Assessing Stream Mitigation Guidelines at the Corps District and State Levels

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INTRODUCTION

In 2008, the U.S. Army Corps of Engineers (Corps or USACE) and the U.S. Environmental Protection Agency (EPA) released regulations on compensatory mitigation under § 404 of the Clean Water Act (33 C.F.R. Parts 325 and 332; 40 C.F.R. Part 230 Subpart J). These regulations ("the 2008 Rule") were intended to improve compensatory mitigation planning, implementation, and management by applying similar standards to all compensation projects and emphasizing a watershed approach to selecting project sites (USACE-EPA 2008). The Rule also clarified the agencies' interest in requiring compensation for impacts to streams. At the same time, stream compensation has been on the rise, as demonstrated by an increase in the percentage of mitigation banks and in-lieu fee programs that provide credits for impacts to streams. The Environmental Law Institute (ELI) reported that in 2005, 12 percent of all approved mitigation banks provided stream credits (Wilkinson and Thompson, 2006). By 2011, the Corps reported that 19 percent of all approved mitigation banks provided stream credits (Martin and Brumbaugh, 2011).

The science of stream restoration is rapidly evolving (Science Paper), as is the development of state and Corps policies governing stream assessment and compensation requirements. Thirteen states have formalized state stream mitigation programs, the majority of which were initiated after the Corps and EPA issued the 2008 Rule (ASWM, 2014), and at least 32 stream mitigation guidance documents and policies have been developed by states and Corps districts across the country. Even so, many decisions are still made on an ad hoc basis, depending on a regulator's own experience or expertise, and there are few resources available to guide the development of science-based policy on stream assessment and mitigation.

ELI, Stream Mechanics, and The Nature Conservancy have partnered to provide a wide-ranging view of the state of stream compensatory mitigation. In this series of white papers, we examine how stream compensatory mitigation has evolved in policy and practice in the more than seven years since the 2008 Rule, identifying trends as well as areas for improvement and best practices. We also examine how stream restoration science continues to evolve and what progress can still be made. Our goals are to improve understanding about how well stream compensatory mitigation policies are integrating best available science and how well practice aligns with these policies. Ultimately, we hope to inform the development of best practices and comprehensive, science-based stream assessment and mitigation programs. The white papers in this series include:

- Assessing Stream Mitigation Guidelines at the Corps district and State levels (Guidelines Paper). This paper includes a review of the credit determination methods, performance standards, and other program components currently being applied.
- Assessing stream mitigation practice (Practice Paper). This paper includes a review of the amounts of stream compensatory mitigation being required and the methods of compensation that are being used to meet permit requirements.
- A Function-Based Review of Stream Restoration Science (Science Paper).
- Aligning Stream Mitigation Policy with Science and Practice (Aligning Science, Policy, and Practice Paper). This paper integrates the first three white papers and evaluates how stream mitigation guidelines align with current mitigation practice and science.

We refer to the other white papers in this series using the abbreviations shown in parentheses.

Guidance Paper

This paper surveys the written guidelines of Corps districts and states. It seeks to understand how stream compensatory mitigation policies vary among jurisdictions and how the 2008 Rule is being implemented across the country. It identifies regional and general trends in compensatory mitigation, as well as areas of consensus or divergent approaches. Some specifics of these District policies (e.g., Somerville, 2010; Doyle *et al.*, 2013) and state policies (ASWM, 2014)[1] have been reviewed elsewhere. This paper builds on these reviews to present a broad look at the relevant issues of stream mitigation policy, examining both the most recently issued written policies in addition to those predate the 2008 Rule. It does not address the many detailed documents prepared by mitigation providers themselves, such as in-lieu fee (ILF) and mitigation bank instruments.

Background

Section 404 of the Clean Water Act regulates the discharge of dredge and fill material in waters of the United States, including many wetlands and streams. The Corps and EPA are responsible for implementing and enforcing Section 404. The Corps is responsible for the day-to-day administration of the program, while EPA has responsibility for enforcement and development of the environmental criteria used by the Corps in Section 404 permitting decisions.

Under the Section 404 regulatory program, no discharge may be permitted if it would cause significant degradation to the Nation's waters or if there is a practicable alternative that is less damaging to the environment. Before an individual or standard permit can be issued, the permittee must show that steps have been taken to avoid impacts, potential impacts have been minimized, and compensation may be required for all remaining unavoidable impact to the extent that compensation is appropriate and practicable. Permittees may be required to restore, enhance, establish, or preserve streams or other aquatic resources to satisfy their compensatory mitigation requirements (EPA, Section 404 Permitting. Accessed 2015, http://water.epa.gov/lawsregs/guidance/cwa/dredgdis/). Nationwide, it is estimated that more than $2.9 billion is spent annually on Section 404 compensatory mitigation projects (ELI, 2007). However, studies on wetland compensatory mitigation suggest that historically a significant proportion of compensation sites were or are failing to meet administrative (permit) and ecological performance standards (NRC, 2001; Kihslinger, 2008; Hill *et al.*, 2013; Doyle & Shields, 2012; Miller & Kochel, 2010; Tullos *et al.*, 2009; Bernhardt *et al.*, 2007).

The foundations for the current mitigation program under Section 404 were established in the 1990 joint MOA. The memorandum "articulate[d] the policy and procedures to be used in the determination of the type and level of mitigation necessary to demonstrate compliance with [Section 404]" (Memorandum of Agreement Between the Department of the Army and EPA, February 6, 1990, Subject: The Determination of Mitigation Under the Clean Water Act Section 404(b)(1) Guidelines. Accessed 2015, http://water.epa.gov/lawsregs/guidance/wetlands/mitigate.cfm). By adopting the "no net loss of wetlands policy" and embracing the long-disputed sequence of avoidance, minimization, and compensation, the MOA provided a shared framework in which mitigation could take place

[1] This report conducted interviews with state agency staff from 47 states involved in mitigation, focusing on how states identify and classify streams, which streams fall within each state's jurisdiction, and how stream mitigation is conducted within each state.

(Hough and Robertson, 2009). The agencies subsequently released guidance on mitigation banking in 1995 and in-lieu fee programs in 2000. In 2002, the Corps released a Regulatory Guidance Letter addressing compensatory mitigation (USACE, 2002), which drew on recommendations in a 2001 National Research Council report, including the use of a watershed approach to site selection, the use of functional assessments for evaluating sites, and inclusion of monitoring and long-term management requirements (NRC, 2001).

When the 1990 Memorandum of Agreement was issued, nearly all compensatory mitigation focused on wetlands. Impacts to streams were given less attention, and often those impacts were compensated with wetland projects, not streams (ASWM, 2014). In the decade preceding the 2008 Rule, some states and Corps districts (especially in the Southeast) gradually began requiring "in-kind" mitigation for streams—that is, stream compensation for stream impacts (Doyle and Shields, 2012; Lave *et al.*, 2008). Although the first national acknowledgement of stream compensatory mitigation as a practice was in the 2002 Nationwide permits, stream mitigation policies were not formally established at a national level until 2008, when EPA and the Corps promulgated the 2008 Rule. In the 2008 Rule, EPA and the Corps explained that projects permitted under Section 404 impact streams and other open waters in addition to wetlands, and that the Rule would therefore apply to all aquatic resources. The Rule notes that stream mitigation is an evolving practice, and states that including streams in the Rule will improve current standards and practices.

At the outset, the Rule recognizes that streams are "difficult-to-replace" resources. It acknowledges "that the scientific literature regarding the issue of stream establishment and re-establishment is limited and that some past projects have had limited success" (73 Fed. Reg. 19596). Accordingly, the Rule establishes the following policies for streams:

- Discourage stream establishment and reestablishment.
- Favor in-kind rehabilitation, enhancement, or preservation for streams and other difficult-to-replace resources if more avoidance and minimization are not practicable (33 C.F.R. § 332.3(e)(3)).
- Include planform geometry, channel form, watershed size, design discharge, and riparian area plantings as possible additional elements in stream mitigation work plans (33 C.F.R. § 332.4(c)(7)).
- Require at least five years of monitoring for mitigation projects, or longer for certain slow-developing resources (73 Fed. Reg. 19597).

Although these requirements are an important step forward, and the Rule is more comprehensive and detailed than prior policies and guidance, it leaves regulators and practitioners substantial discretion on many components of compensatory mitigation. Although some flexibility is necessary to address variation in resource types, project impacts, and compensatory mitigation practices, considerable flexibility can also undermine consistent application of the Rule (Stokstad, 2008) and may lead to disproportionate regulatory risk (that is, risk that the required mitigation may not adequately offset permitted aquatic resource impacts) (BenDor and Riggsbee, 2011). Some have also observed that the Rule is insufficiently rigorous or focused on avoidance and minimization to ensure improvement in resource functions (Doyle and Shields, 2012). The Rule's extension to streams raised particular challenges because the science of stream restoration is considerably younger than the science of wetland restoration, and evidence suggests that some stream functions are very difficult, if not impossible, to restore

(Science Paper; Stokstad, 2008; Murphy *et al.*, 2009). Furthermore, few regulators have specialized training in stream processes, potentially leading to policies that focus on vegetation (or other more wetland-focused criteria) more than fluvial processes specific to streams (Harman *et al.*, 2012).

METHODOLOGY

For this paper, we analyzed 32 stream mitigation guidelines additional documents developed by states and Corps districts (and one Corps division) (Table 1 and Figure 1). The set of documents reviewed here is not intended to be comprehensive; we have sought to identify the main publically available guidance documents in each district or state, with occasional reliance on a supplementary document for particular topics. In some cases, we were able to obtain documents from the primary sources. We did not find guidance documents for all 38 Corps Districts. More specific mitigation-related documents (such as documents focused on one topic or program component) are generally not included here. Whereas some policies apply to an entire district, others cover a particular state, and may have been developed by a state agency or as a joint effort of state and federal agencies with jurisdiction in that state. The documents vary in level of scope and detail, and range from checklists and guidance letters to more comprehensive regulatory guidelines. Some of the procedures are designed to be used alone, while other are designed to be used as a collection with other documents (e.g., in the Fort Worth, Wilmington, Norfolk, and Sacramento Districts), such as assessment methodologies, site selection guidelines, or mitigation bank instrument templates. Eleven of these policies were developed prior to the 2008 Rule and twenty-two were developed (either as new documents or revisions to pre-Rule policies) after the Rule. For convenience, we refer to all of the documents (single documents or collection of documents) as Standard Operating Procedures (SOPs) throughout this paper. We obtained most of the documents from Corps district websites, but some draft documents were obtained directly from Corps or state agency personnel.

Table 1: Policy Documents

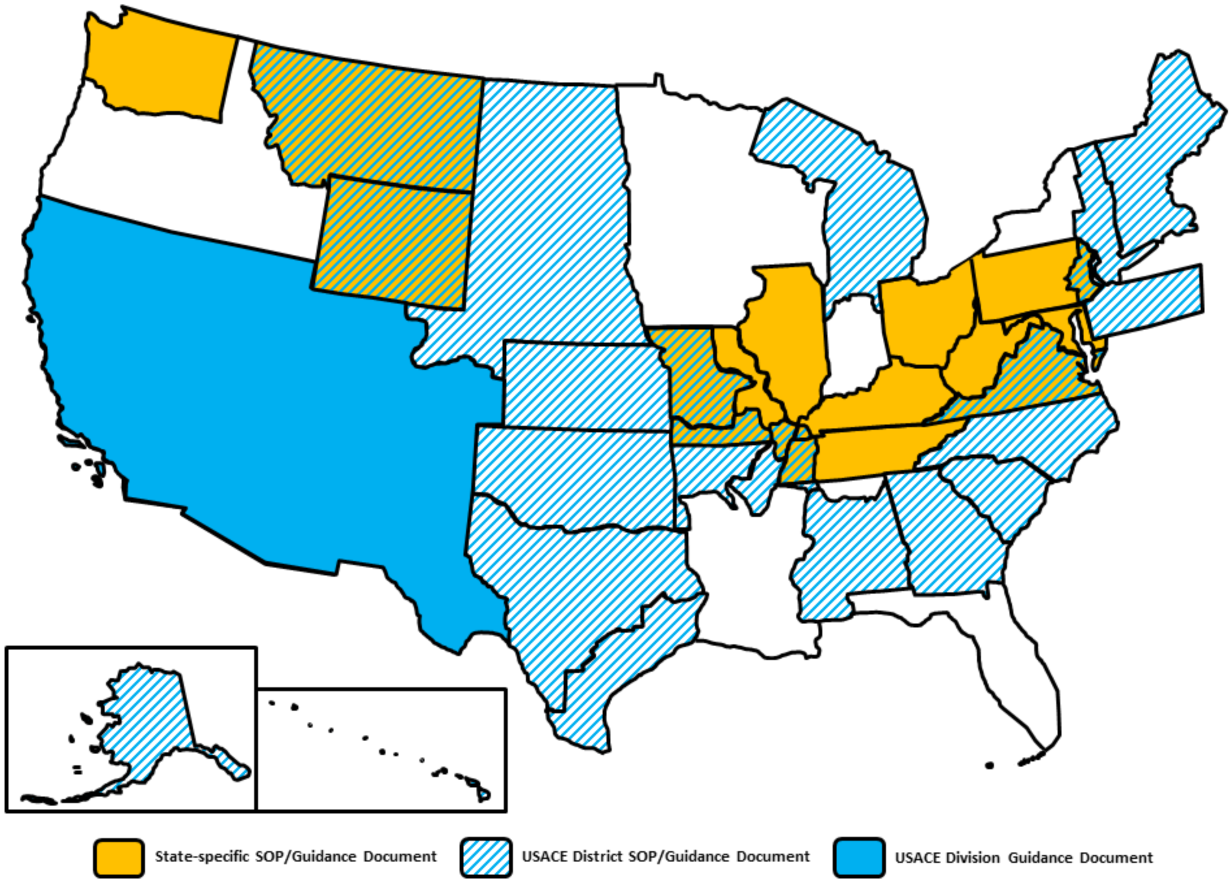
SOP or Guidance Document	Year Issued
U.S. Army Corps of Engineers, Charleston District, *Joint State/Federal Administrative Procedures for Establishment and Operation of Mitigation Banks in **South Carolina*** (2002)	2002
Washington State Aquatic Habitat Guidelines Program, *Integrated Streambank Protection Guidelines* (2003)	2003
U.S. Army Corps of Engineers, **Wilmington** District, North Carolina Division of Water Quality, U.S. Environmental Protection Agency, Region IV, Natural Resources Conservation Service, and North Carolina Wildlife Resources Commission, *Stream Mitigation Guidelines* (2003)[a]	2003
U.S. Army Corps of Engineers, **Memphis** District, *Public Notice for Mitigation Guidelines and Monitoring Requirements, Public Notice No. MVM-MGMR* (2004)	2004
U.S. Army Corps of Engineers, **Philadelphia** District, *Mitigation and Monitoring Guidelines* (2004)	2004
U.S. Army Corps of Engineers, **Savannah** District, *Standard Operating*	2004

Procedure, Compensatory Mitigation, Wetlands, Openwater & Streams (2004)	
U.S. Army Corps of Engineers, **Tulsa** District, *Aquatic Resource Mitigation and Monitoring Guidelines* (2004)	2004
U.S. Army Corps of Engineers, *Guidance for Compensatory Mitigation and Mitigation Banking in the* ***Omaha*** *District* (2005)	2005
U.S. Army Corps of Engineers, **New York District**, *Public Notice Announcing the Compensatory Mitigation Guidelines and the Mitigation Checklist for Review of Mitigation Plans for the U.S. Army Corps of Engineers, New York District* (2005)	2005
Kentucky Division of Water, *Stream Relocation/Mitigation Guidelines* (2007)	2007 (draft)
U.S. Army Corps of Engineers, **Norfolk** District, Virginia Department of Environmental Quality, *Unified Stream Methodology for use in Virginia* (2007)[b]	2007
<u>JOINT EPA/CORPS COMPENSATORY MITIGATION RULE ISSUED</u>	**<u>2008</u>**
U.S. Army Corps of Engineers, **Detroit** District, *Mitigation Guidelines and Requirements* (2008)	2008
U.S. Army Corps of Engineers, **Illinois**, *Illinois Stream Mitigation Guidance* (2010)	2010
U.S. Army Corps of Engineers, Kansas City District, ***Kansas*** *Stream Mitigation Guidance* (2010)[c]	2010
U S. Army Corps of Engineers, St. Louis District and U.S. Environmental Protection Agency, *Mitigation Banking Instrument Outline For Proposed Mitigation Banks Within the State of* ***Missouri*** (2010)	2010
U.S. Army Corps of Engineers, **Charleston** District, *Guidelines for Preparing a Compensatory Mitigation Plan* (2010)	2010 (working draft)
Virginia Department of Environmental Quality, the U.S. Army Corps of Engineers, Norfolk District, and the Interagency Review Team, ***Virginia*** *Mitigation Banking Instrument Template* (2010)	2010
U.S. Army Corps of Engineers, **Fort Worth** District, *Public Notice to Publish New Guidelines Covering Specific Elements for the Establishment of New Mitigation Banks in the Fort Worth District*, CESWF-10-MITB (2011)[d]	2011
U.S. Army Corps of Engineers, **Little Rock** District, *Little Rock District Stream Method*, CESWL-RD (2011)	2011
Maryland Nontidal Wetlands and Waterways Division, ***Maryland*** *Nontidal Wetland Mitigation Guidance* (2011)	2011
U.S. Army Corps of Engineers, **Savannah** District, *Draft Guidelines to Establish and Operate Stream Mitigation Banks in Georgia* (2011)	2011
West Virginia Interagency Review Team, ***West Virginia*** *Stream and Wetland Valuation Metric* (2011)	2011
U.S. Army Corps of Engineers, **Mobile** District, *Compensatory Stream Mitigation Standard Operating Procedures and Guidelines,* SAM-2011-317-MBM (2012)[e]	2012 (draft)
Tennessee Department of Environment and Conservation, Division of Water	2012

