

STREAM MITIGATION GUIDELINES
APRIL 2003

TABLE OF CONTENTS

<u>SECTION</u>	<u>PAGE NUMBER</u>
1. <u>INTRODUCTION</u>	4
2. <u>REGULATORY AUTHORITIES AND GUIDELINES</u>	5
3. <u>TYPES OF PERMITS THAT MAY REQUIRE STREAM MITIGATION</u>	6
4. <u>TERMINOLOGY</u>	7
5. <u>MITIGATION REQUIREMENTS</u>	12
6. <u>SELECTION OF MITIGATION SITES</u>	16
7. <u>MITIGATION PLANS AND SCHEDULING</u>	17
8. <u>BUFFER WIDTHS & RIPARIAN RESTORATION</u>	18
9. <u>EASEMENTS AND HOLDING MITIGATION SITES</u>	19
10. <u>FLEXIBLE STREAM MITIGATION</u>	21
A. Urban Watershed Management	
B. Other Approaches	
11. <u>MONITORING</u>	23

APPENDICES

APPENDIX I	Stream Habitat Designation Criteria
APPENDIX II	Monitoring Criteria and Remedial Action Guidelines
APPENDIX III	NC Ecoregion Map
APPENDIX IV	8 Digit H.U.C. Unit Map
APPENDIX V	Forms
A.	Mitigation Plan Check List
B.	Channel Mitigation Monitoring Sheets I, II, III, AND IV
C.	Stream Quality Assessment Worksheet (under development)
APPENDIX VI	Regional Curves
APPENDIX VII	Stream Classification In North Carolina
APPENDIX VIII	Website Information

1. INTRODUCTION

This guidance has been prepared by a workgroup consisting of representatives from U.S. Army Corps of Engineers, Wilmington District (District), North Carolina Division of Water Quality (DWQ), U.S. Environmental Protection Agency, Region IV (EPA), Natural Resources Conservation Service (NRCS) and the North Carolina Wildlife Resources Commission (WRC). This document is intended to provide the regulated community of North Carolina with joint and consistent, District and DWQ stream mitigation guidance.

Historically, compensatory mitigation for impacts to all aquatic systems was in the form of wetland mitigation. However, wetland mitigation does not provide appropriate replacement of aquatic functions lost due to impacts to fluvial systems. Because of this, the District and DWQ now generally require that compensatory mitigation for impacts to stream resources should be in the form of restoration and/or enhancement of degraded stream channels utilizing natural channel design and bio-engineering techniques. Channel preservation of unique or otherwise ecologically important stream segments may also play an important role in mitigating stream impacts.

Mitigation decisions are made during the permit review process. Mitigation requirements are generally determined through site evaluations that document aquatic resource losses. These site evaluations take into account the resources being impacted and the potential for compensating the public for their loss. This document provides general guidance to be applied when evaluating permit applications and proposed mitigation.

Topics addressed in this document include requirements for stream mitigation, definitions of stream mitigation terms and activities, crediting for mitigation activities and monitoring requirements. This guidance will generally apply to **non-tidal** waters. These guidelines should not be construed as affecting the applicability of the CWA 404 (b)(1) Guidelines, found at 40 CFR Part 230, the Memorandum of Agreement between the Environmental Protection Agency and the Department of the Army concerning the Determination of Mitigation Under the Clean Water Act Section 404(b)(1) Guidelines, or the review process outlined in DWQ's rules (15A NCAC 2H.0506). These guidelines require consideration and the selection of practicable alternatives to proposed project impacts that would avoid or minimize impacts to waters of the United States (including streams) prior to considering compensatory mitigation.

Primary Guidance Objectives:

- a. Restore and enhance aquatic habitat.
- b. Maintain and improve water quality functions.
- c. Promote natural channel design and bio-engineering.

- d. Maintain and restore public use of stream resources.

This document is intended to be fair and flexible and is subject to periodic revision and update as new procedures and stream mitigation monitoring data support changes. Comments and suggestions are welcomed at any time, especially during the initial 12-month period of this document's use from the publication date. Comments should be addressed to Mr. Scott McLendon (scott.c.mclendon@usace.army.mil), Ms. Becky Fox (fox.rebecca@epa.gov), or Mr. Todd St. John (todd.st.john@ncmail.net).

2. REGULATORY AUTHORITIES & GUIDELINES

A. Section 10 of the River and Harbor Act of 1899: In accordance with Section 10 of the River and Harbor Act, the Corps of Engineers is responsible for regulating all work in navigable waters of the United States.

B. Section 404 of the Clean Water Act: In accordance with Section 404 of the Clean Water Act as amended in 1977, the Corps of Engineers is responsible for regulating the discharge of dredged or fill material in waters of the United States, including wetlands. **The purpose of the Clean Water Act is to restore and maintain the physical, chemical, and biological integrity of the nation's waters.** Under both of the above programs, the Corps of Engineers is responsible for receiving and evaluating permit applications affecting waters of the United States. Frequently, the required public interest review of applications results in a finding that the public must be compensated for unavoidable aquatic resource losses, including stream resources.

C. Section 404(b)(1) Guidelines of the Clean Water Act: Section 230.10 (d) of the Section 404 (b)(1) Guidelines states that "... no discharge of dredged or fill material shall be permitted unless appropriate and practicable steps have been taken which will minimize potential adverse impacts of the discharge on the aquatic ecosystem."

D. EPA/Army Mitigation Memorandum of Agreement (MOA), February 6, 1990: The MOA interprets Section 230.10 (d) of the Guidelines to require the use of mitigation in order to be in compliance with this section of the Guidelines. As clarified in the MOA, compliance with the Section 404 (b)(1) Guidelines requires application of a sequence of mitigation -- avoidance, minimization and compensation. In other words, mitigation consists of the set of modifications necessary to avoid adverse impacts altogether, minimize the adverse impacts that are unavoidable and compensate for the unavoidable adverse impacts. Compensatory mitigation is required for unavoidable adverse impacts, which remain after all appropriate and practicable avoidance and minimization has been achieved. The Guidelines identify a number of "Special Aquatic Sites," including riffle pool complexes, which require a higher level of regulatory review and protection. This stream guidance document addresses only compensatory mitigation and should only be used after adequate

avoidance and minimization of impacts associated with the proposed project has occurred

E. 401 Water Quality Certification Program: Section 401 of the Clean Water Act provides that no Federal permit, including 404 permits, will be issued unless a 401 Water Quality Certification has been issued or waived. In North Carolina, DWQ administers the 401 program. The "401" is essentially a verification by DWQ that a given project will not degrade waters of the State or otherwise violate water quality standards (15A NCAC 2B .0200).

