Final Methodology Memo

for

Wetland Management Opportunities

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Prepared for:

U.S. Environmental Protection Agency, Region 5
77 W. Jackson Boulevard
Mail Code: WW-16J
Chicago, IL 60604

Prepared by:

Tetra Tech, Inc.

1468 West 9th Street
Suite 620
Cleveland, OH 44113

P.O. Box 14409
1 Park Drive, Suite 200
Research Triangle Park, NC 27709

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1 Introduction

This project will support Goal 2: Protecting America's Waters, Objective 2.2: Protect and Restore Watersheds and Aquatic Ecosystems of the EPA Strategic Plan (available at http://www.epa.gov/planandbudget/strategicplan.html). The project will address the strategic measure of Increasing Wetlands – "By 2015, working with partners, achieve a net increase in wetlands nationwide with additional focus on coastal wetlands, and biological and functional measures, and assessment of wetland condition" - by providing information which targets restoration efforts in priority watersheds, specifically, the identification of restoration opportunities to restore, create and enhance wetlands. Wetland restoration can be instrumental for improving water quality.

This memorandum details the proposed geographic information system-based (GIS) screening method developed to identify wetland opportunities within select subwatersheds in the Des Plaines River watershed in Lake County, Illinois, which drains to the Illinois River-Mississippi Basin, and the Lower Fox River watershed in Outagamie, Brown and Calumet Counties, Wisconsin, which drains to Lake Michigan (Figure 1). The approach is based on the work of numerous wetland function researchers and is modeled after the 2011 Michigan Department of Environmental Quality (MDEQ) "Landscape Level Wetland Functional Assessment (LLWFA) Version 1.0, Methodology Report." In addition, local efforts related to watershed planning and TMDL implementation will be taken into consideration. Every effort will be made to build upon existing data and analyses.

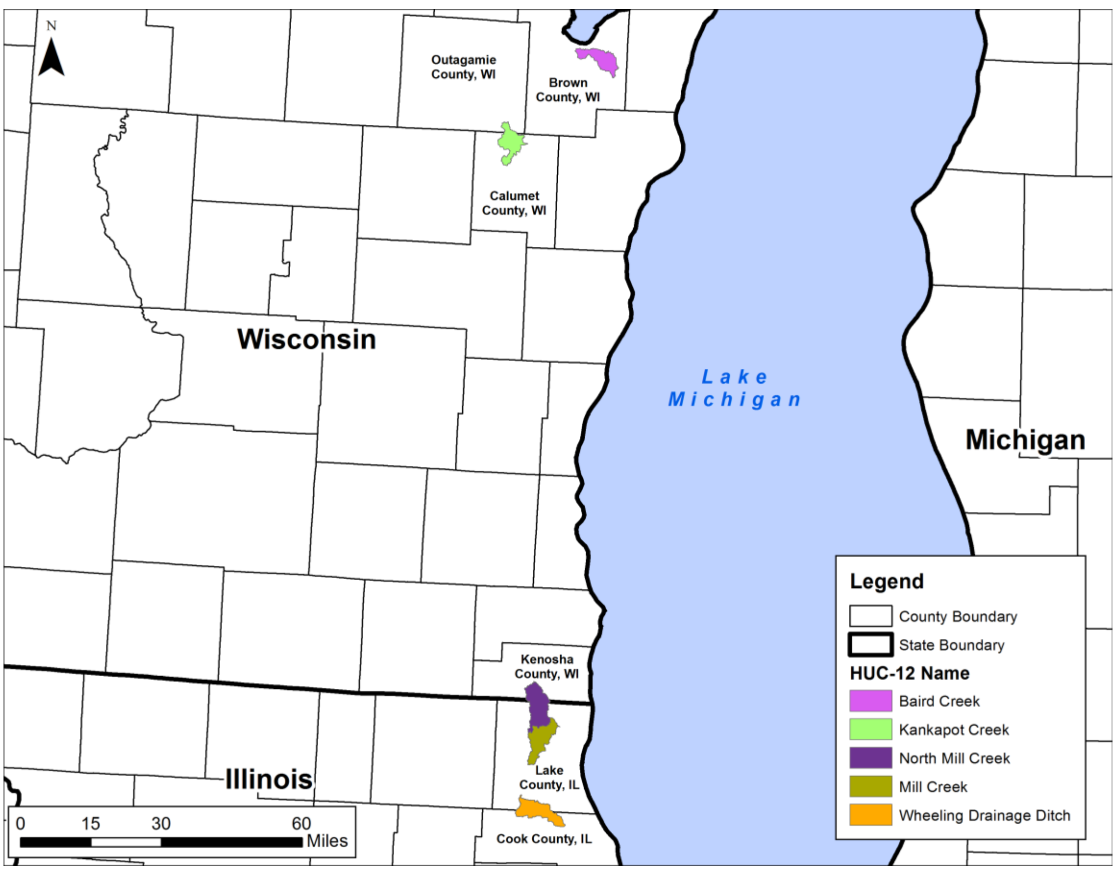

Figure 1. Project watersheds.

The Lake County Stormwater Management Commission (LCSMC) conducts watershed planning throughout the county. A final watershed plan for Mill Creek and draft watershed plan for North Mill Creek watershed (locally known as North Mill Creek/Dutch Gap Canal Subwatershed) have been completed. A watershed plan is currently underway in the Mill Creek and Wheeling Drainage Ditch (locally known as Buffalo Creek). As part of the planning process, wetlands are identified according to the Lake County Wetland Inventory (LCWI) which was updated in 2002 using high resolution aerial photography and enhanced topographic information. The LCWI identifies five different types of wetlands including: wetlands, farmed wetlands, artificial wetlands, converted wetlands, and Advanced Identification wetlands (ADID). The ADID was developed by the USEPA et al. in 1992 and identified high functionality wetlands that should be protected. Three primary functions were used to evaluate wetlands during the ADID process: biological functions (i.e., threatened or endangered species, wildlife habitat, and plant species diversity), hydrologic functions (i.e., stormwater storage), and water quality mitigation functions (i.e., sediment and toxicant retention, shoreline/bank stabilization). ADID wetlands are assessed to determine locations appropriate for preservation, restoration, and management options (Figure 2).

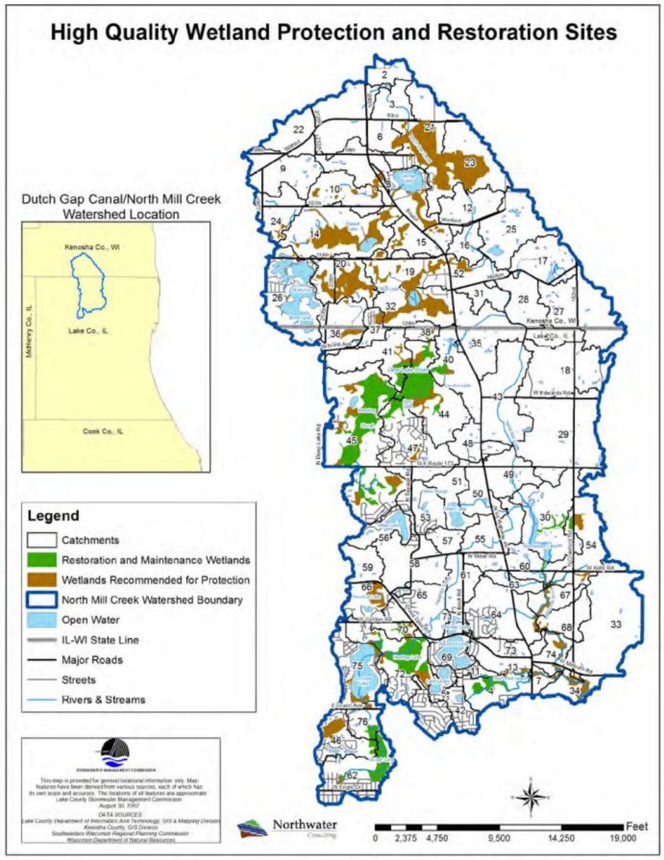

Figure 2. Example of wetland planning results in North Mill Creek watershed.

