U.S. Army Corps of Engineers

Regulatory Program

State of Missouri
Stream Mitigation Method

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This document was jointly created and amended with input from the following Federal and State agencies:

U.S. Army Corps of Engineers (Corps)
U.S. Environmental Protection Agency (USEPA)
U.S. Fish and Wildlife Service (USFWS)
USDA-Natural Resources Conservation Service (NRCS)
Missouri Department of Natural Resources (MDNR)
Missouri Department of Conservation (MDC)
Missouri Department of Transportation (MoDOT)

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Missouri Stream Mitigation Method
(MSMM)

A. Introduction:

This document describes the method for quantifying unavoidable stream impacts associated with the review of permit applications submitted for authorization under Section 10 of the Rivers and Harbors Act of 1899 and Section 404 of the Clean Water Act. The MSMM will typically be applied on those permit evaluations where a pre-construction notification is required to be submitted to the Corps, and the Corps determines that compensatory mitigation is necessary to offset unavoidable stream impacts associated with the permit evaluation. 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 and modified using best available information and applies scientific concepts to assist regulatory agency personnel in determining a value which represents the loss of aquatic functions at an impact or project site (debits).

Another key element of the MSMM is to address the requirements for making a determination of credits identified in Section 332.4 (c)(6) of the Mitigation Rule and does not replace any other mitigation plan requirements or components identified in the rule. All mitigation plan documentation must be prepared in accordance with the Mitigation Rule, which governs planning, implementation, and management of permittee-responsible and third party compensatory mitigation projects. Therefore, the MSMM is intended to serve 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 Missouri.

The MSMM is applicable to regulatory actions requiring compensatory mitigation for adverse ecological effects where more rigorous, detailed studies (e.g., Hydrogeomorphic Approach, Rapid Stream Assessment Technique, Index of Biologic Integrity) are not considered practical or necessary. 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 (streams are natural, man-altered, or man-made tributaries that flow directly or indirectly into traditional navigable waters). **In some cases, the evaluation of the permit application may reveal the 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 reviewing Corps district.**

The policies and regulations regarding mitigation can change and it is possible that new guidance will result in periodic modifications to this MSMM. 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 MSMM as necessary.

1. Regulatory Authorities & Guidelines:

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

Section 404 of the Clean Water Act, as amended in 1977, 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.

Section 230.10 (d) of the Section 404 (b)(1) Guidelines states 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.

Section 401 of the Clean Water 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 MSMM will also assist MDNR in their evaluation of projects for Section 401 state water quality certification. The 401 Certification is a verification by the state that the project will not violate water quality standards. The Missouri Department of Natural Resources (MDNR) works with applicants to avoid and minimize impacts to waters. As part of the 401 Certification, MDNR may require actions on projects to protect water quality. These required actions are called conditions.

Relationship to other federal, tribal, state, 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.

The MSMM is not certified for use in Corps Civil Works ecosystem restoration and mitigation projects. In May 2005, the Corps established a Model Certification process known as the Planning Models Improvement Program (PMIP) to review, improve and validate analytical tools and models for Corps Civil Works business programs [Engineering Circular (EC) 1105-2-407]. The EC requires use of certified models for all planning activities and tasks the Ecosystem Restoration Planning Center of Expertise (ECO-PCX) to evaluate the technical soundness of models used in ecosystem restoration and mitigation projects. The MSMM is not encumbered by the EC and will undergo separate evaluation by ECO-PCX should Corps Civil Works Planning have an interest in using this methodology.

Compensatory Mitigation for Losses of Aquatic Resources; Final Rule, dated 10 April 2008, are the regulations 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 programs to improve the quality and success of compensatory mitigation projects. This Final Rule can be found at **33 CFR Parts 325 and 332**.

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.

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.

