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StreamMechanics

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

Stream Mitigation Workshop Agenda

November 4, 2019: MnDOT Arden Hills Training Center, 1900 County Road I West, Shoreview

November 5, 2019: MnDOT District 3A Office, 7964 Industrial Park Rd., Baxter

Agenda

9:00	Welcome and Opening Comments
9:10	Overview of Tool Development
9:20	Anatomy of a Stream
9:50	Overview of Stream Functions Pyramid Framework
10:20	Break
10:35	Overview of Stream Quantification Tool & Debit Tool
11:15	Overview of Key Metrics
12:00	Lunch (ON YOUR OWN)
1:30	SQT / Debit Tool Examples
2:30	Overview of Stream Mitigation Policy
3:30	Adjourn

Meeting logistics

- Prior to the meeting, please download the "MNSQT Excel Workbook" and the "MN Debit Calculator Excel Workbook" from the Corps website: https://www.mvp.usace.army.mil/Missions/Regulatory/Mitigation/

- Participants should bring a laptop computer with Microsoft Excel. If you don't have a laptop, you can work with someone else or follow on projected screen. Please bring an extension cord for your laptop, if needed.

- Coffee and very light snacks provided. Lunch will be on your own.

Questions?

Contact Jill Bathke at jill.c.bathke@usace.army.mil or 651-290-5697

Stream Mitigation Workshop Presenters

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Tool Development Overview

Kerryann Weaver

EPA, Region 5

Water Division, Watersheds & Wetland Branch

Public Notice Review & Mitigation

Regulatory Review

Assumed Program Oversight

Region 5 Wetlands Section

Contracts & Grants

Jurisdiction Review

Tribal 401 Certification

Contract: EPR & Stream Mechanics

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Function-Based Framework for Stream Assessment and Restoration Projects

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Regionalization of the SQT

Regionalization Process

1. Form Steering & Technical Committees

Steering Committee

- Chaired by EPA

Technical Sub-Teams

- By Functional Category (typically)

- Series of Web Meetings and Emails
  - Monthly
- Research & Reporting

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BOARD OF WATER AND SOIL RESOURCES

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MINNESOTA POLLUTION CONTROL AGENCY

ECOSYSTEM PLANNING & RESTORATION

DEPARTMENT OF NATURAL RESOURCES

Regionalization Process

1. Form Steering & Technical Committees
2. Select parameters & measurement methods

Parameters Included in Various Stream Quantification Tools

Functional Category	Parameter from *A Function-Based Framework for Stream Assessment and Restoration Projects.*	Included in NC-SQT (Yes/No)	Included in WY-SQT (Yes/No)	Included in TN-SQT (Yes/No)	Included in MI-SQT (Yes/No)
Hydrology	Channel Forming Discharge*	No	No	No	No
	Precipitation/Runoff Relationship*	No	No	No	No
	Flood Frequency*	No	No	No	No
	Flow Duration	No	No	No	No
	Reach Runoff**	No	Yes	Yes	Yes
	Baseflow Alteration**	No	Yes	No	No
	Catchment Hydrology**	Yes	No	Yes	No
Hydraulics	Flow Dynamics	No	No	No	No
	Groundwater/Surface Water Exchange	No	No	No	No
	Floodplain Connectivity	Yes	Yes	Yes	Yes
Geomorphology	Channel Evolution	No	No	No	No
	Sediment Transport Competency and Capacity*	No	No	No	No
	Large Woody Debris	Yes	Yes	Yes	Yes
	Bank Migration/Lateral Stability	Yes	Yes	Yes	Yes
	Bed Material Characterization	Yes	Yes	Yes	Yes
	Bed Form Diversity	Yes	Yes	Yes	Yes
	Plan Form**	Yes	Yes	Yes	Yes
	Riparian Vegetation	Yes	Yes	Yes	Yes
Physicochemical	Organic Carbon	Yes	No	Yes	No
	Bacteria**	Yes	No	Yes	Yes
	Water Quality (Dissolved Oxygen, pH, and Conductivity)	Yes Conduc.	No	No	Yes DO
	Water Quality (Temperature)	Yes	Yes	No	Yes
	Nutrients	Yes	Yes	Yes	Yes
Biology	Macrophyte Communities	No	No	No	No
	Microbial Communities	No	No	No	No
	Landscape Connectivity	No	No	No	No
	Macroinvertebrate Communities	Yes	Yes	Yes	Yes
	Fish Communities	Yes	Yes	Yes	Yes

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Regionalization Process

1. Form Steering and Technical Committees
2. Select parameters and measurement methods
3. Collect data (existing and new) to inform performance standards

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Regionalization Process

1. Form Steering and Technical Committees
2. Select parameters and measurement methods
3. Collect data (existing and new) to inform performance standard
4. Edit SQT spreadsheets and User Manuals
5. Develop Debit Determination Process (Debit Tool)

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Timeline

Summer ’18

1. Steering & Technical Committee formed

2. Kickoff call with EPR & Stream Mechanics

Fall ‘18

1. Parameter Selection

2. Performance Standard Development

Winter/Spring ‘19

1. Parameter Selection (con’t)

2. Performance Standard Development (con’t)

3. SQT template

4. List of Metrics

5. Debit Tool Module

Summer ‘19

1. User manual edits/updates

2. Special Public Notice: June 19th

3. Draft review of SQT/Debit Tools by Committees

4. SFP Workshop: Duluth, August

Fall ‘19

1. Public Notice: Sept. 4

Links to SQT & Debit Calculator & Policy Outline

2. Policy Outreach: *Nov 4 & 5*

Winter ‘20

1. Scientific Support Document

2. Stream Mitigation Guidance

Regionalization Process

1. Form Steering and Technical Committees
2. Select parameters and measurement methods
3. Collect data (existing and new) to inform performance standard
4. Edit SQT spreadsheets and User Manuals
5. Develop Debit Determination Process (Debit Tool)
6. Develop Scientific Support Document

