GLMRIS

Great Lakes and Mississippi River Interbasin Study

Aquatic Nuisance Species | Ecosystems | Navigation | Recreation | Flood Risk Management | Water Use

Focus Area 2
Aquatic Pathway Assessment Report

Rosendale-Brandon, Wisconsin

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Executive Summary

This assessment characterizes the potential for a viable aquatic pathway to form at the Rosendale-Brandon location in east central Wisconsin that would enable the transfer of aquatic nuisance species (ANS) between the Great Lakes and Mississippi River Basins. This was done by first evaluating the hydrologic and hydraulic characteristics of the site based on readily available information, and was then followed up with a species-specific assessment of potential ANS capabilities to arrive at the pathway and cross into the adjacent basin.

The Rosendale-Brandon pathway is a mile-wide (1.6 kilometer) emergent and scrubshrub wetland located about midway between the communities of Rosendale and Brandon, Wisconsin. This wetland drains into both the Great Lakes and Mississippi River Basins. There are two drainageways extending from the basin divide toward the Great Lakes Basin which in this area consist primarily of agricultural and roadside ditches. The Great Lakes drainage from the north end of this wetland connects via unnamed tributaries to either to the West Branch Fond du Lac River or to Silver Creek. The tributary of greatest relevance to this pathway is the one flowing to the West Branch Fond du Lac River, which flows into the Fond du Lac River through Lake Winnebago and then the Lower Fox River into Lake Michigan at Green Bay. The other tributary located a little further away to the northwest flows into Silver Creek and into the Puchyan River, then into the Upper Fox River to Lake Butte des Morts, to Lake Winnebago, then to the Lower Fox River, and ultimately Lake Michigan. There are 11 dams on the Lower Fox River, including nine federal dams operated by the U.S. Army Corps of Engineers (USACE). South of the drainage divide, surface water flows to the Mississippi River Basin through a culvert underneath County Road M and into an unnamed tributary to the West Branch Rock River, through the Horicon Marsh and then to the Rock River into the Mississippi River just downstream of Rock Island, Illinois. The National Inventory of Dams lists 21 dams associated with the Rock River in Wisconsin and 29 in Illinois, many of which are deemed severe restrictions to upstream fish movement.

Aquatic Nuisance Species of Concern	
Species	**Common Name**
Hypophthalmichthys molitrix	silver carp
Hypophthalmichthys nobilis	bighead carp
Mylopharyngodon piceus	black carp
Menidia beryllina	inland silverside
Channa argus	northern snakehead
Gasterosteus aculeatus	threespine stickleback
Gymnocephalus cernua	ruffe
Proterorhinus semilunaris	tubenose goby
Novirhabdovirus sp	viral hemorrhagic septicemia virus

The interagency assessment team concluded that the probability of a viable aquatic pathway that might enable ANS transfer across the divide at this location and into the Great Lakes Basin was low. There are several dams on the Mississippi River Basin side of the divide that would prevent upstream spread of ANS, even during high flow events. In addition, the mile-wide (1.6 km) emergent and scrub-shrub wetland at the divide is considered a probable impediment for ANS establishment and movement in the vicinity of this aquatic pathway. The probability of a viable aquatic pathway that would enable ANS spread across the divide into the Mississippi River Basin (from the Great Lakes Basin) was determined to be medium.

A total of nine ANS were selected to evaluate their potential abilities to reach and spread across the basin divide at this pathway location. These species are listed in the table above.

Of these, viral hemoragic septicemia virus (VHSv) was evaluated as having a medium likelihood of being able to spread across the basin divide from the Great Lakes Basin to the Mississippi River Basin, with all the other species being rated as low. The Wisconsin Department of Natural Resources (WDNR) identified the presence of VHSv in 2007 in freshwater drum (*Aplodinotus grunniens*) in the Lake Winnebago system (Great Lakes Basin), which is located upstream of the Rapid Croche Lock and Dam. No additional fish collected from the Lake Winnebago system have since been reported positive for VHSv through the summer of 2011,

although the entire upstream river system has not been thoroughly sampled. An overall aquatic pathway viability rating of medium has been assigned to this pathway because of VHSv. If an infected fish were to arrive at the potential pathway area, a subsequent storm event sufficient to form an intermittent aquatic connection between the basins could facilitate the dispersal of an infected fish across the basin divide at that time. A confirmed infected fish from above the Rapid Croche Lock and Dam in 2007 indicates that the potential exists that VHSv may be present or become present in fish or the water column near the pathway location.

Water quality and volume within the pathway is likely to be suitable for fish movement during a flood event. However, the quality and volume of the water at the pathway and the adjacent ditches would likely decline as water levels dropped and the surface waters became disconnected. If fish were to access the divide wetland during a suitable flood event, the fish would need to move downstream with the receding waters to find suitable habitat to survive for a longer period of time. Uncertainty exists about water depths across the entire wetland divide during flood events because no modeling or survey elevation data exists for the Rosendale-Brandon potential pathway location. A detailed survey of the divide and modeling would provide additional certainty to this rating and provide valuable data regarding the probability that sufficient water is available at the divide for ANS establishment and passage. Although there are some structural opportunities for reducing or eliminating the probability of ANS transfer at this location, the most easily implemented options would likely be continued public education and monitoring to minimize the potential for accidental human transport and introduction.

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Acronyms

ANS . . . . . Aquatic Nuisance Species
ANSTF. . . . Aquatic Nuisance Species Task Force
CAWS . . . . Chicago Area Waterway System
CEQ. . . . . Council on Environmental Quality
CMP. . . . . Corrugated Metal Pipe
DEM. . . . . Digital Elevation Model
FEMA. . . . . Federal Emergency Management Agency
FIS. . . . . Flood Insurance Study
GIS . . . . . Geographic Information System
GLFC. . . . . Great Lakes Fishery Commission
GLMRIS. . . Great Lakes and Mississippi River Interbasin Study
HUC. . . . . Hyrdologic Unit Codes
INDNR . . . . Indiana Department of Natural Resources
NAS . . . . . Nonindigenous Aquatic Species
NCDC . . . . National Climatic Data Center
NEPA . . . . . National Environmental Policy Act
NOAA. . . . . National Oceanic and Atmospheric Administration
NRCS . . . . Natural Resources Conservation Service
NWI . . . . . National Wetlands Inventory
USACE . . . U.S. Army Corps of Engineers
USFWS . . . U.S. Fish and Wildlife Service
USGS . . . . U.S. Geological Survey
VHSv . . . . . Viral Hemorrhagic Septicemia Virus
WDNR . . . . Wisconsin Department of Natural Resources
WRDA . . . . Water Resources Development Act

1 Introduction

The Great Lakes and Mississippi River Interbasin Study (GLMRIS) was authorized in Section 3061(d) of the Water Resources Development Act of 2007, and therein, it prescribes the following authority to the Secretary of the Army and the U.S. Army Corps of Engineers (USACE) (WRDA, 2007):

> *"(d) FEASIBILITY STUDY. - The Secretary, in consultation with appropriate Federal, State, local, and nongovernmental entities, shall conduct, at Federal expense, a feasibility study of the range of options and technologies available to prevent the spread of aquatic nuisance species between the Great Lakes and Mississippi River Basins through the Chicago Sanitary and Ship Canal and other aquatic pathways."*

This GLMRIS Focus Area 2 Aquatic Pathway Assessment report addresses the Rosendale-Brandon location. This location is one of 18 locations identified in the Great Lakes and Mississippi River Interbasin Study Other Pathways Preliminary Risk Characterization (USACE, 2010) as a potential aquatic pathway spanning the watershed divide between the Great Lakes and Mississippi River Basins outside of the Chicago Area Waterway System (CAWS). This report is downloadable from the GLMRIS web site (glmris.anl.gov/).

The dashed line in Figure 1 depicts the nearly 1,500-mile (2,414 km) basin divide from the New York - Pennsylvania state line to north eastern Minnesota, and it depicts each of the 18 potential aquatic pathway locations that were previously identified. The Rosendale-Brandon site is shown as location number 13 on Figure 1.