F. The Fish and Wildlife Coordination Act of 1956: The FWCA expresses the will of Congress to protect the quality of the aquatic environment as it affects the conservation, improvement and enjoyment of fish and wildlife resources. The Act requires the Corps of Engineers to coordinate its regulatory programs with the U.S. Fish And Wildlife Service and the Nation Marine Fisheries Service.

G. Endangered Species Act: The Endangered Species Act declares the intention of Congress to conserve threatened and endangered species and ecosystems in which those species depend. The Act requires consultation with the U.S. Fish and Wildlife Service to insure the regulated activities are not likely to jeopardize the continued existence of threatened or endangered species or result in the destruction or adverse modification of designated critical habitats. The Act also requires the Federal agencies to utilize their authorities in furtherance of the Act by carrying out programs for the conservation of endangered and threatened species.

3. TYPES OF PERMITS THAT MAY REQUIRE STREAM MITIGATION

A. Individual Permits: Individual permits are typically required where the level of project activities exceeds work thresholds authorized by General Permits. Individual permits require the submission of a permit application by the applicant followed by the Corps placement of the project on public notice for agency and public review.

B. Nationwide Permits: Nationwide Permits (NWPs) are issued by the Chief of Engineers (Headquarters) through publication in the *Federal Register* and are applicable throughout the nation. NWPs authorize a number of commonly occurring nationwide activities that typically have minimal impact on the aquatic environment. Where a proposed activity is expected to exceed minimal impact on the aquatic environment, mitigation may be required to reduce aquatic resource impacts to an acceptable, minimal level. Certain conditions attached to specific NWPs require pre-construction notification prior to starting work. The Corps generally responds to such notices within 45 days.

C. Regional General Permits: Regional General Permits (GPs) are developed and issued by the District or the South Atlantic Division on a regional basis. GPs typically authorize commonly occurring activities that are specific to the District/Region and that do not have NWP coverage. Certain GPs require notification prior to starting work. As

with NWPs, GP activities typically cause minimal impact on the aquatic environment. Where authorized work exceeds the minimal impact threshold, mitigation may be necessary to lessen effects on aquatic resources.

D. Letters of Permission: Letters of Permission (LOPs) are a type of permit issued through an abbreviated processing procedure. LOPs include coordination with federal and state fish and wildlife agencies as required by the FWCA and a public interest evaluation. They do not require the publishing of an individual public notice. LOPs apply only to Section 10 authorization in North Carolina.

E. 401 Water Quality Certification: When the District determines that a 404 Permit is required, a 401 Water Quality Certification is also required. The District determines which type of permit is applicable for the project: an Individual Permit, Nationwide, or Regional General Permit. An Individual 401 Water Quality Certification is necessary if an Individual 404 Permit is required. For each Nationwide or Regional General Permit, DWQ must either issue a matching General Certification, or it must issue or waive an individual 401 Certification in order for the permit to be utilized. Once the District has determined which type of GP is needed, the matching General Certification can be reviewed on the DWQ Wetlands Unit web page <http://h2o.ehnr.state.nc.us/ncwetlands/certs.html>. If written concurrence is required, then a formal application and payment of the appropriate fee is needed for the 401 Water Quality Certification.

4. TERMINOLOGY

- **Compensatory Stream Mitigation** - The restoration, enhancement, or, for streams of national or state significance because of the resources they support, preservation of streams and their associated floodplains for the purpose of compensating for unavoidable adverse impacts which remain after all appropriate and practicable avoidance and minimization has been achieved. Compensatory stream mitigation may be required for impacts to perennial and intermittent streams and should be designed to restore, enhance, and maintain stream uses that are adversely impacted by authorized activities.
- **Perennial Stream** - A perennial stream has flowing water year-round during a typical year. The water table is located above the streambed for most of the year. Groundwater is the primary source of water for stream flow. Runoff from precipitation is a supplemental source of water for stream flow. (65 FR 12898). Perennial streams support a diverse aquatic community of organisms year round and are typically the streams that support major fisheries.
- **Intermittent Stream** - An intermittent stream has flowing water during certain times of the year, when ground water provides water for stream flow. During dry periods, intermittent streams may not have flowing water. Runoff from precipitation is a supplemental source of water for stream flow. (65 FR 12898). The biological community of intermittent streams is composed of species that are aquatic during a

part of their life history or move to perennial water sources. For the purpose of mitigation, intermittent streams will be treated as 1st order streams.

- **Ephemeral Stream** – An ephemeral stream has flowing water only during and for a short duration after precipitation events in a typical year. Ephemeral streambeds are located above the water table year-round. Groundwater is not a source of water for the stream. Runoff from precipitation is the primary source of water for stream flow. (65 FR 12897). Ephemeral streams typically support few aquatic organisms. When aquatic organisms are found they typically have a very short aquatic life stage.
- **Stable Stream** – A stream which, over time (in the present climate), transports the sediments and flows produced by its watershed in such a manner that the dimension, pattern and profile are maintained without either aggrading or degrading (Rosgen, 1996).
- **Channelized Stream** – Stream that has been degraded (straightened) by human activities. A channelized stream will generally have increased depth, increased width, and a steeper profile, be disconnected from its floodplain and have a decreased pattern or sinuosity.
- **Ditches Acting as Streams** – Ditches that intercept enough groundwater to have either intermittent or perennial flow. These channels have enough flow to support aquatic life and would be considered waters of US.
- **Natural Channel Design** – A geomorphologic approach to stream restoration based on an understanding of the valley type, general watershed conditions dimension, pattern, profile, hydrology and sediment transport of natural, stable channels (reference condition) and applying this understanding to the reconstruction of an unstable channel.
- **Stream Classification** – Ordering or arranging fluvial systems into groups or sets based on their similarities or relationships. A morphological classification system categorizes a stream based on its physical and geomorphic characteristics. Rosgen (1994) proposed a geomorphic classification system that is widely used in stream restoration and mitigation. Classification allows for predicting the behavior of these systems, extrapolating knowledge of one system to another, and provides a consistent and reproducible frame of reference for communication among those interested in these systems. Alternatively, for North Carolina streams, DWQ has a classification system that is based on water quality standards. This system is a regulatory convention for establishing water quality standards based on a stream's "best use". (Use-support ratings are a method to analyze water quality information and to determine whether the quality is sufficient to support the uses for which the waterbody has been classified by DWQ. The word "use" refers to such activities as swimming, fishing and water supply. All surface waters in the state have been assigned this type of classification.)

