshocton

Percent of map unit: 5 percent
Landform: Hillslopes
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Linear
Hydric soil rating: No

GSF—Gilpin, Weikert, Culleoka channery silt loams and 25 to 80 percent slopes

Map Unit Setting

National map unit symbol: 2wds4
Elevation: 730 to 1,380 feet
Mean annual precipitation: 37 to 41 inches
Mean annual air temperature: 50 to 52 degrees F
Frost-free period: 179 to 206 days

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Farmland classification: Not prime farmland

Map Unit Composition

Gilpin and similar soils: 35 percent
Weikert and similar soils: 30 percent
Culleoka and similar soils: 25 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Gilpin

Setting

Landform: Hillslopes
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Head slope, nose slope, side slope
Down-slope shape: Linear
Across-slope shape: Convex, linear
Parent material: Acid fine-loamy residuum weathered from shale and siltstone

Typical profile

Oi - 0 to 1 inches: slightly decomposed plant material
A - 1 to 8 inches: channery silt loam
Bt - 8 to 24 inches: channery silt loam
C - 24 to 33 inches: extremely channery loam
R - 33 to 43 inches: bedrock

Properties and qualities

Slope: 25 to 80 percent
Depth to restrictive feature: 30 to 36 inches to lithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.20 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 4.5 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: C
Ecological site: F126XY004OH - Side Slope
Hydric soil rating: No

Description of Weikert

Setting

Landform: Hillslopes
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Head slope, nose slope, side slope
Down-slope shape: Linear
Across-slope shape: Convex, linear
Parent material: Acid loamy residuum weathered from shale

Typical profile

Oi - 0 to 1 inches: slightly decomposed plant material
A - 1 to 7 inches: channery silt loam

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Bw - 7 to 15 inches: very channery silt loam
C - 15 to 17 inches: extremely channery silt loam
R - 17 to 26 inches: bedrock

Properties and qualities

Slope: 25 to 80 percent
Depth to restrictive feature: 14 to 19 inches to lithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.20 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Very low (about 2.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: D
Ecological site: F126XY004OH - Side Slope
Hydric soil rating: No

Description of Culleoka

Setting

Landform: Hillslopes
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Head slope, nose slope, side slope
Down-slope shape: Linear
Across-slope shape: Convex, linear
Parent material: Nonacid fine-loamy residuum weathered from sandstone and shale

Typical profile

Oi - 0 to 1 inches: slightly decomposed plant material
A - 1 to 10 inches: channery silt loam
Bt - 10 to 19 inches: channery silt loam
BC - 19 to 26 inches: very channery silt loam
C - 26 to 31 inches: very channery silt loam
R - 31 to 41 inches: bedrock

Properties and qualities

Slope: 25 to 80 percent
Depth to restrictive feature: 24 to 40 inches to lithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.20 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 3.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: B
Ecological site: F126XY004OH - Side Slope

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Hydric soil rating: No

Minor Components

Wharton

Percent of map unit: 5 percent
Landform: Hillslopes
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Head slope, nose slope, side slope
Down-slope shape: Linear
Across-slope shape: Convex, linear
Hydric soil rating: No

Hazleton

Percent of map unit: 5 percent
Landform: Hillslopes
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Head slope, nose slope, side slope
Down-slope shape: Linear
Across-slope shape: Convex, linear
Hydric soil rating: No

Ph—Philo silt loam, 0 to 3 percent slopes, occasionally flooded

Map Unit Setting

National map unit symbol: 2t335
Elevation: 720 to 1,760 feet
Mean annual precipitation: 40 to 50 inches
Mean annual air temperature: 46 to 53 degrees F
Frost-free period: 155 to 201 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Philo and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Philo

Setting

Landform: Flood plains
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Recent coarse-loamy alluvium derived from sandstone and shale over old sandy and gravelly alluvium derived from sandstone

Typical profile

Ap - 0 to 6 inches: silt loam

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Bw1 - 6 to 16 inches: silt loam
Bw2 - 16 to 22 inches: silt loam
Cg1 - 22 to 32 inches: silt loam
Cg2 - 32 to 42 inches: loam
2C3 - 42 to 60 inches: stratified gravelly sand to gravel