The GLMRIS is a very large and complicated task involving multiple USACE Districts and Divisions. Program Management of the study is conducted by the Great Lakes and Ohio River Division. The study considers several aquatic nuisance species (ANS), however, the proximity of Asian carp in the Mississippi River Basin to the basin divide near two locations lend a sense of urgency and national significance to completion of the GLMRIS. These two locations are the CAWS in Chicago, Illinois and Eagle Marsh in Fort Wayne, Indiana.

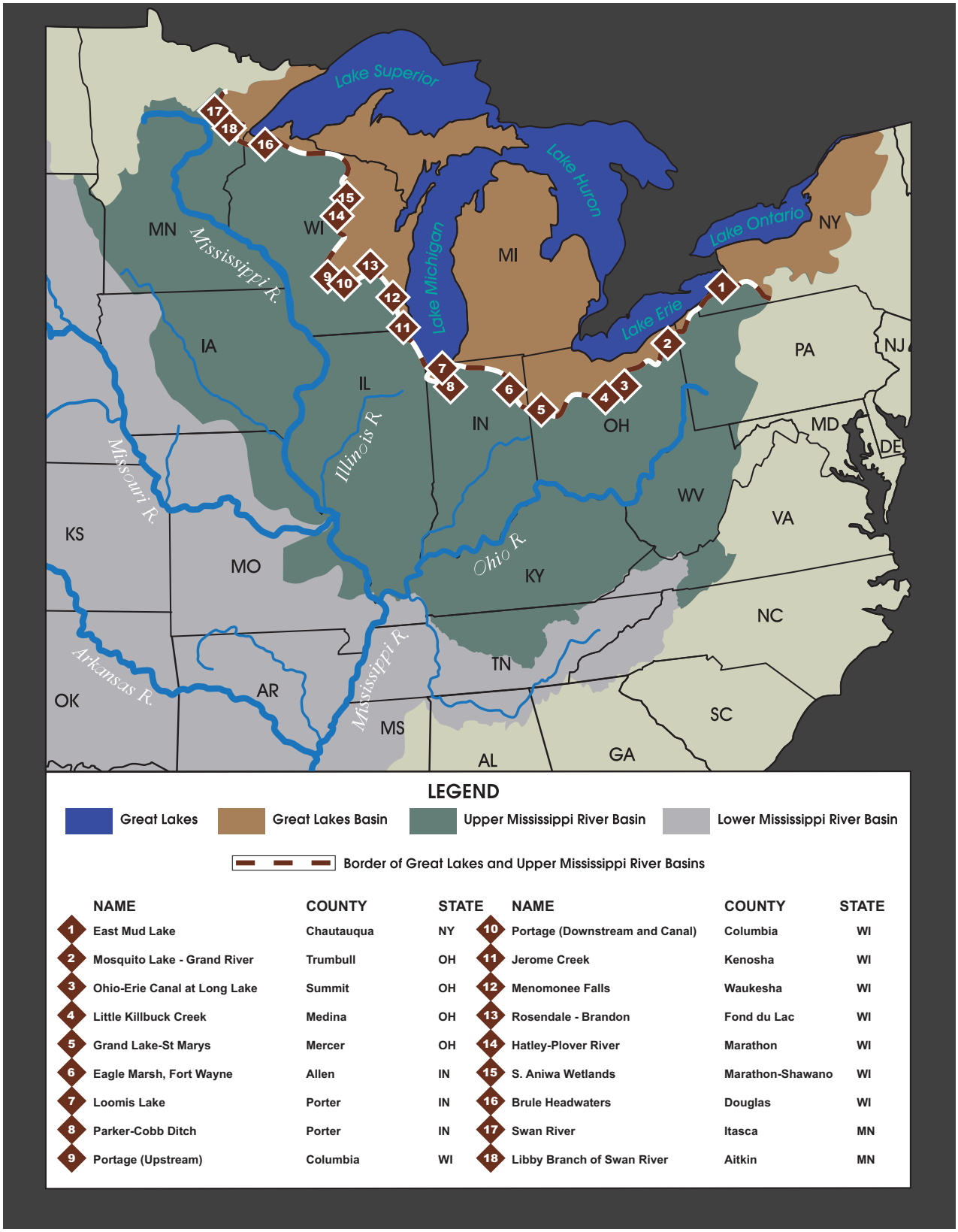
To help accelerate completion of the feasibility study, the Great Lakes and Ohio River Division split management of the GLMRIS into two separate focus areas. Focus Area 1 is managed by the USACE, Chicago District and addresses the CAWS. Focus Area 2 is managed by the USACE, Buffalo District and evaluates all other potential aquatic pathways that exist or are likely to form across the basin divide separating runoff that flows into the Mississippi River and its tributaries from runoff that flows into the Great Lakes and its tributaries.

1.1 Study Purpose

The preliminary report from 2010 and the subsequent analysis contained in this report have been produced for a broad audience ranging from the scientific community to the general public, and are specifically intended to identify any locations where an aquatic pathway exists or may form between the basins, and to evaluate the probability that specific ANS would be able arrive at that pathway and cross into the new basin. The information in this and the other Focus Area 2 reports are intended to provide a sound scientific basis for helping to prioritize future funding of GLMRIS and/or other actions at these potential aquatic pathway locations.

This report is part of a tiered approach to assess the likelihood of ANS spreading between the Great Lakes and Mississippi River Basins via aquatic pathways, and it was prepared in accordance with the detailed procedures and criteria specified in the GLMRIS Focus Area 2 Study Plan (USACE, 2011a). The primary purpose of this report is to present the evidence and explain the procedures used to qualitatively estimate the likelihood a viable aquatic pathway exists at the Rosendale-Brandon location that will enable the interbasin spread of ANS. It is also intended to contribute to the accomplishment of each of the four objectives identified in the plan by including the following:

- A definitive determination of whether the Rosendale-Brandon location should be included in the inventory of locations where a viable surface water connection between headwater streams on both sides of the drainage divide exists or is likely to form



	NAME	COUNTY	STATE
1	East Mud Lake	Chautauqua	NY
2	Mosquito Lake - Grand River	Trumbull	OH
3	Ohio-Erie Canal at Long Lake	Summit	OH
4	Little Killbuck Creek	Medina	OH
5	Grand Lake-St Marys	Mercer	OH
6	Eagle Marsh, Fort Wayne	Allen	IN
7	Loomis Lake	Porter	IN
8	Parker-Cobb Ditch	Porter	IN
9	Portage (Upstream)	Columbia	WI
10	Portage (Downstream and Canal)	Columbia	WI
11	Jerome Creek	Kenosha	WI
12	Menomonee Falls	Waukesha	WI
13	Rosendale - Brandon	Fond du Lac	WI
14	Hatley-Plover River	Marathon	WI
15	S. Aniwa Wetlands	Marathon-Shawano	WI
16	Brule Headwaters	Douglas	WI
17	Swan River	Itasca	MN
18	Libby Branch of Swan River	Aitkin	MN

Figure 1. Potential aquatic pathway locations identified in the GLMRIS Preliminary Risk Characterization Study (USACE, 2010).

between the Great Lakes and the Mississippi River basins;

- A standalone report that characterizes the probability of aquatic pathway formation and the probability that a viable aquatic pathway exists at the Rosendale-Brandon location and will enable the interbasin spread of ANS;

- Development of clear problem statements that frame the means, constraints, and likelihood of the interbasin spread of ANS via the potential aquatic pathway at the Rosendale-Brandon location; and

- Development of clear opportunity statements that illustrate how the collective authorities, resources, and capabilities of USACE and other applicable Federal, State, local, and non-governmental stakeholder organizations may best be coordinated and applied to prevent the interbasin spread of ANS through the Rosendale-Brandon location.

