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of Engineers**



**Regulatory
Program**

Oklahoma Stream Mitigation Method

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Oklahoma Department of Environmental Quality (ODEQ)
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Oklahoma Stream Mitigation Method (OSMM)

1. INTRODUCTION:

1.a. Purpose:

This OSMM document establishes a stream credit system by quantifying proposed unavoidable impacts to streams associated with proposed projects submitted for authorization under Section 10 of the Rivers and Harbors Act of 1899 and Section 404 of the Clean Water Act. The OSMM will typically be applied on those permit evaluations where a pre-construction notification is required to be submitted to the Corps. The OSMM is authorized for use by the Corps, applicants, and authorized agents to determine the amount of compensatory mitigation necessary to offset unavoidable stream impacts associated with Department of the Army permit evaluations. Section 332.3(f) of the Corps and USEPA joint regulation for Compensatory Mitigation for Losses of Aquatic Resource; Final Rule (Federal Register / Vol. 73, No. 70 Pages 19594-19687, April 10, 2008) (herein referred to as Mitigation Rule), specifies that functional or condition assessment methods or other suitable metrics should be used where practicable to determine how much compensatory mitigation is required. Therefore, this document has been developed using best available information and applies scientific concepts to assist Regulatory Office personnel in determining a value which represents the loss of aquatic resource functions by the assessment of conditions at an impact or project site and the gain in aquatic resource functions or condition through restorative or enhancement actions at a mitigation site. The OSMM is based on assessment of the character and quality of a stream environment and converting these characteristics into units of measure called a stream credit. These stream credits are used for both impact assessment and mitigation evaluation.

Another key element of the OSMM addresses the requirement for making a determination of credits identified in Section 332.4(c)(6) of the Mitigation Rule. The OSMM does not replace any other mitigation plan requirements or components identified in the Mitigation Rule. All mitigation plan documentation must be prepared in accordance with the Compensatory Mitigation for Losses of Aquatic Resources; Final Rule (2008) and the Tulsa District Mitigation and Monitoring Guidelines (current edition), which governs planning, implementation, and management of permittee-responsible and third-party compensatory mitigation projects. Therefore, the OSMM serves as a tool for determining the amount of stream mitigation credits that a proposed project will generate based on the mitigation plan prepared for Stream Mitigation Banks, Individual In-Lieu Fee Stream Project Approvals, or Permittee-Responsible Mitigation Sites within the State of Oklahoma.

This method is a rapid protocol and has been established to supplement current policy and provide a consistent rationale to determine appropriate compensatory stream mitigation. This will be the preferred method when assessing mitigation requirements for all types of stream systems (perennial, intermittent, and ephemeral) that contain an ordinary high water mark and are determined to be jurisdictional waters of the United States (consistent with

rules in place at the time of the determination). The OSMM could be companioned with other studies (e.g., Hydrogeomorphic Approach, Rapid Stream Assessment Technique, and/or Index of Biologic Integrity) when considered practical or necessary, as directed by Corps leadership.

In some cases, the evaluation of the permit application may reveal that proposed stream compensation measures are not practical, constructible, or ecologically desirable. Therefore, all determinations involving projects requiring stream mitigation will be made on a case-by-case basis at the discretion of the Corps.

The policies and regulations regarding mitigation can change and it is possible that new guidance will result in periodic modifications to this OSMM. Efforts have been made in the preparation of this document to incorporate the most recent Corps policy. If a discrepancy with any relevant Corps policy is discovered, users should notify the Corps of the item and the Corps will review relevant policy, obtain clarification, and modify this OSMM, as necessary.

1.b. Regulatory Authorities & Guidelines:

1.b.i. Section 10 of the Rivers and Harbors Act of 1899: This Act authorizes the Corps of Engineers to regulate all work in, over, and under navigable waters of the United States.

1.b.ii. Section 404 of the Clean Water Act, as amended in 1977: This Act authorizes the Corps of Engineers to regulate the discharge of dredged or fill material into waters of the United States, including wetlands. The purpose of the Clean Water Act is to restore and maintain the physical, chemical, and biological integrity of the nation's waters.

1.b.iii. Section 230.10 (d) of the Section 404 (b)(1) Guidelines: These guidelines state that "no discharge of dredged or fill material shall be permitted unless appropriate and practicable steps have been taken which will minimize potential adverse impacts of the discharge on the aquatic ecosystem." The Section 404 (b)(1) Guidelines require the application of a sequence of mitigation - avoidance, minimization, and compensation. In other words, mitigation consists of the set of modifications necessary to avoid adverse impacts altogether, minimize the adverse impacts that are unavoidable and compensate for the unavoidable adverse impacts. Compensatory mitigation is required for unavoidable adverse impacts, which remain after all appropriate and practicable avoidance and minimization has been achieved.

1.b.iv. Section 401 of the Clean Water Act: This Act provides authority to each state to issue a 401 Water Quality Certification for any project that needs a federal license or permit to conduct any activity which may result in any discharge. To provide consistency to applicants, the OSMM will also assist ODEQ in their evaluation of projects for Section 401 state water quality certification. The 401 Certification is verification by the state that the project will not violate water quality standards. The ODEQ works with applicants to avoid and minimize impacts to waters. As part of the 401 Certification, ODEQ may require actions on projects to protect water quality.

1.b.v. Relationship to other federal, tribal, state, and local programs: Except for projects undertaken by federal agencies, or where federal funding is specifically authorized to provide compensatory mitigation, federally funded conservation projects undertaken for purposes other than compensatory mitigation cannot be used for the purpose of generating compensatory mitigation credits for activities authorized by Department of the Army permits. However, compensatory mitigation credits may be generated by activities undertaken in conjunction with, but supplemental to, such programs in order to maximize the overall ecological benefits of the conservation project (see regulations at 33 CFR 332.3 (j) and 40 CFR 230.93 (j)). If a supplemental ecological benefit cannot be identified to the federally funded conservation project undertaken for purposes other than compensatory mitigation, then compensatory mitigation credit cannot be given.

1.b.vi. Compensatory Mitigation for Losses of Aquatic Resources; Final Rule, dated 10 April 2008: This Final Rule is the regulation governing compensatory mitigation for activities authorized by permits issued by the Department of the Army. The regulations establish performance standards and the use of permittee-responsible compensatory mitigation, mitigation banks, and in-lieu-fee programs to improve the quality and success of compensatory mitigation projects. This Final Rule can be found at **33 CFR Parts 325 and 332**.

1.b.vii. Tulsa District Mitigation and Monitoring Guidelines (2004): This document addresses mitigation issues within the Tulsa District geographic area in a manner which guides permit applicants toward appropriate, viable, and meaningful mitigation proposals to successfully replace lost functions and values of the aquatic ecosystem.

1.b.viii. Regulatory Guidance Letter (RGL) 08-03, Minimum Monitoring Requirements for Compensatory Mitigation Projects Involving the Establishment, Restoration, and/or Enhancement of Aquatic Resources: This document provides guidance on minimum monitoring requirements for compensatory mitigation projects, including the required content for monitoring reports.

1.b.ix. Regulatory Guidance Letter (RGL) 05-05, Ordinary High Water Mark Identification: This document provides guidance for identifying the ordinary high water mark. RGL 05-05 applies to jurisdictional determinations for non-tidal waters under Section 404 of the Clean Water Act and under Sections 9 and 10 of the Rivers and Harbors Act of 1899.

2. WORKSHEETS:

2.a. Worksheet Instructions: The users of this tool should have an understanding of methodologies related to stream and riparian habitats. The OSMM tool is dependent on the use of the attached worksheets in Appendix A1 through A3. Each worksheet provides the user with specific factors that should assist the user in determining the correct value, when considering proposed project impacts and proposed mitigation. Each worksheet has categories associated with rating factors that have pre-determined scores. The pre-determined categories and scores shall not be altered.

Key to utilizing this OSMM tool, all users must consider the Corps current avoidance and minimization procedures required for all proposals within jurisdictional waters of the United States. This credit-based tool utilizes stream type and stream length impacted to calculate the number of credits that the proposed project would need to off-set potential unavoidable impacts of proposed projects. Certainly, the cost of required mitigation may spur a proponent to revisit their avoidance strategy and incorporate additional minimization into the project design in order to reduce the amount of required mitigation.

2.b ADVERSE IMPACT WORKSHEET: The Adverse Impact Factors Worksheet (Appendix A-1) must be used to evaluate adverse impact factors. This worksheet assesses the proposed project impacts at a site which requires a Department of the Army authorization. The factors for this worksheet can be found in Section 2.b.i.

Adverse impacts are calculated based on the following factors: stream type (ST), priority water (PW), existing condition (EC), impact duration (ID), impact activity (IA), and linear impact magnitude (LIM). The categories are added to calculate the Sum of Factors. The Sum of Factors is then multiplied by the linear feet of proposed stream impacts to calculate the total number of credits. When determined by the Corps, a Compensation Ratio will be added to calculate the total amount of credits required.

When compensatory mitigation requirements will be fulfilled by an approved third party mitigation provider the totaled credit from the Adverse Impact Worksheet (Appendix A-1) will be required for purchase from the mitigation bank or in-lieu-fee program by the applicant. Additional mitigation will be required when proposed project is outside of the primary service area of the mitigation bank or the in-lieu fee program. When permittee-responsible mitigation is determined acceptable by the Corps, the mitigation value of the mitigation plan evaluated under Sections 2.c and 2.d should equal or exceed the total credits required on the Adverse Impact Worksheet (Appendix A-1).

2.b.i. Adverse Impact Factors: The factors below are used to determine the credits for the Adverse Impact Factors Worksheet (Appendix A-1).

2.b.i(1) Stream Types (ST):

2.b.i(1)(a) Ephemeral Streams: Streams that have flowing water only during and for a short duration after precipitation events during a normal precipitation year. Ephemeral streambeds are located above the water table year-round. Groundwater is not a source of water for the stream. Runoff from precipitation is the primary source of water for stream flow. Ephemeral streams typically support few aquatic organisms. When aquatic organisms are found they typically have a very short aquatic life stage.

2.b.i(1)(b) Intermittent Streams: Streams that have flowing water during certain times of the year, when ground water provides water for stream flow. During dry periods, intermittent streams may not have flowing water. Runoff from precipitation is a supplemental source of water for stream flow. The biological community of intermittent streams is composed of species that are aquatic during a part of their life history or move to perennial water sources.

2.b.i(1)(c) Perennial Streams: Streams that have flowing water year-round during a normal precipitation year. The water table is located above the streambed for most of the year. Groundwater is a primary source of water for stream flow. Runoff from precipitation is a supplemental source of water for stream flow. Perennial streams support aquatic organisms year-round.

2.b.ii. Priority Waters (PW) [Appendix B]: The priority waters are divided into three categories:

2.b.ii(1) Priority waters include:

- Outstanding National Resource Waters.
- State Outstanding Resource Waters and tributaries.
- High Quality Waters designated by the state.
- Mussel Beds.
- Waters with Federal Listed Endangered and Threatened species.
- Streams with high aquatic biodiversity.

2.b.ii(2) Secondary waters include:

- Sensitive Water Supply also known as OWRB Sensitive Public and Private Water Supplies (SWS).
- Abutting an approved consolidated mitigation site (banks and in-lieu fee).
- Rivers and streams of the same or lower order within 1.0 mile upstream or downstream of priority waters of a project site.
- Oklahoma 303(d) List of Impaired Waters.

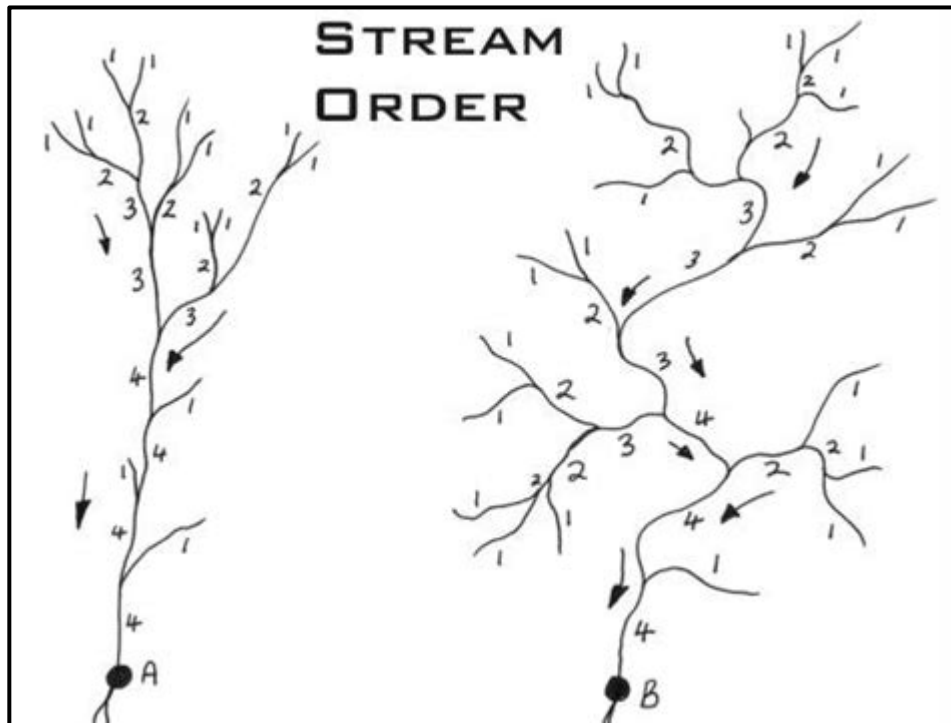
2.b.ii(3) All other waters not described above: These areas include all other freshwater systems not ranked as priority or secondary waters.

2.b.iii. Existing Conditions (EC): The following describes the condition of each stream segment where an impact activity is proposed before any project impacts that would occur from an applicant proposed project. This measures the ability to support normal hydraulic and geomorphic functions relative to the physical, chemical, and biological integrity of the system. If a stream is impaired, it cannot be considered fully functional.

2.b.iii(1) Fully Functional: Describes those stream segments that have been shown to or are likely to support healthy aquatic communities indicative of the ecoregion and stream type. These stream segments also have natural hydrologic variability and responses to precipitation events. Fully functional stream segments are characterized by a combination of little modification, relatively stable bed and banks, good water quality, and undisturbed riparian corridors. A fully functional stream represents a least-disturbed condition and therefore exhibits the conditions used to establish performance standards for restoration and mitigation.

User Note: Streams with a Strahler stream order number 4 or greater are automatically designated as fully functional (see next example drawing).

Example Drawing:



The evaluated stream segment is considered **fully functional** when 4 of 6 of the following criteria are met:

- Is unaltered in any major manner by human activities. It has not been channelized, impounded, or substantially constricted by structures, or had its flow substantially altered.
- Is not listed on the most current Clean Water Act 305 (b) Integrated lists as Category 4 or 5 developed by ODEQ. <https://www.deq.ok.gov/water-quality-division/watershed-planning/integrated-report/>
- Is stable and does not exhibit head cutting, incision, or excessive aggradation and the stream banks are not subject to excessive erosion or disturbance.
- Is connected to its overbank flood plain supporting normal hydrological functions.
- Has a riparian buffer of at least 50 feet in width on both sides of the stream that sustains deep-rooted, native vegetation that exceeds 50% cover. (3rd order stream or larger are expected to have wider riparian zones.)
- If a stream segment is impacted by a minor structural alteration along a stream that is otherwise considered fully functional, but does not substantially alter the stream reaches above and below the structure, the segment from 0.25 miles above to 0.25 miles below the alteration should be considered a separate segment that is moderately functional.