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Moderately well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: About 15 to 19 inches
Frequency of flooding: OccasionalNone
Frequency of ponding: None
Available water supply, 0 to 60 inches: Moderate (about 8.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2w
Hydrologic Soil Group: B/D
Ecological site: F126XY006OH - Well Drained Floodplain
Forage suitability group: Unnamed (G124XYA-5OH)
Other vegetative classification: Unnamed (G124XYA-5OH)
Hydric soil rating: No

Minor Components

Pope

Percent of map unit: 5 percent
Landform: Flood plains
Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

Atkins

Percent of map unit: 5 percent
Landform: Flood plains
Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Concave
Hydric soil rating: Yes

WhC—Wharton silt loam, 8 to 15 percent slopes

Map Unit Setting

National map unit symbol: 2t5mm
Elevation: 620 to 2,160 feet
Mean annual precipitation: 37 to 51 inches
Mean annual air temperature: 47 to 53 degrees F

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Frost-free period: 161 to 205 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Wharton and similar soils: 80 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Wharton

Setting

Landform: Hills
Landform position (two-dimensional): Shoulder, backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Linear
Parent material: Fine-loamy residuum weathered from shale and siltstone

Typical profile

Ap - 0 to 9 inches: silt loam
Bt1 - 9 to 16 inches: silt loam
Bt2 - 16 to 22 inches: silt loam
Bt3 - 22 to 31 inches: silt loam
BC - 31 to 46 inches: silty clay loam
C - 46 to 69 inches: channery silty clay loam
Cr - 69 to 79 inches: bedrock

Properties and qualities

Slope: 8 to 15 percent
Depth to restrictive feature: 40 to 71 inches to paralithic bedrock
Drainage class: Moderately well drained
Capacity of the most limiting layer to transmit water (Ksat): Very low (0.00 to 0.00 in/hr)
Depth to water table: About 16 to 28 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: High (about 9.5 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: C/D
Ecological site: F126XY003OH - Moist Ridge
Forage suitability group: Unnamed (G126XYA-6OH)
Other vegetative classification: Unnamed (G126XYA-6OH)
Hydric soil rating: No

Minor Components

Gilpin

Percent of map unit: 10 percent
Landform: Hillslopes
Landform position (two-dimensional): Shoulder, backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Linear, convex
Hydric soil rating: No

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Ernest

Percent of map unit: 5 percent
Landform: Hillslopes
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Base slope
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: No

Rarden

Percent of map unit: 5 percent
Landform: Hills
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Convex
Across-slope shape: Linear
Hydric soil rating: No

WhD—Wharton silt loam, 15 to 25 percent slopes

Map Unit Setting

National map unit symbol: 2t5mn
Elevation: 520 to 1,890 feet
Mean annual precipitation: 37 to 51 inches
Mean annual air temperature: 47 to 54 degrees F
Frost-free period: 163 to 207 days
Farmland classification: Not prime farmland

Map Unit Composition

Wharton and similar soils: 80 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Wharton

Setting

Landform: Hills
Landform position (two-dimensional): Shoulder, backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Fine-loamy residuum weathered from shale and siltstone

Typical profile

Ap - 0 to 9 inches: silt loam
Bt1 - 9 to 16 inches: silt loam
Bt2 - 16 to 22 inches: silt loam
Bt3 - 22 to 31 inches: silt loam
BC - 31 to 46 inches: silty clay loam
C - 46 to 69 inches: channery silty clay loam

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Cr - 69 to 79 inches: bedrock

Properties and qualities

Slope: 15 to 25 percent
Depth to restrictive feature: 40 to 71 inches to paralithic bedrock
Drainage class: Moderately well drained
Capacity of the most limiting layer to transmit water (Ksat): Very low (0.00 to 0.00 in/hr)
Depth to water table: About 16 to 28 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: High (about 9.5 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: C/D
Ecological site: F124XY002OH - Acid Mixed Sedimentary Upland, F126XY004OH - Side Slope
Forage suitability group: Unnamed (G126XYA-2OH)
Other vegetative classification: Unnamed (G126XYA-2OH)
Hydric soil rating: No

Minor Components

Gilpin

Percent of map unit: 8 percent
Landform: Hillslopes
Landform position (two-dimensional): Shoulder, backslope
Landform position (three-dimensional): Nose slope, side slope
Down-slope shape: Convex
Across-slope shape: Linear, convex
Hydric soil rating: No

Ernest

Percent of map unit: 7 percent
Landform: Hillslopes
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Base slope
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: No

Rarden

Percent of map unit: 5 percent
Landform: Hills
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Convex
Across-slope shape: Linear
Hydric soil rating: No

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Soil Information for All Uses

Soil Properties and Qualities

The Soil Properties and Qualities section includes various soil properties and qualities displayed as thematic maps with a summary table for the soil map units in the selected area of interest. A single value or rating for each map unit is generated by aggregating the interpretive ratings of individual map unit components. This aggregation process is defined for each property or quality.