- **Stream Order** - A method for classifying, or ordering, the hierarchy of natural channels within a catchment. One of the most popular methods for assigning stream orders was proposed by Strahler (1957). The uppermost channels in a catchment with no upstream tributaries are first order downstream to their first confluence. A second order stream is formed below the confluence of two first order streams. A third order stream is formed by the confluence of 2 second-order streams and so on. The confluence of a channel with another channel of lower order does not raise the order of the stream below the confluence.
- **Reference Reach/Condition** – A stable stream reach or, in some instances, condition, generally located in the same physiographic region (see Appendix III), climatic region, and valley type as the project and serves as the blueprint for the dimension, pattern, and profile of the channel to be restored.
- **Bankfull stage** – The point at which water begins to overflow onto its floodplain. This may or may not be at the top of the stream bank on entrenched streams. Typically, the bankfull discharge recurrence interval is between one and two years. It is this discharge that is most effective at moving sediment, forming and removing bars, shaping meanders and generally doing work that results in the morphological characteristics of channels. (Dunne and Leopold, 1978)
- **Channel Dimension** – The two-dimensional, cross sectional profile of a channel taken at selected points on a reach, usually taken at riffle locations. Variables that are commonly measured include width, depth, cross-sectional area, floodprone area and entrenchment ratio. These variables are usually measured relative to the bankfull stage.
- **Channel Pattern** – The sinuosity or meander geometry of a stream. Variables commonly measured include sinuosity, meander wavelength, belt width, meander width ratio and radius of curvature.
- **Channel Profile** – The longitudinal slope of a channel. Variables commonly measured include water surface slope, pool-to-pool spacing, pool slope and riffle slope.
- **Flood-Prone Area** – Floodplain width measured at an elevation corresponding to twice the maximum bankfull depth. This area often correlates to an approximate 50-year flood or less (Rosgen, 1994)
- **Stream Restoration** - The process of converting an unstable, altered, or degraded stream corridor, including adjacent riparian zone (buffers) and flood-prone areas, to its natural stable condition considering recent and future watershed conditions. This process 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), as well as reestablishing the biological and

chemical integrity, including transport of the water and sediment produced by the stream's watershed in order to achieve dynamic equilibrium¹.

- **Stream Enhancement** - Stream rehabilitation activities undertaken to improve water quality or ecological function of a fluvial system. Enhancement activities generally will include some activities that would be required for restoration. These activities may include in-stream or stream-bank activities, but in total fall short of restoring one or more of the geomorphic variables: dimension, pattern and profile. Any proposed stream enhancement activity must demonstrate long-term stability.
- **Enhancement Level I** – Mitigation category that generally includes improvements to the stream channel and riparian zone that restore dimension and profile. This category may also include other appropriate practices that provide improved channel stability, water quality and stream ecology. Work will be based on reference reach information.
- **Enhancement Level II** – Mitigation category for activities that augment channel stability, water quality and stream ecology in accordance with a reference condition but fall short of restoring both dimension and profile. Examples of enhancement level II activities may include stabilization of streambanks through sloping to restore the appropriate dimension and vegetating a riparian zone that is protected from livestock by fencing, construction of structures for the primary purpose of stream bank stabilization and, when appropriate, reattaching a channel to an adjacent floodplain.
- **Streambank Stabilization** – The in-place stabilization of an eroding streambank. Stabilization techniques, which include primarily natural materials, like root wads and log crib structures, as well as sloping stream banks and revegetating the riparian zone may be considered for mitigation. When streambank stabilization is proposed for mitigation, the completed condition should be based on a reference condition. Stream stabilization techniques that consist primarily of “hard” engineering, such as concrete lined channels, rip rap, or gabions, while providing bank stabilization, will not be considered for mitigation. An exception to this may be considered for short reaches when mitigating for urban stream impacts.
- **Stream Relocation** – Movement of a stream to a new location to allow an authorized project to be constructed in the stream's former location. In general, relocated streams must reflect the dimension, pattern and profile indicated by a natural reference reach/condition in order to be adequate compensation for the authorized stream impact. Relocated streams will generally require wooded protected buffers of sufficient width (see buffer section). Relocations resulting in a reduced channel length will generally require mitigation.

¹This definition of stream restoration describes a category of mitigation for use with this guidance, rather than a generic definition of stream restoration. slope according to a reference reach and, when appropriate, reattaching to an adjacent floodplain.

- **Stream Preservation** – Protection of ecologically important streams, generally, in perpetuity through the implementation of appropriate legal and physical mechanisms. Preservation may include the protection of upland buffer areas adjacent to streams as necessary to ensure protection or enhancement of the overall stream. Preservation must protect both sides of the channel. Generally, stream preservation should be in combination with restoration or enhancement activities. Under exceptional circumstances, preservation may stand-alone where high value waters will be protected or ecologically important waters may be subject to development pressure (Refer to Section 6 regarding preservation criteria). Stand-alone preservation may generally be most acceptable in mitigating impacts associated with nationwide and regional general permits. Preservation may be utilized for relatively undisturbed areas that require little or no enhancement activities other than protective measures. Although minimal streambank revegetation may be required in some cases, if mitigation requires extensive streambank revegetation, the mitigation will be considered to be Enhancement Level II.
- **Vegetated Buffer** – An upland or wetland area vegetated with native trees and shrubs next to rivers, streams, lakes, or other open waters that separate aquatic habitats from developed areas, including agricultural land.
- **Stream Riparian Zone** – A riparian zone is the area of vegetated land along each side of a stream or river that includes, but is not limited to, the floodplain. The quality of this terrestrial or wetland habitat varies depending on width and vegetation growing there. As with vegetated buffers, functions of the riparian zone include reducing floodwater velocity, filtering pollutants such as sediment, providing wildlife cover and food, and shading the stream. The ability of the riparian zones to filter pollutants that move to the stream from higher elevations results in this area being referred to as a buffer zone. The riparian zone should be measured landward from the bankfull elevation on each side of a stream or river.
- **Biological Integrity** – A measure of the state of health in aquatic communities. A healthy aquatic community is a balanced community of organisms having a species composition, diversity and functional organization comparable to that found in natural (unimpaired) habitats in the region (Karr, et al. 1986).
- **Best Management Practices (BMPs)** – Policies, practices, procedures, or structures implemented to mitigate the adverse environmental effects on surface water quality resulting from development and other land disturbing activities. BMPs are categorized as structural or non-structural. (See Section 10 for further BMP discussion.)
- **Conservation Easement** – A legally binding, recorded instrument approved by the District and DWQ offices of counsel to protect and preserve mitigation sites.