B. ADVERSE IMPACT FACTORS:

The items discussed in this section assist the Regulatory agencies and permit applicants in determining the adverse impacts of a project and the amount of mitigation required to offset stream losses within the permit area. Adverse impacts are totaled by column based on the following factors: stream type, priority water, existing condition, impact duration, impact activity, and linear impact calculation. Each factor is discussed in detail in the following Sections 1-6. When compensatory mitigation requirements will be fulfilled with an approved third party mitigation provider then the Adverse Impact Worksheet (Appendix A-1) will be completed and the total credits required (debits) on the worksheet are the total credits that will be required for purchase from the mitigation bank or in-lieu-fee program. When permittee-responsible mitigation is determined acceptable by the Corps the mitigation credits discussed in Section C and generated from the evaluation of a compensatory mitigation plan should equal or exceed the total credits required on the impact worksheet.

1. **<u>Stream Types</u>:**

Ephemeral Streams: 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.

Intermittent Streams: 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.

Perennial Streams: 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. **<u>Priority Waters</u>:** is a rating factor used to determine the importance of the stream that would be <u>impacted or used for mitigation</u>. 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:

Primary: 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 primary stream must be impacted, compensation for impacts should emphasize replacement nearby and in the same watershed. Designated primary priority waters include:

- Outstanding National Resource Waters (10 CSR 20-7.031 Table D)*
- Outstanding State Resource Waters (10 CSR 20-7.031 Table E)*
- Wilderness Areas (Designated by Federal resource agencies)*
- Wild Areas (Designated by MDNR, Division of State Parks)*
- Natural Areas (Natural Area Coordinators, MDC [573-522-4115] or MDNR[573-751-3443])*
- Priority Watersheds (Part of Missouri's Aquatic Conservation Opportunity Areas http://www.nwk.usace.army.mil/Portals/29/docs/regulatory/nationwidepermits/2012/PriorityWatersheds.pdf*
- Designated Fish Spawning Habitat (see Appendix B for list of spawning locations)
- Mussel beds**
- Waters with listed Federal Endangered and Threatened species**

*Geospatial Data: Missouri Department of Natural Resources' published geospatial data are available for download from the Missouri Spatial Data Information Service (MSDIS) website at http://msdis.missouri.edu/. Should one require data that cannot be located on the referenced site, the data will be made available upon request, barring any legal or security restrictions. Also for individuals without geospatial software, the MDNR hosts an interactive internet mapping service with much of the same data available from MSDIS at http://www.dnr.mo.gov/internetmapviewer/.

** These areas are determined on a case by case basis in coordination with the USFWS-Ecological Services Office which can be reached at (573) 234-2132 and MDC-Policy Coordination which can be reached at (573) 522-4115.

Secondary: Secondary priority waters include:

- Abutting an approved mitigation site (bank, in-lieu fee, or permittee-responsible)
- Rivers and streams of the same or lower order within 1.0 mile upstream or downstream of primary priority waters.
- Rivers, streams, or identified segments that are not ranked as a primary priority waters but are designated by the Corps District (see Appendix C).

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

3. <u>Existing Condition</u>: Describes the condition of each stream segment where an impact activity is proposed and its ability to support normal hydraulic and geomorphic functions. **Streams are assumed to be moderately functional unless at the Corps discretion the stream is determined to be fully functional or functionally impaired as described below:**

Fully Functional describes those stream segments that have been shown to or are likely to support healthy aquatic communities. 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 if the following criteria are met:

- Is unaltered in any significant manner by human activities. It has not been channelized, impounded, or significantly constricted by structures, or had its flow significantly altered.
- If not listed on the most current Clean Water Act 305 (b) Integrated lists as Category 4 or 5 developed by MDNR. http://www.dnr.mo.gov/env/wpp/waterquality/305b/index.html
- 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 25 feet in width on both sides of the stream that sustains deep-rooted, native vegetation. 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 significantly 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 Ecological Drainage Unit or 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 for any District designations.

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 functions characteristic 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 a functionally impaired stream segment are considered moderately functional.

Functionally Impaired describes those streams that have been degraded in one or more parameters and lacks resilience characterized by loss of one or more integrity functions. Recovery is unlikely to occur naturally unless a substantial rehabilitation project is undertaken.