Activities related to wetland planning in the Lower Fox River watersheds include a Potentially Restorable Wetland Analysis included as part of the Lower Fox River TMDL, completed in 2012. A Potentially Restorable Wetland is defined as a lost wetland based on the presence of hydric soils and a wetness index (i.e., compound topographic index, or CTI) where wetlands no longer exist that has a current land use compatible with restoration (i.e., non-urban land uses).

The 2011 MDEQ LLWFA is a regional customization and expansion of the Landscape Position, Landform, Waterbody Type, and Water Flow Path (LLWW) system of wetland classification, primarily based on the methods of Tiner (2003a, 2003b, and 2011). Using this system, Tiner and other researchers have added information about the hydrology and geomorphology of wetlands to the existing U.S. Fish and Wildlife Service's (USFWS) National Wetlands Inventory (NWI) geospatial database creating an enhanced digital wetland database (often referred to as NWI Plus, or NWI+). The same approach will be used on state and local wetland inventory data sets in the project areas allowing a landscape-level wetland functional analysis to be performed, whereby correlations are drawn between a wetland's hydrogeomorphic (HGM) qualities and the potential functions of each wetland. Understanding the functional level allows regulators and watershed planners to draw inferences between those functional levels and contributions each wetland's function may offer to manage water quality, quantity, and wildlife habitat.

Location and type of wetlands that might have been lost due to land use changes and development will be estimated using similar methods to that performed by MDEQ (2011). Referred to as an inventory of pre-European settlement wetlands, this analysis will be performed in order to model the potential loss of wetland function and identify areas where restoration of wetlands might be most effective for various wetland function recovery.

The approach presented here closely follows the MDEQ method, with regional adjustments for the Des Plaines River and Lower Fox River watersheds as well as further analysis and dataset refinements based on work recently completed in the Sandusky River watershed, Ohio (PG Environmental 2014). The objectives of the analysis, details of the dataset, and an outline of GIS steps to be used in the screening methodology are explained in this report. Existing work done by Wisconsin DNR and the LCSMC on identifying wetland restoration sites will be used as the starting point for this analysis. All watersheds have existing work to identify potential wetland restoration sites completed with the exception of the Wheeling Drainage Ditch watershed.

2 Methods Overview

Tetra Tech's approach to identify wetland opportunities will incorporate information documented in the Region 5 Wetlands Supplement: Incorporating Wetlands into Watershed Planning (USEPA 2012). Specifically, we will closely follow the approach used in the Paw Paw River watershed (Fizzell 2007) including relevant modifications recently employed for the Sandusky River Watershed Wetland Management Opportunity project (PG Environmental 2014). Both the Sandusky and Paw Paw projects resulted in estimates of the extent of "historic" wetlands during pre-settlement times compared to current conditions, and predicted wetlands (both historic and existing) of significance based on thirteen wetland functions. A similar approach will be employed so that project partners can focus restoration efforts on those locations where high priority wetland functions have been lost.

For both existing and historic wetlands, Tetra Tech proposes to use the same 13 wetland functional classes employed by MDEQ and in the Sandusky River project, as well as similar methods for the initial HGM classification process of wetland datasets. However, the HGM approach employed by MDEQ will be modified based on guidance from Tiner's recent 2011 update to the LLWW method, as it was in the Sandusky River project. The USFWS has termed this type of functional analysis a Watershed-based Preliminary Assessment of Wetland Functions, or W-PAWF.

One key limitation of a wetland functional assessment is that it is only an initial screening and does not take into account on-the-ground land use practices that may be affecting wetlands, such as agriculture, stormwater runoff, levels of disturbance in the adjacent non-wetland (upland) areas, or the water quality and quantity of the waterbodies associated with the wetlands. Although multiple wetlands may fall into the same LLWW type, and thus the same category of significance for a wetland function, there can be significant differences between the health and ecology of those wetlands. However, the proposed functional assessment offers a perspective on how water quality and quantity can potentially be affected by various wetland functions, but is just the first step, and is intended to be used in subsequent watershed assessment and planning efforts.

3 Detailed Methodology

Using the methods detailed in this section, relationships will be identified between wetland attributes, LLWW data, and ecological capabilities, combining the results in a GIS geodatabase. The approach will highlight the significance of different wetlands and their existing or potential functions.

There are three main steps being used to identify wetland opportunities, described in detail in the following sections, include:

1) Pre-European Settlement Wetland Inventory – Historic wetland identification and classification of historic wetlands using LLWW descriptors
2) LLWW Classifications – Hydrogeomorphic characterization of each wetland according to landform, landscape position, water flow path, and waterbody type
3) W-PAWF Classification – Classification of wetlands based the significance of 13 functions

The Lake County Wetland Inventory and the Wisconsin Wetland Inventory datasets define polygons representing wetland types and will serve as the starting point for this task. These datasets are considered ideal for the project area because they are more geographically accurate than national data (i.e., NWI). Supplemental classification characteristics found in the NWI data spatially will be appended to these datasets as needed to maximize wetland attribute descriptions for subsequent analyses.

A list of data sets identified or obtained for this project can be found in Table 1.

Table 1. Secondary data sets

Data type	Source	Description
Geography and physical		
Aerial imagery	Natural Resources Conservation Service (NRCS) Lake County	Color air photos by county Air photos, various years 1939-2012
Ecoregions	U.S. EPA	Shapefiles and narrative descriptions of Wisconsin and Illinois level III and IV ecoregions
Elevation	US Geological Survey (USGS)	National Elevation Dataset
	Multiple	Regional, County, and Local Light detection and ranging (LiDAR) data
Land use and land cover	Multi-Resolution Land Characteristics Consortium (MRLC) Lake County Cook County	2011 National Land Cover Dataset (NLCD), county land use
	US Department of Agriculture (USDA), National Agricultural Statistics Service (NASS)	Cropland Data Layer (CDL) available annually from 2006 to 2013
Percent impervious cover	MRLC Lake County	2011 NLCD, Lake County impervious cover (Mill and North Mill completed, Wheeling Drainage Ditch underway)
Geology	WGS / ISGS	Surficial Geology
Soils	NRCS	Soil Survey Geographic database (SSURGO) by county

Data type	Source	Description
Pre-settlement Vegetation	WDNR, Lake County Forest Preserve District, Illinois Natural History Survey(INHS)	Digitized pre-settlement vegetation
Hydrology and hydrography		
Streams	WDNR/Illinois EPA (IEPA) Lake County	National Hydrography Dataset (NHD) medium with designated uses, county mapped streams and waterways
	USGS	NHD high resolution
Water Table Depth	WDNR/ISGS	SSURGO (NRCS) as needed to fill gaps
Wetlands	WDNR, Illinois NWI (Ducks Unlimited) Lake County	Estimated locations of wetlands, Wisconsin Wetland Inventory, Illinois NWI, Lake County Wetland Inventory & ADID Study
	USFWS	NWI
Floodplain boundaries	Federal Emergency Management Agency (FEMA)	100-year floodplain boundaries (Lake County, IL revised 9-18-13; County #17097)
Watershed boundaries	Lake County, WDNR, USGS	Local, State and National watershed delineation outputs
Flow Paths	Lake County	GIS database (flow path determinations)
Constructed Water Bodies	Lake County	GIS database (detention basin inventory); Lake County Wetland Inventory (artificial wetlands)
Historic Hydrology	Lake County	USGS 7.5' and 15' scanned and dereferenced quads
Other		
Roads, political boundaries, etc.	2010 Census, Lake County, and WDNR	Lake County and Wisconsin DNR
Habitat/Biological Assessments	Illinois DNR, Illinois Natural History Survey, IEPA, USACE, Wisconsin DNR, Lake County Forest Preserve District	IL Natural Areas Inventory, forest bird habitat assessment (Lake County), other habitat and biological assessment data, where available
Threatened and Endangered Species	Illinois DNR, Wisconsin DNR	Natural Heritage Inventory Database (IL), Natural Heritage Database (WI)

