Saint Mary's University of Minnesota
GeoSpatial Services

A Watershed Framework for the Assessment of Wetland Functions in the Lake Superior Basin of Douglas County, Wisconsin.

ON THE COVER

A low gradient stream surrounded by a mix of scrub shrub and emergent palustrine wetlands in Douglas County, Wisconsin.

Photograph by: Kevin Stark (GIS & Natural Resource Analyst, GeoSpatial Services, Saint Mary's University of Minnesota)

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Author Names

Kevin J. Stark & Andy Robertson

GeoSpatial Services
Saint Mary's University of Minnesota
700 Terrace Heights, Box #7
Winona, MN 55987

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Acronyms & Abbreviations

CTI – Compound Topographic Index

DC LSB – Douglas County, Lake Superior Basin (the study area)

DEM – digital elevation model

EPA – Environmental Protection Agency

ESRI – Environmental Systems Research Institute Inc.

GIS – Geographic Information Science or Systems

HUC – Hydrologic Unit Code, contained in the National Hydrography Dataset

LLWW – Landscape, Landform, Water body, Water Flow Path

Layer – a geospatial data layer

LTA – Land Type Association

NRCS – Natural Resource Conservation Service

NWI – National Wetlands Inventory

NWI plus – National Wetlands Inventory enhanced with the LLWW classification

PI – Photo Interpreter

PRW – Potentially Restorable Wetland (areas predicted to be former wetland locations except in areas with incompatible present-day land uses).

SMUMN GSS – Saint Mary's University of Minnesota, GeoSpatial Services

SURRGO – Soils Survey Geographic Database

USFWS – United States Fish & Wildlife Service

USGS – United States Geological Service

WI DNR – Wisconsin Department of Natural Resources

WWI – Wisconsin Wetlands Inventory

Executive Summary

This wetland assessment was completed as part of grant, funded through the National Estuarine Research Reserve and University of Wisconsin - Superior awarded to a Science Collaborative, a collaboration of multiple grantees. This document acts as the technical report for the Geodatabase creation, the wetland assessment, portion of this grant-funded work. This assessment describes characteristics of existing wetlands and based on these characteristics assesses select ecological functions that these wetlands are predicted to perform in the Lake Superior Basin portion of Douglas County. The assessment also identifies a population of potential wetland restoration sites, specifically areas predicted to support wetland re-establishment activities. These potential restoration areas were produced through photointerpretation and geospatial data modeling. The geospatial data and report information developed for this project are intended to inform decisions related to wetlands in a watershed context for local-level planning efforts.

The project utilized Wisconsin Wetland Inventory GIS data as a base wetland dataset and converted these data into GIS wetland data following the Cowardin wetland classification system (used by the USFWS's National Wetland Inventory or NWI). A skilled wetland photo-interpreter then utilized several collateral GIS datasets and enhanced the data by adding wetland descriptors following a hydrogeomorphic classification referred to as LLWW, developed by Ralph Tiner. With this enhanced wetland data, predicted wetland functions were applied based upon wetland characteristics contained within the geospatial database along with spatial relationships of the wetlands to each other and their surroundings. For a select group of ecological wetland functions, wetlands predicted to be significant for a given function were ranked as high or moderate. The criterion of wetland characteristics used for high and moderate levels for each ecological function was determined by the best profession judgment of several wetland experts. A final GIS wetland dataset contains coded wetland characteristics for each wetland polygon along with a ranking for each of the ecological function examined in the project. The results are also presented in larger map form in a separate, supplemental map book map form to provide a visual display of where wetlands are predicted to be significant for performing a set of ecological functions across the Lake Superior Basin of Douglas County.

The assessment also identified wetland restoration or mitigation opportunities, specifically sites predicted to offer wetland reestablishment or wetland creation opportunities. This was accomplished using GIS models that incorporated existing wetland, soils, land use / land cover, and derived topographic data combined with a photo interpretive component.

Acknowledgments

We would like to specifically acknowledge Tom Bernthal (Wisconsin Dept. of Natural Resources), Greg Larsen (U.S. Army Corps of Engineers), Nick Miller (The Nature Conservancy), Steve LaValley (WI Dept. of Natural Resources), Bill Sande (US Army Corps of Engineers), Jane Anklem (University of Wisconsin Extension), Mike Gardner (NorthFlow Inc.) Erin O'Brien (Wisconsin Wetlands Association), Tracy Hames (Wisconsin Wetlands Association), Kyle Magyera (Wisconsin Wetlands Association), and Cameron Bertsch (Douglas County) for their collaborative efforts and participation in the Technical Committee meetings that informed the process and the creation of the final GIS products for this project. We would also like to thank Sue O'Hollaran (University of Wisconsin Superior / National Estuarine Research Reserve), Christine Ostern (Douglas County), Erin O'Brien, Tracy Hames, Kyle Magyera (Wisconsin Wetlands Association), and Sarah Wilkins and Katy Thostenson (University of Wisconsin –Madison graduate students) for participation in the larger project which encompassed significant public outreach.

Chapter 1 - Introduction

> "Wetlands should be a key consideration of watershed planners. They play a role in the overall health and functioning of a watershed. In turn, their restoration, enhancement, or creation can be a strategic means to address water quality, water flow, and/or habitat issues.' (EPA 2013, pg. 13)

1.1 Project Background

This report and the geospatial data products discussed in it is part of a larger project entitled Lake Superior Watershed Framework for the Assessment of Wetland Services, a Science Collaborative Grant funded by the National Oceanic and Atmospheric Administration's (NOAA's) Lake Superior National Estuarine Research Reserve (NERR). One of the primary impetuses for this project is that Lake Superior Basin (LSB) watersheds have experienced increases in runoff volume and velocities which result in flashy stream flow condition that erode and further incise stream channels, undercut bluffs, and create turbidity and sedimentation problems. This is especially an issue in the LSB because much of it is geologically young red clay deposits left during the last glacial period and which are of low permeability, highly erodible, and prone to extensive mass wasting along stream banks, tributaries, and intermittent drainages (Verry & Kolka 2003). Additionally, local citizens have expressed concerns regarding the siting of wetland mitigation in the county. This inferred a need for some watershed approach for determining wetland re-establishment, creation, enhancement and preservation priorities. This report and the GIS data create a starting point for this type of planning effort.

Representatives from the following organizations participated in this project: Douglas County Conservation Department; NOAA's - Lake Superior National Estuarine Research Reserve; Wisconsin Wetlands Association; Wisconsin Department of Natural Resources; U.S. Army Corps of Engineers; Nature Conservancy, Northflow Inc.; University of Wisconsin – Superior; University of Wisconsin Extension; University of Wisconsin – Madison.

1.2 Purpose

EPA (2013) defines three tiers of wetlands assessments; level 1) landscape-scale assessments; level 2) rapid wetland assessments; and level 3) intensive site-level assessments. This assessment is a level 1 assessment. The purpose of a level 1 assessment is to:

> "evaluate indicators for a landscape view of watershed and wetland condition. Level 1 wetland assessment methods do not involve a site visit and use the types of information that can be reviewed in the office at a desk, such as maps, soil inventories, and remote sensing-generated data such as GIS models, wetland inventories, and land use datasets." (EPA 2013, pg. 22)

This assessment was informed primarily through remotely-sensed information such as digital elevation models (DEMs), aerial photography, and other GIS datasets. It also relied on best profession judgment of local and regional wetland and soils experts. While there was some limited field investigation to confirm broad-scale wetland mapping information, the data are not intended to provide site-level specificity. However, the data can be used to better understand the present-day distribution wetlands, which wetlands are predicted to be significant for performing certain ecological functions in the study area and provide an initial assessment of locations to be considered for the re-establishment of former wetlands. These areas may have drained some former wetlands or were otherwise altered from pre-settlement conditions based on their topographic position, their soils, and other visual evidence available in high-resolution aerial photography.

This project is intended to inform the public and local-level planning participants on two primary wetland-related topics:

1) Predicted wetland functions of existing, mapped wetlands;

2) Locations of potential wetland restoration (i.e., wetland re-establishment) opportunities in the Lake Superior Basin of Douglas County.

This document acts as the technical report for the Level 1 GIS-based wetland assessment portion of the grant for which GeoSpatial Services, Saint Mary's University of Minnesota was the primary responsible party. However, input for the potential restorable wetlands layer and other GIS processes, which wetland types were predicted to perform which functions, and other technical aspects of dealing with the uniqueness of the clay plain came from a technical committee. The technical committee met for a total of three face to face meetings in Superior, Wisconsin. The technical committee for this project comprised of representatives from the following organizations: WI DNR wetland group, WI DNR local wetlands regulatory representative, University of Wisconsin Extension based in Superior, WI; Douglas County Conservation and GIS Departments, a local U.S. ACOE representative, and a consultant from Northflow Inc. with local watershed planning experience.

1.3 Study Area & Background

The study area for this project is the Lake Superior Basin portion of Douglas County, hereafter study area or DC LSB (Figure 1). Douglas County boundaries define the north, east, and west boundaries of the study area and a WI DNR Watershed Boundary Dataset (WBD) defines the southern boundary of the study area. This southern boundary marks the drainage divide of waters flowing north into Lake Superior and those flowing to the south, into the St. Croix Drainage and eventually into the Mississippi River drainage. The study area covers 765.4 mi^2 of Douglas county, or just over half of the county's total area.

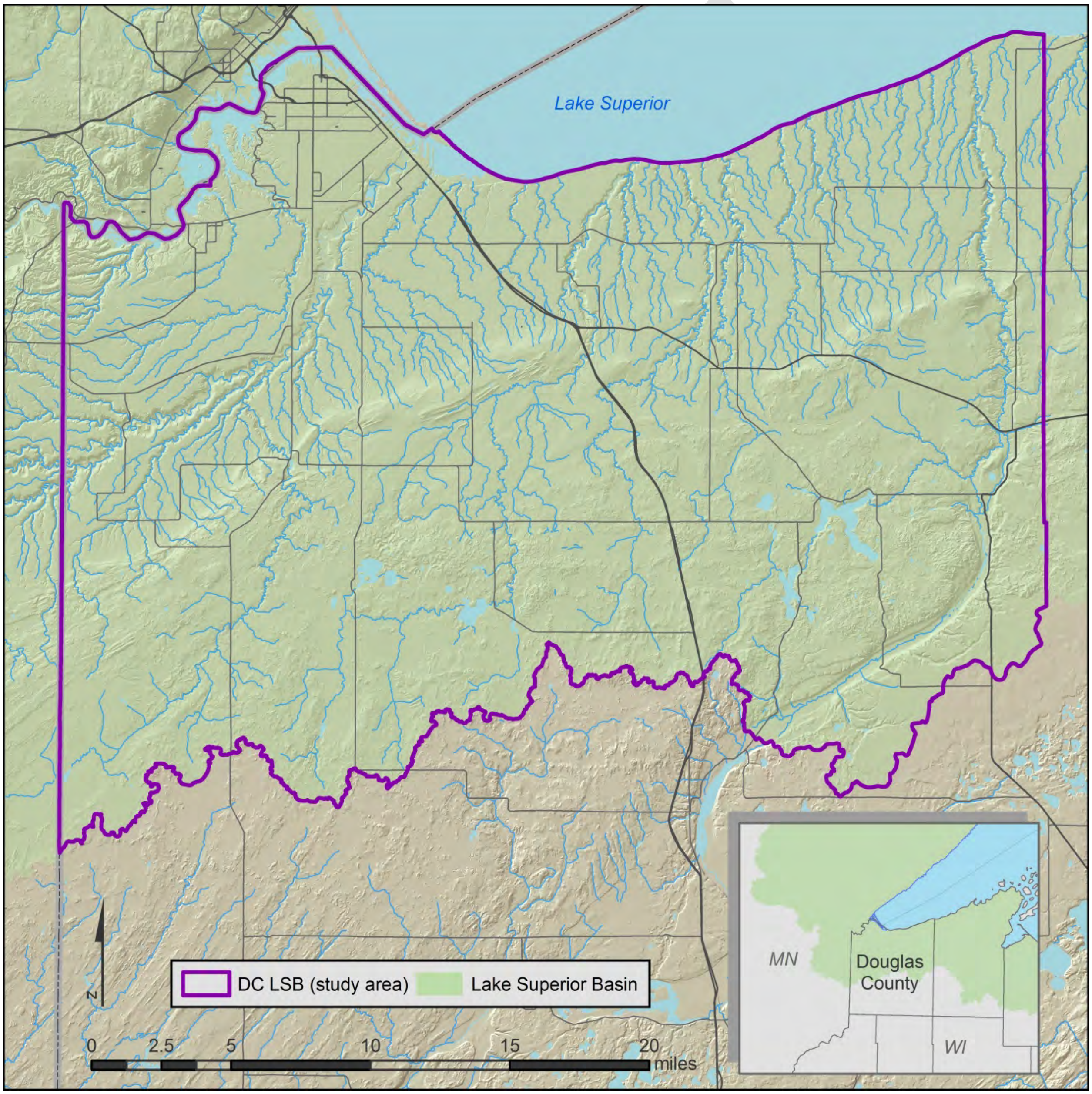

Figure 1. Study area defined as the Lake Superior Basin portion of Douglas County, Wisconsin, approximately the northern half of the county. The study area (CD LSB) is outlined in dark purple.

Ecological Landscapes & Land Type Associations

The study area is comprised of three ecological landscape units, the Superior Coastal Plain, Northwest Lowlands, and the Northwest Sands (WI DNR 2014) (Figure 2).

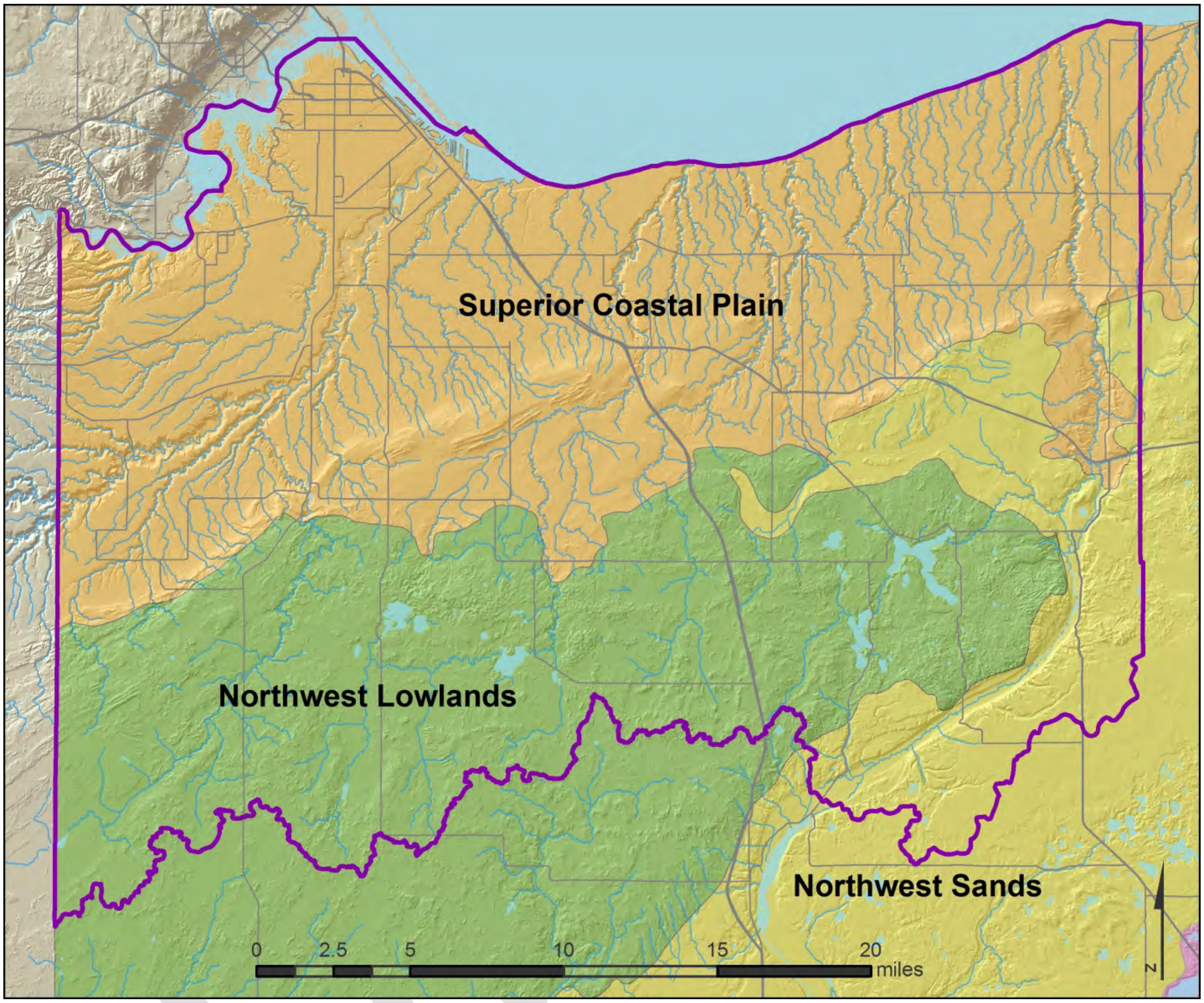

Figure 2. Ecological Landscape Units within the DC LSB.

Wisconsin Land Type Associations (LTAs) provide further definition of the landscape within the National Hierarchical Framework of Ecological Units (NHFEU) (Cleland et al. 1997) such that multiple LTAs nest within the three Ecological Landscape Units in the study area. LTAs are recommended for forest, area-wide, or watershed-level planning and analysis scales (map scale ranges of 1:250,000 to 1:60,000). These ecological units contain similar patterns in their: 1) potential natural plant communities; 2) soils; 3) hydrologic function; 4) landform and topography; 5) lithology; 6) climate; and 7) natural processes (e.g., nutrient cycling, productivity, successional patterns, and natural disturbance regimes such as flooding, wind, or fire). LTAs within the DC LSB are depicted in Figure 3. Descriptions of each of the Ecological Units and the LTAs that fall within them are presented after the figure.

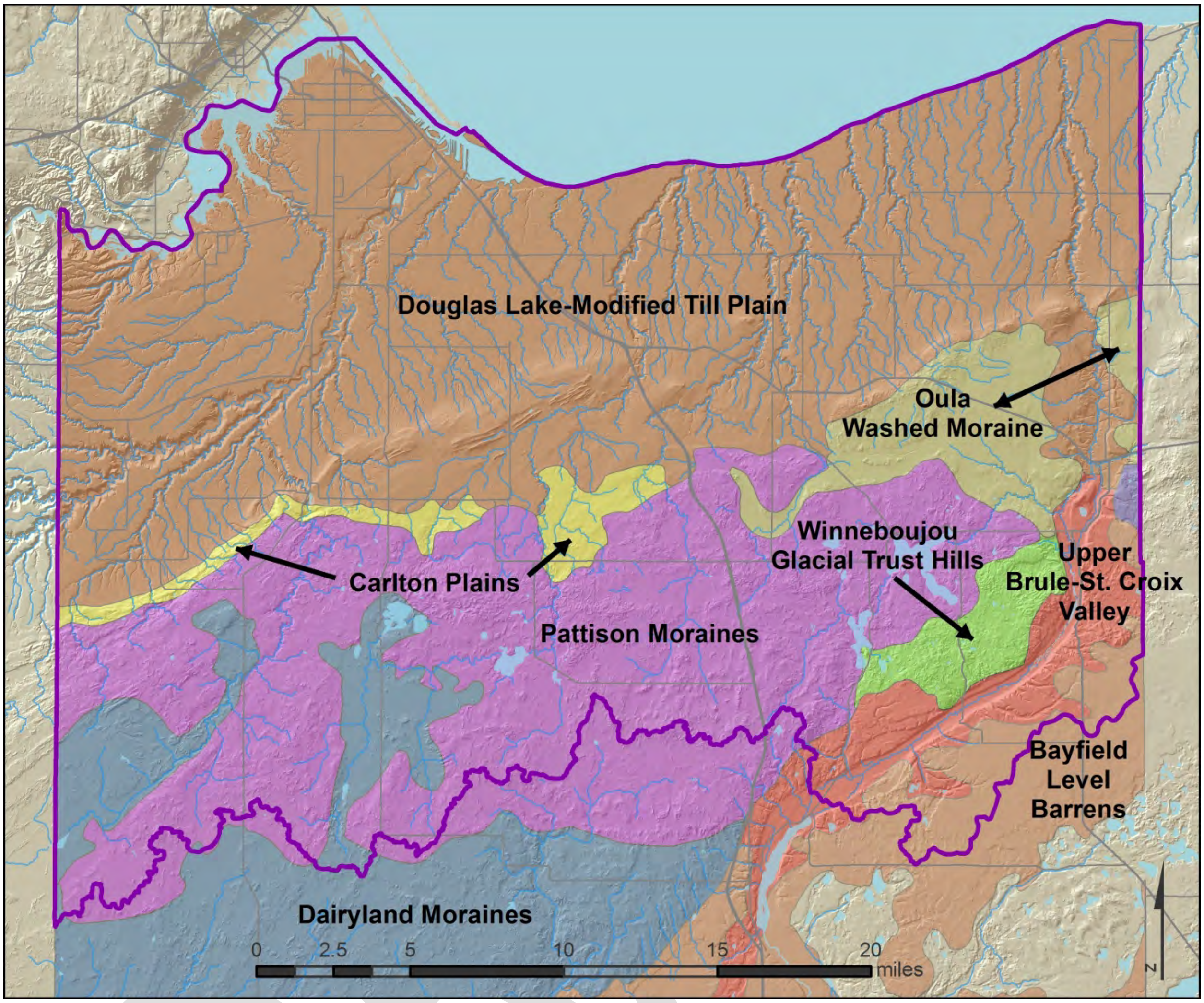

Figure 3. Land Type Associations (LTAs) within DC LSB.

Superior Coastal Plain

Approximately the northern half of the study area falls within the Superior Coastal Plain (Figure 2). This ecological landscape is generally rolling to flat topography with clay soils; primarily agriculture and mixed hardwood and spruce-fir forest with high gradient streams (Merryfield 2000).

> *The following information on the Ecological Unit descriptions (climate, bedrock, geology & landforms, soils, hydrology, and current land cover) is taken directly from WI DNR (2014).*

Climate

Typical of northern Wisconsin, though conditions are somewhat moderated by the proximity to Lake Superior; mean growing season of 122 days, mean annual temperature is 40.2 deg. F, mean annual precipitation is 32 inches, and mean annual snowfall is 87.4 inches. Cool summers, deep snows (including lake effect snows), high humidity, fog, mist, wave spray, currents, ice, and strong winds (e.g., along exposed coastlines, where blow-down events are frequent) affect parts of the Ecological Landscape, especially near Lake Superior. Some areas near Lake Superior support grass-based agriculture (18.5% of the Ecological Landscape). Areas away from Lake Superior have a shorter growing season and forests become more important than agriculture.

Bedrock

Late Precambrian sandstones are exposed and form cliffs and ledges along the northern edge of the Bayfield Peninsula and on the shores of the Apostle Islands. Igneous rocks (e.g., basalts) form the underpinnings of several waterfalls (e.g., Big Manitou Falls on the Black River in Douglas County).

Geology & Landforms

The Bayfield Peninsula is hilly, as are some of the Apostle Islands. Both are covered by glacial tills. The level plains on either side of the Bayfield Peninsula slope gently toward Lake Superior. They are dissected by many deeply incised streams and several large rivers that generally flow from south to north toward Lake Superior (e.g., Middle River). Sand spits, often enclosing lagoons and wetlands, are well-developed in the Apostle Islands archipelago and at river mouths; some of the larger spits are several miles long.

Soils

Important soils include deep, poorly-drained reddish lacustrine clays on either side of the Bayfield Peninsula. The clay deposits include lenses of sand or coarse-textured till; these areas are especially erosion-prone when they are cut by streams. The tills covering the Bayfield Peninsula and Apostle Islands are variable in composition, but include clays, silts, loams and sands. Organic soils are limited in extent, occurring mostly in association with the peatlands on the margins of the coastal lagoons and to a lesser extent in basins underlain by impermeable tills.

Hydrology

Lake Superior has had an enormous influence on the climate, landforms, soils, vegetation, and economy of the Superior Coastal Plain. Freshwater estuaries are present along the coast. Inland lakes are rare, but lagoons, some of them quite large, occur behind the coastal sandpits. Important rivers in this unit within DC LSB include the St. Louis, Nemadji, Amnicon, and the Bois Brule. Coldwater streams originate in the aquifers at the northern edge of the Northwest Sands in Bayfield County and flow north across the Superior Coastal Plain before emptying into Lake Superior. Many of the streams flowing across the clay plain suffered severe damage to their banks and beds during the era of heavy logging in the late 19th and early 20th centuries. Some of them have not yet recovered and their slumping banks continue to dump sediments into the main channels, and ultimately, into Lake Superior. Water (and soil) management can be challenging in this Ecological Landscape (WI DNR 2014).

Current Land Cover

Aspen-dominated boreal forests are abundant on the clay plains to the west and east of the Bayfield Peninsula. In some areas white spruce, balsam fir, and white pine (these were the dominant canopy trees prior to the Cutover) are now common understory species, or are even colonizing abandoned pastures. Older stands of boreal conifers still occur in a few places, such as the City of Superior Municipal Forest. Forest fragmentation is significant on the clay plain owing to the interspersion of forests with fields and pastures. Northern hardwood and hemlock-hardwood forests occur on the Apostle Islands and include old-growth remnants. Dry forests of pine and oak are scarce in this Ecological Landscape but they do occur on some of the sandspits associated with coastal estuaries. The largest coastal wetlands cover thousands of acres, and these are composed of complex vegetation mosaics that include coniferous and deciduous forests, shrublands, wet meadows and marsh. Large wetlands in the interior of the Superior Coastal Plain include the Bibon Swamp, a huge wetland of almost 10,000 acres along the White River on the southern edge of the Ecological Landscape, and Sultz Swamp, a peatland perched high on the northern Bayfield Peninsula. An extensive complex of wetlands of variable structure occurs on poorly drained red clays in and around the City of Superior.

Relevant LTAs

LTAs within the Superior Coastal Plain in the DC LSB are the Douglas Lake-Modified Till Plain and the Carlton Plains. Refer to Figure 3 for a map and Appendix A for further descriptions of these LTAs.

Significant Ecological Places

- Conservation Opportunity Areas (COAs): Pokegama-Namadji Wetlands, Brule Boreal Forest, Bibon Swamp
- State Natural Areas (SNAs): Brule River Boreal Forest, Bibon Swamp, Namadji River Floodplain Forest, Pokegama Carnegie Wetlands, Big Manitou Falls and Gorge, Dwight's Point and Pokegama Wetlands, and Bear Beach.
- Important Bird Areas (IBAs): Bibon Swamp, Wisconsin Point
- Land Legacy Places: Bois Brule River, Middle River Contact, Nemadji River and Wetlands, St. Lousi Estuary and Pokegama Wetlands, Wisconsin Point, Manitou-Black River Falls

Northwest Sands Ecological Landscape

A fairly small portion of the study area in the southeast corner falls within this ecological landscape unit (Figure 2).

> *The following information on the Ecological Unit descriptions (climate, bedrock, geology & landforms, soils, hydrology, and current land cover) is taken directly from WI DNR (2014).*

Climate

Mean annual temperature (41.30 F) is similar to other northern Ecological Landscapes. Annual precipitation averages 31.4 inches and annual snowfall about 61 inches, also similar to other northern Ecological Landscapes. The growing season is short and averages 121 days. Although there is adequate rainfall to support agricultural row crops such as corn, the sandy soil and short growing season limit row crop agriculture, especially in the northern part of the Ecological Landscape.

Bedrock

Underlying bedrock at the southern edge of the Northwest Sands is Cambrian quartzose and glauconitic sandstone and silt-stone. In the northern portion, the bedrock is Precambrian basalt, lithic conglomerate, shale, and feldspathic to quartzose sandstone. Bedrock is covered with 100 to 600 feet of glacial drift (sand, gravel, and silt), with the thickest deposits in the northern half. No terrestrial bedrock exposures are known from this Ecological Landscape.

Geology & Landforms

This Ecological Landscape is the most extensive and continuous xeric glacial outwash system in northern Wisconsin. It has two major geomorphic components. One is a large outwash plain pitted with depressions, or "kettle lakes." The other component is a former spillway of Glacial Lake Duluth (which preceded Lake Superior) and its associated terraces. The spillway is now a river valley occupied by the St. Croix and Bois Brule Rivers. The hills in the northeast are formed primarily of sand, deposited as ice-contact fans at the outlet of subglacial tunnels. Lacustrine deposits (especially fine materials of low permeability such as clays) from Glacial Lake Grantsburg underlie Crex Meadows and Fish Lake Wildlife Areas, and are responsible for impeding drainage, leading to the formation of the large wetlands there.

Soils

Upland soils are typically sands or loamy sands over deeper-lying strata of sand, or sand mixed with gravel. These soils drain rapidly, leading to xeric, droughty conditions within the Ecological Landscape. Wetlands in low-lying depressions have organic soils of peat or muck.

Hydrology

This Ecological Landscape has significant concentrations of glacial kettle lakes, most of them seepage lakes, a well-developed pattern of drainage lakes, and several large wetland complexes. The lakes cover roughly 4.8% of the area of the Northwest Sands, the third highest percentage among ecological landscapes in Wisconsin. The headwaters of the St. Croix and Bois Brule rivers are here. Major rivers include the St. Croix, Namekagon, Yellow, and Totagatic. Springs and seepages are common along the Upper Bois Brule but local elsewhere.

Current Land cover

Land cover is a mix of dry forest, barrens, grassland, and agriculture, with wetlands occupying significant parts of the bed of extinct Glacial Lake Grantsburg, kettle depressions, and some river valleys. Within the forested portion, pine, aspen-birch, and oak are roughly equally dominant. The maple-basswood, spruce-fir, and bottomland hardwood forest types occupy small percentages of the Ecological Landscape's forests. The open lands include a large proportion of grassland and shrubland. Emergent/wet meadow and open water are significant in the southern part of the Northwest Sands. There is very little row-crop agriculture.

Relevant LTAs

LTAs within the Northwest Sands ecological unit in the DC LSB are the Bayfield Level Barrens, Bayfield Rolling Outwash Barrens, Oula Wahed Moraine, and the Upper Brule-St. Croix Valley. Refer to Figure 3 for a map and to Appendix A for further descriptions.

Significant Ecological Places

- Conservation Opportunity Areas (COAs):
- State Natural Areas (SNAs):

- Important Bird Areas (IBAs):
- Land Legacy Places:

Northwest Lowlands Ecological Landscape

Located in the southern portion of the study area, this ecological landscape unit covers nearly half of the study area (Figure 2).

> *The following information on the Ecological Unit descriptions (climate, bedrock, geology & landforms, soils, hydrology, and current land cover) is taken directly from WI DNR (2014).*

Climate

Typical of northern Wisconsin; the mean growing season is 122 days, mean annual temperature is 41.8 deg. F, mean annual precipitation is 30.6, and mean annual snowfall is 49 inches. The cool temperatures and short growing season are not adequate to support agricultural row crops; less than three percent of the land here is used for agricultural purposes and most of this is in the southern "hook" in Burnett County. The climate is favorable for forests, which cover almost 70% of the Ecological Landscape. The cool temperatures and short growing season, along with numerous and large acid peatlands, result in almost boreal-like conditions in parts of the Northwest Lowlands.

Bedrock

Bedrock outcroppings are rare except in association with the basalt ridge that follows the Douglas County fault line and forms part of the northern boundary of the Northwest Lowlands. Waterfalls, cliffs, bedrock glades, and rock-walled gorges are associated with this bedrock feature. Local, relatively small, exposures of sandstones and conglomerates occur in some of these gorges.

Geology & Landforms

The major landforms are ground and end moraines, with drumlins present in the southwestern portion. Topography is gently undulating. In the northern part of the Ecological Landscape many stream valleys run northeast-southwest in roughly parallel courses. This is caused by bedrock ridges that were created by harder strata of lava alternating with weaker sedimentary rocks; these were later tilted upward due to rifting and continental collision. This bedrock feature influences the surface topography of the Northwest Lowlands, especially where glacial deposits are thin.

Soils

Soils are predominantly loams, with significant acreages of peat deposits in the poorly drained lowlands. Major river valleys have soils formed in sandy to loamy-skeletal alluvium or in non-acid muck. Alluvial soils range from well drained to very poorly drained, and have areas subject to periodic flooding.

Hydrology

This Ecological Landscape occupies a major drainage divide, and contains the headwaters of many streams that flow north toward Lake Superior or south toward the St. Croix River system. Important rivers include the St. Croix, Black, Tamarack, Spruce, and Amnicon. Lakes are uncommon except in the heavily agricultural southernmost part of the Ecological Landscape in Burnett County. Impoundments, all fairly small, have been created by constructing dams on the Tamarack and Black rivers, and several creeks. The St. Croix River is fed by springs, spring ponds, and seepages.

Current Land Cover

The present-day forests remain extensive and relatively unbroken, occupying about 68% of the landscape. Forests consist mainly of aspen, paper birch, sugar maple, basswood, spruce and fir. Minor amounts of white pine, red pine and red oak are also present. Older successional stages are currently rare, as almost all of this land is managed as "working forests". The large undisturbed peatland complexes consist of mosaics of black spruce-tamarack swamp, muskeg, open bog, poor fen, shrub swamp, and occasionally, white cedar swamp. The St. Croix River corridor includes forested bluffs and terraces, which support communities unlike those found in most other parts of the Ecological Landscape. These include mesic maple-basswood forest, dry-mesic forests of oak or oak mixed with pine, black ash-dominated hardwood swamps, and numerous forested seeps. Less extensive areas of marsh and sedge meadow also occur along the St. Croix. In most of this Ecological Landscape minor amounts of land are devoted to agricultural and residential uses, and most of these land uses are concentrated along State Highway 35. The major exception to this pattern is the area that wraps around the south end of the Northwest Sands which is a mix of agricultural lands and scattered oak or oak-pine woodlots.

Relevant LTAs

LTAs within the Northwest Lowlands ecological unit in the DC LSB are the Pattison Moraines, Dairlyand Moraines, and the Winneboujou Glacial Trust Hills. Refer to Figure 3 for a map and to Appendix A for further descriptions.

Significant Ecological Places (from Merryfield et al. 2000)

- Conservation Opportunity Areas (COAs): Northwest Lowlands Bogs
- State Natural Areas (SNAs): Belden Swamp, Erickson Creek Forest and Wetlands, Black Lake Bog
- Important Bird Areas (IBAs): none identified
- Land Legacy Places: Manitou-Black River Falls

Watersheds & Notable Rivers

Watersheds are defined by the USGS's National Hydrography Dataset (NHD) using a hierarchy of nested drainage areas defined. These drainage areas are represented by codes and referred to as Hydrologic Unit Codes or HUCs. The larger the number of digits in a HUC the smaller the area or more nested it is in the hierarchy of drainage areas. There are just two eight-digit HUCs that overlap the DC LSB, the St. Louis River 8-digit HUC which is the drainage area of the Pokegama and St. Louis Rivers near the city of Superior and the Bear Trap-Nemadji Rivers 8 digit HUC. This later HUC encompasses the remainder of the DC LSB. These HUCs are broken down further into 10 digit, 12 digit, on down to 16 digit HUCs. FIGURE XX displays 10 digit and 12 digit HUC boundaries in the DC LSB along with the primary rivers, such as the Nemadji, Amnnicon, Middle, and Bois Brule Rivers and some creeks such as Balsam, Bardon, Bluff, Dutchman, and Smith creeks.

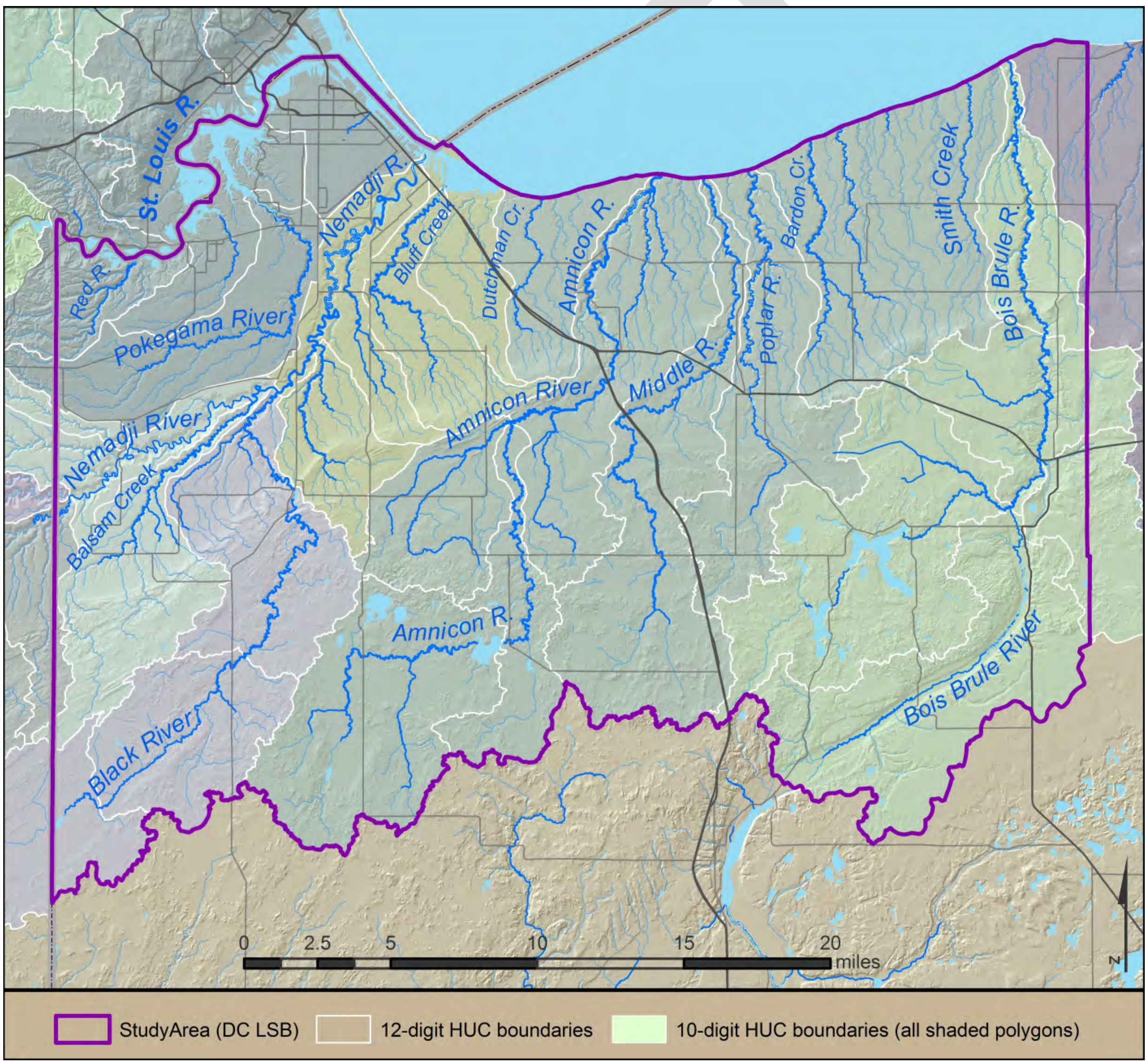

Figure 4. Hydrologic Units (i.e., watersheds & sub-watersheds) and major rivers and streams in the study area.

Red Clay Plain

An important feature in this study area and much of the Lake Superior Basin of Wisconsin is the lake clay plain (sometimes referred to as the red clay plain) where "red clay" soils that were glacial till and glacial lake deposits. For this study, the technical committee agreed to define the clay plain using an ecological classification in Wisconsin's Land Type Association GIS data. The Douglas Lake-Modified Till Plain land type association (LTA) is used to define the boundary of the clay pain, shown as a darker shaded area in the northern half of the study area (Figure 4). Red clay wetlands, those that are composed of a mixture of wet and dry red clay soils, are common here and this area is treated differently than the rest of the study area in terms of identifying potential wetland re-establishment sites and for determining some wetland functions because of these clay-dominant soils and the way they are treated in digital soils data (SURRGO).

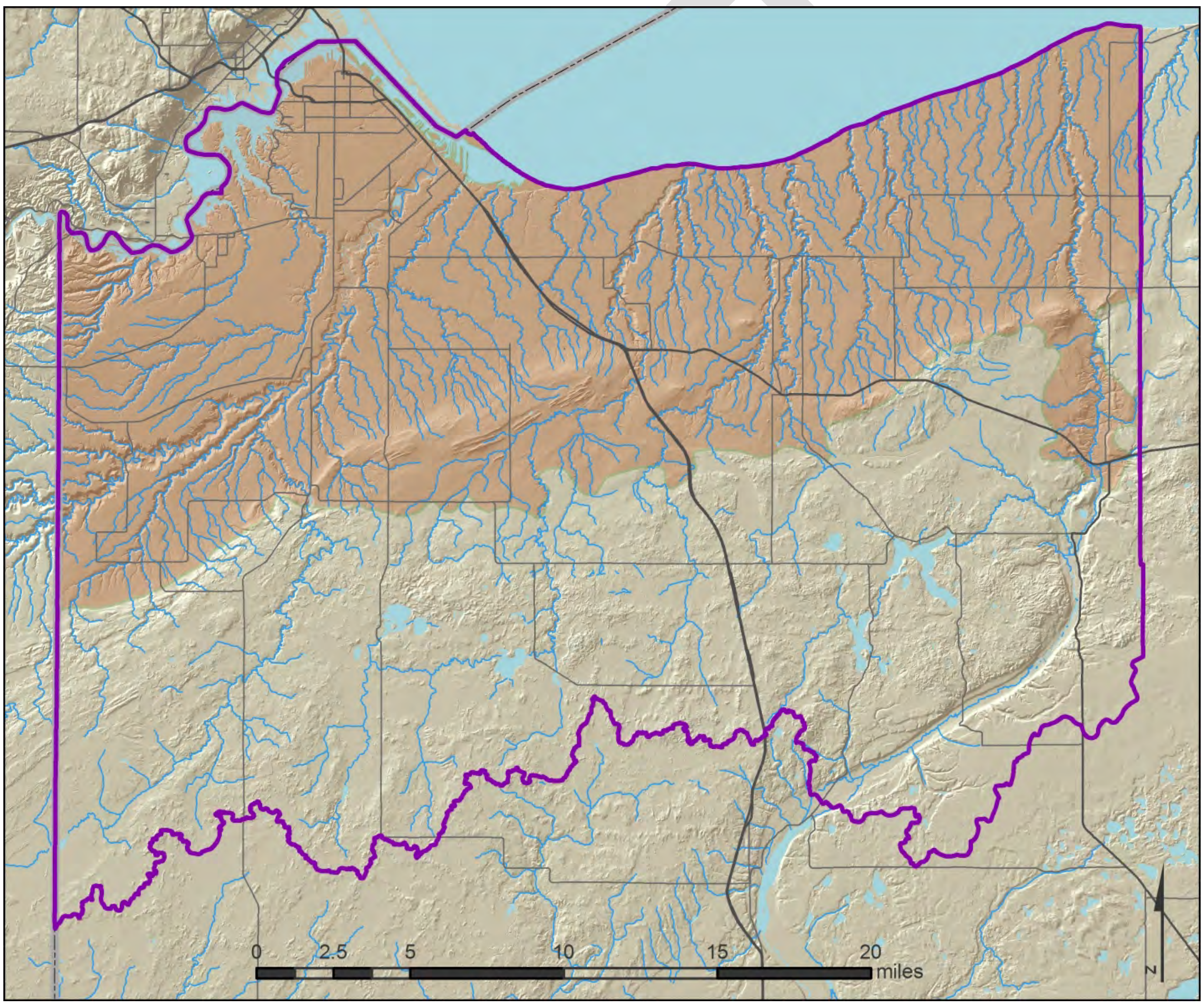

Figure 5. The red clay plain (orange shading) within the study area (outlined in purple). This is defined by the boundaries of the Douglas Lake-Modified Till Plain, a Wisconsin Land Type Association (LTA) (WI DNR 1999).

Land Cover / Land Use

Pre-settlement Land Cover

Forest vegetation dominated the landscape in the study area prior to European settlement. The exact extent of former wetlands is not known, however two datasets provide some general indication of former wetland extent: Finley maps and Bordner Survey maps. Refer to Appendix B for Finley maps of each of the three ecological landscape units in the study area. For a brief discussion on potential use of the Bordner Survey information refer to page 84.

Current Land Cover / Land Use

Multiple GIS data sources are available to define contemporary land cover/land use in Douglas County. Two of the highest resolution and most contemporary datasets include the Western Great Lakes Coastal Change Analysis Program (CCAP) data from 2010 and Community GIS Inc.'s Open/Impervious Land Analysis data (circa 2008-2010).

<u>Western Great Lakes Coastal Change Analysis Program (C-Cap) 2010 Land Cover</u>

Derived from LandSat scenes, this land cover dataset was analyzed according to Coastal Change Analysis Program (C-CAP) protocol. The reported overall accuracy of the classification is 84%. The DC LSB (i.e., study area for this project) is primarily comprised of forested land cover classes, with deciduous forest, evergreen forest, and mixed forest, covering a combined 61% of the total study area. According to this dataset, wetlands (palustrine scrub/shrub, palustrine forested, palustrine emergent) comprise approximately 17% of the study area. However, according to the 2012 WWI polygon data, there are approximately twice as many wetlands; 166,960 acres (34%). In fact, if the area of the NWIplus wetlands are calculated the total increases to 174,572 acres or 36% of the study. The NWIplus wetlands include open water and deep water habitats (larger ponds, lakes, and rivers) and the small wetlands (WWI points) converted to polygons (<2 acre wetlands are buffered to 0.10 acre circles and excavated or damned ponds to 0.3 acres circles). According to the 2012 WWI data much of the deciduous forest areas, especially in the clay plain are likely forested or scrub shrub wetlands.

Table 1. Land cover classes in the DC LSB (2010 C-CAP Land Cover).

Land Cover Class	Area (ha)	area (ac)	% of DC LSB area
Deciduous Forest	81,726	201,948	41.21
Evergreen Forest	19,775	48,865	9.97
Mixed Forest	19,637	48,524	9.90
Palustrine Scrub/Shrub Wetland	17,691	43,715	8.92
Pasture/Hay	16,213	40,062	8.18
Palustrine Forested Wetland	14,543	35,937	7.33
Scrub/Shrub	11,466	28,333	5.78
Open Water	5,094	12,588	2.57
Grassland/Herbaceous	4,051	10,009	2.04
Developed, Low Intensity	1,892	4,675	0.95
Developed, Open Space	1,649	4,074	0.83
Cultivated Crops	1,532	3,786	0.77
Developed, Medium Intensity	1,263	3,120	0.64
Palustrine Emergent Wetland	966	2,387	0.49
Developed, High Intensity	693	1,713	0.35
Bare Land	102	253	0.05
Unconsolidated Shore	2	4	0.00
Total	198,294	489,994	100.00

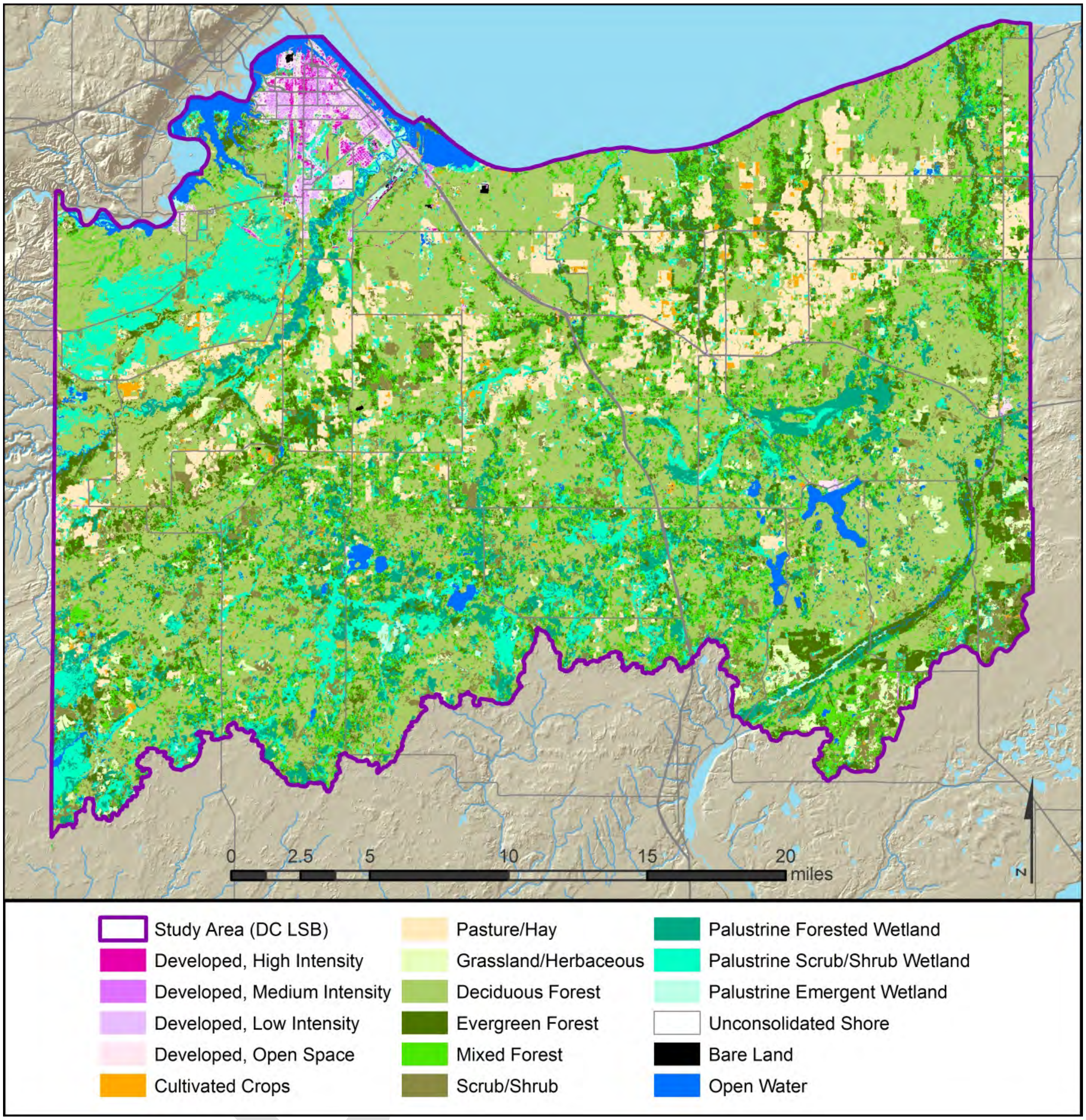

Figure 6. Land cover classes in the DC LSB (2010 C-CAP Land Cover).

Open / Impervious Lands Analysis (2008) – Stable Solutions & Community GIS.
The Open/Impervious GIS dataset was created to measure the proportion of open land and impervious surface within Douglas County, where open land is land that has been cleared for one purpose or another such as timber harvest, residential development, and has no or limited forest canopy cover). Appendix C provides a brief description of each of the land cover/use categories according to the land use / land cover depiction in Figure 7.

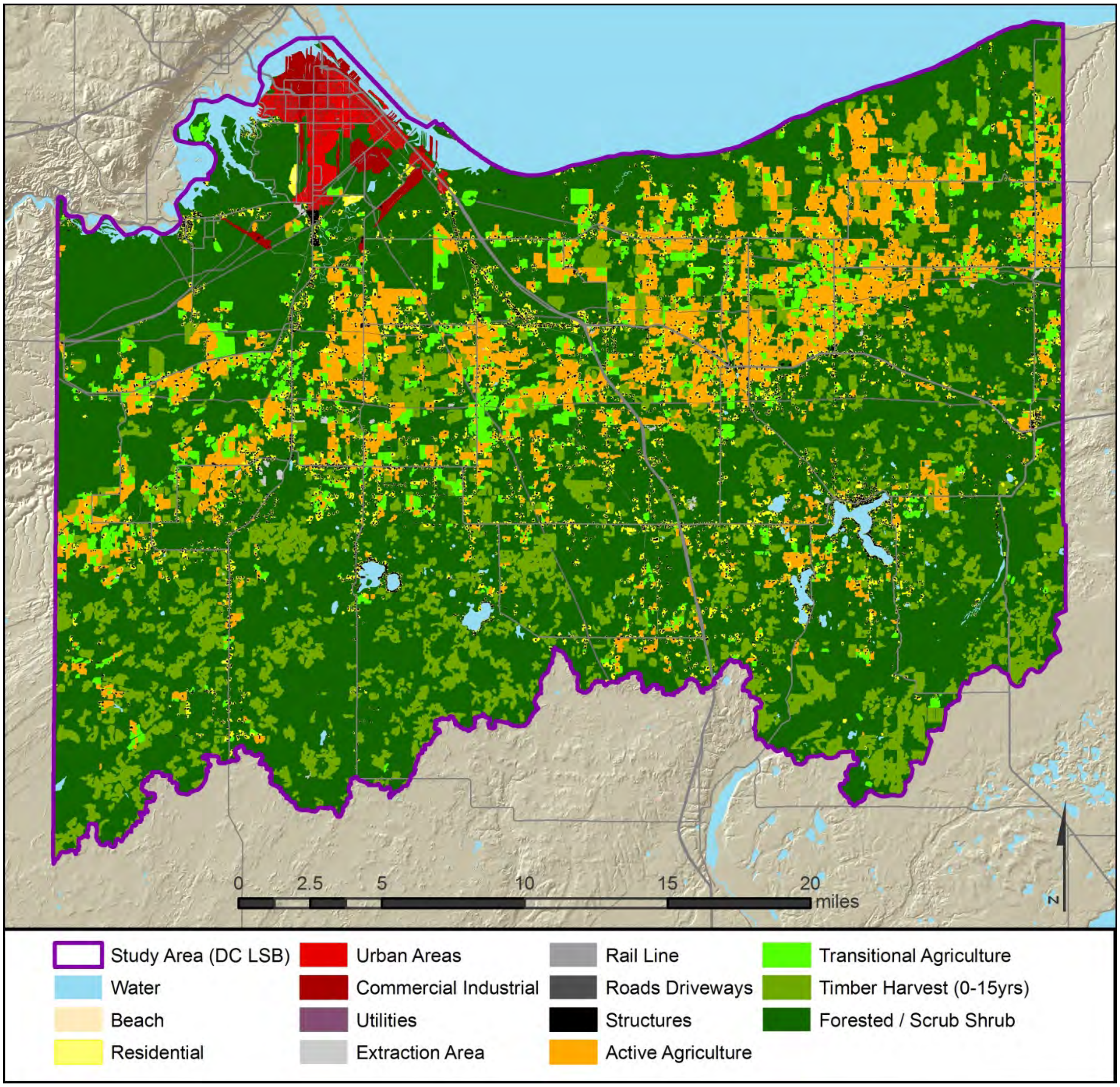

Figure 7. Land cover / land use in the DC LSB as of 2008-10. (Open / Impervious Lands analysis layer created by Community GIS Services Inc.). Note: the forested / scrub shrub class is not explicitly mapped in the Open / Impervious Lands GIS layer; it is considered land with a forested canopy. A significant proportion of this land is mapped as wetland according to the 2012 Wisconsin Wetland Inventory, especially in the northern half of the study area.

