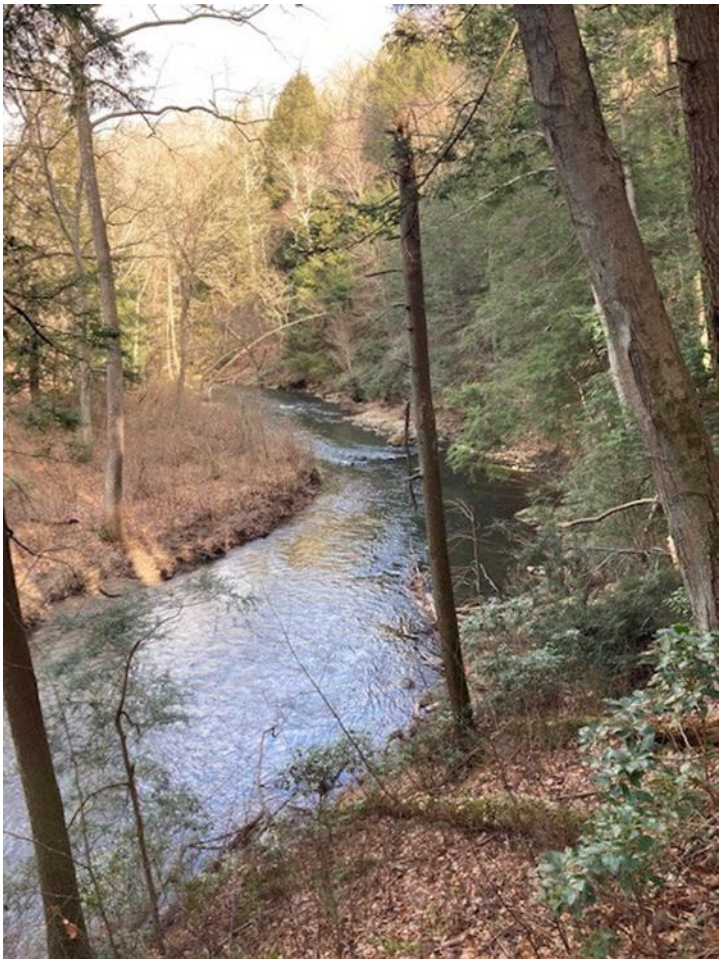
2023

US ARMY CORPS OF ENGINEERS
BALTIMORE DISTRICT
REGULATORY BRANCH



THE MARYLAND STREAM MITIGATION FRAMEWORK VERSION 1 FINAL (MSMF V.1. FINAL)

MANUAL FOR STREAM IMPACT AND STREAM MITIGATION CALCULATION

SEPTEMBER 2023

ACKNOWLEDGEMENTS

The Maryland Stream Mitigation Framework Version 1 (MSMF V.1.) is a product of collaboration between the U.S. Army Corps of Engineers (Baltimore District) and multiple partner agencies with valuable input from the regulated public. Project partners and other contributers are named below.

The Following Agencies and Groups made intellectual contributions to MSMF V.1.:

The Army Corps of Engineers-Baltimore District (USACE)
Maryland Department of the Environment (MDE)
U.S. Fish and Wildlife Service (USFWS)
The U.S. Environmental Protection Agency (EPA-Region 3)
Maryland Environmental Service (MES)
Maryland Department of Natural Resources (DNR)
Maryland State Highways Administration (MDOT SHA)
The Maryland Interagency Review Team (MD IRT)
The Maryland Wetland Assessment Team
The Army Corps of Engineers-Institute for Water Resources (IWR)
Environmental Restoration and Banking Association (ERBA)

In addition, numerous consultants and mitigation bankers provided objective, detailed, and valuable feedback on the MSMF Beta tool and the Draft MSMF V.1.

Stream Mitigation Protocols Reviewed In creation of MSMF V.1. Final

Several Mitigation Protocols from multiple Corps Districts were reviewed during creation of MSMF V.1. Reviews of the Minnesota Stream Quantification Tool (USACE-St.Paul District), The Unified Stream Methodology for Virginia (USACE-Norfolk District), The West Virginia Stream and Wetland Valuation Metric v2.1 (USACE-Huntington District), TXRAM (USACE-Galveston District), and The Tennessee SQT (USACE-Nashville District/TN Dept of Environment and Conservation), the Draft Maryland Wetland Assessment Methodology, and USACE-Louisville District mitigation protocols helped inform decisions made in development of MSMF V.1. Other mitigation protocols were also reviewed.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

MSMF V.1. FINAL CALCULATOR LIST OF CONTENTS (color coded):

LIST OF ASSOCIATED DOCUMENTS AND TOOLS:

Appendices are provided as separate documents

APPENDIX A1: MSMF V.1. Final Calculator

Provides six different calculator worksheets. Only a subset of the worksheets will be needed on a given project. The applicable worksheets, appendices, and tools for common activities is outlined below in Section I: Background. The components of Appendix A are listed on page 2.

APPENDIX A2: MSMF V.1. Final Calculator with Examples

Provides an example calculator completed for an impact with permittee-responsible mitigation.

APPENDIX B: EPA Rapid Bioassessment Protocol-Stream Habitat Forms and Instructions

Provides a stream conditional assessment to be used for smaller impact reaches and for ephemeral channels impacted as well as mitigation reaches. See Sections on Stream Impact Calculations and Stream Mitigation Calculations for more details (Table 2 and Table 3). This appendix will mainly be used to determine stream quality for Appendix A Tab 2 (Stream Impact Calculation).

APPENDIX C1: Function Based Rapid Stream Assessment

Provides a stream functional and conditional assessment to be used for mitigation reaches as well as larger impact reaches (>300 linear feet). See Sections on Stream Impact Calculations and Stream Mitigation Calculations for more details (Table 2 and Table 3). This appendix (also Appendix C2 and C3) will be used primarily for Appendix A Tab 3 (Stream Mitigation Calculation for Stream Channels), but will also sometimes be used for Tab 2 (Stream Impact Calculations). It determines the "Stream Quality" value for each when it is applied.

APPENDIX C2: Function Based Rapid Stream Assessment Methodology

Manual for Function Based Rapid Stream Assessment.

APPENDIX C3: FBRSA for MONITORING

Function Based Rapid Stream Assessment formatted for post-construction monitoring.

APPENDIX D1: Stream Buffer Quality Assessment (SBQA)

Provides a functional and conditional assessment for stream buffers. To be used on stream mitigation projects. Appendix D1 (also D2 and D3) will define the stream buffer quality in Appendix A Tab 4 (Stream Mitigation Calculation for Stream Buffers).

APPENDIX D2: Stream Buffer Quality Assessment (SBQA) Manual

Provides a manual for the Stream Buffer Quality Assessment

APPENDIX D3: MONITORING_STREAM BUFFER QUALITY ASSESSMENT (SBQA)

SBQA for post-construction monitoring

APPENDIX E1: Site Evaluation Report for Stream and Wetland Mitigation

Helps identify site suitability for mitigation and determine weighting for "Site Sensitivity" adjustment outlined in the Stream Mitigation Sections below.

APPENDIX E2: Site Sensitivity Grids

Provides two grids (separate tabs) to determine site sensitivity values for Stream Mitigation in Stream Channels Tab 3 and Stream Mitigation in Stream Buffers Tab 4

APPENDIX F1: MSMF Fish Passage Beta Tool

Calculates mitigation credits for fish passage barrier removals. Not included in MSMF V.1. Release. To Be Released at the end of 2023/early 2024.

Appendix F2: MSMF Fish Passage Beta and Manual

Manual for MSMF Fish Passage Beta Tool

LIST OF EXTERNAL TOOLS:

EXTERNAL TOOL 1: Maryland Watershed Resources Registry

Provides tools under the MSMF Site Sensitivity Analysis for Stream Mitigation, Stream Impacts, and Stream Buffers to aid in site selection. Results are used in the "Site Sensitivity" credit and debit adjustments.

https://watershedresourcesregistry.org/states/maryland.html

EXTERNAL TOOL 2: USGS Stream Stats

Used to Determine Drainage Area in both the Stream Impact and Stream Mitigation for Stream Channels Calculator worksheets.

https://streamstats.usgs.gov/ss/

Table 1. Applicable MSMF V.1. Components by Use

USES	Calculator Tabs	Manual Sections	Appendices	External Tools
Stream Impacts[1] with Permittee Responsible Mitigation	1, 2, 3, 4	I, II, III, IV, V	A and (B or C), and D, E	1 & 2
Stream Impacts purchasing credits from Mitigation Bank	1, 2	I, II, III	A and (B or C)	1 & 2
Standard Mitigation Bank	1,3,4	I, II, IV, V	A and C, D, E,	1 & 2
Stream Mitigation Bank with bundled credits	1,3,4,5,6	I, II, IV, V, VI	A and C, D, E	1 & 2
Stream Mitigation Bank proposing fish passage[3]	1 and FP Calc (separate)	I,II	A, E, F	2
Non-mitigation: Verification of ecological lift on restoration proposal[4]	1, 3,4	I, II, IV,V	A, C, D	1 & 2

Table 1 showing applicable MSMF V.1. Final Components by the type of DA application or use that is proposed. [1] See Section III for information on when mitigation will be required. [2] See Section III: Stream Quality for information on what type of stream assessment to apply (Table 2). [3]The MSMF Fish Passage Beta Tool is an complimentary tool to MSMF V.1 Final and will be provided separately from the MSMF V.1. Final Release [4] MSMF V.1. Final may be used to verify ecological lift has occurred on a non-mitigation stream restoration proposal.

SECTION I

BACKGROUND

I. BACKGROUND

The Maryland Stream Mitigation Framework Version 1 (MSMF V.1.) provides a consistent and transparent process for quantification of stream impact and compensatory mitigation (referred to as "mitigation" throughout this manual) where unavoidable impacts occur to Waters of the US, regulated under Section 404 of the Clean Water Act. The Framework was established primarily as a tool for USACE (Baltimore District) regulators in Maryland to promote minimization and avoidance of impacts to streams and provide an accounting tool when unavoidable impacts occur and must be mitigated, with the goal of replacing lost stream functions and conditions. The tool was also created to improve consistency of Baltimore Districts Mitigation processes with the 2008 Final Mitigation Rule (32 CFR 332). MSMF V.1. Final is posted on to the USACE-Baltimore District Regulatory web page and on RIBITS:

https://www.nab.usace.army.mil/Missions/Regulatory/Mitigation/

https://ribits.ops.usace.army.mil/ords/f?p=107:27:6722572170286::NO::P27_BUTTON_KEY:20

MSMF V.1. may be used by applicants and their consultants in forecasting stream credits/debits lost or gained through various permit actions. Maryland Department of the Environment (MDE) may also utilize MSMF V.1. for their review needs of waterways protected by the state of Maryland. The framework promotes impact minimization and avoidance, as well as strategic mitigation planning by allowing for distinction between stream habitats of different quality, landscape position, and sensitivity. The MSMF V.1. relies on completion of a Functional or Conditional Assessment Methodology (FCAM) for stream channels as suggested by the 2008 mitigation Rule (33 CFR 332.3 (f)(1)).

Initial testing was conducted using the MSMF Beta Tool and Draft MSMF V.1. on multiple impact and mitigation projects between May 2020 and May 2023, and knowledge from the associated project reviews as well as feedback from project managers and permit applicants informed creation of MSMF V.1. Final. This tool was created as a Corps process for internal estimation of stream credits and debits as a result of permitted stream impacts or stream mitigation actions in the Baltimore District and geographic boundaries of Maryland.

The MSMF V.1. Final provides three calculators that are visible in Appendix A MSMF V.1 Final Calculator. The "Stream Impact Calculator Tab 2," the "Stream Mitigation Calculator for Stream Channels Tab 3," and the "Stream Mitigation Calculator for Stream Buffers Tab 4" share a common unit of measure (the functional foot). The functional foot reflects losses and gains in stream functions and conditions by combining factors such as stream quality and stream size to the traditional measure of stream length. All three calculators are provided as independent tabs in the MSMF V.1. Final excel workbook. The manual was written so that each section (for each calculator) stands alone, and some of the information in each section is redundant. Please note that aside from the MSMF V.1. Summary Sheet, the Stream Impact Calculator and Stream Mitigation Calculator sheets are independent, each providing independent calculations for estimated functional loss and functional gain respectively.

The Framework will be implemented by the USACE Baltimore District for quantification of stream losses associated with unavoidable impacts to Waters of the U.S. in Maryland. Stream mitigation

should be considered only after diligent avoidance and minimization efforts have been completed during permit application review as required by the Section 404(b)(1) Guidelines (40 CFR 230). Use of MSMF V.1. Final will be limited to permit applications were greater than minimal stream losses. Additionally, the Stream Framework may be used as a tool to determine whether greater than minimal losses would occur as a result of a DA permit and help a Corps Project manager determine whether mitigation should be required. The Stream Framework will not typically be used for permit applications with minimal stand-alone impacts such as road culverts, minor road crossings, and small-scale nontidal streambank stabilization. Functional foot values provided by the calculation sheets (for both impacts and mitigation) may be adjusted by the Corps based on site specific factors. For example, a Corps project manager may require more mitigation for resources of exceptional quality on impacted reaches and may reduce mitigation credits awarded unforeseen constraints on mitigation reaches. Further, while the tool provides functional foot estimates by comparing existing and proposed conditions, total functional feet awarded for mitigation proposals will be updated during the monitoring period, based on achievement of prescribed site performance standards and the final functional and conditional assessment values (typically in year 10). In addition, functional foot values produced by the calculation tabs may be adjusted by the Corps in the event they do not adequately reflect the change in conditions following an impact or mitigation action. Predicted functional improvements associated with stream mitigation credit calculations (i.e., estimated functional improvements) must be realistic, fully supported, fully documented through monitoring reports, and achievable.

The MSMF V.1. Final Calculation sheets are provided in a single Microsoft Excel Workbook titled "MSMF V.1. Final." The calculators display text in **BLACK**, ORANGE (Stream Impact Tab), GREEN (Stream Mitigation Tab for Stream Channels), and **PURPLE** (Stream Mitigation Tab for Stream Buffers). Note that in each of the calculators, the user will only enter data in the cells with **BLACK** text or those which are blank. Boxes with ORANGE, GREEN, and PURPLE text are locked and are preset or will populate as data is provided in the BLACK text fields. Please note that only the relevant tabs must be filled out for a given project. For example, a project with impacts only would only fill out the Stream Impact tab if purchasing credits from a mitigation bank (See Table 1), making a note in Tab 1 Summary that credits were purchased from a bank. The mitigation bank would typically fill out two stream mitigation tabs in a separate workbook (TAB 3_Mitigation for Stream Channels, and TAB 4_Mitigation for Stream Buffers). Alternatively, when the Fish Passage Calculator (Appendix F1/F2) is used, it may be applied in addition to Tab 3 and 4 where both barrier removal and stream restoration occur. It is also possible for the Fish Passage Calculator (Appendix F1) to stand alone for mitigation where channel and buffer restoration credits are not sought.

The MSMF V.1. Final does not indicate the federal jurisdiction of a channel or whether a stream channel is a "Waters of the US" (WOTUS). Such determinations are made by the Corps project manager according to federal regulations and the effective WOTUS rule in place during project reviews.

The MSMF V.1 Final was intentionally created for adaptability to regions outside of Maryland. For Corps Districts with interest in adapting the MSMF process or components to their district, please contact Nick Ozburn, USACE-Baltimore District-Regulatory Branch at (Nicholas.R.Ozburn@usace.army.mil).