1.1 Pre-European Settlement Wetland Inventory

Records and maps of pre-European settlement land cover and vegetation types and extent offer insight into areas where wetlands might have been before major landscape changes associated with European settlements in the region. NWI Cowardin code vegetative classes (Cowardin et al. 1979) will be assigned to those historic vegetation types within the project watersheds to represent the potential types of wetlands that could have been present in areas coincident with hydric soils. That information will then be cross-referenced in a GIS with hydric soils from present day NRCS SSURGO. This will result in an estimate of the types and extent of pre-European settlement wetlands, in the form of coded polygons within a GIS that are similar in format and function to existing wetland data. The resultant estimation of pre-European settlement wetland footprints will be classified using LLWW descriptors allowing the same functional assessment that will be performed on the present-day wetland data, allowing the two datasets to be directly comparable.

Identifying historic wetlands in the Des Plaines River watershed will rely on historic vegetation data provided by Lake County (to be provided) and information from the Illinois Natural History Survey (INHS) based on the original Public Land Survey information from between 1804 and 1843.

The SSURGO database will be queried to isolate hydric soils. Use of the SSURGO database will be obtained from the "SSURGO Data Downloader," produced by the Environmental Systems Research Institute (ESRI). ESRI's online web map service allows users to download map packages of pre-processed, ready to use SSURGO data that has been grouped by watershed (HUC8). The most useful and commonly used soil fields, variables, and values from the SSURGO database have already been processed using recommended NRCS methods for each soil map unit polygon allowing immediate implementation in a GIS.

A correlation will be developed between hydric soil map units from the SSURGO database and the interpreted historic NWI Cowardin water regime types (Cowardin et al. 1979). A GIS ModelBuilder workflow will be constructed to automatically assign soil map units to a NWI Water Regime. ModelBuilder allows a GIS operator to string together multiple actions from a workflow that are often undertaken manually, one at a time. The resultant model is savable and thus easily transferrable between GIS users, can be modified, and most importantly, can quickly be re-applied to the same data with revised selection criteria or new data.

Identifying pre-European settlement wetlands in the Lower Fox River watersheds will rely on a more complex GIS-based analysis as provided by WDNR. This approach involves the creation of a Compound Topographic Index (CTI). The CTI is a steady state wetness index which strongly correlates to soil moisture and aims to model soil water content (Moore 1991) and is a measure of the likelihood of water to pond in any given location on the landscape.

The CTI incorporates slope and contributing area using the following equation:

$$CTI = \ln (\text{Specific Contributing Area} / \text{Slope})$$

CTI values between 10 and 17 have been previously identified by Wisconsin DNR as areas with potential for wetland restoration (Smith 2014). CTI values less than 10 are typically too dry to provide for wetland hydrology and CTI values greater than 17 have been found to be perennial water bodies (Smith 2014).

Potential restoration sites identified using the CTI will be further evaluated for the presence of hydric soils which are derived from SURRGO databases. Areas that have potential for wetland restoration based on the CTI and have greater than 75 percent hydric soils will be identified. Existing wetlands and water bodies will be removed from the dataset, and the remaining will be classified as potentially restorable wetlands.

In addition to the DEM data needed for the CTI grid creation—obtained from local and national (USGS National Elevation Dataset, or NED) sources—all data required for this more complex approach has been provided by WDNR.

For both Wisconsin and Illinois project areas, the last potentially useful dataset needed for a pre-European settlement wetland area analysis is a GIS coverage representing pre-European settlement hydrography—the historical location of rivers, streams, lakes, and ponds. This type of dataset is often derived from General Land Office records and maps, as well as other resources such as tile drainage maps. Unfortunately, these maps are only available in hardcopy (Wisconsin) or scanned, geo-referenced format (Illinois), and polyline and polygon locations of hydrographic features have not been hand-digitized for efficient employment with a GIS. Such an effort is beyond the scope of this analysis.

Therefore, a modified version of the NHD with waterbodies and flow lines identified as "constructed features" will be removed from the dataset and used as a proxy. For future efforts in the project area or others, if time and budget allow, obtaining hardcopies or digitizing historical hydrographic features can be planned and incorporated into the study. State historic preservation offices (e.g., http://www.inhs.illinois.edu/) and the U.S. National Archives (http://www.archives.gov/research/) are good places to determine if historic hydrographic maps for a study area are available and where those hardcopies can be found.

1.2 LLWW Classification Process

The LLWW system of wetland classification characterizes the HGM qualities of each wetland and is an enhancement to existing wetland classification systems. The LLWW system provides information about wetland location, such as along a river or stream or in a lake basin; provides information about whether that wetland is isolated or is perhaps the source or headwater of a stream, or might instead be located in the middle of a stream network; identifies whether a waterbody associated with the wetland is natural or constructed; and provides an idea of the scale of that waterbody. As previously discussed, the LLWW approach used by MDEQ (2011) will be closely followed and further refined using recent publications by Tiner (2003b, 2011), methods employed in the Sandusky River Watershed project (PG Environmental 2014), and other current research. The order in which the LLWW steps are discussed reflects the recommended order of operations that is most effective for GIS processing, and is in approximate order of the level of effort required, from most to least: 1) landform; 2) landscape position; 3) water flow path; and 4) waterbody type. The following processes will be performed for both existing and estimated historic wetland footprints.

1.2.1 Landform

In the MDEQ (2011) work, landform values were derived only from the NWI Cowardin water regime information; however, for this project (as was employed in the Sandusky project) we propose to expand the classification methodology to include other datasets such as Digital Elevation Model (DEM) data, the NHD Waterbody layer, and the FEMA 100-year floodplain boundaries.

The first step will be to create a slope raster to determine the average percent slope across each wetland polygon allowing the assignment of the landform position class of slope (wetlands with slopes of 5% or greater). The remaining landform class assignments will be based primarily on each wetland's water regime classification contained within its Cowardin code assignment (Table 2). In Lake County, wetlands within the LCWI will be assigned water regime classifications based on landform as needed. The floodplain class assignment will be determined by coincidence of wetlands within the FEMA-designated floodplain areas.

Table 2. Landform Classes and Proposed Classification Schema

Slope (SL)	Wetlands occurring on a slope of 5% or greater, as indicated by a slope raster created from highest-resolution available DEM.
Island (IL)	A wetland completely surrounded by water, as indicated by the NHD Waterbody layer.
Fringe (FR)	Wetland occurs in the shallow water zone of a permanent waterbody. NWI water regimes F, G, and H
Floodplain (FP)	Wetland occurs on an active alluvial plain along a river and some streams, as defined through the use of FEMA floodplain data. Modifiers FPba (basin) and FPfl (flat)
Basin (BA)	Wetland occurs in a distinct depression. NWI water regimes C and E
Flat (FL)	Wetland occurs on a nearly level landform. NWI water regimes A, B, and K.