1.4 Wetland Classifications Overview

Three wetland classification systems are relevant to this project, the Wisconsin Wetland Inventory (WWI) (WI DNR 1992); the National Wetlands Inventory (NWI) employed by the U.S. Fish and Wildlife Service which uses Cowardin et al. (1979); and a hydrogeomorphic classification called Landscape Position, Landform, Water Flow Path, and Waterbody Type or LLWW (Tiner 2011). Each of these systems describe a variety of wetland characteristics which are primarily interpreted by skilled photo-interpreters using remotely sensed data. The WWI system is the official wetland classification for the state of Wisconsin and is similar to NWI, but for this project, 2012 (i.e., photo-interpreted using spring 2012 aerial photography) WWI wetland data for Douglas County were clipped to the study area boundaries (DC LSB) then converted through a set of tabular and GIS processes to NWI data in order for wetland functions to be more readily predicted. Hereafter NWI refers to the NWI GIS wetland data which uses the Cowardin classification system. In an attempt to prevent confusion between codes of these two classification systems, all NWI codes are *italicized* and all LLWW codes **bolded**. The following section provides an introduction and some examples of the NWI and LLWW classification systems

Wisconsin Wetland Inventory (WWI)

The Wisconsin Wetland Inventory (WWI) is a system developed by the Wisconsin DNR (with assistance from the U.S. Fish and Wildlife Service) authorized by the state legislature in 1978. Wisconsin stands alone as the only state in the U.S. with a unique, state-wide wetland classification different than the Cowardin system. The inventory is interpreted from 1:24,000 scale aerial photography. See Appendix D for a detailed description of WWI classification system.

National Wetlands Inventory (NWI)

The National Wetlands Inventory (NWI), a division of the U.S. Fish and Wildlife Service, uses Cowardin et al. (1979) as its system to classify wetlands and deep water habitats within the United States. NWI relies on plant community types as indicators of surface hydrology. A wetland is defined as land supporting hydrophytic plant communities, or has hydric soils, or where the water table is at or near the surface for part of the year. If any of these three conditions are met, then the area can be classified as wetland. Deep water habitats consist of those permanently flooded areas that are below the deep water boundary of wetlands. With the use of high resolution aerial photography the presence of hydrophytic vegetation becomes dominant in identifying wetlands, but collateral data is often used to aid in classification. Collateral data normally consists of soils, topographic, and land cover data. Soils provide information on the location of hydric soils while topographic data will often provide insight into surface hydrology. NWI applies an alpha numeric code to each mapped feature. The coding schema consists of: System, Subsystem, Class, Subclass, Water Regime, and Special Modifiers.

<u>System & Subsystem</u>

System is a single uppercase alphabetic (letter) code that defines the classification in the broadest sense. There are only five systems defined by the NWI, marine (*M*), estuarine (E), palustrine (*P*) (Figure 26), lacustrine (*L*) (Figure 27), and riverine (*R*) (Figure 28). Of these, only *P*, *L*, and *R* apply to the DC LSB. Following System is Subsystem. Subsystems consist of a single number that further specifies the wetlands type. For instance *L2* refers to the lacustrine System (*L*) with a littoral Subsystem (*2*). This is the habitat typically found around lake edges. It should be noted that the meaning of the Subsystem code is dependent upon the System to which it is being applied. For example, *R2* does not mean riverine littoral, but rather riverine (*R*), lower perennial (*2*). There is no Subsystem for the palustrine System. Palustrine wetlands as defined by Cowardin are non-tidal wetlands dominated by trees, shrubs, persistent emergent vegetation, mosses, lichens including open water areas less than 2 meters in depth and smaller than 20 acres.

Class

Class is a two letter uppercase code that refers to the dominant vegetation or substrate type. Examples of Classes include emergent (*EM*), forested (*FO*), and unconsolidated bottom (*UB*). The Subclass, similar to the Subsystem, refers to a more specific type and is again coded with a single number. For example, the code *FO1* refers to broad-leaved deciduous forest versus *FO4* which refers to needle-leaved evergreen forest. It is possible to have dual Classes separated by a slash (/). The meaning of the Subclass is dependent on the Class to which it is being applied. Often the NWI data is not classified to the subclass level. In the following case there is no number after the Class code, but another uppercase letter which is the Water Regime: *PFOC*.

Water Regime

Water Regime is sometimes referred to as the hydrologic modifier. It consists of a single uppercase letter. It encodes hydrologic information such as flooding frequency. For the non-tidal water regimes present in the Douglas County - Lake Superior Basin, the water regime only applies during the growing season, because flooding during the dormant season does not significantly affect the vegetation that is present. The water regime with the most acreage in the DC LSB is the saturated (*B*) water regime which is used to classify saturated soils. Other relevant water regimes for the DC LSB are the non-tidal flooded water regimes. These are, in order of ascending wetness, temporarily flooded (*A*), seasonally flooded (*C*), semi-permanently flooded (*F)*, intermittently exposed (*G*), and permanently flooded (*H*).

Special Modifier

The final component of the NWI code is the special modifier. The special modifier is a lower case letter which characterizes very specific conditions present within the wetland. Among the conditions encoded by the special modifiers are whether the wetland is partially drained (*d*), is the result of human activity such as excavation (*x*) or impoundment (*h*), or if it is a wetland that is currently being drained for farming (*f*). There are special modifiers for water chemistry, the acidic (*a*) water chemistry modifier for bogs is an example and for soil type where organic soils receive the (*g*) modifier. A characteristic of the NWI data is that not all special modifiers are regularly used and the lack of a special modifier does not necessarily mean that the condition that it represents does not exist in that wetland. This is especially true of the water chemistry and soil modifiers and is primarily due to interpretive limitations of the original source data. The excavated and impounded special modifiers are probably the most commonly applied because their presence is easily ascertained from aerial imagery. It is also possible to have more than one special modifier attached to a wetland. As imagery and collateral data resolution have improved, the use of the special modifiers has increased.

Examples

Below are some examples of NWI attributes present in the DC LSB:

PFO4Bg – This is a palustrine *(P)* wetland, where needle-leaved evergreen trees *(FO4)* are the dominant vegetation. This wetland has saturated soil *(B)* which is organic in nature *(g)*. Note there is no subsystem for palustrine wetlands.

PEM1Cg – This is a palustrine *(P)* wetland, where persistent emergent *(EM1)* vegetation such as bulrushes (*Scirpus* spp.) are the dominant vegetation type. This wetland is seasonally flooded *(C)* with organic soils *(g)*. Note again there is no subsystem for palustrine wetlands.

PSS1/EM1Cg – This is a palustrine *(P)* wetland that is a mixture is broad leaf deciduous scrub shrub *(SS1)*, such alder (*Alnus* spp.), and persistent emergent vegetation *(EM1)*. This wetland is seasonally flooded *(C)* with organic soils *(g)*. Generally, with a dual attribute, neither class covers greater than 60% of the wetland, and the class of the dominant cover type is listed first.

L1UBHh – This is a lacustrine (lake) limnetic *(L1)* deep water habitat with an unconsolidated bottom *(UB)* or non-vegetated bottom that is permanently flooded *(H)*. There is no subclass, but the special modifier (*h*) translates to impounded, further describing this as a lake as impounded by, in this case, a dam.

L2ABH – This is a shallow water lake environment, lacustrine littoral *(L2)* wetland dominated by aquatic bed vegetation *(AB)* that is permanently flooded *(H)*. This attribute is an attribute considered to be a wetland type that could potentially support wild rice (*Zizania aquatica*) beds if the wetland has through-flow. Although, wild rice should typically be represented by non-persistent emergent vegetation (EM2) in lake environments it is likely that in the original photo interpretation these two signatures would be difficult to differentiate.

The above examples are certainly not an exhaustive list of the NWI attributes present in DC LSB, in fact, over 300 unique NWI codes are present in the final geospatial dataset. See Appendix E for an example of the classification structure for palustrine, lacustrine, and riverine systems, and for a list of wetland classification modifiers employed in the NWI system. For a comprehensive explanation of the NWI classification system refer to Classification of Wetlands and Deep water habitats of the United States (Cowardin, 1979).

Landscape Position, Landform, Water Flow Path, and Waterbody Type (LLWW)

Landscape Position, Landform, Water Flow Path and Water body (LLWW) descriptors were created to augment the NWI classification with hydrogeomorphic information. For this reason, when LLWW is combined with the NWI data, it is referred to as NWIplus. LLWW does not classify wetlands according to vegetation; rather it classifies wetlands and water bodies based upon landscape position and hydrologic characteristics. In a similar manner to NWI and WWI, LLWW uses alpha numeric codes to describe wetland characteristics. LLWW makes a distinction between wetlands and waterbodies. Wetlands are vegetated, while waterbodies are deep water habitats. The coding schema can actually take two slightly different forms depending on whether the feature is being classified as a wetland or a waterbody. Vegetated wetlands, such as marshes and wet meadows, and non-vegetated substrates that are periodically exposed, for example mud flats, are classified using the wetland landscape position and landform codes. A conceptual model identifying primary Landscape Position, Landforms, Waterbody types, and Water Flow Paths is provided in Figure 8 and a simplified table representing the basis structure of the codes is provided in Table 2.

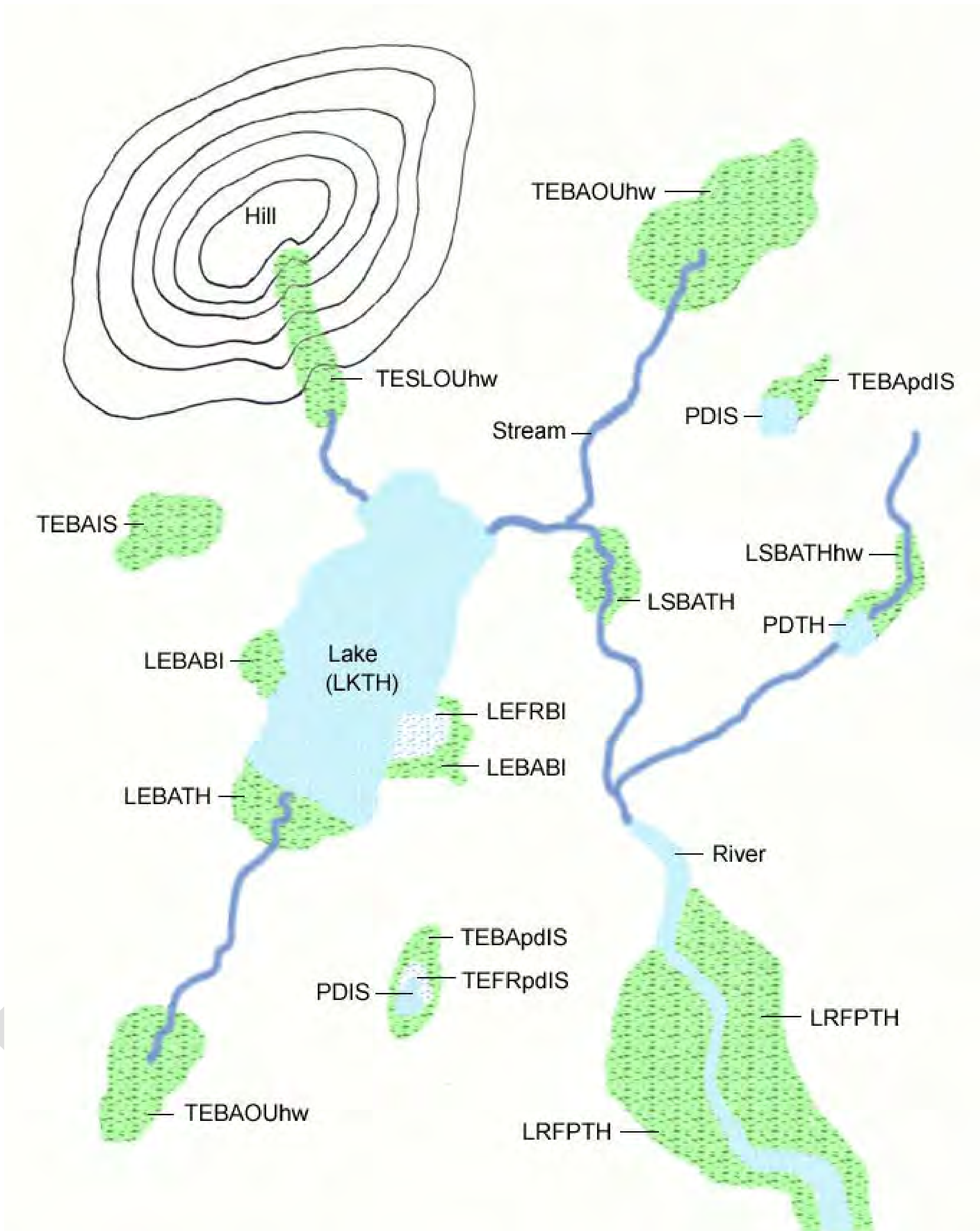

Figure 8. Examples of application of LLWW descriptors to nontidal wetlands. Coding: Landscape position = LE – Lentic, TE – Terrene, LR – Lotic River, LS – Lotic Stream; Landform = BA – Basin, FP – Floodplain, FR – Fringe, SL – Slope; Water Flow Path = BI – Bidirectional-nontidal, IS – Isolated, OU – Outflow, TH – Throughflow; Other descriptors: PD – Pond, LK – Lake, hw – headwater, and pd – pond-bordering wetland. Note: If desired, ponds and lakes can be further classified with landscape position resulting in codes of TEPDIS for the isolated ponds and LSLKTH for the lake shown in this figure. (from Tiner 2011a).

Table 2. List of landscape position, landform, water flow path, and waterbody type (LLWW) descriptors. Note that more detailed categorization of landforms, water flow path, and pond types are possible, but are not shown here in order to simplify for display.

Landscape	Landform	Water Flow Path	Waterbody Type
Lotic (LR or LS)	Floodplain	Througflow	River (gradients: tidal, dammed, high, middle, low, and intermittent)
	Basin	Throughflow-intermittent	Stream (gradients: tidal, dammed, high, middle low, and intermittent)
	Flat	Throughflow-entrenched	
	Fringe	Bidirectional-tidal	
	Island	Bidirectional-nontidal	
	Pond*		
	Lake*		
Lentic (LE)	Fringe	Bidirectional-nontidal	Natural Lake (main body, open embayment, semi-enclosed embayment, barrier beach lagoon)
	Basin	Bidirectional-tidal	Dammed River Valley Lake (Reservoir)
	Flat	Throughflow	Dammed River Valley Lake (Hydropower)
	Island		Dammed River Valley Lake (Other)
	Pond*		Other Dammed Lake (Former Natural Lake)
			Other Dammed Lake (Artificial)
Terrene (TE)	Fringe (pond)	Outflow	Pond (Natural, Dammed/impounded, excavated, beaver, other artificial, many other types
	Basin	Outflow-artificial	
	Basin (former floodplain	Inflow	
	Flat	Throughflow	
	Flat (former floodplain)	Throughflow-artificial	
	Slope	Throughflow-entrenched	
	Floodplain	Isolated	
	Pond*	Paludified	
	Lake*	Bideirectional-tidal	
Estuarine (EY)*	Drowned River Valley Estuary	Throughflow	
	River-Dominated Estuary	Bideirectional-tidal	

* The Estuarine landscape position was applied to the St. Louis River freshwater estuary and associated wetlands which are predicted to be influenced by the Lake Superior seiche.

<u>Landscape Position</u>

Landscape Position is an uppercase two letter code that describes whether the wetland is associated with a lake, river, or surrounded by uplands. There are also classifications for marine and coastal areas that do not apply in the case of the DC LSB. Wetlands associated with lakes are defined as lentic (**LE**). Wetlands associated with flowing water are classified as lotic streams (**LS**) or lotic rivers (**LR**) depending upon their size. Wetlands that are surrounded by upland as part of an isolated basin are classified as terrene (**TE**). Landscape position can be more specifically classified using a hierarchal combination of lowercase letters and numbers similar to the subsystem or subclass in the NWI classification system. For example, the LLWW attribute for a wetland associated with a dammed river valley lake is **LE2**. If the lake is a reservoir it would be classified as **LE2a**, but if it were a hydropower lake it would be classified as **LE2b**. Similar to NWI, the modifying codes are dependent on the landscape position code to which they are being applied.

<u>Landform</u>
Landform is the second portion of the code. It is made up fundamentally of two uppercase letters that can be classified more specifically with the addition of a code consisting of two lower case letters. Landform refers to the geomorphic structure on or in which the wetland resides. There are both coastal and inland landforms defined. There are seven inland landforms included in LLWW, of these five are present in the DC LSB. These are slope (**SL**), fringe (**FR**), floodplain (**FP**), basin (**BA**), and flat (**FL**). Further classification can occur by adding a lowercase two letter code. For example, a fringe wetland (**FR**), associated with a pond (**pd**) would be coded with **FRpd**. Lowercase codes only apply to specific landform types, and although there is not any repetition in codes between the landforms, the key (Tiner, 2011) should be consulted to insure a valid code is being used.

There are also water flow path and modifiers included in the code schema for wetlands. Since these are the same for both wetland and water bodies, the water body coding schema will be addressed first. In LLWW any deep-water habitat greater than 2 meters deep is considered to be a water body and is classified using the water body type codes with no landform assigned. The water body coding schema is shown below:

<u>Water Body</u>
The Water Body component of the LLWW classification consists of an uppercase two letter code. There are six water body types, two coastal and four inland. Of the four inland types three are present in DC LSB including lake (**LK**), river (**RV**), and pond (**PD**). Additional codes consisting of a number followed by a lowercase letter can be added to further specify the water body's characteristics. Woodland ponds surrounded by uplands are a common water body type found in the watershed. These are classified as pond (**PD**), natural (**1**), woodland-dryland (**c**) or **PD1c**.

<u>Water Flow Path</u>
When a feature is classified as a water body there is no landform code applied, because the water body is considered to be its own landform. The next component of the code is Water Flow Path which applies to both wetlands and water bodies as defined by LLWW. Water flow path refers to how and if the feature is part of the surface hydrology network. Common examples of the water flow path code include through- flow (**TH**), inflow (**IN**), and outflow (**OU**). Wetlands that are not connected to the surface hydrology network are classified as isolated (**IS**). Most of the water flow path codes are the same for both wetlands and water bodies, but there are some small differences so the reference materials need to be consulted to make sure the correct codes are being applied. It should be emphasized that this classification can only consider surface hydrology. Subsurface hydrologic connectivity is not considered because these characteristics cannot be assessed through image interpretation.

Modifiers

The final component of the LLWW code is the modifier. Modifier codes consist of two lower case letters. Modifiers are used to encode very specific conditions, and more than one modifier may be used. Common examples are **fv** for floating vegetation mats, **hw** for headwater wetlands, and **dd** for drainage divide wetlands. Again, there are some differences in which modifiers can be applied to wetlands versus those applied to water bodies.

Examples

LLWW codes can vary in length from 5 characters up to 14 or more characters depending on how many modifiers are applied. Some examples of complete codes found in the DC LSB are shown below:

> **LE1BABIhw** – This is a basin (**BA**) wetland associated with a headwater (**hw**) natural lake (**LE1**). It has bidirectional flow (**BI**) which is the type of flow associated with fluctuating lake levels.
>
> **LS1FRpdTHbvhw** – This wetland is a pond (**pd**) located on the fringe (**FR**) of a low-gradient stream (**LS1**). It is a headwater (**hw**) wetland with beaver (**bv**) activity that has throughflow (**TH**).
>
> **LR1FRTH** – This wetland is located on the fringe (**FR**) of a low-gradient river (**LR1**). As might be expected for many of these types of wetlands, it has throughflow (**TH**).
>
> **TEBAVF** – This code refers to a terrene (**TE**) wetland or a wetland surrounded by uplands. It is in a basin (**BA**) and due to its being disconnected from the surface hydrology network it is given the vertical flow (**VF**) water flow path.
>
> **LK2aTH** – This code refers to a lake water body (**LK**) with a modifier that further describes this lake as a damned river valley lake (**3a**). It is also directly connected to the surface hydrology network having throughflow (**TH**).
>
> **PD1cISfv** – This code refers to a water body that is a natural woodland upland pond (**PD1c**) that is isolated (**IS**) from the rest of the surface hydrology network and is covered with floating vegetation (**fv**).

For a comprehensive explanation of LLWW and listings of it codes refer to Dichotomous Keys and Mapping Codes for Wetland Landscape Position, Landform, Water Flow Path, and Waterbody Type Descriptors (Tiner, 2011).

NWIplus

The LLWW system was designed to provide an additional set of hydrogeomorphic and landscape position characteristics to the Cowardin system employed by the U.S. Fish & Wildlife Service's NWI. While the LLWW classification is contained in a separate tabular field in the GIS database, when the Cowardin classification is coupled with the additional LLWW classification codes, the resulting data are referred to as NWIplus wetland data. In this report, all summaries and discussion of wetland functions reference both NWI and LLWW classification codes as the classification codes and in some cases spatial relationships of the wetlands to other wetlands or water bodies in other datasets are ultimately utilized to correlate to set of predicted wetland functions.

Chapter 2 - Methods

2.1 GIS Data

Base Wetland Data

Wisconsin Wetland Inventory (WWI) point and polygon GIS data for Douglas County acted as the base wetland data for this project. These data were developed through standardized mapping methodologies established by the WI DNR. This mapping process involved the use of stereo pairs of 1:20,000 (1 inch – 1,667 feet), hard-copy, black and white, infrared aerial photos taken of Douglas County in April 2012. Wetland boundaries were delineated and attributed according to the WWI classification system by a trained photo-interpreter. The pen and ink boundaries on the hard-copy photos and their codes (labels) were then digitally converted and attributed for use in a GIS by the WI DNR.

Base Imagery

Several collateral geospatial datasets were utilized during the photo-interpreting of the LLWW wetland classification and for a variety of project functions (e.g., correlating wetland functions to the wetland database, creating spatial adjacency queries, modeling topographic features, and identifying potentially restorable wetland sites). Base aerial photography used include two image sources from Douglas County:

1) Spring 2009 leaf-off 12-inch resolution 2013 true color 4-inch resolution aerial photography – images obtained directly from Douglas County GIS. This aerial photography was used as an ancillary photographic base layer to supplement the 2013 imagery.

2) Spring 2013 leaf-off 4-inch resolution true color aerial photo mosaics – the mosaics were used to confirm the WWI to NWI conversion, to interpret ditches, stream reaches, and to apply the LLWW classification codes to the wetland data.

Collateral Data Layers

1) 10 meter NED DEM - (National Elevation Dataset - Digital Elevation Model) for the two 8-digit HUCs overlapping the DC LSB. The various tiles were mosaicked into one DEM. From this mosaicked DEM several GIS data layer were created using ESRI's ArcGIS tools.

    a.

2) WI DNR Hydro Flowlines – 1:24K hydro flowlines represent perennial and intermittent streams, rivers, and artificial flow paths through lakes. This data was used as an aid in interpreting/applying the LLWW classification to the wetland polygons, for conducting spatial selections in applying functions (high or moderate) to the wetland data, and as a base layer for representing potential restorable stream reaches (see the PRW methods section).

3) Douglas County Road Centerlines – a road layer available from Douglas County. This was used as a reference layer.

4) Open/Impervious Lands dataset created by Community GIS Inc. – this dataset was used to remove incompatible land uses from the pre-filtered PRW layer, used to narrow the search for potentially restorable stream reaches, and as a detailed land cover / land use dataset.

5) SSURGO Soils– Douglas County soils data were downloaded and used in the identification of PRWs.

   a. *Relative Wetland Potential Rank* - a rank of soil map units (polygons) based upon their relevant wetland related characteristics such as drainage class, depth to water, flooding frequency, etc. A numerical rank was applied to the soil map unit GIS data to represent the relative potential for a particular map unit to support wetlands based on its map unit description. In order to accommodate the unique soil conditions in the clay plain and the way in which soil components were aggregated into soil map units called complexes in the clay plain area of the study area. Only soils with components having drainage classes of somewhat poorly drained or wetter were ranked and included in the model to locate PRWs in the clay plain.

Data Developed to Support Assessment

Digital elevation data was available for this project in the form of 10-meter NED (National Elevation Dataset). The various elevation tiles were mosaicked such that the output completely covered eight-digit hydrologic unit codes (HUCs) that overlap the study area. From this mosaicked DEM several GIS data layers were created using ESRI's ArcGIS Spatial Analyst tools. The following data layers were created from 10-meter NED tiles for use in this project: slope raster, aspect raster, hillshade raster, compound topographic index (CTI) raster, a synthetic flowline network using a flow accumulation threshold of 500 cells (both a strahler and shreve stream order was applied to this flowline network).

DEM-derived Layers

1) *Hillshade* – a DEM-derived geospatial data product created for this project. It was useful for visualizing the terrain and interpreting the LLWW classification.

2) *Contours (4 ft.)* – a DEM-derived geospatial data product created for this project. It was also useful for interpreting LLWW classification. These data helped the P.I. interpret the Landform and Water Flow Path portions of the LLWW classification.

3) *Synthetic flowline networks* – two different stream orders were created (Shreve and Strahler), both representing a surface flow network that used a flow accumulation threshold of 500 cells, creating a dense representation of surface flow paths in order help locate potentially restorable wetlands and to understand the predicted water flow path in the LLWW classification.

4) *Basins* - this dataset was created for this project by filling the 10 m DEM, creating a slope raster, then reclassifying it to capture all areas with 0% slope. This was another useful dataset for interpreting and applying the LLWW classification on the NWI wetland polygons.

5) *Compound Topographic Index (CTI)* – a GIS based digital terrain analysis product created from the 10m DEM. CTI is a steady state wetness index. The CTI is a function of both the slope and the upstream contributing area per unit width orthogonal to the flow direction the formula for calculating this index is as follows:

$$CTI = \ln (As / (\tan(beta)))$$

Where: *As* = Area Value calculated as (flow accumulation + 1) *(pixel area m^2) and *beta* is the slope expressed in radians.

6) Slope raster – a grid indicating percent slope based on the 10-meter DEM.

<u>Ditches and Drainage Paths</u>

During both technical committee and the larger internal team meetings discussions regarding the study area's historic and contemporary land use and the general characteristics of soils in the study area, especially the clay plain, it was stated that hydrologic alterations to the landscape were critical for understanding the condition of present-day wetlands and for understanding the concept of potentially restorable wetland locations (potential wetland re-establishment areas). Road ditches and agricultural ditches are major contribuors to accelerated runoff levels, therefore, where visible in the 2013 aerial photography these features were digitized. An example of some agricultural ditches and enhanced swales are depicted in INSERT CROSS REFERENCE. It is important to note that not all ditches along roads were digitized, in fact, it was assumed that ditches exist along nearly every road in Douglas County and therefore time was not spent to map these. Also, it is likely that many more ditches might exist in forested or scrub shrub areas, but these are typically not visible, even in the very high resolution aerial photography of the County. These ditches would be much more readily identifiable if high resolution topographic data were collected such as a.g., LiDAR-derived digital elevation model (DEM).

Figure 9. Aerial view of digitized agricultural drainage ditches (yellow lines). Notice the dashed blue line is an intermittent stream according to the WI DNR 24K flowline data.

Preliminary Riparian/Stream Bank Assessment

The riparian areas of stream segments (WI DNR 24K flowline dataset) that intersected open / impervious land classes in the Community GIS Inc. GIS dataset were examined on 2013 aerial photography and a categorization of the aerial coverage of woody vegetation and information regarding other potential stressor factors were noted for these select stream/river reaches. This subset of stream reaches (GIS lines from the WI DNR 24K flowline dataset) were considered potential restorable stream reaches (PRSRs). Additional details regarding methods along with some examples are provide in the potential restorable stream reach section in this chapter (page 84).

2.2 Present-Day Wetlands

WWI to NWI GIS Data Conversion

During the initial stages of the project it was decided that first, in order to apply predicted wetland function levels to wetland data, the 2012 WWI data needed to be converted to the Cowardin et al (1979) classification system employed by USFWS's National Wetland Inventory (NWI). There are a few primary differences between the two classification systems. First there is more differentiation in regards to the water regime (i.e., how long surface water persists in a given wetland area) in the Cowardin system compared to that of the Wisconsin Classification System, (WWI). Secondly, the Cowardin system incorporates deepwater habitats not included in the WWI system. Together these differences represent more differentiation between wetland types so more can be determined about different wetland types' potential to perform certain ecological functions. Lastly, an additional classification referred to as LLWW (Tiner 2011) has been specifically designed to work with and enhance the Cowardin classification (NWI data).

During the first project technical committee meeting, two options were discussed for converting the WWI GIS data to NWI data: 1) manually interpret polygons, adding, cutting, or otherwise altering where needed and attributed according to the NWI data model; or 2) utilize existing GIS models (converting WWI to NWI data) designed by Shannon Garrett in conjunction with the USGS and the USFWS. Experience with these GIS conversion models in another study area, the Douglas County Lake Superior Basin (DC LSB) in Wisconsin, suggested that the model would produce reasonable results. It was decided that the project would proceed by using these conversion models because it was expected to save on project resources. However, it was expected that this would still require some significant quality assurance steps. For example, there were thousands of gaps and slivers created when surface water features such as lakes and rivers were incorporated into the polygon dataset. There were also many cases where the classification systems did not convert in a one to one fashion, so additional classification modifications were performed after running the models.

The WWI to NWI conversion process is outlined by five primary steps (Garrett 2007) (see Appendix G for additional detail of this process):

1) Delete roads, uplands, and filled wetlands from WWI polygon layer;
2) Convert WWI codes to Cowardin et al. (1979) codes using a tabular crosswalk;

3) Add WI DNR hydrographic features and classify with Cowardin et al. (1979) codes while developing a hierarchy among these features;
4) Buffer WWI points (wetlands less than 2 acres) and add to wetlands polygon layer. Modify point buffers based on hierarchy;
5) Overlay soils data and modify the classification of the wetland polygons based on the drainage capability classes and organic components of the soils.

Wetland Data Clean-up

The resulting geospatial data, after the initial WWI to NWI conversion processes, contained thousands "sliver" polygons and other topological issues because of the incorporation of the WI DNR hydrographic features into the dataset. These topology errors were corrected in a GIS through a combination of automated GIS processes and manual, head-up digitizing. The converted geospatial data also contain erroneous NWI codes; a GIS analyst/PI also corrected these erroneous NWI codes using the 2013 4-inch resolution aearial photography of Douglas County as a base imagery layer for review in a GIS environment.

Applying the LLWW classification

The NWI wetland data were then enhanced by adding the LLWW classification codes to the wetland GIS data using Tiner (2011b) codes. The LLWW classification was applied through a combination of manual aerial photo interpretation and semi-automated GIS routines using the 2013 aerial photography and several, collateral geospatial datasets. Datasets consulted were as follows:

1) WD_HYDRO_FLOWLINE_24K (a WI DNR hydro layer of intermittent and perennial streams) given to SMU-GSS by the State of Wisconsin in 2012;
2) NWI Wetlands (i.e., converted WWI to NWI) – some of the codes determine, in part, the LLWW codes (e.g., of important parameters include water regime [A, B, C, F, G, H] and organic [g]);
3) Hillshade (developed from a 10 m NED DEM) -
4) Contours 4ft (developed from a 10 m NED DEM) – help to indicate terrain while still being able to see the aerial photography in a GIS;
5) Synthetic Flow-line Network (developed from a 10 m NED DEM) -
6) Ditches & Drainage Paths (photo interpreted from 2013 aerial photography)
7) Wisconsin Land Type Associations (LTAs)

Outflow-intermittent

To aid in understanding the surface connectivity and therefore the dominant water flow path (a portion of the LLWW classification) a synthetic flowline network dataset was derived from the available 10-meter DEM. This synthetic flowline network was created by using a flow accumulation threshold of 500, where each cell in the flow accumulation raster need to be contributing flow by at least 500 other cells upstream in order to participate in the linear flowline network. During field validation of wetland classification codes, several roadside locations were checked for the presence of culverts. Culverts were found in nearly every instance that a synthetic flowline crossed a road. Therefore, it is assumed that this synthetic flowline reasonably predicts areas with at least emphemeral or intermittent flow. Wetlands that have a synthetic flowline connecting it to other wetlands or the WI DNR 24K flowline data were considered to have a Water Flow Path of "Outflow-Intermittent". Outflow wetlands "OU" in the LLWW classification were used to indicate wetlands predicted to have a more immediate and longer lasting connection to its downstream water body. For example, larger forested wetlands areas not really representing a true floodplain but part of their boundary is adjacent to a steam or river are considered OU wetlands, whereas, an OI wetland may be higher on a plain and only connected to nearby streams through a swale or small ravine.

Headwater Wetlands Definition

For this project headwater wetlands are defined by the by a Strahler's stream order (Strahler 1957) rule which was based on the WI DNR 24K Hydro Flowline GIS data. Headwater wetlands are first defined as those that have outflow (outflow or outflow-intermittent) into a first or second order stream. However, if the wetland draining to first and second order streams were the only criteria used, it would result in the vast majority of all non-river floodplain wetlands being considered headwater wetlands. This is especially true in the clay plain because it is assumed that most clay plain wetlands have intermittent outflow. That is, at certain times of the year (e.g., during spring snow-melt and larger rain events) they quickly become completely saturated due to general low permeability and they contribute to the surface flow of area streams during these times. To further define headwater wetlands, only those that drain into the first and second order that are the first to empty into a third order stream are considered headwater wetlands (i.e., wetlands that drain into the first of the second order streams that combine to create a third order stream). Refer to Figure 8 for an illustration of this.

Figure 10. Example of a Strahlers stream network labeled with stream order and areas defined as headwaters (blue outline).

One exception to this use of the afore-mentioned criteria for identifying headwater wetlands is in the headwater area of the Brule River. This area is known to contain many seepage wetlands and therefore many of these wetlands are considered outflowing headwater wetlands.

Functional Assignments:

Wetlands perform a number of ecological functions that help improve and maintain environmental quality. For each wetland function a list of possible NWIplus codes and, in some cases, spatial relationships are listed for those wetland types that are predicted to be significant in performing that function. These wetland types and spatial relationships are split into two categories, high and moderate. Wetlands identified as highly significant are predicted to be more significant in for performing a given function. The wetland functions assessed in the DC LSB are as follows:

1. Surface Water Detention (SWD) – storage of runoff from rain events and spring melt waters which attenuates peak flood levels downstream.

2. Surface Water Maintenance (SWM) – this is often referenced as stream flow maintenance. During drought conditions and periods of low discharge, wetlands provide a source of water to keep streams from drying up.

3. Nutrient Transformation (NT) – wetlands through natural chemical processes break down nutrients from natural sources as well as fertilizers and other pollutants essentially treating the runoff.

4. Sediment Retention (SR) – wetlands act as filters to physically trap sediment particles before they are carried further downstream.

5. Carbon Sequestration (CAR) – wetlands serve as carbon sinks that help trap atmospheric carbon.

6. Shoreline Stabilization (SS) – wetland plants help hold the soil to prevent erosion.

7. Fish Habitat (FIS) – wetlands serve as habitat for a variety fish. Within this function is a special category containing those factors such as stream shading that keep water temperatures low enough for cold water species such as trout.

8. General Wildlife Habitat (GWH) – wetlands serve as habitat for a variety of other animals and songbirds to turtles to larger mammals such as deer and raccoons.

After the LLWW classification codes were interpreted from aerial photography and additional topographic and hydro-layers were consulted, wetland functions were correlated using predicted wetland functions based on wetland characteristics contained within the Cowardin classification, the LLWW classification, and/or upon spatial relationships of the wetlands to other wetlands, streams, rivers, or lakes. The wetlands (polygons) that are considered significant for each function are split into two levels, high and moderate. All wetlands not predicted to be significant for each function (not designated as high or moderate in the geospatial data table) are either not predicted to perform the function or may simply perform the function less efficiently and therefore are not predicted to be a significant wetland type for that function. For example, most vegetated wetlands have some ability to detain and slowly release surface water through evaporation, transpiration, infiltration, or slowed overland flow, but some wetland types are just more significant for this function. Conversely some wetlands act as predicted habitat for certain species or guilds of species while some wetlands are virtually non-habitat based on their vegetation structure. For example, open water and fringe wetland habitats are significant for waterfowl, while saturated forested wetlands might be considered to have no direct habitat value to most waterfowl. In the latter case, the forested wetland would not be identified as high or moderate for waterfowl habitat.

To determine which wetland classes (i.e., which codes) were to be identified as being significant for each function, technical committee meeting members carefully reviewed existing code lists (often referred to as correlation tables) and made minor adjustments or modifications to them to meet the unique characteristics of this particular project area. The beginning point for these correlation tables were based on tables used in Miller et al. (2012), Richtman et al. (2012), and Stark et al. (2013).

From the existing correlation tables ArcGIS models (using Model Builder ™) were written to automatically populate the NWIplus wetland database with high and moderate. The models consist of a series of queries, both tabular (i.e., attribute) and spatial (i.e., location), to assign high and moderate for each function. Several different wetland functions were assessed based on the codes and spatial relationships in the NWIplus database. The following wetland functions were assessed in the DC LSB: habitat Functions: Amphibian Habitat (AMH), Fish Habitat (FIS), Other Wildlife Habitat (OWH), Shorebird Habitat (SHB), Migratory Bird Habitat (MBIRD), Waterfowl & Waterbird Habitat (WBIRD), and Woodcock Habitat (WCK); physical/chemical functions: Carbon Sequestration (CAR), Nutrient Transformation (NT), Sediment & Other Particulate Retention (SR), Shoreline Stabilization (SS), Stream-flow Maintenance (SM), and Surface Water Detention (SWD). These wetland functions were individually selected through a series of queries, both tabular (i.e., ATTRIBUTE) and spatial (i.e., location), to assign features (polygons) that are predicted to be significant at high and moderate levels. Refer to Appendix L the tabular (attribute) and spatial queries for each function. The resultant wetland dataset provides the location of different wetland types and, based on their classification, whether their predicted to be significant for a particular function at a high or moderate level. Woodcock habitat was an exception where it was either considered potential woodcock habitat or not (WDK, 1 = yes, NULL = no).

Habitat Functions

Amphibian Habitat (AMH)

Amphibians such as frogs, toads, and salamanders are commonly found in floating vegetation and wild rice. Some amphibian species require a variety of habitats for their life cycle, while others tend to stay in much wetter areas throughout their lives. Typically seasonally flooded to permanently flooded wetlands provide amphibian habitat. Shallower water habitats tend to be best for amphibians. As might be expected most wetlands classifications providing amphibian habitat are palustrine or lacustrine littoral. Table 14 contains the codes for APH.

Palustrine and lacustrine littoral aquatic beds (PAB#, L2AB#) function highly as amphibian habitat. Seasonally flooded or wetter emergent palustrine and lacustrine littoral wetlands also provide excellent amphibian habitat ({P, L2}EM{C, F, G, H}). If organic soils are present the palustrine classifications providing the amphibian habitat become much broader including all classes with seasonally flooded or wetter water regimes (P{AB, EM, SS, FO, US, UB}{C, F, G, H}g). Fens are a special habitat type of this group (PEM1Bg). Wild rice beds ({L2, R2, P}EM2#) are also considered highly functional for amphibian habitat. From a water body perspective woodland ponds (PD1{b, c}) provide high quality amphibian habitat.

All permanently flooded and intermittently exposed palustrine and lacustrine littoral wetlands ({P, L2}#,#) are considered moderately functioning regardless of water regime. Water body types providing moderately functioning amphibian habitat include all natural ponds not already classified as highly functioning, impoundments, and excavated ponds (PD1{not b OR c}, PD2#, PD3#).

Fish (FIS)

Wetlands performing the function of fish habitat provide areas vital for various parts of their life cycle. Many organisms on which fish feed need wetlands to survive. Wetlands also provide spawning and nursery areas. Wetland plants provide cover essential to small and young fish avoiding predators. The shade provided by wetland trees and shrubs helps to maintain cooler water temperatures for cold water species. Determining wetland functioning for fish habitat requires using a combination of the LLWW and NWI codes.

Wetlands functioning highly for fish habitat tend to have wetter water regimes and are mostly associated with large or moving bodies of water. Headwater wetlands also function highly as fish habitat. Specifically, lentic, lotic stream, and lotic river wetlands (**LE#, LS#, LR#**) that are semi-permanently flooded, intermittently exposed, or permanently flooded *(##F#, ##G#, ##H#)* are highly functioning for fish habitat. Terrene outflow headwater (**TE#OUhw**) wetlands and any wetlands hydrologically connected to them with semi-permanently flooded or wetter water regimes *(##F#, ##G#, ##H#)* are included in highly functioning as well. Water bodies providing this function include all lakes (**LK##**) and rivers (**RV##**).

Wetlands performing the function of fish habitat to a moderate degree are typically LLWW lotic types. Seasonally flooded *(##C#)* basins classified as low gradient lotic streams (**LS1BA#**) are moderately functioning for fish habitat. Similarly, seasonally flooded *(##C#)* lotic river floodplain basins (**LR#FPba**), oxbows for example, are also moderately functioning as fish habitat. In terms of waterbody, all throughflow ponds (**PD#TH**) are classified as moderately functioning.

Due to the very specific habitat conditions required for trout and other cold water species to thrive, a third level of performance specifically for trout is added to this function. The wetland types included typically contribute to maintaining cooler water temperature through stream shading. Forested palustrine wetlands *(PFO#)* associated with natural high, middle, and low gradient stream wetlands (**LS1#, LS2#, LS3#**) that are not ponded (**###pd**) perform this function. Similarly, scrub-shrub palustrine wetlands *(PSS#)* associated with the same lotic stream types, partly drained or not, also perform this function.

Wetlands that are not considered for the fish habitat function are shrub bog types. Specifically, wetlands classified as saturated palustrine broad leaf evergreen scrub-shrub bogs *(PSS3Ba)* are never considered.

Other Wildlife Habitat (OWH)

General wildlife in this case includes mammals, reptiles, and songbirds. All vegetated wetlands, and only vegetated wetlands, perform this function to some degree. The size and whether there are multiple vegetation types in a complex determine the level at which a wetland complex is functioning for GHW. It needs to be emphasized that this function is dependent on wetland complexes that may be made up of many different interconnected wetlands types. In other words it is the size of the entire wetland complex that determines its level of function and not the size of the individual wetlands making up the complex.

All vegetated wetland complexes *({L#,P}{AB, EM, SS, FO}#)* greater than or equal to 20 acres in size are highly functioning for GHW. Wetland complexes of greater than or equal to 10 acres are highly functioning if composed of multiple vegetative types. For example, a monotypic patch of wild rice *(#EM2#)* that is 14 acres in size would not be highly functioning, but if the complex is 14 acres in size and made up of a mixture of wild rice and water lilies *(#AB#)* it is highly functioning.

All other vegetated wetlands not already classified as highly functioning are moderately functioning. For monotypic wetlands this includes all wetlands less than 20 acres in size. For wetland complexes with multiple vegetation types this includes all wetlands less than 10 acres in size.

Shorebird Habitat (SHB)

Birds including: herons, cranes, egrets, and sandpipers are shorebirds, and are commonly referred to as wading birds. They require shallow open water areas of lakes or ponds, sometimes mixed with emergent vegetation for feeding on invertebrates, fish, and amphibians. Nesting occurs on sandy beaches and bars and mudflats. Classifying wetlands functioning as shorebird habitat is relatively straight forward as compared to some of the other functions because it depends entirely on the NWI Cowardin classification system. Table 13 contains the codes and conditions providing the determination for SBH. Figure 17 shows features performing SBH.

Highly functioning wetlands for shorebird habitat are seasonally or temporarily flooded unconsolidated shore areas *({P, L2,}US{A, C})* and mixes of unconsolidated shore and emergent vegetation *({P,L2}{[US,EM]/[US,EM]}{A, C})*.

Wetlands moderately functioning for shorebird habitat are palustrine and littoral lacustrine wetlands with unconsolidated bottom or aquatic beds ({P,L2}{UB,AB}{F, G}). Unconsolidated bottom and aquatic bed mixes and either type mixed with emergent ({P, L2}{[UB,AB,EM]/[UB,AB,EM]}{F,G}) are also included as moderately functioning.

Migratory Bird Habitat (MBIRD)

This function is intended to identify wetlands that are predicted to act as significant stop-over locations for migratory birds during migration. Migratory birds are considered non-game birds that fly between summer breeding grounds and non-breeding wintering areas. During their migration, they must stop to feed and rest. Some areas are considered especially important as stop-over locations based on the availability of food, water, and shelte they provide to various migratory birds.

For this assessment we simply focused on all wetter wetlands are near Lake Superior. Specific sites identified by the Wisconsin Stopover Initive (WISI) that occur in the DC LSB include the St. Louis River Estuary wetlands and Wisconsin Point. WISI states that the St. Louis River Estuary wetlands (large marshes, shrub swamps, and wet meadows) and coniferous (upland) forests provide stop-over habitat for migrating waterbirds waterfowl and songbirds. The St. Louis River Estuary is important for waterfowl, waterbird, landbirds, and raptors during both spring and fall. Shorebird habitat is important in the fall here.Wisconsin Point is a long spit of sand (these beaches are mapped as lacustrine unconsolidated shore wetlands) and with backshore dunes and some interdunal wetlands that provide stop-over habitat for songbirds, raptors, waterfowl, aterbirds, and shorebirds. Wisconsin Point is specifically notable for waterfowl and raptor stopover habitat during spring and fall and spring time waterbird and landbird stop-over habitat. Lastly, the entire shoreline of Lake Superior in the DC LSB is known for supporting waterfowl and raptors as migratory stop-over areas during both spring and fall migration.

Waterfowl & Waterbird Habitat (WBIRD)

Ducks, geese and swans are most commonly thought of as waterfowl, but a number of other types of birds, such as loons, coots and grebes also rely on similar habitats for survival. Their highly functioning habitat is typically associated in some way with open water. Depending on the species, habitats can range from large open littoral areas, to forested ponds and streams. Much of the functioning of wetlands for WFH is dependent on a combination of specific LLWW and NWI classifications. Table 12 contains the codes and conditions for (WFH), and Figure 16 shows the features that are classified as WFH.

As might be expected, due to the variety of waterfowl and waterbird species there are a variety of classifications that function at a high level. Vegetated wetlands and wetlands with mixes of vegetation and non-vegetated classes that are semi-permanently flooded or wetter are considered highly functioning for waterfowl habitat *({L2,R2,P}{AB,EM,SS,FO}{F,G,H}), ({L2,R2,P}{AB,EM,SS,FO}/{UB/US}{F,G,H})*. Basin and fringe wetlands associated with streams (**LSFR#, LSBA#**) are considered highly functioning waterfowl habitat provided they are seasonally or semi-permanently flooded *(###C)(###F)*. Similarly, lotic river floodplain basin and fringe wetlands (**LRFPba#, LRFR#**) function highly, again provided they are semi-permanently, or seasonally flooded *(###C)(###F).* Of special note are oxbows that have through flow (**LRFPbaoxTH**) which are considered highly functioning regardless of water regime. All natural (**PD1#**) and beaver ponds (**PD4**) are also considered highly functioning.

Moderately functioning wetlands for waterfowl habitat as the term implies do not perform the function as well as the highly functioning wetlands. In many cases this is the result of drier conditions or a different position within the landscape. All littoral open water wetlands *(L2UB#)* are moderately functioning, as well as littoral unconsolidated shore *(L2US{A,C})* Isolated terrene basins (**TEBAIS#**) that are classified as palustrine emergent wetlands which are semi-permanently flooded or wetter *(PEM{F ,G, H})* function at the moderate level. All temporarily flooded wetlands (###A) are moderately functional as waterfowl habitat. All impounded and excavated ponds (**PD2#, PD3#**) are included as moderately functioning. Other water bodies that are included are lakes (**LK#**) and rivers (**RV#**).

Wetlands classified with the saturated water regime *(###B)* are not considered to perform the function of waterfowl/waterbird habitat.

Woodcock Habitat (WCK)

Woodcock prefer a variety of habitats depending on time of day, activity, and season, but generally prefer younger forested areas for nesting and brood rearing and scrub shrub with saturated soils for feeding. To identify the wetlands considered potential woodcock habitat from the NWIplus dataset, all deciduous scrub shrub palustrine wetlands or deciduous forested palustrine wetlands adjacent to deciduous scrub shrub wetlands with a water regime of C, B, or A were selected as potential woodcock habitat.

<u>Physical / Chemical Functions</u>

Carbon Sequestration (CAR)

Carbon sequestration occurs when wetlands act as carbon sinks through chemical and biological processes such as photosynthesis. Typically, wetlands performing carbon sequestration are vegetated to some degree. Therefore, NWI classifications become the major source of information in making determinations regarding carbon sequestration. Soil and water regime information are also important in determining whether a wetland functions at a high or moderate level for this function.

Lacustrine and palustrine aquatic beds *({L2,P}AB{F, G, H}})* perform this function at a high level. Bog and northern white cedar wetlands are also major contributors to carbon sequestration. NWI classifications identifying bogs include palustrine and littoral limnetic wetlands dominated by broad leaf evergreen shrubs with a saturated water regime, acidic water chemistry modifier, and organic soil modifier *({L2/P}SS3Bag)*. Similarly, scrub-shrub and forested bogs dominated by needle leaf evergreens with the saturated water regime and organic soils modifier *({L2/P}{SS,FO}4Bg)* are included as highly functioning as well.In NWI, wild rice is given the non-persistent *(#EM2#)* designation. There are several wetland types containing wild rice that function highly for CAR. Lower perennial riverine with an intermittently exposed or permanently flooded water regime *(R2EM2{G, H}* are included, as well as littoral lacustrine and palustrine wetlands that are semi-permanently flooded or wetter *({L2,P}EM2{,F,G,H})*.

Moderately functioning wetlands for CAR include all wetlands and water bodies not already specified as highly functioning. All wetlands perform carbon sequestration to some degree.

Nutrient Transformation (NT)

Nutrient transformation refers to the natural chemical processes that remove or recycle compounds in the environment. In the case of wetlands, nitrates and phosphorous from agricultural runoff are the primary nutrients of concern. Wetlands performing this function are sinks for excess nutrients. The nutrients are prevented from moving further through the watershed through either storage or by wetland vegetation using the nutrients for their own life cycle.

For nutrient transformation, landscape position is less important than the other factors such as vegetation and soil type. For this reason the NWI classification becomes the primary system that defines the functioning of a wetland for nutrient transformation. Vegetated lacustrine littoral and palustrine wetlands that are seasonally flooded, semi-permanently flooded, intermittently exposed, or permanently flooded *(L2{AB, EM, SS, FO}{C,F,G,H}, P{AB, EM, SS, FO}{C,F,G,H}),* function highly for nutrient transformation. Any mixes of vegetated and non-vegetated NWI classes also function highly if the they are semi-permanently flooded or wetter *(L2{[AB, EM, SS, FO]/[US,UB]}{F,G,H}, P{[AB, EM, SS, FO]/[US,UB]}{F,G,H}).* Vegetated palustrine wetlands with organic saturated soil *(P{EM, SS, FO}Bg)* provided they are not on a coastal or glaciolacustrine plain are also considered to be highly functional.

For moderate nutrient transformation activity vegetation is important, but moderately functioning wetlands tend to be drier than their highly functioning counterparts. Vegetated palustrine wetlands that are temporarily flooded as defined by NWI, *(P{EM, SS, FO}A),* function moderately for nutrient transformation. Any mixes containing vegetated NWI classes also function highly if the they are temporarily flooded,*(P{EM, SS, FO}/{US,UB}A).* Vegetated palustrine wetlands with saturated soil *(P{EM, SS, FO}B)* that are on coastal or glaciolacustrine plains are also considered to be moderately functioning. Finally, any vegetated, palustrine wetland with saturated soil is considered to be moderately functioning if it has the mineral soil modifier *(P#Bm).*

Wetland types that do not provide a nutrient transformation function include bogs, *(P{SS2, SS3, SS4, FO2, FO3, FO4}#).* Similarly, any wetland with acidic water chemistry *(P{EM, SS, FO}Bag)* is excluded. Open water wetlands *(#UB#)* and unconsolidated shore *(#US#)* also do not perform this function.

Sediment & Other Particulate Retention (SR)

Wetlands that physically trap particles that affect water quality have sediment retention properties. In contrast to nutrient transformation which involves chemical processes, SR is a physical process where the suspended particles are filtered by the soil and plant roots. The removal of suspended particles helps to improve water clarity and help maintain cooler temperatures on cold water streams. Due to the physical nature of sediment retention LLWW is the primary system used to make SR determinations with the NWI vegetation classes and water regime also factoring into the process.

In general, wetlands functioning highly for SR tend to be vegetated. However, lentic basins (**LEBA#)** and lotic river fringes (**LRFR#**) perform sediment retention to a high degree regardless of the presence of vegetation. Lentic fringe, and island wetlands (**LEFR#, LEIL#**) that are vegetated *({L, P}{AB, EM, SS, FO})* or vegetated mixes *({L, P}{[AB, EM, SS, FO]/[UB/US]})* perform well in removing particulates. Vegetated lotic stream basins and fringe wetlands (**LSBA#, LSFR#**) are included as well as vegetated lotic river basin, floodplain, fringe, and island wetlands (**LRBA#, LRFP#, LRIL#**). Several terrene wetlands types function highly for sediment retention. All ponded terrene throughflow wetlands are included (**TE#pdTH**). Terrene basins with throughflow (**TEBATH**) and terrene interfluve basins with both regular and intermittent throughflow (**TEIFbaTH, TEIFbaTI**) also perform SR to a high degree. In terms of waterbody type, all ponds with throughflow (**PD#TH**) provide this function to a high level. Any wetland classified as severely human induced **(####hi**) in LLWW and impounded *(###h)* in NWI functions highly for sediment retention as well.