Pollution Control, Natural Resources Section, *Draft Stream Mitigation Guidelines for the State of* ***Tennessee*** (2012)	(draft)
U.S. Army Corps of Engineers, **Galveston** District, *Galveston District Stream Condition Assessment Standard Operating Procedure* (2013)	2013
U.S. Army Corps of Engineers *et al.*, *State of* ***Missouri*** *Stream Mitigation Method* (2013)	2013
U.S. Army Corps of Engineers, Omaha District, ***Montana*** *Stream Mitigation Procedure* (2013)	2013
U.S. Army Corps of Engineers, Omaha District, ***Wyoming*** *Stream Mitigation Procedure* (2013)	2013
U.S. Army Corps of Engineers, Buffalo, Huntington, and Pittsburgh Districts, *Guidelines for Stream Mitigation Banking and In-Lieu Fee Programs in* ***Ohio*** (2014)	2014
Pennsylvania Department of Environmental Protection, Bureau of Waterways, Engineering and Wetlands, Division of Wetlands, Encroachments and Training, ***Pennsylvania*** *Function Based Aquatic Resource Compensation Protocol* (2014)	2014
U.S. Army Corps of Engineers, **South Pacific** Division, *Final 2015 Regional Compensatory Mitigation and Monitoring Guidelines* (2015)[f]	2015
U.S. Army Corps of Engineers, **New England** District, *New England District Compensatory Mitigation Guidance* (2015)	2015 (draft)

[a] Also see U.S. Army Corps of Engineers, Wilmington District, *Stream Mitigation Considerations Checklist* (2011) and U.S. Army Corps of Engineers, Wilmington District and North Carolina Interagency Review Team, *Requirements and Performance Standards for Compensatory Mitigation in North Carolina* (2013).
[b] Also see U.S. Army Corps of Engineers, Norfolk District, *Public Notice: Virginia Offsite Mitigation Location Guidelines* (2008) and U.S. Army Corps of Engineers, Norfolk District, Virginia Department of Environmental Quality, *Suggestions for Proposing Compensatory Mitigation Sites (Dos and Don'ts)* (2009)
[c] Also see U.S. Army Corps of Engineers, Kansas City District, *Mitigation Banking Instrument Outline for Proposed Mitigation Banks within the State of Kansas* (2015)
[d] Also see Fort Worth District and Texas Interagency Review Team, *Guidelines Covering Specific Elements for the Establishment of New Mitigation Banks in the Fort Worth District*, CESWF-12-MITB (2012); U.S. Army Corps of Engineers, Fort Worth District, *Fort Worth District Stream Mitigation Method (2013)*; and U.S. Army Corps of Engineers, Fort Worth and Tulsa Districts, *The Texas Rapid Assessment Method (TXRAM)* (2010)
[e] Also see U.S. Army Corps of Engineers, Mobile District, *Proximity Factor Method* (2009)
[f] Also see South Pacific Division, *Regulatory Uniform Performance Standards for Compensatory Mitigation Requirements* 12505-SPD (2012) and South Pacific Division, *Regulatory Program Standard Operating Procedure for Determination of Mitigation Ratios* (2011)

Figure 1: Areas of Coverage for SOPs or Guidance Documents for Stream Mitigation



States with state-specific SOPs or guidance documents for stream mitigation are colored yellow. USACE districts with relevant SOPs or guidance documents are indicated by blue stripes. The USACE South Pacific Division's guidance document is designated by a solid blue.

We investigated the following fundamental components of the SOPs: (1) Threshold for Requiring Mitigation, (2) Stream Mitigation Approaches and Techniques, (3) Stream Mitigation Methods, (4) Service Area Requirements, (5) Site Selection and the Watershed Approach, (6) Determination of Debits, (7) Determination of Credits, (8) Buffer Credits, (9) Credit Release Schedules, (10) Performance Standards, and (11) Monitoring Requirements. We examined whether the SOPs addressed these topics, or failed to provide guidance on some of them; when SOPs did cover a topic we reviewed and compared their responses.

RESULTS

Our review indicates that the state of stream mitigation is still in flux. Some policies still predate the 2008 Rule, and no consensus policy model has emerged. Many compensation and permitting decisions are made on a case-by-case basis, and the 2008 Rule leaves considerable flexibility on many subjects. Additionally, though several jurisdictions are beginning to incorporate functional (measure of a process and described as a rate of change) or conditional assessments (measure of structure at a specific point of time) into their procedures, credit and debit calculation is still primarily based on the length of stream restored, rather than on functions gained or preserved.

I. Threshold for Requiring Mitigation

Only six SOPs listed thresholds below which compensation would not be required, or would only be required on a case-by-case basis. In many districts the thresholds are associated with providing notification (submitting pre-construction notification) for nationwide permit verification. Some used numeric thresholds: In Montana, projects with less than 300 linear feet of stream impact are evaluated case-by-case and any larger impacts generally require mitigation, as do any culvert impacts longer than 150 linear feet (Montana, p. 1). Savannah sets a lower threshold of 100 feet, requiring mitigation for any larger impact and a case-by-case decision whether mitigation will be required for any smaller impact (Savannah, p. 2). In Tulsa, a project involving only a narrow right-of-way across a stream, like a utility line, generally will not require compensatory mitigation if the project area is restored after construction and the right-of-way is not more than 150 feet wide (pp. 7-8). Los Angeles does not list a threshold for requiring mitigation, but does recommend a functional or conditional assessment for any proposed impact longer than 300 linear feet (pp. 16-17).

Three other SOPs set out a descriptive threshold rather than a numeric one. In both Norfolk and Pennsylvania, the lowest possible category of projected adverse impact—"minimal" in Pennsylvania, "negligible" in Norfolk—will generally not require mitigation. In Norfolk, for example, "negligible" impact is characterized by "[b]ridges or other similar structures associated with roadways or trails causing no permanent impacts to stream channels, including no riprap lining, no piers, no widening, or no constriction of stream channels" (p. 15). One of the possible ways a project impact can qualify as "minimal" in Pennsylvania is if the cumulative impact is less than 100 feet in any one watershed, (p. 16) but other criteria are not numeric.

II. Stream Mitigation Approaches and Techniques

We reviewed the SOPs to identify how various stream restoration approaches and techniques that we have identified are employed to develop stream mitigation plans and credits. To locate stream mitigation approaches and techniques in the SOPs, we created a list of keywords (one or more for each approach and technique) and searched for those keywords in each of the SOPs.

a. Stream Mitigation Approaches

We identified five restoration approaches currently in use across the country (Table 2).

Table 2: Approaches to Stream Mitigation

Approach	Description
Natural Channel Design	Also called the Rosgen Geomorphic Design Methodology. This approach includes eight phases ranging from restoration objectives and watershed assessment to design and monitoring. It primarily focuses on creating or maintaining a bankfull channel with floodplain/floodprone area access that does not aggrade or degrade over time. Design tools include hydraulic geometry relationships, bankfull regional curves, reference reach ratios, sediment transport calculations, and more (NRCS, 2007a).
Regenerative Design	There are two types of Regenerative Design Approaches: Step Pool Storm Conveyance (SPSC) and Floodplain Weirs. SPSC is typically used to convert ephemeral stormwater flow to subsurface flow through the use of step-pool channels and sand seepage berms. Floodplain weirs are used in perennial streams to create stream/wetland systems to reduce energy and improve water chemistry (Anne Arundel County, 2012).
Valley Restoration	This approach is primarily applied in regions with legacy sediments and small headwater systems with low sediment supply, but it has also been applied in larger watersheds with sediment supply. The design methodology includes reconnecting stream/wetland systems to the original valley and groundwater sources, typically through floodplain excavation. The channels are much smaller than bankfull channels. Sediment sinks are used to remove sediment in larger watersheds with sediment supply.
Analytical	This approach uses physically based equations, including continuity, hydraulic resistance, and sediment transport, to design the riffle dimension. The primary result is a channel stability curve that predicts riffle depth and average channel slope for a range of channel widths. Other empirically based methods are generally used to design meander geometry and bed-form profiles (NRCS, 2007b, c).
Process Based	The purpose of process-based restoration is to re-establish normal rates and magnitudes of physical, chemical, and biological processes. This approach provides broad guidelines about design goals and steps and then points to specific techniques that can be used to manipulate stream processes and channel forms (WDFW, 2012).

We first looked at each SOP to see whether and how the identified stream mitigation approaches described above (Natural Channel Design, Regenerative Design, Valley Restoration, Analytical Approach, and Process Based Approach) were included. Although Natural Channel Design has its critics (Lave, 2009; Simon *et al.*, 2007; Kondolf (1995); Miller and Ritter (1996); Kondolf and Downs (1996); Hilderbrand *et al.* 2005; Simon *et al.* (2005, 2008)), the Corps and state policies we reviewed indicate that it remains a predominant approach for stream compensatory mitigation. Ten of the SOPs we reviewed (Galveston, Illinois, Kansas, Kentucky, Missouri, Mobile, New York District, Norfolk, Tennessee, and Wilmington) expressly mention Natural Channel Design (Table 3). Among the SOPs that mention Natural Channel Design, some explicitly require that the approach be used to inform stream mitigation activities. For example, the Mobile SOP mandates that final mitigation plans "will be designed as required by the Natural Channel Design methods" (Mobile, p. 2). The New York District SOP also requires mitigation projects to use Natural Channel Design or bioengineering techniques and principles in choosing mitigation location and design (New York District, p. 15). In discussing possible stream restoration actions, the Kansas SOP states that “constructing channels that do not incorporate the principles of Natural Channel Design” will not generate mitigation credits (Kansas, p. 16). Other SOPs do not require Natural Channel Design to inform stream mitigation activities, but do mention the approach. For example, the Tennessee SOP notes that “[s]tream mitigation projects often involve a Natural Channel Design approach” (Tennessee, p. 23).

Another nine (Charleston, Little Rock, Memphis, Montana, Ohio, Savannah, Tulsa, Washington, and Wyoming) do not use the term “Natural Channel Design,” but refer to at least one of four concepts closely associated with the approach:

- Bankfull channel dimension
- Priority levels of restoration
- Restoring dimension, pattern, and profile
- Restoring a channel so that the dimension, pattern, and profile doesn’t aggrade or degrade over time

For example, the Little Rock SOP states that restoration can include “[s]tream channel restoration that involves the re-establishment of a channel on the original floodplain, using a relic channel or constructing a new channel. The new channel is designed and constructed with the proper dimension, pattern and profile characteristics for a stable stream” (p. 9).

Many SOPs did not mention Natural Channel Design either expressly or implicitly. The other four approaches described above were not mentioned in the SOPs we reviewed.

Table 3: Use of Natural Channel Design

SOP	Discusses Natural Channel Design?
State-specific Guidance	
Georgia (State guidance, Savannah District)	Defines restoration categories by reference to priority levels of restoration (Attachment C)
Illinois (State guidance, Chicago, Rock Island, and St. Louis Districts)	"[A] stream relocated to a new location to accommodate construction of an authorized project must incorporate Natural Channel Design features" (p. 11).
Kansas (State guidance, Kansas City District)	"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" (p. 16).
Kentucky (State guidance, Kansas City District)	"In general, Natural Channel Design is composed of three main components: • Naturally stable planform and profile. • Appropriate in-stream habitat (structures and self-perpetuating features). • Minimum 50' wide riparian zone on each side of the stream channel" (p. 3).
Maryland (State guidance, Baltimore District)	No
Missouri (State guidance, Kansas City, Little Rock, Memphis, St. Louis, and Rock Island Districts)	"Restoring stream channel to its former location and/or restoring sinuosity, channel dimensions, width/depth ratio, and bankfull width…" (p. 12). "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)]" (p. 13).
Montana (State guidance, Omaha District)	Restoration or improvement activities include "stream channel restoration of pattern, profile, and dimensions . . . and reconnection of a stream with its floodplain" (p. 3).
Ohio (State guidance, Buffalo, Huntington, Pittsburgh Districts)	"Activity Level 1 applies to both perennial and intermittent streams. The associated activities may include but are not limited to a full-extent channel restoration involving dimension, pattern and profile work to provide for a stable stream the is reconnected to its original floodplain by using a relic channel or constructing a new channel. Stream restoration plans should be developed in conjunction with a reference reach assessment" (p. 27).
Pennsylvania (State guidance, Pennsylvania, Pittsburgh, and Baltimore Districts)	No

Tennessee (State guidance, Memphis and Nashville Districts)	Defines Natural Channel Design (p. 8). "Stream mitigation projects often involve a Natural Channel Design approach, which consists of returning a severely degraded, disturbed, or altered stream, including adjacent riparian buffer and flood-prone area, to a natural stable condition based on reference conditions or other appropriate standards" (p. 23).
Virginia (State guidance, Norfolk District)	"Streams that will be relocated using the principles of Natural Channel Design may be considered self-mitigating in most cases, eliminating the need to apply the USM" (p. 2). Calls for natural stream channel design methods for restoration projects (p. 20).
Washington (State guidance, Seattle District)	Does not mention the term "Natural Channel Design," but does include channel modification techniques (pp. 6–189).
West Virginia (State guidance, Huntington and Pittsburg Districts)	No
Wyoming (State guidance, Omaha District)	Mitigation activities may include "stream channel restoration of pattern, profile, and dimensions" (p. 3)
District-Wide Guidance	
Charleston	"Stream Enhancement and Maintenance/Improvement activities are designed to … restore natural channel features" (Appendix D, p. 5).
Detroit	No
Fort Worth	No
Galveston	"Restoration projects should focus project designs, using Natural Channel Design, on creating landforms and water flows that streams can maintain naturally that focus on the restoration of the chemical, physical, and biological functions" (p. 20).
Little Rock	Excellent restoration can include "Stream channel restoration that involves the re-establishment of a channel on the original floodplain, using a relic channel or constructing a new channel. The new channel is designed and constructed with the proper dimension, pattern and profile characteristics for a stable stream" (p. 9)
Memphis	Stream Restoration "should be based on a reference condition/reach for the valley type and includes restoring the appropriate geomorphic dimension (cross-section), pattern (sinuosity), and profile (channel slopes)" (p. 12).
Mobile	"The final plans will incorporate appropriate stream restoration techniques based on a reference stream and will be designed as required by the Natural Channel Design methods" (p. 2).
New England	No
New York District	Requires use of Natural Channel Design or bioengineering techniques and principles (p. 15).

Omaha	No
Philadelphia	No
South Pacific	No

b. Stream Mitigation Techniques

Stream mitigation techniques are narrower in scope than approaches and are often used to address a specific problem, such as preventing streambank erosion or increasing buffer width and composition. We define techniques as discrete activities, such as buffer reestablishment or bioengineering, that generally serve a specific purpose as part of the broader goal of stream restoration. Based on a literature review and our prior experience, we identified 22 restoration techniques: agricultural best management practices (BMPs), bio-engineering, buffer establishment, controlled burning, creation of floodplain habitats, culvert removal, dam removal, engineered logjams, fencing, fish passage structures, floodplain connectivity, floodplain grading, groundwater dams, in-stream structures, levee removal, large woody debris placement, remeandering of a straightened channel, removal of invasive species, riparian re-vegetation, sediment removal, stormwater BMPs, and substrate addition (Figure 2 and Table 3). We distinguished a range of stream mitigation purposes for which these techniques are commonly used. Each technique serves one or more stream restoration purposes. Some techniques are used for one primary purpose. For example, removing a dam or a levee is done for the primary purpose of removing channel obstructions. Other techniques can be used to achieve several purposes. Restoring floodplain connectivity, for example, can improve vertical stability, bed-form diversity, and groundwater/surface water interactions, reduce nutrient loading from adjacent land uses, and lower stream temperature. Finally, multiple different techniques may be used to achieve the same purpose. For example, bioengineering and fencing can both improve lateral stability.

We considered an SOP to include a technique if it explicitly identified the technique as a mitigation action or if the context implied that the technique could be used as a mitigation action (that is, to generate mitigation credits), but not if it merely mentioned a technique. The fact that a technique does not appear in an SOP does not necessarily imply that the technique cannot be used as a mitigation action in that district, however. Many Corps districts and states allow mitigation providers flexibility in developing mitigation plans. As a result, a district may allow the use of a technique as a mitigation action even if the SOP does not explicitly identify that technique as a permissible action.

Each of the 22 techniques we have identified, with the exception of groundwater dams, appeared in at least one of the SOPs we reviewed (Figure 2, Tables 4a and 4b). The least commonly mentioned techniques were groundwater dams (which no SOP mentioned), engineered logjams, controlled burning, agricultural BMPs, levee removal, large woody debris placement, and fish passage structures. The other techniques appeared in at least ten of the SOPs and were generally well represented.