Exception: The Corps, at its discretion, may designate the largest streams within an 8-digit Hydrologic Unit Code (HUC) as fully functional, regardless of whether they meet the criteria above, based on the stream's recreational, commercial, or water supply values (see Appendix C).

2.b.iii(2) Moderately Functional: Streams have been altered; however, system recovery has a moderate probability of occurring naturally. These streams support many, but not all, of the hydraulic and geomorphic characteristics of fully functioning streams of similar order in the watershed. All stream segments that **do not meet** the definition of fully functional or **do not have** the characteristics of an impaired stream segment are considered moderately functional.

2.b.iii(3) Partially Impaired: Describes those streams that have been degraded in **one** of the following parameters below or lacks resilience characterized by loss of one integrity function. Recovery is unlikely to occur naturally unless a major rehabilitation project is undertaken.

2.b.iii(4) Impaired: Describes those streams that have been degraded in **two or three** of the following parameters below and/or lacks resilience characterized by loss of two to three of the integrity functions. Recovery is unlikely to occur naturally unless a major rehabilitation project is undertaken.

2.b.iii(5) Severely Impaired: Describes those streams that have been degraded in **four or more** parameters and/or lacks resilience characterized by loss of four or more of the integrity functions. Recovery is unlikely to occur naturally unless a major rehabilitation project is undertaken.

2.b.iii(6) Seven factors of Stream Impairment (a) and Eight factors for Integrity Functions (b): A stream segment is considered impaired if it fails to meet a Fully Functional or Moderately Functional conditions.

2.b.iii(6)(a) The criteria for determining a stream impairment are listed below:

2.b.iii(6)(a)(i) Has been channelized and shows no evidence of self-recovery.

2.b.iii(6)(a)(ii) Is levee protected, impounded, or artificially constricted?

2.b.iii(6)(a)(iii) Is entrenched?

2.b.iii(6)(a)(iv) Contains active head cut (i.e. abrupt drops in stream bed, both banks failing).

2.b.iii(6)(a)(v) Has little or no riparian buffer of deep-rooted vegetation on one or both sides of the stream channel.

2.b.iii(6)(a)(vi) Has banks that are extensively eroded or unstable, obvious bank sloughing, and erosional scars.

2.b.iii(6)(a)(vii) Has four or more stream impacts within 0.5 miles upstream of the proposed stream impact including culverts that convey stream flow, pipes, or other manmade modifications, and stream impacts individually or cumulatively exceeds 100 feet in length.

2.b.iii(6)(b) The following examples can be used to determine stream characteristics that could lack resilience characterized by loss of integrity functions:

2.b.iii(6)(b)(i) Water Quality (physical, chemical, and biological)

2.b.iii(6)(b)(ii) Channel Form – straight, meandering, braided, and branched

2.b.iii(6)(b)(iii) Stream Ecological Integrity (stream cover for fish, and the stream bank and riparian area. It also includes the status and cover that support benthic macroinvertebrate population)

2.b.iii(6)(b)(iv) Stream Bio Assessment (aquatic vegetation and algae, fish, insects, crayfish, salamanders, frogs, worms, snails, mussels, etc.)

2.b.iii(6)(b)(v) Dissolved Organic Matter (lawn clippings, leaves, stems, branches, moss, algae, lichens, any parts of animals, manure, droppings, sewage sludge, sawdust, insects, earthworms, and microbes)

2.b.iii(6)(b)(vi) Eco System Metabolism (organic matter cycling in aquatic ecosystems)

2.b.iii(6)(b)(vii) Aquatic biota including benthic invertebrates and periphyton

2.b.iii(6)(b)(viii) Water chemistry (acidity, dissolved oxygen, and turbidity including metals, nitrates, carbon, sulfates, and organic compounds) See 303(d) List of impaired waters

2.b.iv. Impact Duration (ID): This is the amount of time the impact activity is expected to last. For purposes of this method the duration of the impact activity is factored in the following categories: temporary impacts, recurring impacts, and permanent impacts.

2.b.iv(1) Temporary Impacts: Means the impact activity will remain for a period of less than 6 months with system integrity recovering after cessation of the permitted activity or restoration to pre- construction contours and elevations. Under certain circumstances impacts may remain within a stream for a period greater than 6 months but the decision is contingent upon activity type, impact area, effects to in-stream flows, biological communities, water quality, and best management practices to minimize adverse effects. Examples of activities suitable to receive a temporary duration factor include utility line crossings where appropriate natural substrate is used to backfill an open cut trench, temporary road crossings, work pads, or cofferdams.

User Note: *Compensatory mitigation is not normally required for temporary impacts where the disturbed area is fully restored and there is no permanent reduction in ecological function following the completion of the project.*

2.b.iv(2) Recurring Impacts: Means that impact activities have occurred at this location before. Impacts to some or all aquatic resource functions and/or services are not considered a permanent loss. Recurring impacts to the impact area occur in such a frequency that the impact area could incur additional effects to in-stream flows, biological communities, water quality, and best management practices that could adversely affect existing aquatic resource functions. An example of activities suitable to receive recurring duration factor includes sand or gravel mining activities.

User Note: *Compensatory mitigation may be required for recurring impacts at a project location.*

2.b.iv(3) Permanent Impacts: Means the impact activity will result in the permanent loss of some or all aquatic resource function and/or services. Examples of activities suitable to receive a permanent duration factor include armoring, culverting, detention facilities, morphological changes, impounding, and piping are examples of permanent impact activities.

2.b.v. Impact Activity (IA): This is the type of impact proposed that will diminish the functional integrity of the stream. The following categories are the nine types of impact:

2.b.v(1) Armor: To add riprap to one or both stream channel banks or use other hard methods (i.e. concrete or block retaining wall) on one bank alone leaving the stream bed unaltered. Keying riprap revetments along the toe is an acceptable installation practice under this parameter.

User Note: *Armoring of the stream bed and banks with riprap or installing a retaining wall along both channel banks should be assessed as a “Morphologic change”.*

2.b.v(2) Below Grade (embedded) Culvert: To route a stream through pipes, box culverts, or other enclosed structures for the purpose of a transportation crossing (e.g., roads, highways, railways, trails, driveways, airport runways, and taxiways). New or replacement culverts should be designed to convey geomorphic bankfull discharge with a similar average velocity as upstream and downstream sections. The culvert should be embedded and backfilled below the grade of the stream at least 1 foot for culverts greater than 48 inches diameter. On culverts less than 48 inches in diameter, the bottom of the culvert should be placed at a depth 4 to 12 inches below the natural stream bottom, relative to the culvert size. Bottomless culverts are acceptable in streams with non-erodible beds (i.e., bedrock or stable clay). Culverts that fail to meet the above design criteria will be evaluated under the impact activity known as pipe (see definition below).

2.b.v(3) Clearing: The removal of streambank vegetation or other activities that reduce or eliminate the quality and functions of vegetation within riparian habitat without disturbing the existing topography or soil.

User Note: *This factor is intended for use in combination were no other impact activity is being evaluated. Additional mitigation could be required if both sides of the stream are cleared as a result of the proposed project. Clearing both sides, doubles the adverse impact factor.*

2.b.v(4) Detention Facility: The installation of a storm water management facility within a stream channel. This facility consists of a detention structure and a temporary ponding area upstream of the detention structure. The detention structure (i.e., dam or berm) itself is considered a “fill” activity, as defined below. Water velocities entering the temporary ponding area are typically reduced and may be

temporarily held back while outflow is slowly released back into the channel downstream of the detention structure.

User Note: *If the stream channel upslope of the detention structure is straightened, widened, dredged, excavated, or relocated it will be left to the discretion of the Regulatory Project Manager to determine whether the “morphologic change” or “fill” impact activity factor will be used.*

2.b.v(5) Fill: The filling of a stream channel including the relocation of a stream channel (even if a new stream channel is constructed), or other fill activities.

2.b.v(6) Impoundment: The conversion of stream(s) to open water (pond or lake) through the construction of a dam or similar structure that modifies the natural stream flow. Channel impacts where the structure is located is considered a “fill” activity and the inundation will be considered as an impoundment.

2.b.v(7) Morphologic Change: To alter the established or natural dimensions, depths, or limits of an existing stream channel through straightening, widening, dredging, excavating, or channelizing (leave the channel in the same alignment). Examples of morphologic change include creation of a concrete lined open channel, in channel grading upstream of a detention structure, conversion of a stream to a grassed waterway, lining parallel banks with gabion baskets, concrete or block retaining walls, or channel reaming activities.

2.b.v(8) Pipe: To route a stream through pipes, box culverts, or other enclosed structures for purposes other than transportation crossings.

2.b.v(9) Utility Crossings: Activities required for the construction, maintenance, repair, and removal of utility lines within waters of the United States.

2.b.v(10) Bridge Footings: Activities requiring fill in waters of the United States are also considered in this activity factor. This factor also includes drilled shaft, column/pier placement, cofferdam for footing/pier placement, temporary crossing, and work pad.

2.b.vi. Linear Impact Magnitude (LIM): This is a mathematical calculation that addresses the scope of linear impact for each individual column recorded on the Adverse Impact Factor Worksheet. The corresponding value for each column shall be determined by multiplying a 0.0003 constant by the length of stream impacted per column (0.0003 x length of stream impacted per column). This factor considers those columns with greater affected stream length to have more extensive adverse effects on stream function than those columns containing lesser amounts of affected stream length.

2.c. IN-STREAM WORKSHEET: The In-Stream Worksheet (Appendix A-2) is to be used to evaluate the potential credits at the proposed stream mitigation site. Once credits have been determined using the Adverse Impact Factor Worksheet (Appendix A-1), the In-Stream Worksheet can be used. This worksheet determines the potential amount of credits the proposed stream mitigation project could produce by utilizing factors in Section 2c.i.

All users of this worksheet must be able to assess all factors [Stream Type (ST), Priority Waters (PW), Net Benefit (NB), Site Protection (SP), Credit Schedule (CS), and Location and Kind (LK)] in each category, then calculate the categories to determine the Sum of Factors. The Sum of Factors is then multiplied by the linear feet of Stream Length Benefitted to calculate the total number of credits. The Location and Kind factor only applies to projects requiring permittee-responsible mitigation.

When permittee-responsible mitigation is determined acceptable by the Corps, the mitigation value of the mitigation plan evaluated under this Section and Section 2.d should equal or exceed the total credits required on the Adverse Impact Worksheet. The OSMM tool can also be used to evaluate mitigation site conditions (in terms of credit increase or decrease) as long as this tool was previously used to establish a baseline assessment of the mitigation site. If mitigation site conditions do not meet predicted site conditions as expected, please contact your Regulatory Office Project Manager for guidance. *(This tool does not determine functional lift as required by performance standards within compensatory mitigation plans, unless this tool was used to establish baseline.)*

User Note: *An understanding of stream and riparian functions is required to plan, and design proposed stream restoration projects. The basic functions that stream and riparian corridors support include system dynamics, hydrologic balance, sediment processes and character, biologic support, and chemical processes and pathways (Fischenich 2006).*

Successful stream channel design or determining what restoration technique best fits a given situation is highly dependent on regional and local factors. Stream restoration must account for any potential adjustments in channel form and function that may occur within the watershed as a result of the restoration project. Watershed conditions, site selection, baseline information, mitigation objectives, design alternatives, and other feasibility actions must be considered during permit review as critical components of a compensatory mitigation plan prior to the application of this method. It is important to develop stream mitigation plans in consultation with resource and regulatory agencies and use existing watershed assessments, or other available planning documents to make determinations on the appropriate restoration method.

2.c.i. In-Stream Factors: The factors for the In-Stream Worksheet (A-2) described below are used to determine the mitigation credit that may accrue for mitigation work proposed within a stream channel. Stream Type (ST) and Priority Waters (PW) may be the same as identified in the Adverse Impacts Factors Worksheet (A-1).

2.c.ii. Net Benefit (NB): This is the evaluation of the proposed mitigation relative to the restoration or enhancement of physical, chemical and/or biological processes that occur in aquatic ecosystems. Excellent, Good, and Moderate in-stream activities are covered under

these guidelines and described below. Net benefits address functional objectives such as hydrologic balance, sediment transport, water quality and biological support in the context of the existing conditions prior to mitigation activities. The Corps reserves the right to review and determine the assignment of net benefit for proposed in-stream mitigation actions. Each mitigation proposal will be evaluated to ensure that the permittee documentation for stream mitigation fulfills the requirements of the Mitigation Rule.

If the applicant desires to remove riprap and stabilize all disturbed surfaces with either biodegradable erosion control fabric, native sod mat, and/or seeding with local native vegetation, this could be considered a net benefit.

A stream relocated to a new alignment for purposes of accommodating the construction of a proposed project is not considered a net benefit. However, other modifications of the stream bed and/or banks that restore stream meanders could also be considered a net benefit, if the stream's former location can demonstrate the relocation objectives balance hydrologic and geomorphic processes while incorporating appropriate design features. Under this circumstance, the Corps will determine on a case-by-case basis whether or not moving a stream to its former location is a net benefit of the proposed mitigation activity. The Corps will determine if the net benefit provides no compensation, partial compensation, or full compensation for the permittee's project impacts.

Example: If the historic channel has been filled and the applicant proposes to restore historic aquatic resource functions to the channel, that work could be considered a net benefit for the proposed project.

2.c.ii(1) Excellent: Addresses multiple functions of a stream. The benefits gained as a result of the mitigation project would apply to **all or substantial parts** of a stream's watershed.

Examples of in-stream activities which receive excellent stream net benefits include (but are not limited to):

- Removing dams, weirs, pipes, culverts, and other manmade in-stream structures that affect channel dynamics, configuration, stability and hinder aquatic life movements (grade control structure(s) may be required in streams that are actively incising).
- Low water crossing removals undertaken by the mitigation project sponsor and as part of a compensatory mitigation project and replaced with a span bridge. The replacement structure shall span the channel to provide an opening at least equivalent to the surveyed bedload transport zone of the stream (see Appendix D for general guidelines).
- Artificial levee or dike removal, setback, and/or notch where one of these activities itself will reconnect the stream channel to its natural overbank floodplain, with fifty percent of the 10-year recurrence interval floodplain reconnected across the entire valley.

- Returning a stream channel to its former location and/or reestablishing sinuosity, channel dimensions (width/depth ratio), and bankfull width of a degraded stream reach to appropriate design based on a morphologically stable and appropriate stream.
- Building a new stable channel at higher elevation and reconnecting it to its natural overbank floodplain where functionally appropriate.
- Creating floodplain benches adjacent to streams artificially disconnected from their floodplain. Stream banks shall be re-sloped and reshaped and floodplain bench shall be revegetated with native woody and herbaceous vegetation. Depending on project influence, this activity may be reduced to a good net benefit by the Corps.

“Excellent Net Benefit” **does not** include the relocation of a stream channel to accommodate a project in the stream’s present location.

2.c.ii(2) Good: Addresses **one or more** stream function(s). The benefits gained as a result of the mitigation project would be localized and not system-wide.

Examples of in-stream activities which accrue good stream net benefits include (but are not limited to):

- Removing stream impoundments, pipes, culverts, or other man-made structures, then restoring the stream reach to a stable, appropriate channel configuration as per reference stream reaches.
- Replacing inappropriately designed culvert(s) with a span bridge.
- Implementing appropriate bankfull discharge width, stream sinuosity, entrenchment ratio, length, and width/depth ratio to a referenced morphologic pattern.
- Building a new morphologically stable channel at a higher elevation to connect it to the floodplain.
- Creating or re-connecting floodplains adjacent to streams artificially disconnected from their floodplain.
- Where relocation of an incised stream is impracticable, modifying the existing channel and re-establishing a floodplain *in situ*, but not at the abandoned/disconnected floodplain elevation.
- Construction of off-channel wetland in areas where runoff quantities are increasing.
- Removing a dike, levee, or berm that is within the 100-year floodplain to re-connect the floodplain to the stream channel.