SECTION II

MSMF V.1. FINAL: SUMMARY

See Appendix A Calculator TAB 1

THE MARYLAND STREAM MITIGATION FRAMEWORK VERSION 1 FINAL (MSMF V.1. FINAL) [1,2,6,7]

BACKGROUND-IMPACTS		BACKGROUND-MITIGATION	
Corps Project ID	NAB-2023-85656	Corps Project ID	NAB-2023-88552
Project Name:	Acme Airport Runway Expansion	Project Name:	Panther Branch Mitigation
County:	Baltimore	County:	Baltimore
Corps PM:	James Brown	Corps PM:	James Brown
Sponsor:	Acme Airports	Sponsor:	NA
Landowner(s):	Acme Airports	Landowner(s):	Bob Smith
Collaborators:	GKH, JMB, CTT	Collaborators:	BTD, MPT
MITIGATION TYPE		Select From Dropdown Menu	

SUMMARY

This example illustrates impacts for a proposed airport and associated permitee responsible mitigation. Only Tabs 1, 2, 3, and 4 were needed. The numbers below auto populate. For impacts purchasing from a mitigation bank, only tabs 1 and 2 would be completed, while the bank would independently have their own workbook with tabs 1 and some combination of 3, 4, 5, 6, and/or Fish Passage dependent on

TALLY OF IMPACTS AND MITIGATION

CALCULATION NAME	FUNCTIONAL FEET (FF)	SUMMARY
STREAM IMPACTS TOTAL	-910	
STREAM MITIGATION TOTAL FOR STREAM CHANNELS	693	
STREAM MITIGATION TOTAL FOR STREAM BUFFERS	217	
STREAM MITIGATION TOTAL FOR FISH PASSAGE[3]	0	
FUNCTIONAL FOOT BALANCE[4]	0	

TALLY OF BUNDLED MITIGATION (for *Mitigation Banks Only*) [5]

STREAM MITIGATION TOTAL FOR STREAM CHANNELS (bundled)	#REF!	list ratio and bundled type
STREAM MITIGATION TOTAL FOR STREAM BUFFERS (bundled)	#REF!	list ratio and bundled type
OPTIONAL FUNCTIONAL FEET	#REF!	

Figure 1 Showing MSMF V.1. Final Calculator: Tab 1 Summary. See in Appendix A1 and A2. This example illustrates a stream impact with permittee responsible mitigation.

II. MSMF V.1. FINAL SUMMARY TAB

The MSMF V.1. Final Calculator includes six tabs including six different worksheets with which populate the summary sheet (TAB 1). Each worksheet is color coded. The Stream Impact Calculator is shown in ORANGE. The Stream Mitigation Calculator for Stream Channels is shown in GREEN. The Stream Mitigation Calculator for Stream Buffers is shown in PURPLE. Stream Mitigation for Fish Passage is shown in BLUE. Last, bundled mitigation options are provided, which apply only as an option for mitigation banks and advanced mitigation.

For DA permit applicants proposing impacts only and purchasing credits from an approved Mitigation Bank or In Lieu-Fee Program, fill out tabs 1 (Summary), and 2 Stream Impact Calculator. (The Mitigation Bank will have their own separate calculator workbook (Appendix A) for the respective mitigation bank).

For DA permit applicants proposing impacts and providing their own mitigation, populate tabs 1 (Summary), 2 (Stream Impact Calculator), and some combination of 3(Stream Mitigation Calculator for Stream Channels and 4(Stream Mit. Calculator for Stream Buffers), depending on mitigation provided (e.g., in channel work with buffers or work on buffers only). Alternatively the Fish Passage Beta Tool could be used to determine mitigation credits for fish barrier removals when that tool becomes available.

For DA permit applicants proposing mitigation only (e.g. Mitigation Bank), populate the relevant tabs (1, 3, 4, and possibly 5/6) for the mitigation proposed.

If fish passage is elected as a mitigation option, please use the MSMF Fish Passage Beta Tool (Appendix F1/F2 when it becomes available).

a. Background Information

i. Corps Project ID #
ii. Enter the Corps Permit Number if known. The Corps Permit number will become available after a permit application is received by the Corps.
iii. Project Name:
iv. County:
v. Corps PM:
Enter the Corps project manager (reviewer) name. This may be added at a later time if the Corps PM had not yet been assigned
vi. Sponsor (Indicate the project sponsor or applicant)
viii. Landowner(s):
ix. Collaborators (Provide the name and affiliation of users)
x. Mitigation Type: For DA permit applicants proposing stream impacts, select from the dropdown menu how you will satisfy your stream mitigation requirements. Select from "Mitigation Bank," Permittee Responsible," or "In Lieu Fee". For DA permit applicants proposing mitigation work (e.g. Mitigation Bank Sponsors), also select from the dropdown.

xi. Summary: Briefly describe the stream impacts and proposed mitigation. For example: Stream impacts for MD 27 road widening in Carroll County resulting in 150 Functional Feet of stream impacts. To be mitigated by purchase of credits at Acme Mitigation Bank in Carroll County. OR To Be mitigated by permittee responsible mitigation at Little Pipe Creek in Carroll County, MD.

b. TALLY OF STREAM IMPACTS AND MITIGATION: Tallies Stream Impacts and Stream Mitigation from all tabs (barring bundle credit tabs covered below). The Bundled credit tabs will not be used by typical applicants but may be useful for Mitigation Banks and In Lieu Fee Programs. It is calculated separately in "Optional Functional Feet"

i. STREAM IMPACTS TOTAL: Sum of all stream impacts identified in Tab 2
ii. STREAM MITIGATION TOTAL FOR STREAM CHANNELS: Sum of all stream channel mitigation identified in Tab 3
iii. STREAM MITIGATION TOTAL FOR STREAM BUFFERS: Sum of all stream buffer mitigation from Tab 4
iv. STREAM MITIGATION TOTAL FOR FISH PASSAGE: Must be entered manually with results of the "MSMF Fish Passage Beta Tool." As of the public notice of MSMF V.1. Final, this tool is not yet complete. The Corps plans to release it in late 2023/early 2024 as Appendix F1/F2.
v. FUNCTIONAL FOOT BALANCE: The difference between the "STREAM IMPACTS TOTAL" and the "STREAM MITIGATION TOTAL FOR STREAM CHANNELS" and "STREAM MITIGATION TOTAL FOR STREAM BUFFERS."

c. TALLY OF BUNDLED MITIGATION: This section is specific to mitigation banks and in lieu fee programs. Bundling of mitigation credits allows a mitigation provider to identify up to two resources to sell credits within the same geographic area. It works as an either/or scenario. For example, an applicant proposes to build a stream and riparian wetlands and sell mitigation credits from an approved mitigation bank. They propose wetlands in the floodplain but are unsure of market demand for streams credits vs. wetland credits. They can elect to "bundle" credits. This means that they may sell either wetland credits or stream buffer credits in a given year based on demand. However, after the sale, the total balance of stream buffer credits (functional feet) and wetland credits will both diminish for that release year, regardless of the credit type sold. Consult with the Corps and MDE reviewers and or IRT regarding feasibility of bundling credits.

i. STREAM MITIGAITON TOTAL FOR STREAM CHANNELS (bundled): Sum of all stream mitigation proposed in Tab 5.
ii. STREAM MITIGATION TOTAL FOR STREAM BUFFERS (bundled): Sum of all stream mitigation proposed for stream buffers in Tab 6.
iii. OPTIONAL FUNCTIONAL FEET: Functional feet that are available, should the applicant choose to sell them over the alternative credit it is bundled with. Sum of Tabs 5 and/or 6. Following the credit release schedule, these will diminish each release year, whether they are released for sale or release is chosen for the other credit functional feet are bundled with.

SECTION III
MSMF V.1. STREAM IMPACT CALCULATOR
See Appendix A Tab 2

STREAM IMPACT CALCULATOR

BACKGROUND INFORMATION

Corps Project ID #:	NAB-2023-85656	Corps PM:	James Brown
Project Name:	Acme Airport Runway	Date:	27-Feb-23
Lat/Long:	36.78954, -76.55444	Sponsor:	Acme Airports
County:	Baltimore	Collaborators:	GKH, JMB, CTT

TOTAL STREAM LOSSES (Functional Feet): -910

Reach Name	Physiographic Region	Evaluation	Activity	Resource Type	Reach Length (feet)	Stream Quality	Channel Thread	Drainage Area (sqmi)	Raw Reach Value (Functional Feet)	Raw Change in Value (Functional Feet)	Stream Impact Adjustments: Site Sensitivity	Stream Impact Adjustments: Mitigation Ratio	Stream Losses (Functional Feet)	REMARKS (Include reach coordinates)
example 1	Piedmont	Existing	Preliminary Resource Evaluation	Intermittent	1270	43%	Primary	0.5	417	-417	1	Proposed Mitigation Type	-688	
							1	0.76			10%	Permittee Responsible		
	Piedmont	Proposed	Fill	Intermittent	0	0%	Primary	10	0		-42	1.5		36.78954, -76.55441. Fill of channel to create airport runway.
							1	2.45						
example 2	Piedmont	Existing	Preliminary Resource Evaluation	Perennial Headwater	500	53%	Primary	1.5	310	-135	1	Proposed Mitigation Type	-222	
							1	1.17			10%	Permittee Responsible		
	Piedmont	Proposed	Channel Hardening	Perennial Headwater	500	30%	Primary	1.5	176		-13	1.5		36.78955, -76.55452. Channel armoring below bridge.
							1	1.17						

Figure 2 showing the Stream Impact Calculator in Tab 2 of the MSMF V.1. Final Calculators (See Appendix A1 and A2).

III. STREAM IMPACT CALCULATION TAB

The Stream Impact Calculator should be used by the Baltimore District project (in the state of Maryland) for permit application reviews resulting in permanent stream losses considered greater than minimal. In addition, it may be used by an applicant or Corps project manager to determine whether substantial losses have occurred or to compare stream losses among practicable project alternatives. The Corps will not typically use the Stream Impact Calculator for DA permit applications with minimal impacts such as small stand-alone road crossings, stream bank stabilization, or other work considered minimal. The Corps will require compensatory mitigation whenever impacts are considered greater than minimal and/or involve high quality special aquatic sites or other sensitive aquatic resources.

To populate the Stream Impact Calculator Tab (Tab 2), the user will need the following documents and tools:

The Maryland Watershed Resources Registry, USGS Stream Stats, mapping software, and one or more of the stream assessments listed below (*see also Table 2*):

Appendix B the EPA Rapid Bioassessment Protocol Habitat Form for High Gradient Streams (RBP HG), EPA Rapid Bioassessment Protocol Habitat Form for Low Gradient Streams (RBP LG), EPA RBP Habitat form for High Gradient Intermittent/Ephemeral Streams (RBP HG Int/Eph), and the EPA RBP Habitat form for Low Gradient Intermittent/Ephemeral Streams (RBP LG Int/Eph). *See information regarding stream assessments selection under "Section II. c. vii Stream Quality Table 2" below*. Appendices C1 The Functions Based Rapid Stream Assessment (FBRSA with numeric scoring) will be needed only for impacts exceeding 300 linear feet or resources of exceptional quality.

In the Impact Calculation Tab, rows with white backgrounds represent "existing" conditions, which rows with orange backgrounds represent "proposed" conditions.

When submitting the MSMF Impact Calculation sheet to the Corps for review, the user must also include:

Materials needed to populate the MSMF V.1. Stream Impact Calculator:

-MSMF V.1. Final Workbook: Tab 2 (Stream Impact Calculator) and background info for Tab 1 Summary.
-EPA Rapid Bioassessment Habitat Forms (*See Table 2 to determine which assessment is needed*)
-Function Based Rapid Stream Assessment (*See Table 2 to determine which assessment is needed*)
-Maryland Watershed Resources Registry
https://watershedresourcesregistry.org/states/maryland.html
-USGS Stream Stats (https://streamstats.usgs.gov/ss/)
-Site Map (details in instructions below)

a. Background Information

i. Corps Project ID #
Enter the Corps Permit Number if known. The Corps Permit number will become available after a permit application is received by the Corps.

ii. Project Name

iii. Lat/Long
Provide site coordinates in decimal degrees (*ex. 39.54876, -78.09878*)

iv. County

v. Corps PM
Enter the Corps project manager (reviewer) name. This may be added at a later time if the Corps PM had not yet been assigned.

vi. Date
Enter the date the Impact Calculator Tab was populated with site information

vii. Sponsor
Indicate the project sponsor or applicant

viii. Collaborators
Provide the name and affiliation of users

b. Total Stream Losses
Located in the top far right corner of the Impact Calculator, a number will be seen which tabulates the functional foot values for all stream impacts provided in the sheet from Column O "Stream Losses (functional feet)."

c. Raw Change in Reach Value (functional feet): The "Raw Change in Reach Value" section produces a raw functional foot value (Proposed Value–Existing Value) using several variables described below. The score will then be run through a second section (*See II.d Below* "Stream *Impact Adjustments"*) yielding "Stream Losses" by reach.

i. *Reach Name*: The user must identify a stream reach name. We recommend that you identify reaches which are unique in quality, drainage area, and proposed treatment. Specifically for stream impacts, where stream quality changes noticeably or a major tributary enters the stream, a new reach should be entered as a new Row in the Stream Impact Calculator. A separate reach should also be created for second and third channels when they are part of a multi-thread stream. See Section "viii. Channel Thread" below.

ii. *Physiographic Region*: The user must identify a general physiographic region for their reach: Mountain, Piedmont, or Coastal Plain. The physiographic region sets which bankfull regional curve is used for the Drainage Area Adjustment (*item ix of this section below*). The correct regional curve is automatically identified when the physiographic region is selected.

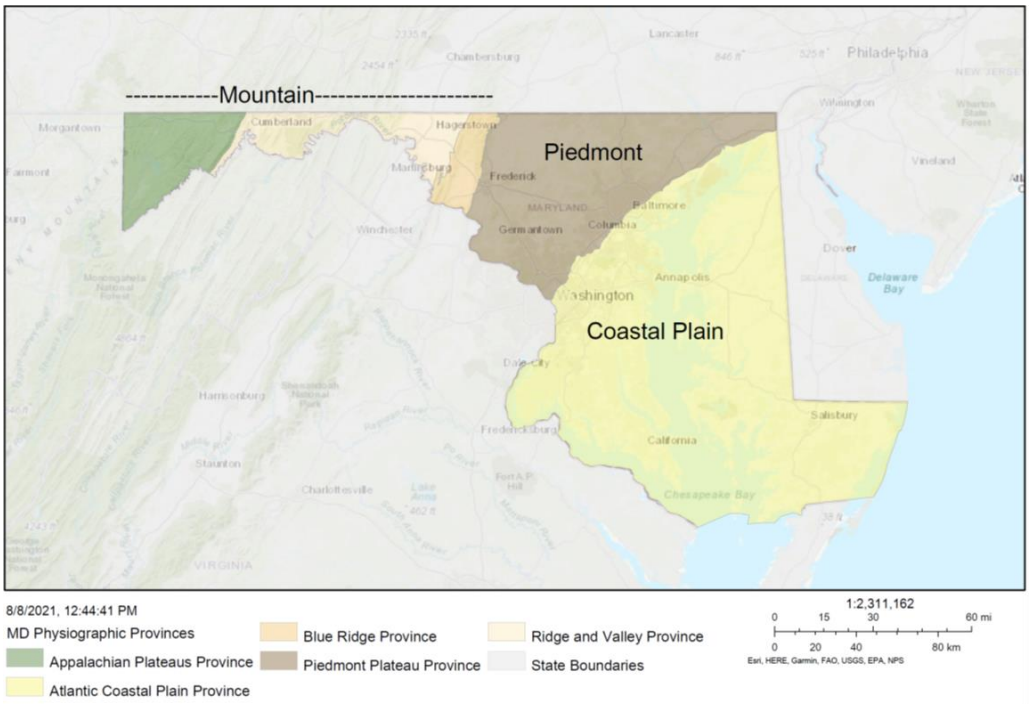


Figure 3 showing general physiographic regions of Maryland

iii. *Evaluation*: For each Stream Reach, there will be two evaluations (rows), one for existing conditions, the other for proposed conditions after an impact (*See Figure 2 above*).

iv. *Activity*: Activity refers to the action affecting the stream reach. In the Stream Impact Calculator Tab, for Existing conditions, "Preliminary Resource Evaluation" is set. When a section of stream is proposed to be impacted, please select the appropriate impact type from the drop-down menu. Enter "fill" for any stream fills, "piping" for placement of an open stream channel into a pipe/culvert, "channel hardening" for stream channels which are to be armored, or "ponding" for areas which are permanently backwatered above the existing bankfull elevation due to a downstream fill. The nature of the selected activity should be consistent for the entire affected stream reach. For example, the proposed installation of a culvert road crossing with downstream stabilization would have separate entries for stream reaches, affected by piping and then channel hardening. Channel hardening must be selected whether one or both stream banks are armored. Please note that the credits are determined from the existing vs. proposed

stream quality values, and the impact category is for categorical only purposes, and is not reflected in the crediting.

v. *Resource Type*: Resource type corresponds to stream channel flow. It may be either Ephemeral, Intermittent, Perennial Headwater, or Perennial Wadable. Perennial Wadable streams are defined as those with a drainage area exceeding 5 square miles. Select the "Resource Type" from the dropdown. Definitions of stream resource types by flow class can be found in the Section VII Definitions. Please note that the resource type is only descriptive and does not factor into the credit determination. Questions regarding Corps jurisdiction over aquatic resources should be coordinated with the assigned project manager or a jurisdictional determination request may be requested by following the instructions on the Baltimore District Webpage at: https://www.nab.usace.army.mil/Missions/RegulatoryA/Jurisdictional-Determinations/

vi. *Reach Length (linear feet)*: The user must indicate the length of the stream reach as measured from the centerline of the active baseflow channel. Reach breaks should occur wherever conditions change substantially. For example, a new reach should be identified where stream bank heights suddenly appear taller for an extended stretch of stream. They should also be identified when a major tributary enters contributing more than 10% of the stream flow.

vii. *Stream Quality*: Stream quality ranges from 0-100% based on the total score of a reach divided by total possible score (*X 100*) of an applied Functional or Conditional Assessment Methodology (FCAM). A Stream Quality of "100%" represents a perfect condition score. The user will enter values in the Stream Quality boxes for both existing and proposed condition scores (%). Where a stream will be filled or placed in a pipe or culvert as a result of the proposed activity, please enter the FCAM Score to the Stream Quality Column under "Existing" and a 0 in the "Proposed" condition. For all other impact types, the user will need to assess stream conditions before the impact and then project conditions following the impact to fill out the "proposed" stream quality. Streams may be assessed following stream impacts to ensure "proposed" condition values were accurate. As mentioned in Section "II. I Reach Name", when a stream reach changes noticeably in quality, treatment, or drainage area, a new stream reach should be entered in rows below the previous reach, and a separate stream quality assessment recorded.