Soil Physical Properties

Soil Physical Properties are measured or inferred from direct observations in the field or laboratory. Examples of soil physical properties include percent clay, organic matter, saturated hydraulic conductivity, available water capacity, and bulk density.

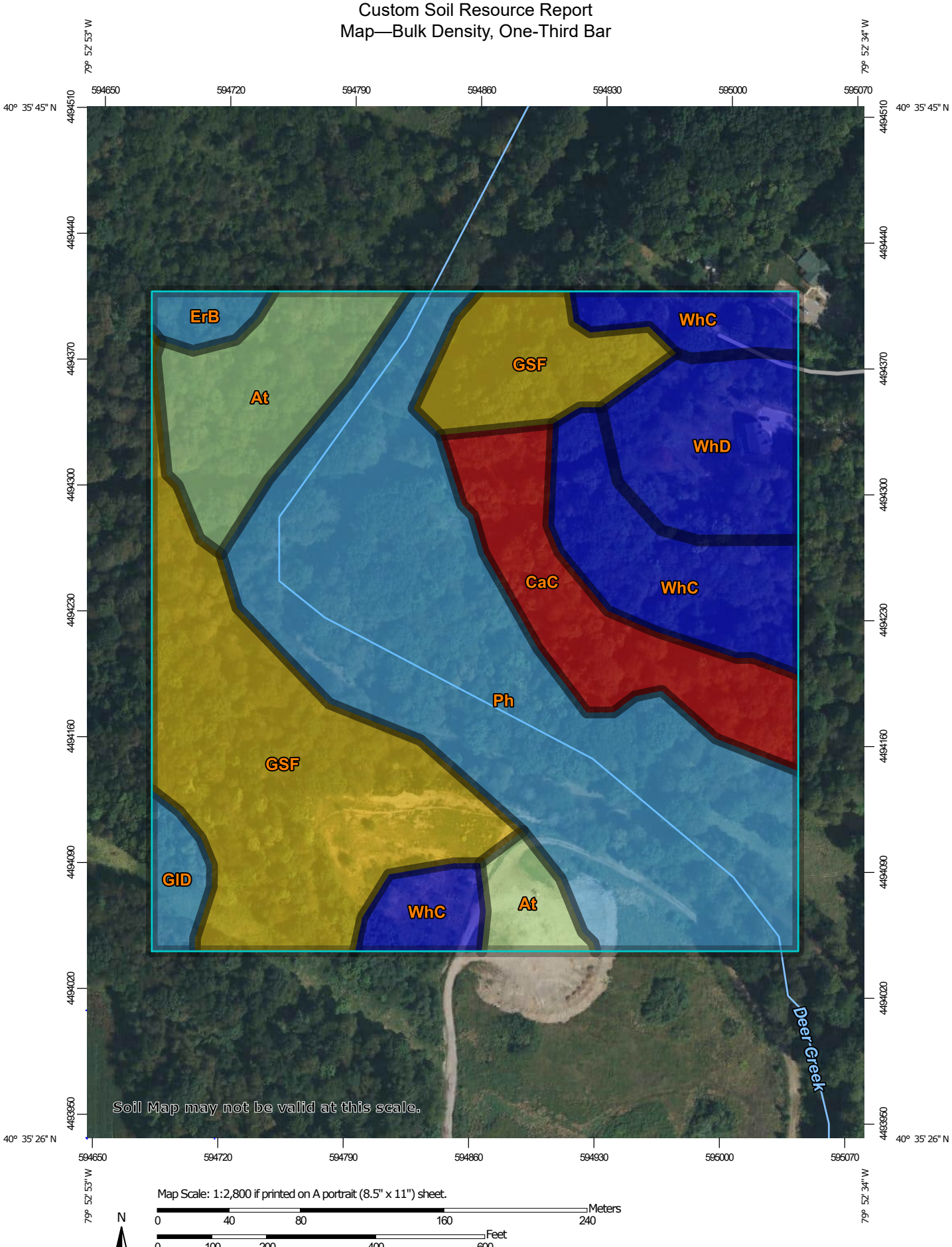
Bulk Density, One-Third Bar

Bulk density, one-third bar, is the ovendry weight of the soil material less than 2 millimeters in size per unit volume of soil at water tension of 1/3 bar, expressed in grams per cubic centimeter. Bulk density data are used to compute linear extensibility, shrink-swell potential, available water capacity, total pore space, and other soil properties. The moist bulk density of a soil indicates the pore space available for water and roots. Depending on soil texture, a bulk density of more than 1.4 can restrict water storage and root penetration. Moist bulk density is influenced by texture, kind of clay, content of organic matter, and soil structure.

For each soil layer, this attribute is actually recorded as three separate values in the database. A low value and a high value indicate the range of this attribute for the soil component. A "representative" value indicates the expected value of this attribute for the component. For this soil property, only the representative value is used.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Custom Soil Resource Report
Map—Bulk Density, One-Third Bar



Map Scale: 1:2,800 if printed on A portrait (8.5" x 11") sheet.

N

Meters: 0 40 80 160 240

Feet: 0 100 200 400 600

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 17N WGS84

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils

Soil Rating Polygons
- <= 1.34
- > 1.34 and <= 1.40
- > 1.40 and <= 1.44
- > 1.44 and <= 1.51
- > 1.51 and <= 1.56
- Not rated or not available

Soil Rating Lines
- <= 1.34
- > 1.34 and <= 1.40
- > 1.40 and <= 1.44
- > 1.44 and <= 1.51
- > 1.51 and <= 1.56
- Not rated or not available

Soil Rating Points
- <= 1.34
- > 1.34 and <= 1.40
- > 1.40 and <= 1.44
- > 1.44 and <= 1.51
- > 1.51 and <= 1.56
- Not rated or not available