- Reconnecting abandoned side channels or meanders that were artificially cutoff, blocked, or filled where functionally appropriate.
- Removing riprap and reconstructing the stream banks to the proper radius of curvature, at the appropriate bank heights, then stabilizing all disturbed surfaces with either biodegradable erosion control fabric, native sod mats, and/or seeding with local native vegetation.

“Good Net Benefit” **does not** include the relocation of a stream channel to accommodate a project in the stream’s present location.

2.c.ii(3) Moderate: Addresses stream function(s) on a specific stream reach. Even if applied on a substantial length of stream, such practices do not markedly enhance the stream’s physical, chemical, and biological processes.

Examples of practices which accrue moderate stream net benefits include (but are not limited to):

- Improving stability in highly eroded areas or areas with artificially accelerated erosion, using non-rigid (soft) methods such as native vegetative stabilization, root wads with a relatively small percentage of rock, re-sloping and reshaping banks and creating a vegetated floodplain bench.
- Constructing natural channel features (i.e., riffle/run/pool/glide habitat) and morphology appropriate to target stream type, but not a comprehensive channel reconstruction/relocation.
- Routing a stream around an existing impoundment by creating a morphologically stable reach.
- Constructing fish ladders or other fish passage structures where appropriate.
- Replacing inadequate culverts/structures with a bottomless culvert or low water crossing.

“Moderate Net Benefit” **does not** include the relocation of a stream channel to accommodate a project in the stream’s present location.

2.c.ii(4) Minimal: Addresses stream channel actions that have **one** functional objective and include (but are not limited to):

- Implement stream bank stability by hardening the existing channel in place where accelerated erosion is documented. It should only be allowed when there are insurmountable constraints to using other restoration solutions, as may be the case in urban settings. Some proposals undertaken by this methodology may be considered to have adverse aquatic impacts and require compensatory mitigation.

- Incorporation of a bankfull planting bench into a rock riprap project.
- The modification of an existing or installed road crossing(s) within floodplain with design elements to facilitate flood flows.
- Replacing inadequate culverts with a conservation designed culvert or a buried culvert that conforms to the appropriate configuration per hydrology requirements.
- Removing check dams, weirs, car bodies, foreign materials/junk, debris, and artificial in-stream structures and/or other structures that are directly contributing to bank erosion, scour or blocking stream processes and aquatic organism movements without any additional measures.
- Excluding livestock with a fence that meets NRCS design standards.

User Note: *No mitigation credit is provided for either constructing channels that do not incorporate the principles of natural channel design or replacing a span bridge with a floored culvert design.*

2.c.ii(5) Preservation Only: Site has been preserved by conservancy agreement, conservation easement, or deed restriction and no mitigation plan will be executed for the site. Land is protected from future adverse impacts, disturbance, and effects.

2.c.ii(6) Stream Relocation to Accommodate a Proposed Project: Is the movement/creation of a stream to allow a proposed project to be constructed. The proposed project should incorporate natural channel design features relative to a morphologically stable and appropriate stream channel [dimension (cross-section), pattern (sinuosity), profile (slope)], and incorporate measures (grade control, in-stream habitat, riparian plantings, etc.). If the proposal would modify the stream bed and/or banks to restore stream meanders within a historic stream bed or incorporate enhancing ecological functions through restoration activities, the Corps may accept the relocated channel as compensatory mitigation. Relocated streams will generally require vegetative buffers of sufficient width that can be evaluated for riparian mitigation credit. Relocations resulting in a reduced channel length will generally require additional ecological appropriate mitigation credits to replace net losses of impacted stream channel.

2.c.iii. Site Protection (SP):

An appropriate legally binding real estate instrument, approved in advance by the Corps, will be required to ensure that the mitigation work, in-stream and/or out of stream are protected in perpetuity. Any site protection instrument listed below is appropriate for a subject property but may vary depending on each situation.

The types of site protection are:

- 2.c.iii(1) Conservation Easements
- 2.c.iii(2) Deed Restrictions
- 2.c.iii(3) Restrictive Covenants
- 2.c.iii(4) Conservancy Agreements

- 2.c.iii(5) Title Transfer
- 2.c.iii(6) Multiple-Party Agreements

2.c.iv. Credit Schedule (CS):

No additional credits are generated for this factor if the mitigation action in a reach is primarily riparian buffer preservation (less than 10% of buffer area would require planting of vegetation (see Table 1). For all forms of compensatory mitigation, the following guidelines apply for construction timing.

Table 1. Credit Schedule

Score	Schedule	Note
0.3	Credit Schedule 1	When 80 to 100 percent of the construction plus completion of all planting components specified in the mitigation work plan are completed before the stream impacts occur.
0.1	Credit Schedule 2	At least 50 percent but less than 80 percent of the construction plus greater than 50 percent of planting components specified in the mitigation work plan are completed prior to and/or concurrent with the stream impacts.
0	Credit Schedule 3	Less than 50 percent of the construction and less than 50 percent of planting components specified in the mitigation work plan will be completed prior to and/or concurrent with the stream impacts.

2.c.iv(1) All mitigation banks qualify for **Credit Schedule 1**. Bank sponsors sell a majority of their credits only after those credits have been released (meaning the aquatic resources are functioning). In order for credits to be released the sponsor must submit a monitoring report to the Corps demonstrating that the appropriate performance based milestones for credit release have been achieved. The Corps in consultation with the IRT determines whether the milestones have been achieved and if credits can be released.

2.c.iv(2) In-lieu fee (ILF) programs qualify for **Credit Schedule 3**. ILF sponsors generally initiate compensatory mitigation projects only after collecting fees, and there is often a substantial time lag between permitted impacts and implementation of compensatory mitigation projects.

User Note: *When an ILF holds (or possesses) released credits in service area that surpass the debits that have occurred, then at the discretion of the reviewing Regulatory project manager a credit schedule 1 or 2 may be acceptable.*

2.c.iv(3) Permittee-responsible mitigation will be evaluated to determine which credit schedule is appropriate for the mitigation proposed.

2.c.v. Stream Length Benefitted: Stream Length Benefitted is the total influence expressed in feet that the in-stream mitigation activity will have on the stream channel. This figure shall be applied in the box labeled Stream Length Benefitted found on the In-Stream Worksheet located in Appendix A-2. Six guidelines have been established below to assist users in determining the appropriate length to apply to the corresponding section of the worksheet.

- Linear credit for removal of low water crossings as discussed in detail in Appendix F.
- Linear credit for installation of localized lateral streambank stabilization measures will be based on the length of the appropriately sized structure.
- Linear credit for artificial levee or dike removal, setback, and/or notch will be based on the longitudinal extent that overbank flooding will occur along the stream channel and where the sponsor or permittee will place an appropriate legally binding real estate instrument that is approved by the Corps.
- Linear credit for grade control structures (also must consider user note below) will be determined on a case-by-case basis taking into consideration overall benefit of the structure to the watershed, survey information, and existing upstream or downstream structures. Selection of an appropriate net benefit factor is also at the sole discretion of the Corps.
- Linear credit for stream relocation activities necessary to accommodate proposed projects will be the length of new channel created provided this activity meets the criteria for consideration of a mitigation activity as described in Section 2.c.iii.
- Linear credit for all other activities will be determined on a case-by-case basis at the discretion of the Corps.

User Note: *Grade control is a prerequisite when an in-stream structure is removed in an actively incising channel, therefore, additional credit for the installation of these structures will not be considered or approved.*

2.c.vi. Location and Kind (LK): The location and kind factors listed below only apply to permittee-responsible mitigation projects. Mitigation banks and in-lieu-fee programs cannot be evaluated by this factor since they are planned and approved independently of the impacts that these programs will assume responsibility. Also, when mitigation bank and in-lieu-fee programs are being evaluated, watershed needs are considered which assists in a determination of credit amount and type which excludes the need to apply the kind portion of this factor. Therefore, when a mitigation bank or in-lieu-fee program is proposed to fulfill the compensatory mitigation requirement, the Adverse Impact Factors Worksheet allows the Corps to determine whether an increased compensation ratio is needed to account for impacts beyond the geographic service area of mitigation banks or in-lieu fee programs.

2.c.vi(a) Use a factor of 0.5 for: The permittee-responsible mitigation proposed outside of the 8-digit Hydrologic Unit Code (HUC) watershed in which the impacts would occur

or when the permittee-responsible mitigation is determined to be out-of-kind (i.e. replacing a high quality riparian buffer with a riparian buffer of a different physical and functional type.)

2.c.vi(b) Use a factor of 1.0 for: The permittee-responsible mitigation proposed within the 8-digit HUC watershed in which the impacts would occur or permittee-responsible mitigation is under a watershed approach which considers how the type and location of the compensatory mitigation project will provide the desired aquatic resource function and when interchanging hydrologic stream types (i.e. ephemeral, intermittent, perennial).

User Note: Mitigation credits generated as part of a permittee-responsible mitigation plan should be equal to or greater than the required credits calculated on the Adverse Impact Factors Worksheet. Any mitigation credit shortage may be compensated by modifying the mitigation plan in an attempt to accrue more mitigation credit, purchasing of credits from an approved mitigation bank, paying a fee to an approved in-lieu fee provider, or combination thereof. **Final decisions regarding how or where any mitigation credit shortage shall be compensated rests with the Corps.**

2.d. RIPARIAN BUFFER WORKSHEET: When considering the riparian corridor characteristics, the Riparian Buffer Worksheet (Appendix A-3) should be used to evaluate riparian buffer credits at the proposed mitigation site.

All users of this worksheet must assess all factors (Stream Type (ST), Priority Waters (PW), Net Benefit (NB), Supplement Buffer Credit (SBC), Site Protection (SP), Credit Schedule (CS), and Temporal Lag (TL)) in each category, then calculate the categories to determine the Sum of Factors. The Sum of Factors is multiplied by the Linear Feet of Stream Buffered to calculate the total number of credits. Location and Kind (LK) factors only apply to permittee-responsible mitigation projects. When permittee-responsible mitigation is determined acceptable by the Corps, the mitigation value of the mitigation plan evaluated under this Section and Section 2.c should equal or exceed the total credits required on the Adverse Impact Worksheet.

To determine Stream Type and Priority Waters on the In-Stream and Riparian Worksheets, users should refer to Sections 2.c.i and 2.d.i respectively for a discussion of these factors. These factors could be different than what is used for the Adverse Impact Worksheet (A-1) depending on the stream type being considered for compensatory mitigation. As mentioned on the In-Stream Worksheet, the OSMM tool can also be used to evaluate mitigation site conditions (*in terms of credit increase or decrease*) as long as this tool was previously used to establish a baseline assessment of the mitigation site. If mitigation site conditions do not meet predicted site conditions as expected, please contact your Regulatory Office Project Manager for guidance. (*This tool does not determine functional lift as required by performance standards within compensatory mitigation plans.*)

User Note: Properly vegetated riparian buffers serve important stream functions including sediment trapping, use and storage of nutrients, stream shading, energy dissipation, natural moderation of floods, bank stability, natural wetland development, and delivery of organic

matter to the stream. Mitigation work within the riparian buffer means implementing physical augmentation of the stream riparian buffer to improve water quality and/or ecosystem function and should strive to mimic the native composition, density, and structure of a fully functional stream situated within the same watershed. Resource professionals should also consider stream size, stream slope, drainage area, need for filtering runoff, stability of the stream, life history requirements of resident species, potential for stream bank erosion, longitudinal and horizontal migration, and floodplain interaction frequency, in determining corridor width.

2.d.i. Riparian Buffer Factors: The Riparian Buffer Worksheet (A-3) utilizes factors below to determine the credits for the existing riparian buffer zone. This worksheet can also be used to measure functional lift for mitigation sites as long as this tool was used for the initial assessment. Stream Type and Priority Waters for this worksheet should be the same as identified in the In-Stream Worksheet (A-2). The Site Protection and Credit Schedule should be the same as identified on In-Stream Worksheet (A-2). The total credits generated from this worksheet must be added to the credits from the In-Stream Worksheet (A-2) to receive the total amount mitigation credits. The credits generated from worksheets (A-2) and (A-3) must be greater than credits generated from worksheet (A-1).

2.d.ii. Net Benefit (NB): Is based on the percent of physical augmentation to the riparian buffer and the buffer width proposed along the stream channel. The Riparian Buffer Net Benefit Values are shown in Table 1 below and will fall under one of the following categories:

2.d.ii(1) Buffer Restoration/Establishment: When at least 51% to 100% of the buffer would require planting and/or undesirable vegetation removal in companion with appropriate native vegetation establishment to achieve important aquatic resource functions in the buffer area.

2.d.ii(2) Buffer Enhancement: When at least 10% to 50% of the buffer would require planting and/or undesirable vegetation removal in companion with appropriate native vegetation establishment to achieve important aquatic resource functions in the buffer area.

2.d.ii(3) Buffer Preservation: For the purposes of this guidance, an area will be considered as riparian buffer preservation if less than 10% of the area would require planting of vegetation to maintain important aquatic resource functions.

User Note: *Credit cannot be obtained for multiple mitigation activities within the same riparian corridor along the same side of the stream (i.e. credit is not allowed for preservation of 500 linear feet of existing corridor and also for the establishment of 500 linear feet of buffer along the same channel segment).*

User Note: *The buffer percentages expressed above shall be calculated for each side of the channel that will be buffered and for which mitigation credit is being sought.*

Example: 500 feet of stream side buffer proposed along left descending bank of stream channel for a distance of 50 feet perpendicular to the channel. Twenty feet of native buffer currently exists perpendicular to the channel resulting in a planting area of 30 feet to establish the 50-foot wide buffer. Therefore, the total planting area is 60% qualifying for riparian buffer restoration/establishment and the value selected from Table 1 is 0.50.

User Note: *Streams which are recognizably unstable, entrenched, or otherwise disconnected from their floodplains, and which require extensive stream bed and/or bank restoration are not considered good candidate streams for solely producing riparian buffer credit. However, under some circumstances the Corps in consultation with the reviewing resource agencies may entertain a setback from the top of stream bank to accommodate changes in the streams' dimension, pattern, and profile as the channel responds to regional influences predicted to occur in a watershed plan. No riparian net benefits will be determined for the setback area due to the instability and eventual loss of ground. However, a net benefit value can be assigned for buffer establishment beyond the setback zone.*

2.d.iii. Requirements for Minimum Buffer Width (MBW): The MBW for which mitigation credits will be earned is 50 feet on one side of the stream, measured from the top of the streambank, perpendicular to the channel. Smaller buffer widths may be allowed on a case-by-case basis for small streams and consideration for a reduced buffer width will be based on issues related to construction constraints, land ownership, and land use activities. If topography within a proposed stream buffer has more than a 2% slope, 2 additional feet of buffer are required for every additional percent of slope (e.g., minimum buffer width with a +10% slope is 66 feet: Calculation [10% - 2% = 8%] [8 x 2 = 16] [16ft + 50ft = 66 feet]).

Slope calculation will be based on the average slope for the first 50 feet adjacent to the channel beginning at the top of bank. For the channel segment being buffered, the slope percentage will be determined at 100-foot intervals and averaged to obtain a mean slope percentage for calculating minimum buffer width. This mean slope percentage will be used to calculate the minimum buffer width for the entire segment of stream being buffered.