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Additional Remaining Tasks

- Support with external review
  - Response to comments
  - Tracking & Implementing edits
- Technical Support
  - Training on updates to the SQT
  - SQT maintenance
- Contract completion
  - July 31, 2020

Site Information and Reference Selection	
Project Name:	
Reach ID:	
Restoration Potential:	0
Existing Stream Type:	
Reference Stream Type:	0
Woody Vegetation Natural Component:	
Use Class:	
River Nutrient Regions:	
Drainage Area (sq.mi.):	
Proposed Bed Material:	
Existing Stream Length (ft):	
Proposed Stream Length (ft):	
Macroinvertebrate IBI Class:	
Fish IBI Class:	
Valley Type:	

Notes
1. Users input values that are highlighted based on restoration potential
2. Users select values from a pull-down menu
3. Leave values blank for field values that were not measured

FUNCTIONAL CHANGE SUMMARY	
Existing Condition Score (ECS)	0.00
Proposed Condition Score (PCS)	0.00
Change in Functional Condition (PCS	0.00
Existing Stream Length (ft)	
Proposed Stream Length (ft)	
Change in Stream Length (ft)	
Existing Functional Feet (FF)	
Proposed Functional Feet (FF)	
Proposed FF - Existing FF	
Percent Change in FF (%)	
FF Yield (FF/ft)	

MITIGATION SUMMARY
(FF)

WARNING: Data are not provided for Reach Runoff, Floodplain Connectivity, Lateral Migration, Riparian Vegetation, or Bed Form Diversity Parameters.

FUNCTION BASED PARAMETERS SUMMARY			
Functional Category	Function-Based Parameters	Existing Parameter	Proposed Parameter
Hydrology	Reach Runoff		
Hydraulics	Floodplain Connectivity		
Geomorphology	Large Woody Debris		
	Lateral Migration		
	Bed Material Characterization		
	Bed Form Diversity		
	Riparian Vegetation		
Physicochemical	Temperature		
	Dissolved Oxygen		
	Total Suspended Solids		
Biology	Macroinvertebrates		
	Fish		

FUNCTIONAL CATEGORY REPORT CARD			
Functional Category	ECS	PCS	Functional Change
Hydrology			
Hydraulics			
Geomorphology			
Physicochemical			
Biology			

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Anatomy of a Stream

Will Harman, PG

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Watershed

The land area that drains water to a specific point along the stream.

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Fluvial Geomorphology

The science of how water shapes the earth.

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From Miller (1990).
©1990 Wadsworth Publishing Co.

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Valley Morphology

Colluvial Valleys

Alluvial Valleys

V-Shaped Valleys

Bed Forms

- Sand (Ripples and Dunes)
- Riffle-pool
- Step-pool

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Riffle-Run–Pool-Glide Sequence

Rosgen, 1996

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Channel Forming Discharge (Q)

- A theory that there is a unique flow that over a long period of time yields the same channel morphology that is shaped by the natural sequence of flows.
- Types of Channel Forming Q
  - Dominant
  - Effective
  - Bankfull

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Bankfull Discharge

- Fills a stable channel up to the elevation of the "active" floodplain.
- Represents a breakpoint between processes of channel formation and floodplain development
- "Leaves a mark"

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Sinuosity

Sinuosity is a plan form measurement of how crooked a stream is. It is expressed as the stream length divided by the valley length or the valley slope divided by the stream slope.

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Headcut

Abrupt change in streambed elevation, which erodes the bed in an upstream direction.

Knickpoint

Abrupt change in streambed elevation, which is stable and provides grade control.

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Overview of Stream Functions Pyramid Framework

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Federal Mitigation Rule Definition of Stream Restoration

"Restoration means 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."

- Re-establishment
- Rehabilitation

2008 Federal Mitigation Rule: 33 C.F.R. § 332/40 C.F.R. § 230

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Stream Functions Pyramid: Broad Level

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Function - The physical, chemical, and biological processes that occur in ecosystems.

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Effect

Cause

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Site Selection

Reach Scale Improvements

Generally Independent Variables.

May be altered in headwater streams.

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Biology

Physicochemical

Geomorphology

Hydraulics

Hydrology

Restoration Activities

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Why do we need this concept?

So we don’t do this …

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So we can quantify functional lift.

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So we can quantify functional loss.

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- *Functional capacity* - the degree to which an aquatic resource performs a specific function.

This is Quality.

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The number of credits should reflect the difference between pre- and post-compensatory mitigation project site conditions, as determined by a functional or condition assessment or other suitable metric.

This is Functional Lift.

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Stream Functions Pyramid Framework (SFPF)

Broad Level View (Stream Functions Pyramid)

Functional Categories

Functional Statements

↓

Function-Based Parameters

Describes/Supports
Functional Statement

↓

Measurement Methods → **Performance Standards**

Quantifies Function-Based Parameter

Functioning
Functioning-At-Risk
Not Functioning

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Function-Based Parameters

Channel Forming Q
Precipitation / Runoff
Flood Frequency
Flow Duration
Catchment Hydrology
Reach Runoff
Flow Alteration

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Function-Based Parameters

Floodplain Connectivity
Flow Dynamics
Groundwater / Surface Water Interaction
Flow Alteration

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Function-Based Parameters

Sediment Transport
LWD Transport & Storage
Channel Evolution
Lateral Stability
Riparian Vegetation
Bed Form Diversity
Bed Material Characterization
Sinuosity