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:15,800.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Allegheny County, Pennsylvania
Survey Area Data: Version 18, Sep 6, 2022

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Sep 11, 2021—Nov 16, 2021

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Table—Bulk Density, One-Third Bar

Map unit symbol	Map unit name	Rating (grams per cubic centimeter)	Acres in AOI	Percent of AOI
At	Atkins silt loam, 0 to 3 percent slopes, frequently flooded	1.44	3.2	9.9%
CaC	Cavode silt loam, 8 to 15 percent slopes	1.34	2.9	8.8%
ErB	Ernest silt loam, 3 to 8 percent slopes	1.48	0.4	1.3%
GlD	Gilpin silt loam, 15 to 25 percent slopes	1.51	0.6	1.7%
GSF	Gilpin, Weikert, Culleoka channery silt loams and 25 to 80 percent slopes	1.40	8.2	24.8%
Ph	Philo silt loam, 0 to 3 percent slopes, occasionally flooded	1.50	11.1	33.6%
WhC	Wharton silt loam, 8 to 15 percent slopes	1.56	4.1	12.5%
WhD	Wharton silt loam, 15 to 25 percent slopes	1.56	2.4	7.3%
Totals for Area of Interest			**32.9**	**100.0%**

Rating Options—Bulk Density, One-Third Bar

Units of Measure: grams per cubic centimeter

Aggregation Method: Dominant Component

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

Interpret Nulls as Zero: No

Layer Options (Horizon Aggregation Method): All Layers (Weighted Average)

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

References

American Association of State Highway and Transportation Officials (AASHTO). 2004. Standard specifications for transportation materials and methods of sampling and testing. 24th edition.

American Society for Testing and Materials (ASTM). 2005. Standard classification of soils for engineering purposes. ASTM Standard D2487-00.

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of wetlands and deep-water habitats of the United States. U.S. Fish and Wildlife Service FWS/OBS-79/31.

Federal Register. July 13, 1994. Changes in hydric soils of the United States.

Federal Register. September 18, 2002. Hydric soils of the United States.

Hurt, G.W., and L.M. Vasilas, editors. Version 6.0, 2006. Field indicators of hydric soils in the United States.

National Research Council. 1995. Wetlands: Characteristics and boundaries.