Figure 2: Frequency of Stream Mitigation Techniques

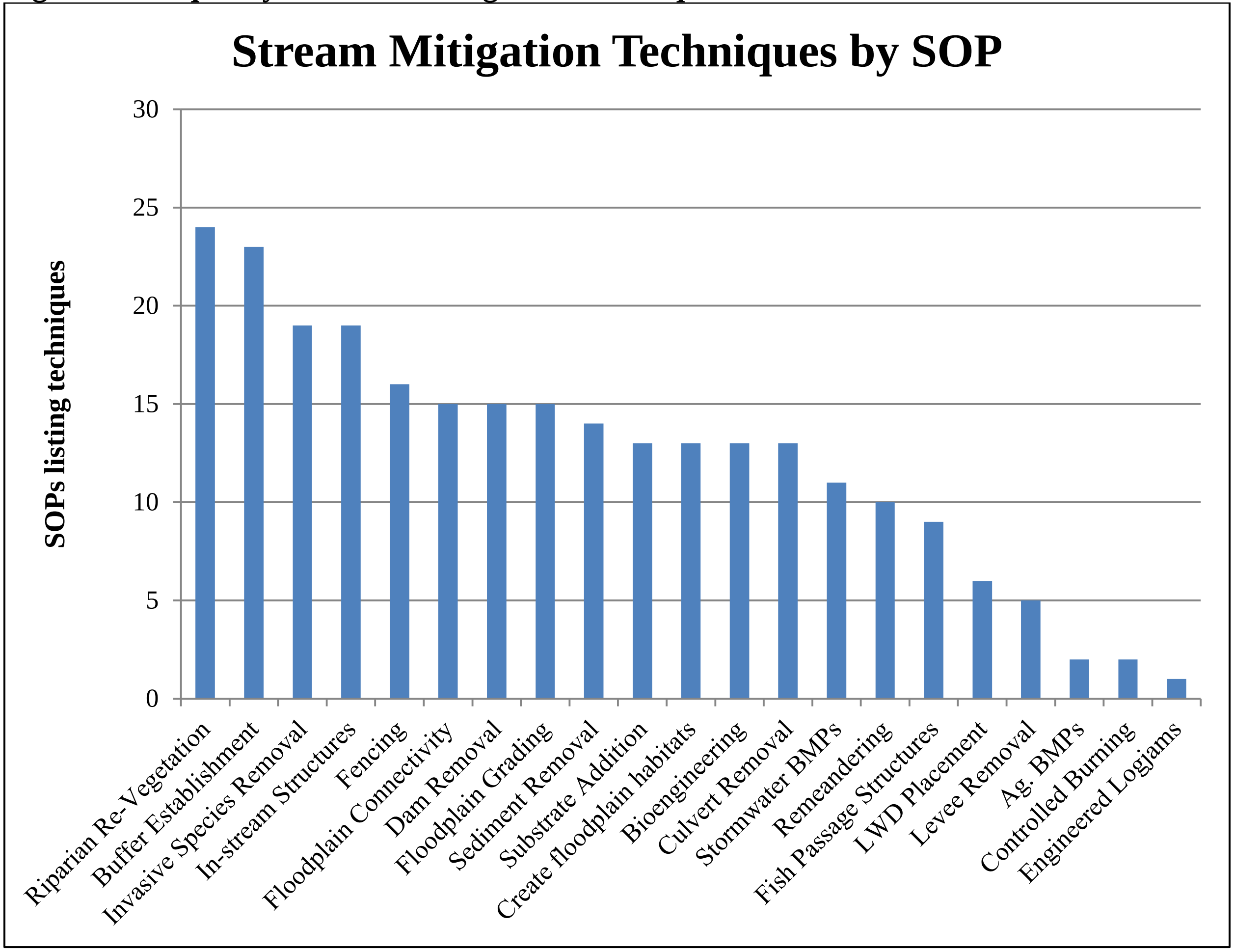


Table 4a: Techniques in State-specific SOP/Guidance Documents

Techniques	Potential Purposes	SOPs												
		GA	IL	KS	KY	MD	MO	MT	OH	PA	TN	VA	WA	WY
Agricultural BMPs	Runoff treatment, reduce nutrient loading from adjacent land uses, reduce stream temperature					X		X						
Bio-engineering	Improve lateral stability / bank erosion	X	X	X	X						X	X	X	
Buffer Establishment	Runoff treatment, reduce nutrient loading from adjacent land uses, reduce stream temperature	X	X	X		X	X	X	X		X	X	X	X
Controlled Burning	Improve floodplain/riparian complexity													
Floodplain Habitat Creation	Improve floodplain/riparian complexity by creating microtopography, vernal pools, oxbows, sloughs, etc.	X	X	X	X	X	X	X	X			X	X	
Culvert Removal	Remove channel obstructions	X	X	X	X	X	X	X			X	X		
Dam Removal	Remove channel obstructions	X	X	X	X		X	X			X	X		X
Engineered Logjams	Improve bed-form diversity, improve groundwater/surface water interaction												X	
Fencing	Improve lateral stability/bank erosion			X		X		X			X	X	X	X
Fish Passage Structures	Remove channel obstructions		X	X			X	X	X				X	
Floodplain Connectivity	Increases the frequency of overbank flooding and possibly increases attenuation for larger projects. This can include floodplain grading or raising the streambed.		X	X	X	X	X	X	X			X		X
Floodplain Grading	Improve floodplain inundation by excavating (lowering) the floodplain.		X	X	X	X	X	X	X				X	
Groundwater Dams	Improve groundwater/surface water interaction by constructing underground dams (e.g., with clay) that increases the elevation of the water table. This technique is most common in mining applications were channels are reconstructed in porous fill material.													
In-stream Structures	Improve lateral stability/bank erosion, improve vertical stability, improve bed-form diversity, improve groundwater/surface water interaction, reduce stream temperature	X	X	X	X		X	X	X			X	X	X
Levee Removal	Improve floodplain/riparian complexity		X	X			X							
Large Woody Debris Placement	Improve bed-form diversity, groundwater/surface water interaction, substrate complexity, and flow complexity.												X	
Remeandering of Straightened Channel	Improve vertical stability, improve bed-form diversity, improve groundwater/surface water interaction, reduce stream temperature		X	X	X			X	X		X		X	X
Removal of Invasive Species	Improve floodplain/riparian complexity	X		X	X	X	X	X	X	X	X	X		X
Riparian Re-vegetation	Improve lateral stability/bank erosion, improve floodplain/riparian complexity	X	X	X	X	X	X	X	X	X	X	X	X	X
Sediment Removal	Improve bed-form diversity	X	X		X	X			X	X			X	
Stormwater BMPs	Runoff treatment, reduce nutrient loading from adjacent land uses	X				X		X					X	
Substrate Addition	Improve bed-form diversity					X			X	X			X	

Table 4b: Techniques in District-Wide SOP/Guidance Documents

Techniques	Purposes	SOPs						
		Charleston	Detroit	Galveston	Little Rock	Memphis	Mobile	New England
Agricultural BMPs	Runoff treatment, reduce nutrient loading from adjacent land uses, reduce stream temperature							
Bio-engineering	Improve lateral stability / bank erosion		X				X	
Buffer Establishment	Runoff treatment, reduce nutrient loading from adjacent land uses, reduce stream temperature	X	X	X	X	X	X	X
Controlled Burning	Improve floodplain/riparian complexity	X	X					
Floodplain Habitat Creation	Improve floodplain/riparian complexity by creating microtopography, vernal pools, oxbows, sloughs, etc.				X		X	
Culvert Removal	Remove channel obstructions	X					X	X
Dam Removal	Remove channel obstructions	X					X	X
Engineered Logjams	Improve bed-form diversity, improve groundwater/surface water interaction							
Fencing	Improve lateral stability/bank erosion	X	X	X	X	X	X	X
Fish Passage Structures	Remove channel obstructions	X					X	X
Floodplain Connectivity	Increases the frequency of overbank flooding and possibly increases attenuation for larger projects. This can include floodplain grading or raising the streambed.	X		X	X		X	X
Floodplain Grading	Improve floodplain inundation by excavating (lowering) the floodplain.		X		X	X	X	X
Groundwater Dams	Improve groundwater/surface water interaction by constructing underground dams (e.g., with clay) that increases the elevation of the water table. This technique is most common in mining applications were channels are reconstructed in porous fill material.							
In-stream Structures	Improve lateral stability/bank erosion, improve vertical stability, improve bed-form diversity, improve groundwater/surface water interaction, reduce stream temperature	X	X	X	X		X	X
Levee Removal	Improve floodplain/riparian complexity	X			X			
Large Woody Debris Placement	Improve bed-form diversity, groundwater/surface water interaction, substrate complexity, and flow complexity.							X
Remeandering of Straightened Channel	Improve vertical stability, improve bed-form diversity, improve groundwater/surface water interaction, reduce stream temperature						X	
Removal of Invasive Species	Improve floodplain/riparian complexity	X	X	X		X	X	X
Riparian Re-vegetation	Improve lateral stability/bank erosion, improve floodplain/riparian complexity	X	X	X	X	X	X	X
Sediment Removal	Improve bed-form diversity	X	X		X	X	X	
Stormwater BMPs	Runoff treatment, reduce nutrient loading from adjacent land uses	X	X					X
Substrate Addition	Improve bed-form diversity	X	X		X	X	X	

Table 4b: Techniques in District-Wide SOP/Guidance Documents (continued)

Techniques	Purposes	SOPs					
		New York District	Omaha	Philadelphia	South Pacific	Tulsa	Wilmington
Agricultural BMPs	Runoff treatment, reduce nutrient loading from adjacent land uses, reduce stream temperature						
Bio-engineering	Improve lateral stability / bank erosion	X	X		X		X
Buffer Establishment	Runoff treatment, reduce nutrient loading from adjacent land uses, reduce stream temperature	X	X	X	X	X	X
Controlled Burning	Improve floodplain/riparian complexity						
Floodplain Habitat Creation	Improve floodplain/riparian complexity by creating microtopography, vernal pools, oxbows, sloughs, etc.						X
Culvert Removal	Remove channel obstructions	X					
Dam Removal	Remove channel obstructions	X		X		X	
Engineered Logjams	Improve bed-form diversity, improve groundwater/surface water interaction						
Fencing	Improve lateral stability/bank erosion					X	X
Fish Passage Structures	Remove channel obstructions	X					
Floodplain Connectivity	Increases the frequency of overbank flooding and possibly increases attenuation for larger projects. This can include floodplain grading or raising the streambed.						X
Floodplain Grading	Improve floodplain inundation by excavating (lowering) the floodplain.				X	X	
Groundwater Dams	Improve groundwater/surface water interaction by constructing underground dams (e.g., with clay) that increases the elevation of the water table. This technique is most common in mining applications were channels are reconstructed in porous fill material.						
In-stream Structures	Improve lateral stability/bank erosion, improve vertical stability, improve bed-form diversity, improve groundwater/surface water interaction, reduce stream temperature	X				X	X
Levee Removal	Improve floodplain/riparian complexity						
Large Woody Debris Placement	Improve bed-form diversity, groundwater/surface water interaction, substrate complexity, and flow complexity.	X		X	X	X	
Remeandering of Straightened Channel	Improve vertical stability, improve bed-form diversity, improve groundwater/surface water interaction, reduce stream temperature					X	X
Removal of Invasive Species	Improve floodplain/riparian complexity	X	X	X	X		
Riparian Re-vegetation	Improve lateral stability/bank erosion, improve floodplain/riparian complexity	X	X			X	X
Sediment Removal	Improve bed-form diversity					X	
Stormwater BMPs	Runoff treatment, reduce nutrient loading from adjacent land uses	X					
Substrate Addition	Improve bed-form diversity	X				X	

Several SOPs categorized techniques according to the level of benefit they provided. The Kansas SOP, for instance, lists several “possible mitigation activities” in its general guidelines for mitigation, and then explains each type of activity in more detail (Kansas, pp. 4–7). Then, in the section on credit calculation, the Kansas SOP categorizes different techniques according to whether they are substantial, moderate, or minimal stream restoration actions, which is a factor in determining how much credit per linear foot a mitigation project can receive. Little Rock, Missouri and Illinois list techniques in a similar fashion to Kansas, though they each use slightly different categories. Missouri divides mitigation activities into moderate, good, or excellent net benefits, Illinois uses the terms minimal, moderate, good, or excellent, and Little Rock uses moderate, good, and excellent within the category of stream restoration/enhancement.

III. Compensatory Mitigation Methods

The 2008 Rule identifies four permissible compensatory mitigation methods: (1) restoration (reestablishment and rehabilitation); (2) establishment or creation; (3) enhancement; and (4) preservation, which is available under more limited circumstances (Box 1). The Rule has a stated preference for restoration, and identifies enhancement and establishment as the next most-preferred options. Preservation is the least preferred compensatory mitigation strategy.

Box 1: The 2008 Rule Mitigation Method Definitions

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. For the purpose of tracking net gains in aquatic resource area, restoration is divided into two categories: re-establishment and rehabilitation.

> ***Re-establishment*** means the manipulation of the physical, chemical, or biological characteristics of a site with the goal of returning natural/ historic functions to a former aquatic resource. Re-establishment results in rebuilding a former aquatic resource and results in a gain in aquatic resource area and functions.

> ***Rehabilitation*** means the manipulation of the physical, chemical, or biological characteristics of a site with the goal of repairing natural/historic functions to a degraded aquatic resource Rehabilitation results in a gain in aquatic resource function, but does not result in a gain in aquatic resource area.

Establishment (creation) means the manipulation of the physical, chemical, or biological characteristics present to develop an aquatic resource that did not previously exist at an upland site. Establishment results in a gain in aquatic resource area and functions.

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.

Preservation means the removal of a threat to, or preventing the decline of, aquatic resources by an action in or near those aquatic resources. This term includes activities commonly associated with the protection and maintenance of aquatic resources through the implementation of appropriate legal and physical mechanisms. Preservation does not result in a gain of aquatic resource area or functions.

Although the SOPs we reviewed generally authorize all four compensatory mitigation methods identified in the federal regulations, many of them do not have a stated preference for any particular strategy (Table 5). The SOPs indicating explicit preferences for mitigation methods often cite either the 2008 Rule or the National Research Council (NRC) report on compensatory mitigation (NRC, 2001). The Memphis and New York District SOPs, citing the NRC report, state that restoration is preferred over establishment/creation (Memphis, p. 5; New York District, p. 2). Similarly, the New England SOP indicates a preference for restoration, but acknowledges that "good restoration sites can be hard to find in New England" (New England, p. 6). The South Pacific SOP states a general preference for restoration but notes, citing the 2008 Rule, that "in-kind rehabilitation, enhancement, or preservation" are preferred for difficult-to-replace resources (33 C.F.R. § 332.3(e)(3)). According to a recent study, no state policy formally allows stream establishment/creation, though some allow activities that closely resemble creation and several state interviewees said it might be considered in practice (ASWM, 2014).

Table 5: Preferred Mitigation Methods

Techniques	Preferred Mitigation Method		
	No stated preference	Stated preference for restoration	Preservation limited to certain circumstances or only allowed in conjunction with restoration or enhancement
State-specific Guidance			
Georgia			X
Illinois	X		
Kansas	X		
Kentucky	X		
Maryland		X	
Missouri	X		
Montana	X		
New York District		X	
Ohio			X
Pennsylvania			X
Tennessee			X
Virginia	X		
Washington	X		
West Virginia	X		
Wyoming			X
District-Wide Guidance			
Charleston		X	X
Detroit	X		
Fort Worth			X
Galveston			X
Little Rock			X
Memphis		X	
Mobile			X
New England		X	X
Omaha		X	
Philadelphia	X		
South Pacific		X	X
Tulsa		X	X
Wilmington			X

Many SOPs have stated limitations on preservation, allowing it only under certain circumstances (generally those listed in the 2008 Rule, Box 2) and/or in conjunction with restoration or enhancement. For example, the Little Rock SOP only authorizes preservation under the conditions in the federal rules (Little Rock, p. 9). The Wilmington District evaluates proposals that include preservation on a case-by-case basis, and requires documentation supporting the use of preservation in the mitigation plan (North Carolina Interagency Review Team, 2012). The North Carolina guidance on preservation limits the amount of preservation in a mitigation bank or ILF project to 1 credit per 5 linear feet of stream preserved (5:1 ratio). The Norfolk District's Dos and Don'ts document suggests that as a rule of thumb no more than 50 percent of a total project should be preservation. At the state level, just under half of states reported that preservation qualified as a stream mitigation activity (ASWM, 2014).

Box 2: The 2008 Rule Preservation Criteria

Preservation is a permissible method only when five specifically enumerated criteria are met:
(i) The resources to be preserved provide important physical, chemical, or biological functions for the watershed;
(ii) The resources to be preserved contribute significantly to the ecological sustainability of the watershed. In determining the contribution of those resources to the ecological sustainability of the watershed, the district engineer must use appropriate quantitative assessment tools, where available;
(iii) Preservation is determined by the district engineer to be appropriate and practicable;
(iv) The resources are under threat of destruction or adverse modifications; and
(v) The preserved site will be permanently protected through an appropriate real estate or other legal instrument (e.g., easement, title transfer to state resource agency or land trust).

(33 C.F.R. § 332.3(h)(1))

IV. Service Area Requirements

The federal regulations impose few mandatory service area requirements for banks and ILF programs, so the Corps districts and state agencies have substantial discretion in their establishment (Box 3). The 2008 Rule provides examples of possible service areas, such as an 8-digit hydrologic unit code (HUC)[2] in urban areas or multiple contiguous HUC-8 areas or a single HUC-6 area for rural regions (ASWM, 2014). Four of the 10 SOPs that discuss service areas use an 8-digit HUC service area as a starting point, and many SOPs, like that of Omaha, state that any proposal for a larger service area should require a rigorous and ecologically based justification. Of the policies that provide service area guidance, half expressly allow secondary

[2] The U.S. Geological Survey uses a hierarchical system to categorize hydrological features, or units, across the country. Each unit is assigned a unique Hydrologic Unit Code (HUC). There are six different levels of units, which are arranged by size. The more digits are in a HUC, the smaller the corresponding geographic area. Thus, the fewest digits are used for regions and sub-regions, the largest units, and the most digits are used for watersheds and sub-watersheds, the smallest units. Basins and sub-basins fall in between, as follows: 2-digit HUC: first level (region); 4-digit HUC: second level (sub-region); 6-digit HUC: third level (basin); 8-digit HUC: fourth level (sub-basin); 10-digit HUC: fifth level (watershed); 12-digit HUC: sixth level (sub-watershed).

service areas, which are used only if no credits (from banks) are available in the primary service area or if an impact site is not within a primary service area. In the Savannah District, secondary service areas can only be used to offset impacts associated with general permits (NWPs).