- **303 (d) Listed Waters** – Section 303(d)(1) of the Clean Water Act, requires states/tribes to provide a list of impaired waters to EPA every two years. Waterbodies are designated as impaired by a state or tribe when existing pollution controls are not stringent enough to attain and maintain the water quality standards the state/tribe has set for them.
- **Mountain Counties** – Counties in which the WRC has Designated Public Mountain Trout Waters and consists of the following: Alleghany, Ashe, Avery, Buncombe, Burke, Caldwell, Cherokee, Clay, Graham, Haywood, Henderson, Jackson, Macon, Madison, McDowell, Mitchell, Polk, Rutherford, Stokes, Surry, Swain, Transylvania, Watauga, Wilkes and Yancey.

5. MITIGATION REQUIREMENTS

Final compensatory mitigation requirements of Department of the Army permits will be commensurate with the type and amount of impact associated with the permitted activity. Proposed compensatory mitigation will be coordinated with the appropriate review agencies and final mitigation requirements will be determined on a project-by-project basis. DWQ may also require stream mitigation for its 401 Certification. For the purposes of defining compensatory stream mitigation options, this guidance establishes four levels or types of mitigation (Restoration, Enhancement Level I, Enhancement Level II and Preservation) that may be used to compensate for unavoidable impacts to intermittent and perennial streams. These mitigation categories are defined in the Terminology Section (Section 4) and do not directly relate to the Rosgen Priority Levels of Stream Restoration.

A. General mitigation requirements associated with direct impacts to stream channels including culvert/pipe installations. This section provides the basic compensatory mitigation requirements (ratios) based solely on the quality of the stream being impacted and are intended to ensure that impacts to higher quality streams are adequately compensated. Stream quality determinations will be made on a case-by-case basis and site-specific conditions may warrant the adjustment of these ratios up or down.

Table 1. Basic Compensatory Mitigation Requirements Associated with Impacts to Poor to Fair, Good, and Excellent Quality Streams.

Existing Channel Quality/Conditions* (Aquatic habitat/water quality)	Proposed Unavoidable Stream impacts** (Linear feet)	Compensatory Mitigation Ratio	Basic Compensatory Mitigation Requirement
Poor to Fair	100	1:1	100 lf
Good	100	2:1	200 lf
Excellent	100	3:1	300 lf

***Refer to section “C” for a discussion of stream quality determinations**

****100 linear feet of proposed channel impacts in column 2 was selected for demonstration purposes only.**

B. Mitigation requirements based on mitigation type.

Table 2 provides guidance on the amount of Restoration, Enhancement I, Enhancement II, and Preservation that would satisfy a requirement of 100 lf of mitigation based on the basic compensation ratios provided in Table 1. Ranges have been established within the Enhancement and Preservation categories to allow flexibility during the evaluation of plans to account for the wide range of potential enhancement, and preservation opportunities that may be available at a particular mitigation site. In addition, for a given impact, compensatory mitigation requirements will generally increase from restoration to preservation to account for the decrease in functional improvements in aquatic habitat and water quality that is expected to occur with enhancement and preservation level projects compared to restoration.

Note: Factors influencing the adjustment of preservation ratios may include the presence of Federally threatened or endangered species, presence of critical habitat, other Federal or state species of concern, outstanding resource waters and other high quality waters, high quality aquatic habitat potentially subject to development impacts, streams with high quality adjacent wetlands and water supply streams. (See Section 6 for preservation site selection criteria and criteria that may enhance stream preservation crediting.)

Table 2. General Mitigation Requirements Based on Restoration, Enhancement I, Enhancement II, and Preservation.

Mitigation Type	Mitigation Activity Multiplier*	Linear Feet of Mitigation Required (from Table 1)	Linear Feet of Mitigation Work Required (by type)
Restoration	1.0	100	100 lf
Enhancement I	1.0 to 1.5	100	100 lf to 150 lf
Enhancement II	1.5 to 2.5	100	150 lf to 250 lf
Preservation	2.5 to 5.0	100	250 lf to 500 lf

***The Mitigation Activity Multiplier is applied to each mitigation type to recognize, that for a given reach, the functional improvement associated with mitigation projects increase along the continuum from preservation to enhancement to restoration.**

Impacts due to impounding stream channels will generally require stream mitigation by the US Army Corps of Engineers. Mitigation requirements will be determined on a case-by-case basis for these impacts.

Table 3 provides a summary of the range of compensatory mitigation requirements based on the quality of the stream being impacted and the type of mitigation (Restoration, Enhancement I, Enhancement II, Preservation) that is proposed to compensate for the authorized impacts.

Table 3. Mitigation Requirements for 100 lf of Impact to Poor to Fair, Good, and Excellent Quality Streams.

Stream Quality	Restoration	Enhancement I	Enhancement II	Preservation
Poor to Fair	100 lf	100 to 150 lf	150 to 250 lf	250 to 500 lf
Good	200 lf	200 to 300 lf	300 to 500 lf	500 to 1000 lf
Excellent	300 lf	300 to 450 lf	450 to 750 lf	750 to 1500 lf

Combinations of mitigation types in one project are acceptable provided these ratios are generally followed. In all cases, the goal of a mitigation project should be to provide for the

replacement of those aquatic functions being lost or adversely impacted by the authorized activity.

Channel relocations, where a stable channel is re-established on the project site and is designed and implemented according to natural stream channel design criteria, will generally result in a 1:1 restoration ratio provided the channel satisfies all success criteria.

B. Stream Quality Determinations

1. Channel Quality/Conditions for large streams and rivers (wet width of 4 meters or more).

Bioclassification criteria and rating protocols have been successfully developed for three major ecoregion types over the past several decades by DWQ. These criteria are based on the community composition of benthic macroinvertebrates and include taxa richness (primarily EPT, or Ephemeroptera, Plecoptera, and Trichoptera) and biotic index values. Habitat quality and fish community conditions are also metrics that are commonly used to assess channel quality for large streams and rivers in NC. These criteria are discussed in the Standard Operating Procedures manual for the Biological Assessment Unit of the Environmental Sciences Branch and can be downloaded from the following website (<http://www.esb.enr.state.nc.us/BAU.html>). These criteria are used to define 5 stream quality conditions as Excellent, Good, Good-Fair, Fair, and Poor.

DWQ and the Corps believe that these rankings can be used to determine stream quality conditions with respect to both impact and mitigation sites. However, the time intensive methodology required for these rankings will probably be prohibitive in most cases. DWQ and the Corps are committed to developing a simpler yet still accurate rapid stream assessment methodology for stream quality conditions.