Soil Survey Division Staff. 1993. Soil survey manual. Soil Conservation Service. U.S. Department of Agriculture Handbook 18. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_054262

Soil Survey Staff. 1999. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. 2nd edition. Natural Resources Conservation Service, U.S. Department of Agriculture Handbook 436. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053577

Soil Survey Staff. 2010. Keys to soil taxonomy. 11th edition. U.S. Department of Agriculture, Natural Resources Conservation Service. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053580

Tiner, R.W., Jr. 1985. Wetlands of Delaware. U.S. Fish and Wildlife Service and Delaware Department of Natural Resources and Environmental Control, Wetlands Section.

United States Army Corps of Engineers, Environmental Laboratory. 1987. Corps of Engineers wetlands delineation manual. Waterways Experiment Station Technical Report Y-87-1.

United States Department of Agriculture, Natural Resources Conservation Service. National forestry manual. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/home/?cid=nrcs142p2_053374

United States Department of Agriculture, Natural Resources Conservation Service. National range and pasture handbook. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/landuse/rangepasture/?cid=stelprdb1043084

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

United States Department of Agriculture, Natural Resources Conservation Service. National soil survey handbook, title 430-VI. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/scientists/?cid=nrcs142p2_054242

United States Department of Agriculture, Natural Resources Conservation Service. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific Basin. U.S. Department of Agriculture Handbook 296. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053624

United States Department of Agriculture, Soil Conservation Service. 1961. Land capability classification. U.S. Department of Agriculture Handbook 210. http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_052290.pdf

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Appendix G: Crediting Summary Sheets

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

PennDOT Sediment Reduction Credit Summary

Moore Park Water Quality Credit Attained (per DEP input and guidance)	
Ave. Bank Height (ft)	2.89
Ave. BEHI	38.39
Ave. NBS	3.55 Mod-High
Ave. Erosion Rate (ft/yr)	1.21
Stream Length (ft)	1,981.00
Estimated Erosion (cf/yr)	11,814.89
Pounds of Sediment Removed (lbs/yr	189,393.18
50% Reduction Based Upon Expert Panel (lbs/yr)	94,696.59
Stormwater Basin Reductions	
Sediment (lbs/yr)	470.38
Flow Rate (CFS)	33.14
Volume Reduction (CF)	117,154

Crane Avenue Water Quality Credit Attained (per DEP input and guidance)	
Ave. Bank Height (ft)	4.81
Ave. BEHI	32.84
Ave. NBS	3.75, Mod-High
Ave. Erosion Rate (ft/yr)	0.82
Stream Length (ft)	1,722.00
Estimated Erosion (cf/yr)	28,952.59
Pounds of Sediment Removed (lbs/yr	520,111.11
50% Reduction Based Upon Expert Panel (lbs/yr)	260,055.78
Stormwater Basin Reductions	
Sediment (lbs/yr)	187.81
Flow Rate (CFS)	5.24

Sediment Reduction from Stream Restorations = 94,696.59 + 260,055.78 = 354,752.37 lbs/yr Sediment Reduction Stormwater Basins = 470.38 + 187.81 = 658.19 lbs/yr

Total Reduction for BMPS = 354,752.37 + 658.19 = 355,410.56 lbs/yr

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

PWSA Sediment Reduction Credit Summary

Moore Park Water Quality Credit Attained (per DEP input and guidance)	
Ave. Bank Height (ft)	2.89
Ave. BEHI	38.39
Ave. NBS	3.55 Mod-High
Ave. Erosion Rate (ft/yr)	1.21
Stream Length (ft)	1,981.00
Estimated Erosion (cf/yr)	11,814.89
Pounds of Sediment Removed (lbs/yr	189,393.18
50% Reduction Based Upon Expert Panel (lbs/yr)	95,166.97
115 lbs/ft Default Rate	228,285.38
Stormwater Basin Reductions	
Sediment (lbs/yr)	470.38
Flow Rate (CFS)	33.14
Volume Reduction (CF)	117,154

Crane Avenue Water Quality Credit Attained (per DEP input and guidance)	
Ave. Bank Height (ft)	4.81
Ave. BEHI	32.84
Ave. NBS	3.75, Mod-High
Ave. Erosion Rate (ft/yr)	0.82
Stream Length (ft)	1,722.00
Estimated Erosion (cf/yr)	28,952.59
Pounds of Sediment Removed (lbs/yr	520,111.11
50% Reduction Based Upon Expert Panel (lbs/yr)	260,055.78
Stormwater Basin Reductions	
Sediment (lbs/yr)	187.81
Flow Rate (CFS)	5.24