Box 3: The 2008 Rule Service Area Provisions

- *Definition*: "the geographic area within which impacts can be mitigated at a specific mitigation bank or an in-lieu fee program, as designated in its instrument" (33 C.F.R. § 332.2)
- Service areas "must be appropriately sized to ensure that the aquatic resources provided will effectively compensate for adverse environmental impacts across the entire service area" (33 C.F.R. § 332.8(d)(6)(ii)(A)).

Not all of the SOPs we reviewed address service area requirements, and few provide extensive guidance on the subject. Montana and Wyoming merely state that regulators will review and approve service areas after receiving a proposal. Little Rock requires that primary service areas be no larger than two adjacent 8-digit HUCs, and Ohio generally requires that primary bank service areas extend only to one HUC-8 area. Ohio's SOP also states that the IRT will consider in-kind replacement, the watershed approach, and proposed location relative to likely impact sites in determining the service area (Little Rock, p. 16; Ohio, p. 15). In Missouri, the largest service area that may be considered for mitigation banks is the Ecological Drainage Unit (Mitigation Banking Instrument Outline for Proposed Mitigation Banks Within the State of Missouri, 2010). Omaha's guidance, which has been superseded in part by the 2008 Rule and subsequent state-specific policies, instructs mitigation banks to propose an 8-digit HUC service area or to include an ecological justification for a larger area (Omaha, p. 13). Maryland requires that bank or ILF instruments describe the proposed service area, which can be based on ecoregions, watersheds, or other geographic areas (Maryland, p. 66). According to EPA, ecoregions are "areas within which ecosystems (and the type, quality, and quantity of environmental resources) are generally similar;" such regions are designed to provide a spatial framework for the assessment and monitoring of ecosystems and their components (EPA Western Ecology Division, Ecoregions. Accessed 2015, http://www.epa.gov/wed/pages/ecoregions.htm). In Georgia, 17 primary service areas have been established, each with an assigned secondary service area. The service areas "were developed to compensate lost aquatic functions associated with permitted impacts to waters to the US within a consistent geographical area where aquatic resources are similar in kind and function" (Georgia Mitigation Banking Guidelines, p. 8 n. 2). They are based in part on HUC-8s but generally cover larger areas. However, affiliated guidance from the Savannah District provides instructions/guidelines for the selection of a mitigation bank from which credits should be purchased within a service area. Criteria include both spatial (i.e. watershed) considerations and functional (i.e. resource type) considerations. The Mobile District uses 8-digit HUC mitigation banking service areas, but allows projects to go outside of this watershed if there are no available mitigation credits in the watershed. Projects that go outside of the watershed must use the district's Proximity Factor Method to determine additional compensation requirements when crossing boundaries (Mobile Proximity Factor Method).

Fort Worth's SOP contains detailed information for service area requirements. It establishes three levels of service area: primary, secondary, and tertiary. Like Ohio, it establishes one 8-digit HUC as the primary service area. The secondary service area is any part of an adjacent 8-digit HUC that is within the same Level III Ecoregion as the bank (using Ecoregions of Texas). Finally, the tertiary service area is any portion of an 8-digit HUC adjacent to the primary service area but in a different Level III Ecoregion than the bank. Furthermore, all service areas must be in the same major river basin, and tertiary service areas must be in an adjacent Ecoregion to the bank (Fort Worth, p. 6). The ratio of mitigation required to amount of impact varies depending on the service area in which an impact is located—a higher ratio is required in the tertiary service area, and a lower in the primary.

The South Pacific Division establishes the HUC-10 as the standard service area, with additional justification required for expanding a service area beyond that. The SOP notes that it may be preferable to expand a service area into a different HUC-8 in the same ecoregion, rather than into the same HUC-8 in an adjacent ecoregion. Secondary service areas may be authorized under certain circumstances, if ecologically justified, and tertiary service areas are generally discouraged. In state-specific guidance for South Carolina, the Charleston district assigns primary, secondary, and tertiary service areas based on location on a case-by-case basis. Primary service areas are bounded using South Carolina Ecoregions and 8-digit HUCS. Secondary service areas may be established in adjacent 8-digit HUCS within the same physiographic province, while tertiary service areas may be established in nonadjacent 8-digit HUCS within the same physiographic province and hydrologic unit sub-regional boundary (Charleston Procedures for Establishment and Operation of Mitigation Banks in South Carolina, p. 8).

V. Site Selection and the Watershed Approach

The SOPs we reviewed include a number of requirements related to site selection, though at least at the state level (Table 6), the ultimate approval of sites takes place on a case-by-case basis most of the time (ASWM, 2014). Many ILF programs and banks also have developed detailed site selection and watershed approach guidance (for the 2008 Rule's definition of the watershed approach, see Box 4), though these were not included within the scope of this paper. A substantial number of the SOPs we reviewed, including Charleston, Fort Worth, Kansas, Montana, New England, Ohio, Omaha, Pennsylvania, Savannah, South Pacific, Tennessee, Tulsa, Wilmington, and Wyoming, appear to expressly authorize both onsite and offsite compensatory mitigation under certain circumstances. For offsite mitigation, regulators generally confine mitigation to within the same watershed as impacts.

Box 4: The 2008 Rule on the Watershed Approach

A watershed approach should be used to establish mitigation requirements "to the extent appropriate and practicable." The purpose and "ultimate goal of a watershed approach is to maintain and improve the quality and quantity of aquatic resources within watersheds through strategic selection of compensatory mitigation sites." (33 C.F.R. § 332.3(b)(6)(c)(1).

As with bank and ILF program service areas, more than half of the SOPs we reviewed use HUCs as the basis of their site selection requirements. With a couple of exceptions, most of the districts that state requirements require or encourage mitigation to occur within the same 8-digit HUC as the project impacts (Charleston, Kansas, Little Rock, Missouri, Mobile, Montana, New England, Savanna, Tulsa, Wilmington, and Wyoming). The exceptions include the Kentucky SOP, which requires 6-digit HUCs, and New York District, which requires 11-digit HUCs. Two other districts (Illinois and Tennessee) require 12-digit HUCs, which correspond to sub-watersheds. A few SOPs (Detroit, Norfolk, and Philadelphia) simply require applicants to provide the applicable HUC in their mitigation plans without specifying a particular requirement. However, Virginia state law requires mitigation banks to be in the same HUC-8 as impacts or an adjoining HUC-8 in the same river basin (VA Code Ann. Sections 62.1-44.15:23).

A small number of the SOPs we reviewed specifically mention ecoregions in their site selection guidance. Ecoregions may allow for more holistic consideration of some ecological functions than do HUCs, because they are based on ecological and biotic factors rather than just hydrologic drainage patterns (Womble and Doyle, 2012). If compensation is intended to comprehensively address aquatic resource functions, including habitat, site selection based on characteristics beyond hydrology and topography may be useful. SOPs that refer to ecoregions generally encourage compensation that occurs close to the project site, although their specific policies differ. The Charleston SOP provides that mitigation sites should be located within the same Level III ecoregion, the same major drainage basin, and the same 8-digit HUC. In addition, the SOP specifically notes that mitigation sites outside the ecoregion are generally not acceptable. New England has a more flexible policy and does not restrict mitigation to the same ecoregion as the project site. However, the distance between the two sites is considered in determining the amount of compensation for a given project, especially if the impact and mitigation sites are located in different HUC-8 watersheds or ecoregions.

Table 6: Site Selection

	HUC	Site Selection Requirements	Ecoregions Considered?
State-Specific Guidance			
Georgia	8-digit	8-digit HUC, offsite	
Illinois	12-digit		
Kansas	8-digit	Onsite, offsite	Yes
Kentucky	6-digit		
Maryland			
Missouri	8-digit		
Montana	8-digit	Onsite, offsite, outside watershed	
Ohio			
Pennsylvania			
Tennessee	12-digit	Within same HUC 8, outside HUC 8, within same HUC 10, within same HUC 12	
Virginia	8-digit	Onsite, offsite, 8-digit HUC required for banks (or adjoining HUC 8 in same river basin) otherwise 8-digit HUC or adjacent preferred	
Washington			
West Virginia			
Wyoming	8-digit	Onsite, offsite HUC 8, offsite HUC 10, outside HUC 8	
District-Wide Guidance			
Charleston	8-digit	8-digit HUC, adjacent 8-digit HUC, drainage basin, case by case	"Mitigation sites should be located within the same Level III eco-region"
Detroit			
Fort Worth			
Galveston			
Little Rock	8-digit	8-digit HUC, out-of-kind	
Memphis			
Mobile	8-digit	8-digit HUC	
New England	8-digit	Onsite, offsite	Yes/Optional
New York District	11-digit		
Omaha		Onsite, offsite	
Philadelphia			
South Pacific		Onsite, offsite	Yes
Tulsa	8-digit	Onsite, offsite	
Wilmington	8-digit	8-digit HUC, streams with similar habitat designations, within same Physiographic Region	Three major ecoregion types

In general, most of the SOPs we reviewed do not address in detail what entails or provide specific instructions on how watershed concerns should influence site selection or mitigation design, especially when watershed plans are absent. Many SOPs require that mitigation plans discuss how watershed concerns influenced site selection or how the mitigation project takes into account watershed concerns and will benefit the watershed. Other SOPs (e.g., New England district, Ohio (state specific), Charleston district, Omaha district, Mobile district, Tulsa district, Detroit) list general site selection criteria, such as current and future hydrology (e.g., available of sustainable water uses), current and future landscape features, adjoining land uses, physical and chemical factors, foreseeable effects of mitigation on ecologically important resources, overall watershed goals, and other features. For example, the SOP for the state of Ohio lists a number of criteria that should be used in site selection, including site channel stability, floodplain connectivity, riparian buffer habitat, substrate and in-stream habitat, faunal assemblage, water chemistry, nutrient enrichment, hydrology, adjacent upstream downstream land use, ownership, relationship to other programs, unique features, hazardous substances, inclusion in land use plan, service area considerations, and relation of bank and ILF service areas to other regulatory criteria (Ohio p. 12). The Wilmington district SOP list general criteria for selecting stream mitigation sites, including preferences for projects on streams with similar habitat designations as impact sites and for sites that have the potential to improve habitat for state or Federally threatened and endangered species (Wilmington, p. 15).

The state-specific SOP for Maryland requires that the mitigation plan "describe how the proposed mitigation is consistent with goals and recommendations for the watershed, as listed in MDE's Priority Areas for Wetland Restoration, Preservation, and Mitigation" (Maryland, p. 73). The Maryland SOP also specifies that lands preferred for mitigation should have the following criteria, "disturbed areas, areas in agricultural production, former wetland areas that may now be degraded, areas adjacent or connected to existing nontidal wetlands, waterways or within the100-year floodplain, and that are accessible to necessary construction equipment." The Memphis and Savannah district SOPs reference the NRC's recommendations for mitigation site selection (i.e., (1) consider the hydrogeomorphic and ecological landscape and climate; (2) adopt a dynamic landscape perspective; (3) pay attention to subsurface conditions, including soil and sediment geochemistry and physics, ground water quantity and quality, and infaunal communities; (4) pay particular attention to appropriate planting elevation, depth, soil type, and seasonal timing; and (5) provide appropriately heterogeneous topography) (NRC, 2001).

A couple of SOPs (e.g., Detroit, Savannah, and Philadelphia) mention that the mitigation plan should describe how the mitigation project will contribute to aquatic resource functions in the watershed. The South Pacific Division SOP requires a watershed overview as part of the description of the site selection process in the mitigation plan. For mitigation projects in a watershed with a watershed plan, a brief description of general watershed condition as well as a description of how the proposed compensatory mitigation site is consistent with restoration priorities identified in the plan is required. For watersheds without a plan, the division requires a general watershed analysis be completed for large projects with substantial impacts (South Pacific Division, p. 32). The SOP also requires the applicant to describe information on landscape setting and position as well as site-specific information.

A few SOPs, such as Kansas and Kentucky, grant additional credit for mitigation work on designated priority watersheds. Wyoming, for one, substantially increases the credit calculation if applicants use a watershed approach, and the SOP for the state of Ohio states that the watershed approach should be considered in service area selection (Wyoming, p. 13; Ohio, p.

15). The Wyoming SOP defines watershed approach as "the applicant/permittee has effectively demonstrated to the Corps that the mitigation site and resource was strategically selected based on local watershed needs and goals (33 CFR 332.2 definition and 332.3(b)) For example, a watershed approach may be demonstrated where a mitigation site addresses an identified priority from a watershed plan, wildlife action plan, or species recovery plan; addresses a TMDL or known source of water quality impairment; restores critical habitat for listed species; and/or improves landscape or ecosystem connectivity" (Wyoming, p 13). The Albuquerque SOP states that it is moving toward a watershed approach (Albuquerque, p. 3).

In 2009 and 2010, the Washington State Department of Ecology published frameworks to guide users in evaluating potential wetland compensatory mitigation sites in the western and eastern portions of the state (Hruby, Harper and Stanley; 2009, 2010). The handbooks include decision trees to help the user to evaluate the ecological functions/values supported by a potential wetland mitigation site and then provide users with specific recommendations based on some consideration of watershed needs and benefits. The tool does not require thorough comparison of the relative ability of many or all potential mitigation sites in the watershed to address watershed needs; instead, a single site or a limited number of sites are considered in the context of watershed stressors and needs.

VI. Determination of Debits

The SOPs we reviewed varied substantially on their guidance for determining debits (Box 5). About half of the SOPs we reviewed provide substantial guidance on debit determination (Table 7),[3] with detailed instructions and relatively standardized methodology, but several others contain little or no guidance on the topic.[4] This is parallel to findings at the state level, in which just over half of the states with state or Corps stream mitigation programs have a procedure for determining debits or credits (ASWM, 2014). Of those that do establish more detailed debit procedures, no one approach predominates, but a few approaches have gained use across several districts. In most, but not all cases, size of the impact, rather than functions impacted, is the main factor in calculating debits.

Box 5: The 2008 Rule's Definition of Debit

"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" (33 C.F.R. § 332.2).

The Illinois, Little Rock, Missouri, Mobile, Montana, Savannah, and Wyoming SOPs provide tables that allow district staff to determine debits by quantifying the impacts to each affected stream reach, based on a set of adverse impact factors (see Figure 3 for an example). These table-based procedures share a basic framework, though the numeric values each district uses vary. The tables generally include the same factors, including stream type (such as ephemeral, intermittent, or perennial), priority area/category (usually primary, secondary, or tertiary), existing condition of the impacted stream,

[3] Charleston, Galveston, Illinois, Kansas, Little Rock, Missouri, Mobile, Montana, Norfolk, Ohio, Pennsylvania, Savannah, Tennessee, West Virginia, and Wyoming.
[4] Detroit, Fort Worth, Kentucky, Maryland, Memphis, New York District, Omaha (Montana & Wyoming are in Omaha district), Philadelphia, Tulsa, Washington, Wilmington.

the duration of the impact, the dominant impact, and the cumulative impacts. The Charleston, Savannah, Illinois, Little Rock, and Missouri SOPs also include type of activity as a factor. The Wyoming SOP also includes special resources and type of loss as factors in its adverse impact table. The Montana adverse impact table is slightly more detailed than the other tables, including factors such as stream status, location of mitigation, comparative stream order of the mitigation site, legal protection on the mitigation site, and mitigation timing. New England's draft SOP uses a similar table, but the only factors on which the amount of debits depends are impacted stream condition, determined by using a visual assessment protocol, and the type of impact (impoundment or dredging, for example). In another example, Nebraska's Stream Condition Assessment Procedure (2012) includes a calculator and stream assessment procedure that allows users to assess impacts and compensation (USACE–Omaha District, 2012). Evaluation factors include Hydraulic Conveyance and Sediment Dynamics, In-stream Habitat/Available Cover, Floodplain Interaction–Connectivity, Vegetation Composition, Riparian Buffer Continuity and Width, and Riparian Land Use: An artificial convention of 100' from the top of each bank.

Each adverse impact factor is assigned a range of multipliers. For example, the Missouri table has three multipliers for the factor "stream type impacted." If the impacted stream is ephemeral, the multiplier is 0.3; if the impacted stream is intermittent, the multiplier is 0.4; and if the impacted stream is perennial, the multiplier is 0.8. In general, for each stream reach, the multipliers for each adverse impact factor are added together to create a total mitigation factor. This number is multiplied by the linear feet of that reach to determine the number of debits from that reach. The process is repeated for each affected reach, and the debit amounts are added together for a total debit amount.