1.2 Summary of 2010 Preliminary Risk Characterization for Rosendale-Brandon, Wisconsin

The Great Lakes and Mississippi River Interbasin Study Other Pathways Preliminary Risk Characterization was designed as the first step of a tiered approach to rapidly conduct a study intended to accomplish two objectives (USACE, 2010). The first and primary objective was to determine if there were any locations within the GLMRIS, aside from the CAWS, where a near term risk for the interbasin spread of ANS exists. Near term, in this case, indicates that implementation of some measure(s) might be warranted to reduce the potential for ANS transfer at that particular location in the short term versus setting that site aside for further analysis. The second objective was to refine the scope of the other aquatic pathways portion of the GLMRIS by developing a list of potential aquatic pathways that could form anywhere along the divide separating the Great Lakes and Mississippi River Basins, and help provide a basis for prioritizing future feasibility study efforts based upon relative risk.

The USACE solicited the input and collaborated with the U.S. Geological Survey (USGS), U.S. Fish and Wildlife Service (USFWS), National Oceanic and Atmospheric Administration (NOAA), Great Lakes Fishery Commission (GLFC) and the natural resource agencies in the states of Minnesota, Wisconsin, Indiana, Ohio, Pennsylvania, and New York. A total of 36 potential locations were initially identified along the divide where it appeared that interbasin flow could occur. These were locations situated in a mixture of rural, forested, suburban, and urban areas, and included locations where surface water flow patterns have been modified through the building of navigation canals, excavation of ditches, and construction of sewers to facilitate storm water management for agricultural, flood damage reduction, or other water management purposes. Also, many of the potential aquatic pathways identified in 2010 were locations where extensive natural wetlands exist in close proximity to, and in some instances appear to span, the basin divide. The lack of prior hydrologic studies and the level of uncertainty in the hydrology information led to a conservative approach in estimating the individual aquatic pathway risk ratings.

At 18 of these locations the interagency group determined that it would likely require an epic storm and flooding event for an aquatic pathway to ever form across the basin divide. These were not recommended for further investigation because this was considered a low level of risk. However, at the remaining 18 locations the group did recommend that a more detailed assessment be conducted (Figure 1). Only one location, Eagle Marsh in Fort Wayne, Indiana, was determined to pose a near term risk for the potential spread of Asian carp into the Great Lakes Basin, and this led to the installation of a temporary barrier by Indiana Department of Natural Resources (INDNR) until a more complete assessment and remedy could be implemented.

The Rosendale-Brandon location is characterized as a wetland located about midway between two rural communities about seven miles (11 km) apart in east central Wisconsin. Drainages from this area are characterized as agricultural and roadside ditches, with a number of downstream obstructions (i.e., dams) in both basins. Federal Emergency Management

Agency (FEMA) base flood mapping of the one percent recurrence interval flood area indicated that the floodplain for a tributary to the West Branch Fond du Lac River (Great Lakes Basin) crossed the basin divide, as defined by the 12-digit Hydrologic Unit Code (HUC) boundary. A recurrence interval relates any given storm, through statistical analysis, to the historical records of rainfall and runoff for a given area. The recurrence interval is based on the statistical probability that a given intensity storm event will be equaled or exceeded in any given year. For instance, a one percent annual recurrence interval storm is a rainfall event that has a one percent probability, one chance in 100, of being equaled or exceeded in any given year. This level of storm event was commonly referred to as a 100-year storm event, but this term has led people to incorrectly conclude that a 100-year storm event is one that only occurs once in any given 100 year period. A ten percent annual recurrence event storm (formerly referred to as a ten year event) is a smaller event that has a one in ten chance of being exceed during any given year, and a 0.2 percent annual recurrence interval storm (formerly referred to as a 500-year event) is a larger event that has a one in 500 chance of being exceeded in any given year.

Although the preliminary risk characterization did not identify the Rosendale-Brandon pathway as a location where there is a near term risk for the interbasin spread of ANS, there was some uncertainty with this rating. This was mainly due to the presence of the large wetland area and lack of readily available hydrological evidence found during the preliminary study effort to discern the relative frequency and potential magnitude of any aquatic pathway at this location. The preliminary effort therefore recommended that a more detailed assessment be conducted at this location. This was subsequently done in collaboration with the Wisconsin Department of Natural Resources (WDNR), USFWS, USGS, and other government agencies. The following actions were taken:

- Federal, State, and local stakeholders (i.e., USGS Water Science Center, WDNR Division of Water, County Surveyor, and local Natural Resource Conservation Service representatives) were briefed on the preliminary risk characterization results. Detailed site visits to observe potential connection locations were conducted and the available topographic mapping and flood hazard information was compiled and reviewed.
- The dams on the connecting streams to the Great Lakes and Mississippi River were evaluated relative to the potential for ANS passage through, around, or over each in-stream structure in both directions.
- Habitat and abiotic conditions in proximity to the location were analyzed relative to the needs and preferences of ANS in proximity to each location.
- The hydrologic risk and ANS risk ratings and characterization were revised for each site based on the new information.
- Measures that could be implemented at the state or local level were identified to mitigate significant risks.

1.3 Aquatic Pathway Team

Due to the large amount of unknowns and natural variability associated with the hydrology and the biology of such a large geographic area, the Study Plan specified formation of a “team of teams,” combining the best available local, state and national hydrologists and biologists to assess conditions at each potential aquatic pathway. The results of this assessment reflect the collective experience, expertise, and focused effort of these biologists and hydrologists from the NRCS, USACE, and WDNR. The results also reflect the guidance, input, review comments and concurrence of the multi-organization Agency Technical Review of experts from the USGS and USACE.

2 Study Methodology

The GLMRIS risk analysis process is an adaptation of the generic model and process described in the Generic Nonindigenous Aquatic Organisms Risk Analysis Review Process (For Estimating Risk Associated with the Introduction of Nonindigenous Aquatic Organisms and How to Manage for that Risk) (ANSTF, 1996). The Aquatic Nuisance Species Task Force (ANSTF) defines

the first step in this process as identification of interested parties and solicitation of input.

2.1 Coordination

The USACE identified interested parties and solicited input early in the process for Focus Area 2 and has included individual visits and discussions with the state agencies responsible for water resources, and fish and wildlife management in the eight states bordering the Great Lakes. The process used for the Focus Area 2 assessments has also been discussed in meetings with representatives of the Council on Environmental Quality (CEQ), USGS, USFWS, NOAA, NRCS, and GLFC. Development of this plan also included input from the public and interested non-governmental organizations received during formal National Environmental Policy Act (NEPA) public scoping meetings which were held at 12 locations across the region in both basins between December 2010 and March 2011. The USACE requested the support and participation of the best available experts from the State and Federal agencies responsible for water resources, and fish and wildlife management in the states along the Great Lakes and Mississippi River Basin divide to address the critically important issue of preventing interbasin transfer of ANS. The USGS, NRCS, and each state DNR assigned personnel to assist each USACE pathway assessment team. In addition, a technical review team comprised of 16 senior level experts from the USACE and these external partner agencies, including NOAA and GLFC, was assembled to review and guide the work of these teams. Overall, extensive collaboration among partner agencies, the review team, and other subject matter experts has led to detailed Focus Area 2 pathway assessments.

2.2 Identification of Potential Pathways

At 18 of the potential aquatic pathways identified during the 2010 Preliminary Risk Characterization, it was determined it would likely require an epic storm and flooding event (i.e., greater than a one percent annual recurrence interval storm event) for an aquatic pathway to ever form across the basin divide. These locations were not recommended for further investigation because areas that might require a flooding event in excess (greater magnitude, less frequency) of the one percent annual recurrence interval flood are less likely, and therefore present a low level of risk. This one percent threshold criterion was established through collaboration with the USGS, USFWS, NRCS, GLFC, and the departments of natural resources in the states of MI, MN, WI, IL, IN, OH, PA, and NY. This threshold is also widely used in flood risk management and is typically aligned with most readily available hydrologic information. The one percent annual recurrence interval threshold only indicates at what level event an aquatic connection can begin to form and would indicate a location that should then be subjected to a more labor intensive evaluation of the probability of ANS being able to utilize that pathway. At the remaining 18 locations, it was recommended that a more detailed assessment be conducted (Figure 1). This was subsequently done in 2011-2012 in collaboration with USGS, NRCS, USFWS, state natural resource agencies, and county surveyors (where applicable), and the results for the Rosendale-Brandon location are presented in this report.