Wetlands that moderately perform the sediment retention function include some non-vegetated types. Lentic fringe (**LEFR#**), lotic stream flats (**LSFL#**), lotic stream fringe (**LSFR#**), lotic river fringes (**LRFR#**) and lotic river islands (**LRIL#**) with non-vegetated NWI classes *(#{UB, US}#)* all fit this category. However, lentic flat wetlands (**LEFL#**) classified with vegetated NWI classes *(#{AB,EM,SS,FO}#)* also moderately perform the SR function. Ponded terrene wetlands (**TE#pd#**) not classified with a throughflow waterflow path are considered to moderately perform sediment retention as well. Non-saturated *(P#B#)* terrene basins (**TEBA#**) with waterflow path other than throughflow (**##TH#**) or intermittent through flow **(##TI#**) function moderately. Terrene flat wetlands (**TEFL#**) with the temporarily flooded *(P#A#)* water regime also fall into the moderately performing category. Natural ponds classified as bogs (**PD1a**), woodland-wetland (**PD1b**), or sinkhole-woodland (**PD1h**) are the only water body types that moderately function in sediment retention. All lacustrine unconsolidated shore and unconsolidated bottom *(L2US#, L2UB#)* wetlands that are not already classified as highly functioning are considered to be moderately functioning. In terms of LLWW water body, any pond without through flow (**PD#**) that is not listed as an exception is moderately functioning as well.

There are several universal exceptions of wetland types that do not function as sediment retention areas, which are never considered to perform the sediment retention function. First, the saturated NWI water regime *(##B#)* is removed from any consideration. Sediment retention only applies to the flooded water regimes. Secondly, floating mat wetlands as designated by the LLWW **(##fm**) code are not considered to provide the sediment/particle retention function. Finally, several types of ponds never perform the sediment retention function. Woodland-dry land (**PDc**) and prairie – dry land (**PDe**) are the two types relevant to the SMWSA that never perform the sediment retention function.

Shoreline Stabilization (SS)

Natural shoreline stabilization structures and vegetation prevent erosion or remediate erosion that has already occurred by binding soils. Vegetation and mixed vegetation along lake, river, stream, and pond shorelines prevent soil from being washed or blown away.

Vegetation is the main factor that contributes to wetlands functioning highly for shoreline stabilization. Non-island lentic, lotic river and lotic stream wetlands ({**LE,LR,LS}{BA,FL,FP,FR,IF,SL}**##), with vegetated NWI classes *({L2,R2,P}{AB,EM,SS,FO}#)* all function highly with respect to shoreline stabilization. Similarly wetlands with the same LLWW attributes and vegetation dominant mixes are also included as highly functioning *({L2,R2,P}{AB,EM,SS,FO}/{UB/US}#)*. The only LLWW water body type that provides SS are ponds (**PD##**) adjacent to streams. Island (**#IL#**) and floating mat (**##fm**) wetlands never perform the shoreline stabilization function.

Wetlands performing shoreline stabilization at a moderate level are vegetated with terrene LLWW attributes. Terrene ponded wetlands (**TE#pd**) attributed as vegetated and dominant vegetated mixes NWI wetlands *({L2,R2,P}{AB,EM,SS,FO}#), ({L2,R2,P}{[AB,EM,SS,FO]}/[UB,US]}#)* perform this function to a moderate degree. Terrene, outflow, headwater wetlands (**TE#Ouhw**) and consisting of vegetated and vegetated mixes like the terrene ponded wetland previously described also provide this function if they are hydrologically connected to a stream. Connectivity in the case of the SMWSA was determined by intersecting wetlands data with a stream data set extracted from the National Hydrography Dataset as provided by the Wisconsin DNR. Lower perennial river wetlands *(R2EM1#)* which are not wild rice beds are also included as moderately functioning for shoreline stabilization.

Wetlands that are never considered to be performing the wetland function include all island wetlands (**#IL##**), isolated wetlands (**##IS#**), inflow wetlands (**##IN#**), floating mat wetlands (**##fm**), and unconsolidated shore wetlands *(#US#)*.

Stream-flow Maintenance (SM)

Surface water maintenance is the ability of a watershed to keep water traveling through the drainage system. Wetlands that help maintain stream flow are those that contribute water to the interconnected conduits within a watershed. Wetlands providing highest surface water maintenance are headwater wetlands. Most other wetland types that provide surface water maintenance are throughflow and outflow types, although in some cases isolated and inflow wetlands also provide this function to a moderate degree.

All headwater wetlands **(###hw**) provide surface water maintenance to a high degree. Lentic wetlands with throughflow or outflow (**LE#TH, LE#OU**) provide SWM to a high degree. Similarly terrene wetlands with throughflow and outflow provide this function to a high degree if they are associated with a pond (**TE#THpd, TE#Oupd**). Water body types functioning highly for SWM are ponds and lakes, provided again that they have throughflow or outflow (**PDTH#, PDOU#, LKTH#, LKOU#**). All wetlands and wetland complexes adjacent to rivers (**RV#**) and streams (**ST#**) function highly as well. All wetlands with organic soils *(###g)* adjacent to third order streams or higher (further downstream) are highly functioning as well.

There are two types of lentic wetlands that moderately function for SWM. Lentic wetlands with bidirectional flow (**LE#BI#**) provide SWM to a moderate degree. Also, lentic wetlands with throughflow (**LE#TH#**) that are adjacent to lakes (**LK#**) also provide this function. Low gradient river floodplain (**LR1FP#**) wetlands and lotic stream basins (**LS#BA#**) perform surface water maintenance to a moderate level as well. Several types of terrene wetlands provide SWM to a moderate degree. The broadest terrene category is terrene wetlands with throughflow (**TE#TH#**). Isolated and inflow terrene wetlands associated with ponds (**TE#Ispd, TE#Inpd**) also function moderately. Terrene wetland flats with outflow (**TEFLOU#**) consisting of saturated soils *(##B#)* that are adjacent to third order streams or higher are moderately functioning. In terms of water bodies, ponds and lakes that are with inflow or isolated water flow paths (**PDIS#, PDIN#, LK#IS#, LK#IN#**) are considered moderately functioning.

Surface Water Detention (SWD)

Wetlands trap and store surface water. Surface water can take the form of precipitation or in colder climates spring snow melt. The wetlands then release the water slowly over time through surface or underground hydrologic networks. From the human perspective, this process equates to lower peak flood levels. In fact, wetlands in a watershed can diminish and even desynchronize peaks flows. Generally, depressional wetlands that capture and store precipitation and runoff are significant for performing the function of surface water detention. They provide ground water recharge points and include wetlands found along stream and river floodplains, in lake basins, fringes, and islands.

There are a number of LLWW classifications that indicate a wetland performs this function at a high level. Lentic basins (**LEBA#**) (# = wild card or a character used as a substitute for any of a class of characters in a search) and lentic fringe (**LEFR#**) wetlands are two major examples. Flat wetlands associated with dammed lakes (**LE2FL#**, **LE3FL#**) also function highly in this capacity. Lentic islands (**LEIL#**) are the final Lentic classification performing this function at a high level. Lotic classifications providing highly functioning SWD include basins (**LSBA#**, **LRBA#**), fringe wetlands (**LSFR#**, **LRFR#**), and lotic river island wetlands (**LRIL#**). Non-vegetated lotic fringe wetlands such as gravel bars do not perform this function. Terrene basins, terrene ponded basins, and terrene fringe wetlands perform this function to a high degree provided there is throughflow present (**TEBATH#, TEBApdTH**, **TEFRpdTH**). In terms of LLWW water body type, all types (**PD#, LK#, ST#, RV#**) contribute highly to this function as well. Finally, any wetland with organic soils, as indicated by the lower case g NWI ***(###g)*** modifier that is adjacent to a LLWW lake (**LK#**), river (**RV#**), or stream (**ST#**) is highly functioning for surface water detention. All wetlands not specifically listed as highly functioning or as an exception perform the function of surface water detention to a moderate level.

Wetlands considered to never perform this function are terrene sloped wetlands, (**TESL#**) and sewage treatment ponds (**PD2f**). Also, non-vegetated banks and bars along rivers (**R2US#**) do not provide any SWD. The final and relatively uncommon exceptions are flat wetlands on a drainage divide **(#FL#dd**).

2.3 Potential Restoration Opportunities

Background – Existing Methods & GIS layers

Wetland restoration, particularly "potential" restoration, in this context is to apply to the idea of finding areas with the potential for the re-establishment of wetlands. These locations are predicted to have once supported wetlands and have since been altered so they are no longer map-able wetlands by NWI landscape-scale standards. Two existing GIS datasets represent potential restorable wetlands in this context and for this assessment additional steps were taken to create customized PRW layers for the study area.

Wisconsin DNR – PRW layer

In recent years the WI DNR created multiple versions of a state-wide PRW GIS dataset. For this version of the PRW GIS layer, the process involved querying each of the state's county-level NRCS SURRGO databases for hydric soil map units. From this selection, existing (mapped wetlands) were removed. Then, all incompatible land uses such as roads, urban, commercial, residential, etc. were also removed from consideration as a PRW. With some post processing to rid the layer of some "noise" (i.e., sliver polygons and very small polygons), the remaining polygons were then considered PRWs. A more detailed step-wise description of the process the WI DNR used to create this dataset is as follows:

1. SSURGO soils data polygons were queried to find hydric soils* with ≥ 85% hydric component(s) of a given soil polygon (map unit);

2. Wetland polygon data were intersected (ESRI Analysis tool) with the hydric soil polygons to determine where hydric soils exist outside of existing mapped wetlands. These might be potential restorable wetland areas, however, some land uses are not conducive to restoration;

3. The resulting polygon data were then intersected with a roads layer and a land use layer to determine where hydric soils have been permanently converted to land use not compatible for wetland reestablishment (e.g., not possible or practical to remove a road or convert developed, urban land back to wetlands).

4. The resulting layer was edited to reduce superfluous or erroneous polygons; this involved removing polygons that had larger perimeters than areas (i.e., shape length > shape area). These “sliver polygons” appear to be primarily the result of mapping discrepancies between wetland data and soils data layers developed as these data were created with different mapping methodologies and geographic scales. Once these slivers were removed, all hydric soil polygons that were not located within an existing wetland and did not overlap roads or urban land use were considered potentially restorable wetlands (PRW).

***According to the NRCS (**Federal Register Doc. 2012-4733 Filed 2-28-12) *Hydric soil* means a soil that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part. This definition includes soils that developed under anaerobic conditions in the upper part but no longer experience these conditions due to hydrologic alteration such as those hydric soils that have been artificially drained or protected (e.g., ditches or levees).

Virtually No Hydric Soil in the Red Clay Plain

Following examination of the WI DNR PRW 2012 version 2 GIS layer in the study area, it was found that PRWs were nearly completely lacking in the clay plain portion of the county (Figure 10). That is, there were very few polygons indicating potential wetland restoration sites in approximately the first 6-8 miles inland of Lake Superior. This was due, in part, to the complex nature of the soils in this area and in part to the way the soils were represented in digital map form. There weren’t soil map units considered hydric by soil taxonomic rules and soil types were aggregated into soil map units (i.e., soil complexes), thereby excluding them from this type of query. In many cases, soil map units (Mus) contained multiple soil components with coverage percentages split across several components. For example, a given soil map unit might be made up of component A at 40%, component B at 30%, component C at 20%, and component D at 10%. If less than 85% of the map unit was a hydric soil, then the map unit would not be selected for consideration as a PRW, or if the soil taxonomy didn’t allow for the soil to be truly considered hydric despite having evidence of hydric conditions, then the map unit also would not be considered as a PRW. This pointed to a need to look for another approach or the need to incorporate some additional data into a PRW GIS model.

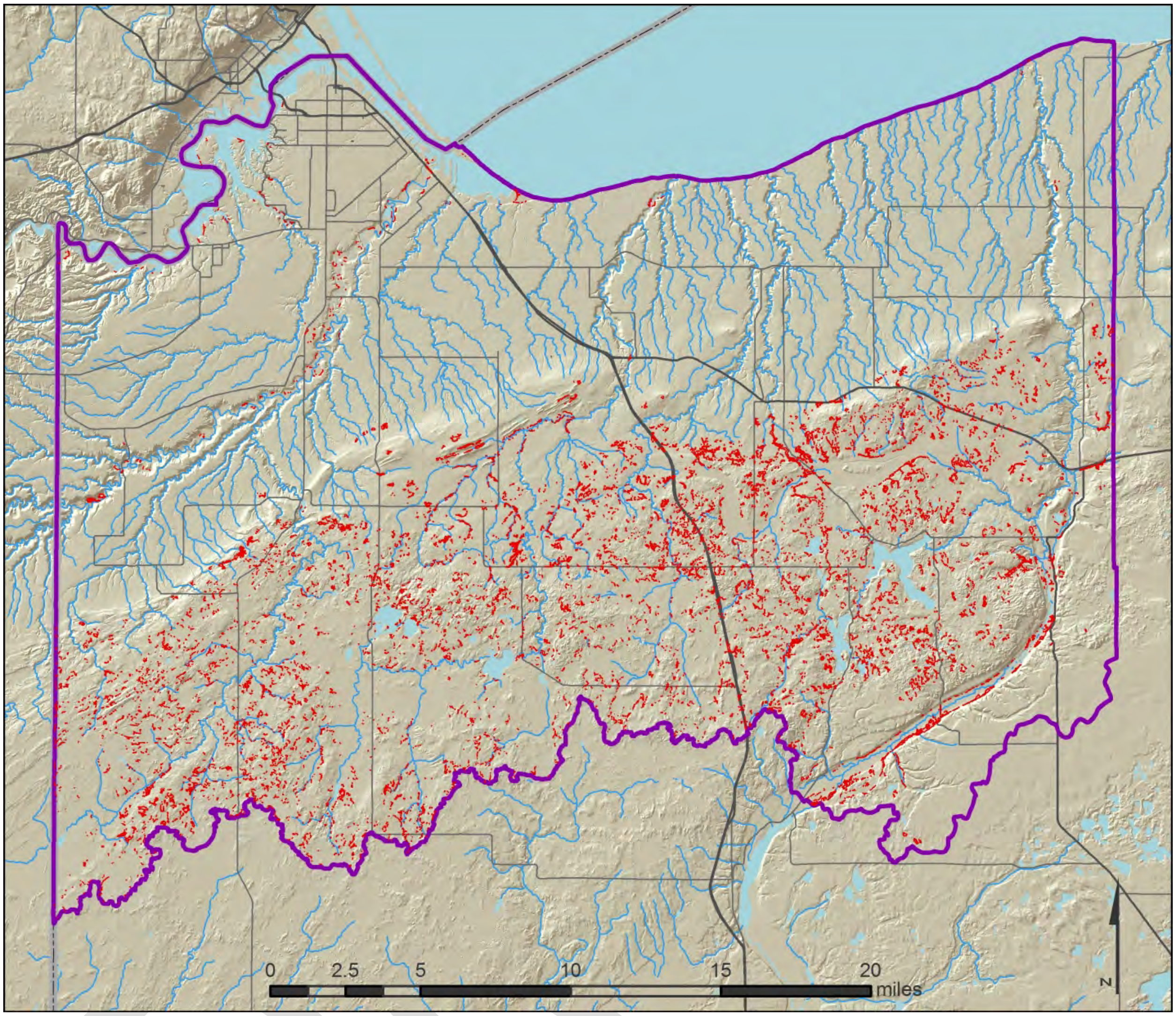

Figure 11. WI DNR 2012 version 2 PRWs (red polygons) in the DC LSB. Notice a concentration of PRWs in the southern portion of the study area (outside of the clay plain) where soil map units are more distinct (i.e., not aggregated or treated as soil complexes made up of mutlitple components in each map unit) like in the clay plain area.

Potential Wetland Soil Landscapes (PWSL) – USDA-NRCS

Another soils dataset made available to the project team near the beginning of the project was the Potential Wetland Soil Landscape (PWSL) GIS layer. The PWSL layer is a nation-wide gridded version of NRCS's SURRGO soils data (referred to as gSURRGO). This layer is intended for the identification of areas with a "hydric" soil as a dominant or named component not already mapped as a wetland. The data contain a tabular field called PWSL that provides an indication of grid cells likely to support wetlands.

The PWSL shows some areas in the red clay plain area of Douglas County as 50% in the PWSL field, but none greater. That is 50% of a given soil map unit contains hydric soils. It is presumed that the same "problem" exists in the data that a lower percentage of the map units are considered hydric because of these "complexes" and therefore don't get captured as a high percentage.

Refined PPW Identification Methods

In order to locate potential wetland restoration opportunities, more accurately, potential wetland re-establishment opportunities in the clay plain, it became clear that a different approach was necessary. First, the problem of aggregated soils data needed to be addressed. That is, the soils information needed to be disaggregated or split by some other covariate (factor) to find the sites with soils that likely supported wetlands but have since been drained or otherwise hydrologically altered. After discussions with local wetland experts including Greg Larsen, a former State of Minnesota Soil Scientist, it was discussed that topography is a major determinant for the position of wetlands in the clay plain. That is, many of the soils have low permeability and even a slight depression or accumulation area is likely to hold water and support hydrophytes (i.e., become or re-establish as a wetland). Therefore it was decided during technical committee meetings that the methods for identifying PRWs in the clay plain would be different than those outside the clay plain in the southern portion of the study area.

<u>Within the clay plain</u>

The identification of potential restorable wetlands (PRWs) in the clay plain involved a process of disaggregating the SURRGO soil map unit data so that only soils with some wetland potential based on soil map unit characteristics coincident with areas of higher compound topographic index (CTI) values were identified. CTI is designed to represent soil wetness; it is a function of the slope and the upstream contributing area per unit width orthogonal to the flow direction. This provides an estimation, based on the best available DEM, where water is likely to accumulate and have a higher probability creating wet soil conditions. From this, additional photo-interpretive effort was taken to examine the largest of the resulting PRWs (polygons) and determine, based on evidence such as land use, visual evidence of hydrologic alteration (namely surface ditching), if a given area might be a more likely viable wetland re-establishment site. If this type of evidence came together in the same site, the area was considered a viable site worthy of further consideration. That is, a preponderance of evidence exists indicating there was likely wetlands removed from the site and the site is likely to still receive enough water that wetlands could be re-established given some reversal of hydrologic alterations. For sites (PRW polygons) that were considered viable, points were digitized through photo interpretation in order to represent likely pour points of the viable PRW area. The following sections further explain each of the resulting potential restoration site layers.

PRW Polygons

PRW polygons for the clay plain area were created using a query of soil map units combined with areas of high CTI values. First, criteria for identifying which soils would be useful for predicting wetland restoration sites. For this, the description of all SURRGO soil map units in the county were reviewed. In order to capture soils that aren't considered hydric by soil taxonomic rules and certain components within a soil map unit (polygon), all soils with a drainage class of "somewhat poorly drained" or wetter were subset from the SURRGO database. Second, a threshold of which CTI values are relevant to predicting wetland restoration sites was needed. During the continual refinement of the PRW GIS modeling process the WI DNR is engaged in, field testing of relevant CTI values (i.e., thresholds) indicate that a CTI threshold (i.e., values equal to or greater) 10.0 is reasonable. However, for this process, the threshold was expanded slightly to accommodate for the generally low permeability of the clay plain soils; areas with a CTI ≥ 9.5 were grouped.

The soil polygons and CTI data (polygons converted from gridded data) meeting the afore-mentioned criteria were combined in a GIS (ESRI ArcGIS Intersect Tool). The resultant layer represents an initial "population" of areas (polygons) likely to support wetlands. Next, the known wetlands were removed in order to locate possible former wetlands (aka potential wetland re-establishment sites). The existing (mapped) mapped wetlands were removed using ESRI's ArcGIS Erase tool.

> *NOTE: Initially these soil map units were ranked for their relative likelihood to support wetlands according to an interpretation of hydrologic characteristics of the soil map components making up each soil map unit (a discrete polygon). Various hydrologic properties contained in each map unit description were reviewed for this process. Appendix H provides a list of these soil map units (Mus). The table in this appendix lists the MUs' symbol, name, percent slope range, drainage class(es) and notable hydrologic variables taken from each map unit description that were considered relevant for determining the relative rank number. This assigned rank (the "Rank" column) is intended to represent the relative probability (1-20) that an MU might spatially define wetlands or former wetlands, where the higher the number the higher the probability.*

The layer resulting from the combination of soil CTI information is an initial representation of potential restorable wetlands (PRWs). It contained well over 10 thousand polygons. Therefore some additional steps were required to clean-up some of the results considered superfluous. For example, the layer contained many very small and some very narrow polygons. These polygons are considered superfluous because they are likely the result of mapping discrepancies or scale issues between the various data sources. Polygons < 0.25 acres were deleted from the layer, then all polygons with shape perimeter > shape area were also deleted, as these were too small or too much of a sliver respectfully.

<u>Initial PRW Viability Filtering – Clay Plain</u>
The top 300 largest PRW polygons (sorted by acreage) from the clay plain were individually examined in a GIS to begin to filter the results of the thousands (over nine thousand) of individual polygons into an initial subset of potentially viable wetland re-establishment locations. Additional polygons were examined by panning for areas with a concentration of PRW polygons and evidence of ditching. For each of these polygons, over 500 in total, a preliminary interpretation of the viability of wetland re-establishment was captured in the data table, with polygons considered either "likely", "possibly", or "not likely" viable. All polygons not specifically reviewed were labeled "not examined". This viability was based on review of the aerial photography and additional GIS data such as the WI DNR Hydro layer, interpreted ditches layer, and land use/cover layer (open/impervious lands layer created by Community GIS Inc.). This subset of locations might be further filtered or prioritized using additional data or criteria and should be visited in field. From the PRW polygons that were considered "likely viable" or "possibly viable", pour points were digitized / interpreted. These pour points were to represent major points where the, "viable" wetland re-establishment sites drain to.

PRW Pour Points

A preponderance of evidence approach was used by the photo interpreter/GIS analyst includes sites that that have certain soils conditions (e.g., somewhat poorly drained or wetter), hydrologic position (high CTI values), conducive land use (e.g., active or "transitional" agriculture), and visual evidence of ditching (i.e., ditches visible in aerial photography).In areas where a "preponderance of evidence" suggested that a site might have once supported wetlands, representative pour points were digitized. Note, a more accurate and inclusive representation of ditches in the study area might be found in the future with high resolution elevation data created (e.g., a LiDAR-derived DEM).

PRW Catchments

From the pour points (locations representing drainage from areas worthy of further investigation as viable wetland re-establishment sites), catchments were delineated using the Watershed Tool in ESRI's ArcGIS 10.2 Spatial Analyst toolset. These catchments were intended to represent the drainage areas that capture the largest, primary wetland re-establishment areas in the study area. It is recommended that the watershed tool or similar be re-run once high resolution elevation data are made available.

<u>Outside the Clay plain</u>

The identification of PRW polygons in the clay plain of DC LSB utilized existing methods of the WI DNR PRW layer with some minor refinements. The WI DNR's method uses soil map units with 85% or more of the components being hydric or partially hydric. The approach was considered by the technical committee to be a reasonable approach as soil map units in this area were not aggregated into soil complexes and therefore were more spatially explicit than map units in the clay plain. The major steps of refining the existing WI DNR GIS layer are as follows:

1. *Update the WI DNR 2012 v2 PRW layer with new wetland boundaries*

   Starting with the WI DNR 2012 v2 PRW layer (an unpublished GIS layer received from the WI DNR), all wetlands contained in the NWIplus wetlands database were used to erase or remove any portion of a hydric soil map unit not already "erased" by the last version (circa 1993) WWI data.

2. *Erase all remaining hydric soil polygons with incompatible land uses*

   Open/Impervious Lands – Community GIS Inc. Data, Type = "Open" & Sub_Type = "Residential" OR Sub_Type = "Urban Areas" OR Sub_Type = "Commercial Industrial" OR Sub_Type = "Utilities"; OR Type = "Impervious" & Sub_Type = "Roads Driveways" OR Sub_Type = "Rail Line" OR Sub_Type = "Structures".

3. *Erase all polygons with shape area > shape length*

   This cleans up some of the very thin "sliver-like" polygons that are assumed to be a result of horizontal registration and very minor mapping scale discrepancies.

4. *Erase all polygons less than 0.25 acres*

   This assumes that most of very small polygons are the result of mapping error/discrepancy and if they aren't error, than it is assumed that the polygons are too small to represent a cost effective wetland restoration opportunity. All remaining polygons <0.5 acres were labeled as "small 0.25-0.5 ac" in the PRWstatus field.

Potential Restorable Stream Reaches (PRSRs)

Along with wetlands and general land cover composition, the riparian zone and its vegetation is important to understanding the primary watershed issue of increased peak flows in area rivers and streams which has resulted in increased erosion and sedimentation and contributed to flooding-related issues. In many cases, riparian areas are either not functionally considered wetlands or they might be too small/narrow to be mapped as wetlands according to both WWI and NWI mapping standards and therefore not captured in this assessment. However, since a significant portion of this project focused on photo-interpreting features such as ditches, wetlands, lands use type, and the LLWW classification from the high resolution aerial photography, a supplemental product was added to the project to provide an initial assessment of potential riparian area issues. The following section describes the methods and outputs of this effort.

The Potentially Restorable Stream Reaches GIS dataset (lines) is intended to provide local planners/decision-makers with an additional dataset to consult in local watershed-level planning efforts. The data identify areas where riparian buffers might be established or re-established to help reduce some potential erosion and sediment issues along streams.

First, all stream segments in the WI DNR 24K flowline hydrography dataset that intersected open / impervious lands (Community GIS Inc.) were examined in 2013 aerial photography. From these lines, stream segments were further subset in cases where the riparian vegetation appeared to be lacking and/or land use practices were interpreted to potentially be affecting the stream bank or riparian area. For these segments, several characteristics were recorded: 1) a characterization of the riparian vegetation (no woody vegetation, minimal woody vegetation, limited woody vegetation, partially forested, forested, scrub shrub wetland, emergent wetland, forested wetland); 2) land use/cover type (e.g., wetland, agriculture, active grazing, past grazing, periodic grazing, golf course, undetermined-past disturbance, utility right of way); 3) unimproved crossing (noted has yes or no); 4) channelized (noted as yes or no), largest associated Shreve stream order (this was determined by a synthetic flow network that utilized a flow accumulation threshold of 500 cells, the higher the number the farther down a stream network the segment is); 5) strahler stream order according to the DNR hydro layer, 6) % slope (min., max., & ave.); and 7) stream power index (SPI) (min., max., % ave.).

Figure 11 and Figure 12 provide some examples of potentially restorable stream reaches (PRSRs). In this example the area appears to be an actively grazed area in which some wetlands appear to be experiencing some effects livestock grazing and no woody riparian vegetation is allowed to grow in the stream's riparian zones apparently due to livestock grazing.

Figure 12. An aerial view (April 2013) of a grazed wetland and riparian zone (i.e., PRSR). A disturbed emergent wetland is outlined in green in the left portion of the image and two stream segments highlighted by blue lines are in the right portion of this aerial view. Both areas appear to be affected by active livestock grazing.

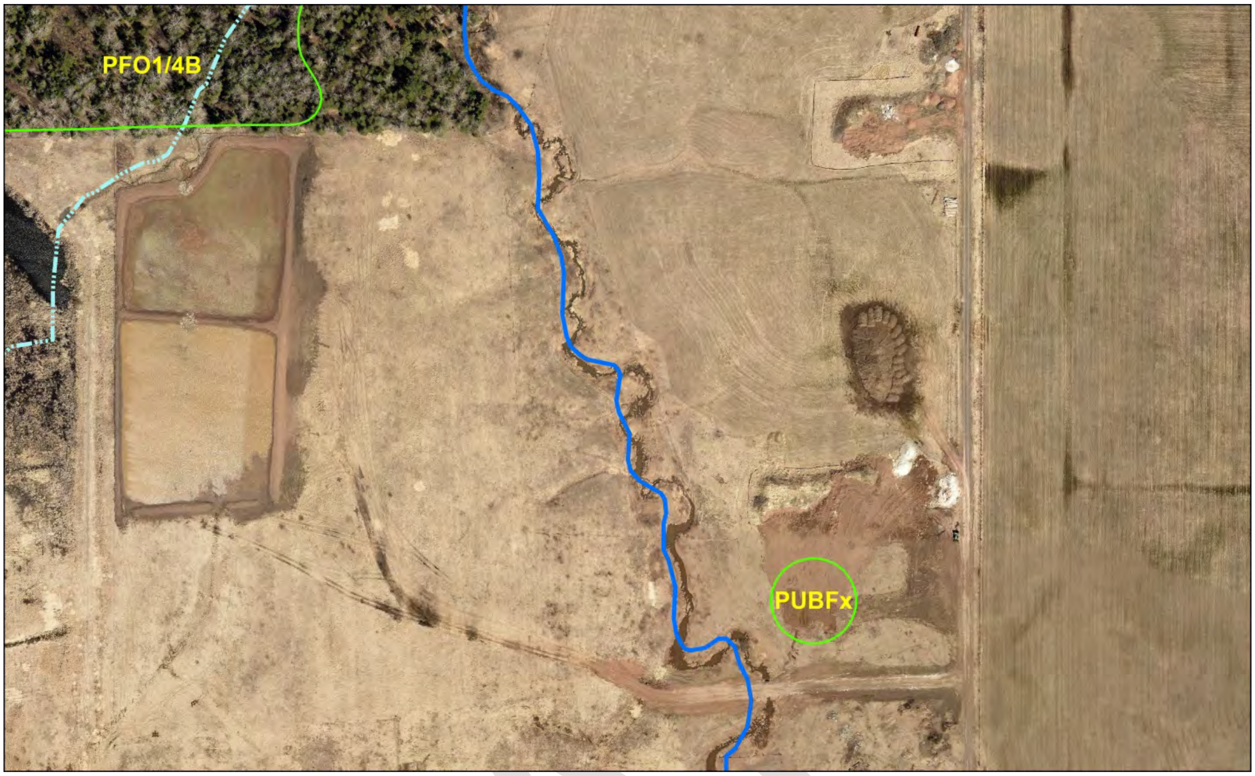

Figure 13. Aerial view (April 2013) of a PRSR (potential restorable stream reach) with virtually no woody riparian vegetation. In this example the dominant adjacent land use appears to be active agriculture (likely a hay field). The stream data (blue line) is the WI DNR 24 flowline data and the green outlines represent wetland boundaries (2012 WWI data converted to NWI data). Note the newly excavated ponds in the upper left hand portion of the photo which were likely not in existance during April 2012 (date of photography used to map WWI data).

Chapter 3 – Results

3.1 Present-Day Wetlands

The tables in the following sections contain data summaries for both classification systems (NWI and LLWW). The summaries list the acreage for each of the wetland classification parameters. In cases where there are dual attributes the dominant attribute was used for the summary. For example, wetlands with the NWI code PFO4/SS3B are summarized as PFO4B.

National Wetland Inventory System (NWI Codes) Summary

A general summary and breakdown of NWI System, Class, Water Regime, and Modifiers applied in the DC LSB can be found in Table 3. Approximately one third (35.5%) of the DC LSB is classified as wetland. Palustrine system wetlands accounted for the vast majority (96%) of the wetland area, lacustrine systems made up 3%, and riverine systems the balance at 2%. The vast majority of wetland area was dominated by forest (72%) or scrub shrub (17%) vegetation. It is likely that these percentages would be even higher if all of the wetlands mapped by WWI, those less than two acres, were characterized into wetlands types. Unconsolidated bottom wetlands (i.e., ponds, lakes and rivers) accounted for 5% of the total wetland area and emergent vegetation dominated wetlands account for 4%.

The (B) water regime accounted for over 80% of the wetland area. The second most abundant was the seasonally flooded (C) water regime at 17%, followed by permanently flooded (H) accounting for 5% of wetland area. Semi-permanently flooded (F), semi-permanently flooded (A), seasonally flooded / saturated (E), intermittently exposed (G), artificially flooded (K), and temporarily flooded – freshwater tidal (S) water regimes made up the remaining area percentages. Organic soil wetlands (g) was a common special modifier in the NWI wetland data which accounted for 22% of the total wetland area, as organic soils are relatively common in wetlands outside of the clay plain. Beaver activity also appears to be having a significant influence on many wetlands. At least XXXX ponds were considered beaver ponds in the DC LSB.

Table 3. NWI Summary Table.

Summary Parameter	No. of polygons	Area (acres)	% of total area in DC LSB	% of total wetland area in DC LSB
General				
Area of DC LSB	--	489,878	100.0	--
Wetlands[a]	46,984	173,752	35.5	--
Uplands	--	303,616	64.5	--
NWI System				
P – palustrine [b]	46,827	166,120	33.91	95.61
L - lacustrine	80	4,838	3.54	2.78
R – riverine	77	2,794	0.57	1.61
NWI Class				
FO- forested	18,603	125,135	25.08	72.02
SS – scrub shrub	4,374	28,945	5.80	16.66
UB – unconsolidated bottom [c]	1,564	9,436	1.89	5.43
EM - emergent	2,191	7,652	1.53	4.40
BLANK	19,847	1,983	0.40	1.14
AB – aquatic bed	168	460	0.09	0.26
US – unconsolidated shore	71	123	0.02	0.07
NWI Water Regime				
B -saturated	21,025	139,990	9.40	80.57
C – seasonally flooded	3,348	18,518	1.24	10.66
H – permanently flooded	308	8,511	0.57	4.90
F – semi-permanently flooded	1,755	2,392	0.16	1.38
(blank)	20,014	2,002	0.13	1.15
A – temporarily flooded	181	966	0.06	0.56
E – seasonally flooded / saturated	133	801	0.05	0.46
G – intermittently exposed	178	414	0.03	0.24
S – temporarily flooded – freshwater tidal	27	98	0.01	0.06

K – artificially flooded	16	62	0.00	0.04
NWI modifiers				
g – organic soil	6,299	37,870	7.71	21.80
b – beaver	499	1,314	0.27	0.76
x – excavated	1,093	934	0.19	0.54
bg – beaver, organic soil*	106	436	0.09	0.25
h – impounded	43	120	0.02	0.07
d – partially drained	5	66	0.01	0.04
f – farmed	15	47	0.01	0.03
hg – impounded, organic soil	6	15	<.001	0.01

[a] Excludes the polygon representing a portion of Lake Superior.

[b] This includes all undefined wetlands <2 acres mapped as WWI points, then converted for this assessment to polygons.

[c] This excludes the polygon representing a portion of Lake Superior in the dataset.

[d] BLANK are all small wetlands: mapped as points in WWI data and labeled as < 2 acre wetlands. These were converted to 0.1 acre circles.

Landscape Position, Landform, Water Flow Path, Water Body Type (LLWW Codes) Summary

The summary for the LLWW data is presented in Table 4. Terrene was the most common landscape position at 85% by total wetland area in the DC LSB. In terms of LLWW Inland landform, flat (**FL**) was the most common classification at 78% by area, with basin (**BA**) the second most abundant at 12.5% by total wetland area. Outflow-intermittent (**OI**) was the most common water flow path with 55.8% of the wetland area classified as such. The headwater modifier (**hw**) was applied to 31.4% of the wetland area. It is important to note linear features were not mapped as wetlands for this project, therefore there are no features to classify as streams in the NWI or LLWW classification systems. However, a contemporary, high resolution stream layer from the WI NDR was used during the process of interpreting the LLWW classification system. Additionally, a synthetic flowline network, created from a 10-meter NED DEM was used to inform the photo interpreter of predicted surface flow connectivity of wetlands.

Table 4. LLWW Summary Table.

Summary Parameter	No. of polygons	Area (acres)	% of total area in DC LSB (*489,879 acres*)	% of total wetland area in DC LSB
General				
Area of DC LSB	--	489,878	100.0	--
Wetlands[a]	46,984	173,752	35.5	--
Uplands	--	303,616	64.5	--
Landscape Position				
EY – Estuary	268	1,305	0.27	0.75
LE – Lentic	102	350	0.07	0.20
LR – Lotic River[b]	861	3,326	0.68	1.91
LS – Lotic Stream	2,141	8,975	1.83	5.17
TE – Terene	21,972	147,925	30.19	85.14
BLANK[c]	21,641	11,871	2.42	6.83
Landform				
IL – island	35	121	0.02	0.07
FR – fringe	69	191	0.03	0.11
FP – floodplain	875	3,307	0.68	1.9
BLANK (*not assigned*)	21,778	12,866	2.63	7.41
BA –basin	4,279	21,668	4.42	12.47
FL – flat	19,949	135,599	27.68	78.04
Waterbody Type				
LK – Lake	13	4,445	0.91	2.56
PD – Pond	1673	2,539	0.52	1.46
RV – River	41	2,778	0.58	1.60
Waterflow path				
IN –inflow	4	7	0.00	0.00
BI – bidirectional flow	374	1,677	0.34	0.96
IS – isolated (*now considered vertical flow*)	1,089	1,899	0.39	1.09
BLANK – small wetlands not assigned	19,859	2,045	0.42	1.18
TI – throughflow-intermittent	986	3,127	0.64	1.80
TH – throughflow	2,762	18,822	3.84	10.83
OU – outflow	7,824	49,185	10.04	28.30
OI – outflow-intermittent	14,085	173,752	19.80	55.82

Select LLWW modifiers				
bv – beaver	605	1,749	0.36	1.01
hw – headwaters	7,646	54,512	11.13	31.37

[a] Wetland area includes all vegetated wetlands and rivers, lakes, ponds. The areas exclude Lake Superior itself.

[b] Wetlands considered lotic river environments are those associated with rivers as identified by a polygon in the NWIplus wetlands data. If the flowing water body was not wide enough to map as a polygon, it was considered a stream and the associated wetlands were then lotic stream wetlands.

[c] The small wetlands (<2acres) identified by WWI as points, which were buffered to 0.10 acre circles were not assigned an LLWW classification and therefore are “BLANK” according to this summary. Additionally, waterbodies (lakes, ponds, and rivers) were not assigned a landscape position, and therefore are “BLANK”.

[d] This area includes all small wetlands (points in the WWI data) identified as <2 acre wetlands. These wetland were buffered into circles of 0.10 acres. Also includes small dammed ponds (points in the WWI data) and excavated ponds (points) both buffered to 0.30 acre circles.

NWIplus Codes (NWI & LLWW codes combined) Summary

A total of 1,962 unique combinations of NWI combined with LLWW codes (NWIplus codes) existed in the DC LSB. A total of 1204 of these codes were represented by less than three instances in the entire study area. The most common NWIplus code in the dataset (largest number of polygons) were polygons that were converted from WWI points. These were not given an LLWW code and only a "P" in NWI and therefore are identified as BLANK NWIplus codes. The second most numerous NWIplus code was *PFO1B*, **TEFLOIds**. These were deciduous forested wetland with a saturated water regime. Most of these were clay plain wetlands that are generally flat, terrene wetlands, that have intermittent outflow and drain to nearby streams. These accounted for a total of 16,769 acres or nearly 10% of total wetland area.

The NWIplus data also provides for increased specificity regarding wetland characteristics than does the WWI or NWI systems alone. This is, in part, evidenced by the fact that over half of the NWI & LLWW code combinations (NWIplus codes) are represented by less than a few instances (i.e., only a few polygons). Common codes by number of polygons and by percentage of total area in the DC LSB and by percentage of total wetland area are displayed in Table 5.

Table 5. Common NWIplus codes by wetland area and by number of polygons in study area. Codes representing ≥ one percent of total wetland area are displayed followed by codes ≥ one percent of total number of wetland polygons. Note, some codes repeat between the two lists.

NWIplus code (NWI, LLWW)	Acres	% of total area in DC LSB	No. of polygons	% of total wetland area
Sorted by % of Total Area (*only includes codes representing ≥ one percent of total wetland area*)				
PFO1B,TEFLOIds	16,769	3.42	6	9.65
PFO1/SS1B,TEFLOIds	12,794	2.61	1,851	7.36
PFO1/4B,TEFLOIds	12,058	2.46	1,435	6.94
PFO1/SS1B,TEFLOIdshw	11,043	2.25	1,094	6.36
PFO1B,TEFLOIdshw	9,261	1.89	748	5.33
PFO1/4B,TEFLOIdshw	8,626	1.76	967	4.96
PFO1/4Bg,TEFLOUds	7,370	1.50	633	4.24
PSS1B,TEFLOIds	4,115	0.84	547	2.37
PFO1B,TEFLOUds	3,676	0.75	457	2.12
PSS1B,TEFLOIdshw	3,570	0.73	560	2.05
PFO1/4Bg,TEFLOIds	3,087	0.63	280	1.78
R2UBH,RV1TH	2,550	0.52	578	1.47
PFO1/SS1B,TEFLOUds	2,486	0.51	36	1.43
PSS1/EMB,TEFLOIds	2,326	0.47	513	1.34
PFO4Bg,TEFLOUds	2,082	0.42	443	1.20

BLANK*	1,998	0.41	301	1.15
NWIplus code (NWI, LLWW)	**Acres**	**% of total area in DC LSB**	**No. of polygons**	**% of total wetland area**
Sorted by % of Total Polygons (only includes codes representing ≥ one percent of total area)				
BLANK*	1,973	0.40	19745	1.14
PFO1B, TEFLOIds	12,794	2.61	1851	7.36
PFO1/SS1B, TEFLOIds	12,058	2.46	1435	6.94
PFO1/4B, TEFLOIds	11,042	2.25	1094	6.36
PFO1B, TEFLOIdshw	8,626	1.76	967	4.96
PFO1/SS1B, TEFLOIdshw	9,260	1.89	748	5.33
PFO1/4B, TEFLOIdshw	7,370	1.50	633	4.24
PFO1/4Bg, TEFLOIds	2,549	0.52	578	1.47
PFO1B, TEFLOUds	3,569	0.73	560	2.05
PFO1/4Bg, TEFLOUds	4,115	0.84	547	2.37
PFO1/SS1B, TEFLOUds	2,326	0.47	513	1.34
PSS1B, TEFLOIds	3,675	0.75	457	2.12
PSS1/EMB, TEFLOIds	2,081	0.42	443	1.20
PFO4/SS1B, TEFLOIds	1,764	0.36	423	1.02
PEMB, TEFLOIds	1,389	0.28	339	0.80
PFO4Bg, TEFLOUds	1,998	0.41	301	1.15

* These are small wetlands (i.e., WWI <2 acres identified by a point), which were buffered to 0.01 acre circles. For these polygons the wetland type was not specified and therefore has no NWIplus code.

WWI Wetland Characteristics Preserved in the NWIplus Wetland Database

The original WWI data which acted as the base layer for creating the NWIplus wetland data captured wetlands interpreted as being grazed, vegetation recently removed, small wetlands (WWI points: <2 acres wetlands), and red clay complexes. The grazed wetlands were coded using “g” in the original WWI data. This information was preserved in the final NWIplus wetlands data in a tabular field titled ‘Grazed’. A total of 174 polygons were identified as being grazed in the final dataset covering a total of 437 acres. Wetlands with vegetation recently removed (usually timber harvest areas) were coded in the original WWI data with “v”. This was preserved in a tabular field titled ‘v_removed’. A total of 825 polygons were identified as vegetation recently removed covering a total of 4,468 acres of wetland. Small wetlands were identified as GIS points in the original WWI data. Through the conversion of the WWI data to NWI data, these points were buffered into circles of 0.1 acres in size. For these wetlands the wetland type was not captured, just that they were small wetlands. This fact was preserved in a field called ‘SmlWeland’. Over 20,0000 wetlands were identified as small wetlands, with an estimated total area of over 2,000 acres. Since the wetland type was not identified for these small wetlands, the data was not converted to a full NWI code or LLWW code and therefore wetland functions were not predicted for these polygons.

Lastly, wetlands considered red clay complexes identified by the WWI code “r” were preserved in a field called ‘r_complex’. This identified 6,493 wetlands covering a total of 69,981 wetland acres. The red clay complex wetlands are an important caveat in the dataset. A precise estimate of actual wetland area for these wetlands is less clear because they often can contain significant upland inclusions as well as contain some slightly deeper depressions within them that might be considered a different wetland type if delineated in the field. For example, a PFO1/SS1B (NWI) or T3/S3Kr (WWI) might contain some seasonally flooded basins that also stay saturated throughout most, if not all of the growing season, but over a large area (e.g., 30 acre), they are generally flat saturated mineral (clay) soil forested or scrub shrub wetlands.

Significant Wetlands for Each Function

Please refer to the MAP SUPPLEMENT to this project titled XXXXXXXXXXXX for larger maps depicting the location of wetlands predicted to perform each function at high or moderate levels.

3.2 Potential Restoration Opportunities

Potential Restorable Wetlands (PRWs)

Several GIS data products are intended to narrow the landscape in search of wetland restoration opportunities in the study area. For this assessment they are divided by those datasets that are intended to: 1) support the identification of potential wetland re-establishment sites and an initial, mannual filtering of the model results; and 2) those stream reaches which might prioritized for future riparian improvements that simply address vegetation and land use.

PRW polygons

The following sections describe the GIS data layers utilized for identifying PRWs. For this study, PRWs are areas where a preponderance of evidence exists indicating the area was once a wetland or at minimum contained more wetland area, but may have since experienced vegetative and/or hydrologic modification. These areas are considered to have a likelihood of supporting wetland development given some hydrologic or land management changes. The following is a list of the GIS feature classes (layers) contained in the final database delivered to Douglas County, Wisconsin's GIS department.

- PRWs clay plain (a combination of wetland soils and high compound topographic index areas)
    - PRW Pour Points (interpreted drainage points of each of the "viable" PRW polygons in the clay plain)
    - PRW Representative Catchments (catchments or watersheds created from the interpreted pour points)
    - Interim layers – relative wetland likelihood soil map units layer (used in creating the clay plain PRW polygons; grouped CTI layer (all CTI cells ≥ 9.5 dissolved into contiguous polygons)
- PRW outside clay plain (hydric or partially hydric soil areas not presently mapped as wetlands, minus roads and incompatible land uses.)
- Potential Restorable Stream Reaches
- Ditches, swales, drainage paths -

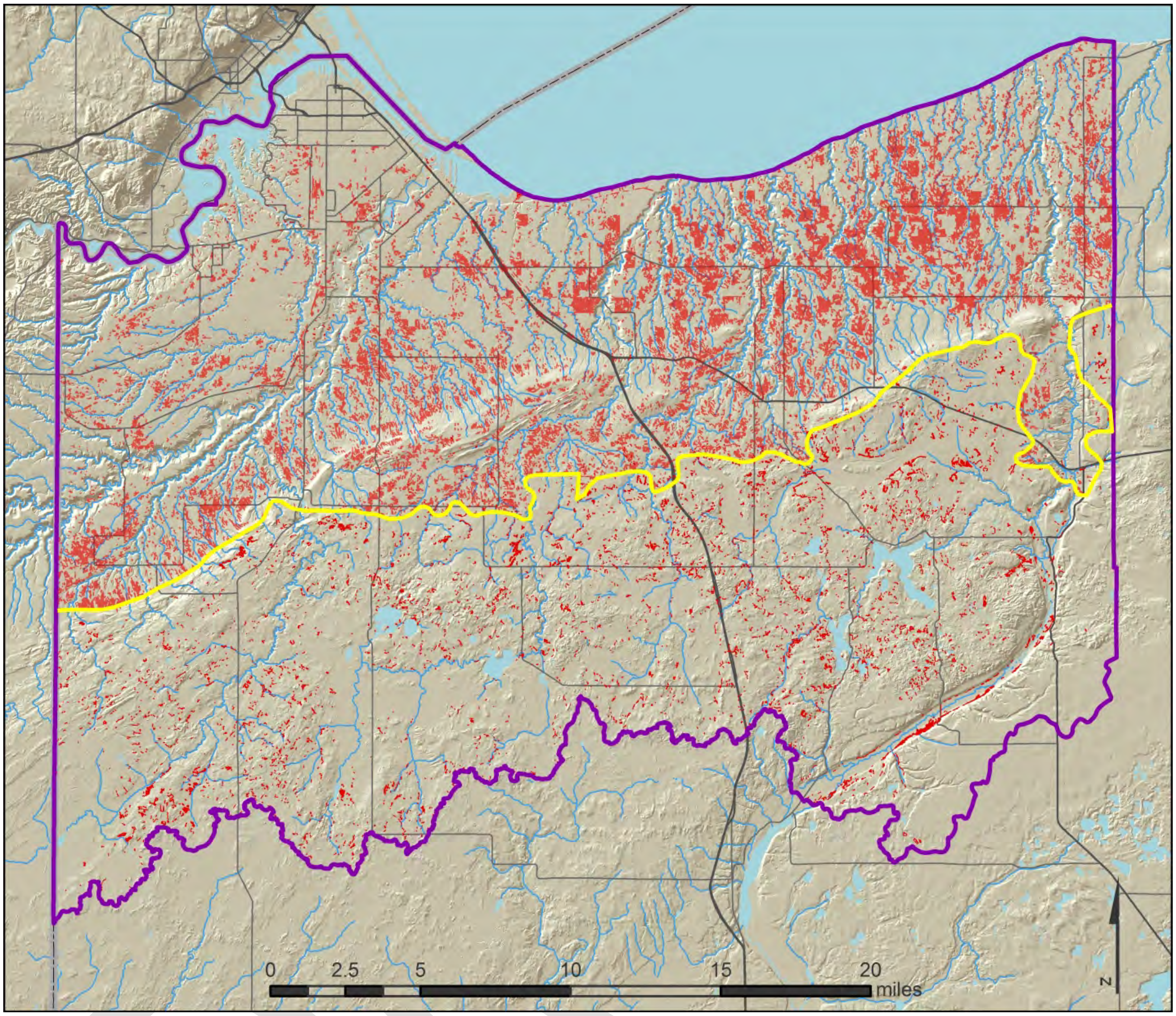

Figure 14. General distribution of PRWs (i.e., potential reestablishment sites) (red polygons) in the DC LSB. The yellow line indicates the clay plain boundary for the purposes of this assessment; the clay plain is to the north of this line. Different methods were employed to define PRWs in the clay plain vs outside of the clay plain.

An example of a PRW categorized as "likely viable" is shown in FIGURE XXXX. This aerial view example has visible ditching, CTI values greater than 9.5 and soils considered to potentially support wetlands. In this case, the soil map unit is the Bergland-Cuttre Complex (map unit symbol = 347A) which contains either poorly drained (Bergland) or somewhat poorly drained (Cuttre) soils. Refer to Appendix I for other relevant hydrologic variables for this map unit.

Figure 15. A PRW area (an ag. field or pasture) considered viable due to a preponderance of evidence at the site. Relatively dense network of ditches is visually evident in the aerial photography here (digitized yellow-lines); the soils are Bergland-Cuttre Complex which are poorly drained and somewhat poorly drain respectively; and the area has CTI values greater than 9.5. The mapped wetland boundaries are the green outlines and a small perennial stream (blue line) is in the lower right portion of the image.

<u>Interpreted Pour Points</u>

Pour Points are locations where the viable or possibly viable PRW polygons are interpreted to outflow. In most cases this location was guided by the nearest synthetic flowline (DEM-derived GIS layer). In many cases multiple pour points were interpreted (digitized) for a PRW polygon as the PRW often appeared to likely drain in multiple directions. Generally, they were found to be most prevalent in agricultural areas, especially in the eastern portion of the clay plain within the DC LSB (Figure 20). This is to be expected because this area has a higher concentration of agriculture and ditching.

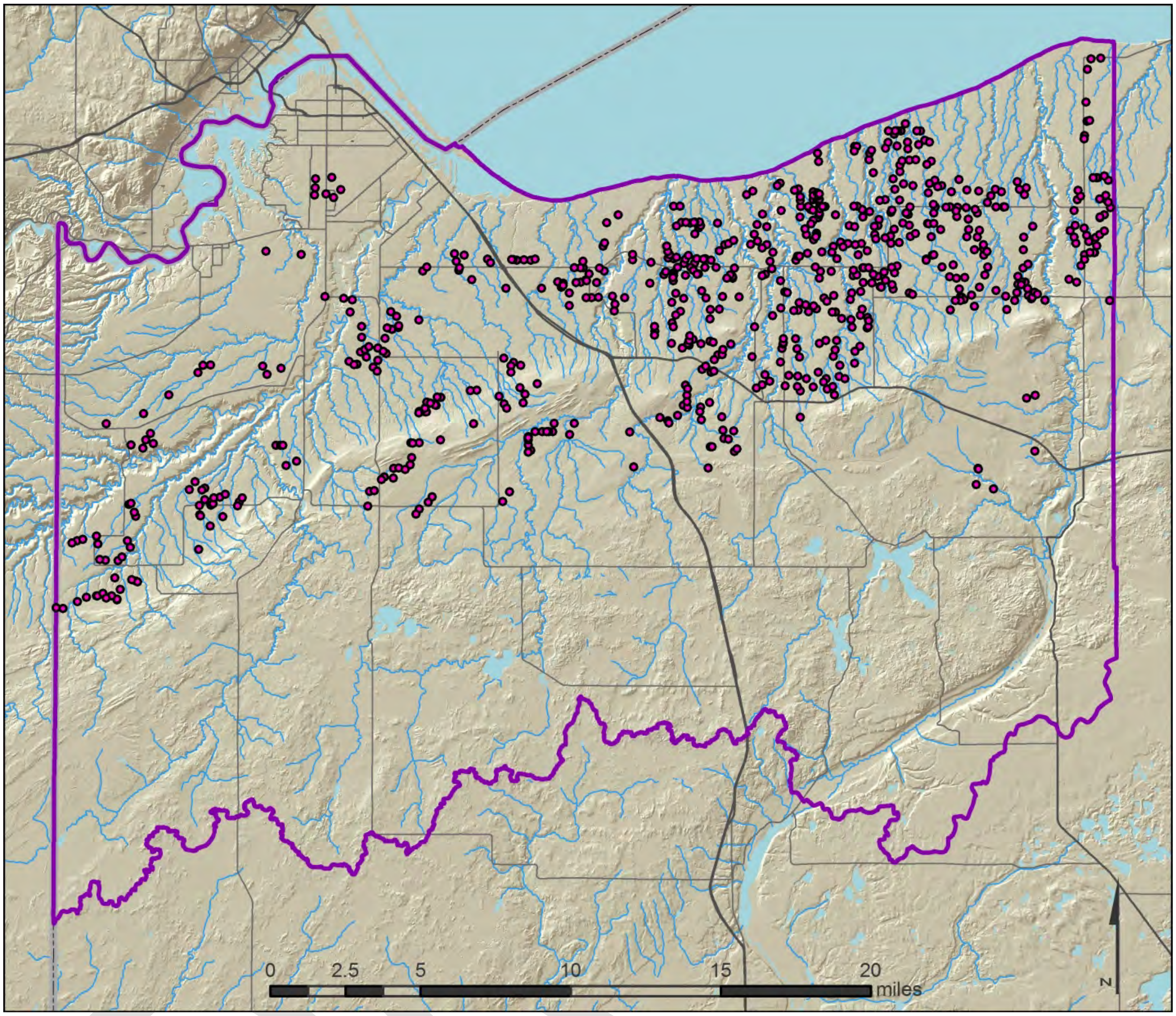

Figure 16. Interpreted PRW pour points (red) in the DC LSB. These were created from individually examining the top 300 largest PRW areas (polygons) in the study area. The pour points are intented to represent the points at which each of these 300 PRWs are likely to drain into the model flowlines (i.e., the synthetic flow patterns created from the available 10m DEM). From the largers 300 PRW polygons, only those areas that appear to have evidence of hydrologic alteration (visible ditching) and land use likely to have resulted in some drained wetlands (e.g., active or "transitional" agriculture from the Open / Impervious Lands GIS data [Community GIS Inc.]). A total of 700 points were identified. Note: in many cases multiple pour points are identified for one PRW polygon or grouping of PRW polygons.

