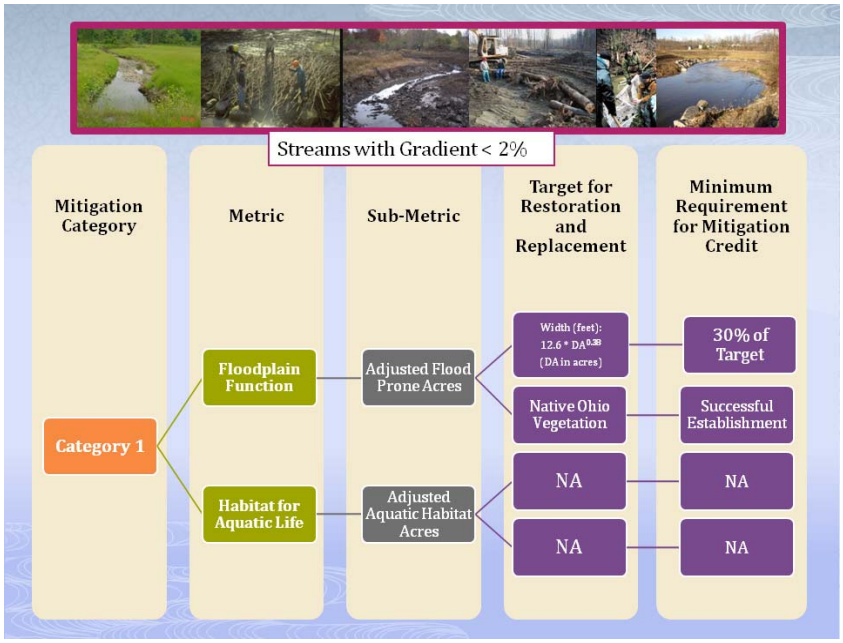
February 2010

Ohio Environmental Protection Agency

Compensatory Mitigation Requirements for Stream Impacts in the State of Ohio (Revision 5.0)



Interested Party Review Draft

Ted Strickland, Governor
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Notice Regarding the Interested Party Review Draft:

Reviewers will note that this version of the stream mitigation protocol does not contain worksheets or other supporting materials (e.g. spreadsheets) for the calculation of mitigation debits and credits. Previous material distributed for earlier versions of this protocol and/or stakeholder meetings should be considered outdated and should not be used in the review of the materials provided in this document or the associated draft rule language regarding stream mitigation requirements. In particular, the Vegetated Riparian Area metric contemplated in earlier work has been eliminated from this draft, and it is not anticipated that this metric will be used in the final rule.

Although useful tools for conducting calculations and summarizing mitigation-related data may be developed in the future, they are not necessary for the review of this document, as the language provided herein will dictate the content of any such materials. As these materials become available, they will be made available on the Ohio EPA web page related to the draft stream mitigation rules using the following links:

http://www.epa.ohio.gov/dsw/rules/draftrules.aspx

http://www.epa.ohio.gov/dsw/rules/draft_401wetland_feb06.aspx

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Preface

Ohio EPA has been working to develop a function-based stream mitigation strategy that reflects the tiered beneficial uses protected by the Ohio Water Quality Standards since 2002. A credit-debit system patterned after a protocol developed by the U.S. Army Corps of Engineers (USACE), Savannah District (U.S. Army Corps of Engineers, 2004) was used to develop a draft stream mitigation rule and an accompanying protocol document (Ohio EPA, 2004) that was circulated for Interested Party Review (IPR) in 2006. Similar approaches have been adopted and utilized in several USACE districts and states throughout the country.

Based upon comments received during the 2006 IPR process, Ohio EPA decided to conduct a series of stakeholder workshops to discuss an appropriate approach for modifications to the 2004 stream mitigation protocol document. The vision statement for this process and the completion of the stream mitigation protocol is:

> *"To develop a scientifically sound and predictable methodology for assessing impacts to stream ecosystems and associated compensatory mitigation proposals under review by Ohio EPA through the 401 Water Quality Certification Program."*

The principle outcome of these meetings was the conclusion that stream mitigation requirements should be constructed to reflect the tiered aquatic life and other beneficial uses of streams in Ohio. Tiered aquatic life uses are established in the beneficial use designations and water quality criteria found within Ohio law and rules, as well as the federal Clean Water Act and associated guidance. In addition, technical discussions regarding the debit-credit model used in the 2004 stream mitigation protocol revealed significant weaknesses within the categories and scoring criteria used in the debit-credit model it contained. Instead, alternative models for assessing debits and credits based upon measureable stream characteristics were proposed by the Ohio Department of Natural Resources for use as the basis of measurement of impact debits and mitigation credits.

Subsequent technical collaboration has resulted in the development of the stream mitigation rule (OAC 3745-1-56) which references this document for amplification. The regulatory framework incorporates a tiered mitigation approach and an acreage-based debit-credit system for impact vs. mitigation accounting in the 401 Water Quality Certification Process. Use of this approach is intended to meet the general goals stated above and provide a predictable, technically sound approach for assessment of stream mitigation projects in Ohio. At the same time, the debit credit system and mitigation goals allow flexibility to use innovative, science-based approaches for water quality improvement associated with these projects.

Acknowledgements

This document was written by Paul Anderson, Ohio EPA Division of Surface Water, Northeast District Office. The concepts regarding the use of flood prone area within the tiered mitigation model were conceived and developed by Dan Mecklenburg of the Ohio Department of Natural Resources (ODNR) Division of Soil and Water Conservation (DSWC). Laura Fay (ODNR, DSWC) and Randy Keitz (ODNR, Division of Mineral Resources Management) also assisted greatly in the development of this concept. The assistance of Dan Ross (Natural Resources Conservation Service), Joan Hug-Anderson Summit Soil and Water Conservation District), James Bissell (Cleveland Museum of Natural History), and Dr. Charles Goebel (The Ohio State University) is also especially acknowledged. In addition, this project could not have been completed without the assistance of many colleagues and stakeholders whose contributions are also acknowledged.

Several Ohio EPA personnel contributed to the formulation and completion of this document and are acknowledged for the time, resources, and energy they provided:

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1. Introduction

This stream mitigation document has been developed to provide guidelines to determine the appropriate stream mitigation requirements related to State Water Quality Certifications under Section 401 of the Clean Water Act[1] (State Water Quality Permits), Chapter 6111 of the Ohio Revised Code (ORC), and Chapters 3745-1 and 3745-32 of the Ohio Administrative Code (OAC). The development of compensatory mitigation plans for projects which qualify for approval under the State Water Quality Certification program is a critical part of the application process. Mitigation projects are required in order to ensure that there is no net loss of existing stream uses, water quality functions of the stream, or overall integrity of the aquatic resource. The purposes of this document are as follows:

1. The protocol provides the mechanism for implementation of the stream mitigation rule OAC 3745-1-56.

2. The protocol accounts for varying types of stream impacts with respect to existing stream uses as well as the range of potential mitigation projects which may be proposed to compensate for these impacts.

3. The protocol provides predictability and uniformity to the 401 Water quality certification process.

4. The protocol encourages the development of mitigation proposals which are scientifically sound and durable.

5. The protocol is designed to ensure that approved stream mitigation plans developed under the protocol are adequate to compensate for lost or impaired in-stream uses.

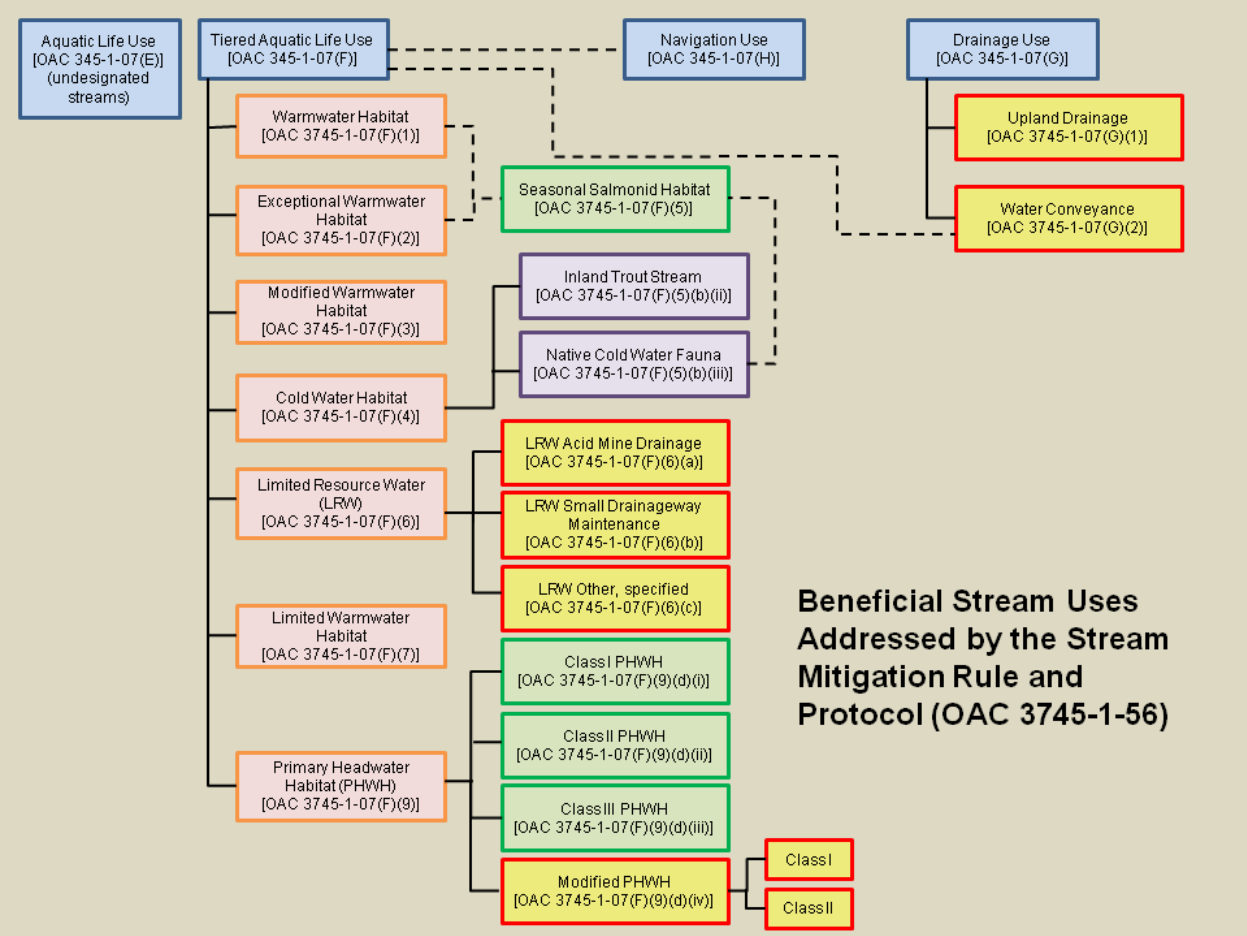
The federal Clean Water Act (Public Law 92-500), as amended, states that its primary objective is to *"...restore and maintain the chemical, physical, and biological integrity of the Nation's waters."* This objective is echoed in Ohio's Water Quality Criteria, which state that the purpose of the criteria is to *"...establish minimum water quality requirements for all surface waters of the state, thereby protecting public health and welfare; and to enhance, improve and maintain water quality as provided under the laws of the State of Ohio, section 6111.041 of the Revised Code, the federal Clean Water Act, 33 U.S.C. section 1251 et seq., and rules adopted thereunder*." [paragraph (A) of OAC Rule 3745-1-01] According to the federal Clean Water Act, anyone who wishes to discharge dredged or fill material into the waters of the U.S., regardless of whether on private or public property, must obtain a Section 404 permit from the U.S. Army Corps of Engineers (Corps of Engineers) and a Section 401 Water Quality Certification from

[1] Throughout this document, the term "State 401 Water Quality Certification" is used for consistency with the effective rule as of January 2010. The draft rule changes now under consideration uses the term "State Water Quality Permit" in place of "State 401 Water Quality Certification."

the State of Ohio. Responsibility for the processing of applications for Section 401 Water Quality Certifications rests with the Ohio EPA Division of Surface Water.

Water quality standards for streams in Ohio are based upon tiered aquatic life uses (Figure 1; also the Ohio EPA web page http://www.epa.ohio.gov/dsw/wqs/index.aspx provides detailed information). This system recognizes that the beneficial uses of streams, best interpreted as services relating to water quality functions, ecological integrity, recreational uses, and aesthetic benefits are variable across the landscape of Ohio. Therefore, antidegradation and stream mitigation requirements promulgated in OAC Rules 3745-32-04 and 3745-1-56 and described in this manual have been "tiered" to protect existing and designated uses and to apply mitigation requirements within the context of these uses for any given stream affected by activities requiring a 401 Water Quality Certification from the Ohio EPA.

Figure 1.



The Ohio EPA does not intend to require the use of any specific methodology, technology or technique in the development, design or implementation of stream mitigation projects. Instead, applicants who are required to develop stream mitigation

plans are encouraged to use sound ecological and engineering principles based upon state of the art knowledge in the development of their plans. It is recognized that the science behind stream assessment, protection and restoration methodologies is constantly evolving. In addition, it is also recognized that the availability of locations for compensatory mitigation projects is variable state-wide and that time constraints for the implementation of projects may make certain mitigation options less viable than others. Efforts have been made in the preparation of this document to allow for flexibility in the development of mitigation plans so that the maximum environmental benefit can be obtained through the mitigation process. It should be noted that these procedures do not exempt any application, regardless of the degree of mitigation proposed, from the anti-degradation requirements found in OAC Chapter 3745-32 or other applicable rules regarding avoidance, minimization, or the protection of existing uses for Waters of the State as required by ORC Chapter 6111.

1.1. What is a Stream?

This document covers the evaluation of impacts to "streams" and associated proposals for compensatory mitigation authorized under Sections 404 and 401 of the Clean Water Act and the water quality certification rule found in OAC 3745-1-56. As will be discussed in further detail below, there are other watercourses that do not meet the definition of "streams" but nevertheless are jurisdictional waters of the United States and as such are under the jurisdiction of the Corps of Engineers and the State of Ohio for permitting purposes. While the focus of this document is on streams, nothing herein should be construed to suggest that mitigation for non-stream jurisdictional waters is not required in the context of the 404/401 process.

1.1.1. Important Definitions:

A common understanding of several definitions is crucial for the correct interpretation and use of this document, since the protocols described in this document apply only to impacts to streams. Within the Ohio Water Quality Standards [OAC 3745-1-02 (B) (87)], a stream is defined as follows:

> "'*Stream' means a water body having a channel with well defined bed and banks, either natural or artificial, that confine and conduct continuous or periodical flowing water*."

The following definitions for terms used in the definition for "stream" and are listed for clarification purposes:

> **Bank:** can be interpreted as the land area bordering the stream channel equivalent to the width delimited by the **ordinary high water mark**.

Channel: the area between definite banks of a natural or artificial watercourse which confine and conduct continuously or periodically flowing water (ORC 6105.01).

Ordinary High Water Mark: that line on the shore established by the fluctuations of water and indicated by physical characteristics such as clear, natural line impressed on the bank, shelving, changes in the character of soil, destruction of terrestrial vegetation, the presence of litter and debris, or other appropriate means that consider the characteristics of the surrounding areas [33 CFR 328.3 (e)].

1.1.2. Watercourses Which Are Not Streams

It is recognized that there are some types of watercourses which either do not meet the definition of a stream or do not possess features meriting protection under compensatory mitigation requirements. Specific examples are roadside ditches and agricultural grass waterways. Typically, these types of waterways are highly modified and maintained water conveyances which do not serve as habitat for aquatic life. Care should be taken to ensure that the watercourse in question has been thoroughly described and evaluated against the definition of a stream as well as the aquatic life use designations found in OAC Rule 3745-1-07 prior to determining that compensatory mitigation under this methodology is appropriate.

In some situations, it may be possible that the Corps of Engineers will determine that an individual Section 404 Permit and Section 401 Water Quality Certification from the Ohio EPA is required for the placement of fill or dredge material into watercourses which do not meet the definition of a stream as described in this document. These cases will be dealt with on a case-by-case basis. It is essential that measures are taken in all circumstances to protect downstream water quality and aquatic life uses.

1.2. State Water Quality Certifications

According to the federal Clean Water Act, anyone (including private citizens, federal, state and local government agencies) who wishes to discharge dredged or fill material into the waters of the U.S., regardless of whether on private or public property, must obtain a Section 404 permit from the Corps of Engineers and a Section 401 Water Quality Certification from the state. In the State of Ohio, the Ohio Environmental Protection Agency administers the Section 401 Certification program in accordance with ORC Chapter 6111 and OAC Chapter 3745-32.

Examples of activities that may require a Section 404 permit and a Section 401 Water Quality Certification for impacts to streams can include, but is not limited to: construction of boat ramps, placement of rigid structures for erosion protection, placing fill, grading, dredging, ditching, construction of dams or dikes, stream channelization, stream

straightening, installation of utility or road crossings, and the installation of road crossings and culverts.

Ohio EPA has pre-granted Section 401 Water Quality Certifications to 404 permits for certain types of projects that are similar in nature and cause minimal degradation to waters of the state. These permits are called Nationwide Permits and substantially expedite the permitting process. To determine if a particular project qualifies for Nationwide Permits coverage, or requires an individual Section 401 Water Quality Certification from Ohio EPA, applicants should contact the Corps of Engineers first to discuss the project, and to become familiarized with all of the regulatory requirements applicable prior to the commencement of any activities. Contact information for the Corps of Engineers District Offices with jurisdiction in Ohio are listed below:

Buffalo District (Lake Erie Basin):

1776 Niagra St.
Buffalo, NY 14207-3199
(716) 879-4330

Louisville District (Little and Great Miami River basins):

CEORL-OR-F
P.O. Box 59
Louisville, KY 40201-0059
(502) 582-5607

Huntington District (Muskingum, Hocking, and Scioto River basins):

502 8th St.
Attn: CEORH-OR-F
Huntington, WV 25701-2070
(304) 529-5210

Pittsburgh District (Mahoning River Basin):

William S. Moorehead Federal Bldg.
1000 Liberty Ave.
Pittsburgh, PA 15222-4186
(412) 395-7152

Information regarding Ohio EPA's requirements and processing guidelines for Section 401 Water Quality Certification applications may be found at the following web address: http://www.epa.ohio.gov/dsw/401/index.aspx , or by contacting the Ohio EPA Division of Surface Water, P.O. Box 1049, Columbus, Ohio 43216-1049. Since application guidelines and processing procedures may change over time, it is important to contact the Ohio EPA prior to submitting an application in order to ensure that current procedures are being followed.