FCAM's by Resource Type, stream gradient, and reach length:

The required FCAM by impact length, gradient, and flow class are summarized in *Table 2* below. The following FCAMS should be applied to determine stream quality for impact reaches less than 300 linear feet in length (*see also Table 2 below*): "EPA RBP Habitat Form HG" for perennial streams with slopes exceeding 2%, "EPA RBP Habitat Form LG" for perennial streams with slopes below 2%, "EPA RBP Habitat Form Int/Eph HG" for intermittent and ephemeral streams with slopes exceeding 2%, and "EPA RBP Habitat Form Int/Eph LG" for intermittent and ephemeral streams with slopes less than 2%. For intermittent or perennial streams reaches exceeding 300 linear feet in length, or reaches exhibiting excellent quality, the "Function Based Rapid Stream Assessment (with numeric scoring)" should be used. Flexibility regarding the appropriate stream assessment for streams with slopes near 2% may be discussed with the Corps project reviewer. Citations for the EPA RBP Habitat forms can be found in the "References" section below (Barbour and others, 1999), and the Function Based Rapid Stream Assessment (USFWS, 2015). In the Function Based Rapid Stream Assessment Manual (FBRSA Rapid-Assessment-

Methodology Manual), please disregard sections referring to the "Watershed Assessment" for the purpose of the MSMF V.1 Final. A new Function Based Rapid Stream Assessment is planned MSMF V.2. in late 2024 or early 2025 with a revised manual.

Table 2. Stream Quality Assessment for IMPACTS (MSMF V.1)				
Channel Characteristics		**Channel Flow Class**		
Channel Gradient	**Reach Length**	**Perennial**	**Intermittent**	**Ephemeral**
High Gradient >2%	1-299 ft	EPA RBP Habitat Form High Gradient	EPA RBP Habitat Form for Int/Ephemeral Streams: High Gradient	
	300 ft +	Function Based Rapid Stream Assessment		EPA RBP Habitat Form for Int/Ephemeral Streams: High Gradient
Low Gradient <2%*	1-299 ft	EPA RBP Habitat Form Low Gradient	EPA RBP Habitat Form for Int/Ephemeral Streams: Low Gradient	
	300 ft +	Function Based Rapid Stream Assessment		EPA RBP Habitat Form for Int/Ephemeral Streams: Low Gradient

*Table 2 Showing required stream assessment to determine stream quality for stream mitigation by channel gradient, reach length, and channel flowclass. The same form must be used for existing and proposed conditions. For high quality streams, a Function Based Rapid Stream Assessment may be required regardless of reach length. *Note that High Gradient Forms should be used for channels nearing 2% slopes, however, the assessor may select to use the Low Gradient Form for channels with slopes <2%.*

viii. *Channel Thread*: Channel Thread was included in the Framework for multi-threaded channels and oxbow channels. There are three options for channel thread (primary, second, or third). Single thread channels are considered "primary" channels and awarded at a ratio of 1.0 (no adjustment). For multi-threaded channels, the user must designate a primary or main channel, then may label any additional channels as second channels (0.2 multiplier) or third channels (0.1 multiplier). For second or third channels, credit will only be debited (or awarded) for perennial channels with active channels at least 1 foot wide with pools at least 0.5 feet deep, exhibiting perennial flow. Oxbows may be treated as second or third channels. The Corps reviewer in consultation with MDE will determine whether to regulate jurisdictional oxbow features as stream channels or wetlands. For the Channel Thread factor, it is important that we note the difference between "Multi-thread channels" and "Braided Channels." For the purpose of the MSMF, multi-thread channels are those channels in the same valley and general flowpath of a primary channel separated by an upland (or wetland) island where vegetation is established and

soil formation is occurring. Braided channels are typically very dynamic streams and a result of high bed load (where soil development and vegetation do not occur on areas between channels). Braided channels are to be treated as one single primary channel for a given valley.

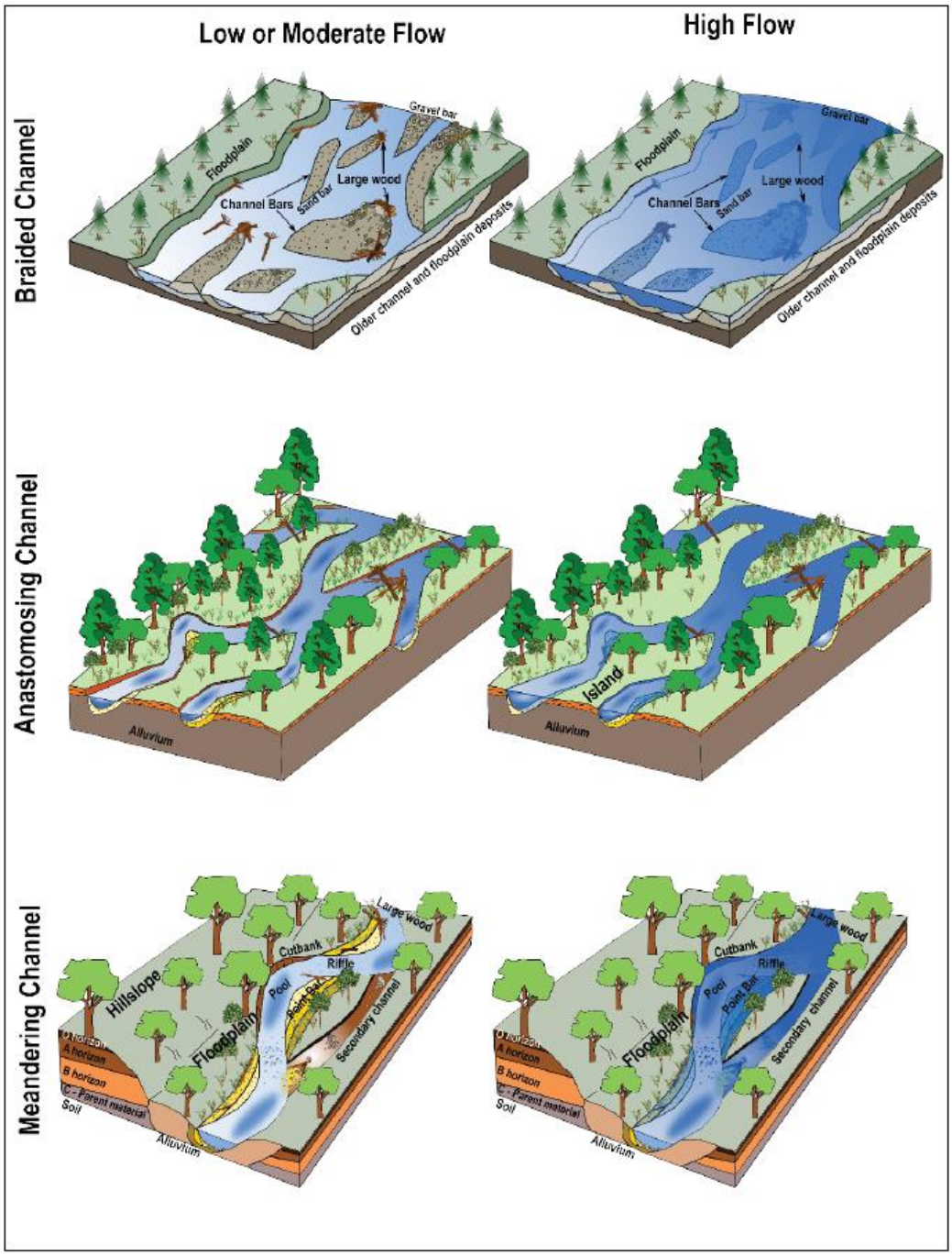


Figure 4 showing difference between braided, anastomosing, and meandering channels. Second and third channels may be credited on anastomosing or meandering channels, but not braided channels. Figure from USACE 2022, adapted from Suazo-Davila et a. 2013.

ix. *Drainage Area (sq mi)*: For primary channels, enter the drainage area (in square miles rounded to the nearest tenth) in the top box of the column (I) and the adjustment factor will populate in

the box below. Drainage area must be determined using USGS stream stats: https://www.usgs.gov/mission-areas/water-resources/science/streamstats-streamflow-statistics-and-spatial-analysis-tools?qt-science_center_objects=0#qt-science_center_objects The drainage area must be measured from the center of the subject reach. Where drainage area is unavailable on USGS Stream stats, the user must measure the drainage area from a topographic map. For multi-threaded streams, indicate the drainage area for primary channels in Column I, and for second or third channels, enter the lesser of the drainage area for the multithread system or 1 sqmi.

The drainage area adjustment is based on the bankfull regional curves for Maryland relating drainage area to bankfull stream width. Bankfull regional curves are a helpful tool for approximating Ordinary High Water Mark (USACE 2022). The Drainage Area Adjustment captures differences in stream sizes in the Framework and differences in estimated regulated stream area. For example, in the Maryland Piedmont (Wbkfl=14.78DA^0.39), (USFWS 2002). MSMF V.1. sets the benchmark drainage area value at 1 sqmi drainage area (Where DA of 1 square mile receives a multiplier of 1, or no adjustment). The Drainage area adjustment is effective in a range between 0.1-10 square miles, and values above and below the range are capped. The Stream Impact Calculator will apply the appropriate Maryland regional curve equation (USFWS 2002, USFWS 2003) based on the physiographic region you select in Column B.

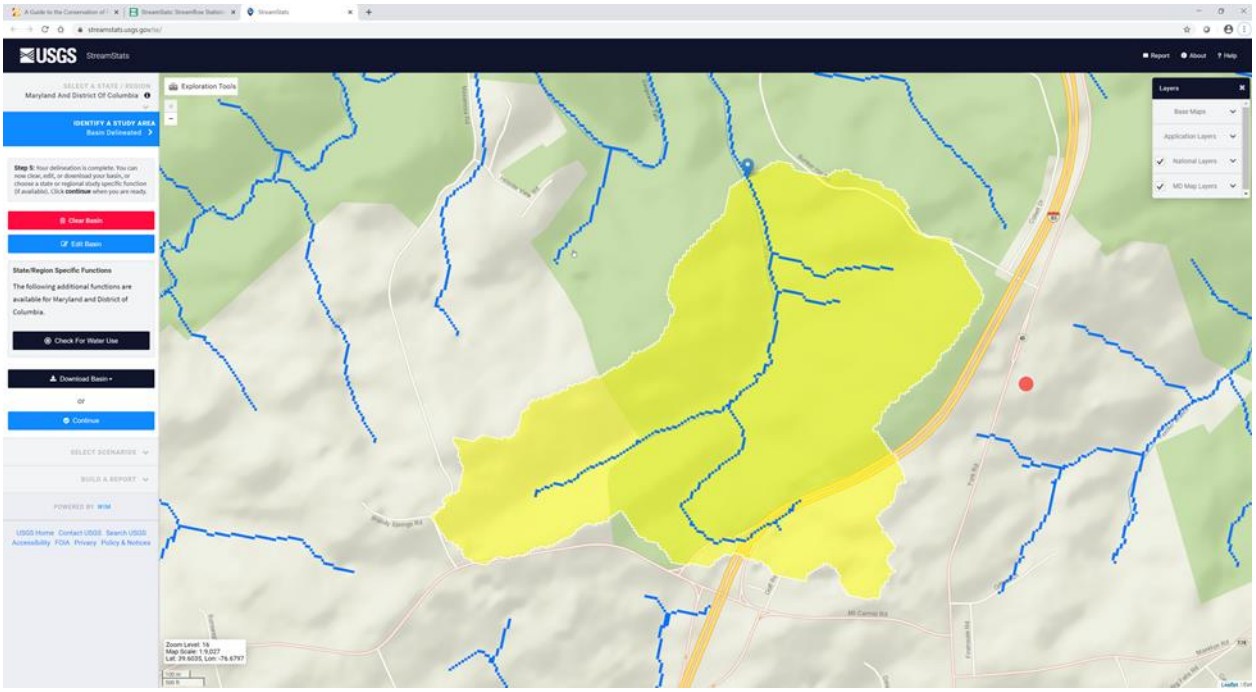


Figure 5 showing drainage area from the center of a subject reach using USGS Stream Stats (Mingo Branch, Baltimore County Maryland). The Drainage area (and other information) can be calculated when generating a report in USGS Stream Stats.

x. *Raw Reach Value (Functional Feet):* The Raw Reach Value (Functional Feet) is the raw functional foot value of a reach before stream impact (or mitigation) adjustments are taken into account. Raw reach value is the product of Stream Length, Stream Quality, Channel Thread factor, and

the Drainage Area factor. Raw Reach Value is calculated for both the existing and proposed conditions. Equation: Raw Reach Value=Reach Length X Stream Quality X Channel Thread Adjustment X Drainage Area Adjustment.

xi. *Raw Change in Reach Value (Functional Feet):* The Raw Change in Reach Value is the difference in the Raw Reach Value between existing and proposed conditions.

d. Stream Impact Adjustments

After the Raw change in stream reach value is determined, two adjustment factors apply to the Raw change in Reach value: Site Sensitivity Adjustment and the Mitigation Ratio.

i. *Site sensitivity*: "Site sensitivity" was included in the Framework to apply general concepts of landscape ecology (MacArthur & Wilson 1967) to mitigation and impact siting. The purpose is to incentivize avoidance and minimization of impacts to streams as well as implement a watershed approach to mitigation as encouraged by the Mitigation Rule (33 CFR 332.2). The Stream Sensitivity adjustment is added to both the Impact and Mitigation Calculators.