User Note: *Typically, riparian buffers along stream order two or smaller (ephemeral streams or intermittent streams) will be a minimum of 50 feet from the top of the bank. Wider buffers may be accepted when the calculation for the MBW above requires additional buffering which is commonly found where steep slopes descend directly to the edge of the stream bank. Wider buffers may also be considered where the stream channel frequently interacts with its overbank floodplain or where a relatively narrow corridor along a small stream can be widened and connect two large tracts of forest.*

User Note: *Streams 3rd order or larger are candidates for stream buffers exceeding 100 feet perpendicular from the top of bank. Wider buffers will be expected when the calculation for the MBW above requires additional buffering which is commonly found where steep slopes descend directly to the edge of the stream bank. Wider buffers may also be considered where the stream channel frequently interacts with its overbank floodplain.*

Wider corridor widths may also be necessary along stream reaches with actively eroding banks or to accommodate long term stream channel changes or meanders. In these situations, setbacks must be carefully considered and performance criteria in the mitigation plan will need to be carefully crafted and closely monitored.

Table 1 below provides appropriate Net Benefit values for the riparian buffer worksheet. Users should note that buffers on each channel bank, generate mitigation credit separately (Stream Side A and Stream Side B).

Table 2. Riparian Buffer Net Benefit Values

Buffer Width (on one side of the stream) that is Equal to or greater than	% Buffer that requires physical improvement		
	Buffer Restoration/Establishment planted and/or undesirable vegetation is removed and appropriate native vegetation to be established at least 51-100%	Buffer Enhancement planted and/or undesirable vegetation is removed and appropriate native	Buffer Preservation with 10% or less plantings
300 feet	1.10	0.55	0.27
275 feet	1.05	0.52	0.26
250 feet	1.00	0.50	0.25
225 feet	0.95	0.47	0.24
200 feet	0.90	0.45	0.23
175 feet	0.85	0.42	0.21
150 feet	0.80	0.40	0.20
125 feet	0.75	0.38	0.19
100 feet	0.70	0.35	0.18
75 feet	0.60	0.30	0.15
50 feet	0.50	0.25	0.13
25 feet* (MBW)	0.10	0.05	0.02
No Buffer	0.00	0.00	0.00

* Smaller buffer widths may be allowed on a case-by-case basis for small streams and consideration for a reduced buffer width based on issues related to pre-existing construction constraints (i.e. sidewalks, roadways), land ownership, and land use activities.

2.d.iv. Supplemental Buffer Credit (SBC): Additional mitigation credit may be generated if minimum width buffers, or greater, are restored/established, enhanced, or preserved on **both** stream banks (lying parallel to one another). Supplemental buffer credit is calculated by adding the corresponding values recorded on the Riparian Buffer Worksheet for Net Benefit Stream Side A and Net Benefit Stream Side B and dividing the total value by two. If a riparian mitigation activity will only occur on one side of the channel segment being evaluated, then this factor will not be considered in the evaluation of credit generated.

2.d.v. Site Protection (SP): This is discussed in Section 2.c.iii.

2.d.vi. Credit Schedule (CS): This is discussed in Section 2.c.iv.

2.d.vii. Temporal Lag (TL): Temporal Lag is a factor that applies only to the Riparian Buffer Worksheet and takes into account the time required (measured in years) for a mitigation area to fully replace the riparian vegetation size and age class lost at the impact site. The riparian buffer targeted for restoration, establishment or enhancement at the mitigation site will require different lengths of time to reach a commensurate level of maturity that existed at the impact site.

2.d.viii. Location and Kind (LK): This is discussed in Section 2.c.vi.

APPENDIX A – OSMM WORKSHEETS

The following worksheets are available in this appendix:

A-1: Adverse Impact Factors Worksheet

A-2: In-Stream Work Worksheet

A-3: Riparian Buffer Worksheet

The Appendix A – OSMM worksheets are also available in an excel spreadsheet format.

The excel spreadsheet may vary due to calculation requirements.

Please contact your Regulatory Project Manager or <https://www.swt.usace.army.mil/Missions/Regulatory/Mitigation/>.

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ADVERSE IMPACT FACTORS WORKSHEET (A-1)

Factors: Variables:

<i>Stream Type Impacted (ST)</i>	Ephemeral 0.3		Intermittent 0.4		Perennial 0.8				
<i>Priority Waters (PW)</i>	All Other 0.05		Secondary 0.4		Priority 0.8				
<i>Existing Condition (EC)</i>	Severely Impaired 0.1	Impaired 0.4	Partially Impaired 0.6	Moderately Functional 0.8	Fully Functional 1.6				
<i>Impact Duration (ID)</i>	Temporary 0.05		Recurring 0.15		Permanent 0.3				
<i>Impact Activity (IA)</i>	Clearing 0.05 or 0.1*	Utility Crossing/Bridge Footing 0.15	Below Grade Culvert 0.3	Armor 0.5	Detention Facility 0.75	Morphologic Change 1.5	Impoundment 2.0	Pipe 2.2	Fill 2.5
<i>Linear Impact Magnitude (LIM)</i>	0.0003 multiplied by linear feet (LF) of stream impact (recorded in each column below)								

IMPACT FACTORS

Site Name									
Station ID									
Stream Type Impacted (ST)									
Priority Waters (PW)									
Existing Condition (EC)									
Impact Duration (ID)									
Impact Activity (IA)									
Linear Impact Magnitude (LIM)									
Sum of Factors (M) = (ST+PW+EC+ID+IA+LIM)									
Linear Feet of Stream Impact (LF)									
Required Credits (C) = M * LF									
Compensation Ratio ¹ * (C)									

Total Credits Required from all Columns= _____

1. **Compensation Ratio** - when the Corps determines that a third party mitigation source is acceptable to fulfill compensatory mitigation requirements the total credits determined on this worksheet shall be applied to mitigation banks or in-lieu fee programs at a 1:1 ratio when the impact area is within an approved service area, however, an increased compensation ratio may be used at the Corps discretion when an impact occurs beyond the geographic service area of an approved mitigation bank or in-lieu fee program.

* Impact Activity - Clearing on both sides of stream double the clearing category to 0.1.

Worksheet Factors for ADVERSE IMPACT FACTORS WORKSHEET (A-1)

2.b.i. Adverse Impact Factors: The factors below are used to determine the credits for the Adverse Impact Factors Worksheet (Appendix A-1).

2.b.i(1) Stream Types (ST):

2.b.i(1)(a) Ephemeral Streams: Streams that have flowing water only during and for a short duration after precipitation events during a normal precipitation year. Ephemeral streambeds are located above the water table year-round. Groundwater is not a source of water for the stream. Runoff from precipitation is the primary source of water for stream flow. Ephemeral streams typically support few aquatic organisms. When aquatic organisms are found they typically have a very short aquatic life stage.

2.b.i(1)(b) Intermittent Streams: Streams that have flowing water during certain times of the year, when ground water provides water for stream flow. During dry periods, intermittent streams may not have flowing water. Runoff from precipitation is a supplemental source of water for stream flow. The biological community of intermittent streams is composed of species that are aquatic during a part of their life history or move to perennial water sources.

2.b.i(1)(c) Perennial Streams: Streams that have flowing water year-round during a normal precipitation year. The water table is located above the streambed for most of the year. Groundwater is a primary source of water for stream flow. Runoff from precipitation is a supplemental source of water for stream flow. Perennial streams support aquatic organisms year-round.

2.b.ii. Priority Waters (PW) [Appendix B]: The priority waters are divided into three categories:

2.b.ii(1) Priority waters include:

- Outstanding National Resource Waters.
- State Outstanding Resource Waters and tributaries.
- High Quality Waters designated by the state.
- Mussel Beds.
- Waters with Federal Listed Endangered and Threatened species.
- Streams with high aquatic biodiversity.

2.b.ii(2) Secondary waters include:

- Sensitive Water Supply also known as OWRB Sensitive Public and Private Water Supplies (SWS).
- Abutting an approved consolidated mitigation site (banks and in-lieu fee).
- Rivers and streams of the same or lower order within 1.0 mile upstream or downstream of priority waters of a project site.
- Oklahoma 303(d) List of Impaired Waters.

2.b.ii(3) All other waters not described above: These areas include all other freshwater systems not ranked as priority or secondary waters.

2.b.iii. Existing Conditions (EC): The following describes the condition of each stream segment where an impact activity is proposed before any project impacts that would occur from an applicant proposed project. This measures the ability to support normal hydraulic and geomorphic functions relative to the physical, chemical, and biological integrity of the system. If a stream is impaired, it cannot be considered fully functional.

2.b.iii(1) Fully Functional: Describes those stream segments that have been shown to or are likely to support healthy aquatic communities indicative of the ecoregion and stream type. These stream segments also have natural hydrologic variability and responses to precipitation events. Fully functional stream segments are characterized by a combination of little modification, relatively stable bed and banks, good water quality, and undisturbed riparian corridors. A fully functional stream represents a least-disturbed condition and therefore exhibits the conditions used to establish performance standards for restoration and mitigation.

The evaluated stream segment is considered fully functional when 4 of 6 of the following criteria are met:

- Is unaltered in any major manner by human activities. It has not been channelized, impounded, or substantially constricted by structures, or had its flow substantially altered.
- Is not listed on the most current Clean Water Act 305 (b) Integrated lists as Category 4 or 5 developed by ODEQ. <https://www.deq.ok.gov/water-quality-division/watershed-planning/integrated-report/>
- Is stable and does not exhibit head cutting, incision, or excessive aggradation and the stream banks are not subject to excessive erosion or disturbance.
- Is connected to its overbank flood plain supporting normal hydrological functions.

- Has a riparian buffer of at least 50 feet in width on both sides of the stream that sustains deep-rooted, native vegetation that exceeds 50% cover. (3rd order stream or larger are expected to have wider riparian zones.)
- If a stream segment is impacted by a minor structural alteration along a stream that is otherwise considered fully functional, but does not substantially alter the stream reaches above and below the structure, the segment from 0.25 miles above to 0.25 miles below the alteration should be considered a separate segment that is moderately functional.

Exception: The Corps, at its discretion, may designate the largest streams within an 8-digit Hydrologic Unit Code (HUC) as fully functional, regardless of whether they meet the criteria above, based on the stream's recreational, commercial, or water supply values (see Appendix C).

2.b.iii(2) Moderately Functional: Streams have been altered; however, system recovery has a moderate probability of occurring naturally. These streams support many, but not all, of the hydraulic and geomorphic characteristics of fully functioning streams of similar order in the watershed. All stream segments that do not meet the definition of fully functional or do not have the characteristics of an impaired stream segment are considered moderately functional.

2.b.iii(3) Partially Impaired: Describes those streams that have been degraded in one of the following parameters below or lacks resilience characterized by loss of one integrity function. Recovery is unlikely to occur naturally unless a major rehabilitation project is undertaken.

2.b.iii(4) Impaired: Describes those streams that have been degraded in two or three of the following parameters below and/or lacks resilience characterized by loss of two to three of the integrity functions. Recovery is unlikely to occur naturally unless a major rehabilitation project is undertaken.

2.b.iii(5) Severely Impaired: Describes those streams that have been degraded in four or more parameters and/or lacks resilience characterized by loss of four or more of the integrity functions. Recovery is unlikely to occur naturally unless a major rehabilitation project is undertaken.

2.b.iii(6) Seven factors of Stream Impairment (a) and Eight factors for Integrity Functions (b): A stream segment is considered impaired if it fails to meet a Fully Functional or Moderately Functional conditions.

2.b.iii(6)(a) The criteria for determining a stream impairment are listed below:

- 2.b.iii(6)(a)(i) Has been channelized and shows no evidence of self-recovery.
- 2.b.iii(6)(a)(ii) Is levee protected, impounded, or artificially constricted?
- 2.b.iii(6)(a)(iii) Is entrenched?
- 2.b.iii(6)(a)(iv) Contains active head cut (i.e. abrupt drops in stream bed, both banks failing).
- 2.b.iii(6)(a)(v) Has little or no riparian buffer of deep-rooted vegetation on one or both sides of the stream channel.
- 2.b.iii(6)(a)(vi) Has banks that are extensively eroded or unstable, obvious bank sloughing, and erosional scars.
- 2.b.iii(6)(a)(vii) Has four or more stream impacts within 0.5 miles upstream of the proposed stream impact including culverts that convey stream flow, pipes, or other manmade modifications, and stream impacts individually or cumulatively exceeds 100 feet in length.

2.b.iii(6)(b) The following examples can be used to determine stream characteristics that could that lacks resilience characterized by loss of integrity functions:

- 2.b.iii(6)(b)(i) Water Quality (physical, chemical, and biological)
- 2.b.iii(6)(b)(ii) Channel Form – straight, meandering, braided, and branched
- 2.b.iii(6)(b)(iii) Stream Ecological Integrity (stream cover for fish, and the streams bank and riparian area. It also includes the status and cover that support benthic macroinvertebrate population)
- 2.b.iii(6)(b)(iv) Stream Bio Assessment (aquatic vegetation and algae, fish, insects, crayfish, salamanders, frogs, worms, snails, mussels, etc.)
- 2.b.iii(6)(b)(v) Dissolved Organic Matter (lawn clippings, leaves, stems, branches, moss, algae, lichens, any parts of animals, manure, droppings, sewage sludge, sawdust, insects, earthworms, and microbes)
- 2.b.iii(6)(b)(vi) Eco System Metabolism (organic matter cycling in aquatic ecosystems)
- 2.b.iii(6)(b)(vii) Aquatic biota including benthic invertebrates and periphyton
- 2.b.iii(6)(b)(viii) Water chemistry (acidity, dissolved oxygen, and turbidity including metals, nitrates, carbon, sulfates, and organic compounds) See 303(d) List of impaired waters

2.b.iv. Impact Duration (ID): This is the amount of time the impact activity is expected to last. For purposes of this method the duration of the impact activity is factored in the following categories: temporary impacts, recurring impacts, and permanent impacts.

2.b.iv(1) Temporary Impacts: Means the impact activity will remain for a period of less than 6 months with system integrity recovering after cessation of the permitted activity or restoration to pre- construction contours and elevations. Under certain circumstances impacts may remain within a stream for a period greater than 6 months but the decision is contingent upon activity type, impact area, effects to in-stream flows, biological communities, water quality, and best management practices to minimize adverse effects. Examples of activities suitable to receive a temporary duration factor

include utility line crossings where appropriate natural substrate is used to backfill an open cut trench, temporary road crossings, work pads, or cofferdams.

User Note: Compensatory mitigation is not normally required for temporary impacts where the disturbed area is fully restored and there is no permanent reduction in ecological function following the completion of the project.

2.b.iv(2) Recurring Impacts: Means that impact activities have occurred at this location before. Impacts to some or all aquatic resource functions and/or services are not considered a permanent loss. Recurring impacts to the impact area occur in such a frequency that the impact area could incur additional effects to in-stream flows, biological communities, water quality, and best management practices that could adversely affect existing aquatic resource functions. An example of activities suitable to receive recurring duration factor includes sand or gravel mining activities.

User Note: Compensatory mitigation may be required for recurring impacts at a project location.

2.b.iv(3) Permanent Impacts: Means the impact activity will result in the permanent loss of some or all aquatic resource function and/or services. Examples of activities suitable to receive a permanent duration factor include armoring, culverting, detention facilities, morphological changes, impounding, and piping are examples of permanent impact activities.