To minimize delays and objections during the permit and Water Quality Certification review process, applicants are encouraged to seek the advice of resource and regulatory agencies during the planning and design of mitigation plans. For restoration or stream relocation proposals and other complex mitigation projects, such consultation may improve the likelihood of mitigation success and reduce permit processing time. Furthermore, applicants should typically seek advice from consultants on complicated mitigation projects.

1.3. Mitigation Categories [OAC 3745-1-56 (B)]

The stream mitigation rule (OAC Rule 3745-1-56) defines four "mitigation categories" that serve as the basis for the development of tiered mitigation goals and requirements. The mitigation categories are based upon aquatic life beneficial uses and antidegradation categories, as defined in OAC Rules 3745-1-05 and 3745-1-07. Mitigation requirements and antidegradation considerations for review of applications for 401 Water Quality Certifications are based upon the mitigation category for the stream in question. It should be noted that in many instances, a stream that is subject to a 401 Water Quality Certification review will not be specifically designated with an aquatic life use, and that a use attainability analysis will be required in order to properly assign the stream to a mitigation category.

1.3.1. Mitigation Category 1 [OAC 3745-1-56 (B)(1)]

Mitigation Category 1 includes the following aquatic life uses:

(a) Limited resource water, acid mine drainage where qualitative habitat evaluation index (QHEI) scores representative of the impacted stream segment are found to be less than forty[2];

(b) Limited resource water, small drainageway maintenance;

(c) Other limited resource water designated streams listed under the provisions of rule 3745-1-07 of the Administrative Code;

[2] The following comment is included in OAC Rule 3745-1-56 (B)(1)(a) regarding acid mine drainage streams: "Although streams that cannot meet the biological water quality criteria found in rule 3745-1-43 of the Administrative Code because of the effects of acid mine drainage may be designated as limited resource water, many of these streams may have the capacity to recover when and if the chemical pollutant source or sources are treated or eliminated. Acid mine drainage streams with adequate habitat quality (QHEI scores greater than or equal to forty) are placed into a higher mitigation category in order to not preclude restoration of these streams."

(d) Class I primary headwater habitat; or

(e) Modified primary headwater habitat stream (regardless of class).

Aquatic life uses listed under Mitigation Category 1 are all considered Limited Quality Waters under OAC 3745-1-05, and have no potential to meet any of the ecological expectations for General High Quality Waters. Streams that fall within this category typically have ephemeral flow or exist only because they are constructed drainage conveyances. The services provided by these streams are overwhelmingly related to their affect on downstream water quality. These services include hydrologic storage and flow moderation, sediment transport processes, and pollutant assimilation. Mitigation goals for replacement, enhancement, or restoration for these stream types relate to physical stability and flood prone area functions. These streams provide no habitat for well balanced communities of aquatic organisms defined within Ohio's biological water quality criteria. Therefore, replacement of a defined stream channel is not a requirement for mitigation of Mitigation Category 1 streams.

1.3.2. Mitigation Category 2 [OAC 3745-1-56 (B)(2)]

Mitigation Category 2 includes the following aquatic life uses:

(a) Modified warmwater habitat (MWH);

(b) Limited resource water (LRW), acid mine drainage where QHEI scores representative of the impacted stream segment are found to be greater than or equal to forty; or

(c) Class II primary headwater habitat (Class II PHWH).

Aquatic life uses listed under Mitigation Category 2 are also considered to be Limited Quality Waters in the antidegradation rule. However, unlike Mitigation Category 1 uses, streams within Mitigation Category 2 do have definable aquatic life expectations and/or can be considered to have an aquatic life restoration potential. This aquatic life potential is lower than the expectations for Mitigation Category 3 streams, and is limited based upon either historic modifications to the stream that are considered to be permanent or of long duration (LRW and MWH uses), or because of natural conditions (Class II PHWH). Therefore, the mitigation goals for streams in Mitigation Category 2 relate both to their influence on downstream water quality as well as expectations (albeit lowered) for aquatic life community integrity.

Data from Ohio EPA surveys has found that the aquatic communities present in Mitigation Category 2 stream types are extremely resilient to perturbation once a stream channel has stabilized. Organisms inhabiting these stream types tend to be adapted to recover quickly from perturbations such as canopy removal, higher water temperatures,

and intermittent flow conditions. Therefore, mitigation goals for Mitigation Category 2 streams are similar to the goals for Mitigation Category 1 with the addition that the outcome must include replacement with a stable channel capable of providing equivalent aquatic life function. Specific habitat targets may be appropriate for LRW-AMD streams assigned to Mitigation Category 2, as well as MWH streams. Habitat targets for Class II PHWH streams are not generally needed, as proper flood prone area dimensions and vertically stable channel design will almost always result in suitable habitat to support Class II PHWH aquatic communities.

1.3.3. Mitigation Category 3 [OAC 3745-1-56 (B)(3)]

Mitigation Category 3 includes the following aquatic life uses:

(a) Warmwater habitat where the stream is categorized as general high quality water in of rule 3745-1-05 of the Administrative Code.

(b) Coldwater habitat – inland trout streams where the stream is categorized as general high quality water in of rule 3745-1-05 of the Administrative Code.

(c) Seasonal salmonid habitat.

(d) Class III primary headwater habitat.

Mitigation Category 3 aquatic life uses fall under the General High Quality Water classification in the antidegradation rule (OAC Rule 3745-1-05). This aquatic life tier represents the primary restoration goal of the Ohio Water Quality Standards and the federal Clean Water Act. Streams falling within the aquatic life uses covered under Mitigation Category 3 have specific biological and habitat quality goals which should be considered within the mitigation context as measurements of success. The outcome of meeting these goals can be stated as preserving, enhancing, or restoring the potential for these waters to support and maintain well balanced communities of aquatic organisms sufficient to meet the aquatic life use category assigned to the stream. The outcomes for mitigation projects involving Mitigation Category 3 streams include goals and performance criteria for stream channel stability, flood prone area function, habitat quality, and riparian vegetation. Specific outcomes with respect to attainment of biological criteria may or may not be applicable for individual stream mitigation projects, dependent upon the site setting and conditions within the watershed.

1.3.4. Mitigation Category 4 [OAC 3745-1-56 (B)(4)]

Mitigation Category 4 includes the following aquatic life uses:

(a) Warmwater habitat (WWH), where the stream is categorized superior high quality water, outstanding state water, or outstanding national resource water in rule 3745-1-05 of the Administrative Code;

(b) Coldwater habitat (CWH) – inland trout streams where the stream is categorized superior high quality water, outstanding state water, or outstanding national resource water in of rule 3745-1-05 of the Administrative Code;

(c) Coldwater habitat (CWH) – native fauna ; and

(d) Exceptional warmwater habitat (EWH).

Streams with aquatic life uses that fall within Mitigation Category 4 include waters found to possess exceptional ecological characteristics typified by a highly diverse or specially adapted aquatic biological community or as providing habitat to Ohio or federal endangered or declining species. These streams also include waters classified as Outstanding State Waters based upon exceptional recreational values that merit a high degree of protection. Streams designated within the uses covered by Mitigation Category 4 represent the best of the best with respect to streams in Ohio, and merit special protection under the Water Quality Standards. Therefore, mitigation goals for streams with uses listed in Mitigation Category 4 must be sufficient to both maintain the potential to support these uses and to demonstrate that the use continues to be supported following the completion of activities governed under the 401 Water Quality Certification. Mitigation standards, performance criteria, and monitoring requirements for mitigation projects associated with these streams must be sufficiently robust to meet these goals with respect to flood prone area, habitat quality, riparian vegetation, and biological community integrity.

1.3.5. Changes to Assignment of Mitigation Category

The provisions of OAC 3745-1-56 describe a procedure to allow changes to the mitigation category assignment for a given stream segment on a case-by-case basis. Two types of changes may occur, either raising a stream segment to a higher mitigation category or allowing an applicant to use a lower mitigation category for evaluation of the design of a mitigation project. Ohio EPA will raise the mitigation category assignment of a stream segment in cases where it is determined that the level of ecological integrity within an impacted reach is higher than implied by a current use designation or where a higher level of protection is necessary in order to protect existing uses or downstream water quality (see Section 1.4).

Applicants may request that a particular stream reach be downgraded to a lower mitigation category in instances where the existing condition of an affected stream reach can be demonstrated to be inconsistent with a designated use. For all such requests, the burden is on the applicant to demonstrate that the request is justified. In most cases, these situations will involve stream reaches in the extreme headwaters of previously designated streams where Ohio EPA has surveyed the stream at a larger drainage scale and the use designation has been applied to the entire stream. However, other instances where it may be appropriate to lower the mitigation category of a stream segment may also exist. An example would be a situation where irretrievable modifications to a stream channel or flood prone area have occurred which eliminates any possibility to meet the criteria for the default mitigation category for the stream.

Justifications to lower the mitigation category for a particular stream segment must demonstrate that all of the following are true: 1) the current condition meets the criteria of another aquatic life use designation, 2) that the condition is the result of either historical modification to the stream channel that is either permanent in nature or of a long-term duration that is unlikely to change, 3) and that the mitigation criteria applied under the lower designation will be protective of downstream beneficial uses.

1.4. Determinations Regarding Protection of Downstream Uses

An important component of the stream antidegradation provisions found in OAC Rule 3745-32-04 is the protection of existing and designated beneficial uses of the stream. This not only includes the direct area of impact (i.e. on-site alterations), but also includes an analysis of potential impacts on both upstream and downstream water quality. Beneficial uses must be protected from unacceptable degradation within the context of the stream continuum. For example, a project to re-locate a stream channel that does not provide measures to ensure vertical stability of the channel bed may result in a head cut migrating upstream from the disturbance. This result may degrade habitat and water quality to the point that applicable water quality criteria are no longer attained. Increased erosion and sediment transport downstream may also affect water quality. In addition, site alterations resulting in changes to the infiltration of groundwater or runoff characteristics may also affect hydrologic regimes critical for the support of sensitive ecological conditions (e.g. Class III PHWH or CWH uses). The potential for these types of impacts should be thoroughly evaluated and addressed during the 401 Water Quality Certification process.

It is not possible to provide universal guidelines regarding the extent or scope of the analysis of potential upstream or downstream impacts within 401 certification applications. However, general guidance is provided below that may assist in providing consistency within the 401 certification process. In addition, specific guidance for on-site replacement of Mitigation Category 1 and 2 streams is provided in this document that are assumed to be protective when properly implemented (see Section 3.0). It is

important to note that the burden is upon the applicant to provide a scientifically reasonable assurance that upstream and downstream beneficial uses will be protected within the context of OAC Rule 3745-32-04 (D) and are protected or enhanced through mitigation. If Ohio EPA has reason to believe that a particular regulated activity will result in an impact which will result in non-attainment of applicable water quality criteria or that existing in-stream uses will be lost, then that application cannot be approved.

1.4.1. Downstream Use – General Guidelines

General guidelines offered for consideration when examining potential downstream or upstream impacts when preparing or reviewing antidegradation applications related to 401 Water Certifications:

1) For affected stream segments that are second order[3] or less based upon examination of the smallest scale stream mapping resource available[4]: the downstream stream reaches that are two orders higher and all contributing streams that are lower in stream order than the affected segment. For example, if the impact is to a second order stream based upon the NRCS county soil map, the applicant should evaluate potential impacts to existing in-stream uses for the first order streams located upstream of the project, and to the third and fourth order streams located downstream of the proposed impact.

2) For affected Mitigation Category 1 or 2 streams that are third order or higher, and for streams defined under the Drainage Use designation [OAC 3745-1-07 (G)] that become subject to a 401 Water Quality Certification: 2,000 linear feet of channel length upstream or downstream of the proposed impact or mitigation.

3) For impacts to Mitigation Category 3 or 4 streams with watershed areas greater than 1 mi^2 (640 acres): 1 river mile (5,280 linear feet) of channel length. For Mitigation Category 3 or 4 streams with drainage areas less than 1 mi^2, the guidance provided in item (1) above should be evaluated for adequacy.

Note that this guidance is provided as a set of recommendations for consideration during the review process. These are not rigid requirements. Where site-specific conditions merit either a more rigorous or less stringent evaluation of potential impacts on upstream or downstream waters, the standards for review should be adjusted accordingly.

[3] First order streams are those streams at the uppermost limits of the drainage network. Two first order streams merge to form a second order stream, two second order streams merge to form a third order streams, and so on.

[4] Detailed hydrologic layers suitable for this evaluation are available for all Ohio counties on NRCS soil maps. These maps can be downloaded at the following URL: http://soils.usda.gov/survey/online_surveys/ohio/ . Other mapping resources may also be available that provide more current information. Use of these resources should be encouraged if they provide information at a similar or more detailed scale.

2. Compensatory Mitigation

Stream mitigation projects are required to compensate for the temporary or permanent lowering of water quality related to impacts authorized under Sections 404 and 401 of the Clean Water Act and State Water Quality Certifications issued in accordance with OAC Chapter 3745-32. This protocol includes descriptions of on-site and off-site stream mitigation requirements that meet the requirements of the state's stream mitigation rule OAC Rule 3745-1-54. Federal requirements for compensatory mitigation for streams are found within USACE and U.S.EPA regulations (33 CFR Part 332 and 40 CFR Part 230, respectively). Ohio EPA rules do not mimic the federal regulations. Instead, they are designed to be consistent with the federal mitigation regulatory framework and to amplify the ecological and water quality goals they are premised upon within the context of the Ohio Water
Quality Standards.

Information regarding the federal stream mitigation requirements for Section 404 permits can be found using the following web page: http://www.epa.gov/wetlandsmitigation/. The federal compensatory mitigation rules were published in the Federal Register on April 10, 2008: http://www.epa.gov/owow/wetlands/pdf/wetlands_mitigation_final_rule_4_10_08.pdf . It is highly recommended that applicants for state water quality permits make every effort to consult with appropriate local, state, and federal agencies prior to the development of permit applications and compensatory mitigation plans in order to facilitate the regulatory process.

2.1. Mitigation Debit – Credit System

The federal stream mitigation rules utilize the concept of debits and credits for determining mitigation requirements for aquatic resources. The federal rules define these terms as follows (40 CFR 230.92, 33 CFR 332.2):

> "*Debit* means a unit of measure (e.g., a functional or areal measure or other suitable metric) representing the loss of aquatic functions at an impact or project site. The measure of aquatic functions is based on the resources impacted by the authorized activity."
>
> "*Credit* means a unit of measure (e.g., a functional or areal measure or other suitable metric) representing the accrual or attainment of aquatic functions at a compensatory mitigation site. The measure of aquatic functions is based on the resources restored, established, enhanced, or preserved."

The Ohio stream mitigation rule (OAC 3745-1-56) and this protocol utilize a debit-credit system that is consistent with the federal definitions to quantify the degree of impact and mitigation improvements. Two categories of credits and debits are used for stream mitigation based upon units of acres: adjusted flood prone area, and adjusted habitat

area. Credits and debits for adjusted flood prone area are not interchangeable with those for the adjusted habitat area; they are accounted for separately.

The adjusted flood prone area is defined as the area (in units of acres) contiguous to a stream channel or flow path that lies at or below the flood prone elevation, adjusted for soil properties and elevation in accordance with the procedures given in Section 4 of this document. Analysis of adjusted flood prone area metric is applicable for debit-credit calculations for all stream types and mitigation categories except for Lake Erie lacustuaries. In Lake Erie lacustuary[5] areas, a single metric (in units of acres) based upon a combination of inundated area delineations and habitat quality scores is quantified for mitigation debits and credits. The calculation methodology used in these unique areas is described in Section 6.

The adjusted habitat area (in units of acres) is defined as the channel area with the potential to support aquatic life, adjusted for habitat quality as measured using standardized indices of habitat quality. The procedures to calculate debits and credits for the adjusted habitat area are provided in Sections d and e. The adjusted habitat area metric applies to all Mitigation Category 3 and 4 streams including segments within Lake Erie lacustuary areas. However, the Adjusted Habitat Area metric is calculated using different procedures in free-flowing lotic systems (Section 5) than that used in lacustuary areas (Section 6).

The procedures used to calculate debits and credits uses measureable conditions and outcomes that directly relate to water quality functions. Stream ecosystem services related to pollutant assimilation capacity, sediment transport, water quantity (flow and velocity) moderation, habitat quality, and the potential to support aquatic life uses are reflected within these estimations. The quantification procedures also are scaled directly to stream size, thus eliminating the inherent weakness associated with the use of linear channel measurements as the currency for mitigation debits and credits.

2.2. Mitigation Design Goals and Targets

The compensatory stream mitigation strategy for Ohio can be summarized as follows:

Premise: The ecological integrity of a stream will be maximized in its natural state when best fit to its existing conditions.

Natural stream systems, though dynamic within the limits of their floodplains, are inherently stable over the long term with respect to their channel form (dimension, pattern, profile, and bed material). Similarly, mitigated streams provided with adequate riparian area at the proper elevation will evolve to a form which mimics natural conditions. The result is the development of a self-maintaining form that provides water

[5] A lacustuary is defined as a transition zone in a river that flows into a freshwater lake and is the portion of river affected by the water level of the lake (Thoma, 1998). Lacustuary in terms of this document refers specifically to Lake Erie estuary areas. See Section 6 for additional information.

quality and ecological services inherent within the natural stream setting. Along with naturalization of the physical channel form, the vegetated riparian area and habitat for aquatic life will also stabilize and improve over time, thereby increasing the potential for the stream to support beneficial ecological services.

From this premise, the following general statement can be made with respect to the design objective for any stream mitigation project:

> ***Stream mitigation projects shall be designed to minimize the deviation of the stream from its natural condition.***

As stated above in Section 1, tiered aquatic life use designations in the Water Quality Standards are used to account for the variations in beneficial uses realized over the ranges of watershed characteristics and stream hydrology. Stream function, as defined in the federal regulations (40 CFR 230.92 and 33 CFR 332.2) are *"…the physical, chemical, and biological processes that occur in ecosystems*." [emphasis added] Therefore the functions pertinent in any stream mitigation setting will vary dependent upon the potential of the stream to support defined aquatic life uses. The mitigation categories defined in OAC Rule 3745-1-56 reflect these variations so that a systematic, watershed-based approach can be developed to protect in-stream uses. The objectives for mitigation project design stated above can therefore be stated as a tiered set of generalized goals based upon the stream mitigation category of the stream in question (see Section 1.3 above and Table 1).

Table 1. General mitigation goals based upon stream mitigation category.