To identify the site sensitivity adjustment for TAB 2_Stream Impacts, visit the WRR link below and select the layer listed below. It will provide a color-code map with white area a score of 0 and the darkest areas with a score of 3. Select the Appropriate number of factors in the "Site Sensitivity" Column. The scores in the dropdown menu will range from 0-3. In general, 10% or 0.1 will be added (max of 0.3 or 30%) for each item from the following list which is reflected in the Maryland Watershed Resources Registry (WRR)
https://watershedresourcesregistry.org/states/maryland.html
under the title: "Maryland Stream Mitigation Framework Layers: Site Sensitivity Analysis for Stream Impacts." The WRR also provides a color-coded map with a composite score for specific areas which reflect the following items below:

WRR: MSMF Site Sensitivity Analysis For Stream Impacts

-*Low impervious Cover*: Streams in catchments with <10% impervious cover from National Land Cover Data 2016 (+10%)

-*Located in Target Ecological Areas*: Sites located in Target Ecological Areas as defined by Maryland Department of Natural Resources (+10%)

-*Located Near Protected Lands*: Sites located within 1 mile of protected lands or the Chesapeake Bay Critical Area (+10%)

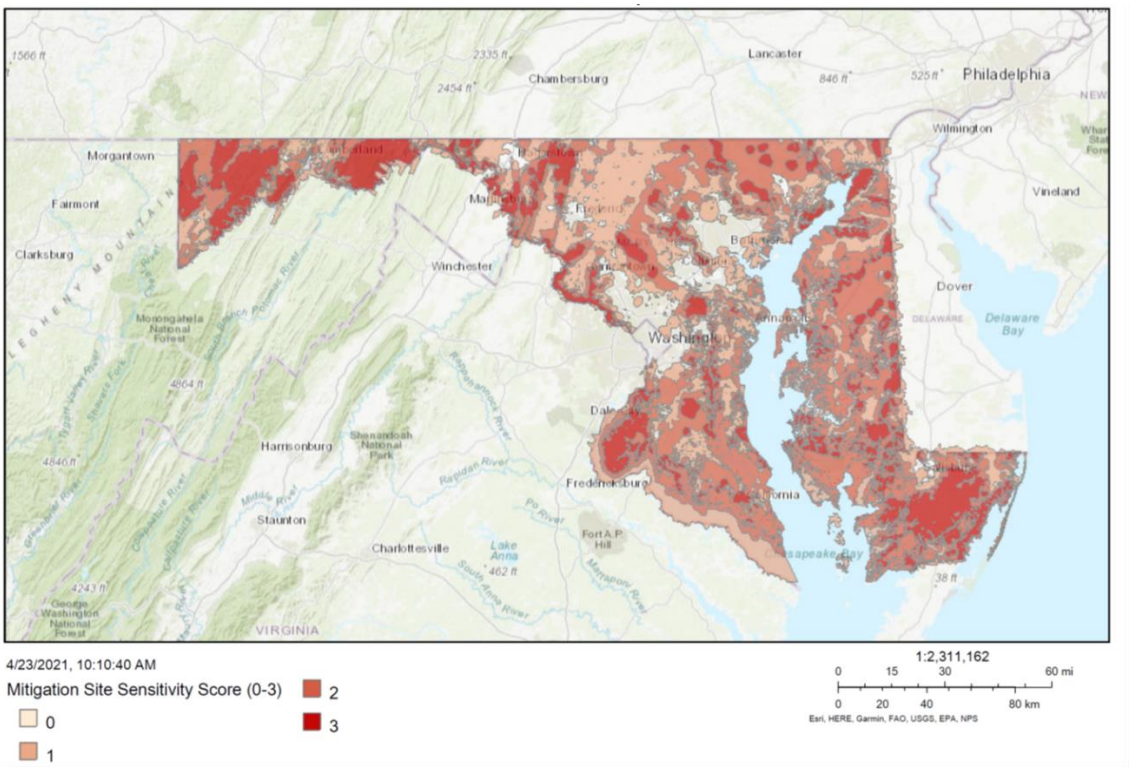


Figure 6 showing the MSMF Site Sensitivity Analysis For Stream Impacts found on the Maryland Watershed Resources Registry.

To illustrate the application of the Site Sensitivity Adjustment, please consider the following example: a stream reach with a Site Sensitivity score of 1, the user would select "1" from the dropdown menu, and a value of 0.1 will populate (or 10% increase).
Note that adjustments to Site Sensitivity factor may be made by the Corps reviewer where justified based on ecological factors (ex. site connecting two Target Ecological Areas, etc.). The user may request an adjustment to this factor based on ecological justification.

ii. *Mitigation Ratio*: Per the recommendation of the 2008 Mitigation Rule compensatory mitigation required is relational to the amount of temporal loss (33 CFR 332.3 (f)(2). The mitigation ratio accounts for temporal loss and other adjustments to provide balance between the Stream Impact Calculator and Stream Mitigation Calculators to offset lost stream functions and conditions. The standard mitigation ratio is set to either 1.5 (Permittee Responsible Mitigation) or 1.3 (Mitigation Banks and Advanced Mitigation). Mitigation Banks and Advanced Mitigation have lower Mitigation Ratios because they are constructed before impacts occur. The above ratios (1.3 or 1.5) will apply to most situations, but it may be adjusted by the Corps where resources are particularly high quality, sensitive, or difficult to replace. The user will Select from the dropdown beneath "Proposed Mitigation Type." There are options for various types of mitigation. The most common historically in Maryland are "Mitigation banks" and "Permittee Responsible."

Notes:
[1]Temporal loss values applied by the USACE Jacksonville District, Huntington District, Louisville District, and others were considered in setting the temporal loss value applied to the Mitigation Ratio for MSMF V.1. Because functions take time to develop on a mitigation site to offset impacts, we applied a temporal loss consideration to the Mitigation Ratio. *The temporal loss applications assume a mitigation site gradually matures over a ten year period (the standard monitoring period).*

e. Stream Losses (functional feet): Calculates the stream losses for an impact activity on a given reach in Functional Feet. Stream Losses are calculated automatically by adjusting the Raw change in reach value by the Site Sensitivity Adjustment and Mitigation Ratio.

f. Remarks: The remarks section provides space to make notes about the reach for the Corps project manager or by a applicant providing notes to the Corps project manager. The user must provide the central coordinates of the reach in this cell to the fifth decimal place (E.g. 39.87945, -76.98097) and should summarize the impact. For example, "300 linear feet of stream placed in a pipe for airport runway expansion."

g. Exceptional circumstances: MSMF V.1. was created for headwater and small wadeable streams. Where impacts to waterways exceed 50 sqmi drainage areas, functional feet should be calculated as follows: 1 sq. ft. of stream loss results in 0.1 functional feet of mitigation. For example, a 100 square foot impact to the Potomac River, resulting in stream loss would result in a need for 10 functional feet of stream mitigation. The equation was derived as follows: 1 linear foot of stream at a 1 square mile drainage area is approximately 14.78 sq. ft. (based on the regional curve for the piedmont of Maryland). In the large waterbody instances, we assume 100% quality, but do not apply the site sensitivity factor. We then multiply by 1.5 (mitigation ratio). 1.5 functional foot per 14.78 sq.ft. yields a value of 0.1 functional feet per square foot of large stream or river loss or 1 functional foot per 10 square feet of large stream or river loss. Such a loss may occur in the placement of bridge piers or abutments over large rivers.

   Alternatively, such waterways may have Anadromous fish considerations, and fish passage options for mitigation may be preferable.

SECTION IV

MSMF V.1. STREAM MITIGATION CALCULATOR FOR STREAM CHANNELS

See Appendix A Calculator Tab 3

STREAM MITIGATION CALCULATOR for Stream Channels

BACKGROUND INFORMATION

Corps Project ID #:	NAB-2023-88552	Corps PM:	James Brown
Project Name:	Panther Branch Mitigation	Date:	26-Feb-23
Lat/Long:	38.58960, -76.9567	Sponsor:	Acme Airports
County:	Baltimore	Collaborators:	DBT, CKL

TOTAL STREAM GAINS from Stream Channels (Functional Feet)

693

Raw Change in Reach Value (Functional Feet)											Adjustments			Stream Gains (Functional Feet)	REMARKS (Incude reach coordinates)
Reach Name	Physiographic Region	Evaluation	Activity	Resource Type	Length (Feet)	Stream Quality	Channel Thread	Drainage Area (sqmi)	Raw Reach Value (Functional Feet)	Raw Change in Value (Functional Feet)	Change in Reach Length Adjustment	Site Sensitivity	Site Protection		
reach 1 small perennial ex	Piedmont	Existing	Preliminary Resource Evaluation	Perennial Headwater	1000	35%	Primary 1	0.5 0.76	267	305	No Change 0	10%	Agricultural Easement 0.04	Easement	366	
	Piedmont	Proposed	Restoration/Enhancement	Perennial Headwater	1000	75%	Primary 1	0.5 0.76	572		0.5 0	31	30			36.90899, -76.99889. Main channel of reach 1
Reach 2 mid perennial example	Piedmont	Existing	Preliminary Resource Evaluation	Perennial Headwater	325	35%	Primary 1	3 1.53	175	200	No Change 0	10%	Agricultural Easement 0.04	Easement	229	
	Piedmont	Proposed	Restoration/Enhancement	Perennial Headwater	325	75%	Primary 1	3 1.53	374		0.5 0	20	10			36.90888, -76.99771
Reach 1 Second channel	Piedmont	Existing	Preliminary Resource Evaluation	Perennial Headwater	1000	33%	Second 0.2	1 1.00	66	84	No Change 0	10%	Agricultural Easement 0.04	Easement	98	
	Piedmont	Proposed	Restoration/Enhancement	Perennial Headwater	1000	75%	Second 0.2	1 1.00	150		0.5 0	8	6			36.90897, -76.99859. Secondary channel of reach 1.

Figure 7 Showing Tab 3_Stream Mitigation Calculator for Stream Channels including example mitigation reaches. See also Appendix A2 for this example

IV. STREAM MITIGATION FOR STREAM CHANNELS CALCULATION TAB 3

The Stream Mitigation Calculator for Stream Channels (Appendix A1: MSMF V.1. Calculator, Tab 3) will be used when stream mitigation is required for unavoidable stream impacts resulting from actions authorized by a CWA Section 404 permit. Please note that stream channel mitigation also requires stream buffers. The calculations for stream buffers are provided separately in Section V: Stream Mitigation Calculator for Stream Buffers and applies to (Appendix A: MSMF V.1. Calculator, Tab 4). Alternatively, fish passage may be a mitigation option, and credits related to it are estimated using a separate tool (MSMF Fish Passage Beta Tool Appendix F1/F2). This is an alternative to traditional stream mitigation work in stream channels and/or stream buffers. Should an applicant seek mitigation credits for restoration work tied to a Fish Passage project, they would still need Calculation Tabs 3 & 4. It is also possible to provide stream mitigation in the form of Stream Buffer work only using Tab 4 only.

In the Stream Mitigation Calculation Tab for Stream Channels, rows with white backgrounds represent "existing" conditions, and rows with green backgrounds represent "proposed" conditions.

When submitting the MSMF V.1. Mitigation Calculation sheet to the Corps for review, the user must also include site mapping (showing locations of each resource which is tabulated in the Mitigation Calculator), a stream assessment form for each reach with a reach photograph, and labeling must be consistent between assessment sheets and maps. In addition, mapping from the Watershed Resources Registry "Maryland Stream Mitigation Framework Layers: Site Sensitivity for Stream Mitigation" is recommended and a "Site Evaluation Report and Stream and Wetland Mitigation" Appendix E1/E2 must be completed.

Materials needed to populate the MSMF V.1. Stream Mitigation Calculator for Stream Channels:

-MSMF V.1. Final Workbook: Tab 3 (Stream Mitigation Calculator) and Tab 4 (Stream Mit Instructions)
-EPA Rapid Bioassessment Habitat Forms (*See Table 3 to determine which assessment is needed*)
-Function Based Rapid Stream Assessment (*See Table 3 to determine which assessment is needed*)
-Maryland Watershed Resources Registry
https://watershedresourcesregistry.org/states/maryland.html
-USGS Stream Stats (https://streamstats.usgs.gov/ss/)
-Appendix E1/E2 Site Evaluation Report for Stream and Wetland Mitigation
-Site Map (more details provided in instructions below)

a. Background Information

i. Corps Project ID #
Enter the Corps Permit Number if known. The Corps Permit number will become available after a permit application is received by the Corps.

ii. Project Name

iii. Lat/Long
Provide site coordinates in decimal degrees (*ex. 39.54876, -78.09878*)

iv. *County*

v. *Corps PM*
Enter the Corps project manager (reviewer) name. This may be added at a later time if the Corps PM had not yet been assigned.

vi. *Date*
Enter the date the Mitigation Calculator Tab was populated with site information

vii. *Sponsor*
Indicate the project sponsor or applicant

viii. *Collaborators*
Provide the name and affiliation of users

b. Total Stream Gains
Located in the top far right corner of the Mitigation Calculator, a number will be seen which tabulates the functional foot values for all stream reaches provided in the sheet from Column P "Stream Gains (functional feet)." Credits for stream buffers are calculated in the "Stream Mitigation-Buffers" tab and covered in Section IV of this manual.

c. *Raw Change in Reach Value (functional feet)*: The "Raw Change in Reach Value" section produces a raw functional foot value (Proposed Value–Existing Value) using several variables described below. The score will then be run through a second section (*See III.d Below "Adjustments"*) yielding "Stream Gains" by reach.

i. *Reach Name*: The user must identify a stream reach name. We recommend that you identify reaches which are unique in quality, drainage area, and proposed treatment. Specifically for stream mitigation, where stream quality changes noticeably or a major tributary enters the stream, a new reach should be entered as a new Row in the Stream Mitigation Calculator. Reach splitting may also be helpful when a stream reach treatment changes (*ex. different restoration approach*). A separate reach should also be created for second and third channels when they are part of a multi-thread stream. See Section "viii. Channel Thread" below.

ii. *Physiographic Region*: The user must identify a general physiographic region for their reach: Mountain, Piedmont, or Coastal Plain. The physiographic region sets which bankfull regional curve is used for the Drainage Area Adjustment (item ix of this section below). The correct regional curve is automatically identified when the physiographic region is selected.

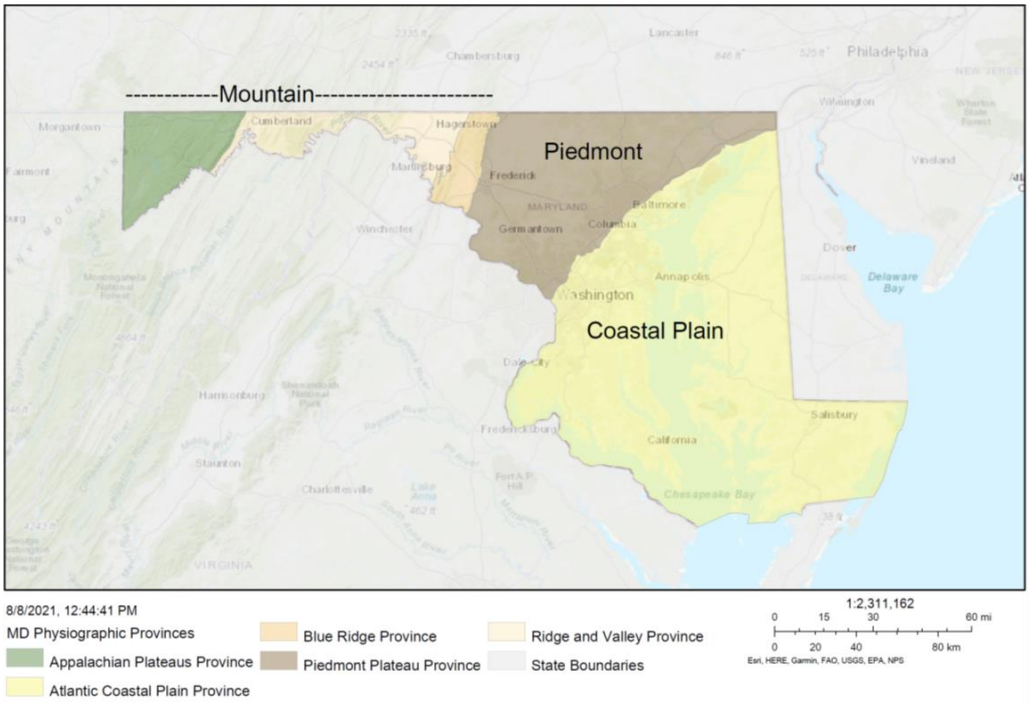


Figure 8 showing general physiographic regions of Maryland

iii. *Evaluation*: For each Stream Reach, there will be two evaluations (rows), one for existing conditions, the other for proposed conditions after an activity.

iv. *Activity*: Activity refers to the action affecting the stream reach. In the Stream Mitigation Calculator Tab, for Existing conditions, "Preliminary Resource Evaluation" is set. When a section of stream is proposed to be restored or enhanced, select "Restoration/Enhancement" in the drop-down menu. When a stream reach is to be preserved, select "Preservation." Equations for "Restoration/Enhancement" and "Preservation" are unique and are visible in the "Stream Gains" column for each reach. Stream reaches generally must be of excellent quality to be considered for preservation. In some instances, streams of above average quality may be preserved when part of a larger mitigation proposal and restoration is infeasible for the subject stream reach. Please note that channel creation is not generally supported in MSMF V.1. unless evidence supports its previous occurrence. In such an instance, the work would classified as "Re-establishment," "Restoration/Enhancement" should be selected from the dropdown list, and a note should be placed in the remarks section for that row. Channel creation ("Establishment") may be acceptable when creating multi-thread systems (new second and third channels). Proposal of multi-thread systems must be supported by documentation that the approach is consistent with the restoration approach and landscape position.