<u>Catchments</u>

Catchments were created from these interpreted pour points. The pour points were first snapped to (ESRI – Spatial Analyst - Snap Pour Point Tool) the flow accumulation grid using a 20 foot threshold. This ensures that the point represents the location with the highest flow accumulation value within 20 feet of the digitized point. Then, ESRI's Spatial Analyst (Watershed Tool) was run to create the catchments for each of the pour points. The catchments are only as accurate as the DEM from which they are based, but provide a starting point for narrowing down areas for wetland restoration opportunities, these might be fed as an input to a future prioritization model that would incorporate other, additional criteria that would provide some guidance on which PRWs (the polygons, the pour points, and the resultant catchments) might be of the highest priority in a watershed planning context. Regardless, it is recommended that catchments and, in fact the PRW methods be re-run once high resolution elevation information is captured and made available in the future. It is likely that the precision of the analysis would be greatly increased.

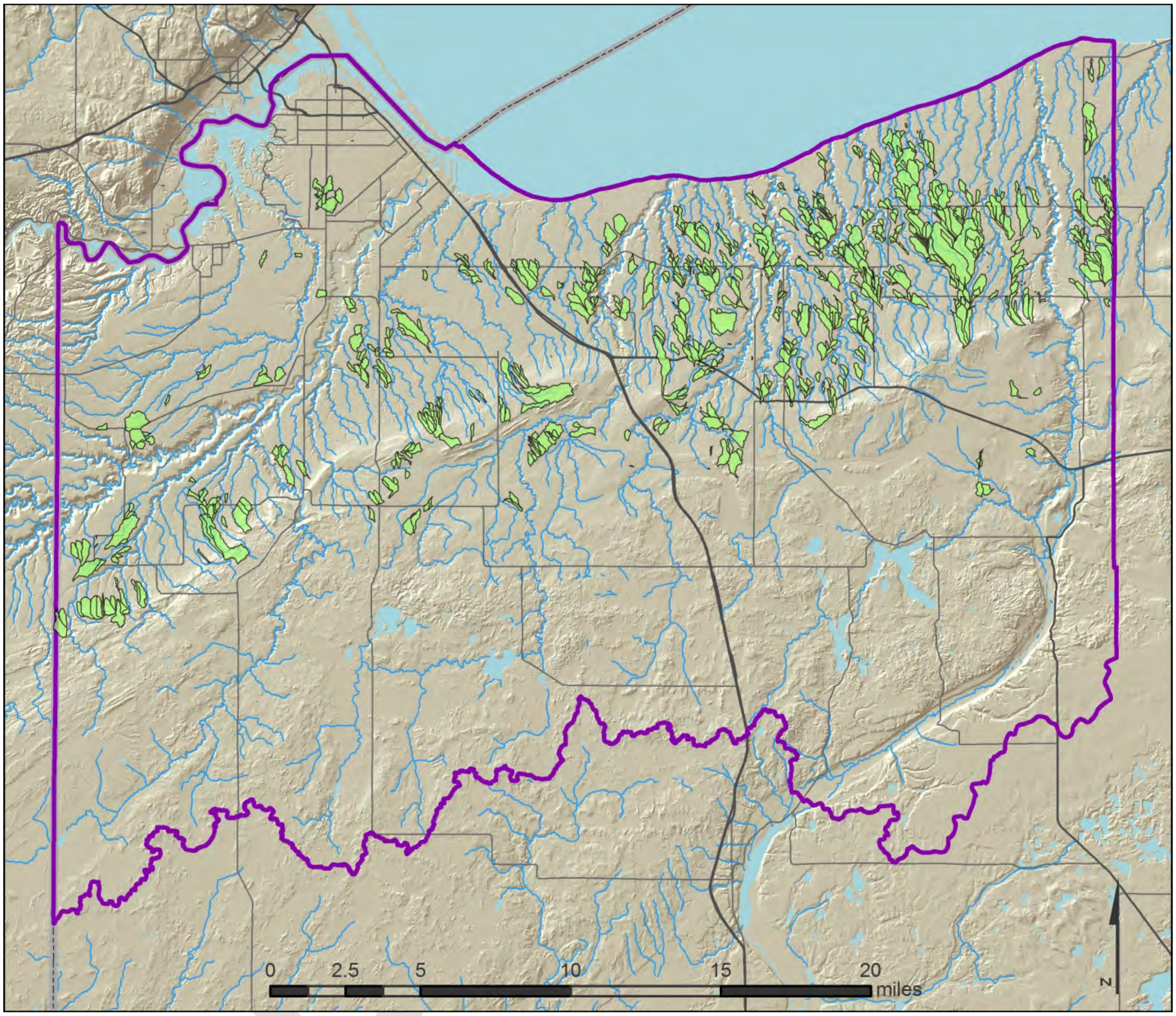

Figure 17. PRW representative catchments (green polygons) created to represent catchments of viable or possibly viable PRW polygons in the clay plain portion of the DC LSB. These were created from a 10-meter DEM; it is recommended to re-run these once high resolution elevation (e.g., from LiDAR) data are collected and become available.

Ditches & Drainage Paths

The ditches and drainage paths were found to be most concentrated in the eastern portion of the clay plain portion of the study area (Figure 25). They often drain agricultural fields to the nearest roadside ditch or stream. An attempt was made to characterized these ditches & drainage paths in order to differentiate between channelized ditches and natural or semi-natural drainage paths. In some cases it was found that drainages might even be intermittent streams not captured in the WI DNR 24K hydro flowline data.

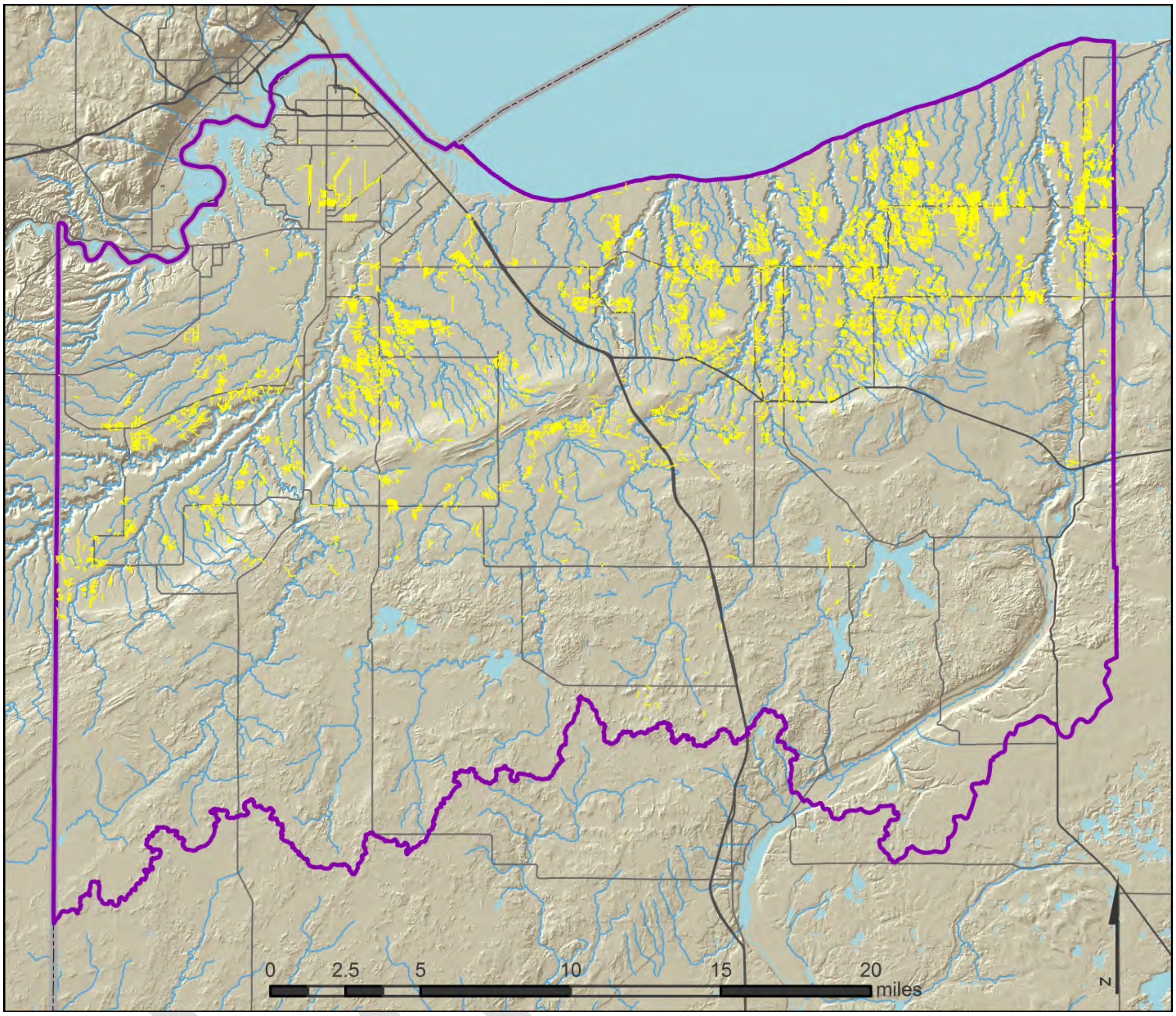

Figure 18. General distribution of ditches (yellow lines) in the DC LSB. Note: some of these “ditches” are likely relatively shallow and include some semi-natural drainage paths that have been enhanced in order to reduce surface ponding.

Figure 19. Ground view of shallow, parallel agricultural ditches (indicated by white arrows) draining to nearby roadside ditch.

Figure 20. Ground view of roadside ditch conveying water during spring snow melt in April 2014. The shallow agricultural ditches shown in Figure 26 are seen in the upper left of this photo; they drain into this roadside ditch.

Potential Restorable Stream Reaches (PRSRs)

PRSRs were generally found to be more common in the agricultural areas of the clay plain in the study area and especially more common on first order streams. The general distribution of these stream reaches are indicated in Figure 22. Additional information regarding the composition of different riparian vegetation along these segments, evidence of grazing, and other information can be queried by data users. It is important to note that this dataset identifies an initial indication of riparian health based only on aerial photo interpretation (i.e., what can be detected in the aerial photo). This is primarily woody riparian vegetation density, land use, evidence of channelization, grazing in the riparian zone, etc. This layer does not identify channel incision or other river or stream morphological characteristics important in understanding erosion susceptibility for example.

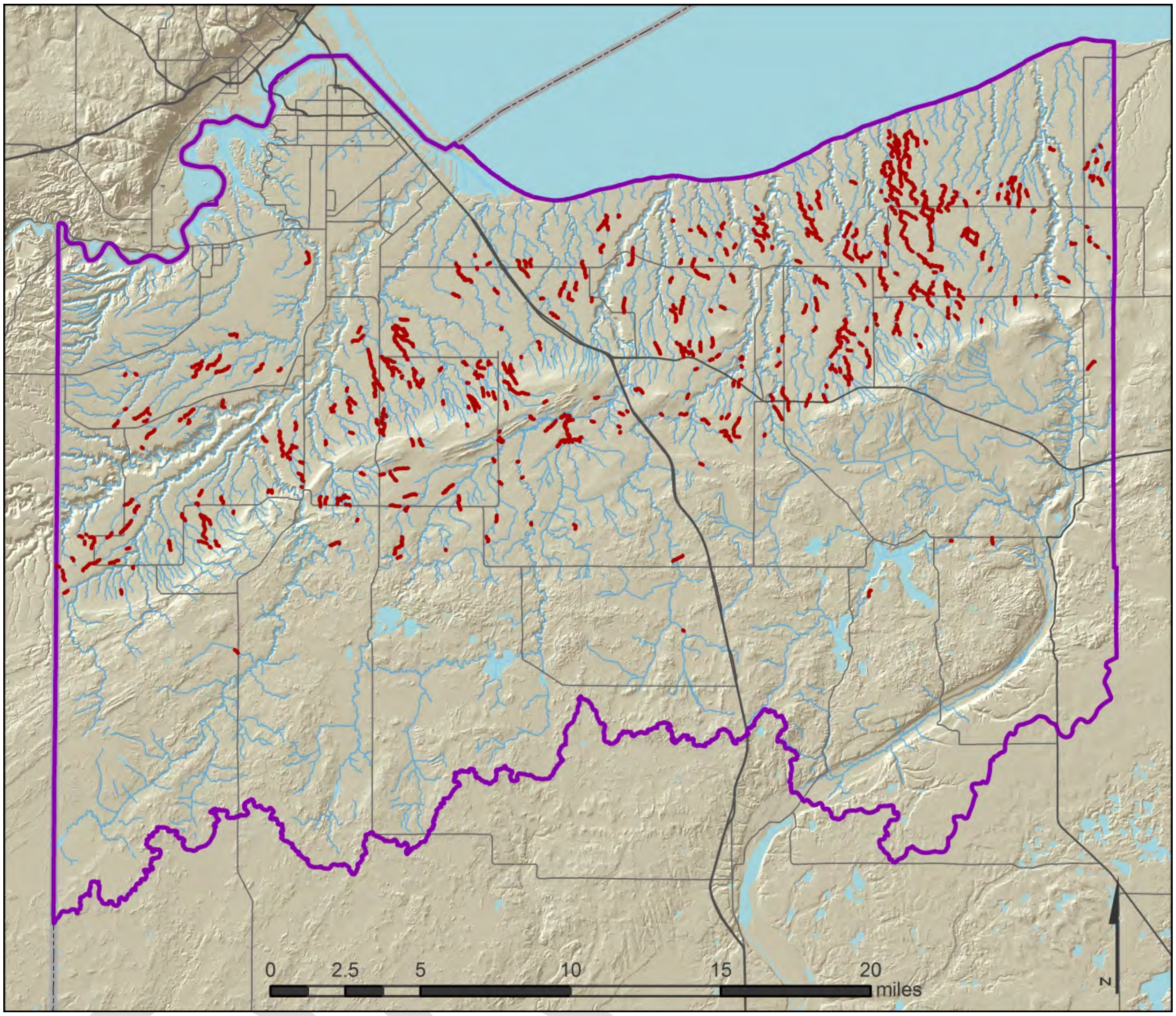

Figure 21. General distribution of potential restorable stream reaches (PRSRs) (dark red) identified in the DC LSB.

An example of a perennial stream reach in the study area which has evidence of livestock grazing in the riparian zone is provided in a ground view in Figure 29 and an aerial view in Figure 30. In the PRSR data this stream reach's riparian area was considered to have "no woody riparian vegetation" and the riparian zone was affected by active livestock grazing.

Figure 22. Ground–level view of a grazed riparian zone along an intermittent stream. Notice some hummocks created by livestock hooves (process referred to as “pugging”). Shown here during spring snow melt (April 2014).

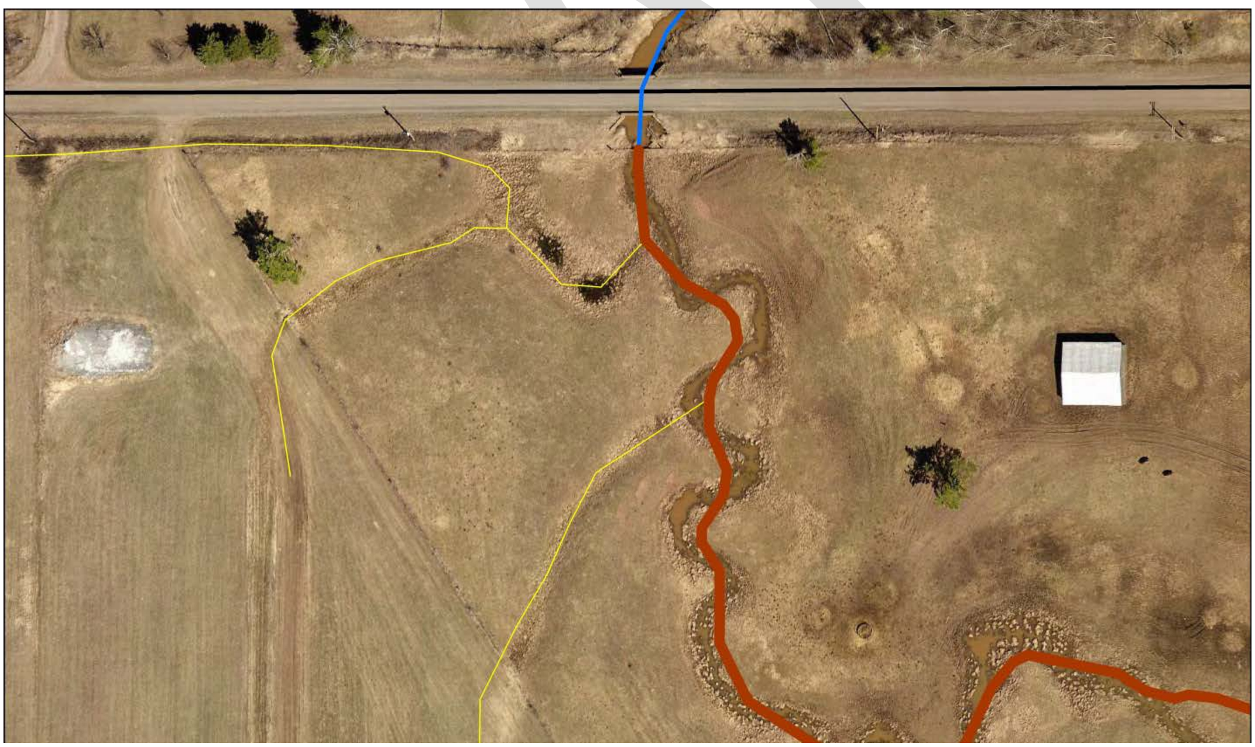

Figure 23. Aerial view of the same grazed riparian area of an unnamed perennial stream identified as a PRSR (maroon line) in April 2013. The above photo was taken from the road facing the south (upstream in this north flowing stream). Notice the drainage ways (yellow lines) coming into the stream from the left side of the photo.

Another example of a grazed stream bank and riparian zone in a woodland area is shown as a ground-level view in Figure 31 and an aerial view in Figure 32.

Figure 24. Ground-level view of a grazed stream riparian zone. Notice the small stream banks affected by livestock. Photo taken in July, 2014.

Figure 25. Aerial view of a grazed stream riparian zone during April, 2013. This segment was identified as a PRSR (maroon line). In this case, the stream is identified as an unnamed perennial stream in the WI NDR Hydro data. The photo in Figure 31 was taken from the road facing north (towards the top of this figure).

Chapter 4 - Discussion

Wetlands in Watershed Planning Context

The primary goal of this wetlands assessment was to describe existing wetland conditions in order to provide more detailed information that can inform decisions regarding wetland preservation, restoration, enhancement, and creation. That is, the data resulting from this effort will allow local planning participants to begin to “determine possible areas in which to restore, enhance, or create wetlands to address watershed plan goals related to water quality, hydrologic alteration, and habitat loss.” (EPA 2013, pg. 14). The working definitions of these terms as per EPA (2013) are as follows:

- **Preservation** is the act of protecting and maintaining existing wetlands or protecting a wetland through implementation of appropriate legal mechanisms (EPA 2013).

- **Restoration** is the reestablishment of a wetland in an area that was formerly a natural wetland or the rehabilitation of historic functions to a degraded wetland (EPA 2013).

- **Enhancement** is increasing one or more of the functions performed by an existing wetland beyond what currently exist in the wetland. *NOTE: there is often n accompanying decrease in other functions*. (EPA 2013).

- **Creation** means establishing a wetland where one did not exist previously. Note that for the purposes of this Supplement, *creation* does not include constructed wetlands to treat effluent (EPA 2013).

Watershed Plan Goals

The primary watershed issue, a long-rocognized problem in the greater Lake Superior Basin, that should be considered when examining this wetland information and incorporating it into land and water plans is the problem of increased peak flows and the increases in flood damage, erosion, and sedimentation often accompanying these high flows. While, erosion and sedimentation are part of natural processes in rivers and streams, especially in the relativley low permeable clay soils in the basin, human-alterations to the land have greatly exacerbated erosion and sedimentation. Alterations to land cover and even manipulation of the land surface itself have caused water to flow even more quickly off the land (i.e., increased peak flows), thereby increasing erosion and sedimentation rates in streams (Schultz et al. 2007). High water volumes and velocities enter stream and river channels causing their bed and banks to erode. Today the area is still experiencing lasting effects of past land practices, mainly turn of the 20th century logging and subsequent fires and the land clearing, leveling, and ditching used in intensive agriculture. Of course, peak flows and the associated erosion and sedimentation is still influenced by present-day land management practices (i.e., the amount of “open” land in a given watershed).

Locating potential wetland restoration sites may depend a bit on what the intended outcomes of the restoration are. That is, if one of the primary goals of restoration efforts is to reduce peak flows, thereby reducing “flooding”, then large depressions in forested areas would likely be the most preferable locations (Gamble et al. 2007). These areas would need to empty and fill with water repeatedly, maximizing water storage. However, if restoration goals are to fit a wide variety of intedended functions, then individual restoration plans might look very different.

A significant portion of the Bear-Trap Nemadji 8-digit HUC (containing, for example, the Middle Nemadji River 10-digit HUC) overlaps the MN/WI border and the majority of the St. Louis River 8-digit HUC falls within the state of Minnesota but contains the estuarine portions of this study area. Not examining the water resources across the state border is counter the "watershed" approach that is to consider the locations, abundance, and conditions of aquatic resources such as wetlands across an entire watershed regardless of the political boundaries that may divide a given watershed (Sumner 2004). Having the whole watershed is important in order to understand how those aquatic resources function and contribute to watershed goals (Sumner 2004). Therefore, it is recommended that for the subwatersheds that cross the MN/WI boundary, wetland and hydrologic information be mapped and analyzed in MN as well to create a true watershed perspective.

Present-Day Wetlands & Predicted Functions (NWIplus w/functions)

Data Use & Limitations

Wetland functions for each of the wetland polygons are based on the particular wetland's Cowardin classification and the LLWW classification system (together referred to as NWIplus). Both the Cowardin and the LLWW classifications have been interpreted from remotely-sensed information (aerial photography, digital elevation models, existing hydrography data, and some additional topographic GIS products). The NWIplus wetland dataset provides the location of different wetland types and, based on their classification, whether they're predicted to be significant for a particular function. If they are predicted to be significant for a particular function, then they are broken into two levels, high or moderate. So, based on the wetland classification, one wetland type might be predicted to perform a function at a high level in comparison to other wetlands types, whereas another wetland might not be predicted to be particularly significant for a given function and therefore is not rated as either high or moderate. In this case the polygon or tabular record with contain a NULL value in the field for that particular function.

It is important to note that this later scenario is not to be confused with an assumption that the wetland type does not perform that particular function at all, rather, compared to other wetland types, the wetland is not predicted to be particularly significant for that function. For example, Cowardin classifications such as palustrine - scrub shrub - deciduous - saturated water regime or other variations of vegetation (e.g., PSS1B, PFO1B, PFO1/SS1B) with an LLWW classification of Terene - Flat - Outflow Intermittent - Drains to Stream (TEFLOIds) are very common wetland types in the clay plain. These wetland types are not predicted to perform surface water detention at a high or moderate level, given that they are generally wetlands with saturated mineral clay soil and compared with many other wetland types they don't have the ability to detain significant surface water. However, that does not mean that they don't detain any surface water. In fact, if one were to create an alternative land cover scenario where a PSS1B, TEFLOIds wetland is cleared of vegetation, the land leveled, and surface drainage ditches added to actively grow and cut hay or pasture the area, there would certainly be an increase of runoff from this area (i.e., a reduced ability to detain surface water). Additionally, taken together, these wetlands would be predicted to have a very significant cumulative effect on runoff rates, depending on the ground conditions and the given precipitation event.

Potential Preservation Priorities

The NWIplus data could be used to create wetland preservation priorities in the study area by looking at priority functions. Additionally, if the explicit boundaries of wetlands already considered by some assessments by various groups were defined, they could be identified in the NWIplus wetland database using possible added tabular field. For example, Merryfield et al. Ecologically Significant Primary "Coastal" Wetlands in Douglas County (Merryfield 2000.

Red Clay Complex Wetlands

The Wisconsin Wetland Inventory (WWI) uses special modifiers in their classification codes. One such code that has particular importance in terms of further understanding the way wetlands in the clay plain are often mapped, the question of where potential restoration opportunities might be, and our ability to predict wetland functions is the "**r**" special modifier or "red clay complex." The WWI classification defines this as:

> *"Wetland mapping units bearing this modifier occur mainly on old lake plains adjoining Lake Superior, where small areas of wet and dry clay soils are so intermingled that they cannot be delineated individually*." (WI DNR 1992)

These wetlands are mapped over large areas in the clay plain in the DC LSB (Figure 26). Figure 27 provides a close-up aerial view of some of these red clay complex wetlands immediately adjacent an active agricultural field with shallow surface ditching. This example may suggest a couple of possible scenarios: 1) as mentioned by local wetland experts, if the vegetation is allowed to come back, then much of the land in the clay plain reverts to wetlands. That is, if the land is no longer cut for hay or grazed, hydrophytic vegetation quickly recolonizes most sites in the clay plain; or 2) the parcel mapped as a mix of scrub shrub and forested wetland is really a mosaic of wetlands and uplands based on micro-topography. However, this mosaic of uplands and wetlands is unrealistic to map at such a fine scale. Instead, much like the aggregation of soil types into soil map units (i.e., soil complexes) in the county's NRCS soil survey GIS data, many of the wetlands in the clay plain are mapped as clay complexes ("r" in the WWI classification). It is likely that a combination of this is true; that many of these wetlands have significant upland inclusions and that while wetland vegetation would certainly recolonize most fields left fallow, it is unlikely that the entire field would revert to wetland. Micro-topographic position is a very significant determinant of wetland / upland boundaries in the clay plain; in these areas, the wetland/upland boundary might be determined by a matter of a few inches in local elevation.

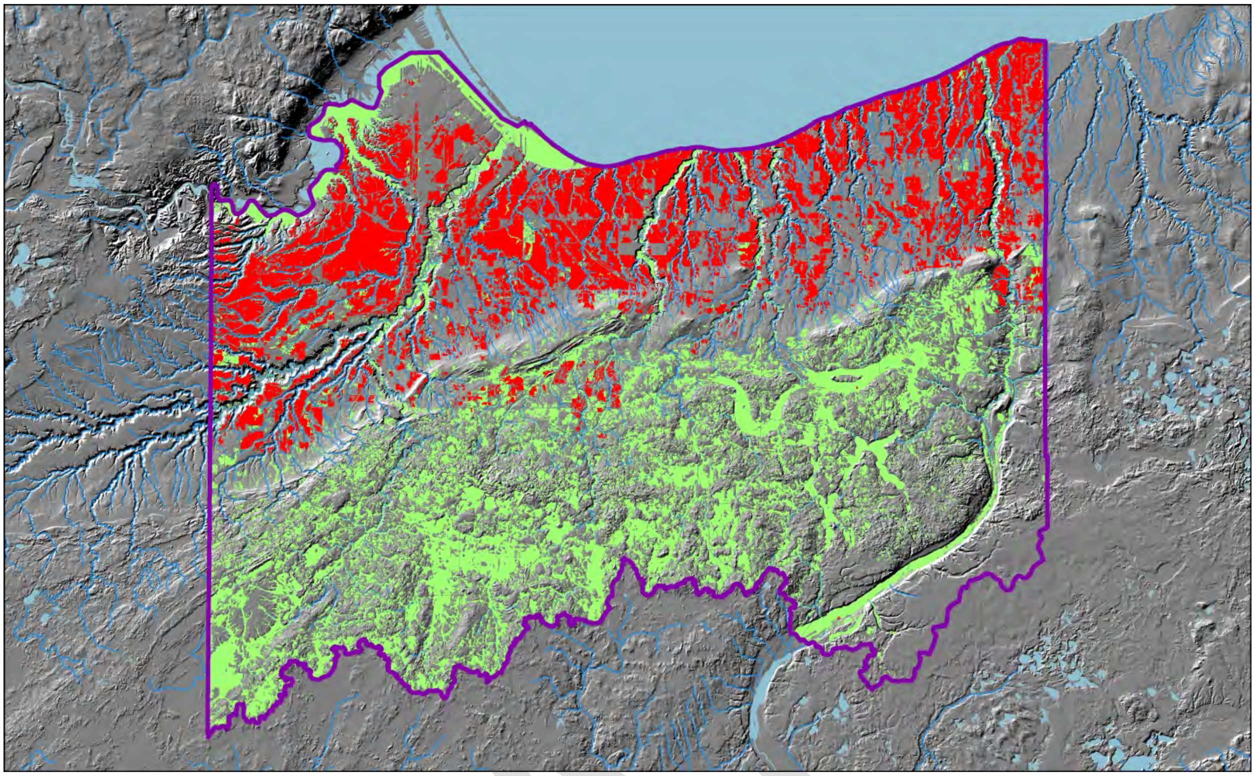

Figure 26. General distribution of red clay complex wetlands identified with an “r” in the special modifier of the WWI classification codes (red polygons) and all other wetlands (light green polygons) in the DC LSB.

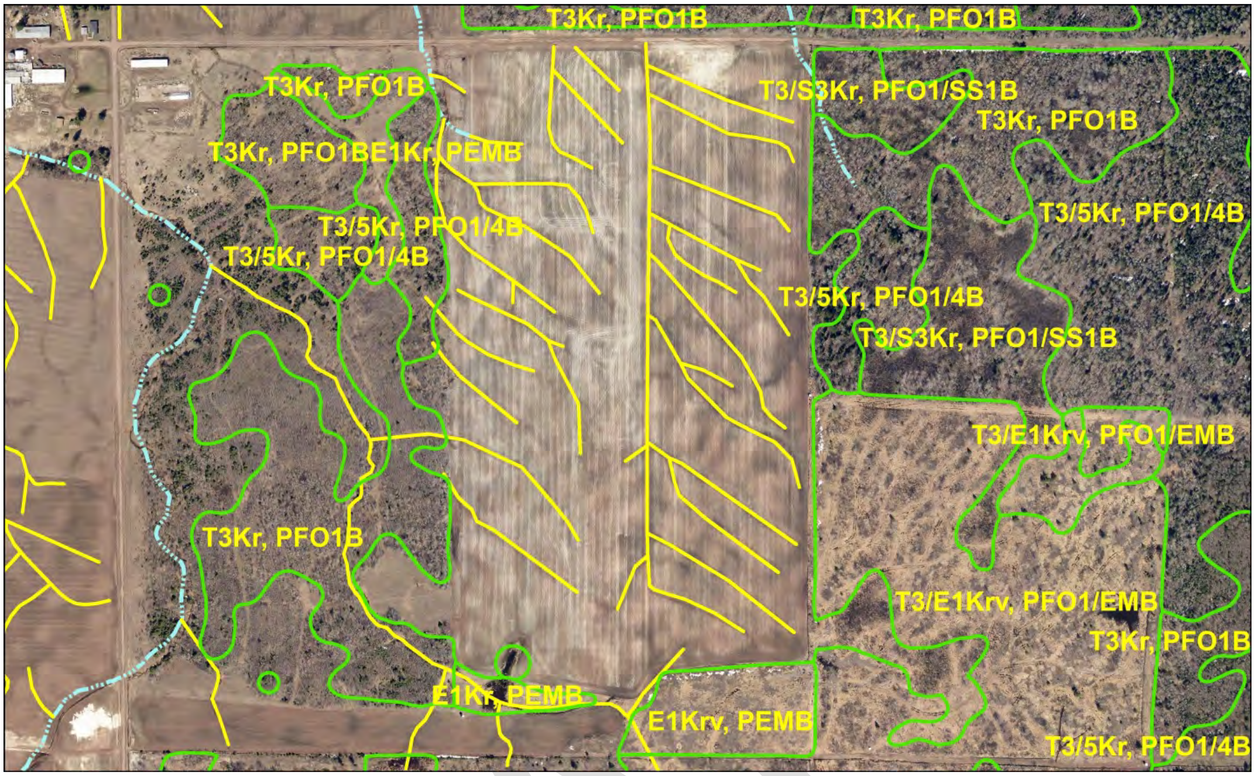

Figure 27. Examples of red clay complex wetlands (green outlined polygons) nearly surrounding an agricultural field with a dense network of ditches (yellow lines).

For the purposes of this wetland functional assessment, specifically the conversion of WWI codes to NWI codes, these red clay complex wetlands were dealt with by using an assumption about their overall water regime. Most of the wetlands with the “r” special modifier were some combination of forested, scrub shrub, or in some cases an emergent wetland typically with a K water regime (i.e., “wet soil” according to WWI). These were converted to a B water regime or “saturated” in the Cowardin classification (NWI). It is likely that if a given red clay wetland (e.g., T3/S3Kr) were to be delineated in the field it may often actually contains pockets of wetter scrub shrub (PSS1C), some uplands, and other flatter saturated forested areas. The “micro depressions” may contain standing water for a large part of the growing season and then at minimum stay saturated because of the high clay contact throughout the entire growing season. They might only dry out during very dry periods. Given the complex nature of these wetlands, the best representation of the water regime for these type of wetlands is assumed to be saturated (B). This is important to note as the water regime is an important piece often directly or indirectly determining the wetlands functional assignment high, moderate, or not significant (i.e., NULL).

Potential Wetland Restoration Opportunities

Wetland Re-Establishment/Creation – PRW GIS layers

The two critical PRW layers in terms of identifying potential wetland re-establishment or possibly wetland creation sites are the clay plain PRWs and the outside the clay plain PRWs. These two datasets represent the population of all potentially restorable wetlands locations as represented by polygons. They are based on the slightly different methods; the “clay plain area” PRWs represent a combination of select set of soil map units and topographic characteristics minus present-day wetland boundaries and incompatible land uses, and the “outside the clay plain” PRWs are primarily hydric soils minus present day wetland boundaries and incompatible land uses. One might consider these two PRW polygons as the population of “former wetlands”, however the precise location, extent, and therefore, true area of former wetlands is unclear because of the area’s unique geologic history and complex soil conditions. A highly confident estimate of total wetland area loss it is not possible. It is likely that many of these PRW polygons represent areas that were once red-clay complex wetlands which were likely a mosaic of uplands and wetlands driven in large part by micro topography. However, these PRW polygons represent an initial approach through GIS-models to identifying potential wetland restoration sites. These PRW polygons can be considered potential opportunities for wetland re-establishment (i.e., former wetland), but they might also be considered potential wetland creation sites since it isn’t possible in most cases to know exactly where former (pre-European settlement) wetlands existed.

In comparing the two PRW polygon layers, the clay plain PRWs are assumed to more often represent actual opportunities (suitable soils and topographic characteristics with evidence of hydrologic alteration) compared with the PRWs outside the clay plain which generally appear to be the result of mapping discrepancies. That is, most PRW polygons identified outside of the clay plain appear to be the result of minor differences in the horizontal position accuracy of one or both of the datasets, soil map units and/or wetlands boundaries. Very few situations have land use suggestive of hydrologic alteration or where there is direct visual evidence of hydrologic alteration in the form of visible ditches. Very often the PRW polygons found outside the clay plain are in forested or recently harvested areas (<15 yrs old as of 2010 – according to the open/impervious lands layer). In these cases it is more likely that a given wetland extent is a bit under mapped or soil data is not precise enough to capture the line between wetland and upland (in this case hydric or partially hydric vs non-hydric). PRWs in the clay plain are assumed to be more likely to represent viable restoration sites because this area has seen far more direct hydrologic alteration from land-leveling, ditching, and enhancement of existing swales to promote the removal of surface ponding and ultimately promote agricultural production. Figure 28 provides an example of PRW polygons found outside of the clay plain that appear to be simply mapping discrepancies were the boundaries of the existing wetlands are quite close to the sliver-shaped PRW polygons.

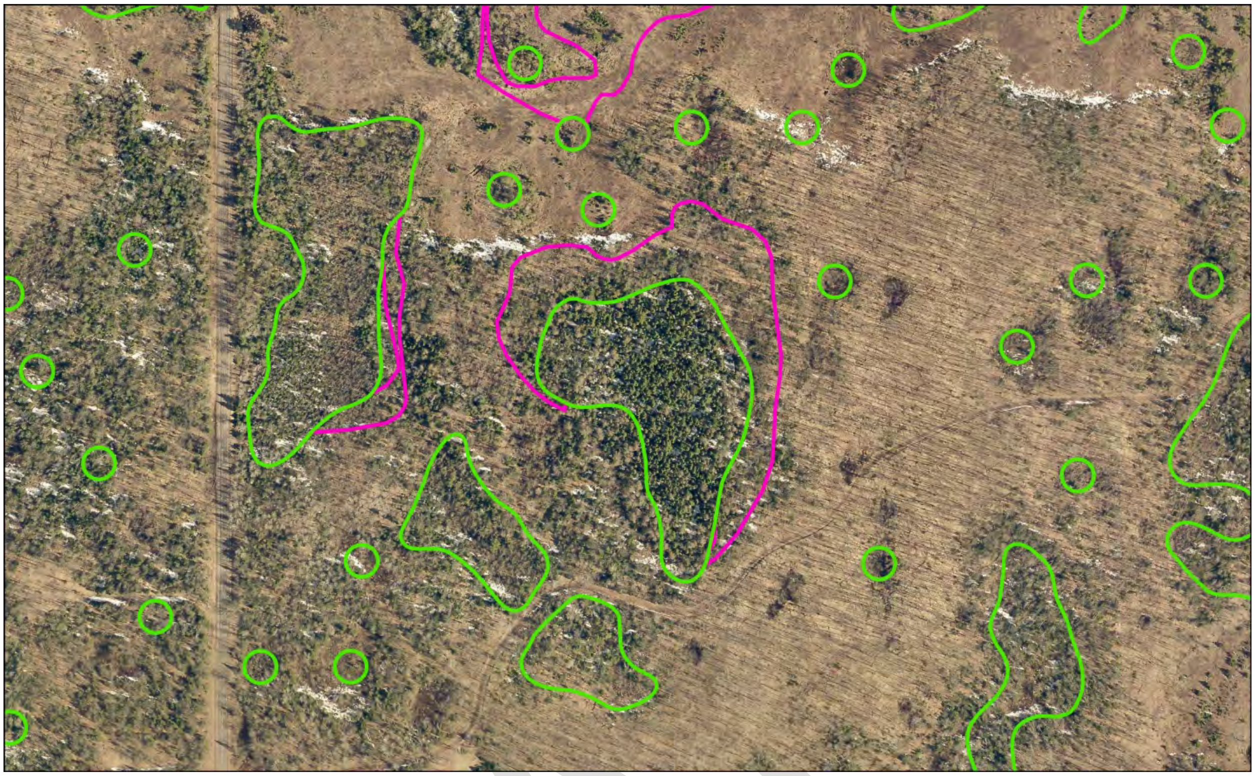

Figure 28. An example of WWI mapped wetlands (green outlines) vs. PRWs (pink outlines) outside the clay plain. Notice that the PRW polygons (pink) closely mirror the shape of the mapped wetland boundaries (green). The vast majority of these PRWs, created from hydric soil map units, are likely not viable wetland re-establishment or creation opportunities, rather mapping discrepancies between the two datasets (WWI and SURRGO soil map units).

The PRW layers contain a large number of polygons, but it is assumed that many of these are either too small to represent viable opportunities to re-establish wetlands or as mentioned, are actually the result of some mapping discrepancy or imprecision. Therefore the data needed further filtering. To accomplish this, the top 300 largest PRW polygons in the clay plain were individually examined in a GIS using the April 2013 high-resolution aerial photography, and supporting "layers of evidence" such as the interpreted ditches layer, the 2010 open/impervious lands layer from Community GIS Inc., and the WI DNR 24K hydro flowline data. Additionally, some PRW polygons where assessed which were situated as a concentration of smaller PRW polygons and where there was some evidence of ditching. These polygons were reviewed and categorized based on their interpreted/predicted viability for supporting wetland re-establishment or creation efforts. Three categories were used: "likely viable", "possibly viable", and "not likely viable". All other PRW polygons not specifically examined in aerial photography were labeled "not examined".

The PRW polygons consider "likely viable" or "possibly viable" represent a further narrowing of the large number of possible wetland restoration sites (represented by polygons). For these PRW polygons two additional steps were experimented with in order to represent potential restoration sites in a different way. First, pour points or primary outflow points of each of the likely viable and possibly viable PRWs were interpreted using aerial photography, a synthetic flowline network, and a hill-shade created from the 10-meter DEM. These pour points were then used to create catchments (subwatersheds) using an ESRI ArcGIS tool. These "representative" catchments could serve as a way to understand more about the individual characteristics of each of the PRWs and their primary, predicted outflow points (i.e., pour points). These catchments were created by using a watershed tool in a GIS and the dataset is limited by the fairly coarse resolution of the available 10-meter DEM. Therefore caution should be employed when using this layer to make watershed decisions. In fact, it is highly recommended that at minimum the pour points be reinterpreted and new catchments determined once high resolution elevation data becomes available in the future.

Data Use & Limitations

PRWs as defined by the methods in this assessment are only intended to represent potential opportunities for re-establishing wetlands in areas where indications suggest they likely existed before hydrologic alterations were made. However, there are some notable limitations to this process given the available data. For example, ditches may be present in many of the forested areas in the study area, however, they are not typically visible in the spring 2013 aerial photography. In these areas, viable PRWs may exist, but the lack of highly precise elevation data may prevent them from be identified.

Possible Queries & Future Use

Another type of wetland restoration is rehabilitation; this is where various wetland functions in existing wetland are uplifted through some alteration (e.g., hydrologic, vegetation composition, etc.). These could be wetlands that are not performing a particular function because they are in some way degraded or experience some sort of hydrologic alteration. This is different from the intended re-establishment type of restoration that is identified with the PRW layers created for this project. However, it is possible to use the NWIplus data w/functions (i.e., present day wetland boundary data) to provide some indication of which wetlands might be examined further for the possibility of wetland rehabilitation activities (i.e., wetlands that might be worthy of further investigation using additional GIS data or even initial site-level investigations).

Some attributes already contained in the NWIplus wetland database from this project might be relevant to identifying wetland rehabilitation opportunities. First, wetlands that are not predicted to be particularly significant for a given function might be worthy of further investigation. For example if, a wetland polygon (a single tabular record) might have a Null in the SWD (Surface Water Detention) field, indicating that, based on the classification or spatial characteristics of that polygon, the wetland is not predicted to be particularly significant for that function, compared with other wetland types. These wetlands might be considered as possible sites where, after field investigations, the wetland might be altered in such a way to increase the wetlands ability detain more surface water, for example.

In addition to querying the NWIplus dataset for functions that might be not predicted to be particularly signification for a given wetland function (i.e., NULL), some additional fields contained in the database might provide a data user a way to narrow the list of wetlands worthy of further investigation in regards to wetland rehabilitation opportunities (i.e., actions completed to change some function or set of functions that a particular wetland or wetland area might provide). Three such fields may have some relevance in this manner: 1) wetlands identified as grazed (where the field heading *Grazed* = 1); 2) vegetation recently removed from a wetland (where the field heanding *v_removed* = 1); or 3) wetlands interpreted to be severely human influenced (*LLWW* LIKE '%hi%', where *hi* means human induced). Wetlands that are noted as being grazed may have some experience some reduced abilities to detain surface water, retain sediment, or stabilize shoreline (stream banks), for example.

Potential Restorable Stream Reaches

This PRSR layer was created to provide an initial identification of stream reaches along which conditions might be improved through best management practices (BMPs). For example, if a stream reach was interpreted to have active grazing along its banks and riparian zone, fencing the riparian area or at least managing livestock to reduce damage to stream banks might be considered. Similarly, if a stream reach was considered channelized, it might be further examined in the field and considered as a possible wetland rehabilitation site. For example, a wetland might have a channelized stream segment that conveys water more quickly through or out of it and depending on the individual scenario, the reach might be altered to restore natural stream meander and possibly some of the functions of adjacent wetlands.

Future Data Needs

LiDAR-derived Elevation Data

Light Detection and Ranging (LiDAR) is data collection method in the realm of remote sensing which incorporates the use of light in the form of laser pulses to measure ranges or variable distances to the surface of the earth. When this distance information is combined with airborne global positioning information, the data are used to create precise three-dimensional information (i.e., digital topographic or elevation information or other surface characteristics like vegetation height). The bare ground DEM (digital elevation models) created as outputs of this type of data collection would greatly enhance the precision in mapping existing wetlands, predicting wetland functions, and identifying potentially restorable wetland locations. Specifically the data could further understanding about the surface hydrology characteristics, increasing hydrologic modeling precision by, for example, locating old ditches under forested or scrub-shrub canopies undetectable in even the high resolution 2013 aerial photography of Douglas County. However, it is worth noting that the high resolution DEMs resulting from most LiDAR collected elevation data also present other challenges not especially problematic in coarser resolution DEMs. High resolution, LiDAR-derived DEMs need to be hydro-conditioned or hydro-enforced such that the elevations of artificial flow impediments like roads are changed to simulate surface flow connectivity important in many hydrological modeling exercises (Poppenga et al. 2014). This hydro-conditioning can require significant technical knowledge and might require a significant amount of time to complete.

Stream/River Bank Assessment – LiDAR Data

While the PRSR GIS layer acts as an initial identification of potential stream bank and riparian zone issues across the study area, it doesn't begin to identify river banks susceptible to mass wasting and erosion. These areas are not discernable in the high resolution aerial photography and the 10-meter DEM is not sensitive enough to begin to accurately zero in on them. An effort to identify these erosion prone areas would be greatly enhanced by the elevation precision provided in many a LiDAR-derived DEMs.

Springs and Seep Locations

If further wetland work is to be completed in the future, it is recommended that known locations of springs and seeps in the study area be incorporated into the LLWW attribution in order to more accurately determine which wetlands might be spring-fed (**sf**), or their Water Flow Path is ground water dominated (**gd**).

Shreve Stream order

It is recommended that a Shreve stream order be used to define headwater wetland areas. This stream order method is more representative of relative stream discharge because it is additive in nature where two first order streams come together to create a second order and if another first order comes into that second order stream, then the subsequent segment becomes a third order, and so on. However, this would require some investigation and consultation with an area hydrologist to determine a meaningful break point in the Shreve Order in terms of defining the headwater/non headwater boundary.

Indications of Former Wetlands - Wisconsin Land Economic Inventory (i.e., Bordner Survey)

Another "layer of evidence" in created a PRW GIS model or decision tree might be the use of the Wisconsin Land Economic Inventory. This was a survey completed circa the Great Depression era (1930s) in which field surveys mapped current land use and land cover across most of the state of Wisconsin. This inventory, often referred to as Bordner Survey maps could be digitally converted and land cover classes relevant to wetlands could be extracted from them.

Possible Future Additions to the Wetland Database (NWIplus wetlands)

Additional fields might be added to the NWIplus wetland dataset to further enhance data users' ability to query different information from it. For example, if precise geographic extents were available for the wetlands that are already considered to be ecologically significant according to Merryfield et al (2000) (Appendix I), a simple field heading could be added to the database to identify these wetland polygons. They might be a considered as a possible first cut of wetlands that would receive prioritization in terms of preservation or wetlands adjacent to them, for example. Another enhancement that could be incorporated directly into the NWIplus cods, specifically in the LLWW codes is the use of an additional special modifier called abandoned agriculture (former farmed wetland now regenerating), coded as "aa". This might be completed in a semi-automated fashion by using the transitional agriculture codes.

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Note: Cross-references to this literature also appear in the Appendices of this document.

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Appendices

Appendix A. Land Type Association Descriptions.

The Wisconsin Land Type Association ecological information listed here depicts subregional and landscape ecological units developed according to the classification scheme of the NHFEU (Avers et al. 1993).The LTA data was created by the WI LTA project team comprised of governmental, university, and tribal organizations (WI DNR 1999). Only LTAs within the study area are listed here.

Superior Lake Plain (ecological landscape unit)

Douglas Lake-Modified Till Plain (LTA)

Description: The characteristic landform pattern is undulating modified lacustrine moraine with deep v-shaped ravines. Soils are predominantly somewhat poorly drained clay over calcareous clay till or loamy lacustrine. Common habitat types include AbArSn, forested

Soil Associations: Cuttre-Misokai-Aminicom-Anton-Borea

Soil Description: somewhat poorly drained, well drained, and moderately well drained clayey soils with a clay, clay loam, or silt loam surface over calcareous clay till or loamy/sandy lacustrine.

Hydrology: Depth to Aquifer: 20’-50’; Surface Drainage: parallel

Presettlement Vegetation: white spruce, balsam fir, tamarack, white cedar, white birch, aspen (81%); white pine and red pine (8%); water (1%), brush (1%)

Carlton Plains (LTA)

Description: The characteristic landform pattern is undulating outwash plains and lake plains with old beaches and dunes common. Soils are predominantly excessively drained sand over outwash or loamy lacustrine. Common habitat types include hydromesic, ArCo, ACI-V.

Soil Associations: Rubicon-Morganlake-Cublake, Alcona-Annalake-Rousseau

Soil Description: Excessively drained and moderately well drained sandy soils with a sand surface over non-calcareous sand outwash or sandy loam till.

Hydrology: depth to aquifer 20’-50’, surface drainage parallel.

Presettlement Vegetation: white spruce, balsam fir, tamarack, white cedar, white birch, apen (60%); sugar maple, yellow birch, white pine, red pin (22%); white pine, red pine (17%), aspen, white birch, pine (1%).

Northwest Sands (ecological landscape unit)

Bayfield Level Barrens (LTA)

Description: The characteristic landform pattern is nearly level outwash plain. Soils are predominantly excessively drained sand over outwash. Common habitat types include QAc, QGCe, and ArQTr.

Soil Associations: Graling-Rubicon, Loxley-Seelyeville

Soil Description: Excessively drained sandy soils with a sand surface over non-calcarous sand outwash.

Hydrology: depth to aquifer (20'-50'); surface drainage (deranged).

Presettlement Vegetation: water (1%); white spruce, balsam fir, tamarack, white cedar, white birch, aspen (<1%); sugar maple, yellow birch, white pine, red pine (<1%); white pine, red pine (5%); jack pine, scrub oak and barrens (74%); aspen, white birch, pine (<1%); oak – black, white, and burr (2%); brush (3%); swamp conifers – white cedar, black spruce, tamarack, hemlock (12%); lowland harwdwoods – willow, soft maple, box elder, ash elm, cottonwood, river birch (<1%).

Bayfield Rolling Outwash Barrens (LTA)

Description: The characteristic landform pattern is collapsed outwash plain with lakes common. Soils are predominantly excessively drained sand over outwash. Common habitat types include ArQV-Sm, ArWTr, PMV-Po, and QGCe.

Soil Associations: Vilas-Rubicon, Loxley-Dawson

Soil Description: Excessively drained sandy soils with a loamy sand or sand surface over non-calcareous

Hydrology: depth to aquifer (20'-50'), surface drainage (deranged)

Presettlement Vegetation:

Oula Washed Moraine (LTA)

Description: The characteristic landform pattern is undulating outwash plain and moraine. Soils are predominantly excessively drained loamy sand over outwash or acid loamy sand debris flow. Common habitat types include PArV-U, PArVAa-Po, ACl and wetland.

Soil Associations: Vilas-Keweenaw-Sultz

Soil Description: excessively drained and well drained sandy soils with a loamy sand surface over non-calcareous sand outwash, loamy sand till, or loamy lacustrine.

Hydrology: depth to aquifer (20'-50')

Presettlement Vegetation: white spruce, balsam fir, tamarack, white cedar, white birch, aspen (30%); sugar maple, yellow birch, white pine, red pine (37%); white pine, red pine (37 %); aspen, white birch, pine (4%); swamp conifers – white cedar, black spruce, tamarack, hemlock (22%)

Upper Brule-St. Croix Valley (LTA)

Description: The characteristic landform pattern is sloping outwash valley with stream terraces and floodplains common. Soils are predominantly excessively drained sand over acid sand outwash. Common habitat types include ArWV-Sm, ArQTr, foreste lowland, ACI-V

Soil Associations: Rubicon-Sayner-Croswell-Lupton-Gander-Dechamps

Soil Description: excessively drained and moderately well drained sandy soils with a sand or loamy sand surface over non-calcareous sand or gravelly sand outwash, along with very poorly drained nonacid organic soils and moderately well drained and somewhat poorly drained

Hydrology: depth to aquifer (>50'), surface drainage (dendritic)

Presettlement Vegetation: water (3%); white spruce, balsam fir, tamarack, white cedar, white birch, aspen (8%) sugar maple, yellow birch, white pine, red pine (2%); white pine, red pine (37%); jack pine, scrub oak and barrens (23%); aspen, white birch, pine (2%); oak – black, white, and burr (10%); brush (2%); swamp conifers – white cedar, black spruce, tamarack, hemlock (10%)

Northwest Lowlands (ecological landscape unit)

Pattison Moraines (LTA)

Description: The characteristic landform pattern is rolling collapsed moraine. Soils are predominantly well drained sandy loam over acid loamy sand till. Common habitat types include forested lowland, ArCo, AVI-V, and ACI.