Mitigation Tier	Maintain, Enhance, or Restore:
Mitigation Category 4:	Function, Form, Habitat, Ecological Integrity
Mitigation Category 3:	Function, Form, Habitat, Ecological Potential
Mitigation Category 2:	Function, Form
Mitigation Category 1:	Function

The generalized goals stated in Table 1 can be expanded upon to provide more specific guidelines for stream mitigation projects as listed in Table 2. These goals are based upon the specific outcome-based criteria presented for the adjusted flood prone area metric (Section 4) and the adjusted habitat area metric (Section 5) presented in this protocol. Note that the targets listed in Table 2 are intended to be generalized guidelines to provide guidance in the development of mitigation plans. Exceptions to these guidelines may be necessary based upon site-specific considerations. To the extent possible, clarification has been provided in Sections 4, 5, and 6 to clarify how to

Table 2. Decision Matrix for Stream Mitigation Design (Streams with < 2% Slope)

	Targeted Use:	Mitigation Category 1	Mitigation Category 2	Mitigation Category 3	Mitigation Category 4
Purpose	**Maintain:**	Pollutant assimilation, sediment transport, flow and velocity control	Plus channel form	Plus habitat features	Plus ecological integrity
	Mitigation Goal:	Protect downstream use	Protect downstream use via reference reach; maintain existing ecological value	Maintain potential to support attainment or enhance/restore to condition to support ALU	Maintain existing ALU indices
Minimum Design Criteria	**Vertical Stability:**	*Stream reach must be vertically stable (demonstrate that incision will not occur during a project-specific monitoring period)*			
			Grade control structures (if necessary) should incorporate ecological design considerations (e.g. riffle structures instead of weirs).		
	Flood Prone Area: (Section 3.0)	*The greater of the area based on existing flood prone width OR: area based on percentage of the target streamway width (see Section 3.1)*			
		30% of the target streamway area	30% of the target streamway area	30% of the target streamway area	50% of the target streamway area
	If sensitive downstream use:	*If the downstream use is Mitigation Category 3 or 4, 50% of the target streamway area if needed to protect downstream use*			
	Floodplain Soils:	Suitable to support native Ohio vegetation suited for locale	Suitable to support native Ohio vegetation suited for locale	or the reference reach conditions	or the reference reach conditions
	Channel Form:	Not applicable	Reference reach conditions	Reference reach conditions	Reference reach conditions
	Substrate:	Not applicable	Not applicable	Reference reach conditions	Reference reach conditions
	Riparian:	Stable bank with native vegetation, and no more than 2 cuttings/year	Plus control of invasive vegetation. Consider Category 3 criteria for sensitive downstream use.	Plus woody vegetation unless natural condition is other. Consider temperature control for Category 4 downstream use	Plus woody vegetation unless natural condition is other and temperature not a concern
	Habitat:	Not applicable	Varies, see Table 10	See Table 10	See Table 10
	Biotic:	Not applicable	Include features to support the greater of the current biological index score or applicable biocriteria	Include features to support the greater of the current biological index score or applicable biocriteria	Plus preserve any special conditions and higher anti-degradation tier attributes
	TMDL:	*Design should address any applicable problems identified in the TMDL report*			

adjust mitigation expectations in these circumstances. Note also, that the guidelines listed in Table 2 are intended for streams with channel slopes less than 2 percent, and also should not be used to evaluate projects conducted in Lake Erie lacustuaries. Instead, the information provided in Sections c and e below should be used to evaluate mitigation proposals for these circumstances.

Terminology used in Table 2:

Channel Form: refers to the channel's cross-sectional dimension, meander pattern, and profile.

Flood Prone Area: The flood prone area is defined in Section 2.1 and is discussed in detail in Section 3 of this document.

Reference Reach: refers to the conditions that are exhibited in a similar stream reach that is stable given the existing land use in the watershed, the upstream drainage area, soils, geology, history, and topography. For guidance on the proper interpretation and use of reference reach in stream channel design, the reader is referred to suitable literature such as Rosgen (2002), or resources provided via the Ohio DNR Division of Soil and Water Conservation web page:
http://www.ohiodnr.com/soilandwater/water/streammorphology/default/tabid/9188/default.aspx

2.3. Types of Compensatory Mitigation for Streams

Four types of stream mitigation projects are recognized within the context of this protocol and OAC Rules 3745-1-56 and 3745-32-04: on-site stream replacement, stream restoration, stream enhancement, and stream preservation. Definitions and guidance for each of these mitigation types is given below. Instructions regarding the assignment of debits and credits and debit-credit accounting related to these activities are provided in Section 2.4.

2.3.1. On-Site Stream Replacement and Stream Relocation

"Stream relocation" means to create a stream channel to convey the stream flows away from the natural or existing stream channel in order to facilitate development, alter hydrologic conditions or otherwise cause a permanent abandonment of the an existing stream channel from flowing water. In conducting a stream relocation project, the existing aquatic habitat typically is completely eliminated through the transfer of flow or the placement of fill material into the existing channel.

"On-site stream replacement" incorporates mitigation activities of varying levels of effort dependent upon the mitigation category of the stream as defined below.

1. For Mitigation Category 1 streams, replacement of functional flood prone area or channel reconstruction in accordance with the procedures described in Section 3.1 or 3.2 of this manual, as appropriate, to meet the on-site mitigation standard set in OAC 3745-1-56 (D)(3)(a). Where the on-site stream replacement criteria are met for Mitigation Category 1 streams, all stream mitigation requirements are satisfied. Furthermore, the project is exempted from avoidance and minimization requirements, the demonstration of important social, economic and environmental benefits and factors reviewed in determination of whether or not to allow a lowering of water quality [see OAC 3745-32-04(C)(1)].

2. For Mitigation Category 2 streams, stream channel relocation in accordance with the procedures described in Section 3.1 or 3.2 of this manual, as appropriate, to meet the on-site mitigation standard set in OAC 3745-1-56 (D)(3)(b). For streams designated or meeting the definition of MWH or LRW-AMD (where QHEI scores are greater than 40), habitat performance criteria also need to be met as described in Table 10 and Section 5 of this manual. Where the on-site stream relocation criteria are met for Mitigation Category 2 streams, all stream mitigation requirements are satisfied. Furthermore, the project automatically is considered to be a minimal degradation alternative and the project is exempt from avoidance and minimization requirements [see paragraph (C)(1) of OAC Rule 3745-32-04.

3. For Mitigation Category 3 and 4 streams, on-site stream relocation projects must account for the provision of adequate flood prone area and habitat quality using the guidelines provided in Sections 3 and 4 of this manual [OAC 3745-1-56 (D)(3)(c)]. Determinations with respect to meeting mitigation requirements are based upon comparisons of impact debits to mitigation credits. In instances where the credits for the relocated channel equal or exceed the debits calculated for the impacts associated with the project, no additional mitigation is needed. However, if a deficit exists for one or both of the debit-credit metrics, then additional mitigation will be required as necessary to balance the debits with mitigation credits in accordance with paragraph (D)(4) of OAC Rule 3745-1-56. There are no exemptions or default minimal degradation alternatives related to the antidegradation rule for Mitigation Category 3 and 4 relocation projects.

Stream relocation involving Mitigation Category 3 and 4 streams is considered to be a severe impact with respect to the existing use of a stream. Avoidance of these types of impacts is highly recommended. However, where the need for relocation is deemed unavoidable, design of the relocated channel meeting the criteria

Re-located stream segments must be protected from further impacts in perpetuity and provide for final mitigation outcomes that foster long-term stream stability (i.e. self-maintaining systems). The general goals include enhancement or restoration of the potential of the stream to meet its designated or potential aquatic life, recreational and

water supply uses, to protect downstream water quality and beneficial uses, and to promote long-term stream integrity.

2.3.2. Stream Restoration

Stream restoration means the implementation of stream channel or riparian buffer improvement activities for stream segments that fail to meet the goals for adjusted flood prone area, adjusted habitat area, or both as outlined in OAC Rule 3745-1-56. Stream restoration projects must provide demonstrable improvements that results in meeting the adjusted flood prone area or habitat quality goals outlined in OAC Rule 3745-1-56 during the applicable mitigation monitoring period."

The federal mitigation regulations provide the following definition:

> *"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." (40 CFR 230.92, 33 CFR 332.2)

To apply these definitions, the debit and credit accounting system can be used as an evaluation tool. In order for a particular mitigation project to be considered as restoration, it must first be determined that the stream segment involved is degraded for one or both of the debit-credit metrics. This evaluation is appropriate because the units for debits and credits used in this protocol are related directly to measureable stream characteristics related to stream functions. Therefore, quantification of pre- and post-mitigation conditions can be used to determine whether an outcome will be considered to meet the stream restoration definition. If comparison of the existing condition of the adjusted flood prone area and/or the adjusted habitat area to the minimum mitigation targets listed in Table 2 indicates that the stream is not meeting the goals, then the site is a candidate for stream restoration credits for the affected metric(s). To receive stream restoration credit, the resulting condition (following the implementation of mitigation activities and the appropriate monitoring period) must meet performance criteria that achieve the minimum mitigation targets. Performance criteria for other characteristics not directly measured by the debit-credit metrics (e.g. outcome of planting plans, etc.) may also be linked to the awarding or credits as appropriate.

2.3.3. Stream Enhancement

Stream enhancement means the implementation of stream channel or riparian buffer improvement activities for stream segments that are fully meeting the goals for adjusted flood prone area, adjusted habitat area, or both as outlined in OAC Rule 3745-1-56. Stream enhancement projects must provide demonstrable improvements in adjusted flood prone area, habitat quality, or riparian buffer quality during the applicable mitigation monitoring period."

The federal mitigation regulations provide the following definition:

> *"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)." (40 CFR 230.92, 33 CFR 332.2)

The approach to determine if enhancement credits are applicable for a stream mitigation project is similar to that described above for stream restoration. The determining factor is the starting point with respect to the debit-credit metric in question. Enhancement credits are appropriate in instances where the existing (pre-mitigation) condition for the site already meets the minimum mitigation goal for the metric in question. The resulting condition (at the end of the monitoring period) must be indicative of an improved condition as quantified by an increase in the adjusted acreage credits for the metric. Enhancement credits are awarded differently than restoration credits, as outlined in Section 2.4.2.

2.3.4. Stream Preservation

Stream preservation means the protection of ecologically important stream segments in perpetuity through the implementation of appropriate legal mechanisms to prevent harm to the stream channel or associated riparian buffer."

The federal mitigation regulations provide the following definition:

> *"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." (40 CFR 230.92, 33 CFR 332.2)

The provisions of the stream mitigation rule (paragraph (D)(4) of OAC Rule 3745-1-56) sets out the following requirements for stream preservation credits:

> (b) For debits accrued for impacts to streams that fall within either mitigation category 3 or 4, the majority of the credits (at least fifty-one per cent) must be generated through stream restoration or stream enhancement activities. Mitigation credits for stream preservation projects up to forty-nine per cent are acceptable for stream segments that are assigned to mitigation categories 3 or 4.
>
> (c) The director may approve mitigation credits for stream preservation projects for stream segments assigned to mitigation category 1 or 2 based upon a demonstration by the applicant that the following conditions are true:
>
> (i) The project is necessary to protect ecologically important downstream uses; and

(ii) The preserved stream segment has sufficient physical or ecological integrity to provide beneficial water quality or ecological function.

(d) Mitigation credits necessary to meet the requirements of this rule shall be provided according to the ratios in table 1 of this rule. The mitigation ratio expresses the number of credits required per number of debits.

Stream preservation projects should be focused upon preserving areas of high ecological significance and stream functional integrity. Some examples of these stream types are as follows:

- streams designated as or meeting the definition of Class III PHWH, Cold Water Habitat, or Exceptional Warmwater Habitat in OAC Chapter 3745-1;
- streams designated as Superior High Quality Waters, Outstanding State Waters, or Outstanding National Resource Waters in accordance with OAC Rule 3745-1-05;
- streams designated as Scenic Rivers or Wild and Scenic Rivers under ORC Section 1517.14;
- streams documented to provide habitat for federal or state listed endangered or threatened species or species of special management concern;

Preservation projects are also encouraged for existing highly functioning stream segments in watersheds listed as impaired in either the State Water Quality Inventory generated in compliance with Section 305 (b) of the Clean Water Act or on the State List of Impaired Waterbodies generated in compliance with Section 303 (d) of the Clean Water Act. Special consideration should be given to situations where stream preservation activities meet the goals for the implementation plans listed in Total Maximum Daily Load studies, watershed-specific stormwater management permits, or watershed management plans developed in conjunction with the state non-point source management plan. Where these types of stream segments exist, their preservation can be an important tool to prevent further degradation within the watershed and to provide the opportunity to restore these watersheds to meet Clean Water Act goals.

Stream preservation projects must include the implementation of legal mechanisms approved by the Ohio EPA which are sufficient to prevent harm to the stream ecosystem. Preservation of the channel alone will not be accepted without inclusion of the protection of an appropriate adjacent riparian buffer as necessary to ensure protection of the stream. This shall include, at a minimum, the entire flood prone area that is included in the credit calculations for the adjusted flood prone area metric.

In order to promote the restoration of impaired waters in the State of Ohio, paragraph (D)(4) of Rule 3745-1-56 requires that the majority (at least 51%) of the mitigation

credits for Mitigation Category 3 and 4 streams be derived from enhancement or restoration projects. This limit does not apply to on-site or off-site mitigation projects for Mitigation Category 1 or 2 stream impacts where mitigation via preservation is offered.

2.3.5. Stream Mitigation Applicability Check Lists

To aid applicants and reviewers in the analysis of applicability credit accounting, Tables 3 through 6 provide check lists of criteria that must be met in order to allocate restoration, enhancement, and preservation credits. The check lists are based upon the design goals provided in Table 2. Note that many stream mitigation projects, especially those involving Mitigation Category 3 and 4 streams, will be hybrid projects. That is, mitigation credits for the two metrics may be generated under a combination of mitigation types, dependent upon the existing (pre-mitigation) condition and the degree of improvement realized in the resulting (post-mitigation) conditions. For example, a project may be conducted on a segment of stream where the existing flood prone area condition is acceptable (meets mitigation goals), but where the habitat for aquatic life is degraded. In this instance, the flood prone area may be credited as a preservation project, but the aquatic habitat may be credited as a stream restoration.
Please note that some projects may also result in a situation where streams will be impacted, but where significant function remains. That is, the resulting condition may still meet the minimum design criteria provided in Table 2, but there is a quantifiable decrease in one or both of the debit-credit metrics. Use of the appropriate check list (Tables 3 through 6) will determine whether the resulting condition will be eligible for any credit toward the mitigation requirements. If the minimum requirements are not met for the debit-credit metric, the resulting condition will be assumed to be 0 (zero) with respect to that metric for accounting purposes.

2.4. Debit and Credit Accounting

Mitigation requirements for impacts to streams are met when the credits generated for a mitigation project equal or exceed the debits accrued for impacts. This is true for both analysis of the on-site replacement requirements of paragraph (D)(3) of OAC Rule 3745-1-56 or the mitigation requirements found in paragraph (D)(4) of OAC Rule 3745-1-56. However, the method of calculation of debits varies according to whether or not the on-site replacement criteria are met, or, if other mitigation is necessary, with respect to the type of mitigation offered (i.e. restoration, enhancement, or preservation). When mitigation is conducted off-site, the credits may be discounted to account for increasing the distance between the location of the impact and the mitigation site (same watershed vs. adjacent watershed vs. distant watershed).

Accounting for the Adjusted Aquatic Habitat Area is conducted independently of that used to determine the mitigation requirements for the Adjusted Flood Prone Area. Projects that result in debits for both debit-credit metrics may provide mitigation for

Table 3. Mitigation credit applicability chart for the Adjusted Habitat Area debit-credit metric.

Metric	Mitigation Category	Applicability	Criterion	Existing Condition Meets Criterion?	Applicable Mitigation Types	Requirements for Credit (Resulting Condition)
Adjusted Habitat Area	Mitigation Category 3 & 4	All assigned uses	Existing habitat index score greater than target and Condition Factor acceptable? (Table w)	Yes	Preservation	Both index score and condition factor must meet minimum mitigation goals.
					Enhancement	The index score, the condition factor, or both must show improvement. No decrease in either component over the monitoring period.
				No	Restoration	Both the index score and the condition factor must improve to meet the minimum mitigation goal during the monitoring period.
	Mitigation Category 2	MWH LRW-AMD (QHEI>40)	Existing habitat index score greater than target and Condition Factor acceptable? (Table w)	Yes	Preservation	Preservation applicable on case-by-case basis with Mit. Cat. 4 or special downstream use and agency permission. Both index score and condition factor must meet minimum mitigation goals.
					Enhancement	The index score, the condition factor, or both must show improvement. No decrease in either component over the monitoring period.
				No	Restoration	Both the index score and the condition factor must improve to meet the minimum mitigation goal during the monitoring period.
		Class II PHWH	No habitat criteria	---	---	---
	Mitigation Category 1	All assigned uses	No habitat criteria	---	---	---

Table 4. Mitigation credit applicability chart for the Adjusted Flood Prone Area debit-credit metric for Mitigation Category 4 streams.

Metric	Mitigation Category	Sensitive Downstream Use-Based Design?	Criterion	Existing Condition Meets Criterion?	Applicable Mitigation Types	Conditions for Credit (Resulting Condition)
Adjusted Flood Prone Area	**Mitigation Category 4**	**---**	**≥50% of Target Streamway Area?**	**Yes**	**Preservation**	Provide long-term protection. No degradation of condition during the monitoring period. Demonstrate that aquatic habitat and riparian vegetation are suitable and do not decline during the monitoring period.
					Enhancement	Positive increase in adjusted flood prone area metric resulting in value greater than initial value. No decline in biological indices, habitat quality, or riparian vegetation quality. Ensure vertical stability.
				No	**Restoration**	Positive increase in adjusted flood prone area metric. Resulting area for the metric equal to at least 30% of the streamway target or greater than the initial area, whichever is larger. No decline in biological indices, habitat quality, or riparian vegetation quality. Ensure vertical stability.

Table 5. Mitigation credit applicability chart for the Adjusted Flood Prone Area debit-credit metric for Mitigation Category 3 streams.

Metric	Mitigation Category	Sensitive Downstream Use-Based Design?	Criterion	Existing Condition Meets Criterion?	Applicable Mitigation Types	Conditions for Credit (Resulting Condition)
Adjusted Flood Prone Area	Mitigation Category 3	Yes	≥50% of Target Streamway Area?	Yes	Preservation	Provide long-term protection. No degradation of condition during the monitoring period. Demonstrate that aquatic habitat and riparian vegetation are suitable and do not decline during the monitoring period.
					Enhancement	Positive increase in adjusted flood prone area metric resulting in value greater than initial value. No decline in habitat quality. Provide suitable vegetated riparian buffer. Ensure vertical stability.
				No	Restoration	Positive increase in adjusted flood prone area metric. Resulting area for the metric equal to at least 30% of the streamway target. No decline in habitat quality. Provide suitable vegetated riparian buffer. Ensure vertical stability.
		No	≥30% of Target Streamway Area?	Yes	Preservation	Provide long-term protection. No degradation of condition during the monitoring period. Demonstrate that aquatic habitat and riparian vegetation are suitable and do not decline during the monitoring period.
					Enhancement	Positive increase in adjusted flood prone area metric. Demonstrate that aquatic habitat and riparian vegetation are suitable and do not decline during the monitoring period. Ensure vertical stability.
				No	Restoration	Positive increase in adjusted flood prone area metric. Resulting area for the metric equal to at least 30% of the streamway target. No decline in habitat quality. Provide suitable vegetated riparian buffer. Ensure vertical stability.