Table 7: Debit Table Factors and Ranges

	Lost Stream Type	Priority Area/ Category	Existing Condition	Duration of Impact	Dominant Impact	Cumulative Impact/Scaling Factor
State-specific Guidance						
Georgia	Intermittent, Perennial (>15 feet wide), Perennial (<15 feet wide). *Debits*: 0.1–0.8	Tertiary, Secondary, Primary. *Debits*: 0.5–1.5	Fully Impaired, Somewhat Impaired, Fully Functional. *Debits*: 0.25–1.0	Temporary (<1 year), Recurrent, Permanent (>1 year). *Debits*: 0.05–0.2	9 impact types with successively greater adverse impact on stream systems *Debits*: 0.05–3.0	If <1000 LF, 0.0-0.2. For impacts >1000 LF, 0.4 for every 1,000 LF.
Illinois	Ephemeral/intermittent, Intermittent with Seasonal Pools, Perennial Streams. *Debits*: 0.1–0.8	Tertiary, Secondary, Primary. *Debits*: 0.1–0.8	Functionally Impaired, Moderately Functional, Fully Functional. *Debits*: 0.2–1.2	Temporary (less than 180 days), Short-term (180 days – 2 years), Permanent (>2 years). *Debits*: 0.05–0.3	Clearing, Utility Crossing/Bridge Footing, Below-grade Culvert, Armor, Detention, Morphological Disturbance, Impoundment, Pipe, Fill. *Debits*: 0.05–2.5	Total linear feet impacted by the project (0.0003 x length of stream impacted).
Kansas	Ephemeral/Intermittent Without Pools, Intermittent w/Pools, Perennial. *Debits*: 0.4–0.8	Tertiary, Secondary, Primary. *Debits*: 0.1–0.8	Functionally Impaired, Moderately Functional, Highly Functional. *Debits*: 0.04–4.0	Temporary (<1yr), Short-term (1-2 yr), Permanent (>2yr). *Debits*: 0.05–0.3	Clearing, Utility Crossing, Below Grade Culvert, Temporary Inundation Zone, Armor, Diversion/Weir, Morphologic, Impound, Pipe, and Fill. *Debits*: 0.05–2.5	0.0003 x length of stream impacted.
Missouri	Ephemeral, Intermittent, Perennial. *Debits*: 0.3–0.8	Tertiary, Secondary, Primary. *Debits*: 0.1–0.8	Functionally Impaired, Moderately Functional, Fully Functional *Debits*: 0.1–1.6	Temporary (<6 months), Permanent. *Debits*: 0.05–0.3	Clearing, Utility Crossing/Bridge Footing, Below-Grade Culvert, Armor, Detention, Morphologic Change, Impoundment, Pipe, Fill. *Debits*: 0.05–2.5	0.0002 per linear foot of impacted stream.
Montana (also comparative stream order, mitigation location, site legal protection, & timing)	Ephemeral, Intermittent, Perennial. *Debits*: 0.2–0.6	High Resource Value, All Others. *Debits*: 0.25–0.75	Impaired, Somewhat Impaired, Fully Functional. *Debits*: 0.25–1.5	N/A	Bank Stabilization (w/ 5 subtypes), Morphologic, Channelization, Impound, Pipe, Fill. *Debits*: 0.2–2.5	<1000 LF (LF x 0.0005), 1001-3000 LF (LF x 0.001), >3000 LF (LF x 0.002)

Tennessee	N/A	High Priority and Standard Priority. *Debits*: 0.3, 0.6	Separate assessment scores for Water Quality, Geomorphology, Riparian Buffer, Aquatic Habitat.		Rip Rap One Bank, Stream Relocation, Rip Rap Lined Channel, Bottomless Culvert, Impoundments/Tail Water, Pipe, Fill. *Debits*: 0.6–2.5	0.2 x total linear feet in 12-digit HUC watershed or same stream reach.
Wyoming	Class 4 (B, A), Class 3 (D, C or B), Class 2 (D, C, A, AB, or B), Class 1. *Debits*: 0.1–2.0	Red Ribbon, Conservation, Blue Ribbon, Wild & Scenic, Threatened & Endangered Species. *Debits*: 0.6–2.0	Non-functional, Deficient, Functional. *Debits*: 0.5–2.0	N/A	Type of Loss: Partial Functional, Functional, Physical. *Debits*: 1.0–6.0	Multiply total length of all stream disturbances (feet) by 0.005.
District-Wide Guidance						
Charleston	Non-RPWs, 1st and 2nd order RPWs (Relatively Permanent Waters), all other streams. *Debits*: 0.1–0.8	Tertiary, Secondary, Primary. *Debits*: 0.1–0.6	Very Impaired, Impaired, Partially Impaired, Fully Functional. Based on functional assessment score. *Debits*: 0.1–1.5	Temporary (<1 year, Recurrent (repeated impacts of short duration), Permanent (>1 year) *Debits*: 0.05–0.3	Armor, Clear, Culvert, Detention/Weir, Fill, Impound/Flood, Morphologic Change, Pipe, Shade, Utility Crossings *Debits*: 0.05–2.5	Between 0.01–1.5 for <6000 linear feet; 3.0 for > 6000 linear feet
Little Rock	Ephemeral, Intermittent, Perennial (with OHWM <15’, 15’-30’, >30’). *Debits*: 0.1–0.8	Tertiary, Secondary, Primary. *Debits*: 0.1–0.8	Functionally Impaired, Moderately Functional, Fully Functional. *Debits*: 0.1–1.6	Temporary (<6 months), Recurrent (repeated impacts of short duration), Permanent. *Debits*: 0.05–0.3	Clearing, Utility Crossing/Bridge Footing, Below-Grade Culvert, Armor, Detention, Morphologic Change, Impoundment, Pipe, Fill. *Debits*: 0.05–2.5	If <1000 LF, 0.0-0.2. For impacts >1000 LF, 0.1 for every 500 LF (example: scaling factor for 5,280 LF of impacts = 1.1)
Mobile	Ephemeral, Intermittent, Perennial. *Debits*: 0.3–1.15	Tertiary, Secondary, Primary. *Debits*: 0.1–0.8	Geomorphologically Stable, Partially Unstable, Unstable. *Debits*: 0.1–1.6	Temporary, Recurrent, or Permanent. *Debits*: 0.05–0.3	Share/Clear, Utility Crossing, Below-Grade Culvert, Armor, Detention/Weir, Morphologic Change, Impoundment, Pipe, Fill. *Debits*: 0.05–2.5	If <1000 LF, 0.0-0.2. For impacts >1000 LF, 0.1 for every 500 LF, max. 2.0.

The SOPs that classify streams as ephemeral, intermittent, or perennial generally assess the most debits for impacts to perennial streams, followed by intermittent streams and ephemeral streams. SOPs (Kansas, for example) that categorize streams as primary, secondary, or tertiary based on the value of the resource affected (whether economic, ecological, or recreational) assess the most debits for adverse impacts to primary streams, fewer debits for impacts to secondary streams, and the fewest debits for impacts to tertiary streams.

These SOPs also assign different debit values based on the type of project impact. Some SOPs recognize more types of impacts than others, although there is substantial overlap among the SOPs. The most commonly identified dominant impacts are clearing vegetation along the stream, utility crossing/bridge footing, below grade culvert installations, streambank and bed armoring, in-channel detention, morphological change or disturbance, impoundment, piping, and in-stream filling.

The West Virginia Stream and Wetland Valuation Metric (WV SWVM) is an example of a more complex table approach. The SWVM includes direct measures of water quality and biological condition in the debit (and credit) calculations. The methodology synthesizes multiple established assessment methodologies (e.g., USEPA Rapid Bioassessment Protocols for Use in Wadeable Streams and Rivers2 (RBP), A Stream Condition Index for West Virginia Wadeable Streams3 (WVSCI), and water quality data utilized by the WVDEP (Water Quality Data Sheet)) to correlate impacts with proposed compensatory mitigation projects. The methodology requires multiple inputs including project specific data (for impacts and proposed compensatory mitigation); stream classification; stream description; the extent of a proposed impact; the form of mitigation (choices are provided in a drop down list); a broad spectrum of physical (using RBP), chemical (using water quality data sheet) and biological indicators (using WVSCI); and other factors including temporal loss and mitigation site protection. The individual assessments are used to indicate the physical, chemical and biological integrity of the site. The SWVM then generates an index score (ranging from 0 (poor condition) to 1.0 (best condition)) that is multiplied by the linear feet to result in a unit score. Unit scores are calculated for the impact site, the mitigation site existing condition, the mitigation site projected upon completion, and the mitigation site projected at maturity. The unit score for the impact site must be less than or equal to the score for the mitigation project at maturity to adequately offset proposed impacts (West Virginia, 2011, p. 3).

The South Pacific Division has developed a mitigation ratios checklist that applies to the Albuquerque, Los Angeles, Sacramento, and San Francisco Districts (South Pacific Division Mitigation Ratios). The checklist provides a methodology to determine a mitigation ratio for compensatory mitigation requirements that incorporates scientific understanding and assessment data if available. The checklist takes into account the location of the impact and mitigation project, net loss of aquatic surface area, the type of conversion, risk and uncertainty, and temporal loss associated with the mitigation site. It allows for the integration of functional assessment data, if available. “Acceptable functional/condition assessment methods must be aquatic resource-based, standardized, comparable from site to site, peer-reviewed, unmodified, and approved by the applicable Corps District” (South Pacific Division Mitigation Ratios). If an approved functional/condition assessment is approved, then a before-after-mitigation-impact (BAMI) spreadsheet is used to determine a baseline ratio.

Figure 3: Example of a Debit Determination Table from the Missouri SOP

<table>
<tr><th colspan="10">ADVERSE IMPACT
FACTORS WORKSHEET</th></tr>
<tr><td>Stream Type Impacted</td><td colspan="3">Ephemeral
0.3</td><td colspan="3">Intermittent
0.4</td><td colspan="3">Perennial
0.8</td></tr>
<tr><td>Priority Area</td><td colspan="3">Tertiary
0.1</td><td colspan="3">Secondary
0.4</td><td colspan="3">Primary
0.8</td></tr>
<tr><td>Existing Condition</td><td colspan="3">Functionally Impaired
0.1</td><td colspan="3">Moderately Functional
0.8</td><td colspan="3">Fully Functional
1.6</td></tr>
<tr><td>Impact Duration</td><td colspan="5">Temporary
0.05</td><td colspan="4">Permanent
0.3</td></tr>
<tr><td>Impact Activity</td><td>Clearing
0.05</td><td>Utility Crossing/ Bridge Footing
0.15</td><td>Below Grade Culvert
0.3</td><td>Armor
0.5</td><td>Detention
0.75</td><td>Morphologic Change
1.5</td><td>Impound-ment (dam)
2.0</td><td>Pipe
2.2</td><td>Fill
2.5</td></tr>
<tr><td>Linear Impact Calculation</td><td colspan="9">0.0002 multiplied by linear feet of stream impact recorded in each column [in subsequent table]</td></tr>
</table>

Source: Missouri, p. 23.

Other SOPs use different debit determination methodologies. The Ohio SOP relies on debit ratios, determining debits by multiplying the number of linear feet of impacts by a set multiplier. In some cases, stream value or type is taken in account when determining how many debits to count per linear foot). For example, the Ohio SOP classifies streams into three categories (groups 1, 2, and 3). Each group contains several types of streams—for example, headwater perennial streams and coldwater streams are both in Group 3—and the SOP provides suggested debit ratios for each type. Except for in the first group, the debit ratio is the same for all of the stream types within a particular grouping; all Group 3 stream types, for example, have a suggested requirement of 3 debits for every linear foot of impact. Unlike the tables used in Illinois, Missouri, and several other SOPs, this approach relies only on the quality of the stream impacted, and does not make more fine-grained distinctions based on the type or duration of impact.

The Pennsylvania SOP (portions of Baltimore, Pittsburgh, and Philadelphia Districts) takes yet another approach. It considers similar factors such as resource quality and condition, size of impact, and intensity of impact, but the approach is more closely focused on aquatic resource functions. Pennsylvania established several functional groups each for rivers, wetlands, and lakes, including hydrologic, biogeochemical, habitat, and recreation or resource support. Each group contains a list of multiple functions with similar attributes, and the categories are designed to capture the main functions of each type of aquatic resource. For each impacted function group four values are determined. First, the project area is calculated. Second, Pennsylvania groups different types of streams into Aquatic Resource Value Categories: significant resource waters, special resource waters, quality resource waters, support resource waters, and minimal resource waters. A table lists criteria for each aquatic resource type, generally with reference to categories established under Pennsylvania statute. Each resource category is assigned a value between 1.0 and 3.0; for example, significant resource waters have a value of 3, while minimal resource waters have a value of 1. Third, a separate table is used to determine the Project Effect Factor, a score between 0.0 and 3.0, with more severe impacts having a greater score. For each function, different potential impacts are grouped according to their severity and the corresponding score: for example, a potential impact to biogeochemical function is elimination of a floodplain's ability to support vegetation. This is categorized as a severe impact, with a Project Effect value of 3.0. A moderate impact, to the recreational function, would be a limited and temporary loss of or interference with recreational use, with a Project Effect value of just 1.0. Fourth, the condition of the resource is assessed, using Pennsylvania's rapid assessment protocols for waterways, lakes, and wetlands, and given a score between 1.0 and 0.0.

Under the Pennsylvania process, for each function group, the compensation requirement, or debits, is the product of the four factor scores. In other words:

Compensation Requirement (CR) = AI x PE x RV x CI, where

CR = Compensation Requirement
AI = Area of Impact (in acres, 0.00)
PE = Project Effect Factor (Table 3)
RV = Resource Value (Table 4)
CI = Condition Index Value (0.00) (from applicable resource condition assessment)

Source: Pennsylvania, p. 21

The calculation is repeated for each impacted function and the score totaled for the overall debit amount. Galveston uses a similar process to calculate debits, though its methodology does not determine the effect for each function separately. In Galveston, the debits are the product of the projected change in resource condition, multiplied by an impact factor score between 1 and 5 that likewise depends on the intensity of impact, multiplied by the linear feet of impact.

Cumulative impacts

Twelve of the SOPs include some way to account for the cumulative impact of permitted activities on streams: Charleston, Illinois, Kansas, Little Rock, Missouri, Mobile, Montana, Pennsylvania, Savannah, South Pacific, Tennessee, and Wyoming. Many of the districts using the table approach shared by Charleston, Savannah, Illinois, Missouri, and others use linear or cumulative impact as a numeric factor that is added into the total debit multiplier number (Table 6). For example, in Kansas, the cumulative impact factor is the overall length of impact in feet multiplied by 0.0003; the resulting amount is added with the other factors to create the overall debit multiplier. In Pennsylvania, cumulative impact (as measured by overall linear footage of project impact) is one of the criteria for assessing project effect on the recreation/resource support function group: a project with more than 2,000 feet of total impact will have a "severe" effect on that function group, a project with between 1,000 and 2,000 feet will have a "moderate" effect, and so forth. The South Pacific division SOP does not have a quantitative way to account for cumulative impact, but it does explain that the landscape and cumulative impacts should be taken into consideration, stating as an example that "if an action's impacts, when considered in the context of impacts of past, present, and reasonably foreseeable actions, could exceed a scientifically based threshold for the watershed (such as watershed impervious cover of 10 percent, exceedance of which research in many parts of the country has shown leads to a decline of most stream quality indicators), additional compensatory mitigation for the action's incremental impacts may be required" (p. 13).

VII. Determination of Credits

The SOPs we reviewed vary considerably in their treatment of credits (Box 6), as they did with debits. Roughly one-third[5] of the SOPs include credit determination tables and/or worksheets,[6] whereas the other two-thirds contain little or no guidance about how to determine credits.[7] The credits granted are generally not a direct measurement of function gained, but instead are calculated and awarded on a linear-foot basis.

The Charleston, Illinois, Kansas, Little Rock, Missouri, Mobile, Montana,[8] Savannah, Tennessee, and Wyoming SOPs provide credit tables that identify mitigation factors, along with multipliers for each factor (Table 8, see Figure 4 for example). These tables operate essentially the same as the debit determination table method shared by most of these SOPs. The tables are generally similar to each other, although there are some differences among the factors and multipliers, and the terminology occasionally differs. In addition, some of the SOPs include factors relating to riparian buffers in their credit tables, while others include separate buffer tables. (Buffer credit determinations are discussed in Part VI below.).

Box 6: The 2008 Rule's Definition of Credit

"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" (33 C.F.R. § 332.2).

The Charleston, Illinois, Kansas, Little Rock, Missouri, Mobile, Savannah, Tennessee, and Wyoming credit determination tables include at least some of the following factors: stream type, (e.g., ephemeral, intermittent, or perennial), priority area/category (e.g., primary, secondary, or tertiary), existing condition of the stream, net benefit (e.g., minimal, moderate, good, or excellent), monitoring/contingency (e.g., Level I, II, or III; higher levels require more monitoring and thus generate more credits), site protection (e.g., deed restriction, conservation easement), mitigation construction timing/timing of mitigation (e.g., before, during,

[5] Charleston, Galveston, Illinois, Kansas, Little Rock, Missouri, Mobile, Norfolk, Montana, Ohio (which includes part of Buffalo, Pittsburgh, & Huntington districts), Pennsylvania (which includes part of Baltimore, Pittsburgh, & Philadelphia districts), Savannah, Tennessee, and Montana and Nebraska (both of which are part of Omaha), and West Virginia (parts of Huntington & Pittsburgh districts).

[6] The Kentucky SOP includes an example calculation for a single factor, but no comprehensive table.

[7] Detroit, Fort Worth, Kentucky, Maryland, Memphis, New England, New York District, Omaha, Philadelphia, Tulsa, Washington, West Virginia, and Wilmington. However, Fort Worth's Stream Mitigation Method (2013) identifies three categories of stream mitigation - ephemeral, intermittent, and perennial (each with five alternatives) - that are evaluated sequentially to ensure an appropriate level of compensatory mitigation for stream function is achieved for each permit. Mitigation banks (and future ILF programs) may generate appropriate credits for each of these categories by submitting data to demonstrate the extent to which ecological lift has been derived from in-channel or riparian buffer work.

[8] The Montana credit tables combine in-stream and riparian buffer work and will be discussed in the buffer section (Part VI).

or after impacts; the earlier mitigation takes place, the more credits it will generate), location of mitigation (e.g., in the same 8-digit HUC as the impacts, or outside the 8-digit HUC), and temporal lag or loss (the time needed for the mitigation site to fully replace the functions that were lost at the impact site). As with its debit method, New England uses a simplified credit calculation table, taking into account the mitigation technique used and the condition of the mitigation stream site.

For each factor, the tables include a range of categories with different multipliers. For example, the Kansas table has three multipliers for the factor "net benefit," with lists of the mitigation activities that fall under each level. If the net benefit is minimal, the multiplier is 1.0; if the net benefit is moderate, the multiplier is 2.0; and if the net benefit is substantial, the multiplier is 3.5. As with the debit determination process used by most of these districts or states, the multipliers for each credit factor are added together to create a total mitigation factor for each reach or mitigation project. This number is multiplied by the linear feet of that reach to determine the number of credits. The process is repeated for each reach or mitigation type within the project, and the credit amounts are added together for a total credit amount for the mitigation project.