A stream segment may be considered functionally impaired if it fails to meet a Fully Functional or Moderately Functional condition and has more than one of the following criteria:

- Has been channelized and shows no evidence of self-recovery.
- Is levee protected, impounded, or artificially constricted.
- Entrenched or contains active headcuts (i.e. abrupt drops in stream bed, both banks failing).
- Has little or no riparian buffer of deep-rooted vegetation on one or both sides of the stream channel.
- Has banks that are extensively eroded or unstable, obvious bank sloughing, and erosional scars.
- Has four or greater stream impacts within 0.5 miles upstream of the proposed stream impact including culverts, pipes, or other manmade modifications, and stream impacts individually or cumulatively exceeds 100 feet in length.

4. Impact Duration: 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 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 instream flows, biological communities, water quality, and best management practices to minimize adverse effects. Examples of activities eligible to receive a temporary duration factor include; utility line crossings where 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, however, in some cases, the amount, location, and type of impacts may necessitate mitigation to ensure that impacts are not adverse.*

Permanent means the impact activity will result in the permanent loss of some or all aquatic resource function and/or services. Examples: armoring, culverting, detention facilities, morphological changes, impounding, and piping.

5. Impact Activity: is the type of impact proposed that will diminish the functional integrity of the stream. Nine categories of impact are used.

Armor means to riprap 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".*

Below Grade (embedded) Culvert means to route a stream through pipes, box culverts, or other enclosed structures for the purpose of a transportation crossing (<= 100 LF of stream to 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 ≥ 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. 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).

Clearing means the clearing or 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. Although these impacts may not be directly regulated, mitigation for these activities may be required if the impact is considered part of the Corps' scope of analysis, and impacts occur as a result of, or in association with, an activity requiring a permit. ***User Note:*** *This factor is not intended for use in combination with a channel segment where a dominant impact activity is being evaluated. However, an example where this factor may be applicable would be on a linear project that parallels a meandering stream channel and multiple stream crossings are proposed. The Regulatory project manager may require compensatory mitigation for clearing activities within the riparian corridor between these crossings with "clearing" identified as the dominant impact activity.*

Detention Facility means installation of a stormwater 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.*

Fill means 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.

Impoundment means 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.

Morphologic Change means 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: 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.

Pipe means to route a stream through pipes, box culverts, or other enclosed structures.
User Note: *If a piped channel section fails to follow the existing channel alignment, it will be left to the discretion of the Regulatory Project Manager to determine whether the "pipe" or "fill" impact activity factor will be used.*

Utility Crossings mean pipeline/utility line installation methods that require temporary disturbance of the streambed. **Bridge footings** requiring fill in waters of the United States are also considered in this activity factor. This factor also includes drilled shafts, column/pier placement, cofferdams for footing/pier placement, temporary crossings and workpads.

6. <u>Linear Impact Calculation</u>: 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 0.0002 constant by the length of stream impacted per column (0.0002 x length of stream impacted per column). This factor considers those columns with greater affected stream length to have more extensive adverse affects on stream function than those columns containing lesser amounts of affected stream length.

C. MITIGATION CREDIT FACTORS:

The items discussed in this section assist the Regulatory agencies, mitigation bankers, in-lieu fee providers, and permit applicants in determining the amount of mitigation credits that are generated as part of a mitigation plan developed in accordance with the Mitigation Rule. Upon the Corps' approval of a mitigation plan, the mitigation credits that are accrued as part of the plan are intended to offset all or portions of stream losses which are evaluated using the Adverse Impact Factors Worksheet Appendix A-1. Both stream and riparian corridor improvements are totaled using the factors listed in the following sections of the guidance document. Any proposed instream mitigation work should be evaluated on the Instream Worksheet located in Appendix A-2, while riparian buffer credit is totaled using the Riparian Buffer Worksheet located in Appendix A-3. **To determine Stream Type and Priority Waters on the Instream and Riparian Worksheets, users should refer to Sections B.1 and B.2 respectively for a discussion of these factors.**

1. In-Stream Work:

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). Stream restoration does not necessarily require returning a system to a pre-disturbance condition, as this is seldom feasible (Copeland, et al., 2001).