Table 6. Mitigation credit applicability chart for the Adjusted Flood Prone Area debit-credit metric for Mitigation Category 1 and 2 streams.

Metric	Mitigation Category	Sensitive Downstream Use-Based Design?	Criterion	Existing Condition Meets Criterion?	Applicable Mitigation Types	Conditions for Credit (Resulting Condition)
Adjusted Flood Prone Area	Mitigation Category 1 & 2	Yes	≥50% of Target Streamway Area?	Yes	Preservation	Applicable on a case-by-case basis only. Provide long-term protection. No degradation of condition during the monitoring period. Demonstrate that riparian vegetation is suitable and does not decline during the monitoring period.
					Enhancement	Positive increase in adjusted flood prone area metric resulting in value greater than initial value. Demonstrate that riparian vegetation is suitable and does not decline during the monitoring period. Ensure vertical stability.
				No	Restoration	Positive increase in adjusted flood prone area metric. Resulting area for the metric equal to at least 30% of the streamway target. Demonstrate that riparian vegetation is suitable and does not decline during the monitoring period. Ensure vertical stability.
		No	≥30% of Target Streamway Area?	Yes	Preservation	Preservation not applicable in this situation.
					Enhancement	Positive increase in adjusted flood prone area metric. Demonstrate that riparian vegetation is suitable and does not decline during the monitoring period. Ensure vertical stability.
				No	Restoration	Positive increase in adjusted flood prone area metric. Resulting area for the metric equal to at least 30% of the streamway target. Demonstrate that riparian vegetation is suitable and does not decline during the monitoring period. Ensure vertical stability.

either metric independently of the other through independent projects. Likewise, mitigation projects may generate credits for one or both metrics, depending upon the setting and efforts needed to meet mitigation goals. Projects are deemed to meet the mitigation criteria when the credits (adjusted acres of mitigation) meet the debits (adjusted acres of impact) as determined through the calculations provided herein and the mitigation ratios set in OAC 3745-1-56(G)(4) and (5).

The procedures and accounting protocol for calculating adjusted flood prone area or adjusted aquatic habitat area debits and credits are described in Sections 2.4.1 and 2.4.2 below. Section 4 of this document describes the procedures for calculating the debit-credit metrics for the adjusted flood prone area metric, and Sections 5 and 6 are used to calculate the adjusted habitat area.

2.4.1. Debit Accounting

The equation for calculation of the base stream impact debits is as follows:

$$(A_i - A_r) = A_d \qquad (eq.\ 1)$$

Where:

A_i = initial Adjusted Flood Prone Area or Adjusted Habitat Area (acres);

A_r = resulting Adjusted Flood Prone Area or Adjusted Habitat Area (acres); and

A_d = the base Adjusted Flood Prone Area or Adjusted Habitat Area debits (acres).

The debits calculated using equation 1 above establish the base for mitigation credits needed to offset stream impacts for the project in question. In order to meet the on-site replacement provisions of paragraph (D)(3) of OAC Rule 3745-1-56 and Section 3 of this document, the following conditions must be met:

1. For streams with channel slopes (gradient) less than two percent, the criteria presented in Section 3.1 below must be met. In addition, the resulting base debit value (A_d from equation 1 above) must be less than or equal to 0 (zero) for the completed project (i.e. the resulting Adjusted Flood Prone Area and/or Adjusted Habitat Area must be greater than or equal to the initial value or values).

2. For streams with channel slopes greater than two percent, the adjusted flood prone area metric is not used for Mitigation Category 1 and 2 streams. Instead, the channel reconstruction criteria provided in Section 3.2 are used to determine if the stream channel is properly sized. For Mitigation Category 3 and 4 streams, evaluation of the Adjusted Habitat Area metric (Section 5), and the performance

criteria listed in Table 3 are used to determine if the on-site replacement criteria are met.

If the on-site replacement criteria are met, no additional mitigation is necessary for the project.

In instances where the on-site replacement criteria are not met, the mitigation requirements are governed by paragraph (D)(4) or OAC Rule 3745-1-56. Mitigation may be conducted on-site, off-site, or in combination. The rule incorporates two adjustment factors to the base debit calculation for calculation of the final debit value that must be offset with credits to meet the mitigation requirements: the mitigation ratio from Table 1 of OAC Rule 3745-1-56 (reproduced as Table 7 below), and any adjustment for the watershed location of the site where mitigation credits are generated.

The appropriate mitigation ratio from Table 7 is chosen based upon the Mitigation Category of the stream segment that is being impacted by the project. The mitigation ratio is multiplied by the base debits to determine the number of credits needed to meet the mitigation requirements (before watershed location adjustment).

For example, if the base debit calculation (A_d from equation 1 above) is equal to 2.1 acres for the Adjusted Flood Prone Area Metric, and the impact is to a Mitigation Category 3 stream segment, the number of credits needed would be:

***2.1 (A_d) times 1.5 (the ratio for Mitigation Category 3) = 3.15 acres**.*

Table 7. Mitigation ratios established in Tabe z of OAC Rule 3745-1-56.

Impacted Stream Category	Mitigation Ratio (Credits:Debits)
Mitigation Category 1	1.0 : 1.0
Mitigation Category 2	1.0 : 1.0
Mitigation Category 3	1.5 : 1.0
Mitigation Category 4	3.0 : 1.0

The provisions of paragraph (D)(4)(e) of OAC Rule 3745-1-56 also require that the credits for mitigation be adjusted based upon the watershed location for the compensatory mitigation relative to the location where the impacts occur. The language of the rule itself provides the necessary guidance for the applicability of the adjustment, and is as follows:

(e) Mitigation credits necessary for off-site stream mitigation projects shall be adjusted based upon the location of the mitigation project in relation to the location of impact as described in this paragraph.

(i) For mitigation projects located along the same stream as the impact and within the same 12-digit HUC watershed, no adjustment is required.

(ii) For mitigation projects that are not along the same stream but are located within the same 12-digit HUC watershed as the impact, ten per cent additional credits are required. The director may waive the addition of required mitigation credits for mitigation projects that are located within the same 12-digit HUC watershed if it is determined that:

(a) Site-specific conditions prevent mitigation either on-site or along the impacted stream;

(b) The resulting stream condition following the completion of the project causing the impacts will not negatively impact downstream water quality; and

(c) The mitigation provided will provide significant water quality benefits.

(iii) For mitigation projects that are not located within the same 12-digit HUC watershed as the impact but are within the same 8-digit HUC watershed, twenty per cent additional credits are required.

(iv) For mitigation projects that are located outside the 8-digit HUC watershed where the impacts occur, forty per cent additional credits are required.

[Comment: mitigation projects outside the 8-digit watershed where the impacts occur will be allowed only rarely and in instances where it can be demonstrated that no other suitable mitigation is possible within the watershed.]

Note that for projects where mitigation is offered from multiple locations (on-site or off-site), the debit calculation should be adjusted to reflect the watershed adjustment for each of the mitigation projects offered.

2.4.2. Credit Accounting

Once eligibility for stream mitigation credits under the Adjusted Flood Prone Area and Adjusted Aquatic Habitat Area metrics is determined based upon the factors listed in Tables 3 through 6 and Sections 3 through 5, credits are allocated as follows:

1. Preservation-only credits are awarded based upon the **initial** adjusted acreages for the eligible metrics.

2. Enhancement-only credits are awarded based upon the **improvement** for those metrics eligible for enhancement credits. The improvement is equal to the difference between the **resulting** condition and the **initial** condition.

3. Enhancement + preservation credits are awarded based upon the **resulting** adjusted acreages for the eligible metrics.

4. Restoration-only credits, credits are awarded based upon the adjusted acreage **improvement** for those metrics eligible for restoration credits. The improvement is equal to the difference between the **resulting** condition and the **initial** (degraded) condition.

5. Restoration + preservation credits are based upon the **resulting** adjusted acreages for all of the eligible metrics **plus** the adjusted acreage **improvement** for those metrics eligible for restoration credits. The improvement is equal to the difference between the **resulting** condition and the **initial** (degraded) condition.

3. Stream Replacement Guidelines

The objective of this section is to set best management practice criteria sufficient to fully meet the on-site mitigation requirements for Mitigation Category 1 and 2 streams found in OAC 3745-1-56 (D)(3).

Physical alterations of stream channels and the resulting degradation of stream channel stability and ecological integrity is a leading cause of impairment in Ohio streams. The integrity of streams, and the ecological services they provide are closely associated with their physical condition with respect to cross-sectional dimensions and vertical stability. Floodplain connectivity determines the erosional and depositional dynamics of the stream system, and provides significant water quality services via physical, chemical, and biological processes that directly influence water quality, quantity, and ecological integrity. Therefore, Ohio EPA's goal is to promote stream mitigation design that recognizes these important water quality services.

Mitigation and replacement goals for impacted stream reaches are based upon the stream gradient of the reach that is impacted. On-site mitigation goals for all categories of streams include vertically stability and a sound ecological trajectory that will replace or enhance existing streams water quality functions.

Specific goals for the outcome of mitigation projects, based upon the mitigation category of the affected stream, are as follows:

1. Mitigation Category 1 and 2 streams with channel slopes that are less than 2 percent: replacement or enhancement of water quality functions associated with the flood prone area. [Criteria used to determine the degree of flood prone area necessary to meet the mitigation requirements are described in Section 3.1.]

2. Mitigation Category 1 and 2 streams with channel slopes greater than or equal to 2 percent: establishment of a vertically and laterally stable channel with proper cross-sectional dimension. [Criteria for meeting this requirement are provided in Section 3.2.]

3. Mitigation Category 3 and 4 streams: the Mitigation Category 1 and 2 replacement criteria should be reviewed for sufficiency in providing desired habitat to meet the requirements of OAC 3745-1-56 (D)(3)(c). Dimensions may be modified if appropriate to the setting and if the design is adequately supported by reference reach data. Additional bed form, meander pattern or habitat features may also be necessary, as the applicant must demonstrate that habitat quality performance criteria found in Section 5 will be met in the affected stream reach at the conclusion of the monitoring period.

4. All Mitigation Category 2, 3, and 4 streams: to be counted as on-site mitigation, the resulting channel length must be greater than or equal to the length of impacted stream segment [OAC 3745-1-56 (D)(3)].

The requirements of this section do not apply to Lake Erie lacustuaries [see Section 6 for applicable performance criteria for these areas].

3.1. On-Site Replacement Requirements for Mitigation Category 1 and 2 Streams with Channel Slopes Less Than 2 Percent

The frequently flooded area adjacent to the stream of interest for the analysis of mitigation requirements is based upon the concept of the streamway (Ward and Trimble, 2004; ODNR, 2006; Ward, et. al, 2008). The streamway is the area associated with a stream where ecological processes and function are dominated by flowing water. It includes the channel and adjacent floodplain where strong interaction and exchange between the two is important for sustaining water recource integrity. The technical definition is as follows:

> *"The streamway is the zone within an active floodplain that is large enough to sustain dynamic equilibirum and provides enough space for the main channel to adjust its pattern".* (Ward, et. al, 2008)

A standard has been established for streamway size generally associated with natural streams in Ohio with channel slopes less than 2%. The standard is a relationship of streamway width to drainage area and is fully described in the Third Edition of the "*Rainwater and Land Development*" manual (ODNR, 2006). The streamway target width is defined by the following equation:

$$W_{sw} = 147 * DA^{0.38} \qquad (eq.\ 2)$$

Where: W_{SW} = width of the target streamway (feet)

DA = upstream drainage area (mi^2).

Streamways measured in units of area rather than width are more indicative of stream quality and more accommodating to site constraints. The target streamway width can be converted to an equivalent area for mitigation project sites using the following equation:

$$A_{sw} = W_{sw} * L_v \div 43{,}560 \qquad (eq.\ 3)$$

Where: A_{sw} = the streamway target area (acres);

W_{sw} = the target streamway width from equation 2 (feet);

$\mathbf{L_v}$ = the valley length (feet)[6]; and

43,560 is the conversion from square feet to acres

General targets for design of replacement stream channels and minimum design standards for mitigation credit eligibility can be related to the target streamway area. The area associated with the full streamway width is sufficient to provide ecological function and services appropriate for high quality stream restoration work. Good quality function describes the threshold of 50 percent of the target, while 30 percent of the target streamway width is typically considered the narrowest streamway that reliably performs some watershed benefit. Below this threshold, stream systems are typically characterized as unstable or simply as conduits with little or no functional value with respect to water quality.

In order to meet the on-site mitigation requirements found in OAC 3745-1-56(D), replacement or relocation of flood prone area associated with Mitigation Category 1 or 2 streams must be equal or exceed the greater of:

1. the existing adjusted floodprone area; or

2. an adjusted flood prone area equivalent to thirty percent of the target streamway area[7] ($\mathbf{A_{sw}}$ as calculated in **equation 3**).

The Adjusted Flood Prone Area is calculated using the procedures described in Section 4 below.

For Mitigation Category 1 and 2 mitigation projects, the primary goal for on-site replacement of stream water quality functions is the protection of downstream water quality. Therefore, the ecological services provided to the watershed are most closely linked to the total streamway area rather than the stream length or target streamway width. The quantity of mitigation is in units of area (acres) determined by the appropriate target width multiplied by valley length. The location and shape of the resulting streamway area is flexible, providing its area is greater than or equal to the appropriate minimum[8].

In very low energy streams where channel forming processes are not controlled by bed load sediment, the flood prone area relationship described above may not apply. Channel forming processes in these streams are often more influenced by herbacious

[6] The valley length is the straight length in the down valley direction of the stream valley as measured between points on the thalweg at the upstream and downstream termini of the stream reach.
[7] A higher value up to the full target streamway area may be required if determined to be necessary to protect sensitive waters such as, but not limited to, Exceptional Warmwater Habitat, Coldwater Habitat-Native Fauna, Outstanding State Waters, and Superior High Quality Waters. The assessment of potential impact shall be determined on a case-by-case basis based upon pertinent facts.
[8] Comment: for projects relating to Mitigation Category 3 and 4 streams, linear connectivity along the stream channel margin is ecologically relavent and must be considered for design.

vegetation along the stream margin. Many of these types of streams were formed through the channelization of wetlands for agricultural development. Use of 15 percent of the target streamway width as alternative mitigation target may still provide measureable improvement over existing channelized conditions (i.e. where the existing adjusted flood prone area is much less than 15 percent). Reduced mitigation targets are only calculated when site-specific considerations justify limiting the requirements for flood prone area creation.

Other examples of the types of situations that may be considered for allowing reduced flood prone area replacement requirements are geological constraints within the stream corridor, regional reference reach data that support reduced targets, or other overwhelming considerations (such as historical preservation concerns, the presence of permanent structures, etc.) that limit the extent for flood prone area creation. Mitigation credit should not be awarded in any situation where the adjusted flood prone area (calculated using the procedures described in Section 4) is less than 15 percent for sites where channel slopes are less than 2 percent. Use of alternative streamway targets is allowed only with the approval of Ohio EPA.

3.2. Design Criteria for Re-Constructed Mitigation Category 1 or 2 Stream Channels with Slopes Greater Than Two Percent

The following criteria in this section are used to meet the on-site replacement requirements found in OAC 3745-1-56 (D) where stream slopes exceed two percent.

3.2.1. Cross-Sectional Shape

The channel cross-section shall be proportioned consistent with a Rosgen Type B channel for channel slopes of two to four percent and with a Rosgen Type A channel for channel slopes greater than four percent (Rosgen, 2002). The channel dimension criteria listed in Table 8 and the channel design criteria listed below shall be considered to be sufficient to satisfy on-site mitigation criteria where $\mathbf{A_{25}}$ is the cross sectional area in square feet of the 25 year recurrence interval peak discharge.

Alternative channel designs may be considered on a site-specific basis where supported by engineering analysis. Use of alternative designs must be approved by Ohio EPA.

Table 8. Cross-section design for reconstructed high gradient channels.

Channel Slope	Side Slope	Base Width (ft)	Minimum Channel Depth (ft)
2-4%	4:1	$1.2(A_{25})^{0.5}$	$0.4(A_{25})^{0.5}$
>4%	2:1	$1.0(A_{25})^{0.5}$	$0.5(A_{25})^{0.5}$

3.2.2. Stream Stability Requirements for Re-Constructed Channels with Slopes Greater Than Two Percent

The re-constructed channel shall be lined or armored as needed to be vertically stable for at least a 25 year recurrence interval event. The channel lining shall be designed utilizing standard engineering methods to ensure vertical and lateral stability (i.e. appropriate bedding material, rock size and thickness). The rock lining shall be top dressed as follows:

1. the channel bed shall be top dressed with gravel sufficient to fill in the voids between the rocks; and

2. the side slopes of the channel shall be covered with topsoil sufficient to cover the rock and allow vegetation to become established. Erosion control matting may be used if necessary to prevent erosion until vegetation becomes established.

4. Adjusted Flood Prone Area Quantification Method

This section defines a standardized methodology for calculating an adjusted flood prone area (in units of acres) adjacent to impacted or mitigated stream segments that can be used to account for stream mitgation debits and credits for all mitigation categories in accordance with the requirements found in OAC 3745-1-56 (D).

The flood prone area is defined as the area adjacent to the stream that is innundated or saturated when the elevation of the water is at twice the maximum depth at bankfull stage (Rosgen, 2002). This flood stage commonly corresponds with large events happening only a few times each century. Lower stages inundated by more frequent events, particularly nearer the bankfull stage, govern the majority of the water quality functions that occur in the flood prone area. Therefore, quantification of the loss or gain of riparian area inundated at different stages can be used as a measurement tool to gage the degree of impacts or mitigation improvements within the stream corridor.-

Floodplain soils are integral with many ecological processes of streams. Benefits of natural healthy floodplain soil include physical stabilization, the quality and vigor of riparian vegetation, nutrient (particularly N and P) assimilation, interception and storage of runoff, carbon sequestration, sediment retention and processing, and soil biodiversity (Wall, et al., 2004). The water quality services provided within the flood prone area adjacent to channels relocated to lie within upland soils or within lower soil horizons often differ remarkably from those provided by the natural riparian soil associations. Poor soil conditions may indefinitely limit the ecological processes and water quality functions associated with the flood prone areas adjacent to the stream.