Soil Associations: Sarwet-Keweenaw-Moodig-Lupton-Annalake-Pence-Vilas

Soil Description: moderately well drained, well drained, and somewhat poorly drained soils with a sandy loam surface over non-calcareous loamy sand till or loamy lacustrine, along with very poorly drained organic soils, and well drained and excessively drained sandy outwash.

Hydrology: depth to aquifer (20'-50'), surface drainage (deranged)

Presettlement Vegetation: water (1%); white spruce, balsam fir, tamarack, white cedar, white birch, aspen (15%); sugar maple, yellow birch, white pine, red pin (10%); white pine, red pine (25%); aspen, white birch, pine (19%); oak – black, white, and burr (1%); swamp conifers – white cedar, black spruce, tamarack, hemlock (25%)

Dairyland Moraines (LTA)

Description: The characteristic landform pattern is undulating moraine with swamps common. Soils are predominantly moderately well drained sandy loam over acid loamy sand till or igneous/metamorphic bedrock. Common habitat types include forested lowland, hydromesic, AAs, ArAbVCo and ACl.

Soil Associations: Newood-Freeon-Pmroy-Lupton-Metonga

Soil Description: Moderately well drained and well drained loamy and sandy soils with a sandy loam, silt loam, or loamy sand surface over non-calcareous sandy loam dense till, some over igneous/metamorphic bedrock, along with very poorly drained nonacid organic soils.

Hydrology: depth to aquifer (0'-20'); surface drainage (parallel)

Presettlement Vegetation: water (0%); white spruce, balsam fir, tamarack, white cedar, white birch, aspen (2%); sugar maple, yellow birch, white pine, red pine (26%), jack pine, scrub oak and barrens (1%), aspen white birch, pine (31%);

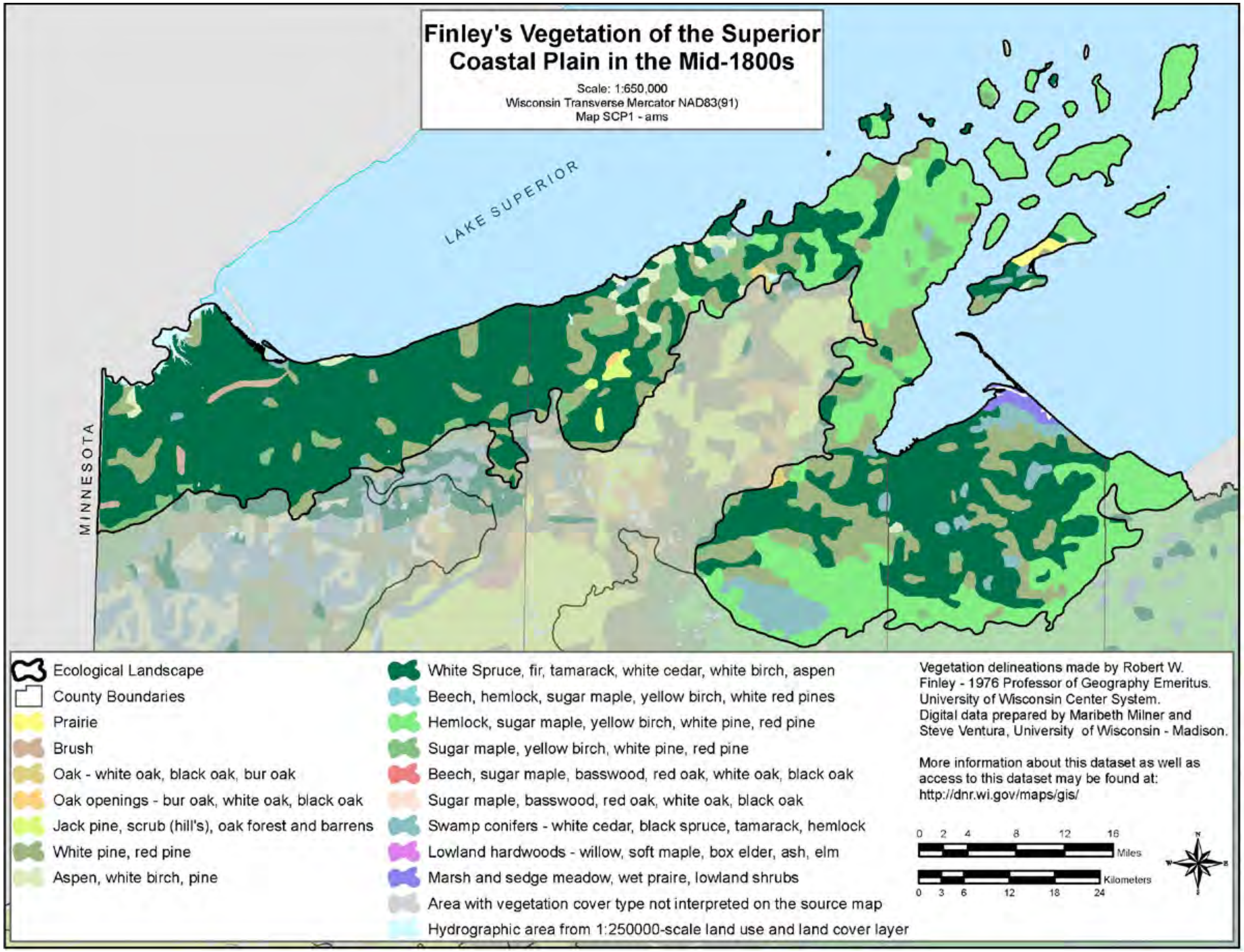
Winneboujou Glacial Trust Hills (LTA)

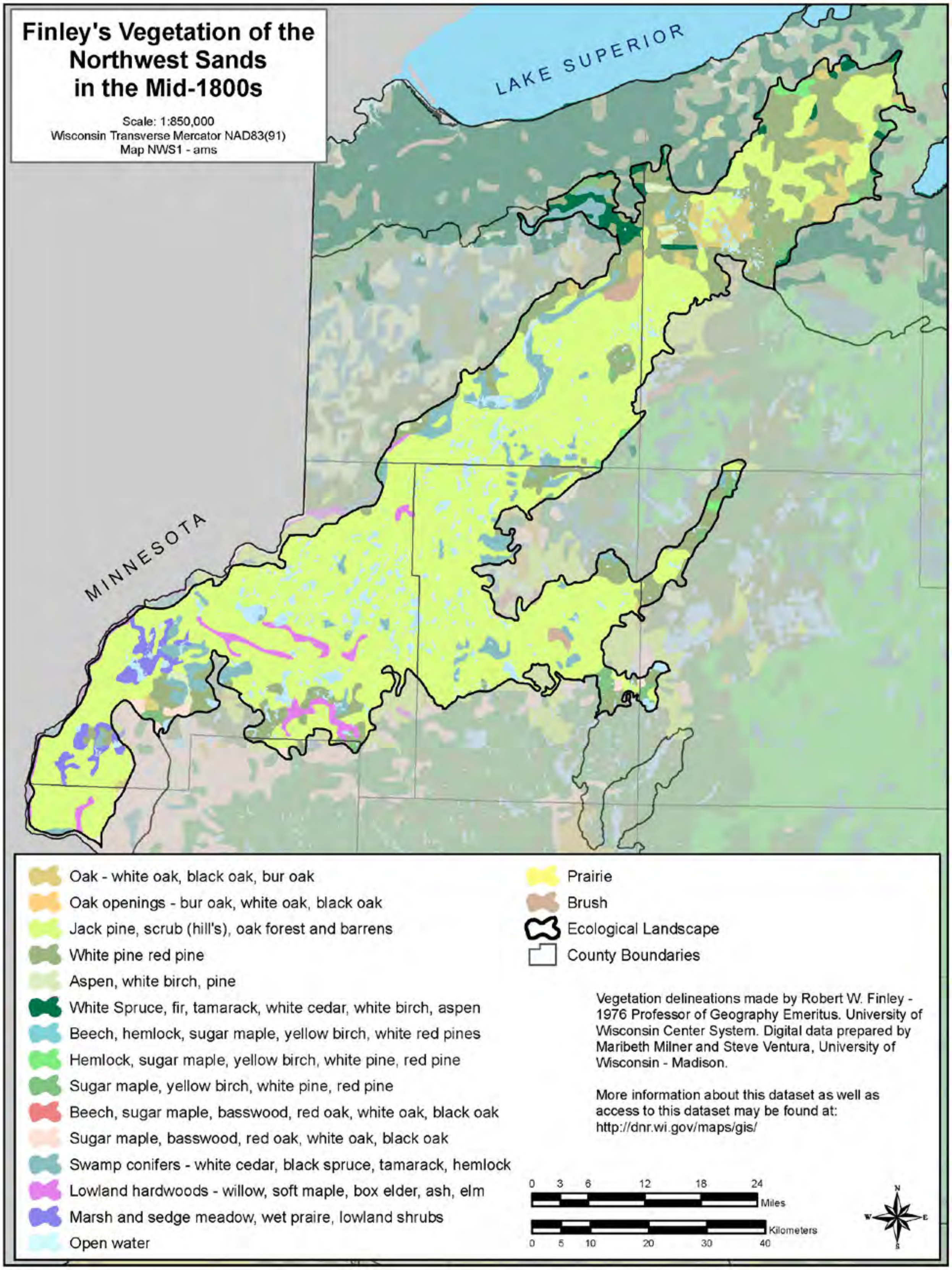
Description: The characteristic landform pattern is rolling glacial thrust mass hills. Soils are predominantly excessively drained loamy sand over outwash or loamy debris flow common habitat types are AAt, ACaCi, and lowland.

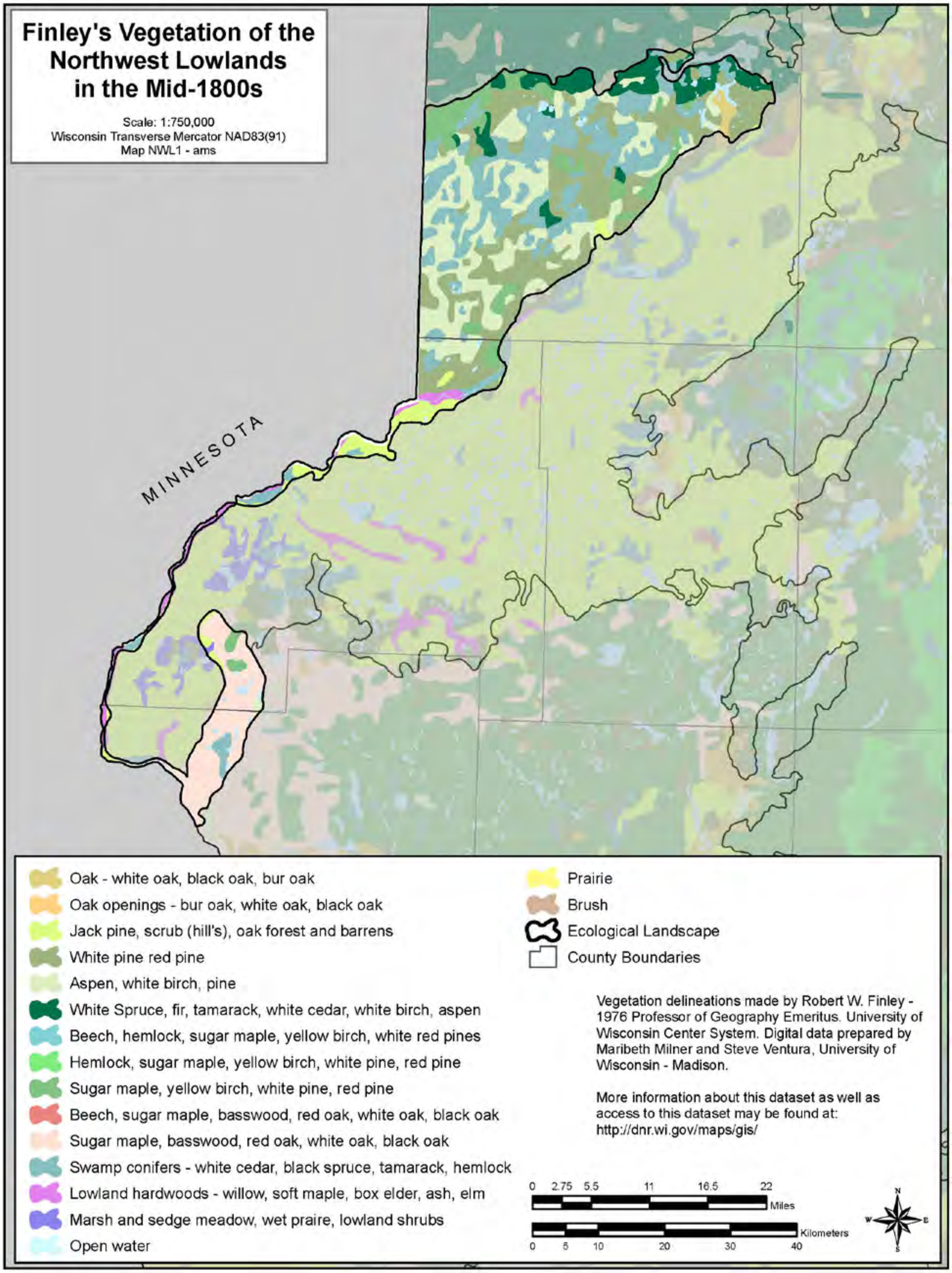
Soil Associations: Vilas-Keweenaw-Sultz Loxley-Dawson

Soil Description: Excessively drained and well drained sandy soils with a loamy sand surface over non-calcareous sand outwash
Hydrology: depth to aquifer (>50'), surface drainage (rectangular)
Presettlement Vegetation: Water (1%); white spruce, balsam fir, tamarack, white cedar, white birch, aspen (4%); white pine, red pint (74%); jack pine, scrub oak and barrens (2%); aspen, white birch, pine (6%); oak – black, white, and burr (13%).

Appendix B. Finley's Vegetation Maps for each Ecological Landscape Unit in the study area (WI DNR 2014).




Finley's Vegetation of the Northwest Sands in the Mid-1800s
Scale: 1:850,000
Wisconsin Transverse Mercator NAD83(91)
Map NWS1 - ams
LAKE SUPERIOR
MINNESOTA
Oak - white oak, black oak, bur oak
Oak openings - bur oak, white oak, black oak
Jack pine, scrub (hill's), oak forest and barrens
White pine red pine
Aspen, white birch, pine
White Spruce, fir, tamarack, white cedar, white birch, aspen
Beech, hemlock, sugar maple, yellow birch, white red pines
Hemlock, sugar maple, yellow birch, white pine, red pine
Sugar maple, yellow birch, white pine, red pine
Beech, sugar maple, basswood, red oak, white oak, black oak
Sugar maple, basswood, red oak, white oak, black oak
Swamp conifers - white cedar, black spruce, tamarack, hemlock
Lowland hardwoods - willow, soft maple, box elder, ash, elm
Marsh and sedge meadow, wet praire, lowland shrubs
Open water
Prairie
Brush
Ecological Landscape
County Boundaries
Vegetation delineations made by Robert W. Finley - 1976 Professor of Geography Emeritus. University of Wisconsin Center System. Digital data prepared by Maribeth Milner and Steve Ventura, University of Wisconsin - Madison.
More information about this dataset as well as access to this dataset may be found at: http://dnr.wi.gov/maps/gis/
0 3 6 12 18 24 Miles
0 5 10 20 30 40 Kilometers


Finley's Vegetation of the Northwest Lowlands in the Mid-1800s
Scale: 1:750,000
Wisconsin Transverse Mercator NAD83(91)
Map NWL1 - ams
MINNESOTA
Oak - white oak, black oak, bur oak
Oak openings - bur oak, white oak, black oak
Jack pine, scrub (hill's), oak forest and barrens
White pine red pine
Aspen, white birch, pine
White Spruce, fir, tamarack, white cedar, white birch, aspen
Beech, hemlock, sugar maple, yellow birch, white red pines
Hemlock, sugar maple, yellow birch, white pine, red pine
Sugar maple, yellow birch, white pine, red pine
Beech, sugar maple, basswood, red oak, white oak, black oak
Sugar maple, basswood, red oak, white oak, black oak
Swamp conifers - white cedar, black spruce, tamarack, hemlock
Lowland hardwoods - willow, soft maple, box elder, ash, elm
Marsh and sedge meadow, wet praire, lowland shrubs
Open water
Prairie
Brush
Ecological Landscape
County Boundaries
Vegetation delineations made by Robert W. Finley - 1976 Professor of Geography Emeritus. University of Wisconsin Center System. Digital data prepared by Maribeth Milner and Steve Ventura, University of Wisconsin - Madison.
More information about this dataset as well as access to this dataset may be found at: http://dnr.wi.gov/maps/gis/
0 2.75 5.5 11 16.5 22
Miles
Kilometers
0 5 10 20 30 40

Appendix C. Open / impervious land use / land cover categories and other land cover categories depicted in Figure 6.

Land Cover/Use	Data source	Description
Water	ESRI U.S. Canada Water Polygons	These include lakes, wider rivers, and the St. Louis River freshwater estuary. They are not mapped in the Open/Impervious GIS layer created by Community GIS.
Beach	Open/Impervious – Community GIS Services Inc.	These areas were onscreen digitized from USDA FSA aerial imagery for the Wisconsin Point area of Lake Superior.
Residential	Open/Impervious – Community GIS Services Inc.	Open rural areas around interpreted residential houses, other structures, and associated land uses
Urban Areas	Open/Impervious – Community GIS Services Inc.	These features are primarily around densely populated areas within the City of Superior.
Commercial Industrial	Open/Impervious – Community GIS Services Inc.	These features are primarily present in the City of Superior. These areas contain a large mix of industrial and commercial land uses.
Utilities	Open/Impervious – Community GIS Services Inc.	These features are approximated buffers of gas lines, pipelines, electrical lines provided by Douglas County GIS. Buffer distances were determined by measured sampling using 2008 USDA FSA aerial imagery.
Extraction Area	Open/Impervious – Community GIS Services Inc.	Interpreted from the 2008 USDA FSA aerial imagery. These features showed evidence of excavation or pitting in the earth surface.
Rail Line	Open/Impervious – Community GIS Services Inc.	25 foot buffer area for rail road lines that were provide by Douglas County GIS
Roadways / driveways	Open/Impervious – Community GIS Services Inc.	Community GIS Services Inc. digitized the driveways and Douglas County GIS provided the road layer. Generic buffer distances for these features were approximated based upon usage amounts. Federal highways were given the highest buffer distances and driveways the least.
Structures	Open/Impervious – Community GIS Services Inc.	These features were onscreen digitized from Douglas county's 2005 leaf off high resolution aerial imagery. Some structures were later added using USDA FSA aerial imagery as a base.
Active Agriculture	Open/Impervious – Community GIS Services Inc.	Open areas that are/can be used for agricultural purposes (primarily hay). These areas that contain little or no trees or shrubs
Transitional Agriculture	Open/Impervious – Community GIS Services Inc.	From the 2008 USDA FSA aerial imagery these features show agricultural lands that are in variable states of transition to forested or wetland areas. Evidence of transitional agriculture are open areas with shrubs and tree adjacent to existing agriculture. Other evidence of transitional agriculture are high amounts of shrubs and some large trees with classic field boundary shapes near rural residential areas.

Timber Harvest (0-15 yrs)	Open/Impervious – Community GIS Services Inc.	To identify timber harvests, color infrared LANDSAT imagery (bands 4,5,3) were rectified to NAD 83 UTM Zone 15 coordinate system. The LandSat of the same path and row and of consecutive years were then compared on a section-by-section basis originally within the Lake Superior Watershed of Wisconsin to identify timber harvests. For example, to identify a timber harvest occurring in 1998, LandSat images from 1997 and 1998 were compared; similarly for a 1999 harvest, LandSat images from 1998 and 1999 were compared. This data was expanded to the entire Douglas County area and updated to 2004. For the years proceeding USDA FSA aerial imagery was used to identify timber harvests using the same methodology as stated above
Forest / Scrub Shrub	*Mask*	In the map depicting land use / land cover, these areas included all areas (except open water) that was not mapped as impervious or open according to the Community GIS Services Inc. data.

Appendix D. Wisconsin Wetland Inventory Classification System Summary

Definitions, Inclusions, Exclusions

The following information on definitions, inclusions, and exclusions is directly from Merryfield (2000).

The Wisconsin Department of Natural Resources has adopted a statutory definition for a wetland, which is "an area where water is at, near or above the land surface long enough to be capable of supporting aquatic or hydrophytic vegetation, and which has soils indicative of wet conditions: [s. 23.32(1), Wis.Stats.]."

The Wisconsin Wetland Inventory (WWI) is a system developed by the Wisconsin DNR (with assistance from the U.S. Fish and Wildlife Service) authorized by the state legislature in 1978. It uses a special classification system for Wisconsin's wetlands and is based on aerial photography. The inventory is at the 1:24,000 scale and identifies wetlands as small as 2-5 acres.

These areas are included in the Wisconsin Wetlands Inventory (WWI):

1. All areas which support the aquatic plant communities as described in *A Manual of Aquatic Plants* (N.C. Fassett, 1940, University of Wisconsin Press.). All Areas which support the following wetland plant communities described in *The Vegetation of Wisconsin* (J.T. Curtis, 1959, University of Wisconsin Press.): wet forests, shrubcarrs, alder thickets, sedge meadows, aquatic communities, wet prairies, fens and open bogs. All areas which support the wetland plant communities listed in Wisconsin DNR's State Hydrophyte List.
2. Wetlands cultivated only during drought years and periods of low water table. These areas must have soils classified by the U.S.D.A. Soil Conservation Service as very poorly or poorly drained and support wetland vegetation during years of normal or high precipitation or periods of normal or high water table.
3. Wetlands where grazing, logging, or harvesting of marsh hay has removed most of the wetland vegetation. These areas must have shallow standing water or saturated soil conditions for significant portions of years having normal precipitation and would be expected to revert to a wetland plant community if left undisturbed.
4. Wetlands which were drained or farmed in the past but have since been abandoned and have reverted to standing water or saturated soil conditions and the wetland plant communities listed in No. 1.
5. All natural or artificial water bodies which have a maximum depth of six feet or less (see exceptions in No. 5-6 next section).
6. All natural or artificial water bodies for which there is no depth information (see exceptions in No. 5-6 next section).
7. Areas of open water or wetland vegetation in sloughs, oxbows and the abandoned and secondary channels of rivers and streams.
8. Beaver ponds or man-made impoundments (six-feet deep or less) on rivers and streams where the main channel is no longer discernible.

9. All cranberry bogs.

The areas excluded by the Wisconsin Wetland Inventory are:

1. Areas of open water or submerged aquatic vegetation in lakes greater than six-feet deep.
2. Areas of flowing open water or submerged aquatic vegetation in the primary channels of rivers and streams.
3. Areas which were wetlands in their natural state but have since been drained or filled as of the date of the interpreted aerial photography.
4. Areas in the floodplain of lakes, rivers, and streams that do not meet the definition of a wetland in section 23.32(1) of the state statutes.
5. All sewage lagoons, manure storage pits, mine waste settling ponds and other manmade waste disposal pits including dredge spoil disposal areas which do not support wetland vegetation.
6. All ponds actively used for mining of gravel or other mineral resources that are unvegetated or support only surface algae.

The Classification

The Wisconsin Wetland Inventory (WWI) classification system uses an approach very similar to the National Wetland Inventory (NWI) for classifying wetlands. Essentially anything mapped in WWI is also included according to NWI. As with NWI, areas supporting hydrophytic vegetation are included. Unlike NWI, WWI does not include any deepwater habitats. If hydrophytes are not present, an area must be classified by the Department of Agriculture's Natural Resource Conservation Service (NRCS) with poorly or very poorly drained soils in order to be included in the WWI. WWI maps to the tallest vegetation present and not necessarily the most dominant in terms of areal coverage. Also in contrast to NWI, WWI does not map deepwater habitats. Anything deeper than six feet is not included. WWI could be considered a lean version of NWI that is tailored specifically to the wetland communities found in Wisconsin. Wisconsin has their own set of codes, but the general idea of a hierarchy of alpha-numeric codes is the same. The coding schema for WWI is as follows:

Class Subclass Hydrologic Modifier Special Modifier

Where:

Class is a single letter uppercase code that refers to the tallest vegetation or substrate type. Examples of classes include emergent *(E)*, forested *(T)*, moss *(M)*, and open water *(W)*. The subclass, like NWI, refers to a more specific type and is coded with a single number. For example, the code *T3* refers to broad- leaved deciduous forest versus *T5* which refers to needle-leaved evergreen forest. Again similar to NWI, the meaning of the subclass is dependent on the class to which it is being applied. In WWI there are a total of eight possible classes. All classes except moss *(M)* and upland *(U)* have subclasses associated with them. Upland is only used as a class for signifying upland inclusions within a wetland complex. It is possible to have a wetland attributed with dual classes.

Hydrologic modifier in WWI is analogous to water regime in NWI. It consists of a single uppercase letter. In WWI it encodes hydrologic information as well as some of the system information such as whether the wetland is a lake, river or palustrine system. There are only four hydrologic modifiers in WWI, standing water, lake *(L)*, flowing water, river *(R)*, standing water, palustrine *(H)*, and wet soil, palustrine *(K)*. With only four hydrologic modifiers in WWI versus eight possible water regimes in NWI, WWI is not as specific as NWI concerning hydrology, therefore wetlands delineated using this system may be more generalized.

The special modifier is the final component of the WWI code. The special modifier is a lower case letter encoding very specific conditions present within the wetland. The special modifier in WWI encodes similar conditions to NWI, as well as some situations unique to Wisconsin. Farmed *(f)* and excavated wetlands *(x)* are examples of the former, while cranberry bog *(c)* and Central Sands complex *(j)* are examples of the former. There are no modifiers in WWI that specifically address water chemistry or soil type. It is possible to have more than one special modifier attached to the same wetland.

Examples

To help further explain WWI here are some examples of attributes present in the Lake Superior Basin portion of Douglas County (DC LSB):

> *S6K* – This is a scrub-shrub *(S)* wetland dominated by deciduous evergreen *(6)* vegetation such as leatherleaf (*Chamaedaphne calyculata*). It has a saturated soil as indicated by the wet soil, palustrine *(K)* hydrologic modifier. This attribute might be associated with a bog.
>
> *E2/S3Kr* – This wetland consists of a mixture of narrow leaved persistent emergent vegetation *(E2)*, for example cattail (*Typha* spp.), and broad leaved deciduous shrubs *(S3)*, such as willow (*Salix* spp.). The first of the dual classes is the dominant class in terms of coverage area. The wet soil palustrine *(K)* hydrologic modifier indicates saturated soil. The special modifier *(r)* is a red clay plain complex.
>
> *A3L* – This is an aquatic bed of rooted floating plants *(A3)*. Water lilies (*Nymphaea odorata*) are an example of a plant species found in this class. The standing water, lake *(L)* hydrologic modifier indicates this wetland is associated with a lake basin of at least 20 acres in size, but the wetland itself could actually be less than 20 acres.
>
> *T3Krv* - This is a forested wetland *(T)* dominated by broad leaved deciduous *(3)* species. Again the wet soil, palustrine *(K)* hydrologic modifier indicates saturated soil conditions. In this case two special modifiers are used; *(r)* is red clay complex and *(v)* is vegetation recently removed. An example of this type of wetland might be an aspen dominated wetland that was recently logged in the clay plain.

These are just a few examples of codes that occur in the DC LSB. For more a detailed explanation of the WWI and lists of possible codes please refer to the Wisconsin Department of Natural Resources publications, A User's Guide to the Wisconsin Wetland Inventory and the Wisconsin Wetland Inventory Classification Guide (WI-DNR, 1991). The WWI covertype classes and hydrologic modifiers are summarized in WWI Classification Codes (Table 7).

WWI Classification Codes

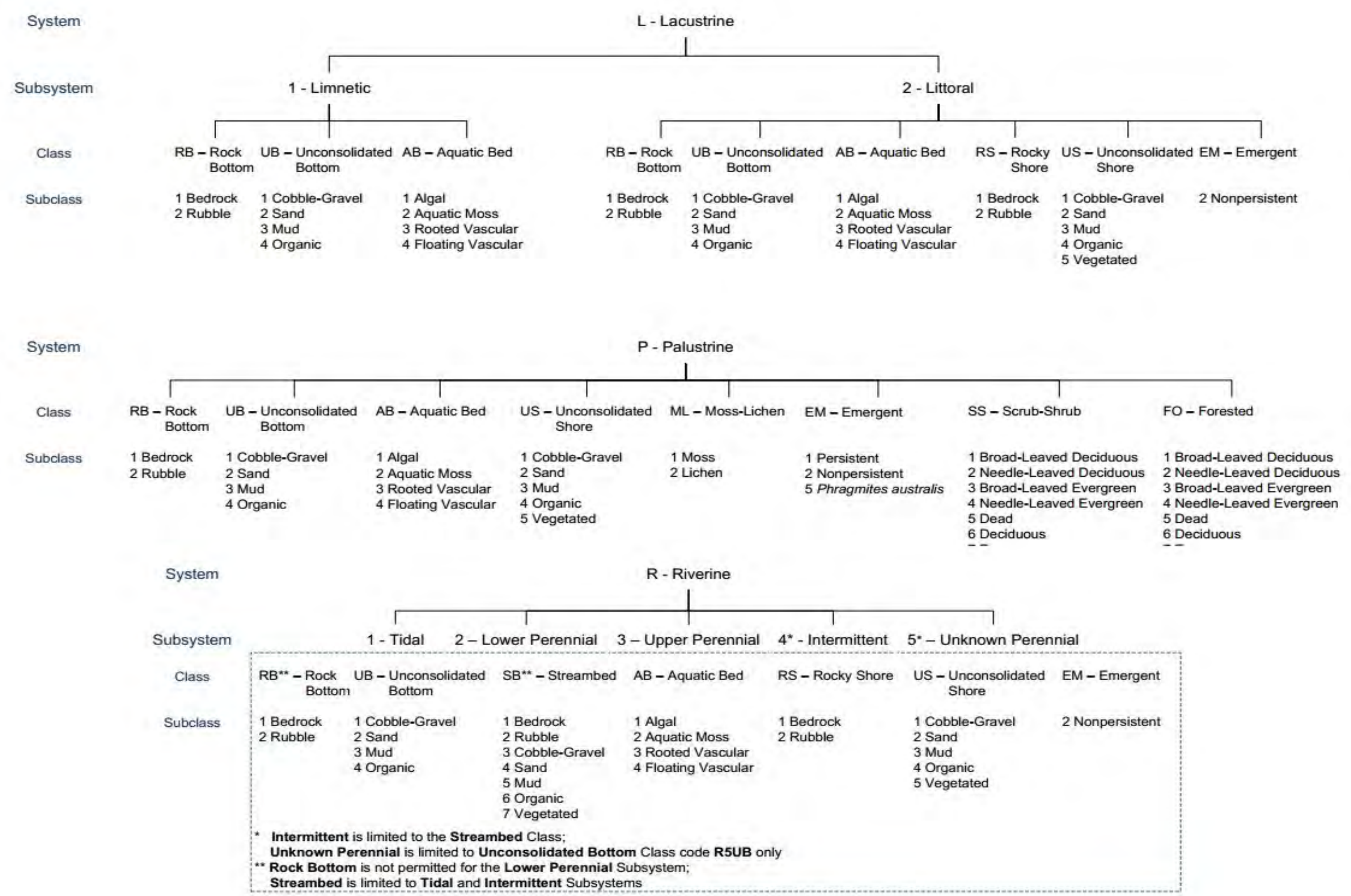
Table 6. Cover type classes and hydrologic modifiers for the Wisconsin Wetland Inventory System (WI DNR 1994).

Class	Description	Subclass Example
A – Aquatic Bed	Plant growing entirely on or in a water body	--
1 - Submergent	Aquatic bed plants growing entirely under water	Milfoil, coontail, pondweeds
2 - Floating	Aquatic bed plant having structures which float at the	Rooted or free floating
3 - Rooted Floating	Rooted aquatic bed plants which have floating leaves	Pond lilies, water shield
4 – Free Floating	Aquatic bed plants which float freely on the water sur	Duckweed, water meal, surface algae
M - Moss	Wetlands where the uppermost layer of vegetation is moss	Sphagnum moss
E - Emergent	Herbaceous plants which stand above the surface of the water or soil	--
1 - Persistent	Plant remains persist into next year's growing season	Narrow- or broad-leaved
2 – Narrow-leaved persistent	Persistent emergents having grass-like leaves without petioles	Cattail, most sedges and grasses
3 – Broad-leaved persistent	Persistent emergents with wide leaf blades	Stinging nettle, some asters
4 - Nonpersistent	Emergent which fall beneath the water and decompose over winter	Narrow- or broad-leaved
5 – Narrow-leaved nonpersistent	Nonpersistent emergents with grass-like leaves without petioles	Wild rice, some bulrush stands
6 – Broad-leaved nonpersistent	Nonpersistent emergents with wide leaf blades	Arrowhead, pickerel weed
S – Scrub/shrub	Woody plants less than 20 feet tall	--
1 - Deciduous	Shrubs which drop their leave in the fall	Narrow- or broad-leaved
2 – Needle-leaved deciduous	Stunted tamaracks	Stunted tamaracks
3 – Broad-leaved deciduous	Deciduous shrubs other than tamarack	Willows, alder, young green ash
4 - Evergreen	Shrubs which keep their leaves over winter	Narrow- or broad-leaved
5 – Needle-leaved evergreen	Evergreen shrubs with needle-like or scale-like leaves	Stunted black spruce
6 – Broad-leaved	Evergreen shrubs with wide lead blades	Labrador tea, leatherleaf

evergreen		
7 - Dead	Dead shrubs	Shrubs killed by flooding
8 – Needle-leaved	Any coniferous shrubs	Deciduous or evergreen
9 – Broad-leaved	Any broad-leaved shrubs	Deciduous or evergreen
T - Forested	Woody plants taller than 20 feet	--
1 – Deciduous	Trees which drop their leaves in the fall	Narrow- or broad-leaved
2 – Needle-leaved deciduous	Tamaracks	Tamaracks
3 – Broad-leaved deciduous	Deciduous trees other than tamarack	Black ash, elm, silver maple
5 – Needle-leaved evergreen	Evergreen trees with needle-like or scale-like leaves	White cedar, black spruce, balsam
7 - Dead	Dead trees	Trees killed by flooding
8 – Needle-leaved	Any coniferous trees	Deciduous or evergreen
F – Flats/unvegetated wet soil	Exposed wet soils which do not support vegetation	--
0 – Subclass unknown	Soil characteristics undetermined	--
1 – Cobble/ gravel	Flats composed of gravel and larger stones	Gravel bar in fast flowing river
2 - Sand	Flats composed of sand	Sand flats in the Wisconsin R.
3 - Mud	Flats composed of silt and clay-sized mineral particles	Mud flats in the Mississippi R.
4 - Organic	Exposed muck	Organic flats exposed by drawdown
5 – Vegetated pioneer	Flats supporting herbaceous pioneer vegetation which is killed by rising water levels before the next growing season	Cocklebur growing in sand flat
W – Open water	Lakes and ponds with a depth of 6 feet or less, and unvegetated river sloughs	--
0 – Subclass unknown	Bottom characteristics undetermined	--
1 – Cobble/ gravel	Cobble or gravel bottom	--
2 - Sand	Sand bottom	--
3 - Mud	Mud bottom	--
4 - Organic	Muck bottom	--
U - Upland	Upland areas surrounded by wetland	
Hydrologic Modifier	Situation Applied To:	Used with Subclasses

L – Standing water, Lake	Lakes of 20 acres or more having a maximum depth of 6 feet or less (smaller lakes and ponds receive the “H” hydrologic modifier)	A1-A4, E4-E6,S7,T7,F0-F5,W0-W4
R – Flowing water, River	The abandoned and secondary channels of rivers and streams	A1-A4,E4-E6, T7,F0-F5,W0-W4
H – Standing water, Palustrine	Wetlands which have surface water present for much of the growing season	All subclasses
K – Wet soil, Palustrine	Areas which are wetlands, but do not appear to have surface water for prolonged periods of time	M0,E1-E3,S1-S9,T1-T8,F0-F5

Appendix E. National Wetlands Inventory – Cowardin et al. (1979) Codes



MODIFIERS

In order to more adequately describe the wetland and deepwater habitats, one or more of the water regime, water chemistry, soil, or special modifiers may be applied at the class or lower level in the hierarchy. The farmed modifier may also be applied to the ecological system.

Water Regime			Special Modifiers	Water Chemistry			Soil
Nontidal	**Saltwater Tidal**	**Freshwater Tidal**		**Coastal Halinity**	**Inland Salinity**	**pH Modifiers for all Fresh Water**	
A Temporarily Flooded	L Subtidal	S Temporarily Flooded-Tidal	b Beaver	1 Hyperhaline	7 Hypersaline	a Acid	g Organic
B Saturated	M Irregularly Exposed	R Seasonally Flooded-Tidal	d Partly Drained/Ditched	2 Euhaline	8 Eusaline	t Circumneutral	n Mineral
C Seasonally Flooded	N Regularly Flooded	T Semipermanently Flooded-Tidal	f Farmed	3 Mixohaline (Brackish)	9 Mixosaline	i Alkaline	
E Seasonally Flooded/ Saturated	P Irregularly Flooded	V Permanently Flooded-Tidal	h Diked/Impounded	4 Polyhaline	0 Fresh		
F Semipermanently Flooded			r Artificial	5 Mesohaline			
G Intermittently Exposed			s Spoil	6 Oligohaline			
H Permanently Flooded			x Excavated	0 Fresh			
J Intermittently Flooded							
K Artificially Flooded							

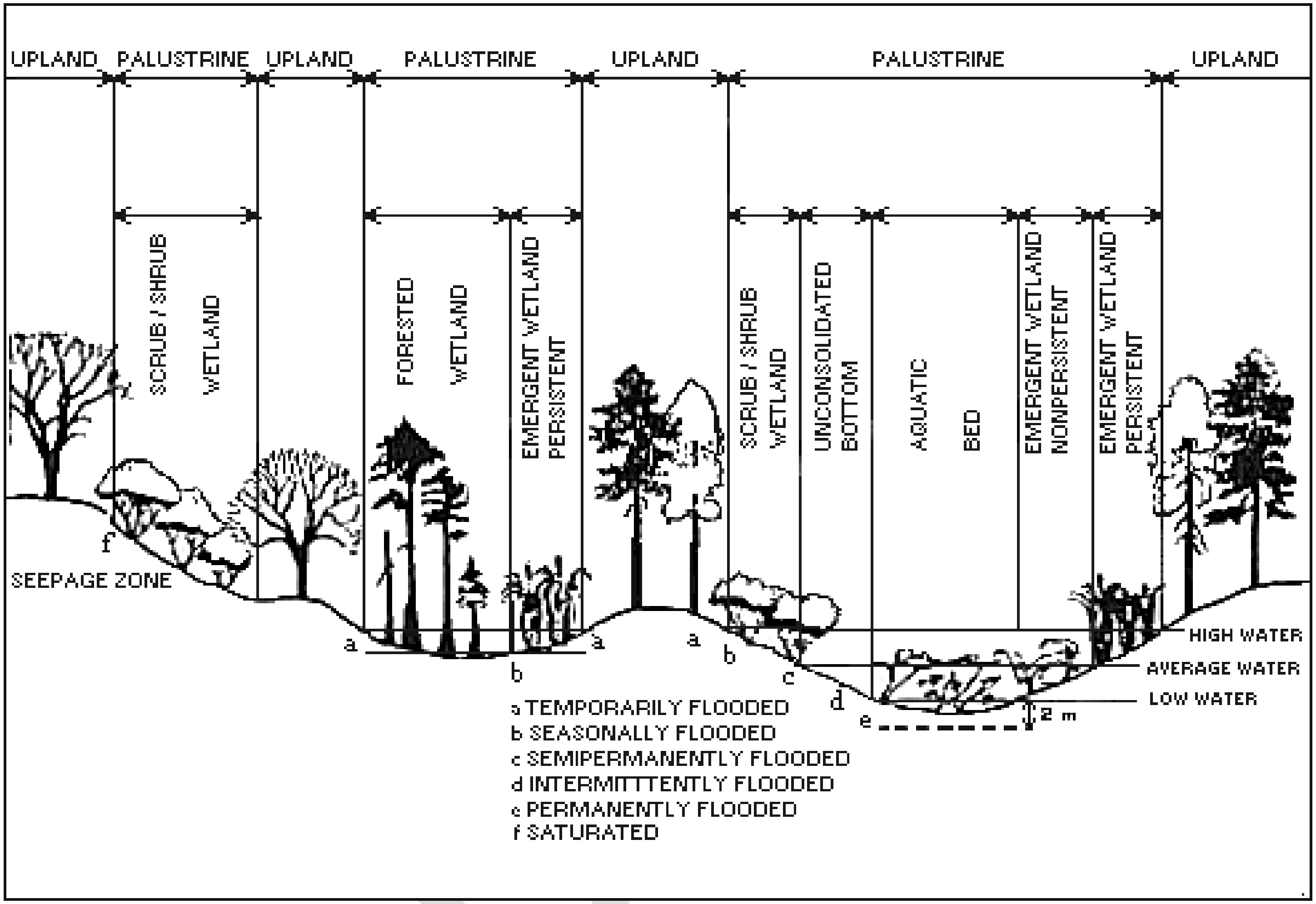


Figure 29. Cross section of distinguishing features and examples of habitats in the Palustrine System (Cowardin et al. 1979).

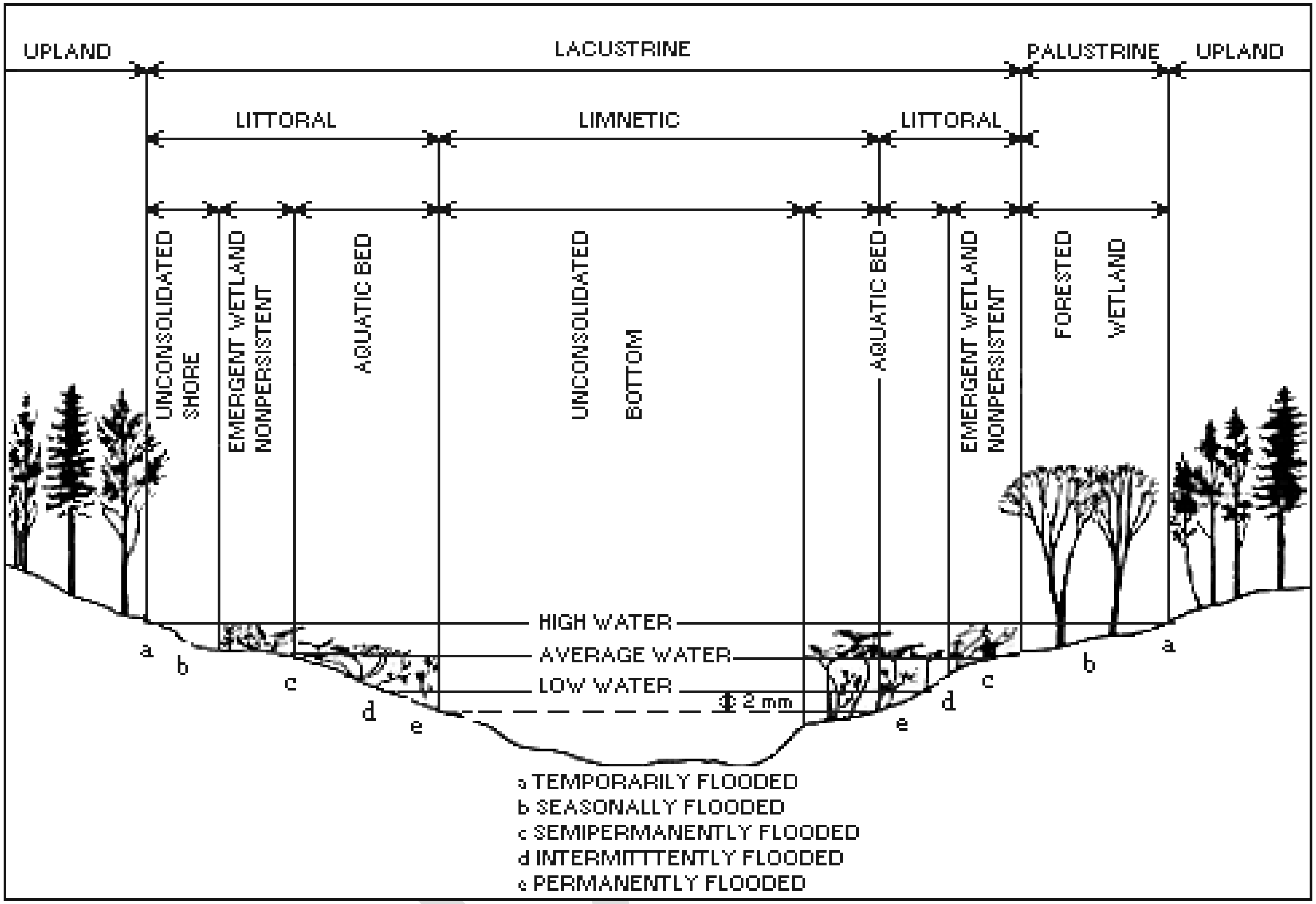


Figure 30. Cross section of distinguishing features and examples of habitats in the Lacustrine System (Cowardin et al. 1979).

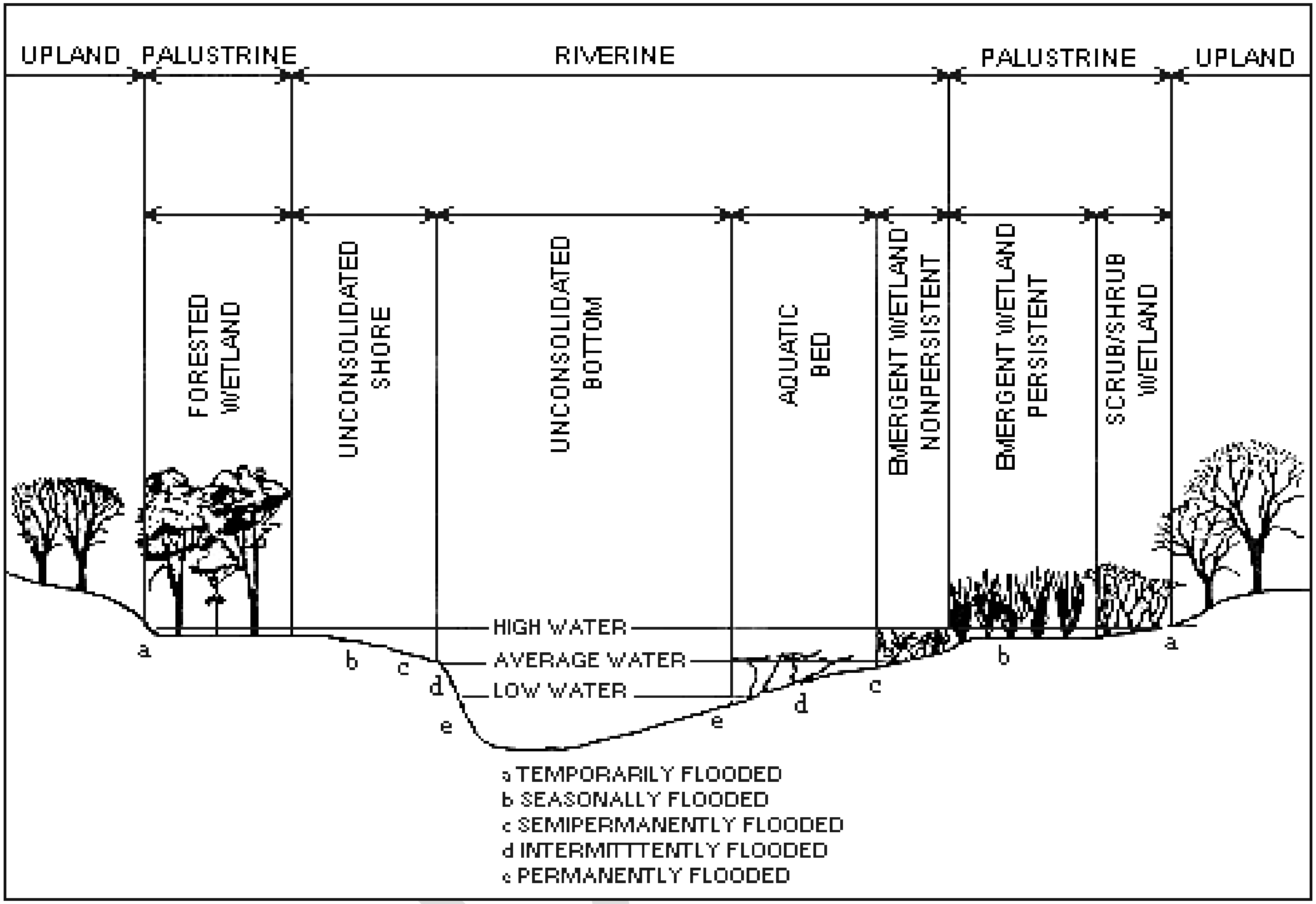


Figure 31. Cross section of distinguishing features and examples of habitats in the Riverine System (Cowardin et al. 1979).

Appendix F. Wisconsin's Wetland Gems™ list for Douglas County Wisconsin (Wisconsin Wetlands Association).

Gem Site Code	Gem Site Name	Owner-ship	Alder thicket	Coniferous bog	Coniferous swamp	Fen	Floodplain forest	Low Prairie	Lowland Hardwood Swamp	Marsh	Open bog	Ephemeral pond	Sedge Meadow	Shrub Carr	Other Rare
NW-1	Belden Swamp[a]	County	X	X		X					X				
NW-2	Black Lake Bog	County	X	X							X		X		
NW-4	Blueberry Swamp	County		X	X				X		X				
NW-5	Brule Glacial Spillway	WDNR	X	X	X								X		*
NW-7	Empire Swamp[a]	County	X	X		X			X	X	X		X		
NW-8	Erickson Creek Peatlands	County	X	X	X	X				X	X		X		
SU-5	Nemadji Floodplain Forest	County	X				X			X			X		
SU-7	Pokegama-Carnegie Wetlands	County, City of Superior, WDNR	X							X			X		
SU-10	St. Louis River Marshes[b]	County, WDNR	X						X	X			X		

* spring runs and spring seeps

[a] These wetlands are a St. Croix River Watershed Priority

[b] The National Estuarine Research Reserve also recognizes the St. Louis River Marshes as ecologically important wetlands.

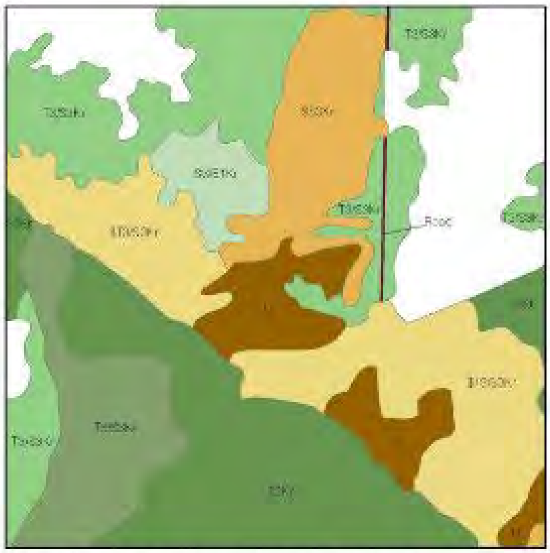
Appendix G. Wisconsin Wetland Inventory (WWI) to National Wetland Inventory (NWI or Cowardin) GIS Conversion Steps

1. Delete roads, uplands, and filled wetlands from WWI polygon layer;
2. Convert WWI codes to Cowardin et al. (1979) codes using a tabular crosswalk*;
3. Add WI DNR hydrographic features and classify with Cowardin et al. (1979) codes while developing a hierarchy among these features;
4. Buffer WWI points (wetlands less than 2 acres) and add to wetlands polygon layer. Modify point buffers based on hierarchy;
5. Overlay soils data and modify the classification of the wetland polygons based on the drainage capability classes and organic components of the soils.

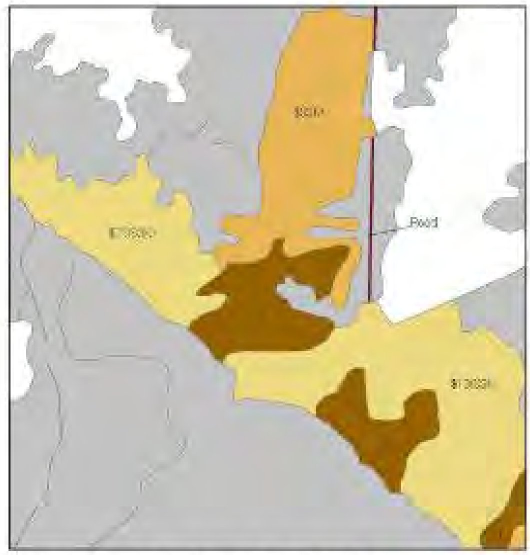
*An example illustration of each step is provided. The numbers on the following pages correspond to the steps listed above.

These steps and figures were reproduced from a poster presentation by Shannon Garrett in conjunction with the U.S. Geological Survey and the U.S. Fish and Wildlife Service.

1. Delete roads, uplands, and filled wetlands from WWI polygon layer



Original WWI wetland polygons.



Uplands, roads, and filled wetland polygons to be deleted from WWI data.

WWI data modified to national standards.