Restoration may be considered in instances where an impaired channel can benefit from restoration work. In general, preservation may be considered only for above average quality resources, above average areas within a larger mitigation site where construction would have an adverse impact on existing resources, or small areas that fit into a larger property, but are inaccessible with necessary construction equipment. Per the 2008 Mitigation Rule, reviewers will need to weigh the value of any stream preservation with the concept of replacing lost functions and should be above average quality and at risk (32 CFR 332.3(h)). In general,

preservation will be allowed as a component of an overall mitigation plan in accordance with the details described above, and in combination with restoration activities. Stand alone preservation projects will be reviewed on a case-by -case basis, and must include high quality resources in ecologically strategic locations.

v. *Resource Type*: Resource type corresponds to channel flow. It may be either Ephemeral, Intermittent, Perennial Headwater, or Perennial Wadeable. Perennial Wadeable streams are defined as those with a drainage area exceeding 5 square miles. Select the "Resource Type" from the dropdown. Definitions of stream resource types by flow class can be found in the definitions section. Please note that the resource type is only descriptive and does not factor into the credit determination. Additionally, mitigation work on ephemeral channels should be limited to the minimum necessary to provide stable elevations for a larger proposal and address erosion presenting design challenges for receiving waters that will be worked. Preservation is also acceptable on high quality ephemeral reaches. Questions regarding Corps jurisdiction over aquatic resources should be coordinated with the assigned project manager or a jurisdictional determination request may be requested by sending an email to: NAB-regulatory@usace.army.mil.

vi. *Reach Length (linear feet)*: The user must indicate the length of the stream reach as measured from the centerline of the active baseflow channel. For tributaries meeting a mainstem stream, excessive downstream extension of a channel may not be credited (extending a channel parallel with the receiving waterbody for an unnaturally long distance). The Corps reviewer will evaluate whether the proposed confluence between two channels is reasonably placed to assist in determining the credited stream length. Reach breaks should occur wherever conditions change substantially. For example, a new reach should be identified where stream bank heights suddenly appear taller for an extended stretch of stream. They should also be identified when a major tributary enters contributing more than 10% of the stream flow.

vii. *Stream Quality*: Stream quality ranges from 0-100% based on the total score of a reach divided by total possible score of an approved Functional or Conditional Assessment Methodology (FCAM). FCAMS are recommended by the 2008 Mitigation Rule to capture functional and conditional changes in resources (33 CFR 332). For the MSMF V.1. Stream Quality of "100%" represents a perfect FCAM score. The user will enter values in the Stream Quality boxes for both existing and proposed condition scores. As mentioned in Section "III.c.i Reach Name", when a stream reach changes noticeably in quality, treatment, or drainage area, a new stream reach should be entered in rows below the previous reach, and a separate stream quality assessment recorded.

Instructions: Assess the existing stream quality using the appropriate stream assessment from Table 3 below. This will typically be the "Function Based Rapid Stream Assessment" on mitigation projects. Next, project the value at year ten for the stream after restoration work. If preservation, keep the same as existing. Take the score out of the total possible to yield a percentage. For example 120/160=75%. Enter this score into the "Stream Quality" column for the applicable stream reach.

FCAM's by Resource Type, stream gradient, and reach length:

One or more of the following FCAMS must be applied to determine stream quality for mitigation reaches for perennial and intermittent streams: Appendix C1_the Function Based Rapid Stream Assessment (USFWS, 2015). The manual for the FBRSA can be found as Appendix C2. Please disregard sections referring to the "Watershed Assessment" for the purpose of the MSMF V.1. For work in ephemeral streams, the user may use Appendix B: the EPA RBP Habitat Form Int/Eph HG for streams with slopes exceeding 2%, and "EPA RBP Habitat Form Int/Eph LG" for ephemeral streams with slopes less than 2%. Flexibility regarding the appropriate stream assessment for streams with slopes near 2% may be discussed with the Corps project reviewer. Citations for the EPA RBP Habitat forms can be found in the "References" section below (Barbour and others, 1999) and the Function Based Rapid Stream Assessment (USFWS, 2015). A new Function Based Rapid Stream Assessment is planned MSMF V.2. in late 2024 or early 2025 with a revised manual.

<table>
<tr><th colspan="5">Table 3. Stream Quality Assessment for MITIGATION (MSMF V.1)</th></tr>
<tr><th colspan="2">Channel Characteristics</th><th colspan="3">Channel Flow Class</th></tr>
<tr><th>Channel Gradient</th><th>Reach Length</th><th>Perennial</th><th>Intermittent</th><th>Ephemeral</th></tr>
<tr><td rowspan="2">High Gradient >2%</td><td>1-299 ft</td><td rowspan="4" colspan="2">Function Based Rapid Stream Assessment</td><td rowspan="2">EPA RBP Habitat Form for Int/Ephemeral Streams: High Gradient</td></tr>
<tr><td>300 ft +</td></tr>
<tr><td rowspan="2">Low Gradient <2%*</td><td>1-299 ft</td><td rowspan="2">EPA RBP Habitat Form for Int/Ephemeral Streams: Low Gradient</td></tr>
<tr><td>300 ft +</td></tr>
</table>

Table 3 *Showing required stream assessment to determine stream quality for stream impacts by channel gradient, reach length, and channel flow class. The same form must be used for existing and proposed conditions. * Note that on ephemeral streams, High Gradient Forms should be used for channels nearing 2% slopes, however, the assessor may select to use the Low Gradient Form for channels with slopes <2%.*

viii. *Channel Thread*: Channel Thread was included to describe calculations for multi-threaded channels and oxbow channels. There are three options for channel thread (primary, second, or third). Single thread channels are considered "primary" channels and awarded at a ratio of 1.0 (no adjustment). For multi-threaded channels, the user must designate a primary or main channel, then may be awarded additional credits for second (0.2 multiplier) or third channels (0.1 multiplier) improvements. For second or third channels, credit will only be debited (or awarded) for intermittent or perennial channels with active channels at least 1 foot wide with pools 0.5 feet deep. Oxbows may be treated as second or third channels. For the Channel

Thread factor, it is important to note the difference between "Multi-thread channels" and "Braided Channels." For the purpose of the MSMF, multi-thread channels are those channels in the same valley and general flowpath of a primary channel separated by an upland (or wetland) island where vegetation is established and soil formation is occurring (see figure 4 of Section III and figure 9 below). Braided channels are typically very dynamic streams and a result of high bed load (where soil development and vegetation do not occur on areas between channels). Braided channels are to be treated as one single primary channel for a given valley.

For multithread channels, generally only one stream assessment (RBP or FBRSA) will be needed covering all channels to determine the "Stream Quality" value. Where channels are separated by 20 feet or more, it may be preferable to assess separately.

Figure 9 showing a photograph of a designed multi-thread, stream-wetland complex exhibiting second and third channels. Each channel (if they meet the size requirements, would be entered as separate entries (reach names) in the Mitigation Calculator Tab 3.

ix. *Drainage Area (sqmi)*: For primary channels, enter the drainage area (in square miles rounded to the nearest tenth) in the top box of the column (I) and the adjustment factor will populate in the box below. Drainage area must be determined using USGS stream stats: https://www.usgs.gov/mission-areas/water-resources/science/streamstats-streamflow-statistics-and-spatial-analysis-tools

The drainage area must be measured from the center of the subject reach. Where drainage area is unavailable on USGS Stream stats, the user must measure the drainage area from a

topographic map. For multi-threaded streams, indicate the drainage area for primary channels in Column I, and for second or third channels, enter the lesser of the drainage area for the multithread reach or 1 sqmi for the drainage area.

The drainage area adjustment is based on the bankfull regional curves for Maryland relating drainage area to bankfull stream width. It captures differences in stream sizes in the Framework and differences in estimated regulated stream area. For example, in the Maryland Piedmont (Wbkfl=14.78DA^0.39), (USFWS 2002). MSMF V.1. sets the benchmark drainage area value at 1 sqmi drainage area (Where DA of 1 square mile receives a multiplier of 1, or no adjustment). The Drainage area adjustment is effective in a range between 0.1-10 square miles, and values above and below the range are capped. The Stream Impact Calculator will apply the appropriate Maryland regional curve equation (USFWS 2002, USFWS 2003) based on the physiographic region you select in Column B.

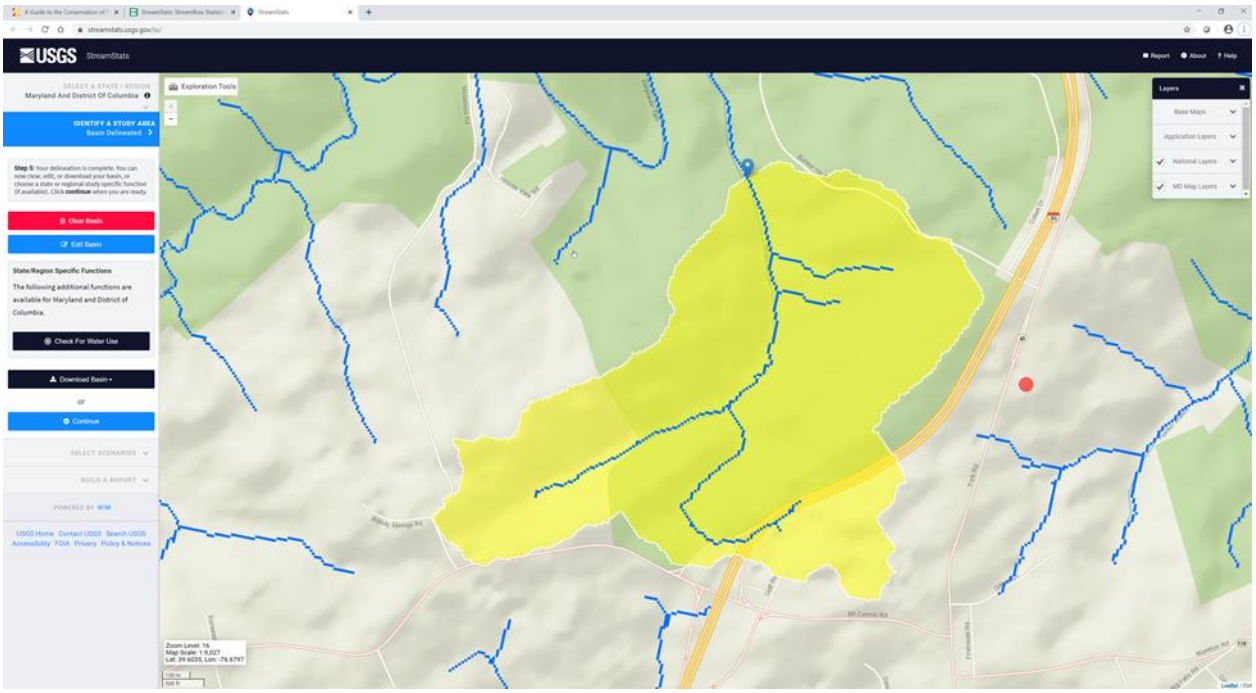


Figure 10 showing drainage area from the center of a subject reach using USGS Stream Stats (Mingo Branch, Baltimore County Maryland). The Drainage area (and other information) can be calculated when generating a report in USGS Stream Stats.

x. *Raw Reach Value (Functional Feet):* The Raw Reach Value (Functional Feet) is the raw functional foot value of a reach before stream mitigation adjustments are taken into account. Raw reach value is the product of Stream Length, Stream Quality, Channel Thread factor, and the Drainage Area factor. Raw Reach Value is calculated for both the existing and proposed conditions.

xi. *Raw Change in Reach Value (Functional Feet):* The Raw Change in Reach Value is the difference in the Raw Reach Value between existing and proposed conditions.

d. <u>Adjustments</u>

After the Raw change in stream reach value is determined, three adjustment factors apply to the Raw change in Reach value: Site Sensitivity Adjustment, Site Protection.

i. *Change in Reach Length*: The "change in reach length" adjustment provides a correction when stream length is gained or lost. The purpose is to make crediting similar to typical restoration work where quality may improve from 35%-75% or so. This field reduces credits awarded for stream length extensions by 50%. It also readjusts credits where stream length is lost. This often occurs in restoring unnaturally sinuous streams that are responding to a past disturbance (e.g. Old millpond sediment). Each of the situations provided above automatically adjust credits during stream length gains and stream length losses by 50%, and the adjustment is only applied to the excess or deficit portion respectively. The user does not need to enter data in this column (L).

ii. *Site sensitivity*: "Site sensitivity" was included in the stream mitigation calculations to apply general concepts of landscape ecology (MacArthur & Wilson 1967) to mitigation siting as well as adjust for on-site factors that may limit the performance of a proposal . Another goal was to implement a watershed approach to mitigation as encouraged by the Mitigation Rule (33 CFR 332.2).

The site sensitivity values range from 30% to -30% and are determined through completion of the Site Evaluation Report (Appendix E1) and the Site Sensitivity Grid (Appendix E2). While it is possible to calculate a score of >30% or <-30% in Appendix E2, the limits for the mitigation calculator (Tab 3 in Appendix A1 and A2) are 30% maximum and -30% minimum. This would effectively adjust the amount of credits awarded for a given proposal by up to 30% or down to -30%. The Corps and MDE reserve the ability to edit the site sensitivity adjustment after consultation with resource agencies, however the output from Appendix E2 will typically be applied directly.

The site sensitivity adjustment is based on a combination of the results of the "Site Evaluation Report for Stream and Wetland Mitigation" and the results of the "MSMF Site Sensitivity Analysis for Stream Mitigation: Stream Channels," as shown on the Maryland Watershed Resources Registry (see Figure 11 above). The Site Evaluation Report (Appendix E1) will direct the user on how to apply the WRR layers noted above.

In instances where water quality is impaired or substantial constraints occur on the site, the reviewers may reject a mitigation site regardless of the weighting provided in the WRR: MSMF Site Sensitivity Analysis and the Site Evaluation Report (Appendix E1) and Site Sensitivity Grids (Appendix E2). Alternatively, a site with only poor water quality as an impairment may still be an acceptable candidate for stream buffer work where credits would be calculated only using TAB 4 Stream Mitigation for Stream Buffers.