Procedures for adjusting the value of the flood prone area for calculating the requirements for stream mitigation are based upon the areas flooded at three specific stages of flow (Section 4.1) and upon the soil characteristics for the existing or proposed flood prone area (Section 4.2).

4.1. Flood Prone Area Height Weighting Factors

The Adjusted Flood Prone Area is calculated as the sum of three sub-areas; high, intermediate and low. The sub-areas are based upon elevation in relation to the maximum bankfull depth (all areas shall be expressed in acres):

> **FPA_{low}** = the flood prone area that is inundated or saturated when the water elevation is at the bankfull stage (including the bankfull channel).
>
> **FPA_{int}** = the flood prone area that lies within the elevation range between the bankfull stage and 1.5 times the maximum stream depth at the bankfull stage.

FPA_{high} = The flood prone area that lies within the elevation range between 1.5 times the maximum stream depth at the bankfull stage to 2.0 times the maximum stream depth at the bankfull stage.

For purposes of adjusting the flood prone area for calculating credits and debits for stream mitigation, less frequently flooded areas are given less weight than more active flood prone areas. Flood prone area height weighting factors used to calculate the Adjusted Flood Prone Area are as follows:

FPA_{low}: no adjustment

Factor for **FPA_{int}** = 0.8

Factor for **FPA_{high}** = 0.5

Figures 2 and 3 provide example representations of the elevation categories and corresponding flood prone areas.

In order to calculate the areas or the sub-areas within the flood prone area of the stream, the elevation of the maximum bankfull depth (**D_{max}**) must be determined. The maximum bankfull depth is defined as the maximum depth of the bankfull channel measured in a riffle or run and not in a pool. Guidance for determining the bankfull elevation are detailed in Harrelson et al. (1994), and is also described in the U.S. Forest Service video resource **"**Identifying Bankfull Stage in Forested Streams in the Eastern United States" (http://stream.fs.fed.us/publications/videos.html).

The elevation categories can be determined using surveyed bankfull channel dimensions, regional curves, or the following general D_{max} equation for Ohio. (Note that this procedure is utilized for evaluating flood prone area debits and credits, and is not intended to be a substitute for engineering analysis in channel design.)

The value of **D_{max}** for Ohio streams can be calculated based upon the upstream drainage area using the following equation:

$$\mathbf{D_{max} = 2.2 * (DA)^{0.24}} \qquad \textbf{(}\textit{eq. 4}\textbf{)}$$

Where: **D_{max}** = the maximum depth of the bankfull channel as measured in a riffle or run section (feet), and

DA = the upstream drainage area (mi^2).

Source: Ohio DNR, Division of soil and Water Conservation, adapted from Dunne and Leopold (1978).

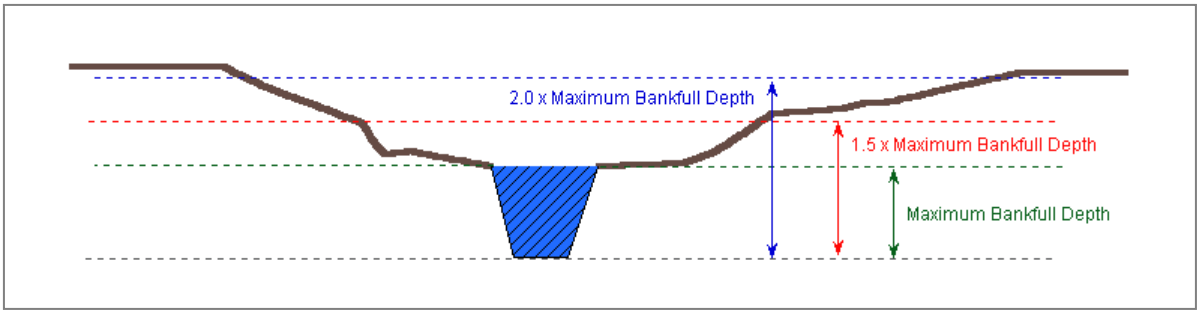


Figure 2. Schematic of elevation categories and cross-sectional measurements used to calculate flood prone areas associated with the calculation of the Adjusted Flood Prone Area.

The area corresponding to $\mathbf{FPA_{low}}$ is determined as all areas inundated or saturated when the water stage is at or below the bankfull stage. Subsequent demarcations for the elevations corresponding to $\mathbf{1.5 * D_{max}}$ (to determine FPA_{int}) and at $\mathbf{2.0 * D_{max}}$ (to determine FPA_{high}) can then be constructed.

Either of two methods is acceptable for the determination of the flood prone areas at the three elevations used to calculate the Adjusted Flood Prone Area:

1. planimetric determination of the areas based upon a site topographic survey or design plans, or

2. the use of average flood prone area cross sectional widths for each elevation category times the valley length.

Where surveys of site topography are used to determine the elevation based flood prone areas, the contour intervals should be no more than 2 feet in elevation. Contour intervals should be 1 foot or less for sites with drainages less than 1 mi^2. Under all circumstances, the contour interval shall be of sufficient detail to provide meaningful measurements of change based upon the proposed impacts or mitigation activities.

Where cross-sectional dimensions are used to calculate the elevation-based flood prone areas, the number of surveyed or designed cross sections must be sufficient to accurately characterize the site. The cross-sections shall be utilized to determine the average widths at the three stages used to calculate the Adjusted Flood Prone Area. Two (2) cross sections shall be provided at a minimum for projects affecting 500 feet of channel or less. For projects affecting more than 500 feet of channel shall provide additional cross sectional data at a minimum of one per 500 foot increment. More frequent cross sections may be necessary to adequately delineate the flood prone areas where there is significant topographic heterogeneity within the stream corridor.

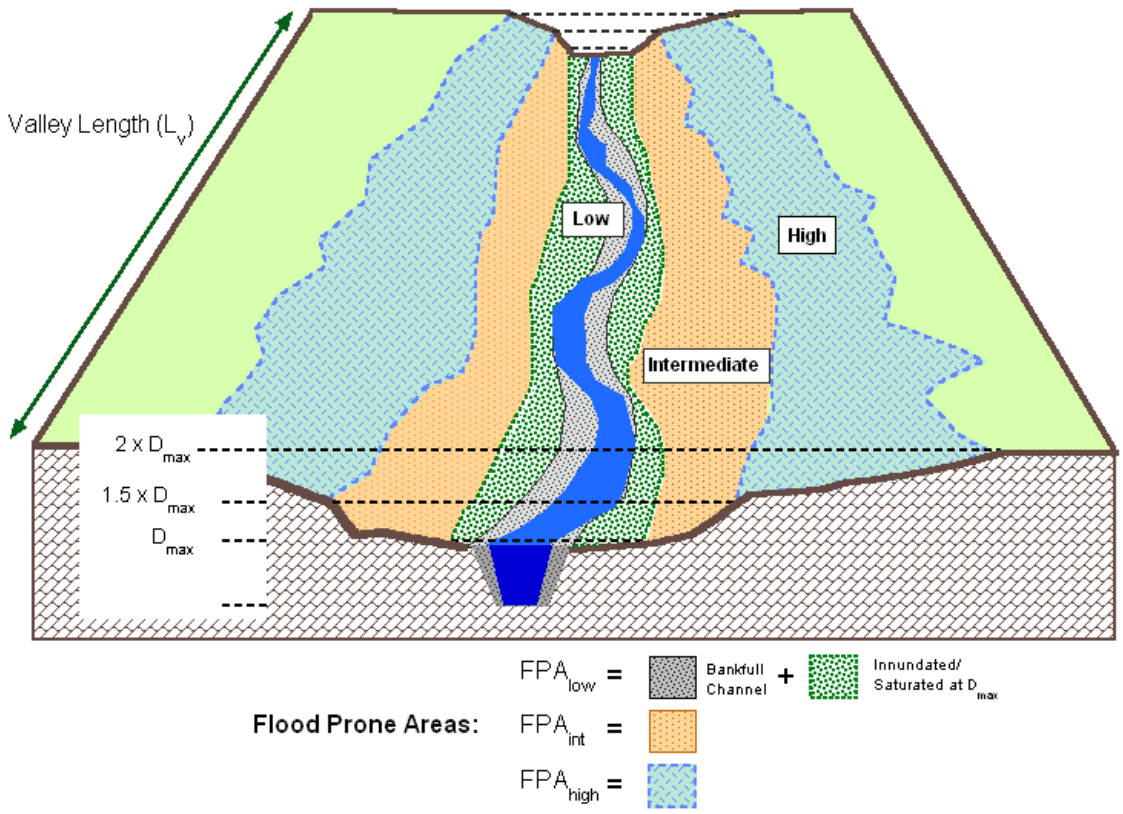


Figure 3. Representation of areas used to calculate the Adjusted Flood Prone Area adjacent to stream segments in accordance with OAC 3745-1-56.

4.2. Soils Weighting Factor

Narrative descriptions and weighting factor scores for the soil categories are listed in Table 3-1. Weighting factors are assigned based upon the average or predominant characteristic of the soils within the flood prone area. The highest ranking for either the percent organic matter or the permeability is used to assign the weighting factor.

Soil conditions for sites of interest can be generally determined from the county soils survey. These resources are available via the internet as county soil surveys (downloadable via Ohio DNR's web page http://ohiodnr.com/tabid/9051/Default.aspx) or via the NRCS web soil survey http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm . In some instances, it may be necessary to sample site soils to determine the appropriate weighting factor condition. These cases should be limited to situations where there have been profound changes to the soils condition since the collection of available data for the soil survey or where the limits of resolution of the soil survey and heterogeneity of the soils in the vicinity of the site preclude reasonable assignment of the weighting factor category. Applicants shall always have the option of submitting site-specific data when it is determined to be necessary to support their application.

Table 9. Soil weighting factor categories, weighting factors, and characteristics for use in calculating Adjusted Flood Prone Areas.

Description	Soils Quality Factor (Swf)	Permeability[9] (in/hr)	Permeability[4] (micro m/sec)	Organic Matter
Excellent	1.2	≥ 1.3	≥ 9.2	≥3%
Good	1.0	≥0.8 - <1.3	≥ 5.6 - <9.2	≥2% - <3%
Fair	0.8	≥0.5" - <0.8	≥ 3.5 - <5.6	≥1% - <3%
Poor	0.5	<0.5	<3.5	<1%

4.3. Final Calculation of Adjusted Flood Prone Area

The final calculation of the Adjusted Flood Prone Area associated with a stream reach or a mitigation design is calculated using the following equation:

$$\mathbf{A_{fp} = (FPA_{low} + 0.8 * FPA_{int} + 0.5 * FPA_{high}) * Swf} \qquad (\textit{eq. 5})$$

Where: $\mathbf{A_{fp}}$ = Adjusted Flood Prone Area (acres);

0.8, and **0.5** are the flood prone area height weighting factors (Section 4.1);

$\mathbf{FPA_{low}}$ = The flood prone area that is inundated or saturated when the water elevation is at the bankfull stage (including the bankfull channel);

$\mathbf{FPA_{int}}$ = The flood prone area that lies within the elevation range between the bankfull stage and 1.5 times the maximum stream depth at the bankfull stage;

$\mathbf{FPA_{high}}$ = The flood prone area that lies within the elevation range between 1.5 times the maximum stream depth at the bankfull stage to 2.0 times the maximum stream depth at the bankfull stage; and

Swf = the Soils Quality Factor (Table 9, Section 4.2)

The calculated value of $\mathbf{A_{fp}}$ can be used to determine whether design requirements for on-site replacement found in Section 3.1 are met for Mitigation Category 1 or Mitigation Category 2 streams. The Adjusted Flood Prone Area can also be used to determine other mitigation requirements in conjunction with analyses required under OAC 3745-1-56(D)(4) and Section 2 of this protocol.

[9] Comment: soil permeability is presented in equivalent English and metric units for ease of use.

5. Aquatic Habitat Area Quantification Method and Mitigation Guidelines

This section provides a standardized methodology for quantifying the area of stream habitat, termed Adjusted Habitat Area, for use in assessing credits and debits with respect to the mitigation requirements found in OAC 3745-1-56 (D). Guidelines for setting mitigation targets for stream habitat necessary to meet antidegradation requirements for stream habitat for aquatic life are also provided.

For purposes of calculating the area of aquatic habitat affected by stream impacts or mitigation projects, an adjustment procedure is used to standardize the acreage calculation based upon measurements of the quality of the resource. The Qualitative Habitat Evaluation Index or QHEI (Rankin, 1989; Ohio EPA, 2006) is used to evaluate habitat quality for all applicable stream types except for Class III Primary Headwater Habitat streams, where the Headwater Habitat Evaluation Index or HHEI (Ohio EPA, 2009) is used for habitat acreage adjustment.

5.1. Applicability of the Adjusted Habitat Area Debit-Credit Metric

The Adjusted Aquatic Habitat Acres metric for the stream mitigation model is applicable for streams that are designated or meet the definition of MWH or are LRW-AMD streams with QHEI scores greater than or equal to 40 within Mitigation Category 2, and for all streams that fall into Mitigation Categories 3 and 4 (Table 10). This methodology is modified for Lake Erie lacustuaries using the procedures outlined in Section 6.

5.2. Calculation Methodology for Adjusted Aquatic Habitat Area

The Adjusted Aquatic Habitat Area is the product of three factors:

a. the calculated area of the stream channel (Section 5.2.1)

b. the habitat index ratio (Section 5.2.2), and

c. the habitat condition factor score (Section 5.2.3).

Table 10. Applicability chart for the Aquatic Habitat Area Metric and general mitigation targets based upon mitigation category and aquatic life uses.

Mitigation Category	Aquatic Life Use	Aquatic Habitat Area Metric Applicable?	Metric Evaluation Index	Habitat Index Target[10]	Condition Factor Target[1]
1	All	No	NA	NA	NA
2	LRW – Other, Class II PHWH, Mod Class II PHWH	No	NA	NA	NA
	MWH	Yes	QHEI	45	FAIR
	LRW-AMD (QHEI>40)	Yes	QHEI	Site-Specific	FAIR
3	Class III PHWH	Yes	HHEI	60	GOOD
	WWH (GHQW), CWH – Inland Trout	Yes	QHEI	60	GOOD
4	WWH (SHQW, OSW)	Yes	QHEI	60	GOOD
	EWH	Yes	QHEI	75	Site-Specific
	CWH – Native Fauna	Yes	QHEI	Site-Specific	Site-Specific

[10] Habitat index and condition factor targets provided in Table 10 are generalized cases for given use categories. Alternative design targets may be required by Ohio EPA or requested by the applicant where sufficient reference site data exists to demonstrate that the general targets are not appropriate. Nothing in Table 10 should be construed to imply that Ohio EPA cannot require evaluation of suitable reference sites to provide background data to inform the design of mitigation projects.

5.2.1. Area of the Stream Channel (A_C)

Stream channel areas are calculated as the product of the bankfull width and the affected channel length. The bankfull width is used since it provides a measurement of the available habitat for aquatic organisms over a reasonable range of flows that include base flow conditions as well as channel forming high flow events where the presence of refugia for aquatic life is important for biological community integrity. Bankfull width values used for the calculation are standardized based upon drainage area according to the following equation:

$$W_{Bkf} = 14.7 * DA^{0.38} \quad (eq.\ 6)$$

Where: W_{Bkf} = the bankfull width (feet); and

DA = the upstream drainage area (mi^2)

The bankfull width equation is derived from relationships for eastern U.S. streams (Dunne and Leopold, 1978) and data from Ohio streams (Sherwood and Huitger, 2005) as modified by the Ohio DNR Division of Soil and Water Conservation. Calculated bankfull widths are used in place of site-specific bankfull width measurements in order to standardize and simplify the calculation. Site-specific bankfull width measurements may be substituted for calculated measurements in instances where site geology or topography creates conditions where actual bankfull width is significantly different than the calculated value and this difference is determined by the Ohio EPA to have a significant effect upon the amount of available habitat for aquatic life[11].

Channel length is determined through measurement of the linear length of channel along the center line of the bankfull channel. For determining existing (pre-impact) conditions, acceptable measurements can be made using a number of techniques including digital measurements from aerial photographs, measurements from maps at an appropriate scale for the project, or a field survey. Applicants should ensure that the sources for making these measurements are up to date, reflect the existing state of the stream channel, and are at the appropriate scale for the project. In cases where no suitable existing data exists, a field survey of the channel centerline length must be conducted to provide the value needed for the metric calculation.

For post-impact or mitigation design scoring, the channel length is determined from the design plans for the project. Again, plans used for determining the channel length should be at an appropriate scale for the project in question. The location of the stream channel should be clearly marked on the project plans.

[11] Examples where these conditions might hold true are in wadable streams that are bedrock controlled, resulting in wider than expected bankfull widths.

The bankfull width and the channel length are used to calculate the area of the bankfull channel using the following equation:

$$\mathbf{A_C = (W_{Bkf} * L_C) / 43{,}560} \qquad (\textit{eq. 7})$$

Where: $\mathbf{A_C}$ = the channel area (in acres);

$\mathbf{W_{Bkf}}$ = the bankfull width (in feet, from eq. 1); and

$\mathbf{L_C}$ = the channel length (in feet)

43,560 = factor for converting square feet to acres

5.2.2. Habitat Index Ratio (R_Q)

The ratio of the existing or proposed habitat index score to a standardized reference value is used to provide a valuation of the quality of the habitat for aquatic life through adjustment of the calculated channel area. As stated above, for all stream uses where the aquatic habitat area metric is applicable except for Class III PHWH streams, the QHEI score is used to calculate the habitat index ratio. For Class III PHWH streams, the existing or proposed HHEI score for the site is used for the ratio. In order to standardize the calculation procedure, the reference index score used to calculate the ratio is 60 regardless of the applicable habitat index. A QHEI score of 60 is used by Ohio EPA as a reference value for conducting aquatic life use attainability analyses based upon correlations with attainment of the WWH aquatic life use (Rankin, 1989; Ohio EPA, 1987; Rankin, 1995). An HHEI score of 60 correlates with the 25th percentile performance for Class III PHWH streams based upon calibration studies used for the development of the HHEI (Ohio EPA, 2002; Anderson et. al, unpublished data).