2. Channel Quality/Conditions for small streams (<3 meter wet width).

A. Small Perennial Streams: Research to determine water quality conditions within small streams has been conducted by DWQ and reported in a series of memos by the Biological Assessment Unit. This research has noted that number of benthic macroinvertebrate taxa decrease as streams become smaller, and this decrease in taxa richness is predictable in reference systems. Decreases in taxa richness in reference catchments is directly related to the loss of habitat diversity as streams become smaller. Biotic index values showed little relationship to stream size and therefore may be a very useful metric to determine water quality conditions in small stream systems. These data also suggest that benthic macroinvertebrate communities can be used to determine impacts from reference reaches. In addition to these data, stream functional assessment forms have been developed with the assistance of a technical advisory committee. However, these forms have not yet been field tested to determine their reliability and accuracy. DWQ and the Corps believe that these forms (or derivatives of them) will be able to be used to assess channel quality conditions

for small perennial streams. These assessment forms incorporate stream morphology, riffle material, streambank stability, and biological components.

B. Intermittent Streams: Research is currently being conducted by DWQ with assistance of an EPA Wetland Program Development Grant to define the ecological functions of intermittent streams. Work is focusing on intermittent streams in the piedmont and mountains of North Carolina. As part of this work, benthic macroinvertebrate communities are being collected and analyzed. It is anticipated that these data will help define channel quality conditions of intermittent streams.

Until an acceptable methodology is available, DWQ and the Corps will evaluate and determine stream quality on a case-by-case basis with applicants based on the best information that is available at the time of the evaluation.

6. SELECTION OF MITIGATION SITES

Stream mitigation should generally be performed on a stream system with the same habitat as the impacted stream, i.e. cold, cool, and warm water habitat. The following criteria should be used to provide general guidance for selecting streams and justifying selections to the District and DWQ. All three criteria apply to any stream being proposed for impact and do not refer to the quality of the stream. Higher mitigation ratios may be required if the mitigation project is in a different 8-digit HUC than the impact site.

Selection Criteria 1. Mitigation should be accomplished within one stream order of the impacted stream, within the same subbasin (8 digit H.U.C) and as close to the impacted stream as possible. For the purpose of mitigation, intermittent streams will be treated like 1st order streams.

Selection Criteria 2. Stream mitigation should be performed on streams with similar habitat designations (cold, cool and warm water as defined in WRC habitat guidance, see Appendix I). Mitigation will be conducted in trout waters if any trout species are found in project stream reaches.

Selection Criteria 3. Mitigation should be performed within the same Physiographic Region (Appendix III) and priority should be given to mitigation sites that have the potential to improve habitat for state or Federally threatened and endangered (T&E) species.

To qualify for stream mitigation, the project plan shall be designed to achieve the maximum level of improvement and should result in the restoration of the channel to its most probable natural state, given the individual constraints of the project location. This acknowledges that the maximum level of improvement may be constrained by water withdrawals, altered precipitation-runoff relationships, adjacent land use and other factors. It is not necessarily the goal of stream mitigation to return stream segments to some pre-impact condition. While site-specific constraints may reduce the potential of mitigation sites (and correspondingly increase the mitigation ratios), mitigation goals

should be to establish the maximum biological, chemical and physical integrity possible in the current environment. However, under no circumstances should stream restoration and enhancement projects be “over” designed in order to generate stream mitigation credit.

For preservation to be an acceptable mitigation option the channel should generally be ecologically important and in a relatively undisturbed condition. The following list of criteria may be used as a guide for selecting high value preservation sites.

Recommended priority areas for channel preservation: *

- Streams in a watershed that are adjacent to, or within a unique wetland as identified by NC Administrative Code 15A 2B .0100.
- Streams in a watershed that contains Critical Habitat Areas identified by the Coastal Habitat Protection Program of the Division of Marine Fisheries.
- Streams in a watershed that contains a significant Natural Heritage Area as identified by the Natural Heritage Program of the Division of Parks and Recreation, provided the Natural Heritage Area contributes to the overall quality of the stream.
- Streams in a watershed that is known to provide habitat for state or federally listed endangered or threatened species.
- Streams in a watershed that contains fishery nursery areas, High Quality Waters, Outstanding Resource Waters, Trout Waters, or Water Supply Watersheds.
- Streams in a watershed that meets the criteria for Exceptional Significance rating under the Division of Coastal Management’s NC CREWS (NC Coastal Region Evaluation of Wetland Significance).
- Streams in a watershed that contains unique and/or high quality habitat (stream and/or wetland) that is adjacent or within an area experiencing a rapid increase in population or development trend.
- Streams in a watershed that contain stream reaches designated as critical habitat by the US F&WS.

* The above are not listed in order of selection priority.

7. MITIGATION PLANS AND SCHEDULING

Except as specifically allowed by permit conditions, authorized projects will not proceed until final mitigation plans have been reviewed and approved by the District. Under most circumstances, mitigation will be implemented either prior to or concurrent with authorized activities. DWQ requires a mitigation site that is available to the applicant and ecologically viable as well as a conceptual mitigation plan before the 401 Water Quality Certification will be issued. A final mitigation plan must then be approved before impacts occur. A review of these plans will be coordinated with state and federal review agencies. Authorized activities that will be mitigated through an approved bank program or in-lieu fee program may start work once the District receives notification that the mitigation request has been accepted and financial documentation has been provided. Use or compliance with these guidelines does not relieve the permittee of the need to obtain other federal, state or local authorizations required by law. (Appendix VIII contains relevant agency websites).

Mitigation options relative to commencing permit activities. These options are not listed in any particular order of priority or preference:

- A. NC Wetland Restoration Program – Determined by WRP/District MOA (November 4, 1998)
- B. Private non-bank – Prior to a permit being issued a final mitigation plan should be approved and the site secured. Plan implementation must commence either prior to or concurrent with authorized activities. A preservation mechanism will be in place before commencing authorized activities.
- C. Federal/State Government – Before a permit is issued a mitigation plan must be approved. Plan implementation must commence either prior to or concurrent with authorized activities. Contractual agreements or MOAs between government bodies addressing mitigation requirements and implementation may be acceptable. Except where these agreements are signed and approved by the District and DWQ, a preservation mechanism should be in place before commencing authorized activities.
- D. Approved Private Mitigation Bank - Credits must be available and payment documented prior to permit activity and in compliance with the established mitigation-banking instrument.