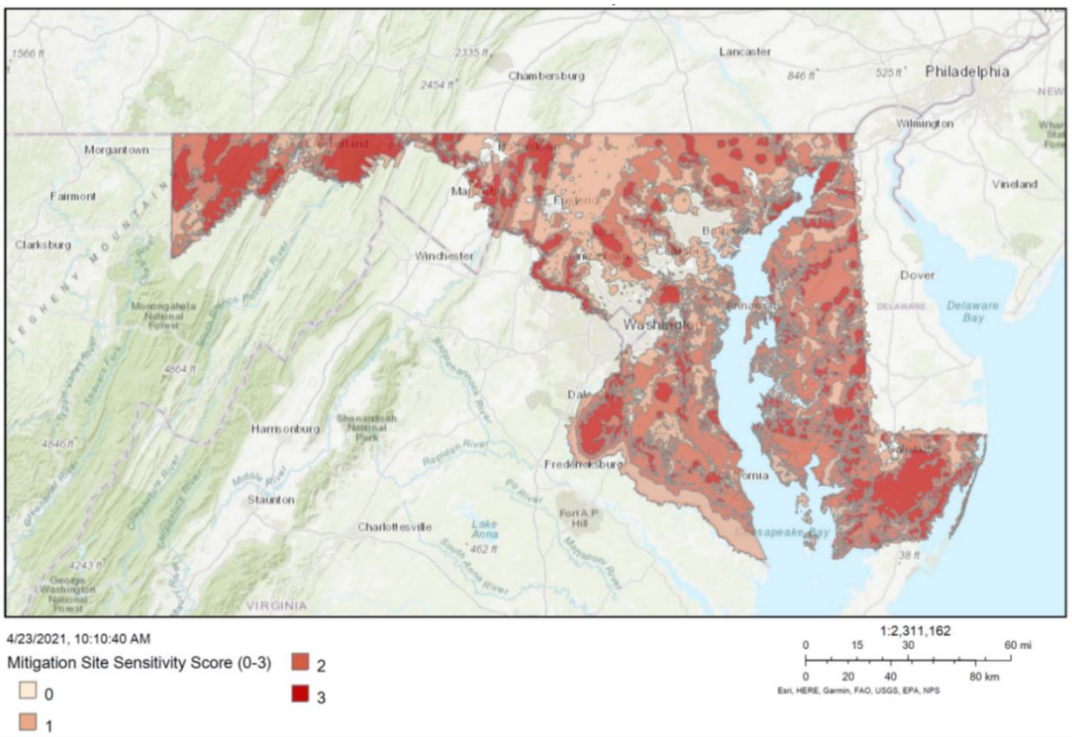


Figure 11 showing output of the MSMF: Site Sensitivity Analysis for Stream Mitigation-Stream Channels located on the Maryland Watershed Resources Registry.

Site Sensitivity Adjustment for Mitigation in Stream Channels (Corresponds to MSMF V.1. Appendix A Tab 3)					
Y/N	Parameter	% Adjustment if Selected	% Adjustment	Appendix E Location	External Tools
	In Tier 2 Waters or Target Ecological Areas	10%		II.A.1	Maryland WRR: Site Sensitivity for Stream Mitigation
	Within 1 mile of Protected Lands	10%		II.A.1	Maryland WRR: Site Sensitivity for Stream Mitigation
	In Catchment with Impervious Surface Cover <10%	10%		II.A.1	Maryland WRR: Site Sensitivity for Stream Mitigation
	Airport requires wildlife culling	-5%		I.7	
	Infrastructure or property presents lateral design constraints	-5%		II.A.5 and II.B	
	Infrastructure or property presents vertical design constraints	-5%		II.A.5 and II.B	
	Aquatic Connectivity to Downstream Waters is limited (perennial channels only)	-10%		II.A.4	
	Moderate Water[1] Quality Impairment(s)	-10%		II.A.1.d and II.B	
	Other:				
	Other:				
		Total	0%		

Table 4. Showing Site Sensitivity Adjustment Grid for Stream Channels. This is completed in Appendix E2 after completing the Site Evaluation Report (Appendix E1). Note that two rows titled "Other" allow both regulators and applicants to list other reasons and proposed adjustments based on the ecological merits or risks of a given mitigation site.

ii. *Site Protection*: The site protection factor captures the level of protection provided to the site. Easements, Accredited Easements, and Fee Simple purchases (with conservation land holder). are the preferred site protection mechanism because they provide the most robust long-term protection. Deed restrictions, or work on public lands may also be proposed. The site protection column captures the gain in benefits from improving legal protection of a site. To estimate this, we must know both what protection type is proposed, and what types of

protection currently occur on a site. The column is split into two sides: On the left, select the existing site protection and on the right, select the proposed site protection. Adjustments range from 0-0.11 (or 0-11%). Because the site protection adjustment is based on the total proposed functional foot value of the site (rather than the delta) this adjustment has a larger effect. For the column on the left, Select from the dropdown which EXISTING protection type the site falls under: "No Existing Protection", "Agricultural Easement", "Environmental Easement", or "Public Lands." If a development Easement occurs on the property, select "Agricultural Easement." In the right column, select from the dropdown which PROPOSED site protection has been selected for the site. Select between "No Additional Protection," "Deed Restriction," "Easement," "Accredited Easement" (Easements held by a Land Trust Alliance-approved holder), "Public Land MOA" (Only for work on public lands where an agreement improves protection), and "Fee Simple to Conservation Holder" (For sites which are purchased and then transferred to a conservation holder after an Easement is placed on the property). Adjustments to functional feet crediting based on site protection are summarized below in *Table 5*.

Notes:

Site protection may vary across a mitigation site and portions of a site may have different values. For the "Fee Simple…" option, the site must be purchased, an easement placed on it, and then transferred to a third party conservation holder (e.g. State Resource agency, or third party such as The Nature Conservancy or a Riverkeeper). This option is not available for sites that already predominately have an environmental easement on them (Maryland Environmental Trust, etc.).

Table 5. STANDARD CREDIT ADJUSTMENT FOR SITE PROTECTION

Existing Site Protection	Proposed Site Protection	Expectation	Protection Benefits Provided	Rank	Multiplier[1, 4]
Fully Protected as Public Lands	Public Lands as-is	Restoration project on public lands that are fully protected	None	8	0%
Public Lands	Public Lands MOA increasing protection	Restoration project on public lands. Public lands are not adequately protected and protection is added (MOA, Easement, etc)	MOA to cover standard gap	6	2%
Environmental Easement	Deed Restriction	Mitigation on private land that already has an environmental protection instrument. A mitigation deed restriction is filed. The existing easement is subordinate to the mitigation deed restriction.	Minimal protection improvement/Protection Weak	8	0%
Agricultural Easement or Transfer of Development Rights	Deed Restriction	Mitigation on private land that already has site protection in fthe form of from ag/timbering or TDR. A mitigation deed restriction is filed. The existing easement is subordinate to the mitigation deed restriction.	Moderate protection improvement/Protection Weak	7	1%
None	Deed Restriction	Mitigation on private land with no existing protection. A mitigation deed restriction is filed. The existing easement is subordinate to the mitigation deed restriction.	Substantial Protection Improvement/protection weak	6	2%
Environmental Easement	Easement	Mitigation on private land that already has an environmental protection instrument. A mitigation easement is filed. The existing easement is subordinate to the mitigation easement.	Minimal protection improvement, Protection moderate	6	2%
Agricultural Easement or Transfer of Development Rights	Easement	Mitigation on private land that already has site protection aside from ag/timbering. A mitigation easement is filed. The existing easement is subordinate to the mitigation easement.	Moderate protection improvement/Protection modearte	4	4%
None	Easement	Mitigation on private land with no existing protection. An easement is filed.	Substantial Protection Improvement, Protection moderate	3	5%
Environmental Easement	Accredited Easement	Mitigation on private land that already has an environmental protection instrument. A mitigation accredited easement is filed. The existing easement is subordinate to the mitigation easement.	Minimal Protection Improvement, Protection strong	5	3%
Agricultural Easement or Transfer of Development Rights	Accredited Easement	Mitigation on private land that already has site protection aside from ag/timbering. A mitigation accredited easement is filed. The existing easement is subordinate to the mitigation easement.	Moderate Protection Improvement/Protection Strong	3	6%
None	Accredited Easement	Mitigation on private land with no existing protection. An Accredited easement is filed.	Substantial Protection Improvement/Protection Strong	2	7%
None or Agricultural Easement	Fee Simple Purchase after easement applied[5]	Property is bought fee-simple. Easement is placed on property. Donated to Conservation holder (Resource agency, non-profit, etc).	Excellent Protection Improvement/New Conservation Lands Created/Protection very strong	1	9%

Table 5 showing proposed credit adjustments for site protection.

[1] *The calculator outputs are suggested values only and may be adjusted at the discretion of the Corps/MDE under the advisement of resource agencies, based on consideration of improvement to protection (e.g., existing environmental easements providing a high existing level of protection may get less than the value shown above).*

[2] *Some parcels may be split between areas with existing easements and areas free of them. Each stream reach and stream buffer area should run through this analysis independently.*

[3] *Note that the incentives for site protection remove drainage area from the calculation. This way all streams and buffer areas receive the same crediting regardless of stream size.*

[4] *Protection % is based on total credits protected (not based on the delta).*

[5] *Land is purchased fee simple. An easement or accredited easement is placed on the property. The property is then donated to a conservation holder. This may be a resource agency, an approved non-profit (TNC, etc.), or a riverkeeper. It may be ideal for the holder to also be the long-term steward.*

e. Stream Gains (functional feet): Provides the stream mitigation produced by a restored or preserved stream reach measured in functional feet. Stream Gains are calculated automatically by adjusting the Raw change in reach value by the Site Sensitivity Adjustment, Site Protection Factor, and Change in Channel Length Adjustment.

f. Remarks: The remarks section provides space to make notes about the reach for the Corps project manager. It should contain a summary of the mitigation provided and must show central coordinates of the reach in decimal degrees to the 5th decimal point. For example: "restoration of incised tributary by grading stream banks and placing instream structure. 39.09898, -76.55879)."

SECTION V

MSMF V.1. STREAM MITIGATION CALCULATOR FOR STREAM BUFFERS

See Appendix A Calculator Tab 4

STREAM MITIGATION CALCULATOR for Stream Buffers

BACKGROUND INFORMATION

Corps Project ID #:	NAB-2023-88552	Corps PM:	James Brown
Project Name:	Panther Branch Mit	Date:	23-Feb-23
Lat/Long:	38.58960,-76.9567	Sponsor:	Acme Airports
County:	Baltimore	Collaborators:	DBT, CKL

Total Stream Gains from Buffers (Functional Feet): **217**

Raw Change in Buffer Value								Adjustments			Stream Gains (Functional Feet)	REMARKS (include CSBA Coordinates)
Credited Stream Buffer Area Name (CBSA)	Activity	Evaluation	Buffer Area (Acres)	Buffer Quality	Quality Acres	Raw Buffer Value (Functional Feet)	Raw Change in Buffer Value (Functional Feet)	Site Sensitivity	Site Protection			
CSBA 1 mature forest	Preliminary Resource Eval	Existing Buffer	4.00	75%	3.00	225	0	10%	Agricultural Easement	Easement	59	
	Preservation	Proposed Buffer	4.00	75%	3.00	225			0.04			
								2	9			38.58960, -78.9565. Preservation of mature forest.
CSBA 2 Pasture	Preliminary Resource Eval	Existing Buffer	4.00	30%	1.20	90	135	10%	Agricultural Easement	Easement	158	
	Restoration/Enhancement	Proposed Buffer	4.00	75%	3.00	225			0.04			
								14	9			38.58960, -78.9567. Forest buffer planted in pasture.

Figure 12 Showing Tab 4_Stream Mitigation for Stream Buffers including example stream buffer areas or (CSBA's). This example may be viewed in better detail in Appendix A2.

V. STREAM MITIGATION CALCULATOR FOR STREAM BUFFER _TAB 4

The Stream Mitigation Calculator for Stream Buffers must be completed whenever stream credits are sought for restoration or preservation work in stream buffers. It is possible to seek stream mitigation credits for buffer only work, even where channel work is not proposed. Credits are awarded based on a combination of size (acreage), quality, site selection, and site protection and are calculated in functional feet. To populate this tab, please first review the "Stream Buffer Quality Assessment" and the associated instructions. A "Quality Acre" is defined as one acre of stream buffer with a quality of 100%. This calculator converts "Quality Acres" to stream credits (functional feet). Each quality acre is worth 75 functional feet and this is applied to the equation for "Raw Change in Buffer Value" in Column I. From there adjustments are made based on "Site Sensitivity" and "Site protection." Calculations for stream buffer restoration capture the improvement in "Quality Acres," while calculations for stream buffer preservation are based on the proposed or final value of all "Quality Acres" in the Buffer.

Credited Stream Buffer Areas generally must occur within 200 linear feet of the edge of a channel at baseflow. However, in some instances where a stream buffer is particularly ecologically valuable or a property is purchased in whole (fee simple), a larger buffer may be considered by the Corps and MDE reviewers.

Figure 13: Credited Stream Buffer Areas

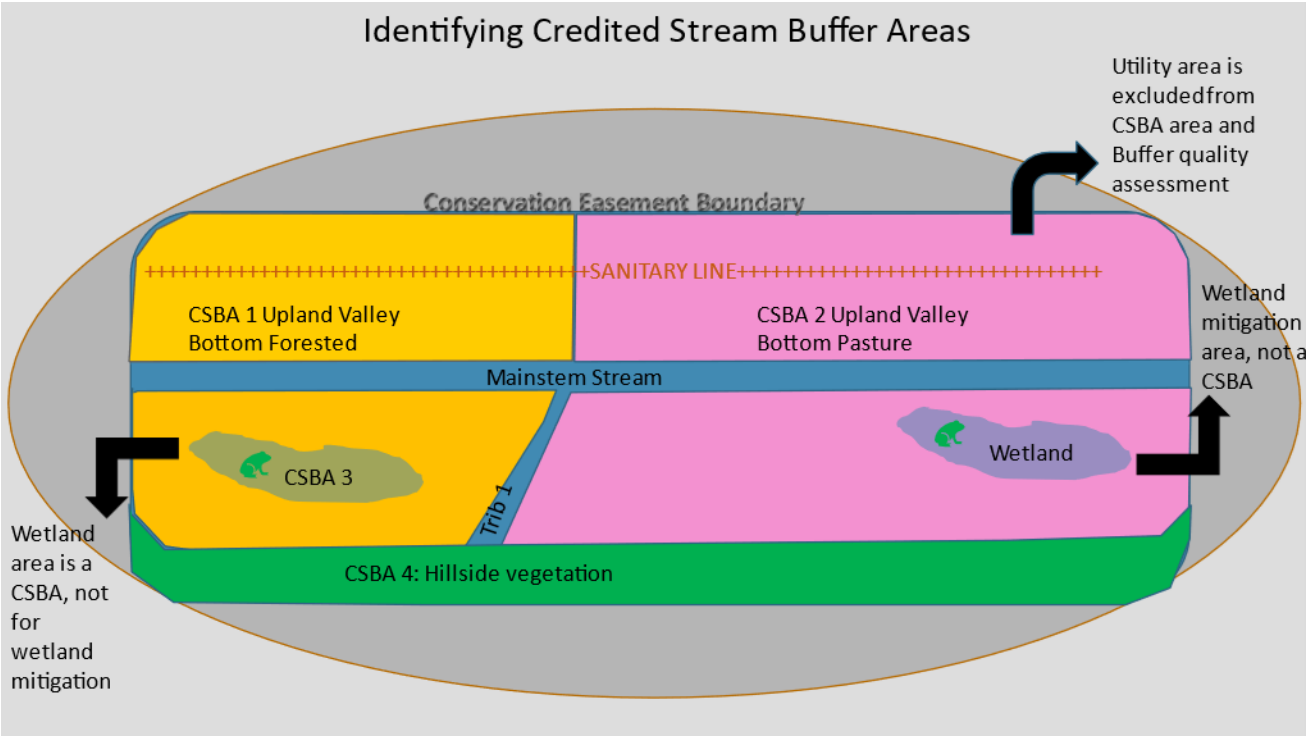


Figure 13 showing how to identify Credited Stream Buffer Areas.

When submitting the MSMF V.1. Mitigation Calculation sheet to the Corps for review, the user must include site mapping (showing locations of each resource which is tabulated in the Mitigation Calculator), a "Stream Buffer Quality Assessment" for each "Credited Stream Buffer Area" with a reach photograph, and labeling must be consistent between assessment sheets and maps. In addition, mapping from the Watershed Resources Registry "Maryland Stream Mitigation Framework Layers: Site Sensitivity for Stream Mitigation" is recommended and a "Site Evaluation Report for Stream and Wetland Mitigation" must be completed.

Note:
[1]Mitigation proposals involving clearing of high quality mature forests or other high quality vegetative communities may result in a loss of stream credits (function feet) under the Stream Mitigation Calculator for Stream Buffers.