Successful stream channel design or uncovering 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.

Net Benefits: are an 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 will determine on a case-by-case basis the net benefit of the proposed in-stream mitigation action. Each mitigation proposal will be evaluated to ensure that the documentation fulfills the requirements of the Mitigation Rule.

A stream relocated to a new alignment for purposes of accommodating construction of an authorized project in the stream's former location, may be construed as a net benefit if 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 the net benefit of the proposed mitigation activity will provide no compensation, partial compensation, or full compensation for project impact.

a. Excellent Stream Channel Restoration: addresses multiple functions of a stream on a large scale. The benefits gained as a result of the mitigation project would apply to all or significant parts of a stream's watershed and are consistent with a watershed plan. <u>Examples</u> of instream activities which receive excellent 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 to determine span width however, there are other appropriate techniques to determine span width).
- 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.
- Restoring stream channel to its former location and/o*r* restoring 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 resloped and reshaped and floodplain bench shall be revegetated with native woody and herbaceous vegetation. Depending on project length, this activity may be classified by the Corps as a good stream channel restoration project.

"Excellent Net Benefit" <u>**does not**</u> include the relocation of a stream channel to accommodate a project in the stream's former location.

b. Good Stream Channel Enhancement: addresses stream function on a smaller scale. The benefits gained as a result of the mitigation project would be localized and not system-wide. <u>Examples</u> of in-stream activities which accrue good 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 pose a hindrance to 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 as part of a compensatory mitigation project and replaced with a structure that meet the general guidelines provided in Appendix E.

- 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 less than fifty but greater than twenty-five percent of the 10-year recurrence interval floodplain reconnected across the entire valley.
- Restoring in-stream channel features (i.e. riffle/run/pool/glide habitat) within a reach, but not comprehensively rehabilitating the channel, using methodologies appropriate to the stream type, size, location in the watershed and current watershed condition.
- Where appropriate, restoring stability in highly eroded areas or areas with artificially accelerated erosion, by resloping and reshaping banks, applying a relatively small percentage of rock, and using non-rigid (soft) methods such as native vegetation. In areas where extreme accelerated erosion is occurring, more rock structures may be used but native vegetation must be planted in combination with the rock structures.

"Good Net Benefit" **<u>does not</u>** include the relocation of a stream channel to accommodate a project in the stream's former location.

c. Moderate Stream Channel Enhancement: addresses stream function on a reach specific scale. Even if applied on a significant length of stream, such practices do not markedly enhance the stream's physical, chemical, and biological processes. <u>Examples</u> of practices which accrue moderate net benefits include (but are not limited to):

- 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.
- Where appropriate, stream stabilization methods utilizing rock/riprap materials in combination with native vegetation to slow velocities and/or train flow for the purpose of enhancing local channel stability and aquatic habitat. Includes stream barbs, cross vanes, bendway weirs (constructed length of no more than 25 percent of base flow width), Newbury rock riffles, etc. but *not* rock armoring of streambanks alone.)
- Reconnecting abandoned side channels or meanders that were artificially cutoff, blocked, or filled where functionally appropriate. Depending on project length, this may be classified as a good stream channel restoration.

"Moderate Net Benefit" **<u>does not</u>** include the relocation of a stream channel to accommodate a project in the stream's former location.

d. Stream Relocation to Accommodate an Authorized Project: is the movement/creation of a stream at a new location to allow an authorized project to be constructed in the stream's former location. A stream moved to a new location to accommodate construction of an authorized 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, instream habitat, riparian plantings, etc.) before consideration will be given by the Corps District to 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 mitigation to replace net losses of stream channel.

Determining Benefited Stream Length: is the total influence expressed in feet that the instream mitigation activity will have on the stream channel. This figure shall be applied in the box labeled Stream Length Benefited found on the Instream 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 is discussed in detail in Appendix F.

- Linear credit for installation of localized lateral streambank stabilization measures will be based on the length of the appropriate 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 reviewing Corps district.

- Linear credit for stream relocation activities necessary to accommodate authorized 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 (C)(1)(d).