8. BUFFER WIDTHS & RIPARIAN RESTORATION

Buffer protection for stream mitigation is intended to enhance the recovery and protection of stream mitigation projects. In most cases, a protected buffer of a minimum of 50 feet on piedmont/coastal plain streams and 30 feet on mountain streams extending landward from the bankfull elevation on each side of the stream will be required at stream mitigation sites (See Section 4 for list of mountain counties). It is generally acknowledged that wider buffers provide increased benefits to adjacent waters and, where appropriate and practicable, the acquisition of wider buffers will be encouraged. Under certain conditions, wider buffers may be required, based on comments from reviewing agencies or due to construction requirements. Increased buffer widths may be sought to protect sensitive riparian or instream environments, threatened or endangered species, or historical or cultural resources. Consideration for reduced buffer widths will be based on issues related to construction constraints and land ownership and may result in increased mitigation ratios. Such requests will be considered on a case-by-case basis. Justification for reduced buffer widths must be provided by the permit applicant and receive approval by the District and DWQ. Where stand-alone stream preservation is proposed as mitigation, additional buffer width of at least two times the base requirement may be required. When the project applicant proposes buffers that exceed the minimum requirement, the District may, with agreement of the permit review agencies, grant additional channel mitigation credit proportionate with expected benefits. Proposed

buffers containing stable riparian wetlands are generally viewed as highly functional ecological areas that often justify enhanced crediting.

Planting the riparian zone should be done as work proceeds or at the latest, immediately upon completion of stream construction activities. Stream banks will be planted with native vegetation that represents both woody (trees and shrubs) and herbaceous species. Species selection will be based on a survey of the vegetation from the reference reach; from less degraded sections of the stream being restored or from reference literature that details native species. The result should be an appropriate vegetative community for the site. Live staking, with such species as willow or dogwood, or the application of other bioengineering methods is recommended to provide bank stability and shade soon after project completion. Survival of woody species planted at mitigation sites should be at least 320 stems/acre through year three. A ten percent mortality rate will be accepted in year four (288 stems/acre) and another ten percent in year five resulting in a required survival rate of 260 trees/acre through year five. This is consistent with Wilmington District (1993) guidance for wetland mitigation. It is critical that disking and/or ripping of the flood prone area be done prior to planting. As knowledge of other systems is published or as reference reach information is developed, it will be incorporated into updated versions of this guidance.

Herbaceous vegetation should be established through plantings of existing plants by relocating sod mats or by seeding with a native riparian seed mix. An annual cover crop (barley, millet, wheat, rye, etc.) should be sowed to stabilize the banks until the other vegetation can become established. A cover crop should be selected whose germination season matches the time of application. Evaluations of the cover crop and perennial herbaceous vegetation should be made regularly to ensure good germination and establishment of the herbaceous community. ~~A project site vegetation plan is required as~~ part of the mitigation proposal.

Where appropriate, stream buffers should be protected from livestock through fencing and, if necessary, the installation of livestock watering facilities and managed stream crossings. The installation of signs or other acceptable forms of demarcation will identify buffers as a protected conservation area.

Wetlands occurring within stream buffers may be used for wetland mitigation purposes.

9. EASEMENTS AND HOLDING-MITIGATION SITES

Stream mitigation sites will generally be held and protected in perpetuity. Permanent conservation easements are acceptable methods of providing long-term protection. Where practicable, either the mitigation site or a conservation easement over the mitigation site must be transferred to a government entity or non-profit conservation organization capable of holding and managing the site for conservation purposes. The organization accepting the property or easement over the property must be acceptable to the District.

Long-term protection through restrictive covenant or deed restriction may be acceptable, provided the mitigation site is owned by the permit applicant and is part of the property for which the permit is issued. The applicant must show that other preservation mechanisms are not practical before the District will consider this option.

Long-term protection methods for all mitigation activities must receive approval by the District prior to implementation. A licensed attorney must draft easements, deeds, and restrictive covenants. Landowners must approve these agreements. Generally speaking, mitigation cannot be used for more than one purpose. Sites that are part of a landowner incentive program, or a federal or state ecosystem restoration program site are therefore unlikely to be acceptable as mitigation for Department of the Army permits. Except for very small sites, all mitigation sites must be surveyed, and an acceptable title opinion must be provided to the grantee of the property, with a copy to the District.

While the purpose of stream mitigation is to achieve long-term restoration, this may not always occur. In some instances, factors that are beyond the control of designers and the regulatory agencies may cause degradation. In those situations further restoration activities may reestablish stability. If the stream mitigation activities have been fully successful through 5 years and at least 2 bankfull events, the mitigation will generally be considered successful.

ACTIVITIES GENERALLY PROHIBITED WITHIN STREAM MITIGATION EASEMENTS:

- **Any change in, disturbance, alteration or impairment of the restored and natural features of the property, or any introduction of non-native plants or animals.**

- **Except as specifically authorized, construction or placement of any building, mobile home, road, trail, path, asphalt or concrete pavement, antenna, utility pole, or any other temporary or permanent structure or facility on the property.**
- **Agricultural, grazing, or horticulture use of property.**
- **Irrigation structures, dams, intakes and outfalls.**
- **Destruction, cutting, mowing, or harming any native vegetation on the easement property.**
- **Display of billboards, signs or advertisements, except the posting of no trespassing signs, or signs identifying the site as a conservation/ mitigation area.**
- **Dumping or storage of soil, trash, ashes, garbage, waste, abandoned vehicles, appliances, machinery, or hazardous substances, or toxic hazardous waste, or any placement of any underground or aboveground storage tanks on the property.**

- **Filling, excavation, dredging, mining or drilling, diking, removal of topsoil, sand, gravel, rock, peat, minerals or other materials, and any change in the topography of the land.**
- **Pollution, alteration, depletion or extraction of surface, natural watercourses or subsurface water. Any activity detrimental to water purity, or that would alter**

natural flows or water levels, drainage, increased in-stream sedimentation, or cause soil degradation or erosion.

- **Operation of motorcycles, dirt bikes, all-terrain vehicles, and any other type of motorized vehicles.**
- **Removal, relocation, modification, or general destruction of grade control, habitat, bank stabilization, or any other channel restoration and enhancement structures.**

10. FLEXIBLE STREAM MITIGATION

A. Urban Watershed Management

The District, DWQ and participating agencies fully support the implementation of stream mitigation within urban municipal areas. As a general rule, mitigation sites within urban areas will be utilized to compensate for unavoidable impacts to urban streams and such mitigation projects will generally comply with the guidance set forth by this document. In urban areas, traditional stream mitigation may not be possible due to multiple landowners, physical constraints, or hydraulic (flooding) concerns. As it is also recognized that innovative approaches to stream mitigation may provide benefits to water quality and aquatic life where traditional mitigation is not possible, these concepts are included in the category of Flexible Stream Mitigation and are described in the following sections. Where innovative approaches are approved, it will be expected that the project proponent will be required to document the benefits of the mitigation through monitoring. The specific mitigation credit that is generated from these innovative approaches will be determined by the District and DWQ on a case-by-case basis.