2.b.v. Impact Activity (IA): This is the type of impact proposed that will diminish the functional integrity of the stream. The following categories are the nine types of impact:

2.b.v(1) Armor: To add riprap to one or both stream channel banks or use other hard methods (i.e. concrete or block retaining wall) on one bank alone leaving the stream bed unaltered. Keying riprap revetments along the toe is an acceptable installation practice under this parameter.

User Note: Armoring of the stream bed and banks with riprap or installing a retaining wall along both channel banks should be assessed as a "Morphologic change".

2.b.v(2) Below Grade (embedded) Culvert: To route a stream through pipes, box culverts, or other enclosed structures for the purpose of a transportation crossing (100 linear feet or less of stream be impacted per linear transportation crossing). New or replacement culverts should be designed to convey geomorphic bankfull discharge with a similar average velocity as upstream and downstream sections. The culvert should be embedded and backfilled below the grade of the stream at least 1 foot for culverts greater than 48 inches diameter. On culverts less than 48 inches in diameter, the bottom of the culvert should be placed at a depth 4 to 12 inches below the natural stream bottom, relative to the culvert size. Bottomless culverts are acceptable in streams with non-erodible beds (i.e. bedrock or stable clay). Culverts that fail to meet the above design criteria will be evaluated under the impact activity known as pipe (see definition below).

2.b.v(3) Clearing: The removal of streambank vegetation or other activities that reduce or eliminate the quality and functions of vegetation within riparian habitat without disturbing the existing topography or soil.

User Note: This factor is intended for use in combination were no other impact activity is being evaluated. Additional mitigation could be required if both sides of the stream are cleared as a result of the proposed project. Clearing both sides, doubles the adverse impact factor.

2.b.v(4) Detention Facility: The installation of a storm water management facility within a stream channel. This facility consists of a detention structure and a temporary ponding area upstream of the detention structure. The detention structure (i.e. dam or berm) itself is considered a "fill" activity, as defined below. Water velocities entering the temporary ponding area are typically reduced and may be temporarily held back while outflow is slowly released back into the channel downstream of the detention structure.

User Note: If the stream channel upslope of the detention structure is straightened, widened, dredged, excavated, or relocated it will be left to the discretion of the Regulatory Project Manager to determine whether the "morphologic change" or "fill" impact activity factor will be used.

2.b.v(5) Fill: The filling of a stream channel including the relocation of a stream channel (even if a new stream channel is constructed), or other fill activities.

2.b.v(6) Impoundment: The conversion of stream(s) to open water (pond or lake) through the construction of a dam or similar structure that modifies the natural stream flow. Channel impacts where the structure is located is considered a "fill" activity and the inundation will be considered as an impoundment.

2.b.v(7) Morphologic Change: To alter the established or natural dimensions, depths, or limits of an existing stream channel through straightening, widening, dredging, excavating, or channelizing (leave the channel in the same alignment). Examples of morphologic change include creation of a concrete lined open channel, in channel grading upstream of a detention structure, conversion of a stream to a grassed waterway, lining parallel banks with gabion baskets, concrete or block retaining walls, or channel reaming activities.

2.b.v(8) Pipe: To route a stream through pipes, box culverts, or other enclosed structures for purposes other than transportation crossings.

2.b.v(9) Utility Crossings: Activities required for the construction, maintenance, repair, and removal of utility lines within waters of the United States.

2.b.v(10) Bridge Footings: Activities requiring fill in waters of the United States are also considered in this activity factor. This factor also includes drilled shaft, column/pier placement, cofferdam for footing/pier placement, temporary crossing, and work pad.

2.b.vi. Linear Impact Magnitude (LIM): This is a mathematical calculation that addresses the scope of linear impact for each individual column recorded on the Adverse Impact Factor Worksheet. The corresponding value for each column shall be determined by multiplying a 0.0003 constant by the length of stream impacted per column ($0.0003 \times \text{length of stream impacted per column}$). This factor considers those columns with greater affected stream length to have more extensive adverse effects on stream function than those columns containing lesser amounts of affected stream length.

IN-STREAM WORKSHEET (A-2)

FACTORS: VARIABLES:

<i>Stream Type (ST)</i>	Ephemeral 0.15	Intermittent 0.2	Perennial 0.4			
<i>Priority Waters (PW)</i>	All Other 0.05		Secondary 0.2	Priority 0.4		
<i>Net Benefit (NB)</i>	Stream Relocation to Accommodate Proposed Project 0.5	Preservation Only 0.65	Minimal 0.9	Moderate 1.2	Good 2.4	Excellent 3.5
<i>Site Protection (SP)</i>	Corps approved site protection without third party grantee 0.0		Corps approved site protection recorded with third party grantee, or transfer of title to a conservancy 0.5			
<i>Credit Schedule (CS)</i>	Schedule 1 0.3		Schedule 2 0.1		Schedule 3 0.0	

IN-STREAM FACTORS

Site Name:					
Station ID:					
<i>Stream Type (ST)</i>					
<i>Priority Waters (PW)</i>					
<i>Net Benefits (NB)</i>					
<i>Site Protection (SP)</i>					
<i>Credit Schedule (CS)</i>					
Sum Factors (M) = (ST+PW+NB+SP+CS)					
Stream Length Benefitted (do not count each bank separately or count same channel reach twice) (LF) =					
Credits (C) = M * LF					
Total In-Stream Credits Generated C * LK Factor¹ =					
Total from Riparian Buffer Worksheet (Page 35) =					
Total (In-stream Credits + Riparian Credits) =					
Total In-Stream Credits Generated from all Columns =					

1. Location and Kind (LK) Factor only applies to permittee-responsible mitigation projects (see page 17 of document).

Worksheet Factor for IN-STREAM WORKSHEET (A-2):

2.c. IN-STREAM WORKSHEET: The In-Stream Worksheet (Appendix A-2) is to be used to evaluate the potential credits at the proposed stream mitigation site. Once credits have been determined using the Adverse Impact Factor Worksheet (Appendix A-1), the In-Stream Worksheet can be used. This worksheet determines the potential amount of credits the proposed stream mitigation project could produce by utilizing factors in Section 2c.i.

All users of this worksheet must be able to assess all factors [Stream Type (ST), Priority Waters (PW), Net Benefit (NB), Site Protection (SP), Credit Schedule (CS), and Location and Kind (LK)] in each category, then calculate the categories to determine the Sum of Factors. The Sum of Factors is then multiplied by the linear feet of Stream Length Benefitted to calculate the total number of credits. The Location and Kind factor only applies to projects requiring permittee-responsible mitigation.

When permittee-responsible mitigation is determined acceptable by the Corps, the mitigation value of the mitigation plan evaluated under this Section and Section 2.d should equal or exceed the total credits required on the Adverse Impact Worksheet. The OSMM tool can also be used to evaluate mitigation site conditions (in terms of credit increase or decrease) as long as this tool was previously used to establish a baseline assessment of the mitigation site. If mitigation site conditions do not meet predicted site conditions as expected, please contact your Regulatory Office Project Manager for guidance. (This tool does not determine functional lift as required by performance standards within compensatory mitigation plans, unless this tool was used to establish baseline.)

User Note: An understanding of stream and riparian functions is required to plan, and design proposed stream restoration projects. The basic functions that stream and riparian corridors support include system dynamics, hydrologic balance, sediment processes and character, biologic support, and chemical processes and pathways (Fischenich 2006).

Successful stream channel design or determining what restoration technique best fits a given situation is highly dependent on regional and local factors. Stream restoration must account for any potential adjustments in channel form and function that may occur within the watershed as a result of the restoration project. Watershed conditions, site selection, baseline information, mitigation objectives, design alternatives, and other feasibility actions must be considered during permit review as critical components of a compensatory mitigation plan prior to the application of this method. It is important to develop stream mitigation plans in consultation with resource and regulatory agencies and use existing watershed assessments, or other available planning documents to make determinations on the appropriate restoration method.

2.c.i. In-Stream Factors: The factors for the In-Stream Worksheet (A-2) described below are used to determine the mitigation credit that may accrue for mitigation work proposed within a stream channel. Stream Type (ST) and Priority Waters (PW) may be the same as identified in the Adverse Impacts Factors Worksheet (A-1).

2.c.ii. Net Benefit (NB): This is the evaluation of the proposed mitigation relative to the restoration or enhancement of physical, chemical and/or biological processes that occur in aquatic ecosystems. Excellent, Good, and Moderate in-stream activities are covered under these guidelines and described below. Net benefits address functional objectives such as hydrologic balance, sediment transport, water quality and biological support in the context of the existing conditions prior to mitigation activities. The Corps reserves the right to review and determine the assignment of net benefit for proposed in-stream mitigation actions. Each mitigation proposal will be evaluated to ensure that the permittee documentation for stream mitigation fulfills the requirements of the Mitigation Rule.

If the applicant desires to remove riprap and stabilize all disturbed surfaces with either biodegradable erosion control fabric, native sod mat, and/or seeding with local native vegetation, this could be considered a net benefit.

A stream relocated to a new alignment for purposes of accommodating the construction of a proposed project is not considered a net benefit. However, other modifications of the stream bed and/or banks that restore stream meanders could also be considered a net benefit, if the stream's former location can demonstrate the relocation objectives balance hydrologic and geomorphic processes while incorporating appropriate design features. Under this circumstance, the Corps will determine on a case-by-case basis whether or not moving a stream to its former location is a net benefit of the proposed mitigation activity. The Corps will determine if the net benefit provides no compensation, partial compensation, or full compensation for the permittee's project impacts.

Example: If the historic channel has been filled and the applicant proposes to restore historic aquatic resource functions to the channel, that work could be considered a net benefit for the proposed project.

2.c.ii(1) Excellent: Addresses multiple functions of a stream. The benefits gained as a result of the mitigation project would apply to all or substantial parts of a stream's watershed.

Examples of in-stream activities which receive excellent stream net benefits include (but are not limited to):

- Removing dams, weirs, pipes, culverts, and other manmade in-stream structures that affect channel dynamics, configuration, stability and hinder aquatic life movements (grade control structure(s) may be required in streams that are actively incising).
- Low water crossing removals undertaken by the mitigation project sponsor and as part of a compensatory mitigation project and replaced with a span bridge. The replacement structure shall span the channel to provide an opening at least equivalent to the surveyed bedload transport zone of the stream (see Appendix D for general guidelines).
- Artificial levee or dike removal, setback, and/or notch where one of these activities itself will reconnect the stream channel to its natural overbank floodplain, with fifty percent of the 10-year recurrence interval floodplain reconnected across the entire valley.

- Returning a stream channel to its former location and/or reestablishing sinuosity, channel dimensions (width/depth ratio), and bankfull width of a degraded stream reach to appropriate design based on a morphologically stable and appropriate stream.
- Building a new stable channel at higher elevation and reconnecting it to its natural overbank floodplain where functionally appropriate.
- Creating floodplain benches adjacent to streams artificially disconnected from their floodplain. Stream banks shall be re-sloped and reshaped and floodplain bench shall be revegetated with native woody and herbaceous vegetation. Depending on project influence, this activity may be reduced to a good net benefit by the Corps.

“Excellent Net Benefit” does not include the relocation of a stream channel to accommodate a project in the stream’s present location.

2.c.ii(2) Good: Addresses one or more stream function(s). The benefits gained as a result of the mitigation project would be localized and not system-wide.

Examples of in-stream activities which accrue good stream net benefits include (but are not limited to):

- Removing stream impoundments, pipes, culverts, or other man-made structures, then restoring the stream reach to a stable, appropriate channel configuration as per reference stream reaches.
- Replacing inappropriately designed culvert(s) with a span bridge.
- Implementing appropriate bankfull discharge width, stream sinuosity, entrenchment ratio, length, and width/depth ratio to a referenced morphologic pattern.
- Building a new morphologically stable channel at a higher elevation to connect it to the floodplain.
- Creating or re-connecting floodplains adjacent to streams artificially disconnected from their floodplain.
- Where relocation of an incised stream is impracticable, modifying the existing channel and re-establishing a floodplain in situ, but not at the abandoned/disconnected floodplain elevation.
- Construction of off-channel wetland in areas where runoff quantities are increasing.
- Removing a dike, levee, or berm that is within the 100-year floodplain to re-connect the floodplain to the stream channel.
- Reconnecting abandoned side channels or meanders that were artificially cutoff, blocked, or filled where functionally appropriate.
- Removing riprap and reconstructing the stream banks to the proper radius of curvature, at the appropriate bank heights, then stabilizing all disturbed surfaces with either biodegradable erosion control fabric, native sod mats, and/or seeding with local native vegetation.

“Good Net Benefit” does not include the relocation of a stream channel to accommodate a project in the stream’s present location.

2.c.ii(3) Moderate: Addresses stream function(s) on a specific stream reach. Even if applied on a substantial length of stream, such practices do not markedly enhance the stream’s physical, chemical, and biological processes.

Examples of practices which accrue moderate stream net benefits include (but are not limited to):

- Improving stability in highly eroded areas or areas with artificially accelerated erosion, using non-rigid (soft) methods such as native vegetative stabilization, root wads with a relatively small percentage of rock, re-sloping and reshaping banks and creating a vegetated floodplain bench.
- Constructing natural channel features (i.e., riffle/run/pool/glide habitat) and morphology appropriate to target stream type, but not a comprehensive channel reconstruction/relocation.
- Routing a stream around an existing impoundment by creating a morphologically stable reach.
- Constructing fish ladders or other fish passage structures where appropriate.
- Replacing inadequate culverts/structures with a bottomless culvert or low water crossing.

“Moderate Net Benefit” does not include the relocation of a stream channel to accommodate a project in the stream’s present location.

2.c.ii(4) Minimal: Addresses stream channel actions that have one functional objective and include (but are not limited to):

- Implement stream bank stability by hardening the existing channel in place where accelerated erosion is documented. It should only be allowed when there are insurmountable constraints to using other restoration solutions, as may be the case in urban settings. Some proposals undertaken by this methodology may be considered to have adverse aquatic impacts and require compensatory mitigation.
- Incorporation of a bankfull planting bench into a rock riprap project.

- The modification of an existing or installed road crossing(s) within floodplain with design elements to facilitate flood flows.
- Replacing inadequate culverts with a conservation designed culvert or a buried culvert that conforms to the appropriate configuration per hydrology requirements.
- Removing check dams, weirs, car bodies, foreign materials/junk, debris, and artificial in-stream structures and/or other structures that are directly contributing to bank erosion, scour or blocking stream processes and aquatic organism movements without any additional measures.
- Excluding livestock with a fence that meets NRCS design standards.

User Note: No mitigation credit is provided for either constructing channels that do not incorporate the principles of natural channel design or replacing a span bridge with a floored culvert design.

2.c.ii(5) Preservation Only: Site has been preserved by conservancy agreement, conservation easement, or deed restriction and no mitigation plan will be executed for the site. Land is protected from future adverse impacts, disturbance, and effects.

2.c.ii(6) Stream Relocation to Accommodate a Proposed Project: Is the movement/creation of a stream to allow a proposed project to be constructed. The proposed project should incorporate natural channel design features relative to a morphologically stable and appropriate stream channel [dimension (cross-section), pattern (sinuosity), profile (slope)], and incorporate measures (grade control, in-stream habitat, riparian plantings, etc.). If the proposal would modify the stream bed and/or banks to restore stream meanders within a historic stream bed or incorporate enhancing ecological functions through restoration activities, the Corps may accept the relocated channel as compensatory mitigation. Relocated streams will generally require vegetative buffers of sufficient width that can be evaluated for riparian mitigation credit. Relocations resulting in a reduced channel length will generally require additional ecological appropriate mitigation credits to replace net losses of impacted stream channel.