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Function-Based Parameters

Water Quality
Temperature
Nutrients
Organic Carbon
Turbidity
Bacteria

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Pyramid and Parameters

Macroinvertebrate Communities
Fish Communities

5 **BIOLOGY »**
Biodiversity and the

4 **PHYSICOCHEMICAL »**
Temperature and oxygen regulation; processing of organic matter and nutrients

3 **GEOMORPHOLOGY »**
Transport of wood and sediment to create diverse bed forms and dynamic equilibrium

2 **HYDRAULIC »**
Transport of water in the channel, on the floodplain, and through sediments

1 **HYDROLOGY »**
Transport of water from the watershed to the channel

Geology

Climate

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Measurement Methods

APPENDIX A.c. Parameters and Measurement Methods

HYDROLOGY	
Parameter	**Measurement Method**
Channel-Forming Discharge	1. Regional Curves
Precipitation/Runoff Relationship	1. Rational Method 2. HEC-HMS 3. USGS Regional Regression Equations
Flood Frequency	1. Bulletin 17b
Flow Duration	1. Flow Duration C 2. Crest Gage 3. Monitoring Devi 4. Rapid Indicators
HYDRAULICS	
Parameter	**Measurement Meth**
Floodplain Connectivity	1. Bank ght Rati 2. Entre ent R 3. Stag Versus Dis
Flow Dynamics	1. Stream Velocity 2. Shear Stress 3. Stream Power
Groundwater/Surface Water Exchange	1. Piezometers 2. Tracers 3. Seepage Meters

Parameter	Measurement Method
Floodplain Connectivity	1. Bank Height Ratio 2. Entrenchment Ratio 3. Stage/Q Relationships

GEOMORPHOLOGY	
Parameter	**Measurement Method**
Sediment Transport Competency	1. Shear Stress Curve 2. Required Depth and Slope 3. Spreadsheets and Computer Models
Sediment Transport Capacity	1. Computer Models 2. FLOWSED and POWERSED
	2. Buffer Density 3. Buffer Composition 4. Buffer Growth 5. Canopy Density 6. Proper Functioning Condition (PFC)
Bed Form Diversity	1. Percent Riffle and Pool 2. Facet Slope 3. Pool-to-Pool Spacing 4. Depth Variability
Bed Material Characterization	1. Bevenger and King (1995) 2. Riffle Stability Index (RSI)
PHYSIOCHEMICAL	
Parameter	**Measurement Method**
Basic Water Chemistry	1. Temperature 2. Dissolved Oxygen 3. Conductivity 4. pH 5. Turbidity
Nutrients	1. Field test kits using reagents reactions 2. Laboratory analysis
Organic Carbon	1. Laboratory analysis

BIOLOGY	
Parameter	**Measurement Method**
Microbial Communities	1. Taxonomic Methods 2. Non-Taxonomic Methods 3. Biological Indices
Macrophyte Communities	1. Taxonomic Methods 2. Non-Taxonomic Methods 3. Biological Indices
Benthic Macroinvertebrate Communities	1. Taxonomic Methods 2. Non-Taxonomic Methods 3. Biological Indices
Fish Communities	1. Taxonomic Methods 2. Non-Taxonomic Methods 3. Biological Indices
Landscape Connectivity	1. Spatial Analysis 2. Species Tracking 3. Habitat Models

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Performance Standards Now: Reference Standards

- Divided into three categories:
  - Functioning
  - Functioning-At-Risk
  - Not Functioning
- Linked to Measurement Methods
- Based on Reference Condition

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Reference Standard

The subset of reference aquatic resources that are least disturbed and exhibit the highest level of functions. This condition is considered functioning for the measurement method being assessed, and ranges from least disturbed to minimally disturbed or pristine condition.

Federal Mitigation Rule

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Performance Standards: Framework Versus Stream Quantification Tool

- Framework
  - Stops at Measurement Method Level
  - Requires Best Professional Judgement to Determine Parameter and Overall “Scores.”
- Stream Quantification Tool
  - Uses an Index from 0 to 1 to create Parameter, Functional Category, and Overall Reach Scores

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Applications

Function-Based Assessments

- Stream Quantification Tool

Goals / Objectives & Restoration Potential

Debit and Credit Determination

And Beyond

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Restoration Potential

Highest level of restoration that can be achieved based on watershed conditions, results of the function-based assessment and project constraints.

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Restoration Potential Results

Full Restoration

(Aquatic animal life)

- Back to reference condition
- Level 5: Biology

Partial Restoration

(Stability / Habitat)

- Functioning through geomorph
- Partial in Levels 4 and 5

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Stream Quantification Tool & Debit Calculator

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www.stream-mechanics.com

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Purposes of the Stream Quantification Tool

1. Determine numerical differences between an existing stream condition and the proposed or after stream condition.
2. Link restoration activities to changes in stream functions (function-based parameters).
3. Link restoration goals to restoration potential.
4. Incentivize high-quality stream mitigation.
5. Assist with site selection.
6. It is a calculator that uses existing assessment methods.