Materials needed to populate the MSMF V.1. Stream Mitigation Calculator for Stream Buffers:

-MSMF V.1. Final Workbook: Tab 4 (Stream Mitigation-Buffers Calculator)
-MSMF V.1. Stream Buffer Quality Assessment (Appendix D1)
-MSMF V.1. Stream Buffer Quality Assessment Manual (Appendix D2)
-Maryland Watershed Resources Registry
https://watershedresourcesregistry.org/states/maryland.html
-USGS Stream Stats (https://streamstats.usgs.gov/ss/)
-Site Evaluation Report for Stream and Wetland Mitigation
-Site Map (more details provided in instructions below)
-For Stream Buffer Post Construction Monitoring (Appendix D3)

a. Background Information

i. Corps Project ID #
Enter the Corps Permit Number if known. The Corps Permit number will become available after a permit application is received by the Corps.

ii. Project Name

iii. Lat/Long
Provide site coordinates in decimal degrees (*ex. 39.54876, -78.09878*)

iv. County

v. Corps PM
Enter the Corps project manager (reviewer) name. This may be added at a later time if the Corps PM had not yet been assigned.

vi. Date
Enter the date the Calculator Tab was populated with site information

vii. Sponsor
Indicate the project sponsor or applicant

viii. Collaborators
Provide the name and affiliation of collaborators

b. Total Stream Buffer Gains

Located in the top far right corner of the Calculator, a number will be seen which tabulates the functional foot values for all Credited Stream Buffer Areas (CSBA's) provided in the sheet from Column P "Stream Gains (functional feet)." For more information

c. Raw Change in Buffer Value (functional feet): *The "Raw Change in Reach Value" section produces a raw functional foot value (Proposed Value–Existing Value) using several variables described below. The score will then be run through a second section (See IV.d Below "Adjustments") yielding "Stream Gains" by reach.*

i. *Credited Stream Buffer Area (CSBA) Name*: Provide a distinct name for the buffer area. A distinct CSBA occurs where vegetative conditions change measurably either in the existing condition or proposed condition after treatment. At a minimum, a CSBA should be designated for valley bottom uplands, hillside, and valley bottom wetlands if those areas are present on a site and are not being used for other credit programs (Wetland mitigation credits, Forest Conservation, TMDL Program, etc.).

ii. *Activity*: Select from the dropdown whether the reach is proposed as "Restoration/Enhancement" or "Preservation." Select "Restoration/Enhancement" whenever action is occurring in the CSBA aside from land protection. Select "Preservation" for any CSBA where no action will occur other than land protection.

iii. *Evaluation*: Separates "Existing" vs "Proposed" values. These are preset. The existing value is calculated in the top half of the section and proposed value in the bottom half.

iv. Buffer Area: Enter the existing and proposed buffer area in Acres as measured around the perimeter of the CBSA using an accurate GPS unit. Remote tools may aid this determination.

v. *Buffer Quality*: Enter the "Existing" and "Proposed" buffer quality from the Stream Buffer Quality Assessment. Assess the existing stream buffer quality for "existing," and project the stream buffer quality after ten years of monitoring (post construction/planting). Please note that the disturbance of a mature forest and replacement with a ten year old forest could result in a negative buffer quality score due.

vi. *Quality Acres*: Product of "Buffer Area" and "Buffer Quality." Functional Foot Credits are calculated based on this number. Quality Acres for "Existing" conditions and "Proposed" conditions are calculated separately. A Quality Acre is defined as an acre of stream buffer with a quality of 100%.

vii. *Raw Buffer Value*: Indicates the Buffer Value in Functional Feet for both "Existing" and "Proposed" conditions. Raw Buffer Value for "Existing" conditions and "Proposed" conditions are calculated separately. This provides a functional foot value for each Quality Acre (Quality Acres X 75 ff/Quality Acre = Raw Buffer Value.

viii. *Raw Change in Buffer Value*: Indicates the difference in functional foot between "Existing" and "Proposed" conditions prior to application of adjustments.

d. Adjustments

iii. *Site Sensitivity:* "Site sensitivity" was included in the stream mitigation calculations to apply general concepts of landscape ecology (MacArthur & Wilson 1967) to mitigation siting as well as adjust for on-site factors that may limit the performance of a proposal . Another goal was to

implement a watershed approach to mitigation as encouraged by the Mitigation Rule (33 CFR 332.2).

The site sensitivity values range from 30% to -30% and are determined through completion of the Site Evaluation Report (Appendix E1) and the Site Sensitivity Grid for Stream Buffers (Appendix E2 Tab 2). While it is possible to calculate a score of >30% or <-30% in Appendix E2, the limits for the mitigation calculator (Tab 4 in Appendix A1 and A2) are 30% maximum and -30% minimum. This would effectively adjust the amount of credits awarded for a given proposal by up to 30% or down to -30%. The Corps and MDE reserve the ability to edit the site sensitivity adjustment after consultation with resource agencies, however the output from Appendix E2 will typically be applied directly.

The site sensitivity adjustment is based on a combination of the results of the "Site Evaluation Report for Stream and Wetland Mitigation" and the results of the "MSMF Site Sensitivity Analysis for Stream Mitigation: Stream Channels," as shown on the Maryland Watershed Resources Registry (see Figure 11 above). The Site Evaluation Report (Appendix E1) will direct the user on how to apply the WRR layers noted above.

In instances where excessive forest clearing or substantial constraints occur on the site, the reviewers may reject a mitigation site regardless of the weighting provided in the WRR: MSMF Site Sensitivity Analysis.

Table 6. Site Sensitivity Adjustment for Mitigation in Stream Buffers (Corresponds to MSMF V.1. Appendix A Tab 4)					
Y/N	Parameter	% Adjustment if Selected	% Adjustment	Appendix E Location	External Tools
	In Tier 2 Waters or Target Ecological Areas	10%		II.A.1	Maryland WRR: Site Sensitivity for Stream Mitigation
	Within 1 mile of Protected Lands	10%		II.A.1	Maryland WRR: Site Sensitivity for Stream Mitigation
	Connects to Green Infrastructure Hubs and Corridors	10%		I.C.7.a	Maryland WRR: Green Infrastructure Layers
	Airport Places limitation on Vegetation Plantings	-5%		I.7	
	Airport requires wildlife culling	-5%		I.7	
	Buffer Fragmented by Infrastructure or Utility Lines	-5%		I.B.6.	
	Other:				
	Other:				
		Total	0%		

Table 6. *Showing Site Sensitivity Adjustment Grid for Stream Buffers. The above grid is completed in Appendix E2 after completing the Site Evaluation Report (Appendix E1). Note that two rows titled "Other" allow both regulators and applicants to list other reasons and proposed adjustments based on the ecological merits of a given mitigation site.*

i. *Site Protection:* The site protection factor captures the level of protection provided to the site. Easements, Accredited Easements, and Fee Simple purchases (with conservation land holder). are the preferred site protection mechanism because they provide the most robust long-term protection. Deed restrictions, or work on public lands may also be proposed. The site protection column captures the gain in benefits from improving legal protection of a site. To estimate this, we must know both what protection type is proposed, and what types of protection currently occur on a site. The column is split into two sides: On the left, select the existing site protection and on the right, select the proposed site protection. Adjustments range from 0-0.11 (or 0-11%). Because the site protection adjustment is based on the total proposed functional foot value of the site (rather than the delta) this adjustment has a larger effect. For the column on the left, select from the dropdown which EXISTING protection type the site falls

under: "No Existing Protection", "Agricultural Easement", "Environmental Easement", or "Public Lands." If a development Easement occurs on the property, select "Agricultural Easement." In the right column, select from the dropdown which PROPOSED site protection has been selected for the site. Select between "No Additional Protection," "Deed Restriction," "Easement," "Accredited Easement" (Easements held by a Land Trust Alliance-approved holder), "Public Land MOA" (Only for work on public lands where an agreement improves protection), and "Fee Simple to Conservation Holder" (For sites which are purchased and then transferred to a conservation holder after an Easement is placed on the property). Adjustments to functional feet crediting based on site protection are summarized below in Table 7.

Notes:
[1]Site protection may vary across a mitigation site and portions of a site may have different values.
[2]For the “Fee Simple…” option, the site must be purchased, an easement placed on it, and then transferred to a third-party conservation holder (e.g., State Resource agency, or an NGO such as The Nature Conservancy or a Riverkeeper). This option is not available for sites that already predominately have an environmental easement on them (Maryland Environmental Trust, etc.).

Table 7. STANDARD CREDIT ADJUSTMENT FOR SITE PROTECTION

Existing Site Protection	Proposed Site Protection	Expectation	Protection Benefits Provided	Rank	Multiplier[1, 4]
Fully Protected as Public Lands	Public Lands as-is	Restoration project on public lands that are fully protected	None	8	0%
Public Lands	Public Lands MOA increasing protection	Restoration project on public lands. Public lands are not adequately protected and protection is added (MOA, Easement, etc)	MOA to cover standard gap	6	2%
Environmental Easement	Deed Restriction	Mitigation on private land that already has an environmental protection instrument. A mitigation deed restriction is filed. The existing easement is subordinate to the mitigation deed restriction.	Minimal protection improvement/Protection Weak	8	0%
Agricultural Easement or Transfer of Development Rights	Deed Restriction	Mitigation on private land that already has site protection in fthe form of from ag/timbering or TDR. A mitigation deed restriction is filed. The existing easement is subordinate to the mitigation deed restriction.	Moderate protection improvement/Protection Weak	7	1%
None	Deed Restriction	Mitigation on private land with no existing protection. A mitigation deed restriction is filed. The existing easement is subordinate to the mitigation deed restriction.	Substantial Protection Improvement/protection weak	6	2%
Environmental Easement	Easement	Mitigation on private land that already has an environmental protection instrument. A mitigation easement is filed. The existing easement is subordinate to the mitigation easement.	Minimal protection improvement, Protection moderate	6	2%
Agricultural Easement or Transfer of Development Rights	Easement	Mitigation on private land that already has site protection aside from ag/timbering. A mitigation easement is filed. The existing easement is subordinate to the mitigation easement.	Moderate protection improvement/Protection modearte	4	4%
None	Easement	Mitigation on private land with no existing protection. An easement is filed.	Substantial Protection Improvement, Protection moderate	3	5%
Environmental Easement	Accredited Easement	Mitigation on private land that already has an environmental protection instrument. A mitigation accredited easement is filed. The existing easement is subordinate to the mitigation easement.	Minimal Protection Improvement, Protection strong	5	3%
Agricultural Easement or Transfer of Development Rights	Accredited Easement	Mitigation on private land that already has site protection aside from ag/timbering. A mitigation accredited easement is filed. The existing easement is subordinate to the mitigation easement.	Moderate Protection Improvement/Protection Strong	3	6%
None	Accredited Easement	Mitigation on private land with no existing protection. An Accredited easement is filed.	Substantial Protection Improvement/Protection Strong	2	7%
None or Agricultural Easement	Fee Simple Purchase after easement applied[5]	Property is bought fee-simple. Easement is placed on property. Donated to Conservation holder (Resource agency, non-profit, etc).	Excellent Protection Improvement/New Conservation Lands Created/Protection very strong	1	9%

Table 7 showing proposed credit adjustments for site protection.

[1] The calculator outputs are suggested values only and may be adjusted at the discretion of the Corps/MDE under the advisement of resource agencies, based on consideration of improvement to protection (e.g., existing environmental easements providing a high existing level of protection may get less than the value shown above).

[2] Some parcels may be split between areas with existing easements and areas free of them. Each stream reach and stream buffer area should run through this analysis independently.

[3] Note that the incentives for site protection remove drainage area from the calculation. This way all streams and buffer areas receive the same crediting regardless of stream size.

[4] Protection % is based on total credits protected (not based on the delta).

[5] Land is purchased fee simple. An easement or accredited easement is placed on the property. The property is then donated to a conservation holder. This may be a resource agency, an approved non-profit (TNC, etc.), or a riverkeeper. It may be ideal for the holder to also be the long-term steward.

e. Stream Gains (Functional Feet): Provides the stream mitigation produced by a restored or preserved stream buffer measured in functional feet. Stream Gains are calculated automatically by adjusting the Raw change in buffer value by the Site Sensitivity Adjustment, Site Protection Factor.

f. Remarks: The remarks section provides space to make notes about the reach for the Corps project manager. It should contain a summary of the mitigation provided and must show central coordinates of the CSBA in decimal degrees to the 5th decimal point.

e. Exceptional circumstances:

i. The 200-foot limit on crediting for stream buffers (400-foot total between two sides) may be lifted based on the judgement of the Corps and MDE reviewers. Instances where this should be considered are:

i. The mitigation property is purchased fee simple, with an easement placed before transfer to a conservation holder.

ii. The mitigation property is abutting protected lands.

iii. The mitigation property helps achieve conservation goals of Forest Interior Dwelling Species (FIDS).

iv. Stream and buffer restoration work where substantial adverse effects to jurisdictional and non-jurisdictional resources (e.g., mature forests and high-quality wetlands) may be rejected outright by Corps and MDE reviewers.

v. For Mitigation Banks: In instances where the applicant is uncertain whether they will desire wetland credits or stream buffer credits (functional feet) for a specific area, a "bundled credit" approach may be proposed. A bundled credit allows for either stream wetland or stream buffer credits to be awarded. The total value of each option would need to be known at the Mitigation Banking Instrument phase, where each release year would either be a quantity of wetland acres, wetland functional acres, or stream buffer credits (functional feet of stream). The bank sponsor would get to choose which credit type to sell, but both total credit balances of each credit type would diminish as a result. This would require a separate "Stream Mitigation Calculator for Stream Buffers" tab for those areas that overlap with wetlands. This could be potentially helpful when wetlands do not meet all performance standards (*e.g. did not meet hydrology standards*). See Section VI on Bundled Credits.

SECTION VI

BUNDLED CREDITS

See Appendix A Tabs 5 & 6

For Mitigation Banks Only (optional)

VI. BUNDLED CREDITS

Summary: This section is specific to mitigation banks, advanced mitigation sites, and in lieu-fee programs and is captured in Tabs 5 and 6 of Appendix A1 and A2. Bundling of mitigation credits allows a mitigation provider to identify up to two resources to sell credits within the same geographic area. It works as an either/or scenario. For example, an applicant proposed to build a stream and riparian wetlands and sell mitigation credits from an approved mitigation bank. They propose wetlands in the floodplain, but are unsure of market demand for streams credits vs. wetland credits. They can elect to "bundle" credits. This means that they may sell either wetland credits or stream buffer credits in a given year based on demand. However, after the sale, the total balance of stream buffer credits (functional feet) and wetland credits with both diminish for that release year, regardless of the credit type sold. Consult with the Corps and MDE reviewers and or IRT regarding feasibility of bundling credits. Figure 14 below shows some areas identified as “Credited Stream Buffer Areas,” but one of the wetlands is being sought for mitigation. When the bank sponsor is unsure of future credit demand, bundling of floodplain wetlands and functional foot credits for stream buffers may be useful.

Instructions: If seeking to bundle credits, first consult the Corps and Maryland Department of the Environment regarding feasibility. If the Corps and MDE support bundling credits a the proposed mitigation bank or In-lieu fee program, the user should fill out Tab 5 and/or Tab 6 of the calculator. These tabs are identical to tabs 3 and 4 respectively, however their totals show in the “Talley of Bundled Credits” section of the Summary Tab (Tab 1). The general instructions are the same as for Tab 3 and Tab 4 of Appendix A, and are covered in this manual (Section IV and V respectively). Regarding the example above, the user would need to determine the total value of wetlands which overlap with the stream buffer and the total functional foot value of the stream buffer work. Each would be represented in the crediting ledgers. For bank sponsors, each credit release year, the bank would decide whether to release wetland credits or stream buffer credits (functional feet). Regardless of the choice, each credit type would diminish in that year, as only one credit type may be counted for a specific geographic area. Mapping is required to show these areas distinctly from stand-alone wetland mitigation areas, stand-alone stream buffer for mitigation areas, and other programs that credits may be sought. For more information on “Credit Bundling” see 33 CFR 332.3(j)(1)(ii).

Notes:

[1] *Only two types of credits may be bundled together.*
[2] *No conversions may occur among credit types following credit sale.*

Example Scenario for Credit Ledger including Bundled Credits:

Note: All values discussed in this example are described as credit types and not as acres.