2.c.iii. Site Protection (SP):

An appropriate legally binding real estate instrument, approved in advance by the Corps, will be required to ensure that the mitigation work, in-stream and/or out of stream are protected in perpetuity. Any site protection instrument listed below is appropriate for a subject property but may vary depending on each situation.

The types of site protection are:

- 2.c.iii(1) Conservation Easements
- 2.c.iii(2) Deed Restrictions
- 2.c.iii(3) Restrictive Covenants
- 2.c.iii(4) Conservancy Agreements
- 2.c.iii(5) Title Transfer
- 2.c.iii(6) Multiple-Party Agreements

2.c.iv. Credit Schedule (CS):

No additional credits are generated for this factor if the mitigation action in a reach is primarily riparian buffer preservation (less than 10% of buffer area would require planting of vegetation (see Table 1). For all forms of compensatory mitigation, the following guidelines apply for construction timing.

Table 1. Credit Schedule

Score	Schedule	Note
0.3	Credit Schedule 1	When 80 to 100 percent of the construction plus completion of all planting components specified in the mitigation work plan are completed before the stream impacts occur.
0.1	Credit Schedule 2	At least 50 percent but less than 80 percent of the construction plus greater than 50 percent of planting components specified in the mitigation work plan are completed prior to and/or concurrent with the stream impacts.
0	Credit Schedule 3	Less than 50 percent of the construction and less than 50 percent of planting components specified in the mitigation work plan will be completed prior to and/or concurrent with the stream impacts.

2.c.iv(1) All mitigation banks qualify for Credit Schedule 1. Bank sponsors sell a majority of their credits only after those credits have been released (meaning the aquatic resources are functioning). In order for credits to be released the sponsor must submit a monitoring report to the Corps demonstrating that the appropriate performance based milestones for credit release have been achieved. The Corps in consultation with the IRT determines whether the milestones have been achieved and if credits can be released.

2.c.iv(2) In-lieu fee (ILF) programs qualify for Credit Schedule 3. ILF sponsors generally initiate compensatory mitigation projects only after collecting fees, and there is often a substantial time lag between permitted impacts and implementation of compensatory mitigation projects.

User Note: When an ILF holds (or possesses) released credits in service area that surpass the debits that have occurred, then at the discretion of the reviewing Regulatory project manager a credit schedule 1 or 2 may be acceptable.

2.c.iv(3) Permittee-responsible mitigation will be evaluated to determine which credit schedule is appropriate for the mitigation proposed.

2.c.v. Stream Length Benefitted: Stream Length Benefitted is the total influence expressed in feet that the in-stream mitigation activity will have on the stream channel. This figure shall be applied in the box labeled Stream Length Benefitted found on the In-Stream Worksheet located in Appendix A-2. Six guidelines have been established below to assist users in determining the appropriate length to apply to the corresponding section of the worksheet.

- Linear credit for removal of low water crossings as discussed in detail in Appendix F.
- Linear credit for installation of localized lateral streambank stabilization measures will be based on the length of the appropriately sized structure.
- Linear credit for artificial levee or dike removal, setback, and/or notch will be based on the longitudinal extent that overbank flooding will occur along the stream channel and where the sponsor or permittee will place an appropriate legally binding real estate instrument that is approved by the Corps.
- Linear credit for grade control structures (also must consider user note below) will be determined on a case-by-case basis taking into consideration overall benefit of the structure to the watershed, survey information, and existing upstream or downstream structures. Selection of an appropriate net benefit factor is also at the sole discretion of the Corps.
- Linear credit for stream relocation activities necessary to accommodate proposed projects will be the length of new channel created provided this activity meets the criteria for consideration of a mitigation activity as described in Section 2.c.iii.
- Linear credit for all other activities will be determined on a case-by-case basis at the discretion of the Corps.

User Note: Grade control is a prerequisite when an in-stream structure is removed in an actively incising channel, therefore, additional credit for the installation of these structures will not be considered or approved.

2.c.vi. Location and Kind (LK): The location and kind factors listed below only apply to permittee-responsible mitigation projects. Mitigation banks and in-lieu-fee programs cannot be evaluated by this factor since they are planned and approved independently of the impacts that these programs will assume responsibility. Also, when mitigation bank and in-lieu-fee programs are being evaluated, watershed needs are considered which assists in a determination of credit amount and type which excludes the need to apply the kind portion of this factor. Therefore, when a mitigation bank or in-lieu-fee program is proposed to fulfill the compensatory mitigation requirement, the Adverse Impact Factors Worksheet allows the Corps to determine whether an increased compensation ratio is needed to account for impacts beyond the geographic service area of mitigation banks or in-lieu fee programs.

2.c.vi(a) Use a factor of 0.5 for: The permittee-responsible mitigation proposed outside of the 8-digit Hydrologic Unit Code (HUC) watershed in which the impacts would occur or when the permittee-responsible mitigation is determined to be out-of-kind (i.e. replacing a high quality riparian buffer with a riparian buffer of a different physical and functional type.)

2.c.vi(b) Use a factor of 1.0 for: The permittee-responsible mitigation proposed within the 8-digit HUC watershed in which the impacts would occur or permittee-responsible mitigation is under a watershed approach which considers how the type and location of the compensatory mitigation project will provide the desired aquatic resource function and when interchanging hydrologic stream types (i.e. ephemeral, intermittent, perennial).

*User Note: Mitigation credits generated as part of a permittee-responsible mitigation plan should be equal to or greater than the required credits calculated on the Adverse Impact Factors Worksheet. Any mitigation credit shortage may be compensated by modifying the mitigation plan in an attempt to accrue more mitigation credit, purchasing of credits from an approved mitigation bank, paying a fee to an approved in-lieu fee provider, or combination thereof. **Final decisions regarding how or where any mitigation credit shortage shall be compensated rests with the Corps.***

RIPARIAN BUFFER WORKSHEET (A-3)

Stream Type	Ephemeral 0.15	Intermittent 0.2	Perennial 0.4	
Priority Waters	All Other Waters 0.05	Secondary 0.2	Priority 0.4	
Net Benefit (for each side of stream)	Riparian Restoration/Establishment, Enhancement, and Preservation Factors (select values from Table 1) (also see Minimum Buffer Width (MBW) page 20)			
Supplemental Buffer Credit	Condition: Buffer established, enhanced or preserved on both stream banks To calculate: (Net Benefit Stream Side A + Net Benefit Stream Side B)/2			
Site Protection	Corps approved site protection without third party grantee 0.0	Corps approved site protection recorded with third party grantee, or transfer of title to a conservancy 0.5		
Credit Schedule	Schedule 1 0.3	Schedule 2 0.1	Schedule 3 0.3	
Temporal Lag (Years)	Over 20 -0.3	10 to 20 -0.2	5 to 10 -0.1	0 to 5 0.0

RIPARIAN FACTORS

Site Name					
Station ID					
<i>Stream Type (ST)</i>					
<i>Priority Waters (PW)</i>					
<i>Net Benefit (NB)</i>	<i>Stream Side</i>				
	<i>Stream Side</i>				
<i>Supplemental Buffer Credit (SBC) (Buffer on both sides)</i>					
<i>Site Protection (SP)</i>					
<i>Credit Schedule (CS)</i>	<i>Stream Side A</i>				
	<i>Stream Side B</i>				
<i>Temporal Lag (TL)</i>					
Sum Factor (M) = (ST+ PW+ NB+SBC+SP+CS+TL)					
Linear Feet of Stream Buffered (LF)= (do not count each bank separately or count same channel segment)					
Credits (C) = M * LF					
Total Credits Generated C * LK Factor ¹ =					
Are current photos of Riparian Area(s) documented for the Corps?		Y	N		

Total Riparian Credits Generated from all Columns = _____

1. Location and Kind (LK) Factor only applies to permittee-responsible mitigation projects (see page 17 of document).

Worksheet Factors for Riparian Buffer Worksheet (A-3):

All users of this worksheet must assess all factors (Stream Type (ST), Priority Waters (PW), Net Benefit (NB), Supplement Buffer Credit (SBC), Site Protection (SP), Credit Schedule (CS), and Temporal Lag (TL)) in each category, then calculate the categories to determine the Sum of Factors. The Sum of Factors is multiplied by the Linear Feet of Stream Buffered to calculate the total number of credits. Location and Kind (LK) factors only apply to permittee-responsible mitigation projects. When permittee-responsible mitigation is determined acceptable by the Corps, the mitigation value of the mitigation plan evaluated under this Section and Section 2.c should equal or exceed the total credits required on the Adverse Impact Worksheet.

To determine Stream Type and Priority Waters on the In-Stream and Riparian Worksheets, users should refer to Sections 2.c.i and 2.d.i respectively for a discussion of these factors. These factors could be different than what is used for the Adverse Impact Worksheet (A-1) depending on the stream type being considered for compensatory mitigation. As mentioned on the In-Stream Worksheet, the OSM tool can also be used to evaluate mitigation site conditions (in terms of credit increase or decrease) as long as this tool was previously used to establish a baseline assessment of the mitigation site. If mitigation site conditions do not meet predicted site conditions as expected, please contact your Regulatory Office Project Manager for guidance. (This tool does not determine functional lift as required by performance standards within compensatory mitigation plans.)

User Note: Properly vegetated riparian buffers serve important stream functions including sediment trapping, use and storage of nutrients, stream shading, energy dissipation, natural moderation of floods, bank stability, natural wetland development, and delivery of organic matter to the stream. Mitigation work within the riparian buffer means implementing physical augmentation of the stream riparian buffer to improve water quality and/or ecosystem function and should strive to mimic the native composition, density, and structure of a fully functional stream situated within the same watershed. Resource professionals should also consider stream size, stream slope, drainage area, need for filtering runoff, stability of the stream, life history requirements of resident species, potential for stream bank erosion, longitudinal and horizontal migration, and floodplain interaction frequency, in determining corridor width.

2.d.i. Riparian Buffer Factors: The Riparian Buffer Worksheet (A-3) utilizes factors below to determine the credits for the existing riparian buffer zone. This worksheet can also be used to measure functional lift for mitigation sites as long as this tool was used for the initial assessment. Stream Type and Priority Waters for this worksheet should be the same as identified in the In-Stream Worksheet (A-2). The Site Protection and Credit Schedule should be the same as identified on In-Stream Worksheet (A-2). The total credits generated from this worksheet must be added to the credits from the In-Stream Worksheet (A-2) to receive the total amount mitigation credits. The credits generated from worksheets (A-2) and (A-3) must be greater than credits generated from worksheet (A-1).

2.d.ii. Net Benefit (NB): Is based on the percent of physical augmentation to the riparian buffer and the buffer width proposed along the stream channel. The Riparian Buffer Net Benefit Values are shown in Table 1 below and will fall under one of the following categories:

2.d.ii(1) Buffer Restoration/Establishment: When at least 51% to 100% of the buffer would require planting and/or undesirable vegetation removal in companion with appropriate native vegetation establishment to achieve important aquatic resource functions in the buffer area.

2.d.ii(2) Buffer Enhancement: When at least 10% to 50% of the buffer would require planting and/or undesirable vegetation removal in companion with appropriate native vegetation establishment to achieve important aquatic resource functions in the buffer area.

2.d.ii(3) Buffer Preservation: For the purposes of this guidance, an area will be considered as riparian buffer preservation if less than 10% of the area would require planting of vegetation to maintain important aquatic resource functions.

User Note: Credit cannot be obtained for multiple mitigation activities within the same riparian corridor along the same side of the stream (i.e. credit is not allowed for preservation of 500 linear feet of existing corridor and also for the establishment of 500 linear feet of buffer along the same channel segment).

User Note: The buffer percentages expressed above shall be calculated for each side of the channel that will be buffered and for which mitigation credit is being sought.

Example: 500 feet of stream side buffer proposed along left descending bank of stream channel for a distance of 50 feet perpendicular to the channel. Twenty feet of native buffer currently exists perpendicular to the channel resulting in a planting area of 30 feet to establish the 50-foot wide buffer. Therefore, the total planting area is 60% qualifying for riparian buffer restoration/establishment and the value selected from Table 1 is 0.50.

User Note: Streams which are recognizably unstable, entrenched, or otherwise disconnected from their floodplains, and which require extensive stream bed and/or bank restoration are not considered good candidate streams for solely producing riparian buffer credit. However, under some circumstances the Corps in consultation with the reviewing resource agencies may entertain a setback from the top of stream bank to accommodate changes in the streams' dimension, pattern, and profile as the channel responds to regional influences predicted to occur in a watershed plan. No riparian net benefits will be determined for the setback area due to the instability and eventual loss of ground. However, a net benefit value can be assigned for buffer establishment beyond the setback zone.

2.d.iii. Requirements for Minimum Buffer Width (MBW): The MBW for which mitigation credits will be earned is 50 feet on one side of the stream, measured from the top of the streambank, perpendicular to the channel. Smaller buffer widths may be allowed on a case-by-case basis for small streams and consideration for a reduced buffer width will be based on issues related to construction constraints, land ownership, and land use activities. If topography within a proposed stream buffer has more than a 2% slope, 2 additional feet of buffer are required for every additional percent of slope (e.g., minimum buffer width with a +10% slope is 66 feet: Calculation [10% - 2% = 8%] [8 x 2 = 16] [16ft + 50ft = 66 feet]).

Slope calculation will be based on the average slope for the first 50 feet adjacent to the channel beginning at the top of bank. For the channel segment being buffered, the slope percentage will be determined at 100-foot intervals and averaged to obtain a mean slope percentage for calculating minimum buffer width. This mean slope percentage will be used to calculate the minimum buffer width for the entire segment of stream being buffered.

User Note: Typically, riparian buffers along stream order two or smaller (ephemeral streams or intermittent streams) will be a minimum of 50 feet from the top of the bank. Wider buffers may be accepted when the calculation for the MBW above requires additional buffering which is commonly found where steep slopes descend directly to the edge of the stream bank. Wider buffers may also be considered where the stream channel frequently interacts with its overbank floodplain or where a relatively narrow corridor along a small stream can be widened and connect two large tracts of forest.

User Note: Streams 3rd order or larger are candidates for stream buffers exceeding 100 feet perpendicular from the top of bank. Wider buffers will be expected when the calculation for the MBW above requires additional buffering which is commonly found where steep slopes descend directly to the edge of the stream bank. Wider buffers may also be considered where the stream channel frequently interacts with its overbank floodplain.

Wider corridor widths may also be necessary along stream reaches with actively eroding banks or to accommodate long term stream channel changes or meanders. In these situations, setbacks must be carefully considered and performance criteria in the mitigation plan will need to be carefully crafted and closely monitored.

Table 1 below provides appropriate Net Benefit values for the riparian buffer worksheet. Users should note that buffers on each channel bank, generate mitigation credit separately (Stream Side A and Stream Side B).