It is important to note that the landform position classes are not mutually exclusive, and that the order of operations is integral. For this reason, it will be important to run the analysis for landform in the exact order of slope-island-fringe-floodplain-basin-flat, as specified by Tiner (2011). For example, a wetland polygon could potentially possess characteristics that would allow it to be coded as basin or slope, depending on which selection process was performed first. If the basin analysis is run first, it could potentially remove wetlands that would have been be coded as SL if the slope analysis had been run first.

1.2.2 Landscape Position

Landscape position refers to the location of a particular wetland with respect to topography and its impact on the wetland's water source(s). There are four possible classes: lentic, lotic river, lotic stream, and terrene (Table 3 and Figure 3). The Lentic (LE) landscape position type should be analyzed and assigned before the other three landscape position classes.

Table 3. Landscape Position Classes and Proposed Classification Schema

Lentic (LE)	Wetland in or along lake (waterbody >= 5 acres in Wisconsin or >=2 acres in Illinois) or within basin, defined as area contiguous to lake affected by rising lake levels.
Lotic River (LR)	Wetland associated with (directly intersected by) a river **or** its active floodplain.
Lotic Stream (LS)	Wetland is associated with (directly intersected by) a stream **or** its active floodplain.
Terrene (TE)	All remaining wetlands including those that are: 1) Located in or borders pond, or wetland is a pond, (waterbody < 5 acres in Wisconsin or < 2 acres in Illinois in size surrounded by upland) 2. Or, adjacent to but is not affected by a stream or river (located in or along, but NOT periodically flooded stream) 3. Or, completely surrounded by upland (non-hydric soils)

Tiner (2011) states that all of the wetlands within the immediate area of the topographic basin containing a lake should be considered lentic, including wetlands near the lake that are bisected by streams. For this analysis, a lake is defined as a waterbody that is 5 acres or greater in Wisconsin or 2 acres or greater in Illinois.

Tiner advises that the upstream limit of a lake's influence can usually be approximated by the extent of the basin that the lake occurs in. However, he notes that assigning the limits of a lake's influence should be based on the physiography and climate of the landscape under analysis. For example, in what Tiner refers to as "wetland landscapes" such as the arctic, subarctic, or the Mississippi delta, there is relatively little topographic relief and a lake in these areas would have an extensive and large drainage basin extending far beyond the lake. Despite that seemingly large drainage area, only wetlands immediately near the shoreline that are periodically flooded by the lake would be classified as lentic, as they are the ones that are influenced by lake level changes.

FEMA flood insurance rate maps (i.e., floodplain maps) are available in GIS format (also known as DFIRM data sets) for all project areas and will be used in conjunction with NHD and local hydrography datasest to determine if a wetland should be classified as lentic. In areas without floodplain maps, the highest-resolution DEM dataset available can be employed to assign the lentic landscape position class.

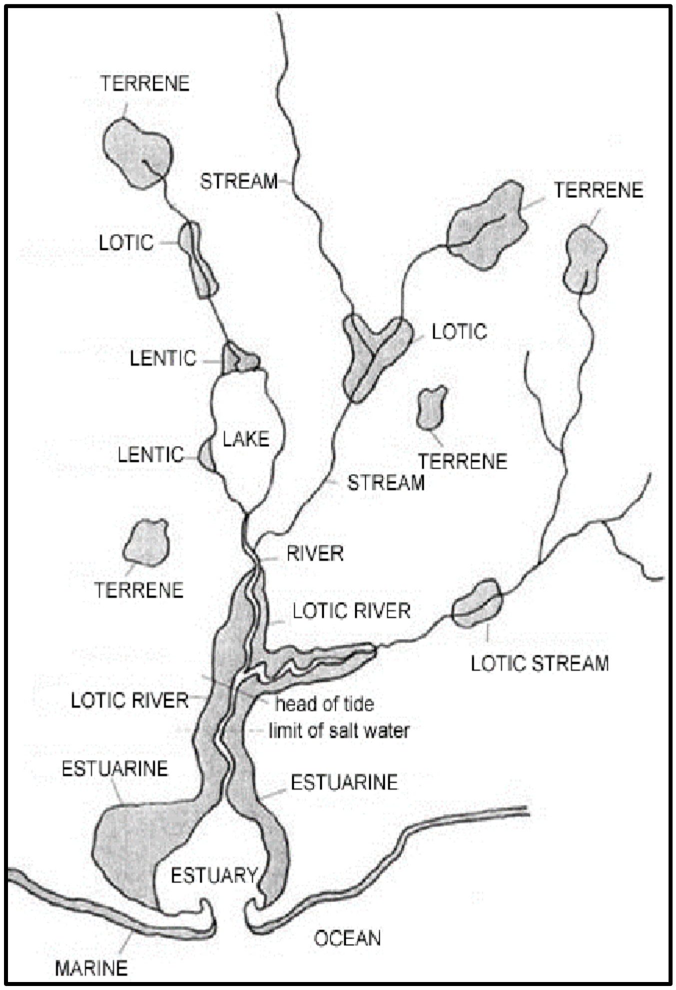

Figure 3. Examples of Landscape Position Classes (Tiner 2011).

Tiner (2011) defines lotic river as: "[w]etland is associated with a river (a broad channel mapped as a polygon or 2-lined watercourse on a 1:24,000 U.S. Geological Survey topographic map) or its active floodplain," as opposed to lotic stream, which is described as: "[w]etland is associated with a stream (a linear or single-line watercourse on a 1:24,000 U.S. Geological Survey topographic map) or its active floodplain." In other words, the distinction for the purpose of a GIS analysis comes down to if a watercourse is defined as a polygon—Tiner's "broad channel mapped as a polygon or 2-lined watercourse"—it would be considered a river, versus a linear feature in the GIS (i.e., polyline), which would be considered a stream.

Previous work in the Sandusky watershed relied on buffering of hydrographic features combined with topographic data to assign the lotic river and lotic stream landscape position classes. Known floodplains such as those developed for flood insurance rate maps can provide a more accurate determination of which wetlands may be connected and influenced by lakes, rivers, or streams, rather than using proximity to other waterbodies which can introduce additional error depending on the topography and drainage patterns. Wetlands located in a floodplain are assumed to be associated with the waterbody (either a river or stream) and are classified as lotic river or lotic stream.

After the lotic river but before the lotic stream analysis steps, an intermediate step for just the headwater subclass of terrene wetlands is performed. Headwater wetlands are classified where a river or stream does not extend through the wetland, and the wetland is often considered the source of the stream. Unless this intermediate step is done first in the GIS, wetlands that should be assigned to the terrene landscape position can potentially get assigned lotic stream in error. Starting points of the stream network system will be identified and wetlands within 75 feet of those starting points will be coded as terrene headwater.

Once the lotic stream assignments are made all remaining wetlands surrounded by upland or those in or adjacent to a pond (a waterbody < 5 acres in Wisconsin or < 2 acres in Illinois) are selected and classed as terrene.

1.2.3 WATER FLOW PATH

Water flow path classification delineates wetlands into five main classes dependent on the wetland's source of water as well as the role that the wetland may play as a source for downstream waterways (Table 4 and Figure 4). Those five classes contain several subclasses that are further subdivided based on whether the body of water is naturally occurring, constructed (e.g., canal or drainage ditch), or if flow is intermittent. The water flow path class is sometimes referred to as hydrodynamics (MDEQ 2011).