Although the focus of this assessment is on aquatic pathways, it should also be mentioned that there are other non-aquatic pathways that may enable ANS to transit across the aquatic pathway or across the basin divide. Although these other pathways do not influence the overall pathway rating outlined in this report, they are included to point out potential other pathways (e.g., anthropogenic) and their potential influence on the same list of ANS as evaluated in Section 4 of this report. Any further analysis of these non-aquatic pathways outside of this study should develop a separate list of ANS that will likely differ from the list of ANS evaluated as part of this aquatic pathway report.

2.3 Aquatic Nuisance Species of Concern

This report addresses the problem of ANS invading, via surface-water pathways, the Great Lakes Basin from the Mississippi River Basin and vice versa.

ANS is defined by the ANSTF as "… nonindigenous species that threaten the diversity or abundance of native species or the ecological stability of infested waters, or commercial, agricultural, aquacultural or recreational activities dependent on such waters." The USGS Nonindigenous Aquatic Species (NAS) information resource http://nas.er.usgs.gov/about/faq.aspx defines NAS as "…a species that enters a body of water or aquatic ecosystem outside of its historic or native range." (USGS, 2012). Based on discussions between the USACE, USGS, and USFWS the following definitions were established for the purposes of the GLMRIS. All non-indigenous aquatic species (per the USGS definition above), that are present in the Great Lakes but not known to be present in the Mississippi River and its tributaries are defined as ANS of concern for GLMRIS. Likewise, all non-indigenous aquatic species present in the Mississippi River or its tributaries but not known to be present in the Great Lakes are also considered as ANS of concern for the GLMRIS. Therefore, the term ANS is synonymous with the term non-indigenous aquatic species in this report.

2.3.1 Lists of Non-indigenous Species in Great Lakes and Mississippi River Basins

The list of ANS of concern for a particular location was developed by first consulting the USACE white paper titled, Non-Native Species of Concern and Dispersal Risk for the Great Lakes and Mississippi River Interbasin Study released in September 2011 (USACE, 2011b). This technical paper, prepared by a multi-disciplinary USACE natural resources team, took a broad look at the potential range of species that could be of concern to the GLMRIS. The paper is Appendix C of the GLMRIS Focus Area 2 Study Plan and it is an integral component of the plan. This USACE white paper included a review of 254 aquatic species that are either non-indigenous to either basin or native species that occur in one basin or the other. The list of 254 aquatic species were iteratively screened to identify all potential ANS that could be of concern in either basin and to systematically focus the study toward those species judged to pose the highest potential risk of ecological impacts if they became established in the other basin.

In the first screening iteration, 119 of the 254 aquatic species reviewed were determined to pose a potential threat of infiltrating the other basin and were carried into the second iteration of the analysis. The other 135 species were rejected for further analysis for several reasons. Initially, 104 species were dropped from further consideration because they were determined to already be established in both basins. Another 31 species were removed from further analysis because they were not yet located in either basin, could bypass any aquatic control mechanism by terrestrial movement, or had no potential to cause adverse affects to the invaded ecosystem.

2.3.2 List of ANS of Concern for GLMRIS

To determine species of concern that are pertinent for the GLMRIS from the list of 119 species, the USACE natural resources team compiled, reviewed, and analyzed the best available information. Literature reviews, species proximity to aquatic interbasin connections (in particular the CAWS), ecological tolerances and needs, and vagility of the species were all included in the analysis. The team ranked each species as high, medium, or low risk according to these parameters. The result was the establishment of a list of 39 species, each identified as having both a high level of potential risk for both transferring from one basin to another, and potentially a high risk in that if they do disperse, and the invaded ecosystem could be moderately to severely affected by their colonization (Table 1). A fact sheet was developed for each of these species of concern detailing morphological characteristics useful for identification, including color photographs of the species, information on their ecology, habitat, distribution, and current status in the Mississippi River or Great Lakes Basins.

Table 1. ANS of Concern for GLMRIS.				
Taxon	**Scientific Name**	**Common Name**	**Basin**	**Interbasin Dispersal Mechanism**
fish	*Alosa aestivalis*	blueback herring	GL	swimmer
fish	*Alosa chrysochloris*	skipjack herring	MS	swimmer
fish	*Alosa pseudoharengus*	Alewife	GL	swimmer
crustacean	*Apocorophium lacustre*	a scud	MS	ballast water
algae	*Bangia atropupurea*	red macro-algae	GL	ballast / recreational boating
annelid	*Branchuris sowerbyi*	tubificid worm	GL	sediment transport
crustacean	*Bythotrephes longimanus*	spiny waterflea	GL	ballast water/sediment transport
plant	*Carex acutiformis*	swamp sedge	GL	recreational boating & trailers
crustacean	*Cercopagis pengoi*	fish-hook water flea	GL	ballast / recreational boating
fish	*Channa argus*	northern snakehead	MS	swimmer
algae	*Cyclotella cryptica*	cryptic algae	GL	unknown / any water
algae	*Cyclotella pseudostelligera*	cylindrical algae	GL	unknown / any water
crustacean	*Daphnia galeata galeata*	water flea	GL	ballast water
crustacean	*Echinogammarus ischnus*	a European amphipod	GL	ballast water
algae	*Enteromorpha flexuosa*	grass kelp	GL	ballast / recreational boating
fish	*Gasterosteus aculeatus*	threespine stickleback	GL	swimmer
plant	*Glyceria maxima*	reed sweetgrass	GL	recreational boating & trailers
fish	*Gymnocephalus cernua*	Ruffe	GL	swimmer
crustacean	*Hemimysis anomala*	bloody red shrimp	GL	ballast water
fish	*Hypophthalmichthys molitrix*	silver carp	MS	swimmer
fish	*Hypophthalmichthys nobilis*	bighead carp	MS	swimmer
plant	*Landoltia (Spirodela) punctata*	dotted duckweed	MS	recreational boating & trailers
bryozoan	*Lophopodella carteri*	bryozoans	GL	with aquatic plants
fish	*Menidia beryllina*	inland silverside	MS	swimmer
plant	*Murdannia keisak*	marsh dewflower	MS	recreational boating & trailers
fish	*Mylopharyngodon piceus*	black carp	MS	swimmer
crustacean	*Neoergasilus japonicus*	a parasitic copepod	GL	parasite to fish
plant	*Oxycaryum cubense*	Cuban bulrush	MS	recreational boating & trailers
fish	*Petromyzon marinus*	sea lamprey	GL	swimmer
mollusk	*Pisidium amnicum*	greater European pea clam	GL	ballast water
fish	*Proterorhinus semilunaris*	tubenose goby	GL	swimmer
protozoan	*Psammonobiotus communis*	testate amoeba	GL	ballast water
protozoan	*Psammonobiotus dziwnowi*	testate amoeba	GL	ballast water
protozoan	*Psammonobiotus linearis*	testate amoeba	GL	ballast water
crustacean	*Schizopera borutzkyi*	parasitic copepod	GL	ballast water
mollusk	*Sphaerium corneum*	European fingernail clam	GL	ballast water
algae	*Stephanodiscus binderanus*	Diatom	GL	ballast water
plant	*Trapa natans*	water chestnut	GL	recreational boating & trailers
mollusk	*Valvata piscinalis*	European stream valvata	GL	ships

2.3.3 List of ANS of Specific Concern at the Rosendale-Brandon Divide Location

The Rosendale-Brandon aquatic pathway team then subdivided the set of species listed in Table 1 into two groups: ANS threatening the Great Lakes, and ANS threatening the Mississippi River and its tributaries. Each of these two lists was then sorted into subgroups in accordance with taxonomy and common dispersal mechanism. Table 2 and Table 3 reflect these groupings of species that were found to pose a significant risk to the Mississippi River and its tributaries, and to the Great Lakes and its tributaries, respectively (USACE, 2011b).