- Linear credit for all other activities will be determined on a case-by-case basis at the discretion of the reviewing Corps district.

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

2. <u>Riparian Buffer Work:</u>

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. The Riparian Buffer Worksheet is located in Appendix A-3.

Net Benefits: are 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:

a. Buffer Restoration/Establishment: (51% - 100%) of the buffer will be planted and/or undesirable vegetation is removed and appropriate native vegetation to be established.

b. Buffer Enhancement: (10% - 50%) of the buffer will be planted and/or undesirable vegetation is removed and appropriate native vegetation to be established.

c. Buffer Preservation: means the conservation, in its naturally occurring or present condition, to prevent its destruction, degradation, or alteration for purposes of preventing the decline of functions within the stream it is buffering. 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 (i.e. 500 feet of stream side buffer proposed along left side 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 district in consultation with the reviewing resource agencies may entertain a set back 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 set back area due to the instability and eventual loss of ground. However, a net benefit value can be assigned for buffer establishment beyond the set back zone.*

Requirements for Minimum Buffer Width: The minimum buffer width (MBW) for which mitigation credit 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 1. 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 (51-100%)	Buffer Enhancement planted and/or undesirable vegetation is removed and appropriate native vegetation to be established (10-50%)	Buffer Preservation (<10%) Planting
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 (MBW)	0.50	0.25	0.13

* 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.

3. **Supplemental Buffer Credit:** 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.

4. Site Protection: 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. Which of the instruments below is appropriate for the subject property may vary depending on the situation.

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

Deed restriction means a provision in a deed limiting the use of the property and prohibiting certain uses. The District 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.

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

Conservancy 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 Services for non-profit purposes.

5. Credit Schedule: No additional credits are generated for this factor if the mitigation action in a reach is primarily riparian buffer preservation (<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.

a. 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.

b. 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: If an ILF program sponsor obtains Corps approval for an ILF mitigation project in a geographic service and all of the advance credits in that service area have been completely fulfilled with release credits from an ILF project or released credits in that service area 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.

c. Permittee-responsible mitigation will be evaluated by one of the following schedules;
Credit Schedule 1: 80 to 100 percent of the construction and any planting components specified in the mitigation work plan are completed before the stream impacts occur.
Credit Schedule 2: At least 50 but less than 80 percent of the construction and any planting components specified in the mitigation work plan are completed prior to and/or concurrent with the stream impacts.
Credit Schedule 3: Less than 50 percent of the construction and any planting components specified in the mitigation work plan will be completed prior to and/or concurrent with the stream impacts.

6. 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 than existed at the impact site.

7. Location and Kind: 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 for. 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 each individual Corps District 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.

Use a factor of 0.5 for: 1) permittee-responsible mitigation proposed outside of the 8-digit Hydrologic Unit Code (HUC) watershed in which the impacts occurred or 2) 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.)

Use a factor of 1.0 for: 1) permittee-responsible mitigation proposed within the 8-digit HUC watershed in which the impacts occurred 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 2) when interchanging hydrologic stream types (i.e. ephemeral, intermittent, perennial).

Final 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.*

D. 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 document referenced in Appendix G as 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.

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

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

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

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.

Ecological Drainage Units (EDU) consists of Aquatic Subregions within Missouri and are based on combining watersheds containing aquatic assemblages that are relatively similar and are distinct within the context of the surrounding watersheds.

Enhancement means the manipulation of the physical, chemical, or biological characteristics of an aquatic resource to heighten, intensify, or improve a 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 does not result in a gain in aquatic resource area.is improvement to the value of particular aspects of the stream and/or related land resources.

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.

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 balance 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.

Hydrologic Function is the exchange of water between the channel and watershed. Two formats are especially useful for planning and designing stream corridor restoration: **Flow duration** which is the probability a given streamflow was equaled or exceeded over a period of time. **Flow frequency** is the probability a given streamflow 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].

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

Mean Depth at Bankfull is the mean depth of the stream channel cross-section at bankfull stage as measured in a riffle section.

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).

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.

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.

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.