Table 4. Water Flow Path Classes and Proposed Classification Schema

Outflow (OU)	Water flows out of the wetland naturally, but does not flow into this wetland from another source.
Outflow Intermittent (OI)	Water flows out of the wetland intermittently, but does not flow into this wetland from another source.
Outflow Artificial (OA)	Water flows out of the wetland, in a channel that was manipulated or artificially created.
Bidirectional (BI)	Wetland along a lake and not along a river or stream entering this type of waterbody; its water levels are subjected to the rise and fall of the lake levels. Lentic wetlands with no streams intersecting them.
Throughflow (TH)	Water flows through wetland, often coming from upstream sources (typically wetlands along rivers and streams). Lentic wetlands with streams running through them are classified as throughflow (or throughflow intermittent, if stream is classed as intermittent).
Throughflow Intermittent (TI)	Water flows through the wetland intermittently, often coming from upstream sources (typically wetlands along streams).
Throughflow Artificial (TA)	Water flows through the wetland, in a channel that was manipulated or artificially created.
Isolated (IS)	Wetland is typically surrounded by upland (nonhydric soil); receives precipitation and runoff from adjacent areas with no apparent outflow.
Inflow (IN)	Wetland is a sink receiving water from a river, stream, or other surface water source, lacking surface-water outflow.

The general approach for the water flow path class is to identify the intersections between the NHD Flowline layer and the wetlands and then classify each wetland based on the type of waterbody it intersects. The identification of waterbody types in the NHD Flowlines layer is done using the data set's feature codes (FCodes) attributes. These FCodes identify the type of waterway that each line represents. Lines are grouped into three types:

1. Perennial (FCode 46006, "Stream/River – Perennial" and FCode 55800, "Artificial Path")
2. Intermittent (FCode 46003, "Stream/River – Intermittent" and FCode 46007, "Stream/River – Ephemeral")
3. Pipes/Canals/Ditches (FCode 42800, "Pipeline," FCode 33600, "Canal/Ditch," and FCode 33400, "Connector").

Note that the "Artificial Path" classification in the NHD (FCode 55800) does not necessarily indicate a natural versus constructed waterway. Artificial paths in the NHD Flowline are connectors developed as a part of NHD to complete pathways facilitating hydrologic network modeling. In fact, the artificial path feature includes many natural rivers and streams. For this reason, they will also be grouped with the perennial FCode features.

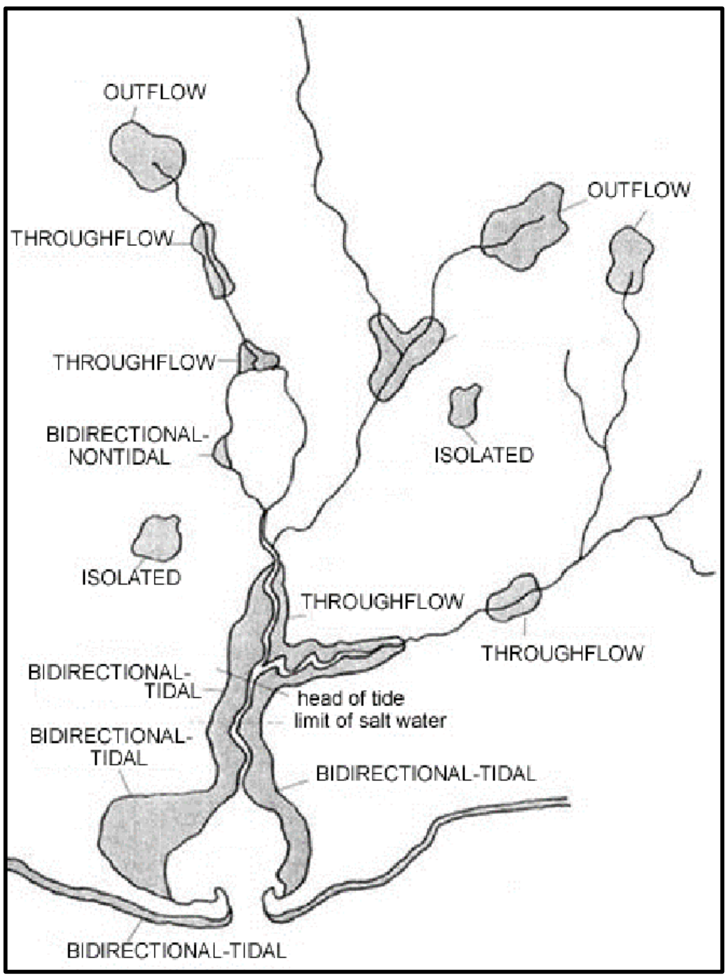

Figure 4. Examples of Water Flow Path Classes (Tiner 2011).

Tiner (2011) states that throughflow water flow path wetlands receive surface or groundwater from a stream, other waterbody, or another wetland at a higher elevation and that the surface or groundwater passes through that wetland to another stream or waterbody. In order to account for groundwater influence—and not just assign the throughflow classification to wetlands directly intersected by NHD Flowlines—the criteria will be expanded by using a 200-ft buffer created for all NHD Flowlines. This will also correct for any potential mismatches between the NHD Flowlines and the true position of a waterway with respect to a wetland. Including groundwater through the use of a NHD Flowline buffer will better classify wetlands that are flow-through systems—one of the major reasons this classification is included in the methodology. The same approach will be used if higher resolution river and stream data are available for the watersheds from local entities (e.g., LCSMC).

1.2.4 WATERBODY TYPE

When possible, the waterbody type of a wetland will be determined by the Cowardin code of that wetland or other attributes of local wetland inventory datasets. When these types of attributes are not available waterbody type will be determined based on waterbody classifications included in available hydrographic datasets—local (e.g., Lake County) and national (e.g., NHD). The waterbody type classification applies only to permanent and deep open water habitats, such as ponds, lakes, and rivers. A pond is an example of a wetland that qualifies as both a wetland and open water, and such wetlands can be assigned a waterbody type. Both “Freshwater Pond” and “Lake” wetland types will be further sorted for the division of lakes versus ponds (Table 5).

Table 5. Waterbody Types and Proposed Classification Schema

Natural Pond (PD1)	A natural pond that is less than 5 acres in size in Wisconsin or less than 2 acres in size in Illinois.
Dike and/or Impounded Pond (PD2)	A pond that is diked and/or impounded and is less than 5 acres in size in Wisconsin or less than 2 acres in size in Illinois.
Excavated Pond (PD3)	A pond that is excavated and is less than 5 acres in size in Wisconsin or less than 2 acres in size in Illinois.
Natural Lake (LK1)	A natural lake that is greater than 5 acres in size in Wisconsin or less than 2 acres in size in Illinois.
Dammed River Valley (LK2)	A lake created by damming a river valley and is greater than 5 acres in size in Wisconsin or less than 2 acres in size in Illinois. [a]
Excavated Lake (LK3)	A lake that is excavated and greater than 5 acres in size in Wisconsin or less than 2 acres in size in Illinois.
River (RV)	A polygonal feature in the NHD (or state-level hydrography datasets) or wetland datasets.

a. A currently dammed stream in Lake County (locally referred to as Rasmussen) is being restored through dam removal.

1.3 W-PAWF CLASSIFICATION PROCESS

The W-PAWF refers to the process of classifying wetlands based on the significance of their functions (USFWS 2010). A wetland function is any natural, physical, and biological process that occurs within the wetland. Additionally, wetland function can, to some extent, be linked to physical and biological processes within the waterways and other ecosystems connected to that the wetland. Those processes may serve to sustain and maintain the wetland, or may just be an incidental function provided by the wetland. Examples include sediment retention and the transformation of nutrients.