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Restoration Activities

SQT

Functional Lift

Credits

$

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A Multi-Disciplinary Team

A team of professionals who have the academic background and practical training in each assessment method should work together to collect and analyze the data. Examples include:

- **Fluvial Geomorphologists** (Bankfull determination, floodplain connectivity, bedform diversity, lateral migration, bed material characterization)
- **Plant Biologists** (Riparian vegetation)
- **Aquatic Ecologists** (Nutrients, temperature, macroinvertebrates, fish)
- **Engineers** (Bankfull verification, floodplain connectivity, reach runoff)

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Excel Workbook (For One Reach)

Eight Worksheets:

1. Project Assessment
2. Catchment Assessment
3. Major Flow Variability Metrics
4. Measurement Method Guide
5. Quantification Tool
6. Monitoring Data
7. Data Summary
8. Reference Curves

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Site Information and Reference Selection	
Project Name:	
Reach ID:	
Restoration Potential:	0
Existing Stream Type:	
Reference Stream Type:	0
Woody Vegetation Natural Component:	
Use Class:	
River Nutrient Regions:	
Drainage Area (sq.mi.):	
Proposed Bed Material:	
Existing Stream Length (ft):	
Proposed Stream Length (ft):	
Macroinvertebrate IBI Class:	
Fish IBI Class:	
Valley Type:	

- Project Information
- Stratification determines which reference standards to use.
- Selected from pull-down menu when provided. Don't type.

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Quantification Tool: Existing and Proposed Condition Assessment

EXISTING CONDITION ASSESSMENT				
Functional Category	**Function-Based Parameters**	**Measurement Method**	**Field Value**	**Index Value**
Hydrology	Catchment Hydrology	Watershed Land Use Runoff Score		
	Reach Runoff	Stormwater Infiltration		
Hydraulics	Floodplain Connectivity	Bank Height Ratio Entrenchment Ratio		
Geomorphology	Large Woody Debris	Large Woody Debris Index # Pieces		
	Lateral Migration	Erosion Rate (ft/yr) Dominant BEHI/NBS Percent Streambank Erosion (%) Percent Armoring (%)		
		Left - Average Diameter at Breast Height (DBH; in) Right - Average DBH (in)		
		Right - Native Shrub Cover (%)		
	Bed Material Characterization	Size Class Pebble Count Analyzer (p-value)		
	Bed Form Diversity	Pool Spacing Ratio Pool Depth Ratio Percent Riffle (%) Aggradation Ratio		
	Plan Form	Sinuosity		
Physicochemical	Bacteria	E. Coli (Cfu/100 mL)		
	Organic Enrichment	Percent Nutrient Tolerant Macroinvertebrates (%)		
	Nitrogen	Nitrate-Nitrite (mg/L)		
	Phosphorus	Total Phosphorus (mg/L)		
Biology	Macroinvertebrates	Tennessee Macroinvertebrate Index Percent Clingers (%) Percent EPT - Cheumatopsyche (%) Percent Oligochaeta and Chironomidae (%)		
	Fish	Native Fish Score Index Catch per Unit Effort Score		

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Quantification Tool: Scoring

Not Functioning	Functioning-At-Risk	Functioning
0.0 - 0.29	0.3 – 0.69	0.7 – 1.0

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Reference Standards Worksheet

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Standard Roll Up Scoring

- Measurement Method Index Scores are averaged to create **Parameter Score.**
- Parameter Index Scores are averaged to create **Functional Category Scores.**
- Category Scores are multiplied by 0.2 and summed to create **Overall Score.**
  - Max Score through Level 3 Geomorphology = 0.6
  - Max Score through Leve 4 Physicochemical = 0.8
  - Max Score through Level 5 Biology = 1.0

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Calculating Functional Lift

- All linear feet are NOT equal when it comes to stream functionality

QUANTITY (stream feet)

X CONDITION SCORE (% function)

FUNCTIONAL FEET

- Functional lift (ΔFunctional Feet): Proposed FFS - Existing FFS

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Basic Rules

- Same parameters evaluated for existing and proposed conditions.
- Must include certain parameters and measurement methods (See Measurement Method Selection Guide)
- Add other parameters based on specific scenarios and environments.

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Results

- Existing Condition Score (ECS)
- Proposed Condition Score (PCS)
- Condition Lift = PCS- ECS
- Percent Condition Lift

Condition Lift

- Existing Functional Feet
  - Existing Stream Length X ECS
- Proposed Functional Feet
  - Proposed Stream Length X PCS
- Functional Lift
  - Proposed Functional Feet – Existing Functional Feet
- Percent Lift from Functional Feet

Functional Feet Lift

Good Lift / Moderate Quality

Low Lift / High Quality

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Existing Condition:

Existing Condition Score = 0.19
Existing Stream Length = 972 Ft
Functional Foot (ft) = 185

Proposed Condition (Year 5):

Proposed Condition Score = 0.35
Proposed Stream Length = 1280 Ft
Functional Foot (ft) = 448

Proposed Lift = 448 – 185 **= 263 functional ft**

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Functional Lift Summary

Exisiting Condition Score	0.36
Proposed Condition Score	0.74
Functional Lift Score	0.38
Percent Condition Lift (%)	106
Existing Stream Length (ft)	736
Proposed Stream Length (ft)	957
Additional Stream Length (ft)	221
Existing Functional Foot Score	265
Proposed Functional Foot Score	708
Proposed Functional Foot Score - Existing Functional Foot Score	443
Functional Lift (%)	167

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FUNCTION BASED PARAMETERS SUMMARY

	Function-Based Parameters	Existing Parameter	Proposed Parameter
	Catchment Hydrology	0.10	0.10
	Reach Runoff	0.26	0.26
	Floodplain Connectivity	0.63	1.00
	Large Woody Debris	0.00	0.00
	Lateral Stability	0.10	0.85
	Riparian Vegetation	0.17	0.56
	Bed Material		
	Bed Form Diversity	0.33	0.64
	Sinuosity	0.00	0.72
	Temperature		
	Bacteria		
	Organic Matter		
	Nitrogen		
	Phosphorus		
	Macros		
	Fish		

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FUNCTIONAL CATEGORY REPORT CARD			
Functional Category	**ECS**	**PCS**	**Functional Lift**
Hydrology	0.18	0.18	0.00
Hydraulics	0.63	1.00	0.37
Geomorphology	0.12	0.56	0.44
Physicochemical			
Biology			