The habitat index ratio is calculated using the following formula:

$$R_Q = Q / 60 \qquad (eq.\ 8)$$

Where: **Q** = the existing or proposed habitat index score (QHEI or HHEI, as applicable); and

60 = the reference index score

5.2.3. Habitat Condition Factor (F_C)

Within the context of evaluating habitat quality, Ohio EPA has recognized that indicators of past channel modification or significant channel adjustment phenomena associated with recovery from stream impacts can influence the interpretation of habitat index scores. Specific sub-metrics within the QHEI have been correlated to be either high-influence or moderate-influence indicators of characteristics of modified warmwater habitat (MWH) streams where impacts to fish community integrity can be expected (Table 11, after Rankin, 1989). Where two or more high influence indicators are present, it can be expected that attainment of WWH biocriteria is extremely unlikely. In addition, combinations of high influence (HI) and moderate influence (MI) MWH characteristics have been identified that can be used to indicate degrees of impact to the habitat for aquatic life that are helpful for the interpretation of overall QHEI scores (Table 11). The classification system for habitat condition presented in Table 4-3 is used by Ohio EPA to identify habitat impairments for reporting attainment status (Ohio EPA, 2008) and has been used in numerous total maximum daily load (TMDL) studies for habitat impairments for streams in Ohio (for examples of habitat TMDL's, see Ohio EPA, 2004, Ohio EPA, 2007).

For primary headwater habitat (PHWH) streams, the condition classification system used for the QHEI cannot be used. These streams are defined as streams with drainage areas less than 1.0 mi^2 and maximum pool depths less than 40 cm at base flow (Ohio EPA, 2009). Habitat classification in these streams relies upon the HHEI as well as interpretation of the degree of impact from past channelization in order to predict the composition of the biological community. The methodology for determining past channelization impacts on PHWH streams is presented in Section 5.2 of the Field Evaluation Manual for Ohio's Primary Headwater Habitat Streams (Ohio EPA, 2009) and is not replicated here. Classification for habitat condition for PHWH where the adjusted aquatic habitat area metric is applicable follows the guidelines presented in Table 12.

The habitat condition factor scores used to calculate the adjusted aquatic habitat area metric are also listed in Table 12.

5.2.4. Final Calculation of the Adjusted Aquatic Habitat Area (A_H)

The final Adjusted Aquatic Habitat Area metric for debit and credit accounting is calculated according to the following formula:

$$A_H = A_C * R_Q * F_C \quad \textbf{(}\textit{eq. 9}\textbf{)}$$

Where: A_H = Adjusted Habitat Area (acres);

A_C = channel area (acres) (eq. 7);

R_Q = habitat index ratio (eq. 8); and

F_C = habitat condition factor (Table 12)

Table 11. QHEI habitat attributes used to determine the habitat condition factor (from Rankin, 1989).

WWH Attributes	High Influence (HI) MWH Attributes	Moderate Influence (MI) MWH Attributes
No channelization or recovered	Recent channelization or no recovery	Recovering channel
Boulder, cobble, gravel substrates	Silt or muck substrates	
Silt-free substrates	---	Heavy or moderate silt cover
Good or excellent substrates	---	---
Moderate or high sinuosity	No sinuosity	Low sinuosity
Extensive to moderate cover	Sparse or no cover	Only 1-2 cover types
Fast currents or eddies present	---	No fast current
Low to normal overall embeddedness	---	High to moderate overall embeddedness
Maximum depth > 40 cm	Maximum depth ≤ 40 cm	---
Low to normal riffle embeddedness	---	High to moderate riffle embeddedness
---	---	No riffle

Table 12. Condition factor descriptions and scoring values for the Adjusted Aquatic Habitat Area metric based upon QHEI or HHEI evaluations.

Habitat Condition Category	**QHEI Evaluation**	**HHEI Evaluation**	**Condition Factor Score (F_c)**
EXCELLENT	No HI MWH Attributes ***and*** ≤ 2 MI MWH Attributes	No channelization / Natural Channel	1.2
GOOD	No HI MWH Attributes ***and*** 3 or 4 MI MWH Attributes	Recovered Channel	1.0
FAIR	No HI MWH Attributes ***and*** > 4 MI MWH Attributes ***Or*** 1 HI MWH Attribute	Recovering Channel	0.8
POOR	≥ 2 HI MWH Attributes	Recent Channelization or No Recovery	0.4

The resulting value for the adjusted aquatic life habitat area metric is rounded to the nearest hundredth (0.01) of an acre for accounting purposes when comparing debits and credits.

The potential ranges for acreage adjustment along the continuum of potential QHEI scores under the various condition factor outcomes is presented in Figure 4. The adjustment value for the actual acreage ranges may significantly reduce or increase the final value of the adjusted aquatic habitat area metric, dependent upon actual site conditions. These ranges indicate the importance of accurate habitat assessments in implementation of the model. Proper training of field personnel in habitat index scoring, thorough verification of site characterization data, and accurate project design are crucial in order to facilitate correct application of the debit-credit system.

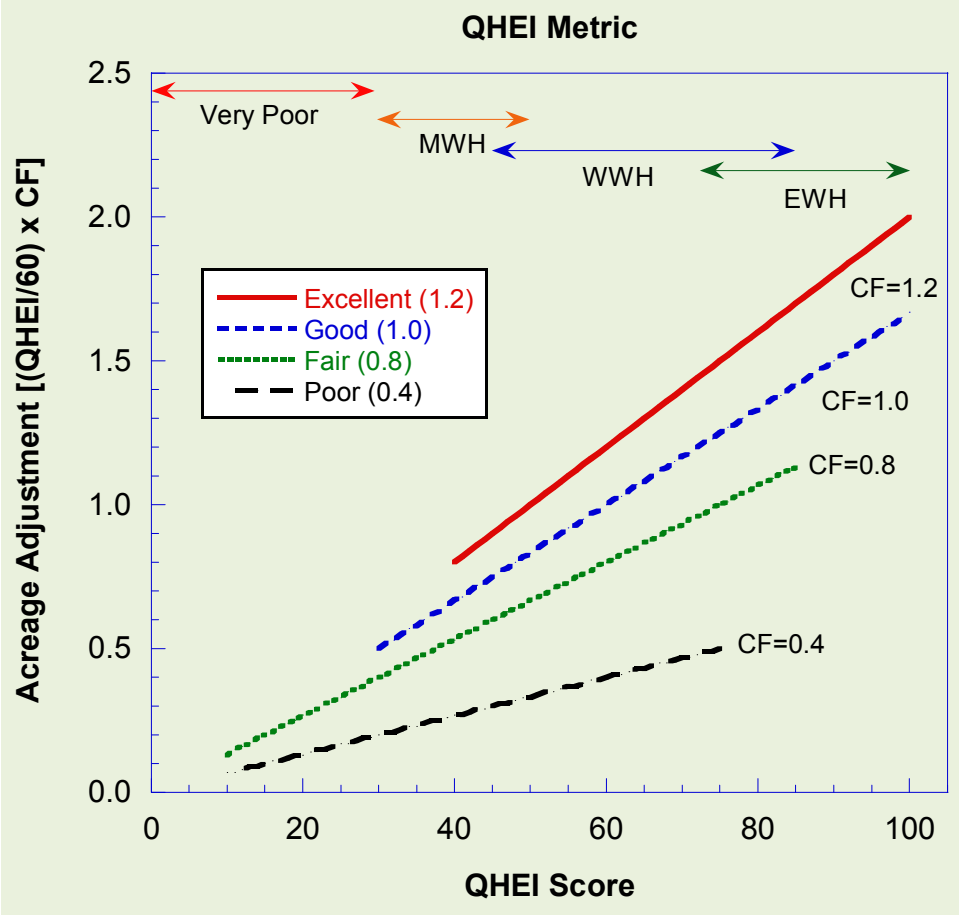


Figure 4. Relationship between QHEI scores and Acreage Adjustment values based upon habitat Condition Factor scoring category. Habitat Condition Factor categories are based on the number of High Influence (HI) and Moderate Influence (MI) Modified Warmwater Habitat (MWH) attributes. QHEI score ranges for the various aquatic life uses are approximated and included for illustration purposes only.

5.3. Design Targets for Mitigation Credits

General design targets for the various mitigation categories and aquatic life uses are listed in Table 10. However, the use of "one target fits all" approaches with respect to stream mitigation project design and performance criteria design should be avoided. It will often be necessary to adjust the design targets for specific stream mitigation projects in order to account for variability in habitat potential. The setting of the affected stream reach with respect to underlying geology, valley type, soils, stream gradient, watershed size and other regional conditions should all be accounted for in the development of an appropriate mitigation design. The need for proper engineering considerations in the design to ensure vertical stability and the appropriate channel dimensions must be factored in when developing habitat-based design components.

The variability in outcomes for habitat quality statewide is illustrated in Figures 5, 6 and 7 where QHEI scores for sites in attainment of the fish biocriterion are compared by ecoregion based upon watershed size. Table 13 lists statistics from the Ohio EPA QHEI database for sites with GOOD or EXCELLENT habitat condition factors. It is recommended that reference data be used wherever possible to provide appropriate habitat index targets for the project setting. In instances where existing Ohio EPA data is not available or relevant for the site, surveys of suitable reference sites may be necessary in order to develop appropriate habitat design targets.

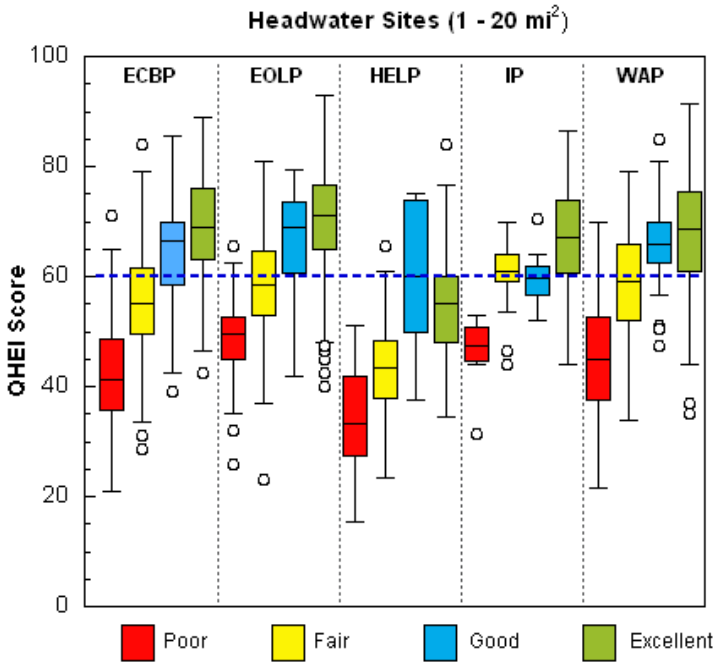


Figure 5. Comparison of QHEI scores for headwater (1-20 mi^2) WWH sites attaining the fish biocriterion based upon ecoregion, watershed size, and habitat condition factor.

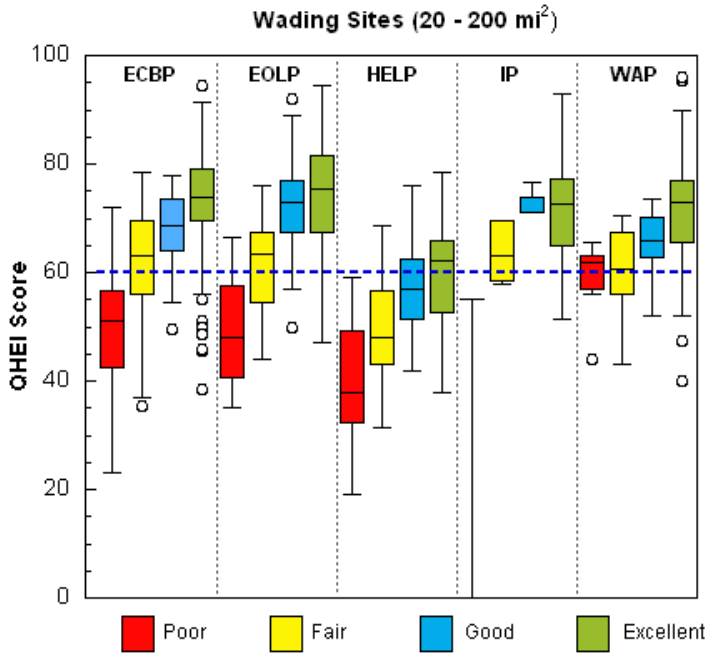


Figure 6. Comparison of QHEI scores for wading (20-200 mi^2) WWH sites attaining the fish biocriterion based upon ecoregion, watershed size, and habitat condition factor.

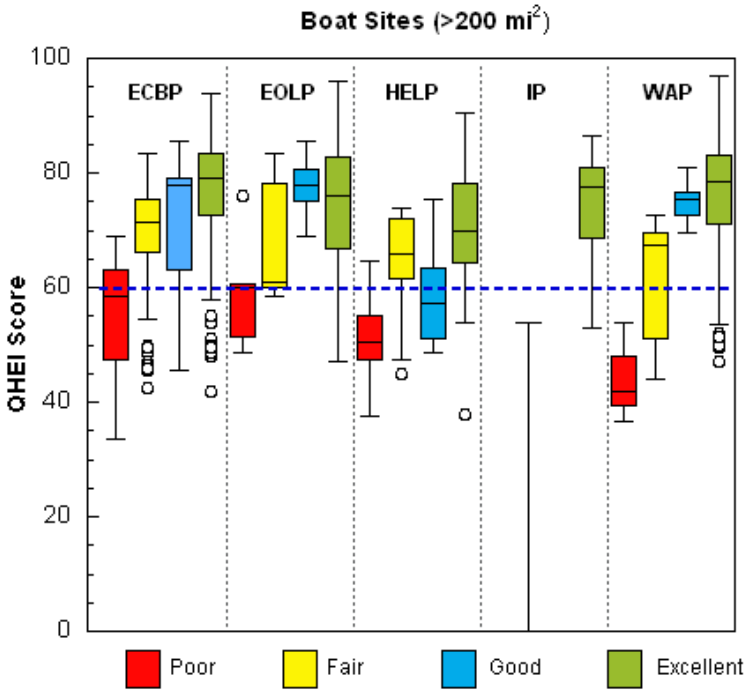


Figure 7. Comparison of QHEI scores for boat (>200 mi^2) WWH sites attaining the fish biocriterion based upon ecoregion, watershed size, and habitat condition factor.

Table 13. QHEI score statistics for attaining Warmwater Habitat sites segregated by habitat condition factor, watershed area category, and ecoregion.

	ECBP		EOLP		HELP		IP		WAP		Statewide
	Good	Excellent	Good	Excellent	Good	Excellent	Good	Excellent	Good	Excellent	All Sites
PHWH (<1 mi^2)											
n=	1	5	0	5	0	0	0	1	1	11	32
25th Percentile		52.0		61.0						57.0	53
Median	69.5	61.5		61.0				50.0	52.5	60.5	60
75th Percentile		70.5		68.0						65.3	68
Max		72.5		68.0						73.0	74
Min		51.0		60.0						43.5	41
Headwater (1 - <20 mi^2)											
n=	67	315	45	376	13	25	12	111	41	373	1,981
25th Percentile	58.5	63.0	60.5	65.0	50.0	48.0	56.8	60.5	62.5	61.0	55
Median	66.5	69.0	69.0	71.0	60.0	55.0	59.8	67.0	66.0	68.5	65
75th Percentile	70.0	76.0	73.5	76.5	74.0	60.0	61.3	74.0	70.0	75.5	73
Max	85.5	89.0	79.5	93.0	75.0	84.0	70.5	86.5	85.0	91.5	93
Min	39.0	42.5	42.0	40.0	37.5	34.5	52.0	44.0	47.5	35.0	16
Wading (20 - <200 mi^2)											
n=	75	460	64	428	10	50	3	92	15	205	1,786
25th Percentile	64.0	69.5	67.4	67.4	51.5	52.8	71.0	65.0	62.8	65.5	63
Median	68.5	74.0	73.0	75.5	57.0	62.3	71.0	72.5	66.0	73.0	71
75th Percentile	73.5	79.0	77.0	81.5	61.1	65.8	73.8	77.1	70.3	77.0	77
Max	78.0	94.5	92.0	94.5	76.0	78.5	76.5	93.0	73.5	96.0	96
Min	49.5	38.5	50.0	47.0	42.0	38.0	71.0	51.5	52.0	40.0	19
Boat (>200 mi^2)											
n=	28	558	14	75	16	96	0	38	8	361	1,445
25th Percentile	63.0	72.5	75.0	66.8	51.0	64.4		69.9	74.0	71.0	69
Median	77.8	79.0	78.0	76.0	57.3	70.0		77.5	75.5	78.5	76
75th Percentile	78.8	83.5	80.1	82.8	62.5	78.1		81.0	76.0	83.0	82
Max	85.5	94.0	85.5	96.0	75.5	90.5		86.5	81.0	97.0	97
Min	45.5	42.0	69.0	47.0	48.5	38.0		53.0	69.5	47.0	34

6. Adjusted Aquatic Habitat Area Quantification and Mitigation Guidelines for Lake Erie Lacustuary Areas[12]

This section is designed to address mitigation goals for Lake Erie estuary areas in Ohio that meet the definition of a lacustuary. As stated by Thoma (1998):

> "A lacustuary is defined as a transition zone in a river that flows into a freshwater lake and is the portion of river affected by the water level of the lake."

Lacustuaries are the estuaries characterized by slack water where water levels ebb and flow is dictated by the level of the lake. The upper limits of the major lacustuaries in Ohio are listed in Table 14. Other tributaries to the lake may or may not have segments that meet the definition of a lacustuary. Projects the mouths of these tributaries should be evaluated to determine whether the requirements in this section or those found in Section 5 are most applicable. It is also important to determine whether requirements for wetlands, streams, or both should be applied when impacts are proposed within the lacustuary environment.

Table 14. Lake Erie lacustuaries in Ohio (after Brant and Herdendorf, 1972).

River	Lacustuary Length (mi)
Ottawa River	5.89
Maumee River	12.85
Crane Creek	4.91
Turtle Creek	4.86
Toussaint River	8.69
Portage River	13.61
Muddy Creek	4.48
Sandusky River	13.39
Huron River	4.00
Old Woman Creek	1.13
Vermillion River	1.30
Black River	3.56
Rocky River	0.43
Cuyahoga River	3.88
Chagrin River	0.76
Grand River	2.86
Ashtabula River	1.51
Conneaut Creek	1.08

[12] Comment: calculation procedures outlined in this Section may also have utility for projects affecting inland lakes, the Ohio River, or Lake Erie nearshore areas. Use of these procedures in these circumstances is only appropriate with approval of Ohio EPA

Lake Erie lacustuary areas are generally designated under the warmwater habitat use, and should be considered to fall within Mitigation Category 3. Alternative assignments should be considered for protected lacustuary areas exhibiting exceptional or unique ecological characteristics, and reaches that have been designated as Superior High Quality Waters or Outstanding State Waters in OAC 3745-1-05. Other lacustuary areas, such as the Cuyahoga River ship channel (see Rule OAC 3745-1-26), may have special use designations that merit consideration for the assignment of the appropriate mitigation category.