Table 8: Credit Table Factors and Ranges

	Net Improvement/ Benefit	Priority Area/ Category	Control/Site Protection	Credit Schedule/ Construction Timing	Kind/Stream Type	Location	Monitoring
State-specific Guidance							
Georgia	Streambank stabilization, Structure removal, Priority 4 Restoration, Priority 3 Restoration, Priority 1-2 Restoration. *Credits*: 1.0–8.0	Tertiary, Secondary, Primary. *Credits*: 0.05–1.0	Restricted covenant on restored channel and 25' buffer (Required), Required RC & conservation easement or government/public protection, or all three protections. *Credits*: 0.1–0.5	Schedule 3, 2 (required for banks), or 1. *Credits*:	N/A	N/A	Minimal, Moderate, Substantial, Excellent levels of monitoring rigor. *Credits*: 0.0–1.0
Illinois	Minimal, Moderate, Good, Excellent. *Credits:* 1.0–3.5	Tertiary, Secondary, Primary. *Credits:* 0.05–0.4	Deed restriction, Conservation easement/title transfer. *Credits:* 0.1–0.4	Mitigation after impacts, Concurrent with impacts, Before impacts. *Credits:* 0–0.3	N/A	N/A	Level I, II, or III. *Credits:* 0.1–0.25
Kansas	Minimal, Moderate, Substantial. *Credits*: 1.0–3.5	Tertiary, Secondary, Primary. *Credits:* 0.05–0.4	Site protection w/o third party OR Site protection w/ third party grantee or transfer of title to a conservancy *Credits:* 0.05–0.2	Schedule 1 (prior to impacts), 2 (at least 75% completed prior to and/or concurrent with impacts), 3 (less than 75% completed prior). *Credits*: 0–0.15	Ephemeral/intermittent w/o pools, Intermittent w/ permanent pools, or Perennial. *Credits*: 0.05–0.4	N/A	N/A
Missouri	Stream relocation to accommodate authorized project, Moderate, Good, Excellent. *Credits*: 0.5–3.5	Tertiary, Secondary, Primary. *Credits*: 0.05–0.4	Site protection w/o third party grantee OR Site protection w/ third party grantee or transfer of title to a conservancy. *Credits*: 0.1–0.4	Schedule 1 (80-100% mitigation before impacts), 2 (50-80% before or concurrent with impacts), 3 (<50% before or concurrent with impacts). *Credits*: 0–0.3	Ephemeral, Intermittent, Perennial. *Credits*: 0.15–0.4	For permittee-responsible mitigation, reduce overall credit by half if outside HUC-8 or out-of-kind.	N/A

Tennessee	Mitigation score – existing condition score = change in value	Standard or High. *Credits*: 0.3–0.6	Non-third party or Third party. *Credits*: 0.1–0.4	Schedule C (prior to impacts), B (75% of mitigation prior to impacts), A (less than 75% prior to impacts). *Credits*: 0–0.3	N/A	Outside HUC 8, W/in same HUC 8, W/in same HUC 10, w/in same HUC 12. *Credits*: 0–0.3	N/A
Wyoming	Minimal (improvements to buffer or other select function rather than stream as a whole), Moderate (deficient to functional or nonfunctional to deficient), Substantial (nonfunctional to functional). *Credits*: 1.0–5.0	Red Ribbon, Conservation, Blue Ribbon, Wild & Scenic, T&E Species. *Credits*: 0.6–2.0	Deed restriction, Permittee easement, Agency-owned, Conservation easement, Fee title *Credits*: 0.5–5.0	Schedule 3 (after impacts), 2 (concurrent), 1 (prior to impacts). *Credits*: -1.5–4.0	Class 4 (B, A), Class 3 (D, C or B), Class 2 (D, C, A, AB, or B), Class 1. *Credits*: 0.1–2.0	Outside watershed, Off-site HUC 10, Off-site HUC 8, On-site. *Credits*: -1.0–0.4	N/A
District-Wide Guidance							
Charleston	Minimal, Moderate, Significant, Maximum. *Credits*: 0.5–3.0	Tertiary, Secondary, Primary. *Credits:* 0.05–0.3	N/A	N/A, mitigation after impact, concurrent with impact, before impact. *Credits:* 0–0.1	Non-RPWs, 1st & 2nd Order RPWs, All Other Streams. *Credits:* 0.05–0.2	Case by case, Drainage basin, Adjacent HUC, 8-digit HUC. *Credits:* 0–0.1	N/A
Little Rock	Relocation, Preservation (moderately or fully functional), Restoration/Enhancement (four sub-levels). *Credits*: 0.1–4.0	Tertiary, Secondary, Primary. *Credits*: 0.05–0.4	Deed restriction/restrictive covenant or Third party easement and monitoring. *Credits*: 0.1–0.4	Schedule 1 (mitigation before impacts), 2 (majority concurrent with impacts), 3 (majority after impacts). *Credits*: 0–0.3	N/A	N/A	Levels I, II, III. *Credits*: 0.05–0.5
Mobile	Relocation, Enhancement, or Restoration. *Credits*: 1.0–4.5	Tertiary, Secondary, Primary. *Credits*: 0.05–0.4	N/A	Mitigation before impact, during impact, or after impact. *Credits*: 0–0.15	Ephemeral, Intermittent, Perennial (<15’, 15-30’, 30’-50’, >50’). *Credits*: 0.2–1.3	N/A	N/A

Some factors appear in only one or two of the tables. For example, aquatic or in-stream habitat is included in the Mobile and Tennessee tables. Savannah addresses macro-invertebrates and fish IBI scores in its performance metrics. Mobile uses a range of four scores for in-stream habitat based on a stream reach assessment and comparison to a reference reach, taking into account the number of habitat types available and other factors. The Mobile table includes a Bank Erosion Hazard Index (Rosgen, 2001) as a factor measuring streambank stability, for stream enhancement projects only. Other districts like Wilmington and Norfolk also have Bank Erosion Hazard Index performance standards. The Wyoming table includes a special resources factor, which is similar to the priority area/category factor (that is, mitigation activities in more highly valued waters, like designated Wild and Scenic Rivers, generate more credits). Wyoming also awards an extra 1.5 credits per linear foot if a project uses a watershed approach, meaning that it demonstrates that it has strategically selected or designed mitigation based on watershed needs. This may involve, for example, addressing "an identified priority, resource and location from a watershed plan, regional wildlife action plan, or species recovery plan; or improve a TMDL or known source of water quality impairment" (Wyoming, p. 13).

The SOPs include various methods to determine the appropriate level of "net benefit" or improvement. Relatively few of these attempt to link functional lift to the amount of credits generated, and several require changes to dimension, pattern, and profile. In Missouri, Kansas, Illinois, and Little Rock, as discussed above, the level of benefit depends on the mitigation activities and techniques used. When an activity addresses multiple functions on a larger scale, it is likely to provide a higher net benefit, and therefore generate more credits. So, for example, the Kansas SOP indicates that "[c]reating or re-connecting floodplains adjacent to streams artificially disconnected from their floodplain" would generally count as "substantial" restoration, whereas "[c]onstructing fish ladders or other fish passage structures where appropriate" would be only "moderate" restoration. However, these four SOPs do not clearly measure or estimate the functional lift associated with each technique. They generally say that the Corps will assess the credit/debit analysis on a case-by-case benefit but do not say how the Corps will do so. Little Rock specifies that restoration should include restoring appropriate pattern, dimension, and profile. In Missouri, Kansas, and Illinois, however, changes to dimension, pattern, and profile are not necessarily required.

Mobile and Savannah both assign different levels of net benefit based on the mitigation method. In the Mobile SOP, different benefit levels are assigned to relocation, enhancement, and restoration, with changes to dimension, pattern, and profile required for restoration and changes to at least one of those factors required for enhancement. Savannah uses streambank stabilization, structure removal, and four levels of stream channel restoration or relocation to categorize net benefit. Like Mobile, Savannah states that restoration should involve changes to dimension, pattern, and profile. It determines the level of restoration or relocation according to the changes in Rosgen stream classification. If mitigation activities do not involve "direct manipulation of a length of stream," like retrofitting stormwater facilities, the Savannah Corps will determine the net benefit case-by-case.

Wyoming's SOP instructs applicants to use an assessment method to calculate anticipated benefit, but it does not specify a particular method, instead suggesting multiple potential assessment methods. Fort Worth and Tulsa districts use the Texas Rapid Assessment Method (TXRAM) to evaluate ecological conditions and assess potential stream impacts. Charleston and Tennessee also appear to calculate net benefit based on assessment methodologies. Charleston uses a functional assessment, and the score from the assessment is converted to one of four levels of net benefit. Tennessee uses the Tennessee Stream Mitigation Assessment to produce scores in four categories: water quality, geomorphology, riparian buffer, and aquatic habitat. The anticipated change in scores at the site between pre- and post-mitigation is factored directly into the crediting worksheet. Tennessee therefore incorporates some functional considerations, but is still based on the basic methodology of assigning a certain number of credits per linear foot of mitigation.

Figure 4: Example of a Credit Determination Table

Mitigation Measures (Credits)

Factors	Multipliers			
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 title to a conservancy 0.4		
Credit Schedule	Schedule 1 0.3	Schedule 2 0.1	Schedule 3 0	

Source: Missouri, p. 24.

The Ohio and Pennsylvania SOPs include credit tables as well, but these tables (like their debit tables, discussed in Part IV.b, *supra*) are structured differently from the other tables. The Ohio SOP credit table, like the debit table, operates on ratios. It divides mitigation into four types: restoration/enhancement, preservation, buffer work, and extra buffer efforts. The SOP also identifies different activity levels within each mitigation type. A different credit ratio is provided for each activity level. The ratios are defined as upper limits on the number of credits that may be generated per linear foot for a particular type of mitigation and a particular activity level. For example, rehabilitating a buffer has a credit ratio of up to 1.4 credits per linear foot. The ratios vary widely depending on the activity level, from 16 linear feet of mitigation per credit to 0.5 linear feet per credit.

The Pennsylvania SOP credit method, like its counterpart for debits, requires resource condition assessment protocols and calculates credits for different functions separately. As with the debit process, the expected credit amount for a mitigation project is the product of four factors, measured separately for each functional group: the area of the project, the resource value, the compensation value, and the condition index differential. The resource value is calculated from the same table used in the debit process. Compensation Value is a score between 1.0 and 3.0, based on a level of benefit (extensive, moderate, limited, or minimal). This score may be adjusted upward if the project involves conservation of the surrounding area, subject to certain conditions, or if the project addresses impairments for which a Total Maximum Daily Load (TMDL) exists. Finally, a condition index differential is calculated based on the difference between a resource's existing condition and projected condition after mitigation, using assessment protocols. As defined in the SOP:

> Functional Credit Gain (FCG) = AP x RV x CV x CIdiff
>
> **FCG** = Functional Credit gain
> **AP** = Area of Project for applicable function group (in acres, 0.00)
> **RV** = Resource Value (Table 4)
> **CV** = Compensation Value (Table 5)
> **CIdiff** = Condition Index Differential Value (0.00)
>
> Source: Pennsylvania, p. 23

The West Virginia Stream and Wetland Valuation Metric (WV SWVM) is also an example of a more complex table approach to credit determination. As described above, the methodology synthesizes multiple established assessment methodologies (e.g., USEPA Rapid Bioassessment Protocols for Use in Wadeable Streams and Rivers2 (RBP), A Stream Condition Index for West Virginia Wadeable Streams3 (WVSCI), and water quality data utilized by the WVDEP (Water Quality Data Sheet)) to correlate impacts with proposed compensatory mitigation projects. See also the South Pacific Division mitigation ratio checklist discussed above.

Temporal Loss

All but nine of the reviewed SOPs in some way address temporal loss, whether with regard to in-stream work, buffer vegetation, or both. For in-stream work, temporal loss generally refers to the temporary loss of function that results when mitigation takes place after the permitted impacts rather than before. In SOPs, this is often called mitigation "timing" or "credit schedule" rather than temporal loss (In reviewing the SOPs for this topic, we performed a keyword search for "temporal," "timing," and "schedule"). Some SOPs (Detroit, Memphis, New York District, and Philadelphia) discuss this only generally, stating that permit applicants must describe the timing of mitigation construction in their work plan and explain the need for any lag between impact and mitigation. West Virginia counts this temporal loss as a factor in its valuation metric. Others account for mitigation timing as a factor in their credit (and for Montana, debit) tables, assigning different numerical factors depending whether mitigation construction takes place primarily before, concurrent with, or after permitted impacts. Montana considers in its debit table whether the mitigation takes place before, during, or after adverse impacts, and assigns corresponding debit factors of 1, 1.25, and 1.5. The credit values and categories for this type of temporal loss are in Table 7.

VIII. Buffer Credits

The federal regulations allow Corps districts and states to require buffers as part of a compensation project, but do not require them to do so (Box 7). The SOPs exhibit considerable variation in their treatment of buffers. Many SOPs authorize credits for restoration, enhancement, or preservation of buffers, and they determine the number of buffer credits generated using separate credit tables (Table 9).[9] In general, credits are based on buffer size (that is, X number of credits are generated per feet of buffer, based on a required buffer width such as 100 feet on both sides of the stream channel). Often the type of mitigation activity influences the amount of buffer credits that are generated. Buffer preservation generates the fewest number of credits, and restoration typically generates the most.

Box 7: The 2008 Rule Buffer Requirements

- *Buffer:* "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" (33 C.F.R. § 332.2).
- "District engineers may require the restoration, establishment, enhancement, and preservation, as well as the maintenance, of riparian areas and/or buffers around aquatic resources where necessary to ensure the long-term viability of those resources. Buffers may also provide habitat or corridors necessary for the ecological functioning of aquatic resources. If buffers are required . . . compensatory mitigation credit will be provided for

Districts that authorize buffer credits often impose minimum and maximum width requirements. Most of the reviewed SOPs that included these policies require a minimum buffer width of 50 feet. A minority requires a minimum width of 25 feet. Wilmington sets different minimums depending on the ecosystem, with a minimum of 30 feet for mountain streams and 50 feet for piedmont/coastal plains streams. Galveston has a minimum of 100 feet per side or a total minimum of 200 feet with each side at least 25 feet. Requirements for maximum buffer width vary more widely, ranging from 100 to 300 feet (with 300 feet being the most common). Two SOPs (Little Rock and Tulsa) allow up to 100 feet, Ohio allows up to 150 feet, except on a case-by-case basis, and two SOPs (Mobile and Savannah) allow up to 200 feet. Four SOPs (Charleston, Illinois, Kansas, and Missouri) allow up to 300 feet.

[9] Charleston, Galveston, Illinois, Kansas, Little Rock, Missouri, Mobile, Ohio, Savannah, Tulsa.

Table 9: Buffer Credit

SOP	Minimum Width (Ft)	Maximum Width (Ft)	Buffer Credit (Credits/Ft)		
			Restoration	Enhancement	Preservation
State-specific Guidance					
Georgia	50	200	0.1 to 2.0	0 to 0.4	0 to 0.3
Illinois	25	300	0 to 2.4	0 to 0.95	0 to 0.65
Kansas	50	300	0.16 to 0.56	0.08 to 0.28	0.04 to 0.14
Missouri	50	300	0.5 to 1.1	0.25 to 0.55	0.13 to 0.27
Ohio	50	150	Up to 0.25 (reestablishment)	Up to 0.125 (rehabilitation)	Up to 0.0625
Virginia**	100	200 (work beyond 100 credited less)	0.2 to 0.4 (reestablishment)	0.15 to 0.38 (planting)	0.07 to 0.14 per percent area
District-Wide Guidance					
Charleston	50	300		0.2 to 0.39	0.075 to 0.2
Galveston	100/side, or 200 total with both >25	200 (work between 100-200 credited less)	0.5	0.25 to 0.5 (planting)	0.05 to 0.1
Little Rock	25	100	0.4 to 1.6	0.2 to 0.8	0.1 to 0.4
Mobile*	50	200	0.4 to 1.6	0.2 to 1.2	0.1 to 0.4
Tulsa	50	100			
Wilmington	30-mountain/ 50-piedmont				

* Buffer requirements variable based on stream type

** Smaller or wider buffers require approval

The Illinois, Kansas, Little Rock, Missouri, Mobile, and Savannah SOPs include buffer credit tables that generally operate like the standard credit tables do, with a range of numerical values for different factors that contribute to an overall number of credits per linear foot. They include some of the same factors as the standard credit tables do, such as stream type, priority area/category, existing condition, net benefit, monitoring, location, and mitigation timing.

Montana takes a different approach. It includes a buffer credit table with buffer-specific factors depending on the mitigation activities conducted, such as removing buffer disturbances, fencing buffers, revegetating riparian buffers, managing invasive species, and others. Available credits are the same (0.05 to 1.0) for each mitigation approach (restoration, enhancement, or preservation). The possible credits are contingent on stream status (primary, secondary, or tertiary), rather than mitigation approach, as shown in Figure 5.

Figure 5: Montana Buffer Credit Table

	Factors	Multipliers
a	Buffer Width	Width of Riparian Buffer Preserved ÷ 100
b	Remove Disturbance to Riparian Buffer	0.5
c	Fence around Buffer	0.5
d	Re-vegetate Riparian Buffer	1.0 x % of buffer re-vegetated
e	Micro Topography in Floodplain	0.5
f	Addition of Woody Debris in Floodplain	0.5
g	Management of Invasive Species	0.5
h	Removal of Riprap Below Ordinary High Water	1.0 X % of Riprap removed
i	Removal of Floodplain Fill (Berms or Impervious Materials)	1.0 X % of fill removed
j	Restoration of Channel Morphology	1 (both sides will earn 1 as a multiplier)

Source: Montana, p. 5

Finally, the Ohio SOP approaches buffer credits slightly differently by setting up a two-tiered system. For buffer work out to 50 feet from the top of the bank on each side of the stream channel, Ohio provides credit for reestablishment and rehabilitation. For work between 51 and 150 feet from the bank, Ohio provides credit for reestablishment, rehabilitation, and preservation, but only if the buffer is permanently protected through a legal real estate instrument. Buffer work between 51 and 150 feet from the bank receives less credit than work within the first 50 feet does.