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SQT Results

FUNCTION BASED PARAMETERS SUMMARY

Functional Category	Function-Based Parameters	Existing Parameter	Proposed Parameter	As-Built	Monitoring Year 1	2	3	4	5	13
Hydrology	Catchment Hydrology	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
	Reach Runoff	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26
Hydraulics	Floodplain Connectivity	0.63	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Geomorphology	Large Woody Debris	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.34
	Lateral Stability	0.10	0.85	0.75	0.71	0.71	0.71	0.71	0.81	0.85
	Riparian Vegetation	0.17	0.56	0.37	0.37	0.37	0.49	0.56	0.60	0.64
	Bed Material									
	Bed Form Diversity	0.33	0.64	0.64	0.62	0.62	0.62	0.62	0.62	0.60
	Sinuosity	0.00	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72
	Temperature									

FUNCTIONAL CATEGORY REPORT CARD

Functional Category	ECS	PCS	As-Built	Monitoring Year 1	2	3	4	5	13
Hydrology	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18
Hydraulics	0.63	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Geomorphology	0.12	0.56	0.50	0.48	0.48	0.51	0.52	0.56	0.63
Physicochemical									
Biology									
Overall Score	**0.19**	**0.35**	**0.34**	**0.33**	**0.33**	**0.34**	**0.34**	**0.35**	**0.36**
Functional Feet	**185**	**448**	**435**	**422**	**422**	**435**	**435**	**448**	**461**

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Known Strengths

- Most hydraulic and geomorphic data are already collected by practitioners.
- Fast and easy to run.
- Requires the determination of restoration potential.
  - Includes catchment assessment form
- Includes a way to quantify lift from adjacent BMPs.

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Known Weaknesses

- Data gaps
  - Ephemeral Channels
- Single Thread, Perennial Stream Centric
- Does not model stream/wetland complexes well
  - Does not model lentic systems
- Does not provide a comparison of different flow types and stream sizes

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Measuring Functional Loss (Debit Calculator)

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Challenge with Debits

- Permitted impacts are not **monitored** after construction.
- Cannot validate a Proposed Condition Score
  - The after score in the Stream Quantification Tool

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Debit Calculator
(Handles multiple reaches)

<u>Five Worksheets</u>

1. Project Assessment
2. Debit Calculator
3. Measurement Selection Guide
4. Existing Conditions
5. Proposed Conditions

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Options for Calculating Functional Loss

Option Number	Existing Condition Score (ECS)	Proposed Condition Score (PCS)
1	Use Existing Condition Worksheet (Collect all data)	Use Proposed Condition Worksheet
2	Use Existing Condition Worksheet (Collect some data)	Use Debit Tool
3	Use Existing Condition Worksheet (Collect no data)	Use Debit Tool

Note: For complete stream removals/fill or piping the PCS score is 0.0

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Debit Tool

- Predicts the Proposed Condition Score (PCS), Using:
  - Impact Severity Tiers
  - PCS versus ECS Curves
- PCS plugged into functional-foot calculation

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Impact Severity Tier

Tier	Description (Impacts to function-based parameters)	Example Activities
0	No permanent impact on any key function-based parameter	Bio-engineering of streambanks, restoration
1	Impacts to riparian vegetation and/or lateral stability.	Bank stabilization, two-stage ditch and utility crossings.
2	Impacts to riparian vegetation, lateral stability, and bed form diversity.	Utility crossings, two-stage ditch, bridges, bottomless arch culverts
3	Impacts to riparian vegetation, lateral stability, bed form diversity, and floodplain connectivity	Bottomless arch culverts, minor channelization
4	Impacts to riparian vegetation, lateral stability, bed form diversity, and floodplain connectivity. Potential impacts to temperature, processing of organic matter, macroinvertebrate and fish communities.	Channelization, box culverts, short-length pipe culverts, weirs/impoundments, and minor relocations.
5	Removal of all aquatic functions	Piping, relocation, removal or complete fill of channel

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Impact Severity Tiers

- Focus is on the impact to function-based parameters rather than the activity.
- Activities are examples.
- A small activity may yield a lower-level tier. And the same activity, but on a large scale, may yield a higher tier.

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Calculate PCS

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Curves to Tables

Impact Severity Tier	PCS Equation	Percent Loss
1	PCS = 0.84 * ECS	16
2	PCS = 0.72 * ECS	28
3	PCS = 0.53 * ECS	47
4	PCS = 0.23 * ECS	77
5	PCS = 0.0	100

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SQT Regionalization

- North Carolina (Update coming soon)
- South Carolina (Starting in 2020)
- Georgia (SQT Lite - Available)
- Tennessee (Available)
- Michigan
- Wyoming (Available)
- Colorado (Beta Version)
- Minnesota (Available)
- Alaska (Starting in 2020)

Completed SQT's will be uploaded to www.stream-mechanics.com under the Pyramid Framework tab.

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Overview of Key Metrics

Will Harman, PG

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Required Parameters and Metrics for all Restoration Projects

Functional Category	Function-Based Parameter	Measurement Method
Hydrology	Reach Runoff	Land Use Coefficient and Concentrated Flow Points
Hydraulics	Floodplain Connectivity	Bank Height Ratio and Entrenchment Ratio
Geomorphology	Lateral Migration	BEHI/NBS and % Erosion Armoring if present
	Riparian Vegetation	Riparian Width, Canopy Cover, Herbaceous Vegetation Cover, Basal area for woody riparian areas.
	Bedform Diversity	Pool Depth Ratio and Pool Spacing Ratio and Percent Riffle. And Aggradation Ratio if aggrading
	Large Woody Debris	Pieces or LWDI

See Measurement Selection Worksheet for more information.