~~Watershed mitigation is essentially a program to provide long-term improvement and protection of an urban watershed (usually ½ square mile or larger) with a variety of best management practices (BMPs), installation of aquatic habitat structures, and measures for improving public access and enjoyment. Watershed mitigation planning will involve a two-step process: an overall watershed assessment that evaluates existing stream channel conditions, and a watershed-level stream channel and floodplain mitigation plan. The watershed analysis should include a detailed assessment of the tributaries and adjacent upland riparian/floodplain areas. The assessment will include information concerning stream classifications, current channel conditions, stream bank erosion potential, pollutant sources, information concerning watershed build-out, existing water quality data (if any) and data on fish and invertebrate species. The watershed assessment will identify needed mitigation measures and activities necessary to achieve the restoration goals stated in the watershed mitigation plan. The assessment will enable the project sponsor to generate a detailed watershed mitigation and management plan.~~

The use of BMPs for mitigation credit must be validated by conducting water quality and/or ecological surveys of benthic macroinvertebrate and/or fish communities to determine if the stated goals of the project have been met. These data should be supported by reviews of scientific literature prior to assigning credits. BMPs including, but not limited to, detention and retention wetlands, ponds or basins should not be placed

in waters of the US. Stand-alone BMP activities will not be credited where other mitigation activities are needed and can be reasonably implemented. Mitigation credits will not be granted on linear areas that are not protected by an approved conservation easement or other approved legal mechanism. Watersheds containing waters on the State of North Carolina's 303(d) list or classified as a High Quality Water/Outstanding Resource Water (or group of tributaries to the same), Trout Waters or tributaries, or similar classifications should be targeted under this watershed mitigation program. Development, implementation, and coordination of watershed mitigation plans will closely follow procedures already established for mitigation banks. This generally includes requirements relative to establishing mitigation review teams, use of banking instruments, and release of mitigation credits.

Watershed assessments will evaluate current stream channel conditions and identify mitigation measures to promote stable channel geometry. The plan will employ priority levels of restoration to the maximum extent practicable. In order for channel areas to receive mitigation credit, an approved conservation easement or other preservation mechanism must be in place.

MITIGATION ACTIVITIES THAT MAY BE IMPLEMENTED IN WATERSHEDS	
CHANNEL RESTORATION	✓
ENHANCEMENT LEVEL I	✓
ENHANCEMENT LEVEL II	✓
BANK STABILIZATION	✓
CHANNEL PRESERVATION	✓
BEST MANAGEMENT PRACTICES	✓
PUBLIC ACCESS	✓

The most important consideration for BMP selection for the watershed approach is the ability of the BMP to remedy the problem(s) identified in the watershed or sub-watershed assessment. For instance, if the problem identified is excess nutrient loading, one might consider utilizing an extended detention wetland, which is considered to be one of the better BMPs for nutrient removal. Similarly, it may be inappropriate to consider a dry detention pond, which is less effective at removing nutrients than other BMPs. In any event, BMPs must be considered on a case-by-case basis. The following table is meant to provide some guidance based on current literature reviews as to appropriateness of certain BMPs for certain situations.

BMP	POLLUTANTS
Extended detention wetlands	Total Suspended Solids (TSS), nutrients, heavy metals, hydrology
Extended detention wet ponds	TSS, nutrients, hydrology
Extended dry detention basins	TSS, hydrology
Forested filter strips or forested buffers	Nutrients, TSS
Bio-retention areas or rain gardens	TSS, nutrients
Grassed swales or open channel practices	Nutrients, TSS
Infiltration basins	TSS, nutrients (only appropriate in proper soils)
Sand filters	TSS, nutrients (only appropriate in special circumstances, very high maintenance required)

Reference: NCDENR Stormwater BMP Manual, April 1999
2000 Maryland Stormwater Design Manual Volumes I & II

B. Other Approaches

Other actions that result in demonstrable stream improvements may also be eligible for stream mitigation crediting on a case-by-case basis. However, these measures (BMPs or any other activity) must not be a requirement of a NPDES permit or other regulatory requirement. These options would have to be beyond those measures required by regulations and should be part of a local watershed restoration plan. These other options can provide long-term protection for a stream segment or a watershed and therefore have a role in stream mitigation. However, the US Army Corps of Engineers and the NC Division of Water Quality may limit the use of these other options in the context of stream mitigation since these agencies need to ensure that aquatic life uses are being replaced. These options must receive case-by-case approval from the US Army Corps of Engineers and the NC Division of Water Quality and must include a provision for monitoring that will demonstrate the water quality and aquatic life benefits of the project. As such, projects that target waters with impaired water quality such as 303(d) waters, closed SA waters and Nutrient Sensitive Waters are more likely to be approved.

11. MONITORING

The purpose of monitoring is to determine the degree of success a mitigation project has achieved in meeting the objectives of providing proper channel function and increased habitat quality. Specific objectives must be included in a project design and may also be evaluated. In general, monitoring data should provide the District and DWQ with evidence that the goals of the project were met. Monitoring should be directed at evaluating primary activities accomplished through mitigation projects. Monitoring secondary benefits or accomplishments may also be appropriate for large-scale projects, when projects are done in ecologically important areas or when secondary benefits are a primary objective. Secondary benefits are those that are not directly accomplished or established during site construction. For example: a primary activity would be constructing a root wad revetment, the secondary benefit would be the enhancement of aquatic populations. Three levels of monitoring will be required based on the complexity of the mitigation project being proposed.

Upon completion of the project, an as-built channel survey shall be conducted. It is recommended that stream surveys, for both project construction and project monitoring, follow the methodology contained in the USDA Forest Service Manual, *Stream Channel Reference Sites* (Harrelson, et.al, 1994). The survey should document the dimension, pattern and profile of the restored channel. Permanent cross-sections should be established at an approximate frequency of one per 20 (bankfull-width) lengths. In general, the locations should be selected to represent approximately 50% pools and 50% riffle areas. Flexibility in the location and frequency will be allowed for

cross-sections and should be based on best professional judgment. The selection of locations should always include areas that may be predisposed for potential problems. In the case of very narrow streams, two cross-sections per 1,000 lf will generally be sufficient. The as-built survey should also include photo documentation at all cross-sections and structures, a plan view diagram, a longitudinal profile, vegetation information and a pebble count for at least six cross-sections (or all cross sections if less than six required for project). If the restored stream section is less than 3,000 lf, the longitudinal profile should include the entire 3,000 lf, if the stream section is greater than 3,000 lf, the profile should be conducted for either 30 % of the restored stream or 3,000 lf (whichever is greater). Subsequent annual surveys will be required per instructions on the monitoring forms (biannual for photo documentation). It should be noted that different levels of mitigation would require different levels of monitoring. The as-built survey described above will generally be required only for Restoration and Enhancement Level I projects. The following paragraphs describe the specific requirements for the different levels of mitigation.