Sediment Reduction from Stream Restorations = 228,285.38 + 260,055.78 = 488,341.16 lbs/yr

Sediment Reduction Stormwater Basins = 470.38 + 187.81 = 658.19 lbs/yr

Total Reduction for BMPS = 488,341.16 + 658.19 = 488,999.35 lbs/yr

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

PTC Sediment Reduction Credit Summary

Deer Creek Water Quality Credit Attained (per DEP input and guidance)	
Ave. Bank Height (ft)	2.86
Ave. BEHI	35.37
Ave. NBS	3.86, Mod-High
Ave. Erosion Rate (ft/yr)	1.15
Stream Length (ft)	830.00
Estimated Erosion (cf/yr)	6,858.80
Pounds of Sediment Removed (lbs/yr)	116,249.21
50% Reduction Based Upon Expert Panel (lbs/yr)	58,124.61
115 lbs/ft Default Rate	94,450.00

Sediment Reduction from Stream Restoration= 94,450.00 lbs/yr

Total Reduction for BMPS = 94,450.00 lbs/yr

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

BOARD RESOLUTION ITEM

Originating Department:	Engineering and Construction	Phone:	412.255.8800-2291
Department Contact:	Barry King	E-mail:	BKing@pgh2o.com
Date:	11.17.2023		

Resolution No: 80

Approval to enter into a Reimbursement Agreement with Baldwin Township for the Saw Mill Run PWSA and PennDOT Watershed Improvements Project.

FINAL BOARD APPROVAL:
ADOPTED NOVEMBER 17, 2023

BJ Leber

BJ Leber, Secretary

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

BOARD RESOLUTION REPORT

Resolution No:	80
DATE:	11.17.2023
TO:	PWSA Board of Directors
SUBJECT:	Approval to enter into a Reimbursement Agreement with Baldwin Township for the Saw Mill Run PWSA and PennDOT Watershed Improvements Project.

STATEMENT OF THE ISSUE:

The Board is requested to approve entering into a Reimbursement Agreement with Baldwin Township for the Saw Mill Run PWSA and PennDOT Watershed Improvements Project. This resolution is to authorize the Chief Executive Officer to sign the Reimbursement Agreement on behalf of the PWSA.

The project consists of two stream restoration projects at Crane Avenue and Moore Park in the City of Pittsburgh to reduce sediment pollution in the Saw Mill Run Watershed. Baldwin desires to participate in the Project located in Moore Park and has agreed to provide a lump sum reimbursement to PWSA in exchange for sediment credit to meet their National Pollutant Discharge Elimination System (NPDES) permit for their respective Municipal Separate Storm Sewer System.

The previously approved fixed project budget for the Saw Mill Run Watershed Improvements Project was $1,500,000, where PWSA will contribute $1,000,000 (66.7%) and PennDOT will contribute $500,000 (33.3%). The budget for PWSA's contribution was approved in the current Capital Improvement Plan. The Cost Share Agreement between PennDOT and PWSA for PWSA's reimbursement of $1,000,000 to PennDOT was approved by the Board via Resolution No. 134 of 2020. This separate Reimbursement Agreement with Baldwin Township will reduce PWSA's ultimate contribution, where the amount to be reimbursed by Baldwin Township will be equal to $5.21 per pound of sediment pollution removed by these two projects.

RECOMMENDED ACTION:

Approve entering into a Reimbursement Agreement with Baldwin Township as described, including authorizing the Chief Executive Officer to sign the Agreement on behalf of the PWSA.

ALTERNATIVES:

Failure to enter into this Agreement will result in PWSA paying 100% of PWSA's Cost Share associated with the work.