The purpose of this section is to translate the concepts for assessing the water quality impacts and benefits associated with the 401 Water Quality Certification process and the requirements of OAC 3745-1-56 for use in lacustuary systems. Mitigation concepts designed for free flowing stream ecosystems are generally difficult to apply to lacustuary systems because of profound differences in their physical and biological characteristics. However, lacustuary ecosystems in Ohio are highly impacted and in need of restoration not only because of the importance of the resources themselves, but because of their current and potential value in improving the ecological integrity of Lake Erie and upstream lotic environments (see the Lake Erie Lakewide Management Plan, 2000[13]).

The methodology for calculating Adjusted Habitat Area values presented here are designed to be translatable into the broader debit-credit framework developed under OAC Rule 3745-1-56 while recognizing the unique ecological and physical characteristics of these systems. In general, Adjusted Flood Prone Area credits and debits (Section 4) are not applicable within the lacustuary areas since the great majority of periodically inundated areas adjacent to Lake Erie lacustuaries are wetlands. However, Ohio EPA may require calculations of Adjusted Flood Prone Area on a case-by-case basis where deemed appropriate based upon the setting in order to protect existing stream uses. Calculation of Adjusted Habitat Area values is not required for designated federal navigation channels that are designated under the provisions of OAC 3745-1-07 (H).

6.1. Calculation methodology for Adjusted Lacustuary Habitat Area (A_{HL})

The Adjusted Lacustuary Habitat Area is calculated as the product of three factors:

a. the area of potential lacustuarine habitat as adjusted based upon areas at varying depth (Section 6.1.1);

b. the lacustuary habitat index ratio (Section 6.1.2); and

c. the lacustuary habitat condition factor score (Section 6.1.3).

[13] http://www.epa.gov/lakeerie/lamp2000/

6.1.1. Potential Lacustuary Habitat Area calculation (A_L)

Areas of potential aquatic habitat within lacustuaries are assigned weighting values based upon their relative potential importance with respect to biological attainment. Area demarcations and weighting for determining the aquatic habitat potential of project sites are listed in Table 15 and are depicted in Figure 8. Potential habitat elevation categories are based upon historical lake level data[14] compiled by the U.S. Army Corps of Engineers measured using the International Great Lakes Datum (IGLD), 1985[15]. The depiction in Figure 8 illustrates one river bank, since many of the lacustuary areas in Ohio include a designated federal navigation channel. In areas where a federal navigation channel exists, the lower limit for potential lacustuarine habitat calculation is the navigation channel boundary if the elevation at this point is greater than 554.9 ft IGLD. In areas where no federal navigation channel exists and no bottom elevations are less than 554.9 ft IGLD, the potential lacustuary area should include areas to the centerline of the river if impacts are restricted to one bank and across the entire river if both banks are affected.

Assignments of weighting factor values for the elevation categories are based upon the potential to support the following beneficial functions:

- colonization by rooted emergent and submergent aquatic plants
- benthic macroinvertebrate community establishment and diversity
- fish spawning and nursery areas
- fish habitat structure and complexity

The rationale for the elevation ranges for each area in the lacustuary matrix is as follows:

Range 1 (LA_1 in Figure 8): This elevation range is assigned the highest weighting in the debit-credit model. The upper elevation (roughly correlating to an upper limit for the establishment of aquatic plants) is set at the maximum Lake Erie water level for the period of record[16].

The lower elevation is set at a point equal to 6.6 ft (2 m) below the minimum Lake Erie water level for the period of record. This elevation range defines a zone that is optimal for aquatic vegetation establishment, fish spawning, and nursery habitat. This zone also constitutes the most important area for lower trophic level community structure and productivity.

[14] http://www.lre.usace.army.mil/greatlakes/hh/greatlakeswaterlevels/historicdata/longtermaveragemin-maxwaterlevels/

[15] http://www.lre.usace.army.mil/greatlakes/hh/links/ccglbhhd/committeepublications/

[16] The period of record for the lake Erie water elevations used to establish long-term water level statistics is 1918 – 2008.

Range 2 (LA_2 in Figure 8): One to one weighting for potential aquatic habitat area is assigned to areas falling within an elevation range from 6.6 ft (2 m) to 11.5 ft (3.5 m) below the average Lake Erie water elevation. This zone serves as important fish and benthic macroinvertebrate habitat, and has potential to provide suitable area for colonization by rooted aquatic plants.

Range 3 (LA_3 in Figure 8): Areas falling within the elevation range from 11.5 ft (3.5 m) to 16.4 ft (5.0 m) below the average Lake Erie water elevation are assigned a low weighting value. The depth range represents areas with diminishing potential as fish habitat and the lower limit for aquatic plant growth.

Range 4 (LA_4 in Figure 8): Areas above the maximum Lake Erie water level for the period of record to 6.6 ft (2.0 m) above that elevation are also assigned a low weighting value. These areas do not provide aquatic habitat, but are important buffer areas for the transition from upland to lacustuary habitat because they are potential areas for the establishment of wooded vegetation along the stream bank.

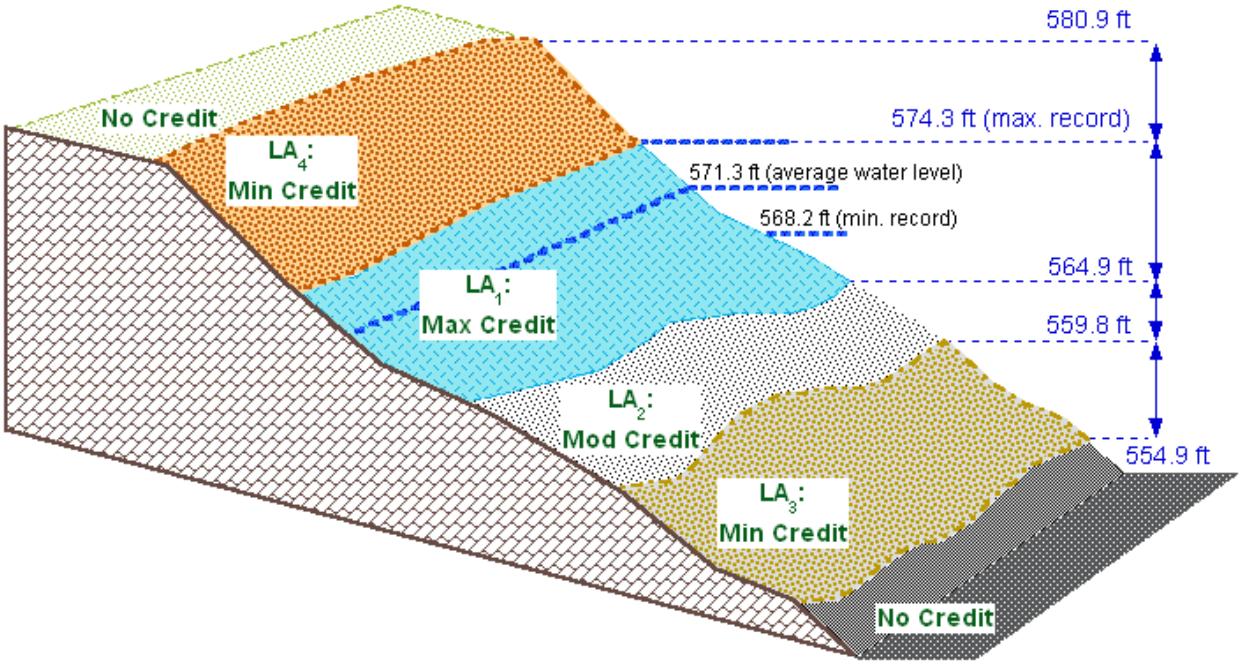


Figure 8. Diagram of lacustuary elevation ranges and areas used to calculate Adjusted Lacustuary Habitat Area values (all elevations expressed in feet IGLD).

Table 15. Bottom elevation categories for calculating potential lacustrine habitat area.

Area Identifier	Upper Elevation (ft IGLD)	Lower Elevation (ft IGLD)	Weighting Value
LA_1	574.3	564.9	1.2
LA_2	564.9	559.8	1.0
LA_3	559.8	554.9	0.7
LA_4	580.9	574.3	0.7

The adjusted lacustuary area (A_L) is calculated using the following formula:

$$\mathbf{A_L = (LA_1 * 1.2) + LA_2 + [(LA_3 + LA_4) * 0.6]} \quad \textbf{(}\textit{eq. 10}\textbf{)}$$

Where: $\mathbf{A_L}$ = the adjusted lacustuary area (acres);

$\mathbf{LA_1}$ = the affected lacustuary area falling within Range 1 (acres);

$\mathbf{LA_2}$ = the affected lacustuary area falling within Range 2 (acres);

$\mathbf{LA_3}$ = the affected lacustuary area falling within Range 3 (acres);

$\mathbf{LA_4}$ = the affected lacustuary area falling within Range 4 (acres).

6.1.2. Lacustuary Habitat Index Ratio (R_{QL})

The ratio of the existing or proposed habitat index score to a standardized reference value is used to provide a valuation of the quality of the habitat for aquatic life through adjustment of the calculated lacustuary area. This methodology is similar to that used for projects where analysis according to Section 5 is applicable. However, for lacustuary stream reaches, the Lake Erie Qualitative Habitat Evaluation Index (L-QHEI) (Thoma, 1998; Ohio EPA, 2009) is used to assess the habitat for aquatic life rather than the QHEI. The L-QHEI was developed specifically to evaluate habitat quality in lacustuary and Lake Erie nearshore areas, and correlates with fish community integrity in these systems. In order to standardize the calculation procedure, the reference index score used to calculate the ratio is based on a L-QHEI score of 50. This score is equivalent to the 10th percentile of sites scoring as "Good" for either the Index of Biotic Integrity or the Modified Index of Well Being for the fish community in Ohio lacustuaries (Thoma, 2006; Thoma, 1999).

The formula for the lacustuary habitat index ratio is therefore expressed as follows:

$$R_{QL} = Q_{LE} / 50 \qquad (eq.\ 11)$$

Where: Q_{LE} is the L-QHEI score for the site either prior to impacted or as projected following the completion of mitigation activities.

6.1.3. Lacustuary Habitat Condition Factor (F_{CL})

Overall biological attainment potential in Lake Erie lacustuary systems is negatively correlated to simplified morphologies associated with shoreline modifications. These modifications regularly include channel deepening and the placement of stabilization structures such as sheet piling along the stream bank. These modifications result in monotonous morphology and substrate composition that significantly reduces or eliminates the shoreline habitat for rooted aquatic plants and benthos, as well as important fish spawning and nursery areas.

The conditions associated with modifications described above are reflected by examination of two sub-metrics within the L-QHEI, "Substrate" (metric 1) and "Shoreline Morphology" (metric 3). The characteristics measured within these two metrics determine the potential for development of the positive habitat features measured using the other metrics within the index (Roger F. Thoma, pers. comm.). The combined scores for these metrics have a maximum score of 40 points within the L-QHEI.

Narrative condition categories based upon the combined substrate and shoreline morphology metric scores are listed in Table 16. The condition factor scores for use in calculating the adjusted lacustuary habitat area are also listed in the table.

Table 16. Condition factor descriptions and scoring values for the Adjusted Lacustuary Habitat Area metric based upon LEQHEI evaluations.

Lacustuary Habitat Condition Category	Combined Substrate Metric + Shoreline Morphology Metric LEQHEI Score	Lacustuary Condition Factor Score (F_{CL})
EXCELLENT	≥35	1.2
GOOD	≥26 to <35	1.0
FAIR	>15 to <26	0.8
POOR	≤15	0.4

6.1.4. Final Calculation of the Adjusted Lacustuary Habitat Area (A_{HL})

The Adusted Lacustuary Habitat Area is calculated using the following formula:

$$A_{HL} = A_L * R_{QL} * F_{CL} \quad \textbf{(}\textit{eq. 12}\textbf{)}$$

Where:

A_{HL} = Adjusted Lacustuary Habitat Area (acres)

A_L = Potential Lacustuarine Habitat Area (Section 6.1.1) (acres)

R_{QL} = Lacustuary Habitat Index Ratio (Section 6.1.2)

F_{CL} = Lacustuary Habitat Condition Factor (Section 6.1.3)

Acreage values calculated for adjusted lacustuary habitat area represent the units of debits and credits for evaluation mitigation proposals associated with OAC Rule 3745-1-56 as outlined in Section 2 above.

6.2. Mitigation Targets for Lacustuary Areas

General mitigation targets for habitat improvement in lacustuary areas should be based upon achieving maximum habitat potential on a site-specific basis. Use of the adjusted lacustuary habitat area calculation procedure for various mitigation scenarios should be helpful in evaluating this potential. However, a target of 50 for the total LEQHEI score, with a Lacustuary Habitat Condition Factor of "Good" (Table 16) can be considered as general restoration or enhancement goals for the majority of Lake Erie lacustuary areas in Ohio. However, many exceptions to these general goals exist where existing habitat quality is either extremely good or profoundly impacted because of relatively permanent changes relating to historical modifications or current uses.

6.3. Lake Erie Remedial Action Plans

Four lacustuaries in Ohio are within designated Areas of Concern (AOC's) by the International Joint Commission. Remedial Action Plans (RAP's), designed to restore beneficial uses, are being developed for these areas (http://www.epa.ohio.gov/dsw/rap/rap.aspx). When planning mitigation efforts in an Ohio AOC, it is important to communicate and coordinate with the local RAP organization since specific remediation plans have been developed for the AOC's. Coordination will insure that mitigation efforts do not conflict with or unnecessarily duplicate existing remediation plans.

The contact information for the four RAP organizations in Ohio is listed below:

Ashtabula River Remedial Action Plan

State Coordinator:
Ted Conlin
Ohio EPA
2110 East Aurora Rd.
Twinsburg, OH 44087
ted.conlin@epa.state.oh.us
330-963-1131

Federal Liaison:
Danielle Green
U.S. EPA / GLNPO
77 West Jackson Blvd. (G-17J)
Chicago, IL 60604
green.danielle@epa.gov
312-886-7594

Black River Remedial Action Plan

State Coordinator:
Ted Conlin
Ohio EPA
2110 East Aurora Rd.
Twinsburg, OH 44087
ted.conlin@epa.state.oh.us
330-963-1131

Federal Liaison:
Anne Marie Vincent
U.S. EPA – Cleveland Office
25089 Center Ridge Rd.
Westlake, OH 60604
Vincent.annemarie@epa.gov
440-250-1720

Cuyahoga River Remedial Action Plan

State Coordinator:
Kelvin Rogers
Ohio EPA
2110 East Aurora Rd.
Twinsburg, OH 44087
kelvin.rogers@epa.state.oh.us
330-963-1117

Federal Liaison:
Mark Maloney
U.S. EPA – Cleveland Office
25089 Center Ridge Rd.
Westlake, OH 60604
Maloney.mark@epa.gov
440-250-1700

Maumee River Remedial Action Plan

State Coordinator:
Cherie Blair
Ohio EPA
347 North Dunbridge Road
Bowling Green, OH 43402
cherie.blair@epa.state.oh.us
(419) 373-3010

Federal Liaison:
David Barna
U.S. EPA – Cleveland Office
25089 Center Ridge Rd.
Westlake, OH 60604
Barna.david@epa.gov
440-250-1708

7. Vegetated Riparian Buffer

The composition and integrity of riparian plant communities often strongly influences the land-water interactions and the ecological processes within streams (Lee et al., 2004; Mayer et al., 2006; Rodewald and Bakermans, 2006; Tabachi et al., 2000). This is especially true for high quality streams where attainment of applicable water quality criteria may be impossible without the presence of a diverse mature riparian plant community. Therefore, protection, enhancement, or restoration of intact vegetated riparian buffer areas adjacent to streams is an important component of a sound stream mitigation plan.

Two difficulties arise when attempting to set standards for mitigation efforts for riparian plant communities in Ohio: 1) the variability of the natural plant communities in riparian areas resulting from the varied glacial history, geological features, and topography; and 2) the history of anthropogenic disturbance and alterations of the riparian areas throughout the state with respect to both physical features and the plant species present. These factors make it extremely challenging to provide specific guidance within a manual such as this for every potential circumstance relating to stream mitigation. Therefore, the regulatory approach for preservation, enhancement, or restoration of the riparian plant communities at stream mitigation sites must be flexible while also providing general goals to improve water quality and ecological function.

Throughout most of Ohio, woody plants should dominate the flora within a vegetated riparian buffer (Gordon, 1966; Goebel, et al., 2003). However, other plant community types may be suitable outcomes in historical prairie and wetland streams, especially along small stable streams identified as Type E channels using the Rosgen Stream Classification System (Rosgen, 2002). Special and rare riparian community types also exist throughout the state, adding to the difficulty of setting standards for vegetation community outcomes (for examples, see the discussion provided in Appendix A).

For stream mitigation projects, re-establishment of stable vegetated communities adjacent to the stream corridor is a primary goal for stream enhancement, and restoration projects. For stream preservation projects the goal is protection of areas with existing high quality riparian plant communities and/or rare and endangered species habitat. With respect to species composition, plantings in riparian buffer areas should utilize only native Ohio vegetation and allow for the natural succession of vegetation, while controlling the influx of non-native invasive species. Comprehensive lists of native Ohio species are readily available (Sheaffer and Rose, 1998; Andreas et al., 2004). The target plant community within a riparian buffer should be based upon regional and site-specific conditions (plant distributions, soils, geology, hydrology, etc.). It is therefore necessary to allow flexibility with respect to specific targets for planting densities, species composition, etc. within this protocol. Section 7.2 below provides additional guidance on the goals of the composition of the riparian plant community for stream mitigation sites.

The protection of high quality wetlands adjacent to streams is a high priority. Preservation, enhancement, or restoration of these systems is highly encouraged, and may qualify for mitigation credits for both streams and wetlands. Proposed projects involving impacts to wetlands adjacent to or connected with streams should be highly scrutinized for avoidance to protect these environs.

Performance criteria set within the mitigation plan must take into account the designated uses of the stream and the beneficial functions that are being protected, enhanced, or restored. In addition, the requirements for the protection of downstream uses must also be considered. It is important to set specific measureable targets for re-establishment, enhancement, or maintenance of the riparian plant community so that success can be directly measured during the monitoring period. Stream mitigation plans should include monitoring components designed to document the prolonged stability of the vegetated buffer.

The following sections provide general guidance regarding minimum outcomes, buffer widths, and planting standards for the vegetated riparian area. As stated above, these requirements can and should vary significantly from project to project. However, these concepts can serve as starting points for planning and project development.