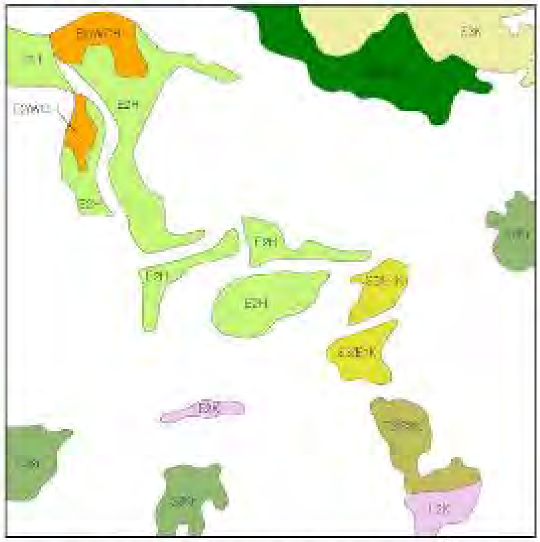
2. Convert WWI codes to Cowardin et al. (1979) codes using a tabular crosswalk. Select examples listed here.

WWI Code (WETCODE)	NWI Code (Cowardin)	Habitat description
T3Kr	PFO1B	Palustrine forested wetland with broad-leaved deciduous, saturated
T3/5Kr	PFO1/4B	Palustrine forested wetland with broad-leaved deciduous and needle-leaved evergreens, temporarily flooded
T5K	PFO4Bg	Palustrine forested wetland with needle-leaved evergreens, saturated, assumed organic soils because of dominant coniferous forest
S3/E2K	PSS1/EM1C	Palustrine scrub shrub wetland with broad-leaved deciduous / emergent wetland with persistent vegetation, seasonally flooded
T3/S3Kw	PFO1/SS1C	Palustrine forested wetland with broad-leaved deciduous / scrub shrub wetland with broad-leaved deciduous, seasonally flooded because it is within the floodplain (WWI = w)
T5/S3K	PFO4/SS3B*	Palustrine forested wetland with needle-leaved evergreens / scrub shrub wetland with
W0H	PUBH	Palustrine with unconsolidated bottom, permanently flooded (open water)
E1Kg	PEMCg	Palustrine emergent wetland, seasonally flooded, organic soils
S3/E1H	PSS1/EM1C	Palustrine scrub shrub wetland with broad-leaved deciduous / emergent wetland with persistent vegetation, seasonally flooded
T8/S3K	PFO2/SS3Bg*	Palustrine forested wetland with needle-leaved deciduous / scrub shrub wetland with broad-leaved evergreens, saturated, organic soils
T5/S3H	PFO4/SS3E	Palustrine forested wetland with needle-leaved evergreens / scrub shrub wetland with broad-leaved evergreens, seasonally flooded /saturated

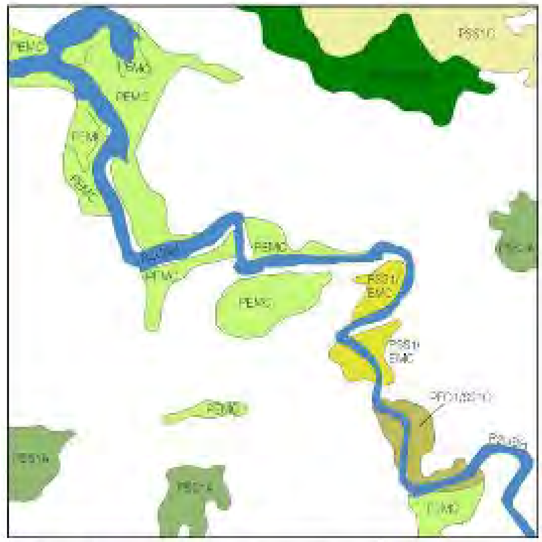
*this is a situation where organic soils intersected the polygon

3. Add WI DNR hydrographic features and classify with Cowardin et al. (1979) codes while developing a hierarchy among these features;

River example



Original WWI wetland polygons and codes.



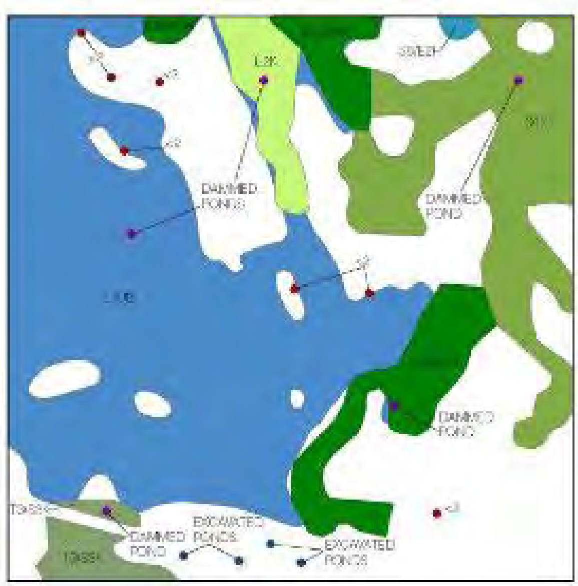
Add river data to wetlands layer, modify the wetland polygons where they overlap, and change codes.

Lake example

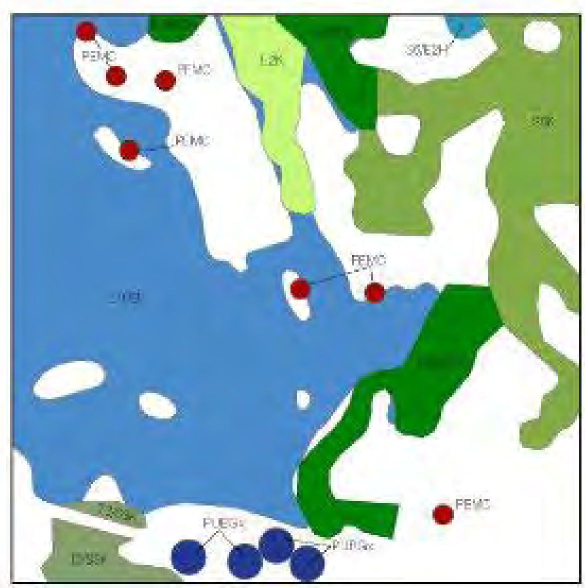
Add hydrography data to wetlands layer.

Modify the lake polygon where it overlaps with wetland polygons.

4. Buffer WWI points (wetlands less than 2 acres) and add to wetlands polygon layer. Modify point buffers based on hierarchy;



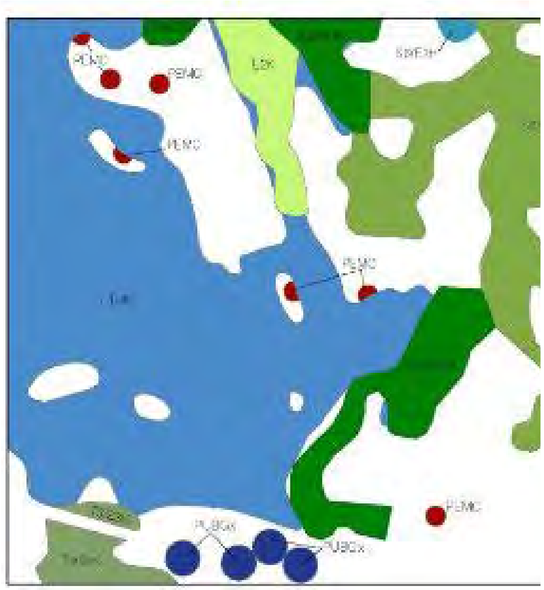
Delete point data that have their center within wetland polygons and hydrography features.



Buffer the point data based on attributes and add to the wetlands polygon layer.

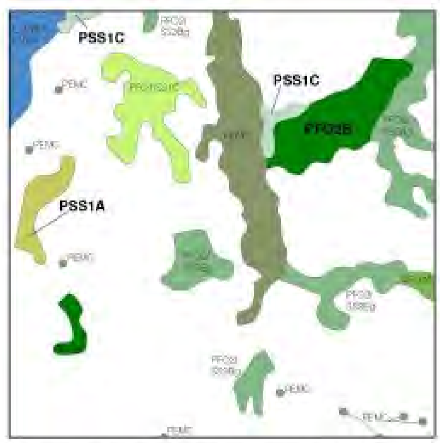
Buffer Point Attributes & Sizes

- Dammed Ponds (PUBGh) are buffered at 0.30 acres
- Excavated ponds (PUBGx) are buffered at 0.30 acres
- Wetlands less than 2 acres (PEMC) in size are buffered at 0.10 acres.

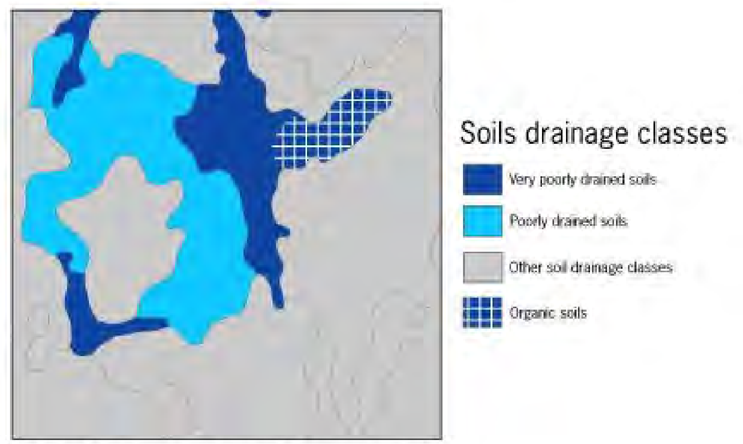


Buffers that are overlapping wetland polygons are midwifed while preserving the wetland polygons

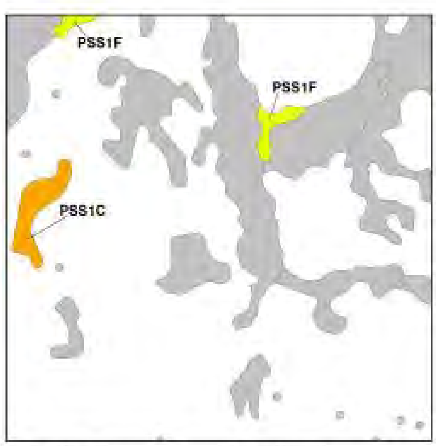
5. Overlay soils data and modify the classification of the wetland polygons based on the drainage capability classes and organic components of the soils.



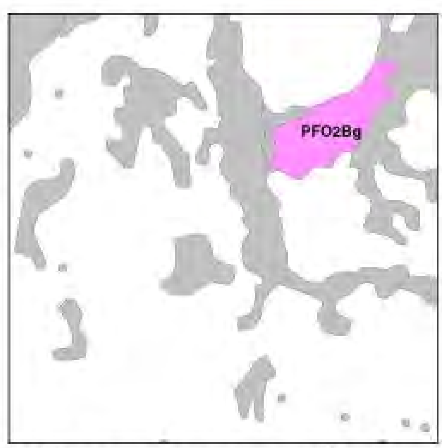
a.) Wetland polygons prior to adding soils classifications.



b.) Drainage classes of very poorly drained, poorly drained, and organic subordered soils used in modifying the codes of the wetland polygons that overlap.



c.) Change wetland polygon water regime classifications based on the intersection with soil drainage capability class polygons.



d.) The organic soils modifier 'g' is added to the code of the wetland polygon that intersects the organic soils polygon.

Appendix H. Soil map unit relative wetland potential ranking.

Table 7. Select characteristics of soil map units within the Lake Superior Basin portion of Douglas County and a relative ranking of wetland potential (1-20). MUs with at least one component having a drainage classes of somewhat poorly drained or wetter received a ranking; all other MUs not meeting this criteria are not listed in this table, with one exception, floodplain soils (e.g., Moquah fine sandy loam). Wetland rankings were determined by examining hydrologic characteristics listed in the map unit descriptions for the major components in the soil survey of Douglas County (NRCS 2006).

Map Unit Symbol	Name	Percent Slopes	Drainage class	Important Hydrologic Notes	Ranking
3A	Totagatic (30-60%)-Bowstring (15-60%) - Ausable (15-40%) Complex	0-2	Poorly drained / very poorly drained / very poorly drained	Frequently flooded,	18
5A	Arnheim mucky silt loam (80-100%)	0-1	Poorly drained	Frequently flooded	16
6A*	Moquah fine sandy loam (890-100%)	0-3	Moderately well drained	Floodplain/riparian wetlands	5
64A	Totagatic (45-65%)-Winterfield (25-55%) complex	0-2	Poorly drained / somewhat poorly drained	Frequently flooded, shallowest depth to wet zone: at surface (April, May, Nov, Dec) / shallowest depth to wet zone: 0.5 ft (April)	13
66A	Pesabic sandy loam (70-100%)	0-3	Somewhat poorly drained	Very stony, shallowest depth to wet zone: 0.5 ft (April, May)	9
121A	Wakeley muck (70-100%)	0-2	Very poorly drained	Sandy outwash and lacustrine material underlain by clayey lacustrine deposits, shallowest depth to wet zone: at surface (Jan, Feb, Mar, April, May, June, Oct, Nov, Dec	18
160A	Oesterle sandy loam (80-100%)	0-2	Somewhat poorly drained	Loamy alluvium underlain by stratified sandy and gravelly outwash, shallowest depth to wet zone: 1.0 ft (April, May)	8
192A	Worcester sandy loam (70-100%)	0-3	Somewhat poorly drained	Loamy alluvium underlain by sandy and gravelly outwash, shallowest depth to wet zone: 1.0 foot (April, May, Nov)	8

Map Unit Symbol	Name	Percent Slopes	Drainage class	Important Hydrologic Notes	Ranking
193A	Minocaqua muck (70-100%)	0-2	Poorly drained	Shallowest depth to wet zone: at surface April, May, November, deepest ponding 0.5 foot (April and May)	14
226A	Allendale loamy fine sand	0-3	Somewhat poorly drained	Shallowest depth to wet zone: 0.5 ft (April, May)	9
262B	Amnicon (40-60%) – Cuttre (30-50%) complex	0-4	Moderately well drained/ Somewhat poorly drained	Amnicon shallowest depth to wet zone: 1ft (April, May, November) /Cuttre: shallowest depth to wet zone 0.5 ft (Jan, Feb, Mar, April, May, Oct, Nov, Dec)	8
319A	Tonkey sandy loam (80-100%)	0-2	Poorly drained	Shallowest depth to wet zone: at surface March, April, May, June, October, November	15
347A	Bergland (40-65%) – Cuttre (20-45%) complex	0-3	Poorly drained/somewhat poorly drained	BERGLAND: Clayey lacustrine deposits, Shallowest depth to wet zone: at surface (Jan, Feb. Mar, Apl, May, June, Oct., Nov., Dec. / CUTTRE: clayey till, shallowest depth to wet zone: 0.5 ft (Jan., Feb., Mar., Apl., May, Oct., Nov., Dec.)	13
375A	Robago fine sandy loam, lake terrace (80-100%)	0-3	Somewhat poorly drained	Shallowest depth to wet zone 0.5 ft (April)	8
376B	Tula fine sandy loam (70-100%)	1-6	Somewhat poorly drained	Shallowest depth to wet zone: at surface (April)	9
388B*	Pelkie (30-70%), occasionally flooded-Dechamps (15-40%), frequently flooded, complex	0-4	Moderately well drained/somewhat poorly drained	Pelkie: Flooding occurs: Mar, Apl, May w/frequent April flooding / Dechamps : frequent April, May flooding, shallowest depth to wet zone: at surface (April)	7
405A	Lutpon (0-100%), Cathro (0-100%, Tawas (0-100%)	0-1	Very poorly drained / very poorly drained / very poorly drained	Obvious wetland	20

Map Unit Symbol	Name	Percent Slopes	Drainage class	Important Hydrologic Notes	Ranking
406A	Loxley mucky peat (70-100%)	0-1	Very poorly drained	Herbaceous organic material more than 51 inches thick (obvious bog), no flooding, but shallowest depth of wet zone: at surface (April, May, June, Oct, Nov) and frequent ponding	20
407A	Seelyeville (0-100%) and Markey (0-100%) soils	0-1	Very poorly drained / very poorly drained	Herbaceous organic material more than 51 inches thick (obvious bog) / Wet zone at surface all year long	20
419A	Seelyeville (0-100), Cathro (0-100%), and Markey (0-100%) soils	0-1	Very poorly drained / very poorly drained / very poorly drained	Obvious wetland, likely bog	20
445A	Kinross muck (65-100%)	0-2	Poorly drained	Shallowest depth to wet zone: at surface April, May, Nov)	16
461A	Bowstring muck	0-1	Very poorly drained	Frequently flooded (Mar, Apl, May, June)	18
514B	Losco loamy sand (80-100%)	0-4	Somewhat poorly drained	Shallowest depth to wet zone: 0.5 ft (April, Nov)	9
523A	Nokasippi muck (80-100%)	0-1	Very poorly drained	Shallowest depth to wet zone: at surface (April, May, June, November)	19
526A	Flink sand (65-100%)	0-3	Somewhat poorly drained	Shallowest depth to wet zone: 1 ft (April)	8
555A	Fordum silt loam (75-100%)	0-2	Poorly drained	Frequent flooding April, May, shallowest depth to wet zone: at surface April, May, November	14
577A	Lerch (40-65%) – Borea (20-50%) complex	0-3	Poorly drained / somewhat poorly drained	Shallowest depth to wet zone: at surface jan, Fb, Mar, Apl, May, Jun, Oct, Nov, Dec / shallowest depth to wet zone: 0.5 ft (Jan, feb, mar, Apl, May, Oct)	12
579B	Parkfalls sandy loam (75-100%)	0-4	Somewhat poorly drained	Very stony, shallowest depth to wet zone 0.5 ft (April)	9
623A	Capitola muck (60-100%)	0-2	Very poorly drained	Shallowest depth to wet zone: at the surface (April, May, Nov)	18

Map Unit Symbol	Name	Percent Slopes	Drainage class	Important Hydrologic Notes	Ranking
631A	Giese muck	0-1	Very poorly drained	Shallowest depth to wet zone: at surface (april, may, nov)	18
654A	Pesabic (25-70%) – Newood (15-60%) – Capitola (10-50%) complex	0-1	Somewhat poorly drained / moderately well drained / very poorly drained	Shallowest depth to wet zone: 0.5 ft (April, May) / shallowest depth to wet zone: 2.5 ft (April, May, Nov) / shallowest depth to wet zone: at surface (April, May, Nov)	999
675A	Robago fine sandy loam (80-100%)	0-3	Somewhat poorly drained	Shallowest depth to wet zone: 0.5 feet (April)	8
706A	Winterfield (50-80%) –Totagatic (15-40%) complex	0-2	Somewhat poorly drained / poorly drained	Frequent flooding April, frequent flooding April & May	11
733A	Wozny muck (70-100%)	0-2	Very poorly drained	Shallowest depth of wet zone: at surface (April, May, Nov.) wetland soil	17
753B	Sedgwick (30-70%) – Munuscong (20-40%) complex	0-6	Somewhat poorly drained / poorly drained	Shallowest depth to wet zone: 0.5 ft (March, April, May, June, Nov.)	12
812B	Mora sandy loam (80-100%)	0-4	Somewhat poorly drained	Shallowest depth to wet zone: 0.5 April, May	9
815A	Wormet sandy loam (70-100%)	0-3	Somewhat poorly drained	Shallowest depth to wet zone: 0.5 ft (April)	9
884C	Keweenaw (20-80%), stony – Vilas (10-60%) – Cathro (10-20%) complex	0-15	Well drained / excessively drained / very poorly drained	Cathro only: wet zone at the surface all year	999
884E	Kewweenaw, stony – Vilas – Cathro complex	0-55	Well drained / excessively drained / very poorly drained	Cathro only: wet zone at the surface all year	999
885B	Springstead (40-65%), stony – Annalake (15-45%) – Cathro (5-45%) complex	0-6	Moderately well drained / moderately well drained / very poorly drained	Cathro only: wet zone at the surface all year	999
926A	Flink loamy sand	0-3	Somewhat poorly drained	Shallowest depth to wet zone 1.0 ft (April)	8

Map Unit Symbol	Name	Percent Slopes	Drainage class	Important Hydrologic Notes	Ranking
1153C	Newood (35-75%)– Pesabic (20-60%)– Capitola (15-40%)complex	0-15	Moderately well drained / somewhat poorly drained / very poorly drained	Newood shallowest depth to wet zone: 2.5 ft (April, May, Nov) / Pesabic: shallowest depth to wet zone: 0.5 ft (April, May) / Capitola: shallowest depth to wet zone: at surface (April, May, Nov)	999
1653B	Stanberry (35-60%) – Parkfalls (25-50%) – Wozny (10-25%) complex	0-6	Moderately well drained / somewhat poorly drained / very poorly drained	Stanberry: shallowest depth to wet zone: 2.5 ft (April, May, Nov) / Parkfalls: shallowest depth to wet zone: 0.5 ft (April) / Wozny: shallowest depth to wet zone: at surface (April, May, November)	999
670C	Keweenaw (30-75%), stony – Newood (15-35%), stony – Cathro (10-20%) complex	0-15	Well drained / moderately well drained / very poorly drained		999
3114A	Sprist, Aquent, and Aquepts	0-1	Very poorly drained / Very poorly drained / Very poorly drained		20
3244A	Brimley fine sandy loam (70-100%)	0-3	Somewhat poorly drained	Shallowest depth to wet zone: 0.5 ft April	9
3247A	Bruce silt loam (75-100%)	0-2	Poorly drained	At the surface April, May, Nov	13
3276A	Au Gres loamy sand (75-100%)	0-3	Somewhat poorly drained	Shallowest depth to wet zone: 0.5 ft April	9
3403A	Loxley (0-100%, Besemand (0-100%), and Dawson (0-100%) soils	0-1	Very poorly drained / very poorly drained / very poorly drained	All: water at surface April, May, Jun, Oct., Nov	19
3423A	Rifle peat (80-100%)	0-1	Very poorly drained	water at surface all year	20
3446A	Newson muck	0-2	Very poorly drained	water at surface April, May, Nov	18

999 = the soil map unit covers a wide range of drainage classes and potential wetland characteristics.

* This map unit was initially considered as a soil worthy of consideration of a soil map unit with some potential to contain wetlands, however it was ultimately not included it in the final PRW selection model because the soil exists in deep-seated river valleys or ravines and are typically not developable sites or of use in agricultural crop production. However, it is important to note that channel incision is known to occur in many rivers and streams of the area and therefore floodplain wetlands may be missing or dramatically reduced in area compared with pre-settlement conditions. For example, portions of the Nemadji River are disconnected from what would be its active floodplain because of channel incision. However, this is a much larger, separate issue, and needs to be looked at with a different set of hydrological analyses and field data. Therefore, these floodplain soil MUs were removed from the PRW “model”.

Appendix I. Ecologically Significant Primary "Coastal" Wetlands in Douglas County (Merryfield 2000)

The following information is directly from Merryfield (2000). It provides site descriptions for notable coastal wetlands in Douglas County.

The wetlands described here fit one of the following criteria according to Merryfield (2000):

1. **Ecological Landscapes.** Wetlands within the coastal ecological landscapes[2], including the Superior Coastal Plain, the Northern Lake Michigan Coastal, and the Southern Lake Michigan Coastal (described above). These are referred throughout this report as either "coastal zones" or "coastal ecological landscapes".

2. **Buffer area.** Wetlands that are within a 6 mile buffer from the Lake Michigan or Lake Superior shoreline.

3. **Size.** Wetlands greater than 5 acres.

4. **Hydrological Connection.** Wetlands having a direct hydrological connection to and influenced by the Great Lakes.

5. **Other significant wetland areas.** Wetlands outside the areas described in criteria #1 and #2 above, having critical or important interactions with the Lakes, and/or having rare or otherwise significant communities, endangered or threatened plants and animals, concentrations of nesting colonial birds, major migratory bird stop-overs, extensive fish spawning areas, or which have scientific or other values.

Black Lake Bog

Black Lake Bog is a vast acid peatland in the headwaters of the Black River. Several thousand acres of open bog, muskeg, and black spruce swamp surround a large shallow lake that drains northward via the Black River, which eventually joins the Nemadji River south of the City of Superior.

Sphagnum mosses, ericaceous shrubs, and sedges blanket the level surface of the site. Representative vascular plants include leatherleaf (*Chamaedaphne calyculata*), bog laurel (*Kalmia polifolia*), bog rosemary (*Andromeda glaucophylla*), small cranberry (*Vaccinium oxycoccos*), round-leaved sundew (*Drosera rotundifolia*), and the sedges *Carex oligosperma, C. pauciflora, C. paupercula*, and *Eriophorum spissum*. Stunted black spruce (*Picea mariana*), often associated with tamarack (*Larix laricina*), are scattered throughout the bog. In areas where the spruces form closed stands, Labrador tea (*Ledum groenlandicum*) and the sedge *Carex trisperma* are frequently members of the understory. Small upland "islands" occur in a few places within the bog, supporting mature stands of red pine (*Pinus resinosa*).

Among the animals, only birds have received even cursory attention. A number of habitat specialists occur here, among them the palm warbler and Lincoln's sparrow. The LeConte's sparrow has been noted in open areas with high sedge cover. Other characteristic birds of the site include common yellowthroat, song sparrow, white-throated sparrow, Nashville warbler, sedge wren, and purple finch. The yellowbellied flycatcher and yellow-rumped warbler occur where the cover of spruce trees is high. Mammals observed on or adjacent to the site in recent years include the timber wolf and moose.

Black Lake Bog occupies portions of both Minnesota and Wisconsin. Ownership is primarily public, with Douglas County and the state of Minnesota the major landowners. The site is managed by cooperative agreement as an interstate natural area.

Belden Swamp

This large, undisturbed acid peatland straddles the drainage divide between the St. Croix River and Lake Superior. The Spruce River originates here, draining southwestward to join the Tamarack River and then the St. Croix River. Several small streams drain northward from Belden Swamp, eventually reaching the Black River.

The peatlands are composed of open bog, muskeg, black spruce swamp, and poor fen communities. A thick carpet of *Sphagnum* mosses covers the surface of most of this wetland. Ericaceous shrubs, sedges, and stunted swamp conifers are the most prominent vascular plants. Important species include leatherleaf (*Chamaedaphne calyculata*), bog laurel (*Kalmia polifolia*), bog rosemary (*Andromeda glaucophylla*), small cranberry (*Vaccinium oxycoccos*), black spruce (*Picea mariana*), tamarack (*Larix laricina)*, and the sedges *Carex lasiocarpa, C. limosa, C. oligosperma, C. paupercula, Eriophorum angustifolium, E. spissum*, and *E. virginicum*. Possibly reflecting subsurface drainage patterns, the vegetation is not uniformly structured throughout the site. Open, sedge-dominated swales alternate with muskeg stands in which scattered, stunted spruces are prominent.

In a few areas, the coniferous trees are dense, and species such as Labrador tea (*Ledum groenlandicum*) and the sedge *Carex trisperma* are abundant in the understory. A wet, tall shrub zone of alder (*Alnus incana*) and willows (*Salix* spp.) is found at the upland-wetland interface. In the eastern portion of this wetland interior to the tall shrub community is an extensive stand of bog birch (*Betula pumila*) and beaked sedge (*Carex rostrata*). Birds of the open sedge swales include sedge wren, savanna sparrow, LeConte's sparrow, and northern harrier. In areas of stunted conifers, palm warbler, Lincoln's sparrow, white-throated sparrow, and Nashville warbler are common. More closed coniferous forest supports yellow-bellied flycatcher, yellow-rumped warbler, and sharp-shinned hawk.

Belden Swamp is owned by Douglas County. The site contains extensive, undisturbed examples of representative acid peatland communities and biota and merits serious consideration for special management designation.

Mud Lake Bog / Ericson Creek

This site encompasses a diverse assemblage of wetland and terrestrial features, including extensive open and forested acid peatlands, seepage lake, stream, mesic hardwood forest, and dry-mesic pine forest. Ericson Creek is part of the Amnicon River system, while the peatlands to the west of Mud Lake drain to the Black River. County Trunk Highway A runs north-south between Ericson Creek and Mud Lake (only the wetlands west of Mud Lake are represented in Figure 55).

The peatland communities include open bog, muskeg, and black spruce swamp. Thick carpets of *Sphagnum* mosses support ericaceous shrubs, sedges, and swamp conifers. Characteristic species are leatherleaf (*Chamaedaphne calyculata*), bog laurel (*Kalmia polifolia*), bog rosemary (*Andromeda glaucophylla*), small cranberry (*Vaccinium oxycoccos*), black spruce (*Picea mariana*), tamarack (*Larix laricina*), and the sedges *Carex oligosperma, C. pauciflora, C. paupercula, Eriophorum angustifolium, E. spissum*, and *E. virginicum*. *Carex trisperma* and Labrador tea (*Ledum groenlandicum*) are important where cover of the conifers is relatively high.

Noteworthy peatland birds include Lincoln's sparrow, palm warbler, gray jay, Nashville warbler, whitethroated sparrow, and red crossbill. Near Ericson Creek, the wetlands are bordered by or surround scattered stands of mature trees including mesic maple-basswood forest and dry-mesic red pine-white pine forest. Patches of white spruce (*Picea glauca*) and balsam fir (*Abies balsamea*) lend a boreal flavor to the complex.

Significant portions of this site are owned by Douglas County and should be considered for special recognition in the Douglas County Forest Plan.

Nemadji River Bottoms

This portion of the deeply incised Nemadji River valley is mostly forested but also contains abandoned oxbows with emergent marsh and shrub swamp. The level landscape away from the river is a mixture of small farms, woodlots, and residential areas.

This forest type is rare, and possibly unique to the Lake Superior Clay Plain subsection. Terraces inside the sharp meanders of the river are situated 3-5 meters above normal flow stages. The canopy is dominated by black ash (*Fraxinus nigra*), and includes green ash (*F. pennsylvanica*), basswood (*Tilia americana*), red maple (*Acer rubrum*), silver maple (*A. saccharinum*), balsam poplar (*Populus balsamifera*), and bur oak (*Quercus macrocarpa*). Scattered conifers are also members of the canopy, though their cover is highest on the steep slopes bordering the river and terraces. Included among these are white spruce (*Picea glauca*), white cedar (*Thuja occidentalis*), white pine (*Pinus strobus*), and balsam fir (*Abies balsamea*). The herb layer is exceptionally rich, and while no rare species have been documented here to date, the flora is diverse and contains many plants more typical of maple-basswood forests far to the south. Spring ephemerals and their associates are especially well-represented, including false rue anemone (*Isopyrum biternatum*), wild leek (*Allium tricoccum*), Virginia waterleaf (*Hydrophyllum virginiana*), toothwort (*Dentaria laciniata)*, spring beauty (*Claytonia virginica*), wild ginger (*Asarum canadense*), yellow trout lily (*Erythronium americanum*), Dutchman's breeches (*Dicentra cucullaria*), bloodroot (*Sanguinaria canadense*), and blue cohosh (*Caulophyllum thalictroides*).

Animals were not formally surveyed at this site, but among the common resident birds found in similar habitats upstream are veery, mourning warbler, red-eyed vireo, ovenbird, and broad-winged hawk. Four adult wood turtles (Wisconsin Threatened) were noted at the site in May of 1994.

Though not a virgin stand, many large trees remain and there has been little recent disturbance. Douglas County is the principal landowner, and is partially protecting the site via a special use designation. This site, and a similar stand several miles upstream, have many properties which are unique at least at the regional level. Protection efforts should be strongly encouraged throughout the Nemadji corridor, including the steep, fragile clay slopes where protection or restoration of long-lived coniferous trees is highly desirable. Slumping banks are common on the outside of stream meanders and the Nemadji River contributes a great deal of sediment to Allouez and Superior bays. The slopes bordering this river were badly damaged during past logging events. Present cover is mostly trembling aspen (*Populus tremuloides*).

Pokegama-Carnegie Wetlands

The extensive, poorly drained, red clay flats in the headwaters of the Pokegama and Little Pokegama rivers support a large wetland mosaic of shrub swamp, sedge meadow, emergent marsh, and small ponds. Tiny, upland "islets" of white spruce (*Picea glauca*), white pine (*Pinus strobus*), red pine (*Pinus resinosa*), balsam poplar (*Populus balsamifera*), and trembling aspen (*Populus tremuloides*) punctuate the flats. The shrub wetlands are composed mostly of speckled alder (*Alnus incana*) and willows (*Salix petiolaris, S. discolor, S. pyrifolia*, others). The more open wet meadows are dominated by sedges (*Carex lacustris, C. stricta*) and bluejoint grass (*Calamagrostis canadensis*). Widely scattered small pools support a variety of emergent and submergent aquatic macrophytes.

Of special significance are the many populations of rare plants occurring in the site's wetlands. Many of the rarities are represented by large and/or multiple populations. It is important to recognize that some of these species are not widespread in the Lake Superior region, but are concentrated in the vicinity of the City of Superior. Amphibians and birds found here include: wood frog, spring peeper, green frog, leopard frog, eastern gray tree frog, American toad, yellow warbler, golden-winged warbler, gray catbird, alder flycatcher, white-throated sparrow, swamp sparrow, song sparrow, sora, Virginia rail, common snipe, woodcock, sharp-shinned hawk, northern goshawk, and common raven.

Appropriate management and protection of this site is critically important. Study of the site's hydrology is needed, as several right-of-ways cross the wetland and may be having impacts which are not clearly understood. Several of these right-of-ways are currently managed via brush-cutting, which appears to be an effective and appropriate means of maintaining conditions to the liking of at least some of the rare plants. Examination of the original land survey notes, as well as historical and current aerial photographs, would be helpful in understanding changes in land use and vegetation composition and structure, which could have management implications. Invasive exotic species are not a problem at present, but should be looked for periodically. At least one of the corridors crossing this wetland carries petroleum. A spill could have a devastating impact on the biota.

The vegetation of the Pokegama-Carnegie Wetlands resembles that occurring at several other sites, all in the vicinity of the City of Superior. Pokegama-Carnegie, however, is the largest site, has the greatest floristic diversity, supports some of the largest populations of rare species, and may be less likely in the short-term to suffer destruction or fragmentation owing to expanded development, disrupted hydrology, or incursions of aggressive species.

Red River Breaks / St. Louis River Marshes

<u>Red River Breaks.</u>

This rough, deeply dissected, red clay landscape drained by the Red River and its tributaries borders the St. Louis River above the City of Superior. Much of the site is forested, with polesize trembling aspen (*Populus tremuloides*) the dominant tree. The canopy is rather sparse, with a dense understory of speckled alder (*Alnus incana*) prominent in many stands. Conifers, which were formerly dominant in this area, presently occur as scattered individuals or in small stands, with white spruce (*Picea glauca*), white pine (*Pinus strobus*), and white cedar (*Thuja occidentalis*) the most important species. In poorly drained "flats" on the level ridges between ravines there are patches of black ash-dominated hardwood swamp and thickets of speckled alder and other tall wetland shrubs. Areas of standing water are infrequent, but where present support small emergent marshes and broad-leaved sedge meadows. A few patches of well-drained mesic hardwood forest occur on the ridges, with sugar maple (*Acer saccharum*) and yellow birch (*Betula alleghaniensis*), but these are not extensive and, in general, the "northern hardwoods" community is rare on the site.

The lower slopes of the steep-sided ravines are often springy, sometimes supporting remnant stands of white cedar (*Thuja occidentalis*) and unusual herbs. Several springs were flowing with brightly colored orange water, the result of the presence of iron bacteria. Another spring was noted in which the deposition of "tufa" (calcium carbonate) was occurring. Some of the small terraces a few meters above the streams in the ravine bottoms contain mature stands of large white spruce (*Picea glauca*), black ash (*Fraxinus nigra*), and balsam poplar (*Populus balsamifera*).

Several of the small feeder creeks entering the site from the vicinity of Minnesota's Jay Cooke State Park to the west were running clear, even after heavy rains. Bottom materials included sand, gravel, and boulders. Small fish and a number of invertebrates were noted in these upper stretches. Closer to the St. Louis River, the water is more turbid, carrying a heavier load of fine sediments. Along the St. Louis River there are stands of emergent macrophytes, shrub swamp, and small patches of black ash swamp.

At least 10 species of rare plants have been documented on the site. No rare animals have been observed to date, but the area supports a representative diversity of the region's birds, including large populations of many neotropical migrants. Further inventory is desirable, especially for breeding birds and aquatic macroinvertebrates. Access to the interior is slow going and difficult.

The site's forests, soils, and waters were seriously damaged during past catastrophic logging episodes. Many of the fragile seeps along the lower valley walls are slumping badly, leading to excessive sedimentation in the lower drainages. Conifers are generally not reproducing well, due to loss of seed source, unstable and possibly waterlogged substrates, overbrowsing by white-tailed deer, and possible past damage to soil structure. Thickets of tall shrubs and dense stands of bluejoint grass (*Calamagrostis canadensis*) may be inhibiting the establishment of seedlings of some species. Recovery is proceeding, but very slowly.

Recommendations include the development of a management plan focused on maintaining the site's extensive forests and unroaded condition, as well as protection of the rare plant populations occurring there. In the short term, any active forest management should focus on stabilization of eroding areas and reestablishment of the diverse coniferous forests native to the site and no longer common in the region. Added study is needed on the regeneration problems currently exhibited by cedar, fir, and pine. Actions on these problems should first be implemented only on the periphery of the site.

St. Louis River Marshes.
Upper portions of the St. Louis River Estuary from Fond du Lac downstream to Oliver feature extensive emergent marshes. These are typically located inside the main channel's meanders, but also occur in protected, shallow bays along the upland shore. Important emergent aquatics include arrowheads (*Sagittaria latifolia, S. rigida*), bulrushes (*Scirpus americanus, S. validus*), bur-reed (*Sparganium eurycarpum*), lake sedge (*Carex lacustris*), and cattail (*Typha* spp.). Wild rice (*Zizania aquatica*) and sweet flag (*Acorus calamus*) are locally common. Deeper waters of the marsh complexes support submergent and floating-leaved macrophytes such as coontail (*Ceratophyllum demersum*), waterweed (*Elodea canadensis*), yellow water lily (*Nuphar variegatum*), wild celery (*Vallisneria americana*), and pondweeds (*Potamogeton* spp.).

The patches of marsh associated with the main channel are often bordered by a natural levee adjoining the flowing river. Where well-developed, the levees are vegetated with tall wetland shrubs and lowland hardwoods, especially speckled alder (*Alnus incana*), red-osier dogwood (*Cornus stolonifera*), meadowsweet (*Spiraea alba*), willows (*Salix* spp.), ashes (F*raxinus nigra* and *F. pennsylvanica*), and box elder (*Acer negundo*).

Animals have not yet been surveyed in detail but use by waterfowl was heavy in early fall. Foraging birds noted during the nesting season included bald eagle, osprey, common tern, merlin, and belted kingfisher. Among the common avian residents were red-winged blackbird, common yellow-throat, swamp sparrow, song sparrow, yellow warbler, and sora.

The Wisconsin shoreline is almost entirely undeveloped, and includes a large block of rough, forested, roadless terrain (see "Red River Breaks" for additional information). A large area was purchased by the State of Wisconsin in the mid-1990's. Termed the St. Louis River Streambank Protection Area, the project acquisition goal is 5,000 acres. Shoreline protection, water quality improvement projects, and exotic species monitoring and control are important management considerations for this site. Other significant wetlands are within the St. Louis River Estuary, to the north, below the Village of Oliver (see "Oliver Marsh" and "Superior Municipal Forest"). The Minnesota side of the St. Louis River also harbors valuable wetlands, including remnant patches of wire-leaved sedge fen at the Oliver Bridge and downstream at Grassy Point.

The Red River Breaks/St. Louis River Marshes site was considered a priority owing to its large size, recent state aquisition, and significance to water quality in the St. Louis River Estuary. Also, a big information gap existed which needed to be filled in order to clarify the biological significance of the area for local and regional planning purposes.

Oliver Marsh

This large marsh occupies a part of the St. Louis River Estuary between the Village of Oliver and the City of Superior Municipal Forest. A narrow natural levee has developed on the outside bend of a channel meander, and is partially vegetated with shrubs and small lowland hardwoods. This separates the northern portion of the marsh from the main channel. The emergent beds are generally composed of tall, narrowleaved plants, especially bulrushes (*Scirpus americanus, S. fluviatilis, S. validus*), bur-reeds (*Sparganium chlorocarpum, S. eurycarpum*), lake sedge (*Carex* *lacustris*), cattails (*Typha* spp.), sweetflag (*Acorus calamus*), and arrowheads (*Sagittaria latifolia, S. rigida*). Pockets of wild rice (*Zizania aquatica*) occur in several protected bays fed by tiny streams draining the uplands to the east. A deep central lagoon between the natural levee and the emergent beds adjacent to the upland shore harbors significant stands of floatingleaved and submergent macrophytes such as waterweed (*Elodea canadensis*), wild celery (*Vallisneria americana*), yellow water lily (*Nuphar variegatum*), and pondweeds (*Potamogeton* spp.).

Animal life has not been studied in detail, but surveys are planned for the near future. Waterfowl, rails, double-crested cormorants, common terns, northern harrier, merlin, and bald eagles were noted during our August 1996 vegetation survey.

Most of the Wisconsin shoreline is undeveloped, and forested with paper birch (*Betula papyrifera*) and trembling aspen (*Populus tremuloides*). Remnant stands of conifers, mostly spruce and pine, are scattered along the clay bluffs. Where homes and docks have been constructed, as is the case near the Village of Oliver, erosion is often noticeable. Small patches of purple loosestrife (*Lythrum salicaria*) are often associated with the natural levees, or disturbed shoreline areas. Slumps occur on many of the clay bluffs exposed to the direct action of water and ice, especially when unprotected by stands of aquatic vegetation. The Minnesota side of the river has more residential and industrial development but also has extensive marshes.

Superior Municipal Forest

The 4,000-acre City of Superior Municipal Forest contains a wealth of natural features unusual in the context of an urban-industrial center. Among the most significant of these are stands of mature coniferous forest, extensive emergent marsh, and wet clay flats supporting a mixture of shrub swamp and wet meadow. The site borders the St. Louis River Estuary, which dissects the uplands into a series of narrow, steep-sided ridges.

The coniferous forests are composed primarily of species often associated with the boreal regions. Canopy dominants include white spruce (*Picea glauca*), white pine (*Pinus strobus*), balsam fir (*Abies balsamea*), balsam poplar (*Populus balsamifera*), and paper birch (*Betula papyrifera*). In some stands, red pine (*Pinus resinosa*), black ash (*Fraxinus nigra*), or white cedar (*Thuja occidentalis*) are important. Stands still showing the influence of past logging followed by fire are generally composed of trembling aspen (*Populus tremuloides*) and paper birch (*Betula papyrifera*). The moist understories are also reminiscent of a boreal flora, and include uncommon species such as lungwort (*Mertensia paniculata*) and rabbit-berry (*Shepherdia canadensis*).

Resident birds include many species associated with mature conifers, such as blackburnian, blackthroated green, pine, yellow-rumped, parula, and Cape May warblers. Winter wren, mourning warbler, veery, and hermit thrush inhabit the forest understory.

Throughout the Lake Superior Clay Plain Ecoregional Subsection, this forest type has been greatly fragmented and often replaced by monotypic stands of aspen (*Populus* spp.). Thus the stands within this site have at least a regional conservation significance. They could also provide a template for restoration actions considered elsewhere.

An extensive emergent marsh borders both sides of the Pokegama River (which is really an arm of the St. Louis River Estuary). Marsh composition is very similar to that of the stands found along the lower stretches of the St. Louis. Dominants include bur-reed (*Sparganium eurycarpum*), bulrushes (*Scirpus americanus, S. validus*), arrowheads (*Sagittaria latifolia, S. rigidus*), and cattail (*Typha* spp.). Deeper waters support submergent and floating-leaved species, such as coontail (*Ceratophyllum demersum*), bladderwort (*Utricularia macrorhiza*), and many pondweeds (*Potamogeton* spp.). Among the resident birds are Virginia rail, sora, and marsh wren. Northern harrier, common tern, and bald eagle were noted foraging in the marsh on several occasions.

The invasive exotic purple loosestrife (*Lythrum salicaria*) is uncommon but unfortunately widespread in the marsh. Efforts to control it should begin as soon as possible. A heavy infestation occurs just to the east of the city forest in ditched wetlands bordering railroad tracks and State Trunk Highway 105 on the west side of the Village of South Superior. As these ditches drain into ravines which eventually reach the Pokegama River, it is possible that this roadside population is a source of propagules which eventually are washed into the marsh. Eradication of this potential source population is recommended.

The shrub swamp and meadow complex provides habitat for several rare plants, including clustered burred (*Sparganium glomeratum*), small yellow water crowfoot (*Ranunculus gmelinii*), and sweet coltsfoot (*Petasites sagittatus*). Dominant plants include speckled alder (*Alnus incana*), willows (*Salix* spp.), lake sedge (*Carex lacustris*), and bluejoint grass (*Calamagrostis canadensis*). Birds such as alder flycatcher, yellow warbler, sedge wren, and white-throated sparrow are common in these communities. This wetland is the southwesternmost portion of a formerly much larger and contiguous wetland which has been partially destroyed and greatly disrupted by growth of the City of Superior. Additional surveys are desirable in the Municipal Forest's shrub swamp and meadow habitats.

A significant portion of this site was designated as a State Natural Area in 1996. This designation encompassed much of the mature forest and marsh, and also included a part of the wet clay flats in which rare plants occur.

Superior Airport / Hill Avenue Wetlands / South Superior Triangle

These three sites, now separated by roads, railroad tracks, and other urban developments, are the largest remnants of a formerly contiguous wetland within the City of Superior. The wetlands are mosaics of shrub swamp and open meadow, with a few small patches of emergent marsh. Trembling aspen (*Populus tremuloides*) often occupies drier portions of the sites. Despite the severe disturbances which have altered the composition, structure, function, size, and configuration of these wetlands, they harbor significant populations of rare plants.

Dominant shrubs are speckled alder (*Alnus incana*) and willows (*Salix discolor, S. petiolaris, S. pyrifolia*, several others). Open meadows are typically dominated by broad-leaved sedges, most commonly lake sedge (*Carex lacustris*). Characteristic associates are flat-topped white aster (*Aster umbellatus*), joe-pye weed (*Eupatorium maculatum*), late goldenrod (*Solidago gigantea*), bedstraw bellflower (*Campanula aparinoides*), and marsh fern (*Thelypteris palustris*). Rare species occurring here include neat spikerush (*Eleocharis nitida*), clustered bur-reed (*Sparganium glomeratum*), small yellow water crowfoot (*Ranunculus gmelinii*), sweet coltsfoot

(*Petasites sagittatus*), Vasey's rush (*Juncus vaseyi*), and New England violet (*Viola novae-angliae*).

Among the resident birds are swamp sparrow, song sparrow, common yellowthroat, yellow warbler, gray catbird, alder flycatcher, and sedge wren.

Because of habitat fragmentation and isolation, and disrupted hydrology, these sites are highly vulnerable to damage even in the absence of future developments. The City of Superior has developed a Rare Plant Conservation Plan in association with the expansion of its airport. As part of the Plan, the City relocated many of the rare plant populations occurring at the new runway site. In addition, the Plan calls for the City to manage the wetlands to benefit rare plant species at the airport site that will not be impacted by the new runway, as well as lands it will be acquiring soon along Hill Avenue. This could include techniques such as brushing, prescribed burning, and scarification to create and perpetuate the microhabitats used by many of these rare species. In an effort to better understand which translocation and management techniques are most effective for these rare species, the City will monitor rare species populations at the airport for ten years.

The City of Superior also recently received approval from the U.S. Army Corps of Engineers for its Special Area Management Plan (SAMP). The goal of SAMP is to encourage residential, commercial, and industrial development in areas of the City that are most logical from a land-use planning perspective while minimizing environmental impacts. In developing the list of potential development sites in the SAMP, the City removed a site initially recommended for development along Hill Avenue due to the presence of rare plants. To ensure that important populations of rare species and high-quality natural communities are protected, the City will also contact BER for guidance on rare species inventories each time a site identified in the SAMP is proposed for development.

Lower Nemadji River Marshes

The lower stretches of the Nemadji River flow in a narrow valley through a heavily industrialized and urbanized portion of the City of Superior before emptying into Allouez Bay. A series of emergent marshes occurs along the inside of the well-developed meanders characteristic of this river. These are separated from the main channel by natural levees, which support a mixture of tall wetland shrubs and small lowland hardwoods. They also tend to be quite weedy. The steep clay bluffs confining the valley are generally undeveloped, sometimes forested, and provide a measure of buffering between the river system and the urban areas.

Important marsh plants include bur-reed (*Sparganium eurycarpum*), arrowheads (*Sagittaria latifolia, S. rigida*), soft-stemmed bulrush (*Scirpus validus*), broad-leaved cattail (*Typha latifolia*), lake sedge (*Carex lacustris*), marsh cinquefoil (*Potentilla palustris*), water horsetail (*Equisetum fluviatile*), and water parsnip (*Sium suave*). Locally deep, slowly flowing sloughs support stands of wild rice (*Zizania aquatica*) and beds of pondweeds (*Potamogeton* spp.). Drier portions of the wetlands contain patches of sedge meadow dominated by tussock sedge (*Carex stricta*) and bluejoint grass (*Calamagrostis canadensis*). Animals were not formally surveyed here but we recorded incidental observations during the breeding season of American bittern, wood duck, blue-winged teal, mallard, hooded merganser, and sedge wren.

Though the lower Nemadji system has suffered many abuses, it has retained many significant natural features and should be a prime candidate for remedial attention. The marshes are representatively diverse, dominated by native species, appear reasonably functional, and support uncommon birds. Exotic plants are still quite localized, associated mostly with the disturbed levees and formerly dredged areas near U.S. Highway 2. It would be worthwhile to expand biological surveys to allow a more complete evaluation of at least the vegetation and the resident birdlife. Future surveys should include additional wetlands upstream.

Wisconsin Point – Allouez Bay Marshes (LS #11)

Wisconsin Point.

Wisconsin Point is the eastern portion of a long coastal barrier spit separating the waters of Lake Superior from Allouez Bay. Major site features include several miles of open sand beach and dunes, small interdunal wetlands, and a xeric forest of white (*Pinus strobus*) and red pines (*P. resinosa*). The point and adjacent Allouez Bay receive heavy visitation by migrating birds in the spring. Developments include roads, vehicle turnouts, a Coast Guard station, and breakwater.

The open dunes are dominated by marram grass (*Ammophila breviligulata*) and beach pea (*Lathyrus japonicus*). Other characteristic plants are evening primrose (*Oenothera biennis*), sand cherry (*Prunus pumila*), Canada wild-rye (*Elymus canadensis*), common milkweed (*Asclepias syriaca*), jointweed (*Polygonella articulata*), rock cress (*Arabis lyrata*), and scouring rushes (*Equisetum* spp.). Stabilized dunes are colonized by shrubs such as common juniper (*Juniperus communis*) and false heather (*Hudsonia tomentosa*), and sapling trees. Disturbed areas are very weedy, with many exotic species present, and often support extensive beds of poison ivy (*Rhus radicans*). The exposed outer beaches are unvegetated.

A small, open, interdunal swale near the western tip of the point supports a community dominated by low graminoid plants, especially sedges (*Carex viridula, C. lasiocarpa*), rushes (*Juncus balticus*), and scouring rushes (*Equisetum* spp.). Other noteworthy species include red-stemmed gentian (*Gentiana rubricaulis)*, nodding ladies'-tresses (*Spiranthes cernua*), and a large population of the rare marsh grassof-Parnassus (*Parnassia palustris*). The swale is surrounded by dense thickets of tall shrubs, mostly speckled alder (*Alnus incana*), willows (*Salix* spp.), and red-osier dogwood (*Cornus stolonifera*). These shrubs are encroaching on the openings and should be monitored and controlled if necessary. The shrubs do provide a measure of security for this fragile site by screening it from most passersby. During 1996 this swale was very wet, with standing water reaching a depth of over 30 cm in July and August.

Many of these same species occur in a small opening east of the Coast Guard station on the bay side of the point. This area was apparently cleared of vegetation and then fenced in the hope that it would provide nesting habitat for the critically endangered piping plover. The center of this sand area was excavated to a depth slightly below the water table, providing suitable conditions for colonization by some of the interdunal swale plants. Of additional interest are other rarities, including little grape fern (*Botrychium simplex*), marsh horsetail (*Equisetum palustre*), and a possible first Wisconsin record for juniper clubmoss (*Lycopodium sabinaefolium*). Identification of the latter by specialists is pending.

The mature xeric forest covering the western half of the point is composed of white and red pines (*Pinus resinosa*), with a dense shrub layer of beaked hazelnut (*Corylus cornuta*). There may be a long-term concern for this forest as the pines cannot reproduce under the dense shade of the shrubs and hardwood saplings. Natural disturbances (such as fire) that formerly occurred here and ultimately benefitted shade intolerant species may no longer be acceptable. Pine plantations adjoin the natural forest and it would be desirable to eventually phase these out, restoring open dune vegetation or pine forest, whichever is most appropriate.

Resident birds include pine, black-throated green, and yellow-rumped warblers, ovenbird, red-breasted nuthatch, hermit thrush, and, possibly, merlin. This site will require both vigilance and active management to maintain and protect the many valuable natural features present.

Allouez Bay

Allouez Bay is situated between the City of Superior's east-side neighborhood of Allouez and Wisconsin Point. The eastern end of the bay is shallow and contains a large marsh, with patches of sedge meadow and a drowned tamarack swamp present near the base of Wisconsin Point. Several small streams, including Bear Creek and Bluff Creek, empty into the bay. A portion of the wetland at the head of the bay, but now cut off by the access road to Wisconsin Point, was filled in the past.

The marsh is dominated by tall graminoids, such as bur-reeds (*Sparganium eurycarpum*), bulrushes (*Scirpus validus, S. americanus*), spikerush (*Eleocharis smallii*), sedges (*Carex lacustris, C. aquatilis*), and cattails (*Typha* spp.). Broad-leaved arrowhead (*Sagittaria latifolia*) is also among the dominants. Other characteristic plant species include water horsetail (*Equisetum fluviatile*), water parsnip (*Sium suave*), and water hemlock (*Cicuta* spp.). Deep areas within and on the margins of the emergent marsh support floating-leaved and submergent aquatic macrophytes, especially coontail (*Ceratophyllum demersum*), pondweeds (*Potamogeton* spp.), common bladderwort (*Utricularia macrorhiza*), and yellow water lily (*Nuphar variegatum*). The uncommon small-leaved yellow water lily (*Nuphar microphyllum*) occurs in the deepest waters of the bay capable of supporting rooted aquatic vegetation. The portions of the wetland nearest the shore are dominated by sedges (especially *Carex lacustris, C. stricta, C. lasiocarpa*). Tamarack (*Larix laricina*) snags are scattered throughout parts of this area.