The significance of a function refers to the ability and level of that natural process to occur in comparison to other wetlands. Significance is a relative measure, and the terms “high,” “moderate,” and “low” are used to describe the level of function that one wetland has in comparison to the other wetlands in the study area. These terms are used without regard to the perceived human value of any wetland function or its benefit to a watershed. Wetlands that have a high functional significance for nutrient transformation do not necessarily meet any particular regulatory standard, but rather are performing that process at a better and higher rate than other wetlands within the area of analysis. The functional value of the ecological services provided by wetlands is a separate step that is determined by the needs and requirements of regulators and watershed planners. Functional significance is only meant as a method to classify and rank wetlands for their ability to perform natural processes.

The W-PAWF analysis starts with wetlands having been classified using LLWW HGM descriptors but also makes use of the original NWI Cowardin wetland type designations (Cowardin et al. 1979). Additional GIS data and information about the ecology, hydrology, and physiography of the watershed are used to supplement the analysis. A correlation is drawn between combinations of those component inputs and the different levels of functional significance for each wetland function. The majority of the functional correlations presented here originally came from R.W. Tiner's 2003 publication "Correlating Enhanced National Wetlands Inventory Data with Wetland Functions for Watershed Assessments: A Rationale for Northeastern U.S. Wetlands." The 2011 MDEQ report applied Tiner's 2003 work in Michigan, adjusting and adding to the functional correlations originally intended for the northeast region of the United States. MDEQ's efforts resulted in 13 different indicators of wetland functional significance.

Those same 13 wetland functions will be employed for this project; however, as seen in recent applications of this method (e.g., Sandusky River Watershed Project), there may be a need for some regional modifications. The 13 functions proposed for this assessment are:

1. Flood Water Storage
2. Streamflow Maintenance
3. Nutrient Transformation
4. Sediment and Other Particulate Retention
5. Shoreline Stabilization
6. Stream Shading
7. Fish Habitat
8. Waterfowl and Waterbird Habitat
9. Shorebird Habitat
10. Interior Forest Bird Habitat
11. Amphibian Habitat
12. Conservation of Rare Wetlands and Species
13. Influence of Groundwater on Streamwater Recharge

Given the proximity of Michigan to Wisconsin and Illinois, MDEQ's W-PAWF criteria are regarded as a suitable foundation for this analysis. Each of the 13 functional indicators, and the methodology proposed for the analysis, is discussed below.

1.3.1 Flood Water Storage

Tiner (2003b) refers to this wetland function as "Surface Water Detention," but discusses it in terms of the ability to stop or delay flooding. The 2011 MDEQ LLWFA report emphasizes the benefit to flood control, and refers to this wetland function as "Flood Water Storage." In this analysis, larger wetlands are assigned a higher functional significance class for flood water storage than smaller wetlands. While the size of a wetland is not a precise estimate of wetland storage capacity or volume for flood water storage, larger wetlands presumably have a higher storage capacity. In past applications of the method, the median value of wetlands acreage from the entire population was used to determine a threshold value (e.g., Sandusky's threshold was found to be 0.59 acres). Other selection criteria to be used for class assignments of various wetland types and LLWW descriptors are listed in the table below.

Table 6. Criteria for Flood Water Storage Function Significance

Functional Significance	Selection Criteria
High	• Wetlands along streams and rivers • Island wetlands • Ponds that are throughflow, throughflow intermittent, bidirectional, and isolated • Area equal or greater than a to-be-determined threshold
Moderate	• All of the above in the High category less than to-be-determined threshold • Terrene basin isolated • Terrene and outflow or outflow intermittent wetlands • Other ponds/terrene wetlands associated with ponds connected to hydrography network • Terrene wetlands that are associated with ponds • All lake-side wetlands not already ranked high
Low	• All remaining wetlands

1.3.2 Streamflow Maintenance

Both Tiner (2003b) and the 2011 MDEQ LLWFA report give high functional significance to wetlands that sustain streamflow by acting as sources of groundwater discharge to surface waterways. Wetlands in the headwaters of a watershed will also be rated high for the streamflow maintenance function, followed by wetlands that store and release water over long periods of time, such as those rated high for the flood water storage wetland function. Tiner also directly correlates the fish habitat wetland function with wetlands that are rated high for the streamflow maintenance function, as consistent streamflow is critical for those organisms. Of additional benefit to fish habitat, streamflow maintenance can provide temperature control in water bodies. Reduced temperatures can decrease solubility for many chemicals, decreasing the chance of toxic stress to aquatic organisms (California SWRCB 2012). As with the flood water storage function, the size of particular wetland is used to place it into either a high or medium functional significance class. Other class assignment criteria are generalized in the table below.

Table 7. Criteria for Streamflow Maintenance Function Significance

Functional Significance	Selection Criteria
High	• All headwater wetlands (hw) that have an area equal or greater than a to-be-determined threshold
Moderate	• All of the above in High category less than to-be-determined threshold • Lotic stream and river floodplain and fringe wetlands • Lotic stream basin wetlands • Throughflow and outflow ponds and lakes • Terrene outflow wetlands associated with a pond • Terrene outflow wetlands outflowing to hydrography network
Low	• All remaining wetlands

1.3.3 Nutrient Transformation

Highly vegetated wetlands with water tables that fluctuate receive high functional significance ratings for nutrient transformation by both Tiner (2003b) and in the 2011 MDEQ LLWFA report. Fluctuation of the water table increases deposition while the presence of vegetation slows the flow of water allowing for the precipitation of minerals and settling out of particulates (and those nutrients sorbed to settled particulates). Other opportunities to encourage deposition, such as the reduction of stream flow velocity upon entering a large body of water, also provide a minor functional value.

More importantly, the frequent rise and fall of water tables and therefore surface water in wetlands promotes accelerated nutrient uptake by most obligate and facultative wetland vegetation. This, coupled with the fact that the frequent wetting and drying of soils increases the probability of completion of the denitrification process (microbial removal of nitrogen dissolved in water through a series of biogeochemical processes resulting in the off-gassing into the atmosphere of nitrogen as N_2) make this particular indicator of important functional significance. Both vegetative class and the water regime wetland attributes are used by MDEQ and Tiner for wetland classification. However, because these hydrodynamic processes help to addresses absorption and reprocessing of nutrients, an additional GIS data layer is proposed for this indicator. The previously discussed SSURGO database soil attribute of flooding frequency from the landscape position LLWW classification can be used as a criterion for functional class assignments in order to address the importance to nutrient transformation of frequent wetting and drying cycles.

Table 8. Criteria for Nutrient Transformation Function Significance

Functional Significance	Selection Criteria
High	• Vegetated wetlands P_ (AB, EM, SS, FO, and mixes) with water regime C, E, F, H, G. No open water types – with SSURGO Flood Frequency of “Frequent” or “Occasional”
Moderate	• Vegetated wetlands P_ (AB, EM, SS, FO, and mixes) with water regime C, E, F, H, G. No open water types – with SSURGO Flood Frequency of “Rare”, “Very Rare”, or “None” • Seasonally Saturated and Temporarily Flooded Vegetated Wetlands P_ (AB, EM, SS, FO, and mixes) with A, B water regime or lacustrine vegetated wetlands (no open water) – with SSURGO Flood Frequency of “Frequent” or “Occasional”
Low	• All remaining wetlands

1.3.4 Sediment and Other Particulate Retention

As mentioned in the nutrient transformation function section above, the ability of a wetland to provide a sediment retention function depends on the presence of vegetation to reduce the flow of water, to drop sediment out of entrainment, and assist in retaining the sediment. However, it is important to note that large, open bodies of water also can offer opportunities to reduce water velocity and produce deposition.