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Reach Runoff

- Runoff from land uses adjacent to project reach.
- Measurement Methods (Metrics)
  - Land Use Coefficient and Concentrated Flow Points
  - BMP MIDS Rv Coefficient
    - Use if BMPs are proposed

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Land Use Coefficient

- Characterizes the runoff potential by land use for adjacent watershed.
- Coefficients are provided in the user manual.
- Calculate weighted curve number.
  - Determine **land use percentage.**
  - Multiply curve number (land use coefficient)

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Concentrated Flow Points

- Counts the number of concentrated flow points (ephemeral channels) caused by human impacts.
- Count along project reach.
- Number per 1,000 feet.

- Examples:
  - Farm ditches
  - Parking lot ditches
  - Road ditches

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Floodplain Connectivity

- Flows greater than bankfull spread onto a floodplain or bankfull bench
- Naturally Varies by Stream and Valley Type
- Measurement Methods
  - Bank Height Ratio and
  - Entrenchment Ratio (Stratified by Stream Type)

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Entrenchment Ratio (ER)

ER = Floodprone Width / Bankfull Width

Bank Height Ratio

BHR = Height of Low Bank / Max Bankfull Depth

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Width that includes bankfull bench must be 2.2 times larger than bankfull width, and bankfull must be the front of the bench, before the bench is also top of bank.

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Large Woody Debris

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Large Woody Debris Index (LWDI)

- Developed by US Forest Service.
  - Focuses on LWD within the channel.
  - Higher scores for larger pieces that are closer to the stream bed and immobile.
- Field Manual at
  - www.stream-mechanics.com

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Large Woody Debris

- > 10 cm in diameter and > 1 meter long
- Dead and fallen wood.
- Sampled over a 100m length that will yield the highest score.

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LWD Measurement Methods

- Pieces per Stream Length (Rapid)
- Large Woody Debris Index (Detailed)

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Bedform Diversity

Source: Michael Baker Corporation

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Measurement Methods

- Pool Spacing Ratio
- Pool Depth Ratio
- Percent Riffle
- Aggradation Ratio if signs of aggradation.

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Pool to Pool Spacing

Pool Spacing 1 = 160 – 84 = 76 feet
Pool Spacing Ratio = 76 / 31 = 2.5 ft/ft

Bankfull Width = 31 feet

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Pool Depth

Pool depth is measured from thalweg to bankfull best-fit line.

Pool Depth 1 = 95.5 - 91.85 = 3.65 feet
Pool Depth Ratio = 3.65 / 2.0 = 1.8 ft/ft. Note: 2.0 = mean depth from riffle cross section.

Percent Riffle

- Measure from profile.
- Percent of length that is riffle habitat.
- Lump runs into riffles and glides into pools.
- Include all major pools.

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Lateral Migration

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Measurement Methods

- Dominant BEHI/NBS
- Percent Streambank Erosion (%)
- Streambank Armoring (%)
  - Only assessed if armoring is present.

BEHI Measurement Method

NBS

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

Level I

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

Level II

(2)	Radius of Curvature R_c (ft)	Bankfull Width W_{bkf} (ft)	*Ratio* R_c / W_{bkf}	Near-Bank Stress (NBS)
(3)	Pool Slope S_p	Average Slope S	*Ratio* S_p / S	Near-Bank Stress (NBS)
(4)	Pool Slope S_p	Riffle Slope S_{rif}	*Ratio* S_p / S_{rif}	Near-Bank Stress (NBS)

Dominant Near-Bank Stress

Level III

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

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

Level IV

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

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Armoring

"Hard" techniques that prevent lateral migration. Includes rip rap, gabions, concrete, etc.

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Armoring

- $$Percent\ Armoring = \frac{Length\ of\ Armored\ Bank}{Total\ length\ of\ Streambank\ in\ Reach} * 100$$

- If armoring exceeds 50% of reach length, lateral migration parameter score equals 0.0.

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Riparian Vegetation: Measurement Methods

- Width
- Canopy Cover
- Herbaceous Cover
- Basal Area

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Riparian Width Ratio

- Riparian Width Ratio
  - Tied to the valley form and geomorphic processes
  - Observed / Expected as a percent.

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Meander Width Ratio = Belt Width / Bankfull Width

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Observed and Expected Widths

- Observed = Width of natural vegetation free from human activity.
- Expected = Width appropriate for valley type.
  - Use Meander Width Ratio.

Valley Type	MWR	Additional Width (ft) $W_{additional}$
Alluvial Valley	4	25
Confined Alluvial	3	15
Colluvial	2	10

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Mission Creek Case Study

Will Harman, PG

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Streams
Lateral Drainage Area
Upstream Catchment

Sources: ESRI Aerial 2017, Open Street Map

Drainage Area = 10.5 sqmi

Mission Creek Stream Reach
Catchment Boundary Map
St. Louis County, MN

Prepared For:
Field Work

N
0 2,000 4,000 Feet

Figure 1

Date:
August 2019

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Sources: ESRI Aerial 2017, Open Street Map, TIGER Roads, NHD streams

Project Reach
Lateral Drainage Area
Upstream Catchment

Mission Creek Stream Reach

Lateral Drainage Area Map

St. Louis County, MN

Prepared For:

Field Work

N

0 100 200 Feet

FIGURE 2

DATE:
August 2019

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ST. PAUL DISTRICT STREAM MITIGATION GUIDANCE UPDATE

MN SQT Workshops
November 2019

US Army Corps of Engineers®

BUILDING STRONG®
and Taking Care of People!

REGULATORY MISSION

To protect the Nation's aquatic resources, while allowing reasonable development through fair and balanced decisions.

WHY ARE WE HERE?