Table 2. Riparian Buffer Net Benefit Values

Buffer Width (on one side of the stream) that is Equal to or greater than	% Buffer that requires physical improvement		
	Buffer Restoration/Establishment planted and/or undesirable vegetation is removed and appropriate native vegetation to be established at least 51-100%	Buffer Enhancement planted and/or undesirable vegetation is removed and appropriate native vegetation to be established at least 10-50%	Buffer Preservation with 10% or less plantings
300 feet	1.10	0.55	0.27
275 feet	1.05	0.52	0.26
250 feet	1.00	0.50	0.25
225 feet	0.95	0.47	0.24
200 feet	0.90	0.45	0.23
175 feet	0.85	0.42	0.21
150 feet	0.80	0.40	0.20
125 feet	0.75	0.38	0.19
100 feet	0.70	0.35	0.18
75 feet	0.60	0.30	0.15
50 feet	0.50	0.25	0.13
25 feet* (MBW)	0.10	0.05	0.02
No Buffer	0.00	0.00	0.00

* Smaller buffer widths may be allowed on a case-by-case basis for small streams and consideration for a reduced buffer width based on issues related to pre-existing construction constraints (i.e. sidewalks, roadways), land ownership, and land use activities.

2.d.iv. Supplemental Buffer Credit (SBC): Additional mitigation credit may be generated if minimum width buffers, or greater, are restored/established, enhanced, or preserved on both stream banks (lying parallel to one another). Supplemental buffer credit is calculated by adding the corresponding values recorded on the Riparian Buffer Worksheet for Net Benefit Stream Side A and Net Benefit Stream Side B and dividing the total value by two. If a riparian mitigation activity will only occur on one side of the channel segment being evaluated, then this factor will not be considered in the evaluation of credit generated.

2.d.v. Site Protection (SP): This is discussed in Section 2.c.iii.

2.d.vi. Credit Schedule (CS): This is discussed in Section 2.c.iv.

2.d.vii. Temporal Lag (TL): Temporal Lag is a factor that applies only to the Riparian Buffer Worksheet and takes into account the time required (measured in years) for a mitigation area to fully replace the riparian vegetation size and age class lost at the impact site. The

riparian buffer targeted for restoration, establishment or enhancement at the mitigation site will require different lengths of time to reach a commensurate level of maturity that existed at the impact site.

2.d.viii. Location and Kind (LK): This is discussed in Section 2.c.vi.

Appendix B

Priority Waters

This is a rating factor used to determine the importance of the stream that would be impacted or used for mitigation. Priority waters are influenced by the quality of the aquatic habitat potentially subject to be impacted or used for mitigation. The priority waters factor will influence the amount of stream credits required or generated. As new technology and new assessment information is available, a stream may increase to a higher category on a case-by-case basis. The priority waters are divided into three categories:

Priority: These streams provide important contributions to biodiversity on an ecosystem scale or high levels of function contributing to landscape or human values. Impacts to these streams should be rigorously avoided or minimized. If a priority stream must be impacted, compensation for impacts should emphasize replacement nearby and in the same watershed.

The following waters fall within the category of priority waters in Oklahoma:

- Outstanding National Resource Waters (None Listed at Publication)
- Critical Resource Waters (CRWs) [Water Quality Standards (OAC 252: Chapter 730):
 1. State Outstanding Resource Waters and watersheds.
[<http://www.swt.usace.army.mil/portals/41/docs/missions/regulatory/wqc/crw.pdf>]
 2. High Quality Waters
[<http://www.swt.usace.army.mil/portals/41/docs/missions/regulatory/wqc/crw.pdf>]
 3. OWRB Sensitive Public and Private Water Supplies (SWS).
[http://www.owrb.ok.gov/maps/pdf_map/WQS%20Special%20Provisions%20SWS.pdf]
 4. Any other waters designated by the State of Oklahoma in Appendix B.

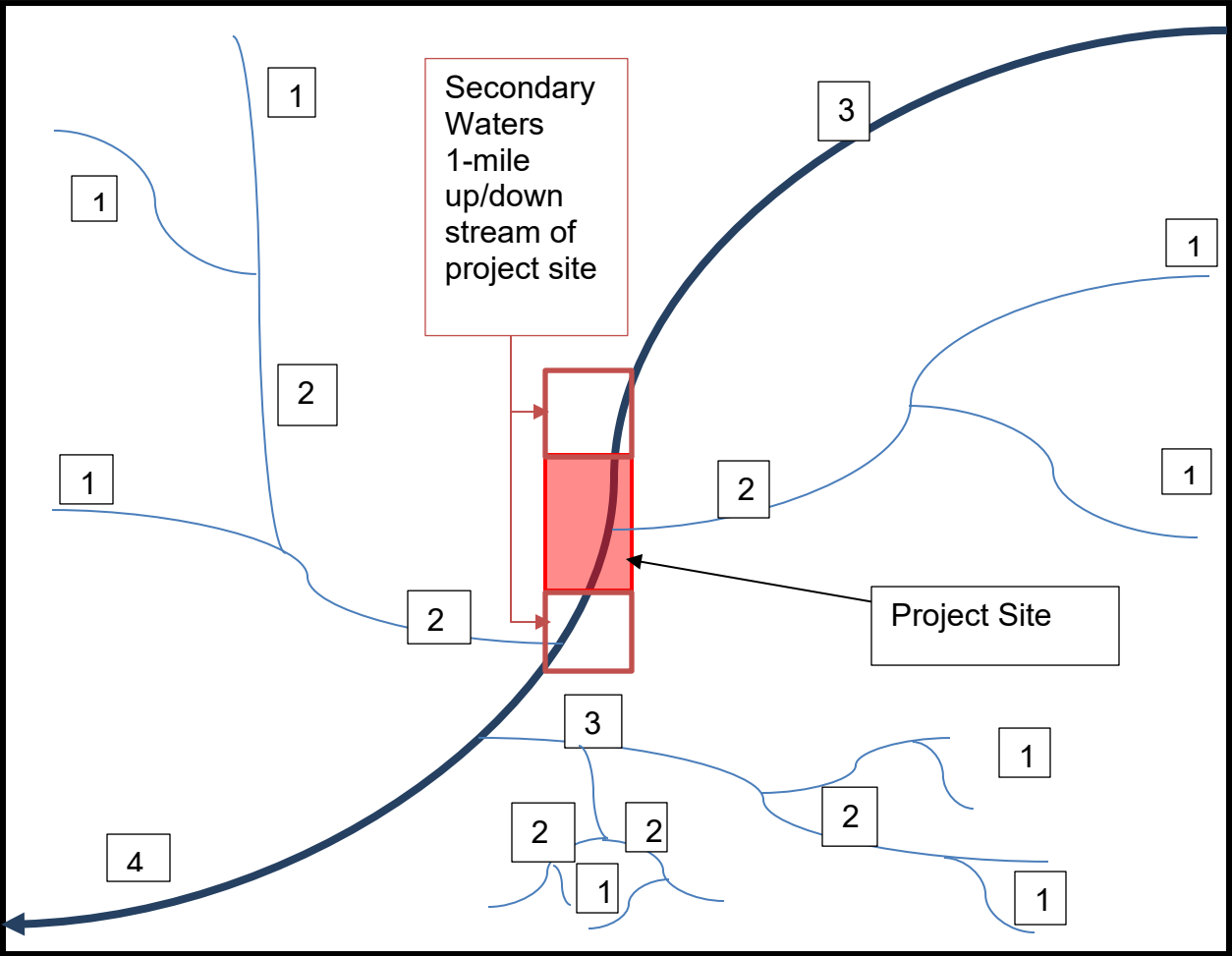
Secondary: Secondary waters include:

- Abutting an approved consolidated mitigation site (banks and in-lieu fee sites)
[<http://www.swt.usace.army.mil/Missions/Regulatory/Mitigation/>]
- Rivers and streams of the same or lower order within 1.0 mile upstream or downstream of priority waters (see Diagram Below).
- Oklahoma 303(d) List of Impaired Waters [Section 303(d) Clean Water Act and 40 CFR 130.7]. [<https://www.deq.ok.gov/water-quality-division/watershed-planning/integrated-report/>]

All other waters: These areas include all other freshwater systems not ranked as priority or secondary waters.

Exception: No large streams have been designated by the Corps as priority waters at the time of publication.

Example Secondary Waters Diagram:



Appendix C

District Designation of Fully Functional Waters

Streams with a Strahler stream order number 4 or greater are automatically designated as fully functional. (Example Drawing on Page 6)

The following are large streams designated as fully functional in Oklahoma:



Description: The map displays the different rivers in Oklahoma.

Disclaimer

Map provided by Maps of World Website

Red River Basin:

Red River, Little River, Little River, Kiamichi River, Blue River, Washita River, North Fork of Red River, Salt Fork Red River, and Town Fork of Red River

Arkansas River Basin:

Arkansas River, Poteau River, Illinois River, Grand (Neosho) River, Elk River, Verdigris River, Salt Fork of the Arkansas River, Chikaskia River, Medicine Lodge River, Cimarron River, and Dry Cimarron River.

Canadian River Basin:

Deep Fork River, North Canadian River, Canadian River, and Little River.

Appendix D

General Guidelines for Determining Span Width for Use in the Oklahoma Stream Mitigation Method for Crossing Replacements

This is adapted from the Missouri Department of Conservation Stream Unit

“Appendix E” of the Oklahoma Stream Mitigation Method provides examples of in-stream mitigation projects that receive good net benefit factors. One example of an excellent net benefit factor is the replacement of a stream crossing with an opening that provides natural channel dimensions. Many existing stream crossings have insufficiently sized or blocked culverts/boxes. This reduces or eliminates longitudinal connectivity of the stream system both geomorphically and ecologically.

These structures can impact stream channels both up and downstream of the crossing by inhibiting the channel’s natural ability to transport sediment. Channel widening and bank erosion can be caused by aggradation upstream of the structure. Downstream of the structure, water can drop from the low water bridge deck or elevated culverts to the channel bed below, which can cause channel bed scour immediately downstream of the structure. Insufficient channel openings through these structures also hinder aquatic organism passage by posing jump, velocity, exhaustion, depth, and behavioral barriers.

Copeland and others (2000) state that priority should be given indicators at the top of bank in a manner protective of the stream. If using top of bank elevations, a minimum of three top of bank cross-section widths in the immediate vicinity should be taken and averaged to determine an appropriate top of bank width.

For low water span bridges however, it can be appropriate to use field indicators within that channel. In this case, the field indicators will be defined as the bedload transport zone (BTZ). As long as the bridge spans the BTZ, bedload and high flows can pass through and over the structure, thus allowing natural channel morphology and aquatic organism passage. The following instructions are to determine widths for Low Water Span Crossings. They yield a narrow range of elevations from which a width can be identified in vertically stable streams. Streams that are not vertically stable may require alternate methods.

Field measurements for this procedure need to be taken downstream of the existing crossing, starting at a distance of at least twice the length of the crossing’s downstream scour hole and upstream of any substantial tributaries. This assures that reference channel dimensions are more natural because they are not being influenced by potential impounding effects occurring upstream of the crossing or scour effects immediately downstream; yet are still representative of discharge potentials for that site. It is also important to attempt to locate the field measurements areas away from human disturbance as much as possible (i.e. levees, gravel mining areas, bank stabilization areas, trampled or modified channel or banks).

1. Survey Cross-section Transects:

Select three downstream cross-section sites that appear to have variable channel widths, attempt to avoid cross-sections that have secondary channels. At least one of the cross-sections should be across a riffle. All cross-sections should extend over the high bank areas on both sides of the river and need to include enough data points on the streambank and point bars to allow detection of subtle slope breaks when graphing the data. A water surface elevation point (or water's edge) should be included as well.

2. Flag BTZ Field Indicators:

Field indications of BTZ include features sometimes used as bankfull indicators: elevation associated with the top of the highest active depositional features (e.g. point bars and central bars); a break in slope and/or change in the depositional particle size distribution on the bank (finer material is associated with deposition by overland flow rather than deposition of coarser material within the active channel); defined benches inside of incised rivers; exposed root hairs below an intact soil layer (indicating exposure to frequent erosive flow) (Rosgen, 2006). For further training see Guide to Identification of Bankfull Stage in the Northeastern United States (USDA, 2005).

After locating the cross-section transects, flag BTZ field indicators along the streambanks downstream of the crossing and extending to the most downstream cross transect. Be sure to identify BTZ field indicator points along the cross transects. A minimum of 6 BTZ field indicators should be identified.

3. Survey Longitudinal Profile:

Traverse downstream from the bridge and collect BTZ field indicator flag elevations, adjacent water surface elevations, and horizontal station distances. Capture and note data points where this profile intersects the cross-section survey lines.

4. Analyze the Data:

Data from the survey can be entered into Reference Reach Survey spreadsheets produced by Dan Mecklenburg at Ohio DNR or any software that can yield the following analysis. Once survey data have been entered to spreadsheets, generate cross-section and longitudinal profile graphs.

Once the water surface points have been plotted on the longitudinal profile graph, fit a linear trend line to these points to calculate a slope for the stream reach. (Most spreadsheets can calculate this.) To find the slope, calculate the equation of the line; formula is $y = m(x) + b$, where m is the slope of the line and b is the y-intercept. The water surface points on the longitudinal profile graph show a frame of reference when comparing the BTZ field indicator points with the BTZ estimated points (which will be added later); it also provides an indicator of vertical streambed instability if the lines slope towards or away from each other considerably. The same process used for water surface points can be done with the BTZ field indicator points.

The final longitudinal profile will contain 3 plots: water surface points, BTZ field indicator points, and BTZ estimated points. The water surface points, and BTZ field indicator points were collected during the field survey. In contrast, the BTZ estimated points will

be determined from the plotted cross-section transects. The process for determining the BTZ estimated points is detailed in the following paragraph.

Examine the cross-section graphs for distinct elevation breaks in slope that precede flatter floodplain or depositional areas within a range of plausible BTZ elevations (i.e., between the lowest point bar and the top of the streambank). Typically, BTZ clues will be much more distinct on one transect than the others, but elevations should be within a reasonable range of each other. Locate the elevation of the BTZ line for the transect that has the most obvious slope break feature and determine what the corresponding BTZ discharge is for that elevation ($Q=V \times A$) by assuming a Manning's "n" value (i.e., 0.041) and computing a slope from the water surface elevations of the longitudinal profile. Velocity is computed by Manning's equation where $V = \frac{1.49 R^{2/3} S^{1/2}}{n}$.

{Terms are defined as: Q= discharge (cubic feet per sec, CFS), V=velocity (feet per second, fps), A= cross-sectional area (square feet), R= hydraulic radius (A/Wetted Perimeter)(feet), S= water surface slope (feet per foot), n = roughness coefficient.]

After the discharge has been determined for the transect with the most obvious BTZ elevation, use that discharge for the remaining cross-sections to see where their BTZ elevations exist and plot those elevations on the graphs. Plot the BTZ elevation points from the cross-section graphs on the longitudinal profile, fit a linear trend line, and compare the differences in elevation and slopes between this estimated BTZ line and the BTZ field point indicator line. Although these lines will not always match, this gives a good indication of the potential range of BTZ elevations (in vertically stable channels).

If there is more than three feet of elevation difference anywhere between the BTZ field indicator line and the BTZ estimated line, or if the slopes of these two lines are not going in the same direction (positive vs. negative), data will need to be re-examined. Delete the most variable outliers of the BTZ field indicator points and compare the slope lines again. If there is still more than three feet of difference between the BTZ field line and the estimated line, return to the cross-section transect graphs and look for another BTZ elevation slope break that will make the elevation difference between the two lines closer. Repeat the previously mentioned steps to determine discharge. Make all three cross-section transects reflect the new discharge and re-plot the new estimated BTZ line on the longitudinal profile graph. If the two lines are now less than 3ft of elevation apart, determine the width of the cross-section transect BTZ lines computed from that BTZ discharge and average them to determine an appropriate estimate of the minimum BTZ width.