Additionally, the Rosendale-Brandon aquatic pathway team reviewed the information on the 119 species initially determined to pose a potential threat of infiltrating the other basin to see if any were in close enough proximity to the Rosendale-Brandon location to be of concern. The team reviewed information on the NOAA Watchlist of species threatening the Great Lakes from international waters, and information on other species cited by the review team as high risk potential invaders not yet in either basin (NOAA, 2011). No additional species from the NOAA Watchlist were added to the species of concern for the Rosendale-Brandon location. However, the NOAA Watchlist was utilized as a resource, at the recommendation of agency team members, to identify any additional potential future species that could be introduced into either basin and possibly spread from there to the other basin.

Each Focus Area 2 aquatic pathway team was granted flexibility in determining whether to add additional species to their assessment based on their review of available information and the actual location of the specific potential pathway relative to the known location of those ANS being considered. Based on concerns from local agencies about the potential for spread of viral hemorrhagic septicemia virus (VHSv, Novirhabdovirus sp), each Focus Area 2 aquatic pathway team evaluated whether VHSv should be included on the ANS of concern list for each of the Focus Area 2 aquatic pathways. Although VHSv has been identified in both basins (i.e., VHSv was confirmed in Ohio River Basin in the Clear Fork Reservoir in Richland and Morrow Counties, Ohio in 2008), it has not yet been determined that VHSv has established within the Mississippi or Ohio River Basins. Minimizing the spread of VHSv remains a priority for the state of Wisconsin (Great Lakes Commission, 2011; USGS, 2011b). It was therefore included as an ANS of concern threatening the Mississippi River Basin for the Rosendale Brandon aquatic pathways.

Each of the three subgroups in Tables 2 and Table 3 were evaluated based on the dispersal mechanisms and general mobility of the species within each group. Since the Rosendale-Brandon potential pathway is positioned on the basin divide, well upstream of any know ANS listed in this assessment, any organism that moves solely through the aquatic pathway must possess either self-propelled mobility or the ability to hitchhike on other organisms to travel upstream. Thus, this eliminates organisms that rely on current for dispersal, such as plants and algae.

The Rosendale-Brandon area does not support any recreational fishery, which virtually eliminates the threat of ANS transfer occurring via water craft or fishing gear. Dumping of ANS (e.g., discarded aquarium pets, ceremonial release, etc.) within the site is considered unlikely because of the lack of available open water. Additionally, dumping of exotic pets is just as likely to occur in suitable aquatic areas within either basin or elsewhere along the basin divide. The intestinal tract of warm-blooded animals inactivates the VHS virus and the virus is not known to replicate in aquatic insects. Therefore, mammals, waterfowl, insects, and parasites are unlikely vectors for the spread of VHSv (Pennsylvania Sea Grant Fact Sheet, not dated).

Organisms that possess the ability to hitchhike over land and therefore would be able to bypass an obstacle in the aquatic pathway were not included in the final list or evaluated in this report. State hatcheries only use brood stock determined to be VHSv free and collected from non-VHSv waters (W. Wawrzyn – WDNR, personal communication, March 2, 2012). Commercial fish hatcheries also are regulated under Wisconsin Administrative Code 10.61, and live bait dealers are regulated. The Wisconsin rules prohibit the harvest of wild minnows, both commercially and for personal

Table 2: ANS of Concern Threatening the Mississippi River Basin.			
Taxon	**Scientific Name**	**Common Name**	**Interbasin Dispersal Mechanism**
fish	*Alosa aestivalis*	blueback herring	swimmer
fish	*Alosa pseudoharengus*	Alewife	swimmer
fish	*Gasterosteus aculeatus*	threespine stickleback	swimmer
fish	*Gymnocephalus cernua*	ruffe	swimmer
fish	*Petromyzon marinus*	sea lamprey	swimmer
fish	*Proterorhinus semilunaris*	tubenose goby	swimmer
crustacean	*Neoergasilus japonicus*	a parasitic copepod	parasite to fish
crustacean	*Bythotrephes longimanus*	spiny waterflea	ballast water/sediment
crustacean	*Cercopagis pengoi*	fish-hook water flea	ballast / rec. boating
crustacean	*Daphnia galeata galeata*	water flea	ballast water
crustacean	*Echinogammarus ischnus*	a European amphipod	ballast water
crustacean	*Hemimysis anomala*	bloody red shrimp	ballast water
crustacean	*Schizopera borutzkyi*	parasitic copepod	ballast water
mollusk	*Pisidium amnicum*	greater European pea clam	ballast water
mollusk	*Valvata piscinalis*	European stream valvata	ships
mollusk	*Sphaerium corneum*	European fingernail clam	ballast water
protozoan	*Psammonobiotus communis*	testate amoeba	ballast water
protozoan	*Psammonobiotus dziwnowi*	testate amoeba	ballast water
protozoan	*Psammonobiotus linearis*	testate amoeba	ballast water
annelid	*Branchuris sowerbyi*	tubificid worm	sediment transport
plant	*Carex acutiformis*	swamp sedge	recreational boats & trailers
plant	*Glyceria maxima*	reed sweetgrass	recreational boats & trailers
plant	*Trapa natans*	water chestnut	recreational boats & trailers
bryozoan	*Lophopodella carteri*	bryozoans	with aquatic plants
algae	*Bangia atropupurea*	red macro-algae	ballast / rec. boating
algae	*Cyclotella cryptica*	cryptic algae	unknown / any water
algae	*Cyclotella pseudostelligera*	cylindrical algae	unknown / any water
algae	*Enteromorpha flexuosa*	grass kelp	ballast / rec. boating
algae	*Stephanodiscus binderanus*	diatom	ballast water

Table 3: ANS of Concern Threatening the Great Lakes.			
Taxon	**Scientific Name**	**Common Name**	**Interbasin Dispersal Mechanism**
fish	*Alosa chrysochloris*	skipjack herring	swimmer
fish	*Channa argus*	northern snakehead	swimmer
fish	*Hypophthalmichthys molitrix*	silver carp	swimmer
fish	*Hypophthalmichthys nobilis*	bighead carp	swimmer
fish	*Menidia beryllina*	inland silverside	swimmer
fish	*Mylopharyngodon piceus*	black carp	swimmer
crustacean	*Apocorophium lacustre*	a scud	ballast water
plant	*Landoltia (Spirodela) punctata*	dotted duckweed	recreational boats & trailers
plant	*Murdannia keisak*	marsh dewflower	recreational boats & trailers
plant	*Oxycaryum cubense*	Cuban bulrush	recreational boats & trailers

use, from all VHSv known and suspect waters (WDNR, 2012a). It is illegal to possess or use minnow harvesting gear on any of the VHSv waters.

Based on the evaluation by subgroups, only fish, and parasites andpathogens (of fish) were considered to have the requisite means of reaching the Rosendale-Brandon basin connections from either direction. Eight fish and one virus were ultimately identified as the species of concern for the Rosendale-Brandon area. These were chosen based on their history of invasiveness and their physical capabilities to utilize this possible aquatic pathway within the next 20 years (Table 4 and Figure 2).