- **The Corps is required to restore and maintain the chemical, physical, and biological integrity of waters** of the US through the 404 permit program
- **No permit if there is an unacceptable adverse impact**
- Mitigation required to minimize adverse impacts

404(b)(1) Guidelines

WHY ARE WE HERE?

- **Mitigation offsets environmental losses** resulting from unavoidable impacts to waters of the United States authorized by DA permits
- Mitigation is required based on what is practicable and capable of **compensating for the aquatic resource functions that will be lost as a result of the permitted activity**

2008 Mitigation Rule

OK… BUT WHY NOW?

- ✓ Availability of a stream functional assessment tool
- ✓ Greater body of knowledge on stream impacts
- ✓ Requests for more transparency for stream project reviews

Goal:

A stream mitigation program that ensures replacement of lost stream functions that is transparent and based on best-available science and a watershed approach.

GUIDANCE RELEASE TIMELINE

November 2019- draft guidance completed

December 2019- draft out for interagency review

Early 2020- Version 1 out on public notice

THE GUIDANCE WILL NOT ADDRESS:

1. Jurisdiction
2. Permit mechanisms
3. Exemptions

The SQT answers:
What stream functional loss/ gain will occur?

Guidance answers:

What stream impacts require mitigation?

What is appropriate stream mitigation and how do I accomplish it?

OUTLINE OF STREAM GUIDANCE

- Introduction
- Determination of stream impacts and compensation requirements
- Stream Functional Assessment Tools
- Stream Compensatory Mitigation
- Definitions
- References

2008 FEDERAL MITIGATION RULE

- The bedrock of our guidance
- St. Paul's Guidance will explain how to implement the rule's principles in MN and WI

STREAM COMPENSATORY MITIGATION

Restoration

Enhancement

Preservation

RESTORATION

Restoration means the manipulation of the physical, chemical, or biological characteristics of a site with the goals of returning natural/historic functions to a former or degraded aquatic resource. **2008 Mitigation Rule**

ACCOMPLISHING STREAM MITIGATION

1. **Permittee implemented projects/actions**

2. **Purchase stream credits in a mitigation bank**

   4 streams banks under review, none approved in MN/WI

3. **Pay into a in-lieu-fee**

   no stream ILFs in MN/WI

PREFERENCE HIERARCHY FOR COMPENSATION

1. Mitigation bank credits

2. In-lieu fee program credits

3. **Permittee-responsible mitigation under a watershed approach**

TYPE AND AMOUNT OF STREAM MITIGATION

- In-kind for almost all situations (stream mitigation for stream loss)

- Amount of compensation- use of the MN SQT or other Corps-reviewed functional assessment

Kettle River; Falls above the Sandstone Dam, which were exposed when the dam was removed in 1995. With the removal of the Sandstone Dam, the Kettle River is now 'free-flowing' and is a tributary to the St. Croix River.

Minnesota Stream Quantification Tool
and Debit Calculator
User Manual (Version 1.0)

US Army Corps of Engineers
St. Paul District

BOARD OF WATER AND SOIL RESOURCES
MINNESOTA POLLUTION CONTROL AGENCY
DEPARTMENT OF NATURAL RESOURCES

StreamMechanics
ECOSYSTEM PLANNING & RESTORATION

WATERSHED APPROACH

- Likely same BSA for stream and wetlands

- GOAL: maintain and improve the quality and quantity of aquatic resources within watersheds through **strategic selection** of mitigation sites

Important because credits will be stratified as “streams”

PERFORMANCE STANDARDS

- Objective, verifiable and enforceable
- Based on best available science, restoration goals and watershed conditions

Performance Standard	Success Indicators	Adaptive Management	Adaptive Management Techniques
Special Condition X	• Survival of at least 70% of planted shrubs within the riparian corridor at the end of year ___ of the monitoring period.	• Survival of at less than 70% of planted shrubs within the riparian corridor at the end of year ___ of the monitoring period.	• Planting of additional native/non-invasive shrub or tree saplings or poles. • Tree growth-tubes to control grazing by local herbivores. • Fencing of riparian area to prevent deer browsing. • Continued monitoring.

EXAMPLE

OBJECTIVES → PERFORMANCE STANDARDS

Quantifiable objectives

Performance standards

Monitoring plans

Based on

Watershed-appropriate project goals that can be measured

MONITORING, REQUIRED FOR ALL MITIGATION

Things to consider:

What parameters to monitor, where, and for how long?

What's in the reports, how often are they submitted?

Who is responsible for monitoring?

Will the monitoring show that you're meeting a performance standard?

SITE MANAGEMENT

REQUIRED ELEMENTS FOR MITIGATION

1. objectives
2. site selection criteria
3. site protection instruments
4. baseline information
5. credit determination methodology
6. mitigation work plan
7. maintenance plan
8. ecological performance standards
9. monitoring requirements
10. long-term management plan
11. adaptive management plan
12. financial assurances

Additional elements: planform geometry, channel form, watershed size, design discharge, and riparian area plantings