The Swamp Oak Mitigation Banking Instrument was approved in January 2023. The bank's potential credits include: 20 PFO wetland credits for stand-alone wetland restoration (In figure 14, shown as wetland 1-Orange) and 3,000 Functional Feet Stream Credit for all stand-alone stream restoration and stream buffer restoration (In figure 14, this includes Mainstem stream, Trib 1, Stream Buffer Area 1, Stream Buffer Area 2, and Stream Buffer Area 4).

An additional 10 Acres of the Swamp Oak Mitigation Bank was restored as wetland, but overlaps with an area also eligible for stream buffer (functional feet credit). This area is shown as "Bundled Credits: Wetland 2/Stream Buffer Area 3" in Figure 14 below-Purple. To provide flexibility with an unknown demand for mitigation credits in the future, the bank elects to "Bundle" this 10 acre area (PFO wetland credits) with Stream Buffer (Functional Feet). Please note that Stream Buffer areas provide mitigation for stream channel impacts. These are the same as stream credits (Functional Feet).

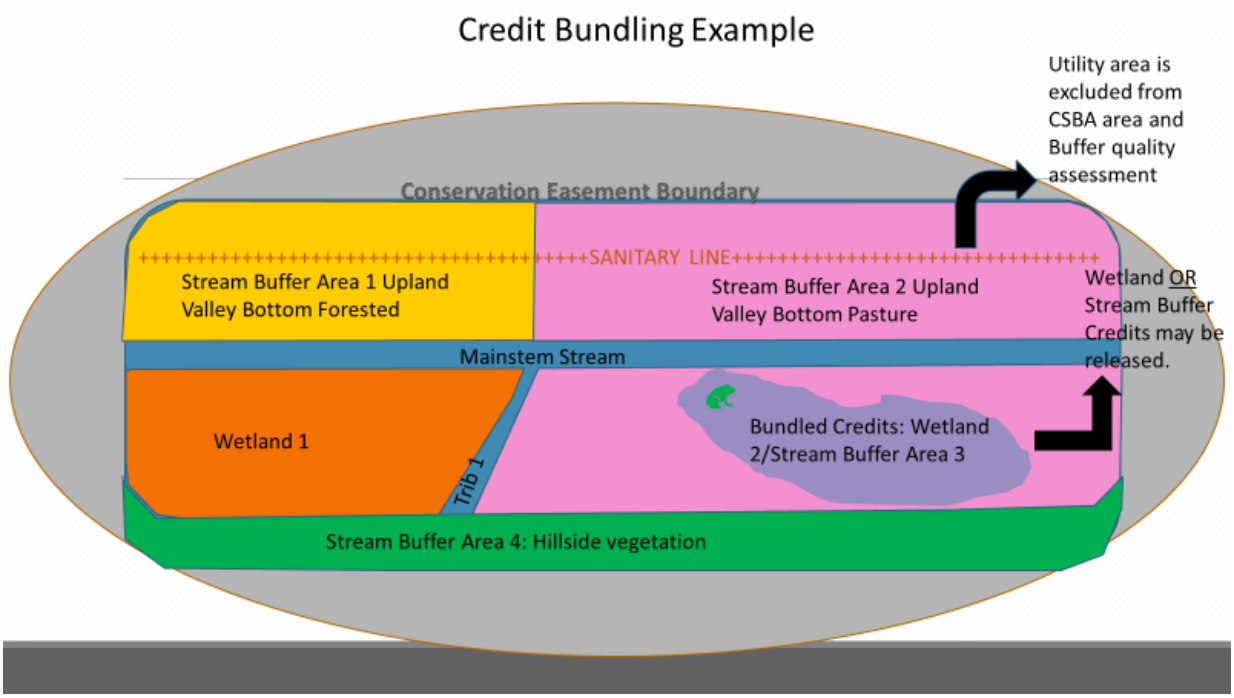


Figure 14 showing the potential credit areas of the Swamp Oak Mitigation Bank.

The ten acre wetland area overlapping the stream buffer has potential values of 10 PFO wetland credits or 400 Functional Feet of Stream Credit for the Stream Buffers. The potential wetland credit value was determined upon consultation with the IRT after assessment of existing vs proposed conditions. The potential stream credit value for the buffer area was determined using Tab 6 (Bundled Stream Mit-Buffers) of the Maryland Stream Mitigation Framework. An existing stream buffer quality assessment was performed and quality was projected post-restoration then entered into the MSMF tool. The ratio of PFO wetland credits to Functional Foot Credits (Stream) in this area is 1 PFO wetland credit =40

Functional Feet stream credit. This was calculated by dividing the total potential credits for the 10 acre area as stream buffer (400 Functional Feet) by the total potential PFO wetland credits for that same 10 acre area (400/10). The area must be assessed separately as a stream buffer and then as a PFO wetland to be eligible for bunding. Both stream buffer monitoring and wetland monitoring is required for the monitoring period.

On the bottom of Table 8, you can see the initial entries for establishment of the bank in January 2023.

Table 8. Example Credit Ledger including Wetlands, Streams, and Bundled Wetland and Stream Credits

Transaction Type	Transaction Date	Project Name	Permittee	Permit #	Credit Classification	STREAM Credits	WETLAND Credits	Comments
Withdrawal	2/15/2023	Acme residential	George Burns	2022-68585	PFO-Wetland Credits		4	Wetland debit-stand alone
Withdrawal	2/15/2023	Acme residential	George Burns	2022-68585	Stream-FF	600		Stream debit-stand alone
Withdrawal	2/15/2023	Acme residential	George Burns	2022-68585	Stream-FF-Bundled	80	2	Group credit based on a ratio of 1 wetland acre credit : 40 FF stream
Release	2/1/2023				PFO-Wetland Credits		4	Initial Credit Release-20%
Release	2/1/2023				Stream-FF	600		Initial Credit Release-20%
Release	2/1/2023				Group: PFO Wetland Credits/Stream FF	80	2	MBI approval. Group credit = 1 PFO Wetland credit : 40 FF stream credits
Initiation*	1/15/2023				PFO-Wetland Credits		20	MBI Approved-Potential Credits to Ledger
Initiation*	1/15/2023				Stream-FF	3000		MBI Approved-Potential Credits to Ledger
Initiation*	1/15/2023				Group: PFO Wetland Credits/Stream FF	400	10	Group credit based on a ratio of 1 PFO wetland credit : 40 FF stream credits.

*Initiation Transaction = Total amount of potential credits that the bank may have if all ecological or performance milestones are met

In February 2023, the initial release (20%) was approved. At this point, the bank has available credits (4 PFO wetland credits, 600 Functional Feet of Stream, and also 2 PFO wetland credits OR 80 Functional Feet of Stream Credit (20% of the 10 acre area was released, and the banker can choose to sell either).

In mid-February 2023, a permit applicant purchased credits from Swamp Oak Mitigation Bank. Acme residential purchased the 4 PFO wetland credits, 600 Functional Feet of Stream Credits, and 2 PFO wetland credits (Bundled).

For the bundled credit area, the ledger shows withdrawals of both PFO-wetland credits and Functional Feet of Stream (2 PFO wetland credits and 80 FF respectively), as 20% of the value of the 10 Acre Bundled Credit zone have been withdrawn. Swamp Oak Mitigation Bank chose to sell the 2 acres of wetland instead of 80 FF of stream based on the need of the applicant. However, both credit types diminish as a result (20% of the available credits in the 10 acre area) as shown in Table 8.

Tables 9 and 10 show the Credit Leger Summary (as in RIBITS) before and after the withdrawal for Acme Residential. Note that the Bundled Credits (labeled as “Group: PFO Wetland Credit/StreamFF” are shown in Functional Feet and diminish after the withdrawal, much like the stand-alone credits. The grouped credits are expressed in “Functional Feet” stream credits instead of “PFO Wetland Credits” because RIBITS defaults to using the higher number when credits are grouped (bundled). Table 10 shows

withdrawal of 20% of the potential credits, corresponding with the initial credit release and sale (80 Functional Feet).

Table 9. Credit Ledger Summary (**BEFORE** Acme Residential Transaction)

Credit Classification	Available Credits	Withdrawn Credits	Released Credits	Potential Credits
PFO-Wetland Credits	4	0	4	20
Stream-Functional Feet (FF)	600	0	600	3000
Group: PFO Wetland Credit/Stream FF	80	0	80	400

Table 10. Credit Ledger Summary (**AFTER** Acme Residential Transaction)*

Credit Classification	Available Credits	Withdrawn Credits	Released Credits	Potential Credits
PFO-Wetland Credits	0	4	4	20
Stream-Functional Feet (FF)	0	600	600	3000
Group: PFO Wetland Credit/Stream FF	0	80	80	400

*Note that for Bundled Credits, this is where two credit types overlap (PFO Wetland Credits with Stream Buffer (Functional Foot Stream Credit). Regardless of the type withdrawn (PFO or Stream-FF) both credit types diminish. The Bundled Scenario provides an either/or option for the 10 acres where wetlands overlap stream buffers.

SECTION VII

DEFINITIONS

VII. DEFINITIONS

Baseflow channel: Stream channel observed during typical low flow (but not drought) conditions.

Bundled credits: Mitigation credits or other program credits that occupy the same geographic area. After mitigation bank approval, the sponsor may choose to sell one credit type or another, but not both. As a result both releases scheduled for a given year will diminish in the credit ledger, regardless of which credit type was sold.

Credited Stream Buffer Area (CSBA): A distinct CSBA occurs where vegetative conditions change measurably either in the existing condition or proposed condition after treatment. At a minimum, a CSBA should be designated for valley bottom uplands, hillside, and valley bottom wetlands if those areas are present on a site and are not being used for other credit programs (Wetland mitigation credits, Forest Conservation, TMDL Program, etc.).

Enhancement: The manipulation of the physical, chemical, or biological characteristics of an aquatic resource to heighten, intensify, or improve specific aquatic resource function(s). Enhancement results in the gain of selected aquatic resource functions, but may also lead to decline in other resource functions. Enhancement does not result in a gain in aquatic resource area. (33 CFR 332.2).

Establishment (creation): The manipulation of the physical, chemical, or biological characteristics present to develop an aquatic resource that did not previously exist at an upland site. Establishment results in a gain in aquatic resource area and functions. (33 CFR 332.2). For the purposes of the MSMF Beta version, Establishment Activities are not included as mitigation activities.

Functional Foot: For the purpose of the Maryland Stream Mitigation Framework, a functional foot is defined as a linear foot of stream of perfect quality (100% or 1.0 score) and a drainage area of 1 square mile. A functional foot relates to streams of any flow type and quality in a stream network and these factors influence the value of a linear foot of stream as a functional foot.

Impact: For the purposes of the MSMF Beta Tool, an impact is defined as an adverse effect to streams pursuant to Section 404 where a loss in stream functions or conditions occur.

Mitigation (Compensatory Mitigation): Activities undertaken for the purpose of offsetting unavoidable impacts to Waters of the US. This may occur in the form of Preservation, Restoration (Rehabilitation or Reestablishment), or Enhancement.

Quality Acre: A Quality Acre is defined as an acre of stream buffer with a quality of 100%.

Resource Types:

Ephemeral Stream: An ephemeral stream has flowing water only during, and for a short duration after, precipitation events in a typical year. Ephemeral stream beds are located above the water table year-round. Groundwater is not a source of water for the stream. Runoff from rainfall is the primary source of water for stream flow. [77 Fed. Reg. 10184 (February 21, 2012)]

Intermittent Stream: An intermittent stream has flowing water during certain times of the year, when groundwater provides water for stream flow. During dry periods, intermittent streams may not have flowing water. Runoff from rainfall is a supplemental source of water for stream flow. [77 Fed. Reg. 10184 (February 21, 2012)]

Perennial Stream: A perennial stream has flowing water year-round during a typical year. The water table is located above the stream bed for most of the year. Groundwater is the primary source of water for stream flow. Runoff from rainfall is a supplemental source of water for stream flow. [77 Fed. Reg. 10184 (February 21, 2012)]

Perennial Headwater Stream: A Perennial stream with a drainage area less than 5 square miles.

Perennial Wadeable Stream: A Perennial stream with a drainage area greater than 5 square miles.

Restoration: The manipulation of the physical, chemical, or biological characteristics of a site with the goal of returning natural/historic functions to a former or degraded aquatic resource. For the purpose of tracking net gains in aquatic resource area, restoration is divided into two categories: reestablishment and rehabilitation (33 CFR 332.2)

Re-establishment: The manipulation of the physical, chemical, or biological characteristics of a site with the goal of returning natural/historic functions to a former aquatic resource. Re-establishment results in rebuilding a former aquatic resource and results in a gain in aquatic resource area and functions. (33 CFR 332.2)

Rehabilitation: The manipulation of the physical, chemical, or biological characteristics of a site with the goal of repairing natural/historic functions to a degraded aquatic resource. Rehabilitation results in a gain in aquatic resource function, but does not result in a gain in aquatic resource area. (33 CFR 332.2)

Riparian Areas: Riparian areas are lands adjacent to streams, rivers, lakes, and estuarine-marine shorelines. Riparian areas are transitional between terrestrial and aquatic ecosystems, through which surface and subsurface hydrology connects riverine, lacustrine, estuarine, and marine waters with their adjacent wetlands, non-wetland waters, or uplands. Riparian areas provide a variety of ecological functions and services and help improve or maintain local water quality. [77 Fed. Reg. 10184 (Feb. 21, 2012)]

REFERENCES

(*Additional references may be found in instructional Appendices C2, D2, E, and F2)*

Barbour and others. 1999. U.S.EPA. Rapid Bioassessment Protocols: Habitat Assessment and Physicochemical parameters. Pages 5-9 through 5-34.

Jones, C, Jim McCann & Susan McConville. 2000. Critical Area Commission for the Chesapeake and Atlantic Coastal Bays. A Guide to the Conservation of Forest Interior Dwelling Birds in the Chesapeake Bay Critical Area.

Final Notice of Issuance and Modification of Nationwide Permits, as published in the February 21, 2012 Federal Register, Vol. 77, No. 34 [77 Fed. Reg. 10184 (Feb. 21, 2012)]

Final Rule for "Compensatory Mitigation for Losses of Aquatic Resources" as published in the April 10, 2008 Federal Register, Vol. 73, No. 70. (33 CFR 332)

Jennings, G and others. 2013. Eco-Geomorphic Rapid Assessment Approaches for Evaluating Stream Restoration Effectiveness. Presentation at Mid-Atlantic Stream Conference, Baltimore MD. Fall 2013.

MacArthur, R & E.O. Wilson. 1967. The Theory of Island Biogeography. Princeton Landmarks in Biology.

Schueler, T. 2000. The Importance of Imperviousness. Watershed Protection Techniques 1(3): 100-111.

Suazo-Davila, D., W. Silva-Araya, and J. Rivera-Santos. 2013. Methodology for Scour Evaluation of US Army Installation Bridges: A Proposed Evaluation for Scour Risk and Channel Instability. GSL TR- 13-1. Vicksburg, MS: Engineer Research and Development Center, Geotechnical and Structures Laboratory. https://erdc-library.erdc.dren.mil/jspui/bitstream/11681/10580/1/ERDC-GSL-TR-13-1.pdf

U.S. Army Corps of Engineers-ERDC. 2022. National Ordinary High Water Mark Field Delineation Manual for Rivers and Streams. Wetland Regulatory Assistance Program (WRAP). Interim version.

U.S. Fish & Wildlife Service. March 2002. Maryland Stream Survey: Bankfull Discharge and Channel Characteristics of Streams in the Piedmont Hydrologic Region.

U.S. Fish & Wildlife Service. July 2003. Maryland Stream Survey: Bankfull Discharge and Channel Characteristics of Streams in the Coastal Plain Hydrologic Region.

U.S. Fish & Wildlife Service. May 2003. Maryland Stream Survey: Bankfull Discharge and Channel Characteristics of Streams in the Allegheny Plateau and Valley and Ridge Hydrologic Region.

U.S. Fish & Wildlife Service. May 2015. Final Draft Function-Based Rapid Stream Assessment Methodology.