SUPPLIER DIVERSITY PROGRAM STATUS:

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

n/a

FINANCIAL IMPACT OF RECOMMENDATION:

Account Information	
Account:	Capital
Operating Department Code:	500 - Stormwater
Operating Account Code:	7701 - Capital Projects Only
Total Amount Requested for Approval	$ .00
Frequency of Expenditure	One-Time

DOCUMENTS ATTACHED:
None

FOR MORE INFORMATION:

Staff contact: Bennett, Ana

E-mail: aflores@pgh2o.com

LEGAL REVIEW: MEGAN THIESSEN 10.24.2023

FINANCE. REVIEW: TIFFANY PATTON 10.23.2023

PROCUR. REVIEW: THORYN SIMPSON 10.24.2023

BY CHIEF EXECUTIVE OFFICER:
William J. Pickering 10.24.2023

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

TOWNSHIP OF BALDWIN
RESOLUTION NO. 2026-9

A RESOLUTION OF THE TOWNSHIP OF BALDWIN, ALLEGHENY COUNTY, PENNSYLVANIA, AUTHORIZING THE EXECUTION OF THE CONTRIBUTION AGREEMENT BETWEEN BALDWIN TOWNSHIP AND THE PITTSBURGH WATER AND SEWER AUTHORITY FOR THE SAW MILL RUN WATERSHED PROJECT.

WHEREAS, Pittsburgh Water and the Commonwealth of Pennsylvania, acting through its Department of Transportation (hereinafter referred to as "PennDOT") partnered to reduce sediment pollution in the Saw Mill Run Watershed as part of the pollutant reduction plan obligations in the National Pollutant Discharge Elimination System (hereinafter referred to as "NPDES") permits for their respective Municipal Separate Storm Sewer Systems (hereinafter referred to as "MS4"); and

WHEREAS, the project consisted of two stream restoration projects at Crane Avenue and Moore Park in the City of Pittsburgh within the Saw Mill Run Watershed to reduce sediment pollution and implement the Total Maximum Daily Loan (hereinafter referred to as "TMDL") plan (hereinafter referred to as the "Project"); and

WHEREAS, the total stream restoration at Moore Park is one thousand nine hundred eighty-one linear feet (1,981ft); and

WHEREAS, Pittsburgh Water is partnering with other municipalities in the Saw Mill Run Watershed to contribute to pollutant reduction; and

WHEREAS, Baldwin Township (hereinafter referred to as the "Township") desires to participate in the Project located in Moore Park; and

WHEREAS, the Township has agreed to restore two hundred linear feet (200ft) of stream in Moore Park and contribute an amount not-to-exceed Forty-Nine Thousand Eight Hundred Seven Dollars and Sixty Cents ($49,807.60) for the design and construction of the restoration; and

WHEREAS, the Contribution Agreement between the Township and Pittsburgh Water outlines the respective duties and entitlements of both Baldwin and Pittsburgh Water; and

WHEREAS, the Board of Commissioners, by and through this resolution, approves of the Contribution Agreement as presented and authorizes the execution of the Contribution Agreement.

NOW, THEREFORE, the Board of Commissioners hereby resolves as follows, incorporating the above recitals by reference:

Docusign Envelope ID: C2DFD882-CA7D-89EB-83A3-1FD3C2289B8D

Section 1. The Board of Commissioners by way of this Resolution, approves the Contribution Agreement as presented.

Section 2. The Board of Commissioners and the Township, by way of this Resolution, ratify and authorize the execution of the Contribution Agreement Between Baldwin Township and the Pittsburgh Water and Sewer Authority for the Saw Mill Run Watershed Project.

Section 3. This Resolution shall take effect immediately.

RESOLVED and **ADOPTED** this 30th day of March, 2026, by the Board of Commissioners of the Township in lawful session duly assembled.

ATTEST:

By: _____
Charla Pfeil, Township Manager

TOWNSHIP OF BALDWIN

By: _____
Nick Pellegrino, Board President

CERTIFICATE OF SERVICE

I hereby certify that I served a copy of the foregoing Public Utility Municipal Contract - Contribution Agreement between Baldwin Township and The Pittsburgh Water and Sewer Authority related to the Saw Mill Run Watershed Project - upon the persons listed below in the manner indicated in accordance with the requirements of 52 Pa. Code Section 1.54.

Via Email Only (due to the current pandemic emergency)

Darryl Lawrence
Office of Consumer Advocate
ra-oca@paoca.org

NazAarah Sabree
Office of Small Business Advocate
nsabree@pa.gov
ra-sba@pa.gov

Allison Kaster
Bureau of Investigation and Enforcement
akaster@pa.gov

Dated: April 8, 2026

/s/ Monica Walaan
Monica Walaan, Esq.
Chief Legal Officer
The Pittsburgh Water and Sewer Authority
d/b/a Pittsburgh Water