References:

- Copeland, R., D. Biedenharn, and J. Fischenich. 2000. Channel-Forming Discharge. U.S. Army Corps of Engineers, Coastal and Hydraulics Laboratory, U.S. Army Engineer Research and Development Center (ERDC). Technical Note ERDC/CHL CHETN-VIII- 5. Vicksburg, MS.
- Mecklenburg, Dan. Stream Morphology Modules, Reference Reach Survey spreadsheets. Ohio Department of Natural Resources.
- Rosgen, Dave. Watershed Assessment of River Stability and Sediment Supply (WARSSS), 2006.
- USDA, Streams Systems Technology Center. Guide to Identification of Bankfull Stage in the Northeastern United States. General Technical Report RMRS-GTR_133_CD. January 2005.

Appendix E

General Guidelines for Replacement Structures Associated with Good Stream Channel Enhancement

Section 2 (c)(iii)(b) of the Oklahoma Stream Mitigation Method provides examples of in-stream mitigation projects that receive good net benefit factors. One example of a good net benefit factor is the replacement of a low water crossing with a structure that allows for the passage of flow, sediment, and promotes the safe passage of fish and other aquatic organisms. A low water crossing removal undertaken as part of a compensatory mitigation project and replaced with a structure should meet the general guidelines below.

- Replacement culverts should be the shortest length necessary to meet the mitigation objectives.
- Replacement culverts should be designed to convey the geomorphic bankfull discharge (return period of 1.01 – 1.7 years) with a similar average velocity as upstream and downstream sections.
- Replacement culverts should be designed, sized, and placed correctly. Perched structures are not acceptable for replacement mitigation structures. The installation of weirs or other in-stream structures placed at the inlet with the purpose to reduce sedimentation within the structure are not acceptable. Streambed gradient should be consistent throughout the replacement culvert(s).
- Bottomless culverts should be used where practicable. For an activity where it is not practicable to use a bottomless culvert, such as circumstances where sub-grade instability would make it unsafe to use a bottomless culvert, the bottom of the culvert should be embedded as described below.
- Replacement culverts should be embedded and backfilled below the grade of the stream ≥ 1 foot for culverts > 48 inches. On culverts ≤ 48 inches the bottom of the culvert should be placed at a depth below the natural stream bottom to provide for passage during low flow conditions.
- Culverts in streams with highly erodible beds should be embedded deeper to lessen the chance of future perching due to downstream degradation and may be accompanied with other grade control measures to prevent erosion.

APPENDIX F

General Guidelines for Determining Channel Bed Aggradation and Degradation Resulting from Elevated Low Water Crossings for Use in the Oklahoma Stream Mitigation Method

This is adapted from the Missouri Department of Conservation Stream Unit

The following guideline have been developed to assist users in determining the upstream and downstream length of streams impacted from elevated low water crossings that have restricted capacity for sediment transport and have caused channel changes. Low water crossings are also known as low water bridges. These structures can impact stream channels both up and downstream of the crossing by inhibiting the channels' natural ability to transport sediment. Channel widening and bank erosion can be caused by aggradation upstream of the structure. Downstream of the structure, water can drop from the low water bridge deck or elevated culverts to the channel bed below, which can cause channel bed scour immediately downstream of the structure. The total length of stream impacted by these structures is determined by adding the length of upstream channel impacted with the length of downstream channel impacted.

To determine the upstream length of stream impacted for the Oklahoma Stream Mitigation Method users must find the elevation in the upstream bed that is equal to the elevation of the top of the low water bridge deck. The distance between this upstream point and the downstream edge of the low water bridge deck would represent the upstream length of stream impacted. This is determined by using a survey instrument and rod to first establish the elevation of the low water bridge deck, at a point midway across the channel. Then collect survey points of the stream channel bed in an upstream direction until the channel bed elevation becomes higher than the deck height; determine the distance from this break point in elevation to the downstream face of the low water bridge deck.

The downstream impact from the low water crossing is the scour hole and the initial displacement of that sediment. The downstream scour hole development caused by the low water crossing does not create a continuous increase in sediment transport through the system so downstream impacts are limited. Determine the downstream length of stream impacted for the Oklahoma Stream Mitigation Method by measuring the maximum size of the scour hole from the downstream edge of the low water bridge deck to the downstream edge of the scour hole, which is often the highest streambed elevation immediately downstream of the scour hole. Multiply that distance by two. This multiplier is to account for the scour hole and the initial movement of the finite amount of displaced sediment downstream. The actual depth of the scour hole is not directly accounted for with this technique but is indirectly included in the multiplier because, under most circumstances, the scour hole length increases as scour hole depth increases.

To attempt to identify any other sediment deposition impacts downstream would be inappropriate due to the fact that there would be no way to discern between effects of the low water crossing and changes caused by land use changes or in-channel perturbations which have occurred over time.

APPENDIX G

Glossary of Stream Restoration Terms and Definitions

For information concerning the Glossary of Stream Restoration Terms, the following website is provided for assistance:

<https://www.swt.usace.army.mil/Missions/Regulatory/Links/>

The Glossary of Stream Restoration Term was written by Craig Fischenich (February 2000).

DEFINITIONS:

The glossary identified below is not intended to be an exhaustive list, rather this list has been compiled based on those terms that are repeatedly used or where the universal definition of the term has substantial variability. Many of the terms used throughout this document are defined in other sources such as the Mitigation Regulation or the documents referenced in Glossary of Stream Restoration Terms.

Bankfull Discharge is the maximum discharge that the channel can convey without overflowing onto the floodplain or bench and is considered the channel forming discharge.

Note: Only for stable streams.

Bankfull Stage is the point at which water begins to overflow onto a floodplain.

Bankfull Width is the width of the stream channel at bankfull discharge, as measured in a riffle section.

Bedload Transport Zone is the stream channel zone where bed load is effectively transported and deposited.

Biological Processes are the processes of living organisms in contiguous systems. Biologic processes are influenced by hydrologic, hydraulic, geomorphic, and physiochemical functions. Therefore, restoration projects that are intended to restore biologic function must consider all of these functions within the watershed.

Buffer means an upland, wetland, and/or riparian area that protects and/or enhances aquatic resource functions associated with wetlands, rivers, streams, lakes, marine, and estuarine systems from disturbances associated with adjacent land uses.

Channel Dimension is the stream's cross-sectional area (calculated as bankfull width multiplied by mean depth at bankfull). Changes in bankfull channel dimensions correspond to changes in the magnitude and frequency of bankfull discharge that are associated with water diversions, reservoir regulation, vegetation conversion, development, overgrazing, and other watershed changes. Stream width is a function

of occurrence and magnitude of discharge, sediment transport (including sediment size and type), and the streambed and bank materials.

Channel Features include riffles, runs, pools, and glide habitat that maintain channel slope and stability and provide diverse aquatic habitat. A **riffle** is a bed feature where the water depth is relatively shallow and the slope is steeper than the average slope of the channel. At low flows, water moves faster over riffles, which provides oxygen to the stream. Riffles are found entering and exiting meanders and control the streambed elevation. A **run** is characterized by fast-flowing, low turbulence flow. A **pool** is much deeper than the average channel depth and has low-velocity water and a smooth surface. A **glide** is the section of stream that has little or no turbulence.

Context is the geographic, biophysical, and social circumstances in which the effects will occur.

Conservancy Agreements means transferring fee title to a qualified, experienced, non-profit conservation organization or government agency. Non-profit organization means an entity recognized and operating under the rules of the Internal Revenue Service for non-profit purposes.

Conservation easement means a legally binding recorded instrument approved by the Corps to protect and preserve mitigation sites by giving protection and enforcement rights by real estate interest to a third party.

Credit means a unit of measure (e.g., a functional or areal measure or other suitable metric) representing the accrual or attainment of aquatic functions at a compensatory mitigation site. The measure of aquatic functions is based on the resources restored, established, enhanced, or preserved.

Debit means a unit of measure (e.g., a functional or areal measure or other suitable metric) representing the loss of aquatic functions at an impact or project site. The measure of aquatic functions is based on the resources impacted by the authorized activity.

Deed Restriction means a provision in a deed limiting the use of the property and prohibiting certain uses. The Corps approves mitigation areas and requires deed restrictions to protect and preserve mitigation sites. If the applicant can demonstrate that the mitigation activity will occur within a right-of-way easement and if the easement will offer protection and preservation of the site, such as associated with highway projects, the credit will be considered the same as that for deed restriction of the mitigation site.

Deep-Rooted vegetation is vegetation with roots that extend down into the soil and provide soil stability along the stream bank.

Enhancement means 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

function(s) but may also lead to a decline in other aquatic resource function(s). Enhancement that does not result in a gain in aquatic resource area can be an improvement to the value of a particular aspects of the stream and/or related land resources.

Entrenchment means to erode downward so as to form a trench, in as much that a stream is no longer capable of spreading out onto the floodplain.

Establishment is 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.

Excessive is defined as more than is necessary, normal, or desirable; immoderate.

Flow duration which is the probability a given stream flow was equaled or exceeded over a period of time. Flow frequency is the probability a given stream flow will be exceeded (or not exceeded) in a year [Sometimes this concept is modified and expressed as the average number of years between exceeding (or not exceeding) a given flow].

Flow duration see *Hydrologic Function*

Flow frequency see *Hydrologic Function*

Functional capacity means the degree to which an area of aquatic resource performs a specific function.

Geomorphic Function is directly influenced by hydrologic and hydraulic processes. As water flows through streams it is affected by the kinds of soils and alluvial features within the channel, in the floodplain, and in the uplands. The amount and kind of sediments carried by a stream largely determines its equilibrium characteristics, including size, shape, and profile. Restoration of geomorphic function requires an understanding of how water and sediment are related to channel form and function and on what processes are involved with channel evolution.

Glide see *Channel Features*

Head Cut is an erosional feature of some intermittent and perennial streams where an abrupt vertical drop, in the stream bed occurs.

Hydrologic Balance is an accounting of all water inflow to, water outflow from, and changes in water storage within a hydrologic unit over a specified period of time.

Hydraulic Function is the transport of water in the channel, on the floodplain, and through sediments. Restoration of hydraulic function requires an understanding of how water flows into and through stream corridors as well as how fast, how much, how deep, how often, and when it flows (i.e., timing, frequency, duration, magnitude, rate of rise, and rate of decline). Hydrologic Function is also known as the exchange of water

between the channel and watershed. This exchange is especially useful for planning and designing stream corridor restoration.

Intensity refers to the severity of the impact, in whatever context(s) it occurs. The regulations require that a number of variables be addressed in measuring intensity.

Integrity Functions are functions relating to metabolism processes, the decomposition of organic matter, nutrient cycling, ground water dynamics, invasive/exotic organisms, invasive/exotic plants, water chemistry, pollutant dynamics and riverine community dynamics. Streams have the ability to support to a broad spectrum of ecological services, including wildlife habitat, nutrient processing, hydrologic cycling, and multiple socioeconomic functions for humans (e.g., water sources, fisheries, recreation).

Jurisdictional Area is defined as the area that the Corps will determine after considering limits of jurisdiction in non-tidal waters in Tulsa District. In the absence of adjacent wetlands, the jurisdiction extends to the Ordinary High Water Mark, or when adjacent wetlands are present, the jurisdiction extend beyond the Ordinary High Water Mark to the limit of the adjacent wetlands. When the water of United States consists only of wetlands, the jurisdiction extends to the limit of the wetlands.

Linear Feet means the length of stream, measured in feet at the thalweg, that will be impacted by an activity, as authorized under Section 404 of the Clean Water Act, and for which mitigation will be required.

Mean Depth at Bankfull is the depth of the stream channel cross-section at a water level as measured in a riffle section.

Minor Structural Alteration is defined as the act or process of altering an existing minor structure within a stream. This may include minor deviations in the structure's configuration or filled area, including those due to changes in materials, construction techniques, requirements of other regulatory agencies, or current construction codes or safety standards that are necessary to make the repair, rehabilitation, or replacement.

Moderate Probability is defined as average work united with the measure of the likelihood that a stream system would recover naturally.

Multiple-Party Agreements are defined as legal agreement that would allow projects impacts to be managed by other agencies (e.g. Land Trust or Natural Resource Agencies).

Note: *The ownership of property does not change.*

Native Vegetation comprises plants including trees, shrubs, herbs and grasses that are indigenous to a given area in geologic time. This includes plants that have developed, occur naturally, or existed for many years in an area.

Natural Hydrologic Variability is defined as acts to disturb and/or reset various biotic populations within aquatic, riparian, and wetland ecosystems, acting as an essential complement to ecological processes (e.g., nutrient cycling) in maintaining complex ecosystem pathways, which in turn promote high biodiversity and biological integrity (Power et al. 1995; Ward and Stanford 1995).

Natural Substrate (site specific) is defined as the earthy material that exists in the bottom of a freshwater habitat or aquatic features that consist of silt and clay, rocks, sand, or gravel.

Ordinary High Water Mark (OHWM) is the line on the shore established by the fluctuations of water and indicated by physical characteristics such as a clear, natural line impressed on the bank, shelving, changes in the character of the soil, destruction of terrestrial vegetation, the presence of litter and debris, or other appropriate means that consider the characteristics of the surrounding area (for more detail see Regulatory Guidance Letter 05-05 dated 7 December 2005).

Permanent Impact means loss of some or all aquatic resource functions and/or services that has been adversely affected by filling, flooding, excavation, or drainage because of a regulated activity.

Physiochemical Function involves the chemical processes and reactions that occur between water, soils, rocks, and living organisms, and the transport of chemical components within the watershed over time. Restoration activities may interact in a variety of complex ways with water quality, affecting both the delivery and impact of water quality stressors or enhancers.

Pools see *Channel Features*

Recovery is relative to only the recovery of aquatic system characteristics.

Recurring Impacts are impact activities that in which the impacts did not result in a permanent loss of some or all aquatic resource functions and/or services. However, the recurring impacts could occur in such a frequency that leads to additional effects to in-stream flows, biological communities, water quality, and best management practices that could adversely affect existing aquatic resource functions.

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.

Restrictive Covenant means a legal document whereby an owner of real property imposes perpetual limitations or affirmative obligations on the real property.

Riffles see *Channel Features*

Riparian Areas are lands adjacent to streams, rivers, lakes, and estuarine marine shorelines. Riparian areas provide a variety of ecological functions and services and help improve or maintain local water quality.

Runs see *Channel Features*

Stream Order the point of confluence, where two lower waterways meet to form the tributary, downstream to the point such tributary enters. For a discussion of the order of tributaries, see Alan Needle Strahler's 1952 article "Dynamic Basis of Geomorphology" in the *Geological Society of America Bulletin*.

Stream Profile The profile of a stream refers to its longitudinal slope. At the watershed scale, channel slope generally decreases in the downstream direction with commensurate increases in stream flow and decreases in sediment size. Channel slope is inversely related to sinuosity, thus steep streams have low sinuosities and flat streams have high sinuosities.

Stream Reach is any defined length of river, creek, or tributary per a water of the United States delineation, identified in engineering plans, or in a compensatory mitigation plan.

Stream Segment is defined as, the area that is from 0.25 mile above to 0.25 mile below the proposed project.

Temporary Impact means the impact activity will remain for a period of less than 6 months with system integrity recovering after cessation of the permitted activity or restoration to pre- construction contours and elevations. Under certain circumstances impacts may remain within a stream for a period greater than 6 months but the decision is contingent upon activity type, impact area, effects to in-stream flows, biological communities, water quality, and best management practices to minimize adverse effects.

Title Transfer is defined as, the act of point in place or time at which ownership of a conservation entity is passed from one person to another to manage and protect.

APPENDIX H

References

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