ANS access to the divide from the Great Lakes Basin would entail significant difficulty in passage of man-made structures. The Rapid Croche Lock and Dam has been converted to a dam in order to prevent sea lamprey passage upstream. If the facility operates boat passage, this would consist of manual boat lifting and cleaning of the hull and live wells as part of the WDNR plan to restrict ANS transfer from the lower Fox River and Great Lakes Basin system. However, at the 10 percent and one percent flood events, the difference between the sill elevation and the tailwater is five feet (1.5 m) and three feet (0.9 m), respectively, with respective velocities of four and 11 feet per second (fps) (3.3 meters per second) at Rapid Croche. Fish passage over the Rapid Croche Dam at the one percent event is considered unlikely based on discharge velocity, but passage at the 10-year or less frequent events is possible. Further, upstream at the Fond du Lac River, a man-made dam is located at the WDNR Eldorado Marsh Management Unit. WDNR fisheries staff indicated that the dam is an ANS blockage to upstream passage (Stertz, 2011). If the Eldorado Marsh Dam is determined to be a true ANS blockage for upstream passage during all flood events along the Fond du Lac River, the potential for ANS transfer along this route would be considered very low. However, as noted in Section 3.7, another ANS route is possible for passage from the Great Lakes Basin in a one percent flood event. The passage would be via Lake Winnebago to Lake Butte des Morts to the Upper Fox River, and then to the Puchyan River and Silver Creek. ANS passage of common carp is possible along this route (potential vector for VHSv), but the probability of passage is considered low since the flood events would have to be in the spring during common carp spawning, require passage over the Rapid Croche Dam for infestation of the upstream area and then access to and across the divide during a one percent flood event. The WDNR identified VHSv in fish located upstream of the Rapid Croche Lock and Dam in 2007 in the Lake Winnebago system, but not more recently through the summer of 2011. The potential exists that VHSv is present above the downstream blockage, and thus VHSv may be in fish at or near the Great Lakes side of the divide.

2.3.4 Key Attributes of Selected Organisms

Excluding the information for VHSv, a significant amount of ANS information was obtained from the USACE White Paper listing the non-native species of concern and dispersal risk for GLMRIS (USACE, 2011b). The VHSv was not identified as a species of concern in this white paper. However, during interagency coordination VHSv was identified as a species of concern for Rosendale-

Table 4: Species of Greatest Concern for Transfer at the Rosendale-Brandon location..

Taxon	Scientific Name	Common Name	Basin	Interbasin Dispersal Mechanism
fish	*Hypophthalmichthys molitrix*	silver carp	MS	swimmer
fish	*Hypophthalmichthys nobilis*	bighead carp	MS	swimmer
fish	*Mylopharyngodon piceus*	black carp	MS	swimmer
fish	*Menidia beryllina*	inland silverside	MS	swimmer
fish	*Channa argus*	northern snakehead	MS	swimmer
fish	*Gasterosteus aculeatus*	threespine stickleback	GL	swimmer
fish	*Gymnocephalus cernua*	ruffe	GL	swimmer
fish	*Proterorhinus semilunaris*	tubenose goby	GL	swimmer
Virus	*Novirhabdovirus sp*	VHSv	GL	Pathogen to Fish & Water Column

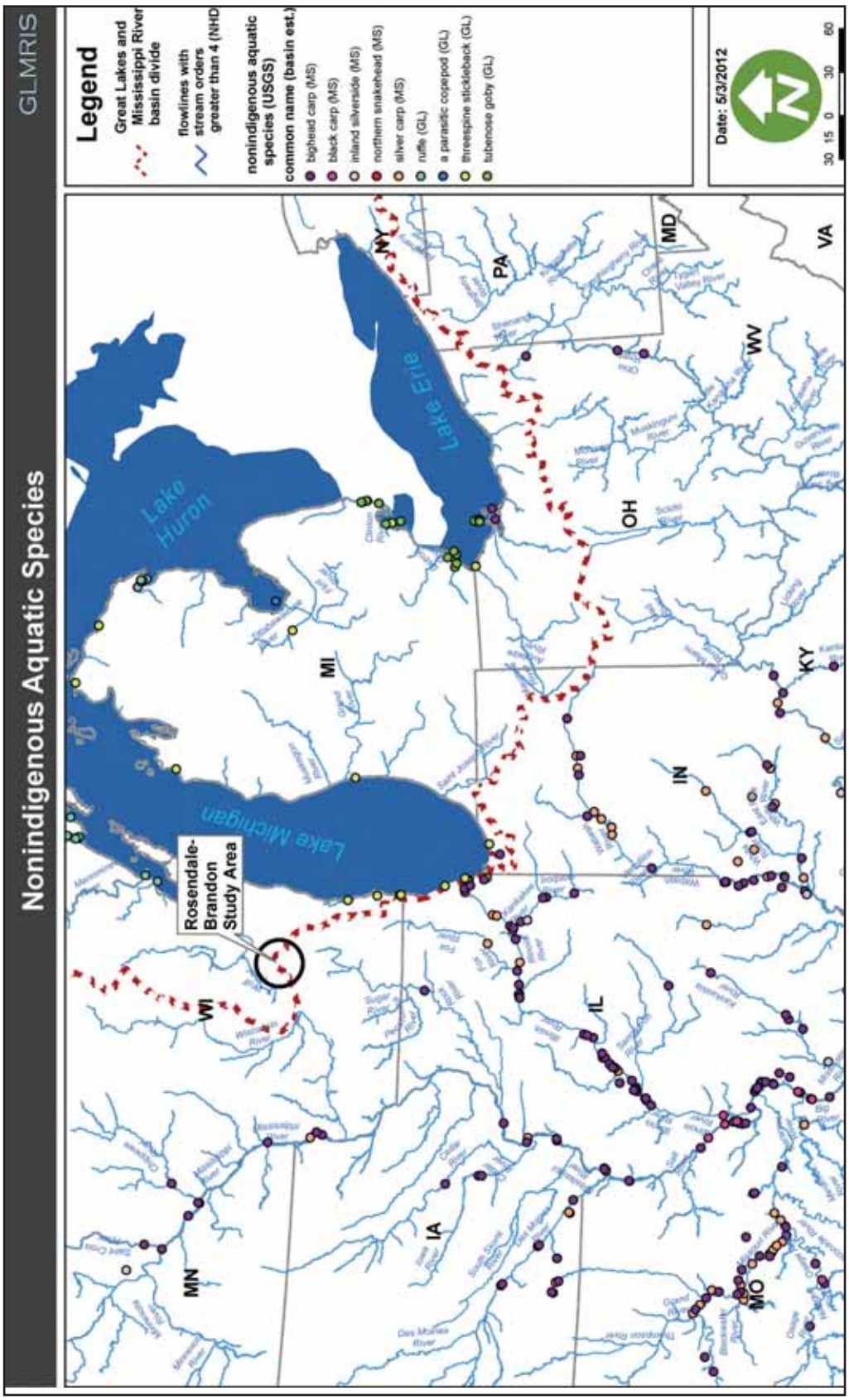


Figure 2. Map of occurrence records for ANS of greatest concern near the Rosendale-Brandon location. Courtesy of USGS.

Brandon location. Additional information was obtained from the USGS Nonindigenous Aquatic Species (NAS) website (USGS, 2011).

2.4 Pathway Assessment Process

The GLMRIS risk analysis process is an adaptation of the generic model and process described in the Generic Nonindigenous Aquatic Organisms Risk Analysis Review Process (For Estimating Risk Associated with the Introduction of Nonindigenous Aquatic Organisms and How to Manage for that Risk) (ANSTF, 1996). ANSTF defines the risk associated with an ANS as:

Equation 1

$R_{Establishment} = P_{Establishment} \times C_{Establishment}$

Where:

$R_{Establishment}$ = Risk of Establishment
$P_{Establishment}$ = Probability of Establishment
$C_{Establishment}$ = Consequence of Establishment

Note the risk is defined as a multiplicative function. That means, if either of these components is zero or low, the overall risk will also be zero or low. In order to work most efficiently given the large number of potential pathways, the GLMRIS Other Aquatic Pathways Team (Focus Area 2) concentrated its effort on characterizing the probability of establishment, while the GLMRIS Focus Area 1 Team for the CAWS is focusing on both components. An estimate of the consequences of any ANS establishment from the Focus Area 2 aquatic pathways will be deferred until possible future study by USACE or others.