Compensatory Mitigation Rule
Timeline for Bank or ILF Instrument Approval*

		Event	# of Days**		
Phase I		Optional Preliminary Review of Draft Prospectus	30		DE provides copies of draft prospectus to IRT and will provide comments back to the sponsor within 30 days.
		Sponsor Prepares and Submits Prospectus ~DE must notify sponsor of completeness w/in 30 days of submission~			
Phase II	Day 1**	Complete Prospectus Received by DE			
	Day 30	Public notice must be provided within 30 days of receipt of a complete prospectus	30		
	Day 60	30-Day Public Comment Period	30		
	Day 90	DE must provide the sponsor with an initial evaluation letter within 30 days of the end of the public comment period.	30	15	DE distributes comments to IRT members and sponsor within 15 days of the close of the public comment period.
		Sponsor Considers Comments, Prepares and Submits Draft Instrument ~DE must notify sponsor of completeness w/in 30 days of submission~			
Phase III	Day 1	Complete Draft Instrument Received by IRT Members			
		30-day IRT comment period begins 5 days after DE distributes draft instrument to IRT members	30	90	Within 90 days of the receipt of a complete draft instrument by IRT members, the DE must notify the sponsor of the status of the IRT review.
	Day 90	DE discusses comments with IRT and seeks to resolve issues ~ # of days variable~	60		
		Sponsor Prepares Final Instrument ~Sponsor provides copies to DE and all IRT members~			
Phase IV	Day 1	Final Instrument Received by DE & IRT			
	Day 30	DE must notify IRT members of intent to approve/not approve instrument within 30 days of receipt.	30	45	IRT members have 45 days from submission of final instrument to object to approval of the instrument and initiate the dispute resolution process.
		Remainder of time for initiation of dispute resolution process by IRT members	15		
	Day 45	INSTRUMENT APPROVED/NOT APPROVED, or DISPUTE RESOLUTION PROCESS INITIATED			

EPA/Corps draft 4/02/08

Total Required Federal Review (Phases II-IV): ≤225 Days
*Timeline also applies to amendments
**The timeline in this column uses the maximum number of days allowed for each phase.

THE WHEEL EXISTS, BUT IT COULD IMPROVE

We can (hope to) learn from:

- Wetland banking/ ILF/ PRM experiences
- Other Corps Districts
- Restoration community

OK, BUT WHEN WILL MITIGATION BE REQUIRED?

Permanent loss to a tributary in excess of 300 feet = talk to the Corps PM, use of debit tool may be required (depending on impact)

Permanent loss to a tributary in excess of 1,000 feet = mandatory use of <u>debit tool</u>

PERMANENT LOSS (GENERAL PERMIT DEFINITION)

Waters of the United States that are permanently adversely affected by filling, flooding, excavation, or drainage because of the regulated activity.

Must have a permanent discharges of dredged or fill material which:

- ✓ changes an aquatic area to dry land,
- ✓ increases the bottom elevation of a waterbody,
- ✓ or changes the use of a waterbody.

Loss = linear feet of stream bed that are filled or excavated as a result of the regulated activity

STREAM IMPACT DATA COLLECTION

Refinement of mitigation guidance provide more detailed mitigation thresholds:

- ✓ Use of the debit tool
- ✓ Team stream impact reviews
- ✓ Potential bank submittals

LINEAR PROJECTS

Something we're considering and would like feedback on:

If **any** crossing exceeds 300 linear feet you add up all the single and complete crossings

(this is not final)

CATCHMENT ASSESSMENT TOOL

Characterizes watershed processes and stressors that exist outside the project reach but affect functions within the reach

Watershed Health Assessment Framework

WHERE ARE THE TOOLS?

About | Business With Us | Missions | Locations | Careers | Media | Library | Contact | Search St. Paul Distri

US Army Corps of Engineers St. Paul District

Published: 10/8/2019

2019-00557-MJB (Renville County, MN) Midtown Wetland Mitigation Bank

PUBLIC NOTICE: The sponsor is proposing to develop Midtown Wetland Bank. The proposed bank site is approximately 27.1 acres in size, including

Published: 9/30/2019

2012-04872-LED (St. Louis County, MN) Lake Superior Wetland Mitigation Bank

PUBLIC NOTICE: The Lake Superior Wetland Bank (LSWB) was approved by the St. Paul District in 2015 and is currently undergoing construction. Since construction was completed in Zone A over the summer of 2018, the LSWB has finished construction on all of the proposed activities from the approved 2015 Mitigation Banking Instrument (MBI). On January 30, 2019, the bank Sponsor requested that the

mitigation in the following order although flexibility in approach can be exercised on a project-specific basis: mitigation bank credits, in-lieu fee program credits, [illegible] responsible mitigation under a watershed approach, permittee responsible mitigation through on-site and in-kind mitigation, and permittee responsible mitigation through off-site and/or out-of-kind mitigation.

Sources of Compensatory Mitigation	
Mitigation Bank	One or more sites where aquatic resources such as wetlands or streams are restored, established, enhanced and / or preserved for the purpose of providing compensatory resources.
In-lieu Fee Program	A program that involves the compensatory mitigation of aquatic and related terrestrial resources through funds paid to a government or non-governmental natural resource management organization.
Permittee-responsible Mitigation	Individual projects constructed by permittees to provide compensatory mitigation for activities authorized by Corps of Engineers' permits.

www.mvp.usace.army.mil/Missions/Regulatory/Mitigation/

Federal Mitigation Rule

Stream Quantification Tool

Submit SQT comments *(email)*

MNSQT Excel Workbook Field Forms (Appendix B)

MN Debit Calculator Excel Workbook

MNSQT and Debit Tool Field Data Collection Methods (Appendix A)

Effective Vegetated Riparian Area Documentation Form

MNSQT Excel Workbook

MNSQT and Debit Calculator User Manual

Scientific Support for the Debit Calculator

Large Woody Debris Forms

Macroinvertebrate and Fish Forms

A Function-Based Framework - 2012 EPA FWS

WHAT'S NEXT

- Stream Mitigation Guidance early 2020
- Webinars winter 2020
- Future workshops/ trainings- let us know your interest!

INTERESTED IN LEARNING MORE?

Sign up for our public notices!

Mitigation Rule:

www.epa.gov/cwa-404/compensatory-mitigation-losses-aquatic-resources-under-cwa-section-404-final-rule

Questions?