Tiner (2003a) notes that when watershed planners are using this criteria and assigning a functional significance value based on the presence of ponds, certain types of waterbodies should probably be removed, such as ponds formed in gravel pits, impoundments that are completely surrounded by dikes, and man-made dug-out ponds with little or no surface water inflow, such as stormwater detention ponds. The NHD Waterbody GIS data layer will be used to differentiate waterbody types that should be removed, or ranked low, for this indicator. In addition, the LCSMC's detention basin inventory (classified as artificial wetlands) and LCWI will be used to identify constructed ponds.

Table 9. Criteria for Sediment and Other Particulate Retention Function Significance

Functional Significance	Selection Criteria
High	• Basin wetlands associated with lakes • Fringe and island wetlands associated with lakes • Floodplain wetlands • Lotic stream basin, flat, and fringe wetlands that are throughflow or throughflow intermittent • Lotic river floodplain or fringe throughflow wetlands • Throughflow or throughflow intermittent ponds • Island wetlands
Moderate	• Terrene basin wetlands that are outflow, outflow intermittent or outflow artificial • Natural ponds not already rated water regime H (Permanently Flooded) • All wetlands associated with a pond • Terrene basin wetlands that are isolated
Low	• All remaining wetlands

1.3.5 Shoreline Stabilization

The function of wetlands to provide erosion control by minimizing the effect of wave action or stream cutting on shores and banks is evaluated with these criteria. The presence of vegetation on shorelines and banks is the primary characteristic for rating a wetland as being highly significant for this function. To provide a more accurate assessment than past applications of the LLWFA methods, a GIS-based analysis will be explored using the Red-Green-Blue, or RGB, signature of high-resolution aerial imagery (1-meter) that may be predominantly unique to land with well-established vegetated cover. This would allow wetlands to be more accurately classified for this particular functional assessment.

Table 10. Criteria for Shoreline Stabilization Function Significance

Functional Significance	Selection Criteria
High	• Vegetated wetlands along water bodies (rivers, lakes, streams)
Moderate	• Terrene vegetated wetlands along ponds • Terrene outflow, outflow intermittent, outflow artificial wetlands that are headwater
Low	• All remaining wetlands

1.3.6 Stream Shading

Forested or scrub-shrub wetlands that provide stream shading functions are capable of regulating water temperature in nearby streams and waterways. Shaded headwater wetlands provide the highest level of this function. Tiner (2003b) did not specifically call out this wetland function, but it is a criterion employed in the 2011 MDEQ LLWFA report. Temperature regulation contributes to increasing the significance of the fish and amphibian habitat wetland functions, as well as providing increased function in nearby streams and rivers. Temperature control of streams and waterways can decrease the solubility of many chemicals, and thus decrease the chance of toxic stress to aquatic organisms overall (California SWRCB 2012).

Table 11. Criteria for Stream Shading Function Significance

Functional Significance	Selection Criteria
High	• Wetlands that are forested and scrub-shrub and headwater and within 50 feet of the hydrography network • Stream Wetlands that are palustrine forested and palustrine scrub-shrub and headwater
Moderate	• All other wetlands that are not forested and scrub-shrub and within 50 feet of the hydrography network • Stream wetlands that are palustrine forested and palustrine scrub-shrub and not headwater
Low	• All remaining wetlands

1.3.7 FISH HABITAT

Tiner (2003b) states that the functional significance criteria identified for fish habitat are specific to the Northeast and need to be re-examined for individual watersheds when using the functional assessment in other regions of the country. He suggests that the other functional criteria in his analysis method should be relevant nationwide, but that fish and wildlife habitat are highly watershed-dependent. While the Great Lakes do experience water level fluctuations that could affect near-shore wetlands, those changes are primarily driven by meteorological effects such as wind and pressure change. True gravitational effects are limited to less than several inches of height change daily. The Great Lakes can therefore be considered non-tidal, and Tiner's functional significance criteria that involve tidal influence have been left out of the proposed approach for this project, as was done in the 2011 MDEQ LLWFA report and Sandusky River Watershed Project.

Table 12. Criteria for Fish Habitat Function Significance

Functional Significance	Selection Criteria
High	• Lentic wetlands • Stream and river wetlands that are only throughflow • Wetlands associated with a pond connected to the hydrography network • Ponds connected to the hydrography network that are associated with a wetland • Palustrine aquatic bed outflowing wetlands • Natural lakes • All lakes that are throughflow, throughflow intermittent, or throughflow artificial, outflow, outflow intermittent or outflow artificial • Headwater wetlands except artificial types connected to the hydrography network
Moderate	• Wetlands associated with a pond not connected to the hydrography network • Ponds not connected to the hydrography network that are associated with a wetland • Natural ponds that are isolated (moved from MDEQ's assignment of a high classification) • Headwater wetlands except artificial types not connected to the hydrography network • Throughflow ponds
Low	• All remaining wetlands

1.3.8 Waterfowl and Waterbird Habitat

As with the Fish Habitat function, Tiner (2003b) states that the correlations for significance of this criterion are specific to the Northeast, and that in other parts of the country they will need to be tailored for each watershed under consideration. Tiner's general characteristics of wetlands that should be rated high for providing the function of waterfowl and waterbird habitat are those that are more consistently wet or that are flooded for long periods of time. Generally, this provides a better habitat for nesting, reproduction, or feeding.

The 2011 MDEQ LLWFA methodology further defines wetlands that perform habitat functions for additional bird types, such as shorebirds and interior forest birds. MDEQ's original approach to bird habitat will be supplemented with the addition of SSURGO flooding frequency information.

Table 13. Criteria for Waterfowl and Waterbird Habitat Function Significance

Functional Significance	Selection Criteria
High	• Frequently flooded (as defined by SSURGO dataset) that are: Palustrine aquatic bed emergent and scrub-shrub wetlands that are seasonally flooded, seasonally flooded/saturated, semi-permanently flooded, intermittently exposed, and permanently flooded. No coniferous.
Moderate	• Palustrine forested wetlands that are seasonally flooded, seasonally flooded/saturated, Semi permanently flooded, intermittently exposed, and permanently flooded. No coniferous.
Low	• All remaining wetlands

1.3.9 Shorebird Habitat

General characteristics of wetlands that should be rated high for providing the function of shorebird habitat are those that have more open water areas and less canopy coverage along the shoreline. This provides better habitats for nesting, reproducing, or feeding. MDEQ's approach to shorebird habitat will be supplemented with the addition of SSURGO flooding frequency information.

Table 14. Criteria for Shorebird Habitat Function Significance

Functional Significance	Selection Criteria
High	• Frequently flooded (as defined by SSURGO dataset) that are: Palustrine aquatic bed emergent and scrub-shrub wetlands not intermittently exposed or permanently flooded • Non-persistent wetlands (PEM2) • Lacustrine unconsolidated shore that is partially flooded
Moderate	• Palustrine emergent, scrub-shrub, and forested wetlands that are not intermittently exposed or permanently flooded
Low	• All remaining wetlands

1.3.10 Interior Forest Bird Habitat

Interior forest birds require large areas of forested land along waterways and waterbodies that offer habitat for nesting, reproducing, and feeding. Supplementing MDEQ's approach to this indicator with the interpretations of the RGB signature of recent high-resolution (1-meter) aerial imagery and most recent vegetative cover dataset, such as the 2013 U.S. Department of Agriculture's Cropland Data Layer, will help to achieve a greater confidence in the functional significance assignment for interior forest bird habitat. In Lake County, local knowledge of areas with high function for forest bird habitat as provided by the Forest Preserve District will be incorporated.