Many of the same SOPs that consider loss from mitigation construction timing also consider temporal loss (or "temporal lag") in riparian vegetation, accounting for the lag between the lost function at the impact site and the maturity of new buffer vegetation at the mitigation site. This appears as a factor in buffer credit tables for Illinois, Kansas, Little Rock, and Missouri, and as a factor in the combined stream credit table for Tennessee. For all of these SOPs, temporal loss is broken down into four categories: 0-5 years, 5-10 years, 10-20 years, or more than 20 years. The credit multiplier values range from 0 to -0.3. Illinois, Mobile, and Savannah include not only temporal loss but also mitigation construction timing as two separate factors in their buffer credit tables. West Virginia incorporates temporal loss to buffer vegetation into its valuation metric.

IX. Credit Release Schedules

Only a few of the SOPs we reviewed include credit release schedules, though often credit release schedules are included in specific operating agreements for ILF programs and banks (Box 8). A few other SOPs mention, but do not specifically establish, credit release schedules (Table 10).

Box 8: The 2008 Rule Credit Release Provisions

- Mitigation banking credits may not be "released for debiting until specific milestones associated with the mitigation bank site's protection and development are achieved" (33 C.F.R. § 332.3(b)(2)).
- Using a phased credit release schedule can "help reduce risk that mitigation will not be fully successful" (33 C.F.R. § 332.3(b)(2)).
- Mitigation bank draft instruments and ILF program project plans must include a credit release schedule, subject to approval by the District Engineer (33 C.F.R. § 332.8(d)(6)(iii)(B), (j)(1)).
- Credit release schedules must be tied to performance-based milestones, and a "significant portion" of the credits must be reserved until the ecological performance standards have been met (33 C.F.R. § 332.8(o)(8)).

Table 10: Credit Release Schedules (percentages)

	State-specific Guidance		District-Wide Guidance			
	Virginia	**Georgia (Financial Assurance Schedule #2)**	**Fort Worth***	**Mobile**	**South Pacific**	**Wilmington**
Initial Release	15	10	30	20	15 (bank establishment)	15 (bank site establishment)
As-Built/ Construction	10	10 beginning, 10 end	10	10	25	15 (bank) 30 (ILF) (Completion of all initial physical and biological improvements)
Bankfull event 1 (BFE)				20		
BFE 2				30		
2 BFEs			10			
Year 1	10, 25 if BFE	10				10 (bank) 10 (ILF)
Year 2	10, 25 if BFE	10	10		15	10 (bank) 10 (ILF)
Year 3	10, 25 if BFE	10	10		15 (plus WOUS determination)	10 (bank) 10 (ILF)
Year 4	10, 25 if BFE	10			15	5 (bank) 5 (ILF)
Year 5		5	10	10	15 (plus WOUS determination)	10 (bank) 10 (ILF)
Year 6		5				5 (bank) 5 (ILF)
Year 7						10 (bank) 10 (ILF)
Final	25 for each BFE	20	20	10		

*Complete (75% or more) channel restoration only

The Fort Worth SOP provides two similar credit release schedules depending on the extent of stream restoration work. For a complete channel restoration, where 75% or more of the channel needs reconstruction, 30% of credits are released when initial success criteria are met, and another 10% are released after planting and construction. Thus, 40% of the credits are released before monitoring has taken place. An additional 10% of the credits are released in the second year, the third year, and the fifth year of monitoring, depending on the results of a functional or conditional assessment (for a total of 30%). Thus, after five years of monitoring, at least 70% of the credits have been released. When the project survives through two bankfull events at least one year apart, another 10% are released. The final 20% are released after the second bank full event occurs and the long-term management non-wasting endowment is funded. When channel restoration is only partial, a similar schedule applies with slightly different percentages at each stage.

The Mobile SOP provides that 20% of credits are released for an approved MBI, conservation easement, financial assurance, and approval of the final, detailed stream channel restoration design plans. An additional 10% of the credits are released when site preparation and earthwork or hydrology work related to the stream buffer and channel is complete. An additional 20% of the credits are released following the first successful bankfull event, while another 30% of the credits are released following the second successful bankfull event. An additional 10% of the credits are released after the fifth year of successful bank stability and riparian monitoring, and the final 10% of the credits are released upon completion of monitoring (around year 10).

Virginia's mitigation bank instrument template makes a large portion of credit releases contingent on meeting success criteria. It sets out different schedules for streams, wetlands, and buffers. For all categories, an initial 15% release will be approved after satisfaction of initial legal and planning criteria, including mitigation banking instrument approval, financial assurances, and long-term management plan submission. At this stage, 100% of stream buffer preservation credits can be released. For stream restoration or enhancement projects, credit release is heavily dependent on bankfull events. After the initial release, the remaining 85% are released as follows:

- 10% after construction is completed.
- 10% each year for the first four years of monitoring, if success criteria are met and no bankfull event occurred that year.
- 25% each year for the first four years of monitoring, if success criteria are met *and* a bankfull event occurred that year (not to exceed 100% total).
- After the fourth year of monitoring, no credits unless a bankfull event occurs, and then 25% for each year with a bankfull event until all credits are released.

Savannah's credit release schedules, like those in Virginia, are closely tied to fulfillment of performance standards. Savannah sets out three separate schedules depending on the amount of financial assurances required. The Corps decides on a case-by-case basis which schedule will apply, looking at the bank's experience and track record as well as its financial status. The guidelines state explicitly that the Corps will suspend credit releases if performance standards are not being met, and (as discussed later in this paper), the amount of credits released within a given period is in part dependent on how many performance standards have been met. For all three schedules, 20% of credits are reserved until the monitoring period concludes.

The South Pacific Division's recommended credit release schedules similarly tie 60% of credits to the achievement of performance standards. The first 15% and 25% are released when the bank is established and an as-built drawing submitted, respectively. The remaining 60% are released in 15% increments at attainment of the two, three, four, and five-year performance standards, with a verified jurisdictional determination at years three and five (California Mitigation Bank Enabling Agreement Template).

A few of the SOPs we reviewed refer to credit release schedules, but do not actually establish a schedule. The Ohio SOP is the most informative: it includes a detailed sample credit release schedule, but nonetheless emphasizes that "Independent credit release schedules will be required for each site mitigation plan" (Ohio, p. 24). The other SOPs are significantly less detailed. For example, the Maryland SOP simply provides that a complete Mitigation Banking Instrument must include a credit release schedule that is linked to the achievement of specific milestones (Maryland, p. 66). Kansas allows up to 20% of credits to be released upon MBI approval, with further credits released upon achievement of performance standards (Kansas 2015, 10). Finally, the Illinois SOP states that the IRT will determine the release of credits on a case-by-case basis (Illinois, p. 14).

X. Performance Standards

As with credit release schedules, the federal regulations leave substantial discretion to Corps districts and states in developing performance standards. In a review of regulatory documents from thirteen states and Corps districts, Doyle *et al.* analyzed geographic variation in performance standards and trading ratios in stream mitigation policies across the country (2013). They concluded that jurisdictions typically did not require extensive success criteria for projects, and that there was a complex relationship between success criteria and monitoring requirements. Most states and districts reviewed by Doyle *et al.* employed specific performance standards for riparian buffers and physical criteria, such as streambank stability (2013). However, they generally did not require in-stream chemical or biological performance standards, or they did so on a case-by-case basis. Monitoring requirements, the study found, often went beyond performance standards.

A large number of the SOPs (individual as well as collective documents) we reviewed do not mention performance standards at all. Other SOPs include general language about performance standards, but do not provide specific examples. A few provide examples of performance standards for wetlands, such as measures of hydrology

Box 9: The 2008 Rule Performance Standard Requirements

- *Definition:* "observable or measurable physical (including hydrological), chemical and/or biological attributes that are used to determine if a compensatory mitigation project meets its objectives" (33 C.F.R. § 332.2(a)).
- Must be included in mitigation plans
- Should relate to the objectives of the mitigation project and "must be based on the best available science that can be measured or assessed in a practicable manner" (33 C.F.R. § 332.5(a)-(b))
- "may be based on variables or measures of functional capacity described in functional assessment methodologies, measurements of hydrology or other aquatic resource characteristics, and/or comparisons to reference aquatic resources of similar type and landscape position" (33 C.F.R. § 332.2(b))

or vegetation (e.g., species diversity required), but do not provide detailed information about performance standards for streams. Finally, a handful of SOPs, or associated mitigation banking templates, among those we reviewed, provide detailed information and specific examples of performance standards for streams, which may serve as models for others.

SOPs that include general language on performance standards essentially track the language in the 2008 Rule (Box 9), without providing additional guidance. These SOPs explain that such standards are used to determine whether a project is satisfying its objectives. In all cases, performance standards should be objective, verifiable, meaningful, achievable, and enforceable. They should also be clear, precise, and quantifiable. Various measures may be used to help develop performance standards. The standards may be based on measures of functional capacity, or on measures of hydrology or other aquatic resources (e.g., vegetation, fauna, or soil), or they may be based on comparisons to reference aquatic resources.

Only a small number of the SOPs we reviewed provide specific examples of performance standards for streams. Consistent with the work of Doyle *et al.*, our review indicates that performance standards (alternately referred to as success criteria) in formal guidance primarily focus on physical criteria such as stream pattern, profile, dimension, pebble counts, and erosion. In addition, the performance standards reviewed here almost all address riparian buffers, often with specific quantitative vegetation requirements. Chemical and biological success criteria are much less common.

In Wilmington, the Wilmington Monitoring Requirements and Performance Standards include performance standards for vegetation planting (for woody vegetation), stream channel stability, stream hydrology, and coastal headwater streams. The 2011 Wilmington Stream Mitigation Considerations Checklist asks providers to detail vegetation, hydrology, and soils performance criteria, and whether or not the criteria are SMART (i.e., specific, measurable, achievable, relevant, and time-bound).

The Ohio SOP takes a similar approach. Although it notes that "[b]ecause each compensatory stream mitigation activity is unique, performance standards will vary with mitigation type, stream type, landscape position, etc.," the SOP goes on to identify example performance standards for channel form or stability, stream habitat, stream biological function, water chemistry, and riparian vegetation (Ohio p. 21). The SOP states that biological standards (based on one of multiple indices) or chemical standards (such as pH or acid loading) should be included if appropriate for the stream and the mitigation project.

The Mobile SOP performance standard guidelines depend on comparison of the mitigation site to a chosen Reference Stream Reach, data from which provides a target for the mitigation project to achieve. When requesting a credit release, mitigation banks must provide detailed worksheets of measurements for the project stream and reference stream to demonstrate achievement of performance standards (Mobile, Appendix B). The performance standards include habitat adequacy, and the SOP notes that habitat quality is an indirect measurement of biological productivity. Measurements of water chemistry and species diversity are optional, but not required performance standards.

For large or controversial projects, Omaha calls for detailed assessment methods for help in determining whether success criteria have been met. The district's sample success criteria focus almost entirely on vegetation, but also mention hydrology (Omaha, p. 9). The South Pacific guidance on performance standards calls for physical, hydrological, biological, and, if appropriate, water quality/chemical standards. It recommends reliance on a reference site for comparison.

Performance standards for streams and wetlands in Virginia are laid out in the 2010 joint federal-state Mitigation Banking Instrument Template. In many ways, the standards are typical of those in other jurisdictions—they have numeric vegetative standards for buffers, and in-stream performance standards do not include biological or chemical criteria. Like roughly half of the jurisdictions that provide example standards, Virginia addresses invasive species in its performance standards. For example, in buffer areas restored, enhanced, or created, native non-invasive plant coverage should be 80%, and buffers generally may have no more than 5 % aerial cover made up of invasive species for every 500-foot reach (Appendix M). Ohio and Omaha list similar criteria, but Wilmington does not mention invasive species in its performance standards. The Savannah Mitigation Bank Guidelines include an example standard providing that less than 5 % of stems are non-native woody species (Appendix 10).

The Savannah performance standards for mitigation banks in Georgia are particularly comprehensive, containing physical, chemical, and biological metrics. For some standards, there are different requirements depending whether the project is preservation or restoration and, if restoration, which Rosgen priority level it is (Rosgen, 1997). Within each of the physical, chemical, and biological factors, several variables are listed, and monitoring is used to determine whether the project has "passed" or "failed" a given variable in a monitoring period. The Savannah guidance also expressly connects performance standards, monitoring, and credit release. For each period, a project must "pass" a minimum number of variables to achieve any credit release. Beyond that minimum, the amount of credits released in each monitoring period depends on the percentage of variables (specific criteria) passed within each of the physical, chemical, and biological categories. A project that meets 100% of its variables in a monitoring period will have more credits released than one that meets just 65%, for example (Appendix 10).

Overall, the performance standards reviewed include a mix of qualitative and quantitative criteria. Wilmington, for example, requires visual monitoring in addition to other routine monitoring activities to identify concerns such as encroachments, areas with poor vegetation growth, beaver activity, excessively or inadequately drained areas, stream bank instability, etc. (Wilmington Monitoring Guidance, p. 13). Ohio's SOP refers to several indices that help to quantify more descriptive criteria such as habitat quality or stream biological function, and it looks at numerical measures of water quality and vegetation. Mobile's approach depends on comparison with reference stream reaches, which depend on a series of quantitative measurements, but it also lists a series of qualitative sample standards.

The following table provides an example (not the entire set) of suggested performance standards in different categories from each jurisdiction that provides them (Table 11).

Table 11: Performance Standard Examples (Not Comprehensive)

	Physical	Chemical	Biological	Buffer
State-specific Guidance				
Georgia	Streambanks are stable, (using Bank Erosion Hazard Index).	Temperature < 90ºF (32ºC) for warm water streams	Set increase over baseline in Fish Index of Biotic Integrity	For Restoration: 150 planted stems (bare root trees and shrubs) per acre.
Ohio	Stream channel is vertically stable and connected to its floodplain-- neither aggrading nor degrading.	increase in pH, decrease in acid loading (case-by-case)	target biological index score (case-by-case)	A minimum of 400 native, live and healthy (disease and pest free) woody plants per acre (of which at least 200 are tree species)
Virginia	The sinuosity of the stream does not increase or decrease by an amount greater than 0.1 of the approved as-built pattern.			Native non-invasive herbaceous plant coverage shall be at least 60% by the end of the first growing season, and at least 80% each monitoring year thereafter.
District-Wide Guidance				
Mobile	Riffle/pool and depth variation meets reference conditions	Water pH, turbidity (not required)	Target aquatic habitat reflects appropriate composition, density, and diversity present (not required)	Tree and plant species density, diversity, and composition meet target approved by Mobile District
Omaha	Adequate amount of hydrology present for the stream types.			Dominant species present ratios should be based on regional conditions and benefit/protect the wetland or streams.
South Pacific	"Annually, as viewed along representative cross-sections has at least two benches or breaks in slope, including the riparian area, above the channel bottom, not including the thalweg"	Dissolved oxygen	Meet target natural species recruitment by year 5	Minimum percentage native vegetation, soil undisturbed
Wilmington	Pool/riffle spacing		Minimum planted stems per acre for woody vegetation	80% survival of planted species required after 5 years)

XI. Monitoring Requirements

a. Duration of Monitoring

The 2008 Rule requires mitigation plans to establish a monitoring period "sufficient to demonstrate that the compensatory mitigation project has met performance standards, but not less than five years." Also, "[a] longer monitoring period *must* be required for aquatic resources with slow development rates" (emphasis added). However, the district engineer can reduce or waive the monitoring period after a mitigation project has been implemented if he or she determines that the performance standards have already been achieved. The monitoring period can also be extended if the performance standards have not been met or if the project is not on track to meet them (33 C.F.R. § 332.6(b)).

After a mitigation project has been completed, the SOPs we reviewed require the site to be monitored for a number of years (Table 12). The duration of monitoring varies from 3 to10 years, with 5 years being the most common. Three SOPs require monitoring for at least three years: Detroit requires monitoring of emergent or aquatic systems for 3 to 5 years; Kentucky requires monitoring for 3 to 8 years (and may adjust the monitoring duration in response to the project's success, or lack thereof); and Tulsa requires monitoring for 3 to 10 years, depending on the project type. Of these three, the Kentucky and Tulsa SOPs predate the 2008 Rule, and the Detroit SOP was issued just months after it. Nine SOPs[10] require monitoring for five years; three of these SOPs establish five years as a minimum for at least some streams. Fort Worth and New York District require 5 to 10 years of monitoring; for certain projects, Fort Worth requires 7 to 10 years.[11] Only one of the SOPs requiring at least five years of monitoring—Washington—predated the 2008 Rule. Wilmington's 2013 Monitoring Requirements require at least seven years of monitoring except where specific monitoring activities may be terminated after five years (Wilmington Monitoring Guidelines, p. 3). Detroit and Omaha require ten years of monitoring for forested streams.

The Kansas SOP requires annual monitoring but does not specify the duration, beyond stating that monitoring "may be required for several years." Kansas, p. 25. Similarly, the Ohio SOP does not specify monitoring duration; however, its sample credit release schedule includes ten years of monitoring. The Ohio SOP also notes that "monitoring requirements will vary greatly and be directly related to data collections necessary to evaluate the performance criteria of a specific site." Ohio, p. 23. The Pennsylvania SOP mentions monitoring plans, but does not specify how long conditions must be monitored. Each of these three SOPs was written after the 2008 Rule.