7.1. Vegetated Buffer Widths

When possible, the vegetated riparian buffer width targets for stream mitigation projects should be scaled based upon the upstream drainage area. This concept mimics natural conditions. It also conforms to the metrics in this protocol for debits and credits. The target vegetated buffer widths presented below were developed through a review of pertinent literature, prevailing practices with respect to riparian setbacks and buffers under local ordinances in Ohio, and evaluation of practices in State of Ohio silviculture and stormwater management programs. The purpose is to provide guidelines based upon the maintenance or restoration of biological attainment of applicable water quality criteria. The resulting consensus guidelines for appropriate vegetated buffer widths based upon upstream watershed area are provided in Table 17. The values in Table 17 are a step function which can be converted into a continuous equation based upon the upstream drainage area:

$$\mathbf{B_{target} = 160 * (DA/640)^{0.10}} \qquad \textit{(eq. 13)}$$

Where: $\mathbf{B_{target}}$ = the target vegetated buffer width (in feet)

DA = the upstream drainage area (in acres)

The recommended minimum vegetated buffer is 50% (one half) of the target width. Figure 9 illustrates the relationship of the original step-function, the equation based target width, and the minimum recommended buffer width.

In situations where there steep slopes exist adjacent to the stream the riparian buffer requirements should be enlarged to protect these areas from erosion. In areas where

slopes exceed 15% along the stream channel, the vegetated riparian buffer width should be expanded to extend to the top of slopes. Other requirements may also be necessary to protect stream banks and the flood prone areas adjacent to mitigated stream sites on a site-specific basis.

Table 17. Vegetated riparian buffer targets developed during stakeholder review process. These values are used to develop the function for target buffers used in this protocol (eq. 21). See Figure 9 for a graphical representation of the relationship.

Upstream Drainage Area	Minimum Buffer (ft per bank)	Target Buffer Width (ft per bank)
<1.0 mi^2	25	50
≥1.0 - 20 mi^2	50	75
≥20 - 100 mi^2	75	100
≥100 mi^2	75	150

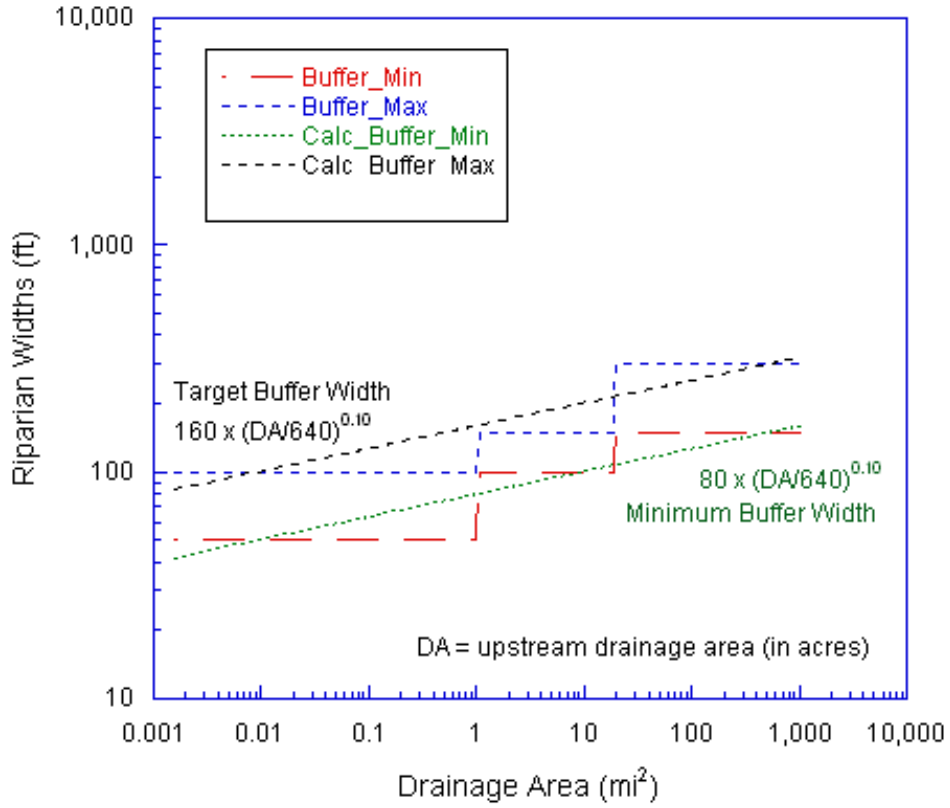


Figure 9. Comparison of vegetated riparian buffer width targets developed for the stream mitigation protocol. The function given in equation xx is used to determine the target vegetated buffer width.

7.2. Riparian Vegetation Requirements Applicable for Mitigation Category 1 and 2 Streams

General requirements for re-vegetation of areas adjacent to Mitigation Categories 1 and 2 segments are listed below. Maintenance and monitoring plans for the flood prone area and associated vegetated buffer area shall be provided to Ohio EPA for approval as part of the mitigation plan.

1. Disturbed areas adjacent to and on the side slopes of relocated, reconstructed, or restored channels shall be planted with native Ohio species appropriate to the setting and mitigation requirements based stream mitigation category and the downstream designated or existing uses;

2. Where woody riparian plant communities are not deemed necessary to protect downstream uses or habitat for aquatic life, maintenance cutting on an infrequent basis (1 or 2 times per year) is allowable to control unwanted vegetation if approved as part of a site maintenance plan.

3. Where the mitigation requirements call for the establishment or enhancement of woody riparian buffer adjacent to the stream, herbaceous ground cover and shrubs shall be planted to stabilize the stream margins until woody vegetation can become established.

4. Herbicide use within the flood prone width of the stream channel shall be allowed for control of invasive plants only in conformance with an approved mitigation maintenance plan.

7.3. Planting Plan

The stream mitigation plan must include a planting plan designed to stabilize disturbed areas and/or to enhance riparian buffer areas. All plantings should include only flora native to Ohio, and the planting plan should consider the natural floristic communities characteristic of the watershed setting.
Disturbance of mature riparian vegetation, especially trees, should be avoided whenever possible. Desirable vegetation suitable for re-planting should be salvaged prior to construction for inclusion in post-construction planting.

The planting plan should include the following elements, as appropriate:

- a table of species to be planted, including approximate numbers, spacing, types of propagules, pot sizes, etc. (both scientific and common names must be provided);

- a description of the methods to be used to establish the various plant species including planting densities and timing (timing should foster successful growth);

- a description of any expected volunteer native re-vegetation that is included in the site recovery expectations;
- a plan view depicting the proposed locations of planted stock and transplants;
- a narrative describing the appropriateness of the selection of plant species within the mitigation site;
- a listing of the source(s) of seeds, root stock, cuttings, plant plugs, etc.;
- a description of the methods to be used for storage if plants are to be transplanted, as well as a schedule for the duration of storage;
- if temporary or permanent grass cover is used to stabilize the mitigation site, a description of the seed mixture must be provided as well as methods planned to remove any temporary ground cover, if required; and
- a control plan that describes the strategy to recognize and control invasions of exotic or undesirable vegetation.

7.4. Performance Criteria for Forested Buffer Re-Establishment

Where past land use has eliminated or significantly disturbed the riparian buffer area, the mitigation plan must include performance criteria resulting in an acceptable condition by the end of the monitoring period. In some cases, an extended monitoring period may be necessary to accomplish the mitigation goals.

The Floristic Quality Assessment Index (FQAI, Andreas et al., 2004) should be utilized to develop performance criteria for where re-establishment of a wooded riparian buffer is necessary. Use of reference reach conditions is encouraged for setting these performance criteria. Appropriate targets are as follows:

1. For preservation projects, the FQAI should score above the 50th percentile for least impacted reference sites within the watershed for Mitigation Category 3 streams and above the 25th percentile for Mitigation Category 4 streams.

2. For enhancement projects, the FQAI should show a menaingful improvement in score over the monitoring period with a trend indicating that the performance criteria above will be met within a reasonable time frame (15-20 years).

3. For restoration projects involving rehabilitation of riparian areas that were either denuded, in urban, industrial, or agricultural land use, the following criteria for planting should be followed where forest re-establishment is undertaken:

    a. a minimum of 200 native, free standing, live and healthy (disease and pest free) trees per acre are present at the end of the monitoring period;

b. a minimum of 8 native tree species are growing within the forested area, and each of these 8 species represents at least 5% of the overall tree count;

c. a minimum of 25% of all live trees present consist of at least 4 species having coefficient of conservatism values from 5 to 10.

d. a minimum of 200 native, free standing, live and healthy (disease and pest free) shrubs/sub-canopy trees per acre are present at the end of the monitoring period;

e. a minimum of 8 native shrub/sub-canopy species are growing within the forested area, and each of these 8 species represents at least 5% of the overall shrub/sub-canopy tree count;

f. a minimum of 25% of all live shrubs/sub-canopy trees present consist of at least 4 species having coefficient of conservatism values from 5 to 10.

Applicants must also demonstrate that forested areas are on a trajectory to being forested in the long term. This can be demonstrated by graphing basic forestry measures, including frequency, density, dominance per species against time.

For riparian wetland areas, specific performance criteria should be provided to demonstrate that the wetland areas have been satisfactorily re-vegetated or protected to provide sufficient quality to meet the goals of a stable, well balanced wetland system. Criteria proposed should consist of ORAM scores, VIBI scores, or other suitable standards to demosntrate success of the re-establishment, enhancement, or preservation goals outlined in the application.

8. Construction Practices

Construction practices at stream mitigation sites should be designed and scheduled to minimize water quality impacts with respect to the export of sediment and nutrients, and with the least impact to in-stream and riparian habitat to non-work areas. Work areas must be clearly delineated and flagged to prevent damage to non-work areas during the construction process. Staging areas and waste areas for excavated or imported materials must be protected from erosive forces to the greatest extent possible. Re-graded or exposed portions of the site should be quickly stabilized with vegetative cover following the completion of work, or if there is an anticipated delay during the construction process prior to final grading.

A storm water pollution prevention plan must be prepared for the mitigation work site whenever the plan calls for earth work. Earth work within the stream channel should be scheduled during low flow periods, and stream flows should be diverted around the work area to prevent undo erosion during construction. Best management practices for construction stormwater control should be described in the storm water pollution prevention plan, and must be installed, inspected, and maintained during construction activities. When applicable, a Notice of Intent for construction must be filed with the Ohio EPA in order to obtain coverage under the general construction stormwater NPDES permit. Applicants should consult the Ohio EPA for guidance regarding the development and implementation of this plan, as well as other requirements under this program. Information regarding the construction stormwater program can be accessed via Ohio EPA's web page: http://www.epa.ohio.gov/dsw/storm/index.aspx .

Where equipment will be used within riparian areas which will be re-vegetated following the completion of construction, precautions must be taken to prevent over-compaction of soils which will hinder re-growth. Specifications for construction equipment should state that only low compression equipment (≤ 6 lbs/inch^2) will be used in these sensitive areas and that any haul roads or other fill placed within the riparian buffer area will be removed, replaced with top soil consistent with site conditions, and re-vegetated following the completion of construction. Access points and work areas for construction equipment should be chosen so that equipment is used within the stream channel only when absolutely necessary and so that mature riparian vegetation and areas containing sensitive plant species are left intact to the greatest extent possible.

General work specifications for construction activities must be provided with the Section 401 Water Quality Certification application. A schedule should be provided for the development of detailed construction plans and specifications, and this information should be made available to the Ohio EPA for review upon request during the development process. Pre-construction coordination with the Ohio EPA is strongly encouraged in order to prevent problems from occurring during the implementation period.

9. Drawings

Mitigation plans should include drawings in conformance with the following:

1. Drawings must be provided at a scale sufficient to show a level of detail adequate to review site topography and geographical features to a degree necessary to allow an adequate review of the project. Since projects are quite variable in scope, it is impossible to dictate appropriate scale for all applications. In cases where large plan sheets will be provided, duplicate copies no larger than 11 x 17" should also be provided. Generally, all drawings should have a scale no smaller than 1”=200’. Drawings must be clear, readable, and reproducible on standard, non-color office copiers. Each drawing sheet should include the following:

    a. an unused margin of no less than ½”;

    b. An appropriate graphic scale (when reasonable);

    c. all significant dimensions clearly indicated and annotated;

    d. title block with applicant's name, project title, site location, drawing date, and sheet number;

    e. a directional arrow indicating north;a clear, legible plan view indicating area sizes (e.g., square feet, acres) for all mitigation sites;

2. Location maps for the proposed activity must be included. Three maps must be submitted with the sites clearly delineated: a county road map, a Soil Conservation Service or Natural Resources Conservation Service county soil map which includes hydrologic features, and a U.S. Geological Service 7.5 minute quadrangle map. The location maps must show roads leading to the site and must include the name or number of these roads. The project latitude and longitude should be annotated on the maps. Each map should include a title block.

3. Plan views of the proposed mitigation must be included. These drawings must show the general and specific site location and character of all proposed activities, including the relationship of all proposed work to Waters of the State in the vicinity of the project.

4. For ground-disturbing mitigation work, cross section And longitudinal views must be submitted depicting the existing ground and channel contours and the proposed finished contours.

5. All aquatic areas within the project boundaries (avoided, impacted, or mitigated) must be shown.

6. Each restoration, enhancement, preservation, creation and upland buffer area must be shown.

7. A legend must be shown identifying cross-hatching, shading, or other marking techniques used.
8. A summary table with the quantity of each category of impact and each category of mitigation must be provided.
9. Show the ordinary high water line of affected and adjacent open surface waterbodies.
10. For mitigation plans with more than ten acres of riparian buffer area restoration or supplemental water quality projects or a combination thereof, certified topographic drawings showing the contours and elevations of the completed mitigation area may be required. The drawings should show types of plantings, locations of plantings, and all structures and work which are a significant part of the mitigation.

10. Financial Assurances

Financial assurances for mitigation and contingencies must be provided that are commensurate with the level of work being proposed. Applicants are referred to the federal mitigation regulations [33CFR 332.3(n) and 40 CFR 230.93(n)] for specific requirements for development of financial assurances for stream mitigation plan development.

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APPENDIX A

The following is a description of rare and special riparian habitats that may be found in Ohio that bear consideration during the stream impact and mitigation review process provided by James Bissell, Botany Curator at the Cleveland Museum of Natural History:

"Some limestone or sandstone rock scours are naturally sparsely vegetated, often lower than 25 percent cover of shrubs or helophytes. Often, there is a very low density of shrubs or trees. The habitat of the globally rare and Federally Threatened Virginia spiraea (*Spiraea Virginia*) and the state-endangered Carolina willow (*Salix caroliniana*) on SciotO Brush Creek is a good example. Some sandstone or limestone rock scours support rare herbaceous species such as Canada milk-vetch (*Astagalus canadensis*) and blue fals-indigo (*Baptisia australis*).

Another rare riparian habitat in Ohio is the Glacial slump Community. Some of rarest plants and insects in Ohio occupy this habitat. The Glacial Slump Community supports the globally rare, state-endangered Cooper's milk-vetch (*Astragalus neglectus*), state-threatened pale vetchling (*Lathyrus ochroleuca)*, state-threatened stout goldenrod (*Solidago squarrosa*), state-threatened golden-fruited sedge (*Carex aurea*), state potentially-threatened fringed gentian (*Gentianopsis crinita*) and many other state listed species. The rare habitat is located primarily on open, south-facing, west-facing or east-facing steep valley cliffs where rivers are actively cutting into lower-slope shale cliffs, lacustrine sediments or alkaline, finely textured glacial till. Some slumps have sand layers with perennial springs that support many wet prairie or fen plants such as grass of Parnassus (*Parnassia glauca*), Kalm's lobelia (*Lobelia Kalmii*), swamp thistle (*Cirsium muticum*), interior sedge (*Carex interior*) and cowbane (*Oxypolis rigidior*). Some slumps in the Grand River Gorge, Cuyahoga River Valley and Vermilion River Valley support Tall Grass Prairie plants such as big bluestem (Andropogon geradi) and Indian grass (Sorghastrum nutans)

The Mixed Floodplain Meadow Plant Community on ice-scoured meadows and low stream terraces is one of the most colorful plant communities within Ohio. Typical Mixed Floodplain Meadow is dominated by a large number of plants including Emory sedge (*Carex emoryi*), wingstem (*Verbesina alternifolia*), ox-eye (*Helopsis helianthoides*), sneezeweed (*Helenium autumnale*), great blue lobelia (*Lobelia siphilitica*), perfoliate boneset (*Eupatorium perfoliatum*) , giant goldenrod (Solidago gigantean),common rush (*Juncus effusus*), wood reed-grass (*Cinna arundinacea*), blue vervain (*Verbena hastata*), soft-stem bulrush (*Schoenoplectus tabernaemontanae*), wool-grass (*Scirpus cyperinus*), lurid sedge (*Carex lurida*), deer tongue (*Panicum clandestinum*), Joe Pye weed (*Eupatorium fistulosum*), ironweed (*Vernonia altissima*), panicled aster (*Symphiotrichum lanceolatum*), New England aster (*Symphiotrichum novae-angliae) Vir*ginia wild-rye (*Elymus virginicus*), dogbane (*Apocynum cannabinum*), brome grass (*Bromus altissimus*). Emory sedge, water-willow (*Justicia Americana*) and a shrub, sandbar willow (*Salix interior*) are the major species that build floodplains and islands along Ohio rivers. Both plants have dense roots and thick underground stems that capture sediments suspended in the stream and rapidly build new meadows into the river.

Tall Grass Prairie is present and sometimes dominates the Mixed Floodplain Meadow Community on ice-scoured islands and low terraces within the Grand River Gorge, Cuyahoga River and every Lake Erie tributary river from Rocky River west to the Maumee River and most other rivers within Ohio including the Ohio River and its tributaries. Most of the former prairie stands on the Ohio River have been lost due to the placement of locks on the river. The Tall-grass Prairie is only absent from ice-scoured islands and low shore terraces within three rivers in Ohio: Conneaut, Ashtabula and the Chagrin River. The river-bottom Tall-grass Prairie stands are usually dominated by stands of big bluestem, Indian grass and prairie cord-grass (*Spartina pectinata*). Non-native plants such as canary grass (*Phalaris arundinacea*), Japanese knotweed (*Polygonum cuspidatum*), mugwort (*Artemisia vulgaris*), reed grass (*Phragmites australis*) are the greatest threat to the Mixed Floodplain Meadow Community and Tall-grass Prairie stands. Canary grass is perhaps the most serious threat. The allelophatic canary grass has the ability to completely replace both native Mixed Floodplain Meadow and flood-scour shore s and island supporting Tall-grass Prairie. At the current rate of encroachment, canary grass and the other non-native plants spreading along our river shores and islands will within the next half century completely replace the native helophytes within every river system in Ohio unless efforts are made to curtail the spread of invasive plants on our river floodplains and islands."