Table 15. Criteria for Interior Forest Bird Habitat Function Significance

Functional Significance	Selection Criteria
High	• Frequently flooded (as defined by SSURGO dataset) forested or scrub-shrub wetlands with >50% of surrounding areas (within a 1 km buffer) under forest or scrub-shrub coverage (including non-wetland areas) • Palustrine forested wetlands that are along rivers and streams • Palustrine scrub-shrub wetlands and those mixed with other wetlands types • Within an area identified by local entities as a highly functional forested bird habitat
Moderate	• Of the remaining wetlands, those frequently flooded (as defined by SSURGO dataset) forested or scrub-shrub wetlands with <50% of surrounding areas (within a 1 km buffer) under forest or scrub-shrub coverage (including non-wetland areas) • Of the remaining wetlands, those palustrine forested wetlands that are not already rated as high
Low	• All remaining wetlands

1.3.11 CONSERVATION OF RARE WETLANDS AND SPECIES

Wetlands considered rare either globally, on a state-level, or even within a particular area of interest, such as a single watershed, provide the foundation for this indicator. Wetlands will fall into this category if they are identified as having a large diversity of flora and fauna and/or habitat that is threatened, endangered, or rare. Designations of such wetlands by state or local agencies can often be employed for this indicator. For example, in Lake County, the USACE's Chicago District has developed an approach to identify rare wetlands using a coefficient of conservatism or floristic quality index. At the time of this analysis, these data are not comprehensively available but in the future could be added by local entities.

Table 16. Criteria for Rare Wetlands and Species Conservation Function Significance

Functional Significance	Selection Criteria
High	• Wetland has at least one occurrence of a Federal or State-listed threatened or endangered species • Wetland is identified as locally rare by local assessment work
Low	• All remaining wetlands

1.3.12 AMPHIBIAN HABITAT

Tiner (2003b) did not specifically address significance criteria for amphibians, such as frogs, but instead noted that some of the criteria that he mainly intended for fish and shellfish should be applicable to amphibians and what he called other aquatic-dependent species. The 2011 MDEQ LLWFA report builds on Tiner's original criteria and identifies more specific characteristics of wetlands that provide the function of amphibian habitat. The size of the wetland is a primary consideration. Vegetated wetlands less than 5 acres in size in Wisconsin or less than 2 acres in size in Illinois that are isolated and can provide terrestrial habitat for some or all of the year rank high for the amphibian habitat function. Other wetlands that rank high include those that are naturally outflow water flow path, floodplain landform wetlands, lentic landscape position wetlands, and wetlands associated with natural ponds, as well as the ponds themselves. The SSURGO flooding frequency criteria will also be added to this indicator.

Table 17. Criteria for Amphibian Habitat Function Significance

Functional Significance	Selection Criteria
High	• Palustrine emergent, scrub-shrub, and forested wetlands along with those mixed types less than 5 acres in size in Wisconsin or less than 2 acres in size in Illinois, isolated, and only seasonally flooded, seasonally flooded/saturated, or semipermanently flooded; and not frequently flooded as defined by SSURGO. • Outflowing wetlands • Palustrine aquatic beds that are isolated and not intermittently exposed or permanently flooded; and not frequently flooded as defined by SSURGO. • Wetlands adjacent to rivers • Lakeside wetlands • Ponds and any wetlands that are associated with those ponds
Moderate	• Palustrine emergent, scrub-shrub, and forested wetlands with those mixed types that are less than 5 acres in size in Wisconsin or less than 2 acres in size in Illinois and within 50 feet of the hydrography network and only seasonally flooded, seasonally flooded/ saturated, or semi-permanently flooded; and not frequently flooded as defined by SSURGO. • Palustrine emergent, scrub-shrub, and forested wetlands along with those mixed types that less than 5 acres in size in Wisconsin or less than 2 acres in size in Illinois and outflowing artificially or intermittently and only seasonally flooded, seasonally flooded/ saturated, or semi-permanently flooded; and not frequently flooded as defined by SSURGO. • Palustrine emergent, scrub-shrub, and forested wetlands along with those mixed types that are isolated and only seasonally flooded, seasonally flooded/ saturated, or semi-permanently flooded; and not frequently flooded as defined by SSURGO. • Palustrine aquatic bed isolated wetlands that are permanently flooded • Scrub-shrub and forested wetlands less than less than 5 acres in size in Wisconsin or less than 2 acres in size in Illinois (must be PFO1) • Rivers
Low	• All remaining wetlands

1.3.13 GROUNDWATER INFLUENCE ON STREAMWATER RECHARGE

The 2011 Michigan LLWFA analysis method employed geospatial output from a model based on Darcy's law with inputs of soil transmissivity and topography to determine the rate of groundwater movement. This allowed ranking areas of transmissivity as high or moderate for groundwater influence. These data are not available in the project watersheds. Wetlands which have documented groundwater discharge (per the Lake County ADID or other studies) and those wetlands which have a zero depth to the annual or seasonally high water table based on SSURGO will be identified as groundwater dependent. Those groundwater dependent wetlands that are outflow or throughflow are labeled as having High functional significance.

Table 18. Criteria for Groundwater Influence Function Significance

Functional Significance	Selection Criteria
High	• Wetland with a zero depth to the water table (annual or seasonal) and is outflow or throughflow
Moderate	• All remaining wetlands with a zero depth to the water table (annual or seasonal)
Low	• All remaining wetlands

4 Expected Results

Functional characteristics of wetlands help to provide valuable information on what ecological services an existing wetland is providing—or historic wetland once provided—on the landscape, and therefore what services could be replaced by wetland enhancement and/or restoration activities. It is important to note that only one indicator (Interior Forest Bird Habitat) incorporated upland conditions adjacent to the wetland for functional significance scoring.

Based on the methodology described within this memorandum, each wetland will receive an overall composite score for functional significance that ranges from 13 (low significance) to 39. The overall composite score will then be used to rank each wetland (historic and existing combined and separately). Additional value to the proposed approach is the ability of the end user to isolate one or more indicators of interest for an alternative final scoring and ranking output. Alternatively, a user can weight different indicators more or less as the composite score is compiled allowing customizable analysis based on the 13 functional significance indicators. A hypothetical table of results can be found on the following page.

The preliminary results of both the current and historic wetland analyses will be delivered to EPA in a draft report. The report will explain in detail the objectives, datasets used, final screening methodology, and summarize the results. The draft report will also contain maps to illustrate the end products including tables for each watershed identifying rankings for each site (example shown in Table 19). For the final delivery, reports and maps will be submitted electronically and in hardcopy form. Maps and data will also be provided in GIS and tabular formats. Local entities and users will be able to adjust the weighting of the various indicators and prioritize indicators based on local goals.

Table 19. Example of Potential Expected Results

Indicator	Hypothetical Wetland ID & Scores						
	#101	#201	#301	#401	#501	#601	#701
Flood Water Storage	3	1	2	2	3	1	3
Streamflow Maintenance	3	2	3	2	2	1	1
Nutrient Transformation	3	3	2	3	1	1	1
Sediment and Other Particulate Retention	3	2	2	2	1	1	1
Shoreline Stabilization	1	2	2	1	1	1	2
Stream Shading	2	2	2	1	1	2	1
Fish Habitat	2	3	1	1	1	1	1
Waterfowl and Waterbird Habitat	1	2	1	2	1	1	2
Shorebird Habitat	3	3	2	1	1	2	1
Interior Forest Bird Habitat	3	2	1	1	3	3	1
Conservation of Rare Wetlands and Species	1	1	3	1	3	3	1
Amphibian Habitat	1	2	1	3	1	1	1
Groundwater Influence on Streamwater Recharge	3	1	1	2	2	1	1
Overall Composite Score	29	26	23	22	21	19	17
Overall Rank	1	2	3	4	5	6	7

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