ANSTF divides the probability of establishment component shown in Equation 1 into four basic elements which describe the basic events that must occur for an ANS to establish in the new environment:

Equation 2

$P_{Establishment} = [P_1 \times P_2 \times P_3 \times P_4]$

Where:

P_1 = P *ANS associated with pathway*
P_2 = P *ANS survives transit*
P_3 = P *ANS colonizes in new environment*
P_4 = P *ANS spreads beyond colonized area*

Each of the four elements of Equation 2 is qualitatively rated a High (H), Medium (M), or Low (L) based on the available evidence. They are also qualitatively assigned a level of certainty (Very Certain, Reasonably Certain, Moderately Certain, Reasonably Uncertain, Very Uncertain). The overall probability rating is the rating of the element with the lowest probability. Thus, in a quartet of HLHH the overall probability rating is L. The multiplicative nature of the function assures this is actually a somewhat conservative estimate. With actual numbers the overall probability would always be smaller than the smallest of the four factors. These elements have been modified for use in GLMRIS (Equation 3) to describe the basic sequence of events that must occur for an ANS to successfully cross the basin divide through an aquatic pathway and establish in the new basin:

Equation 3 [FA1 Model]

$P_{Establishment} = [P_0 \times P_1 \times P_2 \times P_3 \times P_4]$

Where:

P_0 = P *Pathway exists*
P_1 = P *ANS has access to pathway*
P_2 = P *ANS transits pathway*
P_3 = P *ANS colonizes in new waterway*
P_4 = P *ANS spreads in new waterway*

This model works well in areas where a viable pathway is already known to exist, such as the CAWS. However, for many of the 18 locations identified in GLMRIS Focus Area 2, it was uncertain at the outset whether or not an aquatic pathway does in fact ever form. The team recognized that formation of a pathway at these locations would likely be infrequent, and with a limited duration and magnitude (width, depth, and rate of surface water flow across the basin divide). Consequently, the model in Equation 3 was modified further for Focus Area 2.

Greater efficiency in analysis can be gained by

modifying Equation 3 by eliminating evaluation of the last two elements because if a pathway does not exist there is no reason to collect data on colonization (P_3) and spread (P_4) in the new basin. In addition, the third element of Equation 3, ANS transits pathway (P_2), is broken down into its own sequence of necessary events to characterize in greater detail those variables being evaluated to determine whether or not a viable pathway exists. In setting aside the last two elements in Equation 3 (P_3 and P_4), no attempt is therefore made in this report to assess the probability that an ANS will colonize in or spread through the receiving waterway or basin. USACE or others may assess the last two elements of Equation 3 in the future when evaluating specific measures that could be taken to eliminate the probability of transfer at certain aquatic pathways.

Once again, in order to work efficiently in assessing ANS risk for Focus Area 2, the initial assessment focuses narrowly on the question of whether or not a viable aquatic pathway exists. Equation 4 shows how the third element of Equation 3 has been broken down to provide greater resolution for evaluating the pathway itself:

Equation 4 [Modification of Equation 3 – P2 Element]

$P_2 = [P_{2a} \times P_{2b} \times P_{2c}]$

Where:

P_2 = P *ANS transits pathway*

P_{2a} = P *ANS surviving transit to aquatic pathway*

P_{2b} = P *ANS establishing in proximity to the aquatic pathway*

P_{2c} = P *ANS spreading across aquatic pathway into new basin*

Delaying consideration of the last two elements of Equation 3 and substituting the more detailed consideration of the third element as expressed in Equation 4 yields the following model used in the GLMRIS Focus Area 2 assessments:

Equation 5 [FA2 Modified]

$P_{Viable\ pathway} = [P_0 \times P_{1'} \times P_{2a} \times P_{2b} \times P_{2c}]$

Where:

P_0 = P *Pathway exists*

$P_{1'}$ = P *ANS occurring within either basin*

P_{2a} = P *ANS surviving transit to aquatic pathway*

P_{2b} = P *ANS establishing in proximity to the aquatic pathway*

P_{2c} = P *ANS spreading across aquatic pathway into new basin*

Notice the overall probability is now the "probability a viable pathway exists" ($P_{Viable\ pathway}$) and is no longer the original "probability of establishment" from Equation 3. The probability of establishment for certain aquatic pathways may be assessed in future studies by USACE or others, but likely only for those pathways with an unacceptable rating for the "probability of a viable pathway" existing. Note also that (P_1), ANS has access to pathway from Equation 3 has been renamed ($P_{1'}$), ANS occurring within either basin". This did not change the element being evaluated but made it clearer to team members what "access to the pathway" actually meant.

This model remains consistent with the overall GLMRIS risk assessment approach and the ANSTF methodology, and the refinements enabled the assessors to focus more appropriately on the relevant evidence. At those locations along the basin divide where the first element in Equation 5 (i.e., likelihood that an aquatic pathway exists at up to a one percent annual recurrence interval event) was estimated to be low, no further assessment of that location was necessary. The low rating of this initial element assures that the overall probability of a viable pathway existing (Equation 5), the overall probability of establishment (Equation 3), and the ANS risk potential (Equation 1), will all be low because of the multiplicative nature of the model. This approach assured a more prudent use of public resources in data collection and assessment by minimizing the collection of unnecessary data, and the conduct of unnecessary analyses. It should also be understood that a low rating for probability of a pathway existing (P_0) is not necessarily the same as there being no probability of a pathway existing. At those locations where the probability of a pathway existing (P_0) was determined to be medium or high which includes the Rosendale-Brandon pathway, the remaining four elements in Equation 5 were evaluated for each ANS of concern specific to that particular location over a 50 year period of analysis.