It is possible that this wetland formerly contained extensive mats of wire-leaved sedges, but that eutrophication and other disturbances led to changed conditions which aided the spread and eventual dominance of the coarser, more tolerant emergents. Nevertheless, this wetland retains high wildlife values. In the early spring, substantial numbers of waterbirds of many kinds congregate here. This site may be especially significant in years when the break-up of ice on Lake Superior is late (as it was in 1996), and little open water is available elsewhere. The marsh also supports many nesting birds, including uncommon species like American bittern, least bittern, and northern harrier. The DNR has been supporting a tern nesting habitat restoration project at Wisconsin Point-Allouez Bay and common terns, sometimes several score, were observed foraging on the bay in 1995-96.

Divide Swamp (LS #12)

This complex of lowland forests, shrub swamp, and springs is the headwaters region of both the St. Croix and Brule rivers. The diverse lowland forests include stands of tamarack (*Larix laricina*), white cedar (*Thuja occidentalis*), black spruce (*Picea mariana*), and black ash (*Fraxinus nigra*). The sandy, rolling uplands are intensively managed for trembling aspen

(*Populus tremuloides*) and pine (*Pinus* spp.). Much of the latter is grown in plantations. County Trunk Highway P crosses the site from north to south.

The mature tamarack swamp is even-aged and has few canopy associates. The understory features a well-developed layer of tall shrubs, especially speckled alder (*Alnus incana*). Saplings are mostly black ash (*Fraxinus nigra*), with occasional balsam fir (*Abies balsamea*). Representative herbs include the sedges *Carex disperma, C. leptalea,* and *C. vaginata*, manna grass (*Glyceria striata*), cinnamon fern (*Osmunda cinnamomea*), sensitive fern (*Onoclea sensibilis*), marsh marigold (*Caltha palustris*), and the violets *Viola cucullata* and *V. pallens*. *Sphagnum* and other mosses are significant in parts of this community. Small pools are frequent where there is a hummock-hollow microtopography. Several rare plants occur here.

The white cedar-dominated (*Thuja occidentalis*) forest is quite extensive. Though evidence of past logging was noted, the canopy has closed and recent disturbance is mostly due to heavy browse by whitetailed deer. Trees are mostly in the 9"-15" d.b.h. size class but larger individuals are occasionally encountered. Generally drier than the tamarack swamp, understory plants include goldthread (*Coptis trifolia*), bunchberry (*Cornus canadensis*), twinflower (*Linnaea borealis*), sedges and mosses. Where black spruce (*Picea mariana*) becomes dominant, the understory often includes many ericaceous shrubs, such as Labrador tea (*Ledum groenlandicum*), blueberries (*Vaccinium angustifolium, V. myrtilloides*), leatherleaf (*Chamaedaphne calyculata*) and creeping snowberry (*Gaultheria hispidula*). The moss layer is well-developed and includes a number of *Sphagnum* spp.

Several small rectangular clearcuts occurred in the 1970s just east of County Trunk Highway P, close to the Brule River. Each of these was given a different post-cutting treatment to study regeneration of white cedar (*Thuja occidentalis*). None of the treatments appeared successful, but it would be worthwhile to examine this problem in considerably more detail, as cedar reproduction is as poor throughout the Lake Superior drainage basin as it is elsewhere in Wisconsin. The cedar forests of the Brule River are major repositories of biodiversity and their loss would be of great significance.

Black ash (*Fraxinus nigra*) is the primary canopy component of the site's hardwood swamps. Tree size, canopy closure, and shrub/sapling density are all variable. Common understory plants are speckled alder (*Alnus incana*), manna grass (*Glyceria striata*), marsh marigold (*Caltha palustris*), bluejoint grass (*Calamagrostis canadensis*), sensitive fern (*Onoclea sensibilis*), crested shield fern (*Dryopteris cristata*) and sedges (*Carex* spp.).

Divide Swamp is within the Brule River State Forest and its ecological attributes should be thoroughly evaluated prior to committing to any management decisions. As a new master plan for the Brule River State Forest is scheduled to be developed in the near future, that would be an appropriate time to consider the site's values.

Brule Spillway (LS #13)
This six-mile stretch of the Brule River features an extensive conifer swamp, shrub swamp, sedge meadow, and numerous springs and spring runs. The site also contains several stands of old-growth white (*Pinus strobus*) and red pine (*P. resinosa*), an extremely rare successional stage of this formerly widespread community.

The conifer swamp is dominated by white cedar (*Thuja occidentalis*), with balsam fir (*Abies balsamea*), tamarack (*Larix laricina*), black spruce (*Picea mariana*), and black ash (*Fraxinus nigra*) the major associates. Some stands are in or are approaching old-growth condition. The sapling layer is composed mostly of fir, with black ash (*Fraxinus nigra*) locally common. Cedar seedlings are common but saplings are very rare. Important shrubs include mountain maple (*Acer spicatum*), speckled alder (*Alnus incana*), and alder-leaved buckthorn (*Rhamnus alnifolia*). A few small patches of Canada yew (*Taxus canadensis*) are present. The vascular flora is quite rich. Among the common herbs and low shrubs are goldthread (*Coptis trifolia*), twinflower (*Linnaea borealis*), Labrador tea (*Ledum groenlandicum*), bunchberry (*Cornus canadensis*), and many sedges and orchids. Rich lichen and bryophtye flora also occur here.

Many species of rare plants are found here, including lapland buttercup (*Ranunculus lapponicus*), fairy slipper (*Calypso bulbosa*), northern black currant (*Ribes hudsonianum*), small yellow lady's-slipper (*Cypripedium parviflorum*), and sheathed sedge (*Carex vaginata*).

Bibon Swamp

Bibon Swamp is a vast wetland of over 10,000 acres within the drainage of the White River. The western portion of the site is a mosaic of several extensive wetland communities of generally good quality: a rich wet-mesic conifer swamp dominated by white cedar (*Thuja occidentalis*); a much more acid peaty swamp of black spruce (*Picea mariana*) and tamarack (*Larix laricina*); a hardwood swamp of black ash (*Fraxinus nigra*); and large stands of tall shrubs, especially speckled alder (*Alnus incana*) and willows (*Salix* spp.). Other communities of significance though of lesser areal extent are: northern sedge meadow composed of *Carex* spp. and bluejoint grass (*Calamagrostis canadensis*); and patches or strips of riparian hardwoods composed of American elm (*Ulmus americana*), red maple (*Acer rubrum*), green ash (*Fraxinus pennsylvanica*), and box elder (*Acer negundo*) along the White River.

The white cedar swamp canopy is made up of mostly medium-size trees (9-15" d.b.h. size class). Trunk corings revealed that at least parts of this stand are in excess of 150 years old. Saplings are mostly of black ash (*Fraxinus nigra*) and balsam fir (*Abies balsamea*), with cedar reproduction limited to small seedlings. A tall shrub layer of moderate density is composed of mountain maple (*Acer spicatum*), alder buckthorn (*Rhamnus alnifolia*), and speckled alder (*Alnus incana*). Representative herbs and low shrubs include bunchberry (*Cornus canadensis*), twinflower (*Linnaea borealis*), small bishop's cap (*Mitella nuda*), and dwarf raspberry (*Rubus pubescens*). A number of orchid taxa are scattered through portions of this forest. Mosses of several genera form a surface cover which is broken by pools of muck and occasional spring runs. Overall, groundlayer species richness is high. Resident birds include Nashville, parula and Canada warblers, northern waterthrush, and winter wren. Deer remains were noted in the interior of the stand, victims of the harsh winter of 1995-96. This community is located south of the White River near the western edge of the site.

Bordering the cedar swamp on the extreme western edge of the site is a wet forest of mature black ash (*Fraxinus nigra*). In portions of this forested wetland the trees grow on low hummocks, which are separated by pools of soupy muck. The ash is represented in all vegetative strata. Characteristic groundlayer species are speckled alder (*Alnus incana*), fowl manna grass (*Glyceria striata*), sensitive fern (*Onoclea sensibilis*), orange touch-me-not (*Impatiens biflora*), lake sedge (*Carex lacustris*), and wood nettle (*Laportea canadensis*). Poison ivy (*Rhus radicans*) is abundant (maddeningly so!) in some areas. Red-eyed vireo, black-and-white warbler, Nashville warbler, and veery are common in this forest.

North of the river conditions are very different and there is a large complex of acid peatland communities including open bog, muskeg, and black spruce swamp. The more open areas are characterized by scattered, stunted black spruce (*Picea mariana*) with some tamarack (*Larix laricina*). Deep sphagnum hummocks form a continuous ground cover, upon which ericaceous shrubs grow including leatherleaf (*Chamaedaphne calyculata*), bog laurel (*Kalmia polifolia*), bog rosemary (*Andromeda glaucophylla*), and small cranberry (*Vaccinium oxycoccos*). Common herbs include the sedges *Carex oligosperma, C. pauciflora*, and *C. paupercula*, and *Eriophorum spissum*. Where the canopy of spruce is more closed, Labrador tea (*Ledum groenlandicum*), three-leaved false Solomon's seal (*Smilacina trifolia*), and threeseeded sedge (*Carex trisperma*) are common understory members.

From the air it was apparent that the depth of the sphagnum peat has formed a dome, somewhat isolating the peatland vegetation from the influence of mineral rich groundwater or runoff from the uplands. A ring of large tamarack (*Larix laricina*) encircles the bog, and beyond that is a minerotrophic shrub swamp of alder (*Alnus* spp.) and willow (*Salix* spp.). Among the resident birds of these coniferous peatlands are palm warbler, Lincoln's sparrow, white-throated sparrow, yellow-bellied flycatcher, sharp-shinned hawk, and boreal chickadee.

The shrub swamps are vast, densely structured, and very difficult to cross. In some places, especially to the east, they may be a result of the combined impacts of disrupted hydrology, past logging, fire suppression, and natural succession. Stumps and remnants of open sedge meadows give evidence of historical changes in the vegetation. Dominant or characteristic species include slender willow (*Salix gracilis*), red-osier dogwood (*Cornus stolonifera*), speckled alder (*Alnus incana*), meadowsweet (*Spiraea alba*), rough bedstraw (*Galium asprellum*), and many sedges (*Carex* spp.). Representative species of the open meadows are lake sedge, tussock sedge (*Carex stricta*), bluejoint grass (*Calamagrostis canadensis*), spotted joe-pye-weed (*Eupatorium maculatum*), flat-topped aster (*Aster umbellatus*), marsh marigold (*Caltha palustris*), marsh bellflower (*Campanula aparinoides*), and fringed brome (*Bromus ciliatus*). Occasional tamarack (*Larix laricina*), balsam poplar (*Populus balsamifera*), and trembling aspen (*P. tremuloides*) rise above the shrub canopy.

Birds present in the shrub and meadow stands are common yellowthroat, yellow warbler, gray catbird, alder flycatcher, mourning warbler, golden-winged warbler, sedge wren, common snipe, woodcock, ruffed grouse, and black-billed cuckoo.

This site has considerable intrinsic value owing to its size, roadlessness, and the quality of some of its communities. It also supports at least seven rare plant and animal species. Formerly disturbed areas are recovering in some places, but seem to be in a holding pattern in others. Agricultural lands adjacent to the wetlands could pose runoff problems. White cedar (*Thuja occidentalis*) is not successfully reproducing due to heavy browse pressure. A threat to this site includes the presence of glossy buckthorn. This site also supports a valuable sport fishery, and is fed by small streams and springs coming from the south and west. Bibon Swamp is a vital connecting link between the extensive forests to the south and the Bad River corridor downstream. Maintenance of high water quality and streamside vegetation, especially along the White River, is critical throughout the watershed.

Appendix J. Wetland Functional Correlations (NWIplus Tabular & Spatial Querries)

Amphibian Habitat (AMH) Function

AMH Function Performance Correlations		
Level of Function	**Wetland Type**	**Notes**
High	PEM_C or wetter (and mixes where EM is dominant), Any P__Cg or wetter water regime, PD1b and c (forest upland context = vernal pool), PEM1B_g (fen), PEM2_, L2AB, L2EM2_, PAB, R_EM2 (wild rice)	
Moderate	P__H or G (not rated as High), _AB_F & _UB_F (not rated as High), L2__H or G (not rated as High)	

AMH = High Model Query Statements				
Function Correlation Statement	**Query Statement**	**Notes**	**Corrected Query Statement**	**Action Needed**
PEM_C or wetter (and mixes where EM is dominant),	*Select PEM_C_wetter* "NWI_System" = 'P' AND "NWI_Class" = 'EM' AND ("NWI_Regime" = 'C' OR "NWI_Regime" = 'F' OR "NWI_Regime" = 'G' OR "NWI_Regime" = 'H' OR "NWI_Regime" = 'K')			
Any P__Cg or wetter water regime (note: Cg is expected to have standing water for 2 months during growing season),	*Select P__Cg* "NWI_System" = 'P' AND ("NWI_Regime" = 'C' OR "NWI_Regime" = 'F' OR "NWI_Regime" = 'G' OR "NWI_Regime" = 'H' OR "NWI_Regime" = 'K') AND "NWI_Modifier" = 'g'			
PD1b and c (forest upland context = vernal pool),	*Select PD* "NWI_PLUS_CODE" LIKE ('PD%') AND (			

AMH = High Model Query Statements				
Function Correlation Statement	**Query Statement**	**Notes**	**Corrected Query Statement**	**Action Needed**
	"NWI_PLUS_CODE" LIKE '%1b%' OR "NWI_PLUS_CODE" LIKE '%1c%')			
PEM1B_g (fen), PEM2_,	*Select PEM* "NWI_System" = 'P' AND "NWI_Class" = 'EM' AND (("NWI_SubClass" = '1' AND "NWI_Regime" = 'B' AND "NWI_Modifier" = 'g') OR ("NWI_SubClass" = '2'))	What about mixes?		
L2AB, L2EM2_	*Select L2* "NWI_System" = 'L' AND "NWI_Subsystem" = '2' AND (("NWI_Class" = 'AB') OR ("NWI_Class" = 'EM' AND "NWI_SubClass" = '2'))			
PAB,	*Select PAB* "NWI_System" = 'P' AND "NWI_Class" = 'AB'			
R_EM2 (wild rice)	*Select R_EM2* "NWI_System" = 'R' AND "NWI_Class" = 'EM' AND "NWI_SubClass" = '2'			

<u>Process steps/Queries:</u>

Select PEM_C_wetter

"NWI_System" = 'P' AND "NWI_Class" = 'EM' AND ("NWI_Regime" = 'C' OR "NWI_Regime" = 'F' OR "NWI_Regime" = 'G' OR "NWI_Regime" = 'H' OR "NWI_Regime" = 'K')

Select P__Cg

"NWI_System" = 'P' AND ("NWI_Regime" = 'C' OR "NWI_Regime" = 'F' OR "NWI_Regime" = 'G' OR "NWI_Regime" = 'H' OR "NWI_Regime" = 'K') AND "NWI_Modifier" = 'g'

Select PD

"NWI_PLUS_CODE" LIKE ('PD%') AND ("NWI_PLUS_CODE" LIKE '%1b%' OR "NWI_PLUS_CODE" LIKE '%1c%')

Select PEM

"NWI_System" = 'P' AND "NWI_Class" = 'EM' AND (("NWI_SubClass" = '1' AND "NWI_Regime" = 'B' AND "NWI_Modifier" = 'g') OR ("NWI_SubClass" = '2'))

Select L2

"NWI_System" = 'L' AND "NWI_Subsystem" = '2' AND (("NWI_Class" = 'AB') OR ("NWI_Class" = 'EM' AND "NWI_SubClass" = '2'))

Select PAB

"NWI_System" = 'P' AND "NWI_Class" = 'AB'

Select R_EM2

"NWI_System" = 'R' AND "NWI_Class" = 'EM' AND "NWI_SubClass" = '2'

AMH = Moderate Model Query Statements				
Function Correlation Statement	**Query Statement**	**Notes**	**Corrected Query Statement**	**Action Needed**
P__H or G (not rated as High),	Select P__H/G "NWI_System" = 'P' AND ("NWI_Regime" = 'H' OR "NWI_Regime" = 'G')			
L2__H or G (not rated as High)	Select L2__H/G ("NWI_System" = 'L' AND "NWI_Subsystem" = '2') AND ("NWI_Regime" = 'H' OR "NWI_Regime" = 'G')			
_AB_F & _UB_F (not rated as High)	Select _F_ "NWI_Regime" = 'F' AND ("NWI_Class" = 'AB' OR "NWI_Class" = 'UB')			

<u>Process steps/Queries:</u>

Select P__H/G

"NWI_System" = 'P' AND "NWI_Class" = 'EM' AND ("NWI_Regime" = 'C' OR "NWI_Regime" = 'F' OR "NWI_Regime" = 'G' OR "NWI_Regime" = 'H' OR "NWI_Regime" = 'K')

Select L2__H/G

("NWI_System" = 'L' AND "NWI_Subsystem" = '2') AND ("NWI_Regime" = 'H' OR "NWI_Regime" = 'G')

*Select L2_F_*

"NWI_Regime" = 'F' AND ("NWI_Class" = 'AB' OR "NWI_Class" = 'UB')

Carbon Sequestration (CAR) Function

CAR Function Performance Correlations		
Level of Function	**Wetland Type**	**Notes**
High	P__ (AB,EM, SS, FO, and mixes)F, P__ (AB,EM, SS, FO, and mixes)G, P__ (AB,EM, SS, FO, and mixes)H, P__ (AB,EM, SS, FO, and mixes)Cg, P___Ba (and mixes), PFO4Bg (and mixes), R_EM2, L2EM2__, PEM2_, R_EMF, L1AB, P___g	Exclude _FO2/_, _SS2/_
Moderate	All remaining vegetated wetlands not selected as High	

CAR = High & Moderate Model Query Statements				
Function Correlation Statement	**Query Statement**	**Notes**	**Corrected Query Statement**	**Action Needed**
P__ (AB,EM, SS, FO, and mixes)F, P__ (AB,EM, SS, FO, and mixes)G, P__ (AB,EM, SS, FO, and mixes)H, P__ (AB,EM, SS, FO, and mixes)Cg,	*Select P_Veg_F/G/H/Cg* ("NWI_System" = 'P' AND ("NWI_Class" = 'AB' OR "NWI_Class" = 'EM' OR "NWI_Class" = 'SS' OR "NWI_Class" = 'FO')) AND ("NWI_Regime" = 'F' OR "NWI_Regime" = 'G' OR "NWI_Regime" = 'H' OR ("NWI_Regime" = 'C' AND "NWI_Modifier" = 'g'))			
P___Ba (and mixes),	*Select P__Ba* "NWI_System" = 'P' AND "NWI_Regime" = 'B' AND "NWI_Modifier" = 'a'			
PFO4Bg (and mixes),	*Select PFO4Bg* ("NWI_System" = 'P' AND "NWI_Class" = 'FO' AND "NWI_SubClass" = '4' AND "NWI_Regime" = 'B' AND "NWI_Modifier" = 'g')			

CAR = High & Moderate Model Query Statements				
Function Correlation Statement	**Query Statement**	**Notes**	**Corrected Query Statement**	**Action Needed**
R_EM2, L2EM2__, PEM2_,	*Select R,L,P_EM2* ("NWI_System" = 'R' OR "NWI_System" = 'P' OR "NWI_System" = 'L') AND ("NWI_Class" = 'EM' AND "NWI_SubClass" = '2')			
R_EMF,	*Select R_EMF* "NWI_System" = 'R' AND "NWI_Class" = 'EM' AND "NWI_Regime" = 'F'			
L1AB	*Select L1AB* "NWI_System" = 'L' AND "NWI_Subsystem" = '1' AND "NWI_Class" = 'AB'			
P___g	*Select P__g* "NWI_System" = 'P' AND "NWI_Modifier" = 'g'			
Exclude _FO2/_, _SS2/_	*Exclude* NOT ((("NWI_Class" = 'FO' AND "NWI_SubClass" = '2') OR ("NWI_Class" = 'SS' AND "NWI_SubClass" = '2')) AND "NWI_SubClass" IS NOT NULL)			

Process steps/Queries:

Exclude

NOT ((("NWI_Class" = 'FO' AND "NWI_SubClass" = '2') OR ("NWI_Class" = 'SS' AND "NWI_SubClass" = '2')) AND "NWI_SubClass" IS NOT NULL)

Select P_Veg_F/G/H/Cg

("NWI_System" = 'P' AND ("NWI_Class" = 'AB' OR "NWI_Class" = 'EM' OR "NWI_Class" = 'SS' OR "NWI_Class" = 'FO')) AND ("NWI_Regime" = 'F' OR "NWI_Regime" = 'G' OR "NWI_Regime" = 'H' OR ("NWI_Regime" = 'C' AND "NWI_Modifier" = 'g'))

Select P__Ba

"NWI_System" = 'P' AND "NWI_Regime" = 'B' AND "NWI_Modifier" = 'a'

Select PFO4Bg

("NWI_System" = 'P' AND "NWI_Class" = 'FO' AND "NWI_SubClass" = '4' AND "NWI_Regime" = 'B' AND "NWI_Modifier" = 'g')

Select P__g

"NWI_System" = 'P' AND "NWI_Modifier" = 'g'

Select R,L,P_EM2

("NWI_System" = 'R' OR "NWI_System" = 'P' OR "NWI_System" = 'L') AND ("NWI_Class" = 'EM' AND "NWI_SubClass" = '2')

Select R_EMF

"NWI_System" = 'R' AND "NWI_Class" = 'EM' AND "NWI_Regime" = 'F'

Select L1AB

"NWI_System" = 'L' AND "NWI_Subsystem" = '1' AND "NWI_Class" = 'AB'

CAR = Moderate Model Query Statements				
Function Correlation Statement	**Query Statement**	**Notes**	**Corrected Query Statement**	**Action Needed**
All remaining vegetated wetlands not selected as High = Moderate	*Select Veg* "NWI_Class" IN ('AB', 'EM', 'FO', 'SS')			

<u>Process steps/Queries:</u>

Select Veg

"NWI_Class" IN ('AB', 'EM', 'FO', 'SS')

Fish Habitat (FIS) Function

FIS Function Performance Correlations		
Level of Function	**Wetland Type**	**Notes**
High	LE and F or wetter; LS and LR F or wetter water regime; TE_OUhw and TEFROUhw F or wetter wetlands; PD_OU F or wetter, PD_TH F or wetter, Any LK_ or RV_,	Shrub bogs (e.g., PSS3Ba) and commercial bogs (PSSf) should be excluded
Moderate	PD1_TH, PD2_TH, PD4_TH, LS_BA_TH (C water regime), LR_FPbaTH (C water regime), PUBG or PUBH or split classes of these	Shrub bogs (e.g., PSS3Ba) and commercial bogs (PSSf) should be excluded
Stream Shading	LS (not LS4 or not LS__pd) and PFO, LS (not LS4) and PSS (not PSS_Ba or not PSSf)	Shrub bogs (e.g., PSS3Ba) and commercial bogs (PSSf) should be excluded

FIS = High Model Query Statements				
Function Correlation Statement	**Query Statement**	**Notes**	**Corrected Query Statement**	**Action Needed**
LE and F or wetter; LS and LR F or wetter water regime;	*Select LS_LR_LE_F+* ("NWI_PLUS_CODE" LIKE 'LE%' OR "NWI_PLUS_CODE" LIKE 'LR%' OR "NWI_PLUS_CODE" LIKE 'LR%') AND ("NWI_Regime" = 'F' OR "NWI_Regime" = 'G' OR "NWI_Regime" = 'H')			
TE_OUhw and TEFROUhw F or wetter wetlands;	*Select TE_F+* ("NWI_PLUS_CODE" LIKE 'TE%OU%hw%') AND ("NWI_Regime" = 'F' OR "NWI_Regime" = 'G' OR "NWI_Regime" = 'H')			
PD_OU F or wetter, PD_TH F or wetter,	*Select PD_F+* ("NWI_PLUS_CODE" LIKE 'PD%OU%' OR			

FIS = High Model Query Statements				
Function Correlation Statement	**Query Statement**	**Notes**	**Corrected Query Statement**	**Action Needed**
	"NWI_PLUS_CODE" LIKE 'PD%TH%') AND ("NWI_Regime" = 'F' OR "NWI_Regime" = 'G' OR "NWI_Regime" = 'H')			
Any LK_ or RV_,	*Select LK_RV* "NWI_PLUS_CODE" LIKE 'LK%' OR "NWI_PLUS_CODE" LIKE 'RV%'			
Shrub bogs (e.g., PSS3Ba) and commercial bogs (PSSf) should be excluded	*Exclude* NOT (("NWI_System" = 'P' AND "NWI_Class" = 'SS' AND "NWI_SubClass" = '3' AND "NWI_Regime" = 'B') OR ("NWI_System" = 'P' AND "NWI_Class" = 'SS' AND "NWI_Modifier" = 'f' AND NOT "NWI_Modifier" IS NULL))			

Process steps/Queries:

Exclude

NOT (("NWI_System" = 'P' AND "NWI_Class" = 'SS' AND "NWI_SubClass" = '3' AND "NWI_Regime" = 'B') OR ("NWI_System" = 'P' AND "NWI_Class" = 'SS' AND "NWI_Modifier" = 'f' AND NOT "NWI_Modifier" IS NULL))

Select LS_LR_LE_F+

("NWI_PLUS_CODE" LIKE 'LE%' OR "NWI_PLUS_CODE" LIKE 'LR%' OR "NWI_PLUS_CODE" LIKE 'LR%') AND ("NWI_Regime" = 'F' OR "NWI_Regime" = 'G' OR "NWI_Regime" = 'H')

Select TE_F+

("NWI_PLUS_CODE" LIKE 'TE%OU%hw%') AND ("NWI_Regime" = 'F' OR "NWI_Regime" = 'G' OR "NWI_Regime" = 'H')

Select PD_F+

("NWI_PLUS_CODE" LIKE 'PD%OU%' OR "NWI_PLUS_CODE" LIKE 'PD%TH%') AND ("NWI_Regime" = 'F' OR "NWI_Regime" = 'G' OR "NWI_Regime" = 'H')

Select LK_RV

"NWI_PLUS_CODE" LIKE 'LK%' OR "NWI_PLUS_CODE" LIKE 'RV%'

FIS = Moderate Model Query Statements				
Function Correlation Statement	**Query Statement**	**Notes**	**Corrected Query Statement**	**Action Needed**
PD1_TH, PD2_TH, PD4_TH	*Select PD* "NWI_PLUS_CODE" LIKE 'PD1%TH%' OR "NWI_PLUS_CODE" LIKE 'PD2%TH%' OR "NWI_PLUS_CODE" LIKE 'PD4%TH%'			
LS_BA_TH (C water regime)	*Select LS* "NWI_PLUS_CODE" LIKE 'LS%BA%TH%' AND "NWI_Regime" = 'C'			
LR_FPbaTH (C water regime)	*Select LR* "NWI_PLUS_CODE" LIKE 'LR%FP%ba%TH%' AND "NWI_Regime" = 'C'			
PUBG or PUBH or split classes of these,	*Select PUB_G_H* (("NWI_System" = 'P' AND "NWI_Class" = 'UB') AND ("NWI_Regime" = 'G' OR "NWI_Regime" = 'H')) OR (("NWI_System" = 'P' AND "NWI_Class2" = 'UB') AND ("NWI_Regime" = 'G' OR "NWI_Regime" = 'H'))	Be sure to capture any split class PUBG or PUBH (e.g., PFO5/UBH), also, be sure that PUBF are not selected unless they have TH (throughflow)		
Shrub bogs (e.g., PSS3Ba) and commercial bogs (PSSf) should be excluded	*Exclude* NOT (("NWI_System" = 'P' AND "NWI_Class" = 'SS' AND "NWI_SubClass" = '3' AND "NWI_Regime" = 'B') OR ("NWI_System" = 'P' AND "NWI_Class" = 'SS' AND			

FIS = Moderate Model Query Statements				
Function Correlation Statement	**Query Statement**	**Notes**	**Corrected Query Statement**	**Action Needed**
	"NWI_Modifier" = 'f'))			

Process steps/Queries:

Exclude

NOT (("NWI_System" = 'P' AND "NWI_Class" = 'SS' AND "NWI_SubClass" = '3' AND "NWI_Regime" = 'B') OR ("NWI_System" = 'P' AND "NWI_Class" = 'SS' AND "NWI_Modifier" = 'f'))

Select PD

"NWI_PLUS_CODE" LIKE 'PD1%TH%' OR "NWI_PLUS_CODE" LIKE 'PD2%TH%' OR "NWI_PLUS_CODE" LIKE 'PD4%TH%'

Select LS

"NWI_PLUS_CODE" LIKE 'LS%BA%TH%' AND "NWI_Regime" = 'C'

Select LR

"NWI_PLUS_CODE" LIKE 'LR%FP%ba%TH%' AND "NWI_Regime" = 'C'

Select PUB_G_H

(("NWI_System" = 'P' AND "NWI_Class" = 'UB') AND ("NWI_Regime" = 'G' OR "NWI_Regime" = 'H')) OR (("NWI_System" = 'P' AND "NWI_Class2" = 'UB') AND ("NWI_Regime" = 'G' OR "NWI_Regime" = 'H'))

FIS = Shade Model Query Statements				
Function Correlation Statement	**Query Statement**	**Notes**	**Corrected Query Statement**	**Action Needed**
LS (not LS4 or not LS__pd) and PFO,	*Select LS_PFO* ("NWI_PLUS_CODE" LIKE 'LS%' AND NOT ("NWI_PLUS_CODE" LIKE 'LS4%' OR "NWI_PLUS_CODE" LIKE 'LS%pd%')) AND ("NWI_System" = 'P' AND "NWI_Class" = 'FO')			
LS (not LS4) and PSS (not PSS_Ba or not PSSf)	*Select LS_PSS* ("NWI_PLUS_CODE" LIKE 'LS%' AND NOT "NWI_PLUS_CODE" LIKE 'LS4%') AND ("NWI_System" = 'P' AND "NWI_Class" = 'SS')			

FIS = Shade Model Query Statements				
Function Correlation Statement	**Query Statement**	**Notes**	**Corrected Query Statement**	**Action Needed**
Shrub bogs (e.g., PSS3Ba) and commercial bogs (PSSf) should be excluded	*Exclude* NOT (("NWI_System" = 'P' AND "NWI_Class" = 'SS' AND "NWI_SubClass" = '3' AND "NWI_Regime" = 'B') OR ("NWI_System" = 'P' AND "NWI_Class" = 'SS' AND "NWI_Modifier" = 'f' AND NOT "NWI_Modifier" IS NULL))			

<u>Process steps/Queries:</u>

Exclude

NOT (("NWI_System" = 'P' AND "NWI_Class" = 'SS' AND "NWI_SubClass" = '3' AND "NWI_Regime" = 'B') OR ("NWI_System" = 'P' AND "NWI_Class" = 'SS' AND "NWI_Modifier" = 'f' AND NOT "NWI_Modifier" IS NULL))

Select LS_PFO

("NWI_PLUS_CODE" LIKE 'LS%' AND NOT ("NWI_PLUS_CODE" LIKE 'LS4%' OR "NWI_PLUS_CODE" LIKE 'LS%pd%')) AND ("NWI_System" = 'P' AND "NWI_Class" = 'FO')

Select LS_PSS

("NWI_PLUS_CODE" LIKE 'LS%' AND NOT "NWI_PLUS_CODE" LIKE 'LS4%') AND ("NWI_System" = 'P' AND "NWI_Class" = 'SS')

Nutrient Transformation (NT) Function

NT Function Performance Correlations		
Level of Function	**Wetland Type**	**Notes**
High	P__(AB, EM, SS, FO and mixes)C, P__(AB, EM, SS, FO and mixes)H (except impoundments), P__(AB, EM, SS, FO and mixes)B (not on coastal plain or glaciolacustrine plain), Wetlands with "Bg" (except "Bag" or beaver impoundments (b)), PD3fv	
Moderate	P__(AB, EM, SS, FO and mixes including __/UB and UB/__, etc.)F except farmed (f) and non semipermanently flooded and excavated (x) associated with UB, P__(EM, SS, FO)A, P__(AB, EM, SS, FO and mixes)B (e.g., on coastal plain or	

NT Function Performance Correlations		
Level of Function	**Wetland Type**	**Notes**
	glaciolacustrine plain; excluding bogs such as PSS3Ba and beaver impoundments (b)), Wetlands with “Bm”	
	Douglas County criteria:	

NT = High Model Query Statements				
Function Correlation Statement	**Query Statement**	**Notes**	**Corrected Query Statement**	**Action Needed**
P__(AB, EM, SS, FO and mixes)C, P__(AB, EM, SS, FO and mixes)H (except impoundments),	*Select P__C/H* ("NWI_System" = 'P' AND ("NWI_Class" IN ('AB', 'EM', 'FO', 'SS') AND "NWI_Class2" IN ('AB', 'EM', 'FO', 'SS', NULL))) AND (("NWI_Regime" = 'C') OR (("NWI_Regime" = 'H' AND NOT "NWI_Modifier" = 'h') OR ("NWI_Regime" = 'H' AND "NWI_Modifier" IS NULL)))			
P__(AB, EM, SS, FO and mixes)B (not on coastal plain or glaciolacustrine plain),	*Select P__B* (("NWI_System" = 'P' AND ("NWI_Class" IN ('AB', 'EM', 'FO', 'SS') AND "NWI_Class2" IN ('AB', 'EM', 'FO', 'SS', NULL))) AND ("NWI_Regime" = 'B')) AND "clay_plain" IS NULL			
Wetlands with “Bg” (except “Bag” or beaver impoundments (b))	*Select Bg* "NWI_Regime" = 'B' AND "NWI_Modifier" = 'g'			
PD3fv	*Select PD3_fv* "NWI_PLUS_CODE" LIKE			

NT = High Model Query Statements				
Function Correlation Statement	**Query Statement**	**Notes**	**Corrected Query Statement**	**Action Needed**
	'PD3%fv%'			

Process steps/Queries:

Select P__C/H

("NWI_System" = 'P' AND ("NWI_Class" IN ('AB', 'EM', 'FO', 'SS') AND "NWI_Class2" IN ('AB', 'EM', 'FO', 'SS', NULL))) AND (("NWI_Regime" = 'C') OR (("NWI_Regime" = 'H' AND NOT "NWI_Modifier" = 'h') OR ("NWI_Regime" = 'H' AND "NWI_Modifier" IS NULL)))

Select P__B

(("NWI_System" = 'P' AND ("NWI_Class" IN ('AB', 'EM', 'FO', 'SS') AND "NWI_Class2" IN ('AB', 'EM', 'FO', 'SS', NULL))) AND ("NWI_Regime" = 'B')) AND "clay_plain" IS NULL

Select Bg

"NWI_Regime" = 'B' AND "NWI_Modifier" = 'g'

Select PD3_fv

"NWI_PLUS_CODE" LIKE 'PD3%fv%'

NT = Moderate Model Query Statements				
Function Correlation Statement	**Query Statement**	**Notes**	**Corrected Query Statement**	**Action Needed**
P__(AB, EM, SS, FO and mixes including __/UB and UB/__, etc.)F except farmed (f) and non semipermanently flooded and excavated (x) associated with UB	*Select P__F* "NWI_System" = 'P' AND ((("NWI_Class" IN ('AB', 'EM', 'FO', 'SS') AND "NWI_Class2" IN ('AB', 'EM', 'FO', 'SS', 'UB' ,NULL)) OR ("NWI_Class" = 'UB' AND NOT "NWI_Class2" IS NULL)) AND NOT ("NWI_Class" = 'UB' AND "NWI_Modifier" = 'x' OR "NWI_Class2" = 'UB' AND "NWI_Modifier" = 'x')) AND (("NWI_Regime" = 'F' AND			

NT = Moderate Model Query Statements				
Function Correlation Statement	**Query Statement**	**Notes**	**Corrected Query Statement**	**Action Needed**
	NOT "NWI_Modifier" = 'f') OR ("NWI_Regime" = 'F' AND "NWI_Modifier" IS NULL))			
P__(EM, SS, FO)A	*Select P__A* ("NWI_System" = 'P' AND ("NWI_Class" IN ('EM', 'FO', 'SS') AND "NWI_Class2" IN ('EM', 'FO', 'SS', NULL))) AND ("NWI_Regime" = 'A')			
P__(AB, EM, SS, FO and mixes)B (e.g., on coastal plain or glaciolacustrine plain; excluding bogs such as PSS3Ba and beaver impoundments (b))	*Select P__B* (("NWI_System" = 'P' AND ("NWI_Class" IN ('AB', 'EM', 'FO', 'SS') AND "NWI_Class2" IN ('AB', 'EM', 'FO', 'SS', NULL))) AND ("NWI_Regime" = 'B')) AND "clay_plain" = 1			
Wetlands with "Bm"	*Select Bm* "NWI_Regime" = 'B' AND "NWI_Modifier" = 'm'			

<u>Process steps/Queries:</u>

Select P__F

"NWI_System" = 'P' AND ((("NWI_Class" IN ('AB', 'EM', 'FO', 'SS') AND "NWI_Class2" IN ('AB', 'EM', 'FO', 'SS', 'UB' ,NULL)) OR ("NWI_Class" = 'UB' AND NOT "NWI_Class2" IS NULL)) AND NOT ("NWI_Class" = 'UB' AND "NWI_Modifier" = 'x' OR "NWI_Class2" = 'UB' AND "NWI_Modifier" = 'x')) AND (("NWI_Regime" = 'F' AND NOT "NWI_Modifier" = 'f') OR ("NWI_Regime" = 'F' AND "NWI_Modifier" IS NULL))

Select P__A

("NWI_System" = 'P' AND ("NWI_Class" IN ('EM', 'FO', 'SS') AND "NWI_Class2" IN ('EM', 'FO', 'SS', NULL))) AND ("NWI_Regime" = 'A')

Select P__B

(("NWI_System" = 'P' AND ("NWI_Class" IN ('AB', 'EM', 'FO', 'SS') AND "NWI_Class2" IN ('AB', 'EM', 'FO', 'SS', NULL))) AND ("NWI_Regime" = 'B')) AND "clay_plain" = 1

Select Bm

"NWI_Regime" = 'B' AND "NWI_Modifier" = 'm'

Other Wildlife Habitat (OWH) Function

OWH Function Performance Correlations		
Level of Function	**Wetland Type**	**Notes**
High	Any vegetated wetland complex > 20 acres, wetlands 10-20 acres with 2 or more vegetated classes (excluding EM5), small isolated wetlands in dense cluster in a forest matrix (restrict to forest regions of U.S. with woodland vernal pools currently unable to delineate), Vegetated wetlands and wetland complexes < 10 acres and directly adjacent to RV or part of chain of wetlands adjacent to RV	
Moderate	Other vegetated wetlands	

OWH = High Model Query Statements				
Function Correlation Statement	**Query Statement**	**Notes**	**Corrected Query Statement**	**Action Needed**
Any vegetated wetland complex > 20 acres, wetlands 10-20 acres with 2 or more vegetated classes (excluding EM5),	*Select Vegetated* ("NWI_Class" IN ('AB', 'EM', 'SS', 'FO') AND NOT ("NWI_Class" = 'EM' AND "NWI_SubClass2" = '5')) *Select GTE_20* ACRES >= 20 *Select LT_20* ACRES < 20 *Select 10-20* ACRES >= 10 AND ACRES < 20 *Select LT_10* ACRES < 10			
small isolated wetlands in dense cluster in a forest		Can't identify from available data		

OWH = High Model Query Statements				
Function Correlation Statement	**Query Statement**	**Notes**	**Corrected Query Statement**	**Action Needed**
matrix (restrict to forest regions of U.S. with woodland vernal pools)				
Vegetated wetlands and wetland complexes < 10 acres and directly adjacent to RV or part of chain of wetlands adjacent to RV	*Select RV* "NWI_PLUS_CODE" LIKE 'RV%'			

<u>Process steps/Queries:</u>

Select Vegetated

("NWI_Class" IN ('AB', 'EM', 'SS', 'FO') AND NOT ("NWI_Class" = 'EM' AND "NWI_SubClass2" = '5'))

Select GTE_20

ACRES >= 20

Select LT_20

ACRES < 20

Select 10-20

ACRES >= 10 AND ACRES < 20

Select LT_10

ACRES < 10

Select RV

"NWI_PLUS_CODE" LIKE 'RV%'

OWH = Moderate Model Query Statements				
Function Correlation Statement	**Query Statement**	**Notes**	**Corrected Query Statement**	**Action Needed**
Other vegetated wetlands	All vegetated wetlands not already identified as High			

Process steps/Queries:

Select vegetated wetlands and erase from selection those already selected as "High"

Sediment and Other Particulate Retention (SR) Function

SR Function Performance Correlations		
Level of Function	**Wetland Type**	**Notes**
High	LEBA (veg), LEFR (vegetated and mixes, not “fm”-floating mat), LEIL(veg and mixes, not “fm”), LSFR(veg), LRFR (veg, not “fm”), LRIL (veg), LSBA, LRBA, LRFP, PDTH, TEBATH, TEBATI, TEBAIS, TEBAIN, TEIFbaTH, TEIFbaTI, TE_FR_TH, TE__pdTH (including __pq), All impounded (h) wetlands, “Moderate” wetlands with _IN_ or _TH_ and adjacent or intersect ditcches	Floating mats (fm) and no “B” wetlands should be identified as significant for this function
Moderate	LEBA (nonveg), LEFR (nonveg), LRIL (nonveg), LRFR (nonveg), LSFR (nonveg), LEFL (veg), LSFL or LRFL (not P___B_), Other TE__pd (not P__B_), Other TEBA (not P__B_), TEFL__ (P__A, not P__B_), PD (not c, d, e, f, g, j types)	Floating mats (fm) and no “B” wetlands should be identified as significant for this function

SR = High Model Query Statements				
Function Correlation Statement	**Query Statement**	**Notes**	**Corrected Query Statement**	**Action Needed**
LEBA (veg), LEFR (vegetated and mixes, not “fm”-floating mat), LEIL(veg and mixes, not “fm”), LSFR(veg), LRFR (veg, not “fm”), LRIL (veg),	*Select Veg_no_fm* ("NWI_Class" IN ('AB', 'EM', 'FO', 'SS') AND "NWI_Class2" IN ('AB', 'EM', 'FO', 'SS', NULL)) *Select LE_Veg* ("NWI_PLUS_CODE" LIKE 'LE%BA%' OR "NWI_PLUS_CODE" LIKE 'LE%FR%' OR "NWI_PLUS_CODE" LIKE 'LE%IL%') *Select LR_Veg* ("NWI_PLUS_CODE" LIKE 'LR%FR%' OR "NWI_PLUS_CODE" LIKE			

SR = High Model Query Statements				
Function Correlation Statement	**Query Statement**	**Notes**	**Corrected Query Statement**	**Action Needed**
	'LR%IL%') *Select LS_Veg* ("NWI_PLUS_CODE" LIKE 'LS%FR%')			
LSBA, LRBA, LRFP, PDTH,	*Select Lotic_Ponds* ("NWI_PLUS_CODE" LIKE 'LS%BA%' OR "NWI_PLUS_CODE" LIKE 'LR%BA%' OR "NWI_PLUS_CODE" LIKE 'LR%FP%' OR "NWI_PLUS_CODE" LIKE 'PD%TH%')			
TEBATH, TEBATI, TEBAIS TEBAIN TEIFbaTH, TEIFbaTI, TE_FR_TH TE__pdTH (including __pq),	*Select TEBA* ("NWI_PLUS_CODE" LIKE 'TE%BA%' AND ("NWI_PLUS_CODE" LIKE '%IN%' OR "NWI_PLUS_CODE" LIKE '%IS%' OR "NWI_PLUS_CODE" LIKE '%TH%' OR "NWI_PLUS_CODE" LIKE '%TI%')) *Select TEIFba* ("NWI_PLUS_CODE" LIKE 'TE%IF%ba%' AND ("NWI_PLUS_CODE" LIKE '%TH%' OR "NWI_PLUS_CODE" LIKE '%TI%')) *Select TE* ("NWI_PLUS_CODE" LIKE 'TE%' AND (			

SR = High Model Query Statements				
Function Correlation Statement	**Query Statement**	**Notes**	**Corrected Query Statement**	**Action Needed**
	"NWI_PLUS_CODE" LIKE '%FR%TH%' OR "NWI_PLUS_CODE" LIKE '%pd%TH%'))			
All impounded (h) wetlands	Select Impound "NWI_Modifier" = 'h'			
"Moderate" wetlands with _IN_ or _TH_ and adjacent or intersect ditches	***In SR-Moderate model*** *Select TEOI* "SR" = 'Moderate' AND "NWI_PLUS_CODE" LIKE 'TE%OI%ds%'			
No isolated Terrene Flats that are saturated, B wetlands or floating mats	*Exclude* NOT (("NWI_PLUS_CODE" LIKE 'TE%FL%IS%' AND "NWI_Regime" = 'B') OR ("NWI_Regime" = 'B') OR ("NWI_PLUS_CODE" LIKE '%fm%'))			

<u>Process steps/Queries:</u>

Exclude

NOT (("NWI_PLUS_CODE" LIKE 'TE%FL%IS%' AND "NWI_Regime" = 'B') OR ("NWI_Regime" = 'B') OR ("NWI_PLUS_CODE" LIKE '%fm%'))

Select Veg_no_fm

("NWI_Class" IN ('AB', 'EM', 'FO', 'SS') AND "NWI_Class2" IN ('AB', 'EM', 'FO', 'SS', NULL))

Select LE_Veg

("NWI_PLUS_CODE" LIKE 'LE%BA%' OR "NWI_PLUS_CODE" LIKE 'LE%FR%' OR "NWI_PLUS_CODE" LIKE 'LE%IL%')

Select LR_Veg

("NWI_PLUS_CODE" LIKE 'LR%FR%' OR "NWI_PLUS_CODE" LIKE 'LR%IL%')

Select LS_Veg

("NWI_PLUS_CODE" LIKE 'LS%FR%')

Select Lotic_Ponds

("NWI_PLUS_CODE" LIKE 'LS%BA%' OR "NWI_PLUS_CODE" LIKE 'LR%BA%' OR "NWI_PLUS_CODE" LIKE 'LR%FP%' OR "NWI_PLUS_CODE" LIKE 'PD%TH%')

Select TEBA

("NWI_PLUS_CODE" LIKE 'TE%BA%' AND ("NWI_PLUS_CODE" LIKE '%IN%' OR "NWI_PLUS_CODE" LIKE '%IS%' OR "NWI_PLUS_CODE" LIKE '%TH%' OR "NWI_PLUS_CODE" LIKE '%TI%'))

Select TEIFba

("NWI_PLUS_CODE" LIKE 'TE%IF%ba%' AND ("NWI_PLUS_CODE" LIKE '%TH%' OR "NWI_PLUS_CODE" LIKE '%TI%'))

Select TE

("NWI_PLUS_CODE" LIKE 'TE%' AND ("NWI_PLUS_CODE" LIKE '%FR%TH%' OR "NWI_PLUS_CODE" LIKE '%pd%TH%'))

Select Impound

"NWI_Modifier" = 'h'

SR = Moderate Model Query Statements				
Function Correlation Statement	**Query Statement**	**Notes**	**Corrected Query Statement**	**Action Needed**
LEBA (nonveg), LEFR (nonveg), LRIL (nonveg), LRFR (nonveg), LSFR (nonveg)	*Select LE_LR_LS_NonVeg* ("NWI_PLUS_CODE" LIKE 'LE%BA%' OR "NWI_PLUS_CODE" LIKE 'LE%FR%' OR "NWI_PLUS_CODE" LIKE 'LR%IL%' OR "NWI_PLUS_CODE" LIKE 'LR%FR%' OR "NWI_PLUS_CODE" LIKE 'LS%FR%') AND NOT "NWI_Class" IN ('AB','EM','FO','SS')			
LEFL (veg),	*Select LEFL* "NWI_Class" IN ('AB','EM','FO','SS') AND "NWI_PLUS_CODE" LIKE 'LE%FL%'			
LSFLor LRFL (not P___B_),	*Select LS/RFL* "NWI_PLUS_CODE" LIKE 'LS%FL%' OR			

SR = Moderate Model Query Statements				
Function Correlation Statement	**Query Statement**	**Notes**	**Corrected Query Statement**	**Action Needed**
	"NWI_PLUS_CODE" LIKE 'LR%FL%'			
Other TE__pd (not P__B_), Other TEBA (not P__B_)	*Select TE* "NWI_PLUS_CODE" LIKE 'TE%BA%' OR "NWI_PLUS_CODE" LIKE 'TE%pd%'			
TEFL__ (P__A, not P__B_)	*Select TEFL_A* "NWI_PLUS_CODE" LIKE 'TE%FL%' AND "NWI_Regime" = 'A'			
PD (not c, d, e, f, g, j types),	*Select PD* "NWI_PLUS_CODE" LIKE 'PD%' AND NOT ("NWI_PLUS_CODE" LIKE '%c%' OR "NWI_PLUS_CODE" LIKE '%d%' OR "NWI_PLUS_CODE" LIKE '%e%' OR "NWI_PLUS_CODE" LIKE '%f%' OR "NWI_PLUS_CODE" LIKE '%g%' OR "NWI_PLUS_CODE" LIKE '%j%')			
No isolated Terrene Flats that are saturated, B wetlands or floating mats	*Exclude* NOT (("NWI_PLUS_CODE" LIKE 'TE%FL%IS%' AND "NWI_Regime" = 'B') OR ("NWI_Regime" = 'B') OR ("NWI_PLUS_CODE" LIKE '%fm%'))			

SR = Moderate Model Query Statements				
Function Correlation Statement	**Query Statement**	**Notes**	**Corrected Query Statement**	**Action Needed**
Spatial				
"Moderate" wetlands with _IN_ or _TH_ and adjacent or intersect ditches	*In SR-Moderate model* *Select I~~F~~N or TH* "SR" = 'High' AND ("NWI_PLUS_CODE" LIKE '%TH%' OR "NWI_PLUS_CODE" LIKE '%IN%')			

Process steps/Queries:

Exclude

NOT (("NWI_PLUS_CODE" LIKE 'TE%FL%IS%' AND "NWI_Regime" = 'B') OR ("NWI_Regime" = 'B') OR ("NWI_PLUS_CODE" LIKE '%fm%'))

Select LE_LR_LS_NonVeg

("NWI_PLUS_CODE" LIKE 'LE%BA%' OR "NWI_PLUS_CODE" LIKE 'LE%FR%' OR "NWI_PLUS_CODE" LIKE 'LR%IL%' OR "NWI_PLUS_CODE" LIKE 'LR%FR%' OR "NWI_PLUS_CODE" LIKE 'LS%FR%') AND NOT "NWI_Class" IN ('AB','EM','FO','SS')

Select LEFL

"NWI_Class" IN ('AB','EM','FO','SS') AND "NWI_PLUS_CODE" LIKE 'LE%FL%'

Select LS/RFL

"NWI_PLUS_CODE" LIKE 'LS%FL%' OR "NWI_PLUS_CODE" LIKE 'LR%FL%'

Select TE

"NWI_PLUS_CODE" LIKE 'TE%BA%' OR "NWI_PLUS_CODE" LIKE 'TE%pd%'

Select TEFL_A

"NWI_PLUS_CODE" LIKE 'TE%FL%' AND "NWI_Regime" = 'A'

Select PD

"NWI_PLUS_CODE" LIKE 'PD%' AND NOT ("NWI_PLUS_CODE" LIKE '%c%' OR "NWI_PLUS_CODE" LIKE '%d%' OR "NWI_PLUS_CODE" LIKE '%e%' OR "NWI_PLUS_CODE" LIKE '%f%' OR "NWI_PLUS_CODE" LIKE '%g%' OR "NWI_PLUS_CODE" LIKE '%j%')

Spatial & Attribute queries:

Select TEOI

"SR" = 'Moderate' AND "NWI_PLUS_CODE" LIKE 'TE%OI%ds%'

Shorebird Habitat (SBH) Function

SBH Function Performance Correlations		
Level of Function	**Wetland Type**	**Notes**
High	PUS_C or A; L2US_C or A, R2US_C or A	
Moderate	L2UB_G, L2UBF (and mixes with EM if mapped), PUBG, PUBF	

SBH = High Model Query Statements				
Function Correlation Statement	**Query Statement**	**Notes**	**Corrected Query Statement**	**Action Needed**
PUS_C or A;	*Select PUS* ("NWI_System" = 'P' AND "NWI_Class" = 'US') AND ("NWI_Regime" = 'A' OR "NWI_Regime" = 'C')			
L2US_C, S or A,	*Select L2US* ("NWI_System" = 'L' AND "NWI_Subsystem" = '2' AND "NWI_Class" = 'US') AND ("NWI_Regime" = 'A' OR "NWI_Regime" = 'C' OR "NWI_Regime" = 'S')			
R2US_C or A	*Select R2US* ("NWI_System" = 'R' AND "NWI_Subsystem" = '2' AND "NWI_Class" = 'US') AND ("NWI_Regime" = 'A' OR "NWI_Regime" = 'C')			

Process steps/Queries:

Select PUS

("NWI_System" = 'P' AND "NWI_Class" = 'US') AND ("NWI_Regime" = 'A' OR "NWI_Regime" = 'C')

Select L2US

("NWI_System" = 'L' AND "NWI_Subsystem" = '2' AND "NWI_Class" = 'US') AND ("NWI_Regime" = 'A' OR "NWI_Regime" = 'C' OR "NWI_Regime" = 'S')

Select R2US

("NWI_System" = 'R' AND "NWI_Subsystem" = '2' AND "NWI_Class" = 'US') AND ("NWI_Regime" = 'A' OR "NWI_Regime" = 'C')

SBH = Moderate Model Query Statements				
Function Correlation Statement	**Query Statement**	**Notes**	**Corrected Query Statement**	**Action Needed**
L2UB_G, L2UBF (and mixes with EM if mapped)	*Select L2UB* ("NWI_System" = 'L' AND "NWI_Subsystem" = '2' AND "NWI_Class" = 'UB') AND ("NWI_Regime" = 'G' OR "NWI_Regime" = 'F')			
PUBG, PUBF	*Select PUB* ("NWI_System" = 'P' AND "NWI_Class" = 'UB') AND ("NWI_Regime" = 'G' OR "NWI_Regime" = 'F')			