Monitoring Level I: This level of monitoring will apply to Restoration and Enhancement Level I projects. Because these projects involve the greatest degree of complexity they will require a more complex monitoring protocol. The required monitoring shall be performed each year for the 5-year monitoring period and no less than two bankfull flow events must be documented through the monitoring period. If less than two bankfull events occur during the first 5 years, monitoring will continue until the second bankfull event is documented. The bankfull events must occur during separate monitoring years. In the event that the required bankfull events do not occur during the five-year monitoring period, the Corps and DWQ, in consultation with the resource agencies, may determine that further monitoring is not required. It is suggested that all bankfull occurrences be monitored and reported through the required monitoring period. Monitoring data collected at level I sites should include the following: reference photos, plant survival analysis, channel stability analysis, and biological data if specifically required by permit conditions. Biological sampling evaluates secondary impacts of restoration projects. DWQ plans to evaluate 80 projects across the state to determine the benefits of these data in a mitigation monitoring protocol (see "Interim, Internal Technical Guide Summary – Benthic Macroinvertebrate Monitoring Protocols For Compensatory Stream Restoration Projects, dated July 2002, Version 1.3) which is available on DWQ's website <http://h2o.enr.state.nc.us/ncwetlands/>. These data will be required for those projects that are recommended by DWQ. Biological data may be required for other projects on a case-by-case basis. Data are to be collected prior to construction and for at least 3 years following construction. A 1-year recolonization/population adjustment time of biological monitoring following construction is usually warranted. In addition, the yearly data should be collected during the same season. (Photo documentation will be required twice a year – summer and winter.) Deviations from the required monitoring protocol will generally not be acceptable. However, proposed exceptions will be evaluated on a case-by-case basis by the District and DWQ, and will be coordinated with appropriate permit review agencies.

Monitoring Level 2: This level of monitoring will apply to Enhancement Level 2 projects. Because these projects will generally be on a smaller scale and less complex a simpler protocol is required. Monitoring data at these sites should include the following: reference photos and plant survival. Channel stability should also be evaluated when the mitigation project alters the bankfull channel. Additional types of information may be required from mitigating parties if recommended and justified by project reviewers. Data must be collected each year for 5 years at the same time of year. No less than two bankfull flow events must be documented through the required 5-year monitoring period. If less than two bankfull events occur during the first 5 years, monitoring will continue until the second bankfull event is documented. The bankfull events must occur during separate monitoring years. It is suggested that all bankfull occurrences be monitored and reported through the required monitoring period. Deviations from this protocol may be acceptable when they can be justified.

Monitoring Level 3: This level of monitoring will apply to mitigation consisting only of preservation. Since the only action in this case is administrative, protecting a reach, a 5-year monitoring plan is not required. However, reference photos should be taken and provided to the District and DWQ. These should well document the reach, including the riparian zone being preserved. As for all photo reference sites, a detailed description of the location at which the photo was taken should also be provided. Additional types of information may be required from mitigating parties if recommended and justified by project reviewers.

Success Criteria: As described above, this guidance requires three forms of monitoring to evaluate the success of the project; photo documentation, ecological function, and channel stability measurements. These criteria will be used to evaluate success by considering the following:

Photo documentation

- Channel aggradation or degradation
- Bank erosion
- Success of riparian vegetation
- Effectiveness of erosion control measures
- Presence or absence of developing instream bars (should be absent)

Ecological Function

- Health and survival of vegetation (80% survival of planted species required after 5 years)
- Restoration reach should mimic upstream conditions (or reference reach when applicable)

Channel Stability

- Should be insignificant change from the as-built dimension
- Do changes represent a movement in the direction of instability (e.g. increased width to depth ratio or a decreased width to depth ratio with decreased entrenchment ratio) or are changes minor and represent an increase in stability (e.g. decreased width to depth ratio without a decrease in entrenchment ratio)?
- Should be little change from the as-built longitudinal profile

Pool/riffle spacing should remain fairly constant
Pools should not be filling in (aggradation) or riffles starting to change to pools (degradation)
Pebble count should show a change in the size of bed material toward a desired composition.

Annual monitoring forms require as-built plans and current data. Monitoring reports should contain a discussion of any deviations from as-built and an evaluation of the significance of these deviations and whether they are indicative of a stabilizing or destabilizing situation. Appendix II summarizes the measures of success, failure, and required remedial actions.

Specific biological success criteria are currently a subject of applied research being coordinated by the NC Division of Water Quality. Formal development and adoption of biological success criteria (if any) will be done upon completion of that research.

REFERENCES

Dunne, T. and L. B. Leopold, 1978. *Water in Environmental Planning*, New York: W. H. Freeman and Company.

Federal Register. Thursday, March 9, 2000. Part III, Department of Defense, District of Engineers. *Final Notice of Issuance and Modification of Nationwide Permits*. Volume 65, No. 47, pp. 12818-12899.

Harrelson, C.C., C.L. Rawlins, J.P. Potyondy. 1994. *Stream Channel Reference Sites: An Illustrated Guide to Field Technique*. USDA Forest Service. General Technical Report RM-245.

Karr, J.R., K.D. Fausch, P.L. Angermeier, P.R. Yant and I.J. Schlosser. 1986. *Assessing Biological Integrity in Running Waters: A Method and Its Rationale*. Illinois Natural History Survey. Special Publication 5. 28pp.

Rosgen, D.L., 1994. A Classification of Rivers. *Catena* 22: 169-199.

Rosgen, D.L., 1996. *Applied River Morphology*. Wildland Hydrology Books, Pagosa Springs, CO.

Rosgen, D.L., 1997. A geomorphological approach to restoration of incised rivers. Proceedings of the conference On Management of Landscapes Disturbed by Channel Incision. S.S.Y. Wang, E.J. Langendoen and F.F. Shields, Jr. (editors).

Strahler, A.N. 1957. Quantitative Analysis of Watershed Geomorphology. *American Geophysical Union Transactions*. 38:913-920.