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, so 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 Order the point of confluence, where two lower order streams meet to form the tributary, downstream to the point such tributary enters a higher order stream. 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.*

APPENDIX A

A-1: Adverse Impact Factors Worksheet
A-2: In-Stream Work Worksheet
A-3: Riparian Buffer Worksheet

ADVERSE IMPACT FACTORS
WORKSHEET

Stream Type Impacted	Ephemeral 0.3			Intermittent 0.4			Perennial 0.8		
Priority Waters	Tertiary 0.1			Secondary 0.4			Primary 0.8		
Existing Condition	Functionally Impaired 0.1			Moderately Functional 0.8			Fully Functional 1.6		
Impact Duration	Temporary 0.05			Permanent 0.3					
Impact Activity	Clearing 0.05	Utility Crossing/Bridge Footing 0.15	Below Grade Culvert 0.3	Armor 0.5	Detention facility 0.75	Morpho -logic Change 1.5	Impound -ment 2.0	Pipe 2.2	Fill 2.5
Linear Impact Calculation	0.0002 multiplied by linear feet of stream impact recorded in each column below								

Factor	Impact 1	Impact 2	Impact 3	Impact 4	Impact 5
Stream Type Impacted					
Priority Waters					
Existing Condition					
Impact Duration					
Impact Activity					
Linear Impact Calculation					
Sum of Factors (M)					
Linear Feet of Stream Impact (LF)					
Credits (C) = M X LF					
*Compensation Ratio X (C)					

Total Credits Required from all Columns= ________________

* ***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.*

IN-STREAM WORKSHEET

Stream Type	Ephemeral 0.15	Intermittent 0.2	Perennial Stream 0.4		
Priority Waters	Tertiary 0.05		Secondary 0.2	Primary 0.4	
Net Benefit	Stream Relocation to Accommodate Authorized Project 0.5		Moderate 1.2	Good 2.4	Excellent 3.5
Site Protection	Corps approved site protection without third party grantee 0.1		Corps approved site protection recorded with third party grantee, or transfer of title to a conservancy 0.4		
Credit Schedule	Schedule 1 0.3		Schedule 2 0.1	Schedule 3 0	

Factors	Net Benefit 1	Net Benefit 2	Net Benefit 3	Net Benefit 4	Net Benefit 5	Net Benefit 6
Stream Type						
Priority Waters						
Net Benefit						
Site Protection						
Credit Schedule						
Sum Factors (M)=						
Stream Length Benefited (do not count each bank separately or count same channel reach twice) (LF)=						
Credits (C) = M X LF						
Total Instream Credits Generated C X LK Factor***** =						

Total Instream Credits Generated from all Columns = ____________

* Location and Kind (LK) Factor only applies to permittee-responsible mitigation projects (see page 18 of document) .

RIPARIAN BUFFER WORKSHEET

Stream Type	Ephemeral 0.15	Intermittent 0.2		Perennial 0.4
Priority Waters	Tertiary 0.05	Secondary 0.2		Primary 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 15)			
Supplemental Buffer Credit	Condition: Buffer established, enhanced or preserved on both streambanks To calculate:(Net Benefit Stream Side A + Net Benefit Stream Side B) / 2			
Site Protection	Corps approved site protection without third party grantee 0.05		Corps approved site protection recorded with third party grantee, or transfer of title to a conservancy 0.2	
Credit Schedule	Schedule 1 0.15		Schedule 2 0.05	Schedule 3 0
Temporal Lag (Years)	Over 20 -0.3	10 to 20 -0.2	5 to 10 -0.1	0 to 5 0

Factors		Net Benefit 1	Net Benefit 2	Net Benefit 3	Net Benefit 4	Net Benefit 5	Net Benefit 6
Stream Type							
Priority Waters							
Net Benefit	Stream Side A						
	Stream Side B						
Supplemental Buffer Credit (Buffer on both sides)							
Site Protection							
Credit Schedule	Stream Side A						
	Stream Side B						
Temporal Lag							
Sum Factors (M)=							
Linear Feet of Stream Buffered (LF)= (do not count each bank separately or count same channel segment twice)							
Credits (C) =M X LF							
Total Credits Generated C X LK Factor * =							

Total Riparian Credits Generated from all Columns = ____________________

* Location and Kind (LK) Factor only applies to permittee-responsible mitigation projects (see page 18 of document) .