<u>Process steps/Queries:</u>

Select L2UB

("NWI_System" = 'L' AND "NWI_Subsystem" = '2' AND "NWI_Class" = 'UB') AND ("NWI_Regime" = 'G' OR "NWI_Regime" = 'F')

Select PUB

("NWI_System" = 'P' AND "NWI_Class" = 'UB') AND ("NWI_Regime" = 'G' OR "NWI_Regime" = 'F')

Shoreline Stabilization (SS) Function

SS Function Performance Correlations		
Level of Function	**Wetland Type**	**Notes**
High	LR_(AB, EM, SS, FO and mixes; not LRIL), LS_(AB, EM, SS, FO and mixes, not LSIL), LE__(AB, EM, SS, FO and mixes; not LEIL and not “fm”), PD’s adjacent to streams, vegetated wetlands adjacent to Streams	Exclude __Fh, __Gh, & __Hh
Moderate	TE__pd (AB, EM, SS, FO and mixes), TE%TI% or TE%TH%, TE__OUhw (AB, EM, SS, FO and mixes, no __IN or __IS) associated with Streams, vegetated wetlands adjacent to Ponds (PD)	Exclude __Fh, __Gh, & __Hh

SS = High Model Query Statements				
Function Correlation Statement	**Query Statement**	**Notes**	**Corrected Query Statement**	**Action Needed**
LR_(AB, EM, SS, FO and mixes; not LRIL),	*Select LR* ("NWI_PLUS_CODE" LIKE 'LR%' AND "NWI_Class" IN ('AB', 'EM', 'FO', 'SS')) AND NOT ("NWI_PLUS_CODE" LIKE '%IL%')			
LS_(AB, EM, SS, FO and mixes, not LSIL),	*Select LS* ("NWI_PLUS_CODE" LIKE 'LS%' AND "NWI_Class" IN ('AB', 'EM', 'FO', 'SS')) AND NOT ("NWI_PLUS_CODE" LIKE '%IL%')			
LE__(AB, EM, SS, FO and mixes; not LEIL and not “fm”)	*Select LE* ("NWI_PLUS_CODE" LIKE 'LE%' AND "NWI_Class" IN ('AB', 'EM', 'FO', 'SS')) AND NOT ("NWI_PLUS_CODE" LIKE '%IL%' OR "NWI_Modifier" = 'fm' AND NOT "NWI_Modifier" IS NULL			

SS = High Model Query Statements				
Function Correlation Statement	**Query Statement**	**Notes**	**Corrected Query Statement**	**Action Needed**
	)			
PD's adjacent to streams, vegetated wetlands adjacent to Streams (ST), Lakes (LK) or Rivers (RV)	*Select PD* "NWI_PLUS_CODE" LIKE 'PD%' *Select Veg* "NWI_Class" IN ('AB', 'EM', 'FO', 'SS') AND NOT ("NWI_PLUS_CODE" LIKE '%IL%') *Select LK,RV,ST* "NWI_System" = 'R' OR "NWI_PLUS_CODE" LIKE 'RV%' OR "NWI_PLUS_CODE" LIKE 'ST%' OR "NWI_PLUS_CODE" LIKE 'LK%''			
Exclude __Fh, __Gh, & __Hh	*Exclude* NOT (("NWI_Regime" = 'F' AND "NWI_Modifier" = 'h' AND NOT "NWI_Modifier" IS NULL) OR ("NWI_Regime" = 'G' AND "NWI_Modifier" = 'h' AND NOT "NWI_Modifier" IS NULL) OR ("NWI_Regime" = 'H' AND "NWI_Modifier" = 'h' AND NOT "NWI_Modifier" IS NULL))			

<u>Process steps/Queries:</u>

Attribute only queries:

Exclude

NOT (("NWI_Regime" = 'F' AND "NWI_Modifier" = 'h' AND NOT "NWI_Modifier" IS NULL) OR ("NWI_Regime" = 'G' AND "NWI_Modifier" = 'h' AND NOT "NWI_Modifier" IS NULL) OR ("NWI_Regime" = 'H' AND "NWI_Modifier" = 'h' AND NOT "NWI_Modifier" IS NULL))

Select LR

("NWI_PLUS_CODE" LIKE 'LR%' AND "NWI_Class" IN ('AB', 'EM', 'FO', 'SS')) AND NOT ("NWI_PLUS_CODE" LIKE '%IL%')

Select LS

("NWI_PLUS_CODE" LIKE 'LS%' AND "NWI_Class" IN ('AB', 'EM', 'FO', 'SS')) AND NOT ("NWI_PLUS_CODE" LIKE '%IL%')

Select LE

("NWI_PLUS_CODE" LIKE 'LE%' AND "NWI_Class" IN ('AB', 'EM', 'FO', 'SS')) AND NOT ("NWI_PLUS_CODE" LIKE '%IL%' OR "NWI_Modifier" = 'fm' AND NOT "NWI_Modifier" IS NULL)

Spatial & Attribute queries:

Select PD

"NWI_PLUS_CODE" LIKE 'PD%'

Select Veg

"NWI_Class" IN ('AB', 'EM', 'FO', 'SS') AND NOT ("NWI_PLUS_CODE" LIKE '%IL%')

Select LK,RV,ST

"NWI_System" = 'R' OR "NWI_PLUS_CODE" LIKE 'RV%' OR "NWI_PLUS_CODE" LIKE 'ST%' OR "NWI_PLUS_CODE" LIKE 'LK%'

SS = Moderate Model Query Statements				
Function Correlation Statement	**Query Statement**	**Notes**	**Corrected Query Statement**	**Action Needed**
TE__pd (AB, EM, SS, FO and mixes)	*Select TE_pd* "NWI_PLUS_CODE" LIKE 'TE%pd%' AND "NWI_Class" IN ('AB', 'EM', 'FO', 'SS')			
TE%TI% or TE%TH%	*Select TE* "NWI_PLUS_CODE" LIKE 'TE%TI%' OR "NWI_PLUS_CODE" LIKE 'TE%TH%'			
TE__OUhw (AB, EM, SS, FO and mixes, no __IN or __IS) associated with Streams	*Select TE_OUhw* ("NWI_PLUS_CODE" LIKE 'TE%OU%hw%' AND "NWI_Class" IN ('AB', 'EM',			

SS = Moderate Model Query Statements				
Function Correlation Statement	**Query Statement**	**Notes**	**Corrected Query Statement**	**Action Needed**
	'FO', 'SS')) AND NOT ("NWI_PLUS_CODE" LIKE '%IS%' OR "NWI_PLUS_CODE" LIKE '%IN%') *Select ST* (query NHD flowline layer) STREAM_ORDER = 1			
vegetated wetlands adjacent to Ponds (PD)	*Select Veg* "NWI_Class" IN ('AB', 'EM', 'FO', 'SS') AND NOT ("NWI_PLUS_CODE" LIKE '%IL%') *Select PD* "NWI_PLUS_CODE" LIKE 'PD%'			
Exclude __Fh, __Gh, & __Hh	*Exclude* NOT (("NWI_Regime" = 'F' AND "NWI_Modifier" = 'h' AND NOT "NWI_Modifier" IS NULL) OR ("NWI_Regime" = 'G' AND "NWI_Modifier" = 'h' AND NOT "NWI_Modifier" IS NULL) OR ("NWI_Regime" = 'H' AND "NWI_Modifier" = 'h' AND NOT "NWI_Modifier" IS NULL))			

Process steps/Queries:

Exclude

NOT (("NWI_Regime" = 'F' AND "NWI_Modifier" = 'h' AND NOT "NWI_Modifier" IS NULL) OR ("NWI_Regime" = 'G' AND "NWI_Modifier" = 'h' AND NOT "NWI_Modifier" IS NULL) OR ("NWI_Regime" = 'H' AND "NWI_Modifier" = 'h' AND NOT "NWI_Modifier" IS NULL))

Select TE_pd

("NWI_PLUS_CODE" LIKE 'TE%OU%hw%' AND "NWI_Class" IN ('AB', 'EM', 'FO', 'SS')) AND NOT ("NWI_PLUS_CODE" LIKE '%IS%' OR "NWI_PLUS_CODE" LIKE '%IN%')

Select TE

"NWI_PLUS_CODE" LIKE 'TE%TI%' OR "NWI_PLUS_CODE" LIKE 'TE%TH%'

Spatial & Attribute queries:

Select TE_OUhw

("NWI_PLUS_CODE" LIKE 'TE%OU%hw%' AND "NWI_Class" IN ('AB', 'EM', 'FO', 'SS')) AND NOT ("NWI_PLUS_CODE" LIKE '%IS%' OR "NWI_PLUS_CODE" LIKE '%IN%')

Select ST

STREAM_ORDER = 1

Select Veg

"NWI_Class" IN ('AB', 'EM', 'FO', 'SS') AND NOT ("NWI_PLUS_CODE" LIKE '%IL%')

Select PD

"NWI_PLUS_CODE" LIKE 'PD%'

Surface Water Detention (SWD) Function

SWD Function Performance Correlations		
Level of Function	**Wetland Type**	**Notes**
High	LEBA(ba), LEIL(il), LEFL (in reservoir and dammed areas only: LE2FL and LE3FL), LEFR, LE_ox_, LRBA(ba), LRIL(il), LRFPba, LRFR (excluding non-vegetated gravel bars/banks), LR_ox_, LSBA(ba), LSIL(il), LRFPba , LSFR (excluding non-vegetated gravel bars/banks), LS_ox_, PDBI (and adjacent to PDBI), PDIL(il), PD_ox_, PDTH, (excluding PD2f), TEBApdTH, TEBATH, TEIL(il), TEFRpdTH, TH_ox_, wetlands with "organic" soils associated with waterbodies, Small wetlands (buffered points) within floodplain of 3rd order streams, TE wetlands adjacent ditches	Exclude all sloped wetlands. Retained floating mat bogs such as LEFR because their area will store surface water when lake levels rise.
Moderate	LRFPfl, LSFL, PD (other except PD2f), LE1FL, TEBA (other than above, includes TEBA_IS), TE__pd (other, excluding slope wetlands TESLpd__), TEBATI, Temporarily Flooded Terrene Flat Outflow wetlands (TEFLOU__ + P___A_), all non-headwaters Saturated Terrene Flats Outflow (TEFLOU + P___B), Lotic sandbars and mudflats (TEFLOU + R_USA) (TEBAOU + R_USC), Temporarily Flooded Lentic wetlands adjacent to "natural lakes" (LE1_FLBI + P___A) and wetlands adjacent to "other dammed lakes" (LE3_FLBI + P___A),	Exclude all sloped wetlands. Retained floating mat bogs such as LEFR because their area will store surface water when lake levels rise.

SWD = High Model Query Statements				
Function Correlation Statement	**Query Statement**	**Notes**	**Corrected Query Statement**	**Action Needed**
Exclude all sloped wetlands	*Remove from selection* "NWI_PLUS_CODE" LIKE 'TE%SL%'	Excludes sloped wetlands		
LEBA(ba), LEIL(il), LEFL (in reservoir and dammed areas only: LE2FL and LE3FL), LEFR, LE_ox_,	*Select LE* "NWI_PLUS_CODE" LIKE 'LE%' AND ("NWI_PLUS_CODE" LIKE '%BA%' OR "NWI_PLUS_CODE" LIKE '%ba%' OR			

SWD = High Model Query Statements				
Function Correlation Statement	Query Statement	Notes	Corrected Query Statement	Action Needed
	"NWI_PLUS_CODE" LIKE '%IL%' OR "NWI_PLUS_CODE" LIKE '%il%' OR "NWI_PLUS_CODE" LIKE '%2%FL%' OR "NWI_PLUS_CODE" LIKE '%3%FL%' OR "NWI_PLUS_CODE" LIKE '%FR%' OR "NWI_PLUS_CODE" LIKE '%ox%')			
LRBA(ba), LRIL(il), LRFPba, LRFR (excluding non-vegetated gravel bars/banks), LR_ox_,	*Select LR* "NWI_PLUS_CODE" LIKE 'LR%' AND ("NWI_PLUS_CODE" LIKE '%BA%' OR "NWI_PLUS_CODE" LIKE '%ba%' OR "NWI_PLUS_CODE" LIKE '%IL%' OR "NWI_PLUS_CODE" LIKE '%il%' OR "NWI_PLUS_CODE" LIKE '%FP%ba%' OR ("NWI_PLUS_CODE" LIKE '%FR%' AND NOT "NWI_Class" = 'US' OR "NWI_Class" = 'UB') OR "NWI_PLUS_CODE" LIKE '%ox%')			
LSBA(ba), LSIL(il), LRFPba , LSFR (excluding non-vegetated gravel bars/banks), LS_ox_,	*Select LS* "NWI_PLUS_CODE" LIKE 'LS%' AND ("NWI_PLUS_CODE" LIKE '%BA%' OR "NWI_PLUS_CODE" LIKE			

SWD = High Model Query Statements				
Function Correlation Statement	**Query Statement**	**Notes**	**Corrected Query Statement**	**Action Needed**
	'%ba%' OR "NWI_PLUS_CODE" LIKE '%IL%' OR "NWI_PLUS_CODE" LIKE '%il%' OR "NWI_PLUS_CODE" LIKE '%FP%ba%' OR ("NWI_PLUS_CODE" LIKE '%FR%' AND NOT "NWI_Class" = 'US' OR "NWI_Class" = 'UB') OR "NWI_PLUS_CODE" LIKE '%ox%')			
PDBI, PDIL(il), PD_ox_, PDTH, (excluding PD2f)	*Select PD* ("NWI_PLUS_CODE" LIKE 'PD%' AND ("NWI_PLUS_CODE" LIKE '%BI%' OR "NWI_PLUS_CODE" LIKE '%IL%' OR "NWI_PLUS_CODE" LIKE '%il%' OR "NWI_PLUS_CODE" LIKE '%TH%' OR "NWI_PLUS_CODE" LIKE '%ox%')) AND NOT "NWI_PLUS_CODE" LIKE 'PD2f%'			
TEBApdTH, TEBATH, TEIL(il), TEFRpdTH, TH_ox_	*Select TE* "NWI_PLUS_CODE" LIKE 'TE%' AND ("NWI_PLUS_CODE" LIKE '%BA%pd%TH%' OR "NWI_PLUS_CODE" LIKE '%BA%TH%' OR "NWI_PLUS_CODE" LIKE '%IL%' OR			

SWD = High Model Query Statements				
Function Correlation Statement	**Query Statement**	**Notes**	**Corrected Query Statement**	**Action Needed**
	"NWI_PLUS_CODE" LIKE '%il%' OR "NWI_PLUS_CODE" LIKE '%FR%pd%TH%' OR "NWI_PLUS_CODE" LIKE '%ox%')			
LK, RV, ST, and PD (not PD2f) Waterbodies	*Select Waterbody* "NWI_PLUS_CODE" LIKE 'LK%' OR "NWI_PLUS_CODE" LIKE 'RV%' OR "NWI_PLUS_CODE" LIKE 'ST%' OR ("NWI_PLUS_CODE" LIKE 'PD%' AND NOT "NWI_PLUS_CODE" LIKE '%PD2f%')			
Small wetlands (buffered points within 3rd + order floodplain	*Select Floodpl* Floodpln =1			
Wetlands associated with bidirectional ponds	*Select Adj PDBI* "NWI_PLUS_CODE" LIKE 'PD%BI%'			

Process steps/Queries:

Attribute only queries:

Remove from selection

"NWI_PLUS_CODE" LIKE 'TE%SL%'

Select LE

"NWI_PLUS_CODE" LIKE 'LE%' AND ("NWI_PLUS_CODE" LIKE '%BA%' OR "NWI_PLUS_CODE" LIKE '%ba%' OR "NWI_PLUS_CODE" LIKE '%IL%' OR "NWI_PLUS_CODE" LIKE '%il%' OR "NWI_PLUS_CODE" LIKE '%2%FL%' OR "NWI_PLUS_CODE" LIKE '%3%FL%' OR "NWI_PLUS_CODE" LIKE '%FR%' OR "NWI_PLUS_CODE" LIKE '%ox%')

Select LR

"NWI_PLUS_CODE" LIKE 'LR%' AND ("NWI_PLUS_CODE" LIKE '%BA%' OR "NWI_PLUS_CODE" LIKE '%ba%' OR "NWI_PLUS_CODE" LIKE '%IL%' OR "NWI_PLUS_CODE" LIKE '%il%' OR "NWI_PLUS_CODE" LIKE '%FP%ba%' OR ("NWI_PLUS_CODE" LIKE '%FR%' AND NOT "NWI_Class" = 'US' OR "NWI_Class" = 'UB') OR "NWI_PLUS_CODE" LIKE '%ox%')

Select LS

"NWI_PLUS_CODE" LIKE 'LS%' AND ("NWI_PLUS_CODE" LIKE '%BA%' OR "NWI_PLUS_CODE" LIKE '%ba%' OR "NWI_PLUS_CODE" LIKE '%IL%' OR "NWI_PLUS_CODE" LIKE '%il%' OR "NWI_PLUS_CODE" LIKE '%FP%ba%' OR ("NWI_PLUS_CODE" LIKE '%FR%' AND NOT "NWI_Class" = 'US' OR "NWI_Class" = 'UB') OR "NWI_PLUS_CODE" LIKE '%ox%')

Select PD

("NWI_PLUS_CODE" LIKE 'PD%' AND ("NWI_PLUS_CODE" LIKE '%BI%' OR "NWI_PLUS_CODE" LIKE '%IL%' OR "NWI_PLUS_CODE" LIKE '%il%' OR "NWI_PLUS_CODE" LIKE '%TH%' OR "NWI_PLUS_CODE" LIKE '%ox%')) AND NOT "NWI_PLUS_CODE" LIKE 'PD2f%'

Select TE

"NWI_PLUS_CODE" LIKE 'TE%' AND ("NWI_PLUS_CODE" LIKE '%BA%pd%TH%' OR "NWI_PLUS_CODE" LIKE '%BA%TH%' OR "NWI_PLUS_CODE" LIKE '%IL%' OR "NWI_PLUS_CODE" LIKE '%il%' OR "NWI_PLUS_CODE" LIKE '%FR%pd%TH%' OR "NWI_PLUS_CODE" LIKE '%ox%')

Select Waterbody

"NWI_PLUS_CODE" LIKE 'LK%' OR "NWI_PLUS_CODE" LIKE 'RV%' OR "NWI_PLUS_CODE" LIKE 'ST%' OR ("NWI_PLUS_CODE" LIKE 'PD%' AND NOT "NWI_PLUS_CODE" LIKE '%PD2f%')

Select Floodpln

Floodpln =1

Spatial & Attribute queries:

Select Adj PDBI

"NWI_PLUS_CODE" LIKE 'PD%BI%'

SWD = High Submodel Query Statements				
Function Correlation Statement	**Query Statement**	**Notes**	**Corrected Query Statement**	**Action Needed**
Submodel - select "g" soils adjacent to water No TESL, PD2f, or R2US	*Exclude Uplands, TESL, PD2f & R2US* NOT ("NWI_PLUS_CODE" LIKE 'TE%SL%' OR "NWI_PLUS_CODE" LIKE 'PD2f%' OR ("NWI_System" = 'R' AND "NWI_Subsystem"			

SWD = High Submodel Query Statements				
Function Correlation Statement	**Query Statement**	**Notes**	**Corrected Query Statement**	**Action Needed**
	= '2' AND "NWI_Class" = 'US'))			
Wetlands with organic soils	Select Organic "NWI_Modifier" = 'g'			
LK, RV, ST, and PD (not PD2f) Waterbodies	Select Waterbody "NWI_PLUS_CODE" LIKE 'LK%' OR "NWI_PLUS_CODE" LIKE 'RV%' OR "NWI_PLUS_CODE" LIKE 'ST%' OR ("NWI_PLUS_CODE" LIKE 'PD%' AND NOT "NWI_PLUS_CODE" LIKE '%PD2f%')			

Process steps/Queries:

Select Waterbody

"NWI_PLUS_CODE" LIKE 'LK%' OR "NWI_PLUS_CODE" LIKE 'RV%' OR "NWI_PLUS_CODE" LIKE 'ST%' OR ("NWI_PLUS_CODE" LIKE 'PD%' AND NOT "NWI_PLUS_CODE" LIKE '%PD2f%')

Select Organic

"NWI_Modifier" = 'g'

Exclude Uplands, TESL, PD2f & R2US

NOT ("NWI_PLUS_CODE" LIKE 'TE%SL%' OR "NWI_PLUS_CODE" LIKE 'PD2f%' OR ("NWI_System" = 'R' AND "NWI_Subsystem" = '2' AND "NWI_Class" = 'US'))

SWD = Moderate Model Query Statements				
Function Correlation Statement	**Query Statement**	**Notes**	**Corrected Query Statement**	**Action Needed**
LRFPfl, LSFL, PD (other except PD2f),	*Select LR_LS_PD* "NWI_PLUS_CODE" LIKE 'LR%FP%fl%' OR			

SWD = Moderate Model Query Statements				
Function Correlation Statement	**Query Statement**	**Notes**	**Corrected Query Statement**	**Action Needed**
	"NWI_PLUS_CODE" LIKE 'LS%FL%' OR ("NWI_PLUS_CODE" LIKE 'PD%' AND NOT ("NWI_PLUS_CODE" LIKE 'PD2f%'))			
LE1FL,	*Select LE* "NWI_PLUS_CODE" LIKE 'LE1%FL%'			
TEBA (other than above, includes TEBAIS), TE__pd (other, excluding slope wetlands TESLpd__), TEBATI Temporarily Flooded Terrene Flat Outflow wetlands (TEFLOU__ + P___A_), all non-headwaters Saturated Terrene Flats Outflow (TEFLOU + P___B), Lotic sandbars and mudflats (TEFLOU + R_USA) (TEBAOU + R_USC). These classifications have not been mapped in this watershed.	*Select TE* "NWI_PLUS_CODE" LIKE 'TE%BA%' OR "NWI_PLUS_CODE" LIKE 'TE%BA%TI%' OR ("NWI_PLUS_CODE" LIKE 'TE%pd%' AND NOT ("NWI_PLUS_CODE" LIKE '%SL%')) OR ("NWI_PLUS_CODE" LIKE 'TE%FL%OU%' AND ("NWI_System" = 'P' AND ("NWI_Regime" = 'A' OR "NWI_Regime" = 'B'))) OR ("NWI_PLUS_CODE" LIKE 'TE%FL%OU%' AND ("NWI_System" = 'R' AND "NWI_Class" = 'US' AND "NWI_Regime" = 'A')) OR ("NWI_PLUS_CODE" LIKE 'TE%BA%OU%' AND ("NWI_System" = 'R' AND "NWI_Class" = 'US' AND "NWI_Regime" = 'C'))			
Any terrene wetland with outflow intermittent or outflow (TE_OI or TE_OU)	*Select All_TE* "NWI_PLUS_CODE" LIKE 'TE%OU%' OR			

SWD = Moderate Model Query Statements				
Function Correlation Statement	**Query Statement**	**Notes**	**Corrected Query Statement**	**Action Needed**
	"NWI_PLUS_CODE" LIKE 'TE%OI%'			
Temporarily Flooded Lentic wetlands adjacent to "natural lakes" (LE1_FLBI + P___A) and wetlands adjacent to "other dammed lakes" (LE3_FLBI + P___A)	*Select P__A* "NWI_System" = 'P' AND "NWI_Regime" = 'A' *Select Lakes* "NWI_PLUS_CODE" LIKE 'LE1%FL%BI%' OR "NWI_PLUS_CODE" LIKE 'LE3%FL%BI%'			
Exclude Terrene Flat Outflow or Outflow Intermittent (OI) wetlands with Saturated organic soils (e.g., TEFLOIds + P___B_g_), industrial wastewater ponds, any saturated wetlands "B" water regime from Moderate, e.g., PFO1Bg that is LSFL), sloped wetlands and wetland polygons previously selected as "High"	*Exclude* NOT (("NWI_PLUS_CODE" LIKE 'TE%FL%OU%' OR "NWI_PLUS_CODE" LIKE 'TE%FL%OI%' AND ("NWI_Regime" = 'B' AND "NWI_Modifier" = 'g' AND NOT "NWI_Modifier" IS NULL)) OR ("NWI_PLUS_CODE" LIKE 'PD%2d%' OR "NWI_PLUS_CODE" LIKE 'PD2f%' OR "NWI_PLUS_CODE" LIKE 'PD3f%') OR ("NWI_System" = 'R' AND "NWI_Subsystem" = '2' AND "NWI_Class" = 'US') OR ("NWI_Regime" = 'B') OR ("NWI_PLUS_CODE" LIKE 'TE%SL%'))	Exclude Terrene Flat Outflow headwaters wetlands with Saturated soils (TEFLOU + P___B_), sloped wetlands, industrial wastewater ponds and any saturated wetlands "B" water regime from Moderate, e.g., PFO1B that is LSFL		

Process steps/Queries:

Attribute Queries

Exclude

NOT ((("NWI_PLUS_CODE" LIKE 'TE%FL%OU%' OR "NWI_PLUS_CODE" LIKE 'TE%FL%OI%') AND ("NWI_Regime" = 'B' AND (NWI_Modifier = 'g' AND NOT NWI_Modifier IS NULL))) OR ("NWI_PLUS_CODE" LIKE 'PD%2d%' OR "NWI_PLUS_CODE" LIKE 'PD2f%' OR "NWI_PLUS_CODE" LIKE 'PD3f%') OR ("NWI_System" = 'R' AND "NWI_Subsystem" = '2' AND "NWI_Class" = 'US') OR ("NWI_Regime" = 'B') OR ("NWI_PLUS_CODE" LIKE 'TE%SL%'))

Select LR_LS_PD

"NWI_PLUS_CODE" LIKE 'LR%FP%fl%' OR "NWI_PLUS_CODE" LIKE 'LS%FL%' OR ("NWI_PLUS_CODE" LIKE 'PD%' AND NOT ("NWI_PLUS_CODE" LIKE 'PD2f%'))

Select LE

"NWI_PLUS_CODE" LIKE 'LE1%FL%'

Select TE

"NWI_PLUS_CODE" LIKE 'TE%BA%' OR "NWI_PLUS_CODE" LIKE 'TE%BA%TI%' OR ("NWI_PLUS_CODE" LIKE 'TE%pd%' AND NOT ("NWI_PLUS_CODE" LIKE '%SL%')) OR ("NWI_PLUS_CODE" LIKE 'TE%FL%OU%' AND ("NWI_System" = 'P' AND ("NWI_Regime" = 'A' OR "NWI_Regime" = 'B'))) OR ("NWI_PLUS_CODE" LIKE 'TE%FL%OU%' AND ("NWI_System" = 'R' AND "NWI_Class" = 'US' AND "NWI_Regime" = 'A')) OR ("NWI_PLUS_CODE" LIKE 'TE%BA%OU%' AND ("NWI_System" = 'R' AND "NWI_Class" = 'US' AND "NWI_Regime" = 'C'))

Select All_TE

"NWI_PLUS_CODE" LIKE 'TE%OU%' OR "NWI_PLUS_CODE" LIKE 'TE%OI%'

Spatial Queries:

Select P__A

"NWI_System" = 'P' AND "NWI_Regime" = 'A'

Select Lakes

"NWI_PLUS_CODE" LIKE 'LE1%FL%BI%' OR "NWI_PLUS_CODE" LIKE 'LE3%FL%BI%'

Stream-flow Maintenance (SM) Function

SM Function Performance Correlations		
Level of Function	**Wetland Type**	**Notes**
High	_hw_ (all headwater wetlands), _gd_ (groundwater dominated), PD_ (all ponds, excluding sewage treatment), all wetlands associated with waterbodies (excluding _IS_ and _IN_), Wetlands with “organic” soils	Exclude all sloped wetlands
Moderate	LR1FP, LS_BA, PDTH, TE__pdTH, PDOU, TE__pdOU, TEOU , LE wetlands associated with through-flow lakes (LK__TH), outside red clay plain wetlands connected to intermittent streams	Exclude all sloped wetlands

SM = High Model Query Statements				
Function Correlation Statement	**Query Statement**	**Notes**	**Corrected Query Statement**	**Action Needed**
hw (all headwater wetlands) & _gd_ (groundwater dominated	*Select hw_gd* "NWI_PLUS_CODE" LIKE '%hw%' OR "NWI_PLUS_CODE" LIKE '%gd%'			
PD_	*Select PD* "NWI_PLUS_CODE" LIKE 'PD%' AND NOT ("NWI_PLUS_CODE" LIKE 'PD2f%')			
Wetlands with organic soils	Select Organic "NWI_Modifier" = 'g'			

<u>Process steps/Queries:</u>

Exclude

NOT "NWI_PLUS_CODE" LIKE 'TE%SL%'

Select hw_gd

"NWI_PLUS_CODE" LIKE '%hw%' OR "NWI_PLUS_CODE" LIKE '%gd%'

Select PD

"NWI_PLUS_CODE" LIKE 'PD%' AND NOT ("NWI_PLUS_CODE" LIKE 'PD2f%')

Select Organic

"NWI_Modifier" = 'g'

SM = High Submodel Query Statements				
Function Correlation Statement	**Query Statement**	**Notes**	**Corrected Query Statement**	**Action Needed**
Submodel - select wetlands adjacent to water Exclude sloped wetlands	*Exclude* NOT "NWI_PLUS_CODE" LIKE 'TE%SL%'			
Exclude IN and IS wetlands	*Remove IN_IS* NOT "NWI_PLUS_CODE" LIKE '%IN%' OR "NWI_PLUS_CODE" LIKE '%IS%'			
LK, RV, ST, and PD (not PD2f) Waterbodies	*Add LK, PD, RV, ST* ("NWI_PLUS_CODE" LIKE 'LK%' OR "NWI_PLUS_CODE" LIKE 'RV%' OR "NWI_PLUS_CODE" LIKE 'ST%' OR ("NWI_PLUS_CODE" LIKE 'PD%' AND NOT ("NWI_PLUS_CODE" LIKE 'PD2f%'))) AND NOT ("NWI_PLUS_CODE" LIKE '%IN%' OR "NWI_PLUS_CODE" LIKE '%IS%')			

<u>Process steps/Queries:</u>

Exclude

NOT "NWI_PLUS_CODE" LIKE 'TE%SL%'

Add LK, PD, RV, ST

("NWI_PLUS_CODE" LIKE 'LK%' OR "NWI_PLUS_CODE" LIKE 'RV%' OR "NWI_PLUS_CODE" LIKE 'ST%' OR ("NWI_PLUS_CODE" LIKE 'PD%' AND NOT ("NWI_PLUS_CODE" LIKE 'PD2f%'))) AND NOT ("NWI_PLUS_CODE" LIKE '%IN%' OR "NWI_PLUS_CODE" LIKE '%IS%')

Remove IN_IS

NOT "NWI_PLUS_CODE" LIKE '%IN%' OR "NWI_PLUS_CODE" LIKE '%IS%'

SM = Moderate Model Query Statements				
Function Correlation Statement	**Query Statement**	**Notes**	**Corrected Query Statement**	**Action Needed**
LR1FP, LS_BA,	*Select LR_LS* "NWI_PLUS_CODE" LIKE 'LR1FP%' OR "NWI_PLUS_CODE" LIKE 'LS%BA%'			
PDTH, PDOU,	*Select PD* "NWI_PLUS_CODE" LIKE 'PD%TH%' OR "NWI_PLUS_CODE" LIKE 'PD%OU%'			
TE__pdTH,, TE__pdOU, TE_pd_IS, TE_pd_IN,	*Select TE_pd* "NWI_PLUS_CODE" LIKE 'TE%pd%' AND ("NWI_PLUS_CODE" LIKE '%IN%' OR "NWI_PLUS_CODE" LIKE '%IS%' OR "NWI_PLUS_CODE" LIKE '%TH%' OR "NWI_PLUS_CODE" LIKE '%OU%')			
TE_OU	*Select TE_OU* "NWI_PLUS_CODE" LIKE 'TE%OU%'			
LE%TH%,	*Select LE* "NWI_PLUS_CODE" LIKE			

SM = Moderate Model Query Statements				
Function Correlation Statement	**Query Statement**	**Notes**	**Corrected Query Statement**	**Action Needed**
	'LE%TH%'			

<u>Process steps/Queries:</u>

Exclude

NOT "NWI_PLUS_CODE" LIKE 'TE%SL%'

Select LR_LS

"NWI_PLUS_CODE" LIKE 'LR1FP%' OR "NWI_PLUS_CODE" LIKE 'LS%BA%'

Select PD

"NWI_PLUS_CODE" LIKE 'PD%TH%' OR "NWI_PLUS_CODE" LIKE 'PD%OU%'

Select TE_pd

"NWI_PLUS_CODE" LIKE 'TE%pd%' AND ("NWI_PLUS_CODE" LIKE '%IN%' OR "NWI_PLUS_CODE" LIKE '%IS%' OR "NWI_PLUS_CODE" LIKE '%TH%' OR "NWI_PLUS_CODE" LIKE '%OU%')

Select TE_OU

"NWI_PLUS_CODE" LIKE 'TE%OU%'

Select LE_TH

"NWI_PLUS_CODE" LIKE 'LE%TH%'

SM = Moderate Submodel Query Statements				
Function Correlation Statement	**Query Statement**	**Notes**	**Corrected Query Statement**	**Action Needed**
Submodel - select wetlands adjacent to water Remove sloped wetlands	*Exclude* NOT "NWI_PLUS_CODE" LIKE '%SL%'			
LE wetlands associated with throughflow lakes (LK__TH)	*Select LE* "NWI_PLUS_CODE" LIKE 'LE%'			

SM = Moderate Submodel Query Statements				
Function Correlation Statement	**Query Statement**	**Notes**	**Corrected Query Statement**	**Action Needed**
	Select LK_TH "NWI_PLUS_CODE" LIKE 'LK%TH%'			

<u>Process steps/Queries:</u>

Exclude

NOT "NWI_PLUS_CODE" LIKE '%SL%'

Select LE

"NWI_PLUS_CODE" LIKE 'LE%'

Select LK_TH

"NWI_PLUS_CODE" LIKE 'LK%TH%'

Waterfowl and Waterbird Habitat (WBIRD) Function

WBIRD Function Performance Correlations		
Level of Function	**Wetland Type**	**Notes**
High	LS(1,2, or 5)BA and P__ (FO or SS and mixes; not PSS3Ba or SSf), LS(1,2)FR and P__ (FO or SS and mixes; not PSS3Ba or PSSf), LR(1,2)FPba and P__(FO or SS and mixes; not PSS3Ba or PSSf), LR(1,2)BA and P__(FO or SS and mixes; not PSS3Ba or PSSf), LRFPba and PFO/EM, LRFPba and PUB/FO, L2AB (and mixes with non- vegetated), L2US_(F), L2UB_F, L2_F (vegetated, AB, EM, SS, FO and mixes with non-vegetated), L2_H or G (vegetated, AB, EM, SS, FO and mixes with non-vegetated), PAB, PUB__b, R_EMF, P__H or G (vegetated, EM, SS, FO including mixes with UB), P__F and adjacent to PD, LK, RV(not LR4) ST(not LS4), or waters; PEM1C__ (including mixes) and associated with PD, LK, RV(not LR4), or ST(not LS4), PD associated with P__(AB, EM,SS, FO)F	Shrub bogs (e.g., PSS3Ba) and commercial bogs(PSSf) should be excluded
Moderate	other L2UB (not listed as high), PD1, PD2 a3, b, h, PD3, or PD4, Other PEMF,PEMCs that are TEBA% or split classes (e.g., PEM/SS1C TEBAOIhw)	Shrub bogs (e.g., PSS3Ba) and commercial bogs(PSSf) should be excluded

WBIRD = High Model Query Statements				
Function Correlation Statement	**Query Statement**	**Notes**	**Corrected Query Statement**	**Action Needed**
LS(1,2, or 5)BA and P__ (FO or SS and mixes; not PSS3Ba or SSf), LS(1,2)FR and P__ (FO or SS and mixes; not PSS3Ba or PSSf),	*Select LSBA_LSFR_PSS-FO* ("NWI_System" = 'P' AND (("NWI_Class" = 'SS' OR "NWI_Class" = 'FO') AND ("NWI_Class2" IS NULL OR NOT "NWI_Class2" = 'UB'))) AND ("NWI_PLUS_CODE" LIKE 'LS1%BA%' OR "NWI_PLUS_CODE" LIKE 'LS2%BA%' OR "NWI_PLUS_CODE" LIKE 'LS5%BA%' OR "NWI_PLUS_CODE" LIKE			

WBIRD = High Model Query Statements				
Function Correlation Statement	**Query Statement**	**Notes**	**Corrected Query Statement**	**Action Needed**
	'LS1%FR%' OR "NWI_PLUS_CODE" LIKE 'LS2%FR%')			
LR(1,2)FPba and P__(FO or SS and mixes; not PSS3Ba or PSSf), LR(1,2)BA and P__(FO or SS and mixes; not PSS3Ba or PSSf),	*Select LRBA_LRFPba_PSS-FO* ("NWI_System" = 'P' AND (("NWI_Class" = 'SS' OR "NWI_Class" = 'FO') AND ("NWI_Class2" IS NULL OR NOT "NWI_Class2" = 'UB'))) AND ("NWI_PLUS_CODE" LIKE 'LR1%BA%' OR "NWI_PLUS_CODE" LIKE 'LR2%BA%' OR "NWI_PLUS_CODE" LIKE 'LR1%FP%ba%' OR "NWI_PLUS_CODE" LIKE 'LR2%FP%ba%')			
LRFPba and PFO/EM, LRFPba and PUB/FO	*Select LRFPba* ("NWI_PLUS_CODE" LIKE 'LR%FP%ba%' AND ("NWI_System" = 'P' AND "NWI_Class" = 'FO' AND "NWI_Class2" = 'EM')) OR ("NWI_PLUS_CODE" LIKE 'LR%FP%ba%' AND ("NWI_System" = 'P' AND "NWI_Class" = 'UB' AND "NWI_Class2" = 'FO'))			
L2AB (and mixes with non-vegetated),	*Select L2AB* "NWI_System" = 'L' AND "NWI_Subsystem" = '2' AND "NWI_Class" = 'AB'			
L2US_(F), L2UB_F	*Select L2US_UB_F* "NWI_System" = 'L' AND			

WBIRD = High Model Query Statements				
Function Correlation Statement	**Query Statement**	**Notes**	**Corrected Query Statement**	**Action Needed**
	"NWI_Subsystem" = '2' AND ("NWI_Class" = 'US' OR "NWI_Class" = 'UB') AND "NWI_Regime" = 'F'			
L2_F (vegetated, AB, EM, SS, FO and mixes with non-vegetated), L2_H or G (vegetated, AB, EM, SS, FO and mixes with nonvegetated)	*Select L2_(Veg)_F/G/H* "NWI_Class" in ('AB', 'EM', 'FO', 'SS') AND ("NWI_System" = 'L' AND "NWI_Subsystem" = '2' AND ("NWI_Regime" = 'F' OR "NWI_Regime" = 'G' OR "NWI_Regime" = 'H'))			
PAB PUB__b, R_EMF,	*Select P_R* ("NWI_System" = 'P' AND "NWI_Class" = 'AB') OR ("NWI_System" = 'P' AND "NWI_Class" = 'UB' AND "NWI_Modifier" = 'b') OR ("NWI_System" = 'R' AND "NWI_Class" = 'EM' AND "NWI_Regime" = 'F')			
P__H or G (vegetated, EM, SS, FO including mixes with UB)	*Select P__G/H* "NWI_Class" in ('EM', 'FO', 'SS') AND ("NWI_System" = 'P' AND ("NWI_Regime" = 'G' OR "NWI_Regime" = 'H'))			
P__F and adjacent to PD, LK, RV(not LR4) ST(not LS4), or waters; PEM1C__ (including mixes) and associated with PD, LK,	*Select P__F& PEM1C* ("NWI_System" = 'P' AND "NWI_Regime" = 'F') OR ("NWI_System" = 'P' AND "NWI_Class" = 'EM' AND "NWI_SubClass" = '1' AND "NWI_Regime" = 'C')	Process: Perform a "Select by Location" query for where *Select P__F* touches the boundary of *Select PD,LK,RV* to select where P__F is adjacent to PD, LK, RV (not LR4), or ST (not LS4)		

WBIRD = High Model Query Statements				
Function Correlation Statement	**Query Statement**	**Notes**	**Corrected Query Statement**	**Action Needed**
RV(not LR4), or ST(not LS4),	*Select PD,LK,RV* "NWI_PLUS_CODE" LIKE 'PD%' OR "NWI_PLUS_CODE" LIKE 'LK%' OR ("NWI_PLUS_CODE" LIKE 'RV%' AND NOT "NWI_PLUS_CODE" LIKE 'RV4%') OR ("NWI_PLUS_CODE" LIKE 'ST%' AND NOT "NWI_PLUS_CODE" LIKE 'ST4%') OR ("NWI_PLUS_CODE" LIKE 'LR%' AND NOT "NWI_PLUS_CODE" LIKE 'LR4%') OR ("NWI_PLUS_CODE" LIKE 'LS%' AND NOT "NWI_PLUS_CODE" LIKE 'LS4%')	Process: Perform a "Select by Location" query for where *Select PEM1C* intersects of *Select PD,LK,RV* to select where PEM1C is associated with 1) is PEM1C, 2) is PEM1C & PD, LK, RV (not LR4), or ST (not LS4), 3) is PEM1C and adjacent to PD, LK, RV (not LR4), or ST (not LS4), or 4) is PEM1C & is PD, LK, RV (not LR4), or ST (not LS4) and is adjacent to PD, LK, RV (not LR4), or ST (not LS4)		
PD associated with P__(AB, EM,SS, FO)F	*Select PD* "NWI_PLUS_CODE" LIKE 'PD%' *Select P_Veg_F* "NWI_System" = 'P' AND "NWI_Class" IN ('AB', 'EM', 'SS', 'FO') AND "NWI_Regime" = 'F'	Process: Perform a "Select by Location" query for where *Select PD* intersects of *Select P_Veg_F* to select where PD is associated with 1) is PD, 2) is PD & P(AB, EM, SS, FO)_F, 3) is PD and adjacent to P(AB, EM, SS, FO)_F , or 4) is PD & is P(AB, EM, SS, FO)_F and is adjacent to P(AB, EM, SS, FO)_F		
Shrub bogs should be excluded from all the above, e.g., PSS3Ba and commercial bogs = PSSf	Exclude NOT (("NWI_System" = 'P' AND "NWI_Class" = 'SS' AND "NWI_SubClass" = '3' AND			

WBIRD = High Model Query Statements				
Function Correlation Statement	Query Statement	Notes	Corrected Query Statement	Action Needed
	"NWI_Regime" = 'B') OR ("NWI_System" = 'P' AND "NWI_Class" = 'SS' AND "NWI_Modifier" = 'f' AND NOT "NWI_Modifier" IS NULL))			

Process steps/Queries:

Attribute only queries:

Exclude

NOT (("NWI_System" = 'P' AND "NWI_Class" = 'SS' AND "NWI_SubClass" = '3' AND "NWI_Regime" = 'B') OR ("NWI_System" = 'P' AND "NWI_Class" = 'SS' AND "NWI_Modifier" = 'f' AND NOT "NWI_Modifier" IS NULL))

Select LSBA_LSFR_PSS-FO

("NWI_System" = 'P' AND (("NWI_Class" = 'SS' OR "NWI_Class" = 'FO') AND ("NWI_Class2" IS NULL OR NOT "NWI_Class2" = 'UB'))) AND ("NWI_PLUS_CODE" LIKE 'LS1%BA%' OR "NWI_PLUS_CODE" LIKE 'LS2%BA%' OR "NWI_PLUS_CODE" LIKE 'LS5%BA%' OR "NWI_PLUS_CODE" LIKE 'LS1%FR%' OR "NWI_PLUS_CODE" LIKE 'LS2%FR%')

Select LRBA_LRFPba_PSS-FO

("NWI_System" = 'P' AND (("NWI_Class" = 'SS' OR "NWI_Class" = 'FO') AND ("NWI_Class2" IS NULL OR NOT "NWI_Class2" = 'UB'))) AND ("NWI_PLUS_CODE" LIKE 'LR1%BA%' OR "NWI_PLUS_CODE" LIKE 'LR2%BA%' OR "NWI_PLUS_CODE" LIKE 'LR1%FP%ba%' OR "NWI_PLUS_CODE" LIKE 'LR2%FP%ba%')

Select LRFPba

("NWI_PLUS_CODE" LIKE 'LR%FP%ba%' AND ("NWI_System" = 'P' AND "NWI_Class" = 'FO' AND "NWI_Class2" = 'EM')) OR ("NWI_PLUS_CODE" LIKE 'LR%FP%ba%' AND ("NWI_System" = 'P' AND "NWI_Class" = 'UB' AND "NWI_Class2" = 'FO'))

Select L2AB

"NWI_System" = 'L' AND "NWI_Subsystem" = '2' AND "NWI_Class" = 'AB'

Select L2US_UB_F

"NWI_System" = 'L' AND "NWI_Subsystem" = '2' AND ("NWI_Class" = 'US' OR "NWI_Class" = 'UB') AND "NWI_Regime" = 'F'

Select L2_(Veg)_F/G/H

"NWI_Class" in ('AB', 'EM', 'FO', 'SS') AND ("NWI_System" = 'L' AND "NWI_Subsystem" = '2' AND ("NWI_Regime" = 'F' OR "NWI_Regime" = 'G' OR "NWI_Regime" = 'H'))

Select P_R

("NWI_System" = 'P' AND "NWI_Class" = 'AB') OR ("NWI_System" = 'P' AND "NWI_Class" = 'UB' AND "NWI_Modifier" = 'b') OR ("NWI_System" = 'R' AND "NWI_Class" = 'EM' AND "NWI_Regime" = 'F')

Select P__G/H

"NWI_Class" in ('EM', 'FO', 'SS') AND ("NWI_System" = 'P' AND ("NWI_Regime" = 'G' OR "NWI_Regime" = 'H'))

Spatial & Attribute queries:

Select P__F& PEM1C

("NWI_System" = 'P' AND "NWI_Regime" = 'F') OR ("NWI_System" = 'P' AND "NWI_Class" = 'EM' AND "NWI_SubClass" = '1' AND "NWI_Regime" = 'C')

Select PD,LK,RV

"NWI_PLUS_CODE" LIKE 'PD%' OR "NWI_PLUS_CODE" LIKE 'LK%' OR ("NWI_PLUS_CODE" LIKE 'RV%' AND NOT "NWI_PLUS_CODE" LIKE 'RV4%') OR ("NWI_PLUS_CODE" LIKE 'ST%' AND NOT "NWI_PLUS_CODE" LIKE 'ST4%') OR ("NWI_PLUS_CODE" LIKE 'LR%' AND NOT "NWI_PLUS_CODE" LIKE 'LR4%') OR ("NWI_PLUS_CODE" LIKE 'LS%' AND NOT "NWI_PLUS_CODE" LIKE 'LS4%')

Select PD

"NWI_PLUS_CODE" LIKE 'PD%'

Select P_Veg_F

"NWI_System" = 'P' AND "NWI_Class" IN ('AB', 'EM', 'SS', 'FO') AND "NWI_Regime" = 'F'

WBIRD = Moderate Model Query Statements				
Function Correlation Statement	**Query Statement**	**Notes**	**Corrected Query Statement**	**Action Needed**
other L2UB (not listed as high),	*Select L2UB* "NWI_System" = 'L' AND "NWI_Subsystem" = '2' AND "NWI_Class" = 'UB'			
PD1, PD2 a3, b, h, PD3, or PD4	*Select PD_1-4* "NWI_PLUS_CODE" LIKE 'PD1%' OR "NWI_PLUS_CODE" LIKE 'PD2a3%' OR "NWI_PLUS_CODE" LIKE 'PD2b%' OR "NWI_PLUS_CODE" LIKE 'PD2h%' OR "NWI_PLUS_CODE" LIKE 'PD3%' OR "NWI_PLUS_CODE" LIKE 'PD4%'			

WBIRD = Moderate Model Query Statements				
Function Correlation Statement	**Query Statement**	**Notes**	**Corrected Query Statement**	**Action Needed**
Other PEMF	*Select PEMF* "NWI_System" = 'P' AND "NWI_Class" = 'EM' AND "NWI_Regime" = 'F'			
PEMC that are TEBA	*Select PEMC* ("NWI_System" = 'P' AND "NWI_Class" = 'EM' AND "NWI_Regime" = 'C') AND ("NWI_PLUS_CODE" LIKE 'TE%BA%')			
Shrub bogs should be excluded from all the above, e.g., PSS3Ba and commercial bogs = PSSf	*Exclude* NOT (("NWI_System" = 'P' AND "NWI_Class" = 'SS' AND "NWI_SubClass" = '3' AND "NWI_Regime" = 'B') OR ("NWI_System" = 'P' AND "NWI_Class" = 'SS' AND "NWI_Modifier" = 'f' AND NOT "NWI_Modifier" IS NULL))			

<u>Process steps/Queries:</u>

Exclude

NOT (("NWI_System" = 'P' AND "NWI_Class" = 'SS' AND "NWI_SubClass" = '3' AND "NWI_Regime" = 'B') OR ("NWI_System" = 'P' AND "NWI_Class" = 'SS' AND "NWI_Modifier" = 'f' AND NOT "NWI_Modifier" IS NULL))

Select L2UB

"NWI_System" = 'L' AND "NWI_Subsystem" = '2' AND "NWI_Class" = 'UB'

Select PD_1-4

"NWI_PLUS_CODE" LIKE 'PD1%' OR "NWI_PLUS_CODE" LIKE 'PD2a3%' OR "NWI_PLUS_CODE" LIKE 'PD2b%' OR "NWI_PLUS_CODE" LIKE 'PD2h%' OR "NWI_PLUS_CODE" LIKE 'PD3%' OR "NWI_PLUS_CODE" LIKE 'PD4%'

Select PEMF

"NWI_System" = 'P' AND "NWI_Class" = 'EM' AND "NWI_Regime" = 'F'

Select PEMC

("NWI_System" = 'P' AND "NWI_Class" = 'EM' AND "NWI_Regime" = 'C') AND ("NWI_PLUS_CODE" LIKE 'TE%BA%')

Migratory Bird Habitat (MBIRD) Function

MBIRD Function Performance Correlations		
Level of Function	**Wetland Type**	**Notes**
High	All palustrine environments with an F or wetter water regime within 3 miles of Lake Superior and within 100 meters of a river. Also the River itself if mapped as a wetland (i.e., R2UBH)	
Moderate	All palustrine wetlands with an F or wetter water regime within 3 miles of Lake Superior not already identified as High in the above selection	

MBIRD = High Model Query Statements				
Function Correlation Statement	**Query Statement**	**Notes**	**Corrected Query Statement**	**Action Needed**
Riverine wetlands	*Select R* NWI_System = 'R'			
P_F, P_G, or P_H within 3 miles of Lake Superior and within 100 meters of river	*Select Mod* MBIRD = "Moderate" *Select Adj River* NWI_System = 'R'	(Performed in "Moderate" query.		

Process steps/Queries:

Spatial & Attribute queries:

Select R

NWI_System = 'R'

Select Adj River

NWI_System = 'R'

MBIRD = Moderate Model Query Statements				
Function Correlation Statement	**Query Statement**	**Notes**	**Corrected Query Statement**	**Action Needed**
P_F, P_G, P_H, Within 3 miles of Lake Superior (Hydro dataset)	*Select P_F+* "NWI_System" = 'P' AND ("NWI_Regime" = 'F' OR "NWI_Regime" = 'G' OR "NWI_Regime" = 'H') *Select Waterbody* WATERBODY_NAME = 'Lake Superior'	All wetlands that meet these two criteria will be given a moderate classification From this selection those that meet the distance criteria to rivers will be elevated to "High"		

Process steps/Queries:

Spatial & Attribute queries:

Select P_F+

"NWI_System" = 'P' AND ("NWI_Regime" = 'F' OR "NWI_Regime" = 'G' OR "NWI_Regime" = 'H')

Select Waterbody

WATERBODY_NAME = 'Lake Superior'

Woodcock Habitat (WCK) Function

WCK Function Performance Correlations		
Level of Function	**Wetland Type**	**Notes**
Function performed	All deciduous scrub shrub palustrine wetlands or deciduous forested palustrine wetlands adjacent to deciduous scrub shrub wetlands with a water regime of C, B, or A	

WCK = Habitat Model Query Statements				
Function Correlation Statement	**Query Statement**	**Notes**	**Corrected Query Statement**	**Action Needed**

WCK = Habitat Model Query Statements				
Function Correlation Statement	**Query Statement**	**Notes**	**Corrected Query Statement**	**Action Needed**
PSS1A, PSS1B,or PSS1C (including split class SS),	*Select PSS1_ABC* (("NWI_System" = 'P' AND "NWI_Class" = 'SS' AND "NWI_SubClass" = '1') AND ("NWI_Regime" = 'A' OR "NWI_Regime" = 'B' OR "NWI_Regime" = 'C')) OR (("NWI_System" = 'P' AND "NWI_Class2" = 'SS' AND "NWI_SubClass2" = '1') AND ("NWI_Regime" = 'A' OR "NWI_Regime" = 'B' OR "NWI_Regime" = 'C'))			
PFO1 adjacent to PSS1A, PSS1B, or PSS1C	*Select PFO1* "NWI_System" = 'P' AND "NWI_Class" = 'FO' AND "NWI_SubClass" = '1'			

<u>Process steps/Queries:</u>

Spatial & Attribute queries:

Select PSS1_ABC

(("NWI_System" = 'P' AND "NWI_Class" = 'SS' AND "NWI_SubClass" = '1') AND ("NWI_Regime" = 'A' OR "NWI_Regime" = 'B' OR "NWI_Regime" = 'C')) OR (("NWI_System" = 'P' AND "NWI_Class2" = 'SS' AND "NWI_SubClass2" = '1') AND ("NWI_Regime" = 'A' OR "NWI_Regime" = 'B' OR "NWI_Regime" = 'C'))

Select PFO1

"NWI_System" = 'P' AND "NWI_Class" = 'FO' AND "NWI_SubClass" = '1'

Saint Mary's University of Minnesota

GeoSpatial Services

890 Prairie Island Road
Winona, Minnesota 55987
www.geospatialservices.org