[10] Charleston (minimum of five years), Little Rock, Maryland, Mobile (minimum of five years), Omaha (minimum of five years for emergent streams), South Pacific, Tennessee, Washington (for barbs), and Wilmington (for levels 2 and 3).

[11] If a project in Fort Worth is irrigated to ensure new plant survival, the monitoring period begins one year after irrigation ends (Public Notice CESWF-12-MITB, Guidelines Covering Specific Elements for the Establishment of New Mitigation Banks in the Fort Worth District, August 6, 2012).

Table 12: Monitoring Requirements

	Years	What Must be Monitored	Explicitly Tied to Performance Standards?
State-specific Guidance			
Georgia	"Monitoring efforts should usually include periodic reviews in the first year and annually thereafter"	Soils, hydrology, vegetation, and wildlife	No
Kansas	Annually; no less than 5 years, longer depending on resource type and adaptive management measures occurring after initial site work	Physical and biological	No
Kentucky	Annual physical monitoring for 3-8 years	As-built survey, permanent picture stations, riffle and channel pebble counts, bar samples, vegetative monitoring, habitat assessment of stream projects	No
Maryland	5 years		No
New York District	5-10 years		No
Ohio	Project-specific	Monitoring requirements are based on project activities. Examples include substrate sampling, stream stability rating, water chemistry, hydrology monitoring, vegetation monitoring, qualitative habitat evaluation index, qualitative macroinvertebrate sampling, invertebrate community index, index of biotic integrity, amphibian/salamander sampling.	Yes

Tennessee	Five annual monitoring reports; if longer than 5 years then "monitoring may be conducted on a less than annual timeframe (such as every other year)"	Photos, riparian vegetation survey, aquatic species survey, channel morphology survey	No
Virginia	10 years		No
Washington	5 years for barbs		No
District-Wide Guidance			
Charleston	Minimum of five annual monitoring reports	Stream channel stability and improved biological integrity	No
Detroit	Emergent or aquatic systems will require monitoring for 3-5 years; those with scrub-shrub component require monitoring no less than 5 years; forested component require 10 years of monitoring	Percent vegetation cover and/or density; plant species diversity; realization of targeted vegetative communities and/or habitat types; soil must support targeted vegetation; hydrology (meet criteria of Corps of Engineers Wetlands Delineation Manual (USACE, 1987)); control/absence of certain exotic and/or undesirable species; wetland delineation, with land survey, verified by the Corps	No
Fort Worth	5-10 years (7-10 years for certain projects); monitoring begins one year after irrigation ceases		No

Little Rock	Annual monitoring for 5 years	Level 1: physical monitoring (riparian buffer) Level 2: level 1 plus biological monitoring and substrate characteristics, streambank erosion patterns, and cross-sectional profiles at sites within the restored reach Level 3: same as 1 and 2 plus simultaneous collection and statistical comparison of as-built data and the suitable reference site	No
Mobile	Minimum of five annual monitoring reports	Stream pattern, profile, and dimension + geomorphology, hydrology, and hydraulic	Yes
New England	10 years (generally)	As-built plan, species list, photographs; "aquatic resource structure, processes, and function" as well as process monitoring such as water-level fluctuations and plant flowering.	No
Omaha	Minimum of 5 years for emergent streams, 10 years for forested streams		Yes
South Pacific	Minimum of 5 years	Quantitative sampling, maps, photographs,	No
Tulsa	3-10 years	Hydrologic, vegetative, and physical features	No
Wilmington	7 years	Vegetation planting (where projects include planning of woody vegetation), stream channel stability, stream hydrology, stream water quality, and macroinvertebrate monitoring	Yes

b. What Must be Monitored

In general, monitoring requirements track performance standards. Most SOPs require physical (abiotic) monitoring; some also require biological (biotic) monitoring. Examples of what must be monitored include: hydrology, such as flooding frequency and duration, vegetation (cover and/or density), soils, geomorphology, nutrients, riffle photos, riffle and channel pebble counts, bar samples, stream channel stability, streambank erosion patterns, period of inundation, substrate characteristics, wildlife usage, fauna (native and nonindigenous/invasive species), aquatic species, and habitat assessment. While districts may measure floodplain connectivity, bed form diversity, and lateral stability, they rarely assign credits based on these metrics. The do, however, for riparian vegetation.

The general content of monitoring requirements does not vary significantly among SOPs, but some SOPs impose more specific requirements than others. In the most flexible SOPs, monitoring requirements are determined on a case-by-case basis. For example, the Kansas SOP explains that, due to "the many variables involved, no specific [monitoring] standards are set forth [in the SOP]. Instead, a monitoring plan should be included as a part of the mitigation proposal submitted for review" (Kansas, p. 24). This approach maximizes flexibility by enabling monitoring requirements to be tailored to each specific project.

The Little Rock SOP establishes three levels of monitoring requirements depending on the type of mitigation project. In Little Rock, Level 1, which imposes the fewest requirements, is required when mitigation consists of riparian buffer mitigation only. This level requires only basic physical monitoring, including vegetation success and species composition. Level 2 applies for minor stream relocation and moderate restoration or enhancement; it involves both physical and biological monitoring, including substrates, erosion, and stream cross-sections. Level 3 applies for stream relocation, excellent restoration, and good restoration or enhancement. It has the same requirements as Level 2, but also requires comparison to a reference reach over five years. The Little Rock SOP makes clear that monitoring requirements will vary substantially on a case-by-case basis.

In the Wilmington District the Interagency Review Team released updated monitoring requirements and performance standards for compensatory mitigation in 2013. Many of the stream monitoring requirements apply to all stream mitigation reaches that utilize a Restoration and Enhancement Level I approach, as well as Enhancement Level II reaches where in-stream work alters the channel dimensions (Wilmington Monitoring Guidelines, pgs. 4 – 12). The guidelines outline stream monitoring requirements (describe when and how monitoring should take place) and performance standards for vegetation planting (where projects include planning of woody vegetation), stream channel stability, stream hydrology, stream water quality (including acidity, temperature, dissolved oxygen, and conductivity), and macroinvertebrate monitoring. Coastal headwater stream monitoring requirements and performance standards are also included. The guidance also includes requirements for visual monitoring to "identify any concerns on a mitigation project that may not be picked up by other routine monitoring activities (Wilmington Monitoring Guidelines, p. 13). A monitoring schedule is provided to illustrate the general list of monitoring requirements (Figure 6).

Figure 6: Wilmington Monitoring Requirements Schedule

Monitoring Event	Stream Monitoring Activities Required
Pre-Construction	☐ Water Quality Monitoring ☐ Macroinvertebrate Monitoring
Year 0 (as built)	☐ As-built Survey (includes longitudinal profile)
Year 1	☐ Vegetation Plot Monitoring ☐ Stream Channel Stability/Hydrology Monitoring ☐ Water Quality Monitoring, two times ☐ Visual Monitoring, two times
Year 2	☐ Vegetation Plot Monitoring ☐ Stream Channel Stability/Hydrology Monitoring ☐ Water Quality Monitoring, two times ☐ Visual Monitoring, two times
Year 3	☐ Vegetation Plot Monitoring ☐ Stream Channel Stability/Hydrology Monitoring ☐ Water Quality Monitoring, two times ☐ Macroinvertebrate Monitoring ☐ Visual Monitoring, two times
Year 4	☐ Water Quality Monitoring, two times ☐ Visual Monitoring, two times
Year 5	☐ Vegetation Plot Monitoring ☐ Stream Channel Stability/Hydrology Monitoring ☐ Water Quality Monitoring, two times ☐ Macroinvertebrate Monitoring ☐ Visual Monitoring, two times
Year 6	☐ Water Quality Monitoring, two times ☐ Visual Monitoring, two times
Year 7	☐ Vegetation Plot Monitoring ☐ Stream Channel Stability/Hydrology Monitoring ☐ Water Quality Monitoring, two times ☐ Macroinvertebrate Monitoring ☐ Visual Monitoring, two times

Wilmington Monitoring Guidance p. 16

The Kentucky SOP's monitoring guidelines are among the most detailed of the SOPs we reviewed (Kentucky, pp. 7–9). For example, the Kentucky guidelines not only require permanent picture stations to be established, but also state where the stations should be located, how often photographs must be taken, and what information the photographs should capture. The Kentucky SOP also includes specific requirements for riffle and channel pebble counts, bar samples, vegetative monitoring, and habitat assessment, and provides an entire manual on how to conduct biological monitoring.

c. Monitoring and Performance Standards

Several of the reviewed SOPs that provide specific performance standards expressly tie monitoring requirements to performance standards. Wilmington, for example, states that "[t]he fundamental purpose of a monitoring program is to provide reliable data upon which valid conclusions can be reached regarding the success or failure of a mitigation site and to demonstrate whether the goals and objectives of the Mitigation Plan are being met. Success is documented through the use of performance standards…" (Wilmington Monitoring Guidelines,

p. 1). Ohio, Mobile, and Omaha include similar statements. The Wilmington Guidelines also accompany stream-monitoring requirements, including those for stream channel stability and hydrology, with appropriate performance standards. But, as Doyle *et al.* also observed, monitoring requirements occasionally exceed performance standards (2013). Monitoring can serve purposes beyond measuring success criteria achievement; Mobile's SOP notes that monitoring also collects information that can facilitate adaptive management (Mobile, p. 41). However, if mitigation plans lack specific and measurable project goals or performance standards, and standards and credits are not linked to functional lift, then it is difficult for monitoring to determine project success.

XII. Land protection

Most state and Corps district SOPs discuss site protection instruments needed to protect compensation sites in perpetuity by reiterating the language in the 2008 Rule. Per the regulations, mitigation plans for each compensation project must identify the party or parties responsible for long-term management and the role of each party, address all water and mineral rights, and describe an appropriate real estate instrument to ensure long-term site protection. Site protection is provided through the creation of a legally binding instrument, such as an easement or a deed restriction, that expressly precludes certain activities that would threaten stream function, both in-stream or out-stream (33 C.F.R. § 332.7(a)). Mitigation plans should also detail that funding adequate for monitoring and maintenance will be provided and, if a non-profit resource management, government agency, or other third party is designated to carry out long-term management, they should have a right to enforce site protections. Although only Savannah and Wilmington SOPs require a licensed attorney to draft legal site protections, all SOPs that discuss site protection require review and approval of the instrument by the Corps district. In considering approval, the districts may also consider how the proposed protections may improve public recreation and the conservation of surrounding lands, but they must be directly linked to the long-term viability of the project.

The rule recognizes three forms of site protection: title transfer or sale for a restricted purpose; a conservation easement; and a deed restriction placed on the mitigation site (33 C.F.R. § 332.7(a)). Several SOPs, such as New England, state that conservation easements held by a third party are the preferred method for long-term site protection, as it is the most secure method to ensure perpetual protection of the site. Most SOPs require easements to designate and fund a third party to monitor and enforce site protections. SOPs acknowledge that conservation easements are site-specific in terms of goals and management responsibilities, but indicate easements must describe incompatible uses, such as the destruction, cutting, mowing, or harming of any native vegetation on the property. Many SOPs expressly encourage conservation easements, and some, like Charleston and Omaha, provide model conservation easements as a reference. New York District's SOP notes that early planning is key, as soliciting and securing potential easement holders and negotiating the terms of the easement and management fees is complex and requires considerable time.

While direct title transfer and conservation easements are the preferred means of long-term site protection, the use of title deed restrictions is both allowed and expressly discouraged among the various SOPs. A deed restriction is, "A provision in a deed limiting the use of the property and prohibiting certain uses" (Memphis, p. 11). Many states and districts discourage deed restrictions because they can be difficult to enforce if there is no third party accepting legal responsibility and/or monitoring the site (ex. New England 2015, p. 18). In addition, they can be easily changed and, in some cases, state statutes may limit the number of years a deed restriction is in force (New England, p. 16; South Pacific, p. 43). Even when in force, several states may circumvent deed restrictions if enforcement would be adverse to 'public policy.' Nonetheless, deed restrictions are allowed because it is not always possible to secure a party for either title transfer or a conservation easement. When used, many SOPs require the deed restrictions to expressly allow for the creation of protections and associated monitoring activities to preserve the mitigation site. For example, the South Pacific Division SOP states that when deed restrictions are approved by the Corps as sufficient protection, the permittee or landowner of the mitigation site may be required to report periodically on the status of the deed restriction in order to monitor whether the restriction remains in the chain of title in perpetuity (South Pacific, pp. 46-47). The burden of enforcement is on the property owner, as well as, in theory, the Corps and/or state regulatory agencies. In reality, these agencies generally do not have sufficient staff and resources to inspect all mitigation sites on a regular basis (South Pacific, p. 43). Nevertheless, Corps oversight may deter violations. A common approach to overcome this hurdle is to establish third-party enforcement rights in the deed restrictions, although caution must be exercised to ensure these rights are not so broad as to expose the landowner to legal action (ELI and Land Trust Alliance, pp. 89, 92, 99).

XIII. Long-term management

Approximately half of district and state SOPs have provisions relating to long-term management, most of which reiterate the language in the 2008 Rule. Specifically, these plans must identify the responsible party, list possible long-term management needs, provide estimates of the annual cost needed to address them, and establish a funding mechanism to meet those needs in perpetuity (33 C.F.R. § 332.7(d)). Described in the final mitigation plan, long-term management plans are intended to ensure continued provision of aquatic resource functions at mitigation sites after mitigation activities are completed.

SOPs generally require the identification of the party responsible for long-term management of the mitigation site. Several SOPs outline the necessary qualifications of the responsible party, such as, “resources and expertise in long-term management and stewardship of mitigation properties” (New England, p. 31).

Although the SOPs require long-term management plans to describe long-term management needs, these are generally left undefined. The only SOP to provide examples of long-term management needs is Ohio, which lists invasive plant control, maintenance of water control structures, site access restriction, monitoring, and administrative costs as potential needs (Ohio, p. 17).

The funding mechanism for long-term management is usually a non-wasting endowment (South Pacific, p. 47), but the rule explicitly allows other forms of financing, such as trusts and contractual arrangements with future responsible parties (33 C.F.R. § 332.7(d)). SOPs may also stipulate that this must be fully funded before the final release of credits (Fort Worth, p. 5). In several SOPs, including New York District, Savannah, and the South Pacific, the practicability of long-term management at a mitigation site is listed as a factor in site selection

CONCLUSION

The first and most basic lesson from our review is that stream compensatory mitigation policy is a dynamic process. Regulators are still working to bring older guidance in line with the 2008 Rule and with progress in stream restoration science. Although SOPs are being revised and updated constantly, even while this paper is being compiled, several still predate the 2008 Rule. Indeed, some districts and states have yet to develop formal detailed stream mitigation policies. Moreover, substantial variation persists in the substantive requirements of the SOPs as well as in the length, topics covered, and manner of presenting information. Additionally, a case-by-case approach to mitigation and permitting decision-making is still the rule in many issues. In many cases, the most complicated and important aspects of stream mitigation policy – the siting of projects and performance standards – are also the least well defined in policy and left up to review on a case by case basis, while the staff doing this case by case review are often not well trained in this area.

Second, in most jurisdictions, credit determination is still tied to length of stream restored or preserved, rather than to functional lift. At the state level, functional assessments are slowly growing more common, with ten states using them and six states currently developing them (ASWM, 2014). More specific assessment methodologies, such as those for habitat or water quality, are more prevalent than general functional assessments. Functional assessments are starting to be integrated into district stream mitigation policies as well, but it is still an emerging practice. For some of the SOPs that we reviewed, like Pennsylvania's, regulators have designated a particular assessment methodology and tied it to the calculation of debits and credits. The Wyoming SOP does not require a particular assessment method, but requires that applicants use an approved conditional or functional assessment to determine the existing condition of the impact site and the anticipated stream improvement. Missouri, like Wyoming, uses a system of tables to calculate debits and credits, but it does not generally rely on assessments: regulators evaluate the existing condition of streams and the net benefit of mitigation projects on a case-by-case basis, using criteria stated in the SOPs. Ohio, likewise, mentions assessment methodologies for project design and monitoring, and recommends using habitat and biological indices for performance standards, but assessments do not factor into its ratio determinations for credits and debits. Progress remains to be made before the use of a functional approach is the rule across jurisdictions.

Though SOPs vary in many regards, many of them are alike in what they do not address. Some topics consistently receive less attention than others, in particular performance standards, monitoring, and credit release schedules. Regulators address these topics on a case-by-case basis, but these categories have been much less developed in formal policy than other topics. This is true at both the district and state level, as the Association of State Wetland Managers found that the vast majority of states evaluated success on a case-by-case basis (ASWM, 2014).

Similarly, most districts lack a comprehensive discussion of how to implement the watershed approach. Generally SOPs incorporate watershed considerations by requiring or favoring mitigation within the same watershed as impacts. In addition, most of them require applicants to discuss how they considered watershed conditions in their site selection and design and how their project will address issues in the watershed. Some also instruct applicants to note which watershed plans or assessments they have relied on in their planning. These guidelines likely facilitate better site selection, and they do encourage applicants to consider watershed problems to a degree. But the SOPs include very little guidance on how best to select sites and design projects to maximize watershed benefits. As discussed at greater length elsewhere (Practice Paper), the lack of available watershed plans inhibits efforts to understand and base decisions on identified problems in the watershed.

Given the ongoing work of states and Corps districts to improve their policies, this review serves primarily as a snapshot of the current state of stream compensatory mitigation. In sum, we found that districts and states continue to revise and update policies to better meet the objectives of the 2008 Rule. Despite progress in the last decade, in general both the Corps and many states have not yet fully adopted a functional approach to evaluating and crediting stream compensatory mitigation, and guidance on how to implement the watershed approach is still lacking. Additionally, many measures key to long-term management of mitigation sites, such as performance standards and monitoring, are less commonly addressed in compensatory stream mitigation policies than other topics.

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