APPENDIX B

Designated Fish Spawning Habitat

APPENDIX C

District Designations

<u>Priority Waters</u>
Rivers, streams or identified segments that are not ranked as primary priority waters, but are ranked by the Corps District as secondary priority waters.

Kansas City District Designated Areas:

Little Rock District Designated Areas:

Memphis District Designated Areas:

Rock Island District Designated Areas:

St. Louis District Designated Areas:

<u>Existing Condition</u>
Large streams within EDU or 8-digit HUC automatically designated as fully functional.

Kansas City District Designated Streams:

Little Rock District Designated Streams:

Memphis District Designated Streams:

Rock Island District Designated Streams:

St. Louis District Designated Streams:

APPENDIX D

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

Recommendations Prepared by the Missouri Department of Conservation Stream Unit

Section C.1.a of the Missouri Stream Mitigation Method provides examples of instream mitigation projects that receive excellent 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 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. Insufficient channel openings through these structures also hinder aquatic organism passage by posing jump, velocity, exhaustion, depth and behavioral barriers.

In Missouri, field identification of bankfull elevations are difficult to correctly and consistently identify therefore, multiple approaches are necessary. Copeland and others (2000) state that priority should be given indicators at the top of bank at the elevation of incipient flooding onto a floodplain. Using this elevation along the top of banks will always provide the ability to determine bankfull width 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 or 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 significant 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 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 streambanks 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 (http://ohiodnr.com/?TabId=9188) 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=VxA) by assuming a Mannings "n" value (i.e., 0.041) and computing a slope from the water surface elevations of the longitudinal profile. Velocity is computed by Mannings 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 feet), 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 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 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. http://ohiodnr.com/?TabId=9188

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 C.1.b of the Missouri Stream Mitigation Method provides examples of instream 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 Missouri Stream Mitigation Method

Prepared by the Missouri Department of Conservation Stream Unit

The following guideline has been developed to assist users in determining the upstream and downstream length of stream 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 Missouri 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 Missouri 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

References

Copeland, R. R., McComas, D. N., Thorne, C. R., Soar, P. J., Jonas, M.M., and Fripp, J. B. (2001). “Hydraulic design of stream restoration projects,” Technical Rep. No. ERDC/CHL TR-01-28, U.S. Army Engineer Research and Development Center, Vicksburg, MS.

Fischenich, Craig. J. 2006. “Functional Objectives for Stream Restoration,” Technical Rep. No. ERDC TN-EMRRP SR-52, U.S. Army Engineer Research and Development Center, Vicksburg, MS.

Fischenich, Craig. J. 2000. “Glossary of Stream Restoration Terms,” ERDC TN-EMRRP-SR-01 U.S. Army Engineer Research and Development Center, Vicksburg, MS.

Fischenich, Craig. J. 2000. “Preliminary Watershed Assessment,” Technical Rep. No. ERDC TN-EMRRP SR-03, U.S. Army Engineer Research and Development Center, Vicksburg, MS.

Missouri Department of Conservation. 2009. “Watershed and Stream Management Guidelines for Lands and Waters Managed,”

Sowa, S.P., Annis, G., Morey, M.E., and Diamond, D.D., (2007). “Gap Analysis and Comprehensive Conservation Strategy for Riverine Ecosystems of Missouri,” *Ecological Monographs*, Volume 77 Number 3, pp. 301–334

United States Army Corps of Engineers. 2008. Final Rule for Compensatory Mitigation for Losses of Aquatic Resources (Federal Register / Vol. 73, No.19594-19642).

United States Army Corps of Engineers. 2008. Regulatory Guidance Letter No. 08-03. Minimum Monitoring Requirements for Compensatory Mitigation Projects Involving the Restoration, Establishment, and/or Enhancement of Aquatic Resources.