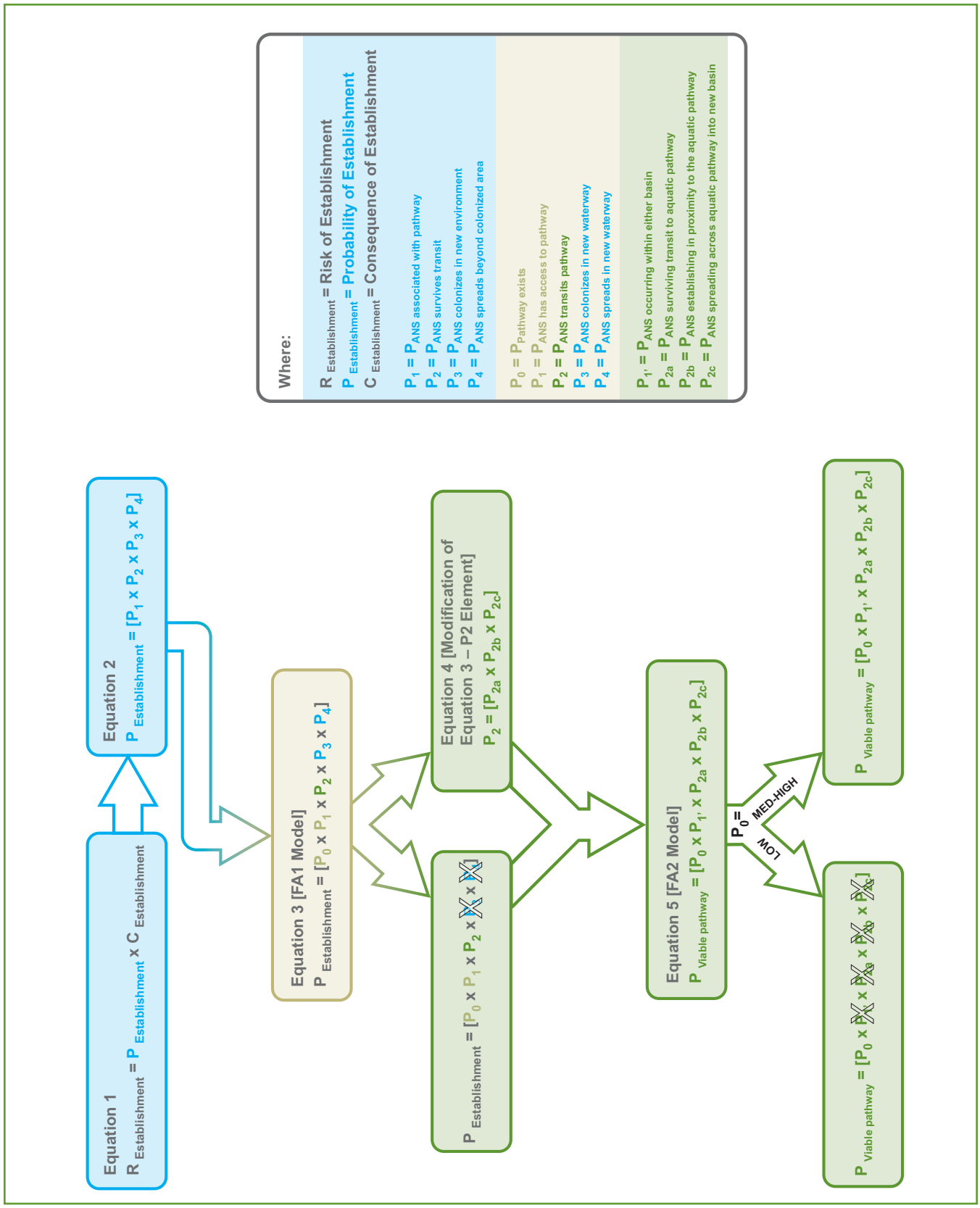


Figure 3. Diagram of the derivation of the GLMRIS Focus Area 2 aquatic pathway assessment model.

2.5 Example Calculation of Overall Aquatic Pathway Viability

As described in Section 2.2, a list of ANS of concern for the Rosendale-Brandon pathway was developed with input from Federal, State, and local agencies responsible for water resources, and fish and wildlife management in the state of Wisconsin and neighboring states along the Great Lakes and Mississippi River Basin divide. ANS of concern were grouped according to which basin they were currently established in to determine the viability of the aquatic pathway to transfer species across the divide in either direction. The determination of the likelihood of a viable aquatic pathway for each ANS of concern is the product of five probability elements (Equation 5). Thus, the probability of a viable pathway for a particular ANS of concern is equal to the lowest rating determined for each of the five probability elements (Table 5 and Table 6). The overall pathway viability for transferring ANS of concern from the Mississippi River Basin to the Great Lakes Basin was equal to the highest probability of a viable pathway for each ANS of concern in Table 4. In this example, all were rated low and thus the overall pathway viability for transferring species from the Mississippi River Basin

Table 5. Example calculation of Pathway Viability for ANS Spreading from Mississippi River Basin to the Great Lakes Basin.

			Form 1 P_0	Form 2 P_1	Form 3 P_{2a}	Form 4 P_{2b}	Form 5 P_{2c}	$P_{viable\ pathway}$
Group	**Common Name**	**Mode of Dispersal**	**Pathway Exists?**	**ANS Occuring Within Either Basin?**	**ANS Surviving Transit to Pathway?**	**ANS Establishing in Proximity to Aquatic Pathway?**	**ANS Spreading Across Aquatic Pathway into New Basin?**	**ANS/Pathway Viability Rating**
fish	Asian carp, silver carp, bighead carp, black carp	swimmer	M (RC)	M (RC)	L (RC)	L (MC)	M (RU)	L
fish	inland silverside	swimmer		M (VC)	L (MC)	L (RC)	L (RC)	L
Overall Pathway Viability for Spread of ANS from Mississippi River Basin to Great Lakes Basin								**L**

VC=Very Certain (as certain as going to get), RC=Reasonably Certain (reasonably certain), MC=Moderately Certain (more certain than not), RU=Relatively Uncertain (reasonably uncertain), VU=Very Uncertain (a guess)

Table 6. Example calculation of Pathway Viability for ANS Spreading from Great Lakes Basin to the Mississippi River Basin.

			Form 1 P_0	Form 2 P_1	Form 3 P_{2a}	Form 4 P_{2b}	Form 5 P_{2c}	$P_{viable\ pathway}$
Group	**Common Name**	**Mode of Dispersal**	**Pathway Exists?**	**ANS Occuring Within Either Basin?**	**ANS Surviving Transit to Pathway?**	**ANS Establishing in Proximity to Aquatic Pathway?**	**ANS Spreading Across Aquatic Pathway into New Basin?**	**ANS/Pathway Viability Rating**
fish	threespine stickleback	swimmer	M (RC)	M (VC)	L (RC)	L (MC)	L (MC)	L
pathogen	VHSv	fish pathogen / water column		H (VC)	H (MC)	H (RC)	H (RU)	M
Overall Pathway Viability for Spread of ANS from Great Lakes Basin to Mississippi River Basin								**M**

to the Great Lakes Basin is “low”. The overall pathway viability for transferring species from the Great Lakes Basin is calculated the same way and is shown in Table 5. In this example, the overall pathway viability for transferring species from the Great Lakes Basin to the Mississippi River Basin is “medium”.

The last calculation is to determine the overall pathway viability for interbasin spread of ANS which is calculated by taking the highest of the overall ANS ratings for unidirectional transfer which were calculated in Tables 5 and 6. Thus, in Table 6, the overall probability that a viable aquatic pathway exists is “medium”. The ratings given for each element as well as the overall pathway viability ratings shown in Tables 5 and 6 were coordinated amongst the members of the pathway team until agreement was reached regarding the probability rating (H, M, or L) and the level of certainty (VC, RC, MC, RU, or VU).

3 Aquatic Pathway Characterization

This section describes and illustrates the topography and features in the vicinity of the potential pathway near Rosendale-Brandon, Wisconsin and is intended to help inform the biological evaluations contained in Sections 3 and 4 of this report with a compilation of any readily available and applicable information of this area as it may influence local hydrology. Maps, photographs, and figures are included to aid understanding of the significant hydrologic and hydraulic conditions near the drainage divide. Also, this section identifies any significant data gaps and uncertainties related to the available topographic information and hydrologic modeling in the area of interest.

3.1 Location

The Rosendale-Brandon potential pathway is located between the cities of Rosendale and Brandon, which are approximately 15 miles (24 km) west of Fond du Lac, Wisconsin and in Fond du Lac County, Wisconsin. The Rosendale-Brandon potential pathway is at a latitude of 43°46’27.95”N, and a longitude of 88°43’41.28”W, and is located in a wetland just west of County Road M, about halfway between Bell School Road and Davis Road. Figure 4 and Figure 5 show the location of the Rosendale-Brandon potential pathway. The Great Lakes and Mississippi River Basins, the basin divide, the FEMA one percent annual chance floodplains, and the major roads in the area can be seen in Figure 5.

3.2 Climate

Climate is looked at in this section just in terms of identifying any applicable elements of climate (e.g., temperature, rainfall) and how they may influence the likelihood of an aquatic connection forming at the subject pathway that could be utilized by ANS to spread between basins. This area of central Wisconsin is classified as continental with large temperature variance, four distinct seasons, and relatively small or moderate precipitation. Temperature extremes range from an all-time high of 107ºF (41.6ºC) which was observed on July 14th, 1936 to a record low of -37ºF (-38ºC), which occurred on January 30th, 1951. The average daily temperature in the winter (Dec-Feb) typically ranges from 12ºF to 30ºF (-11ºC to -1ºC), while summers (Jun-Aug) are usually around 64ºF to 74ºF (18ºC to 23ºC). Normal annual precipitation is about 30 inches (76 cm) and the normal snowfall is around 40 inches (101 cm). Daily temperatures average below 32ºF (0ºC) about 120 days and above 40ºF (4.4ºC) about 210 days of the year. Fond du Lac lakes are normally frozen from mid-December to early April. See Table 7 for National Climatic Data Center (NCDC) normals, from 1971-2000.

The highest precipitation accumulation occurs in the summer months, primarily from June to August. Although rainfall amount do not always conform to averages, they are suggestive that substantial precipitation does not occur frequently and a greater than average amount of precipitation would likely be necessary to cause a surface water connection to form between the basins, although this is an area of uncertainty due to a lack of data linking precipitation amounts to the behavior of surface hydrology at the pathway location. The higher discharge needed to form an aquatic pathway would

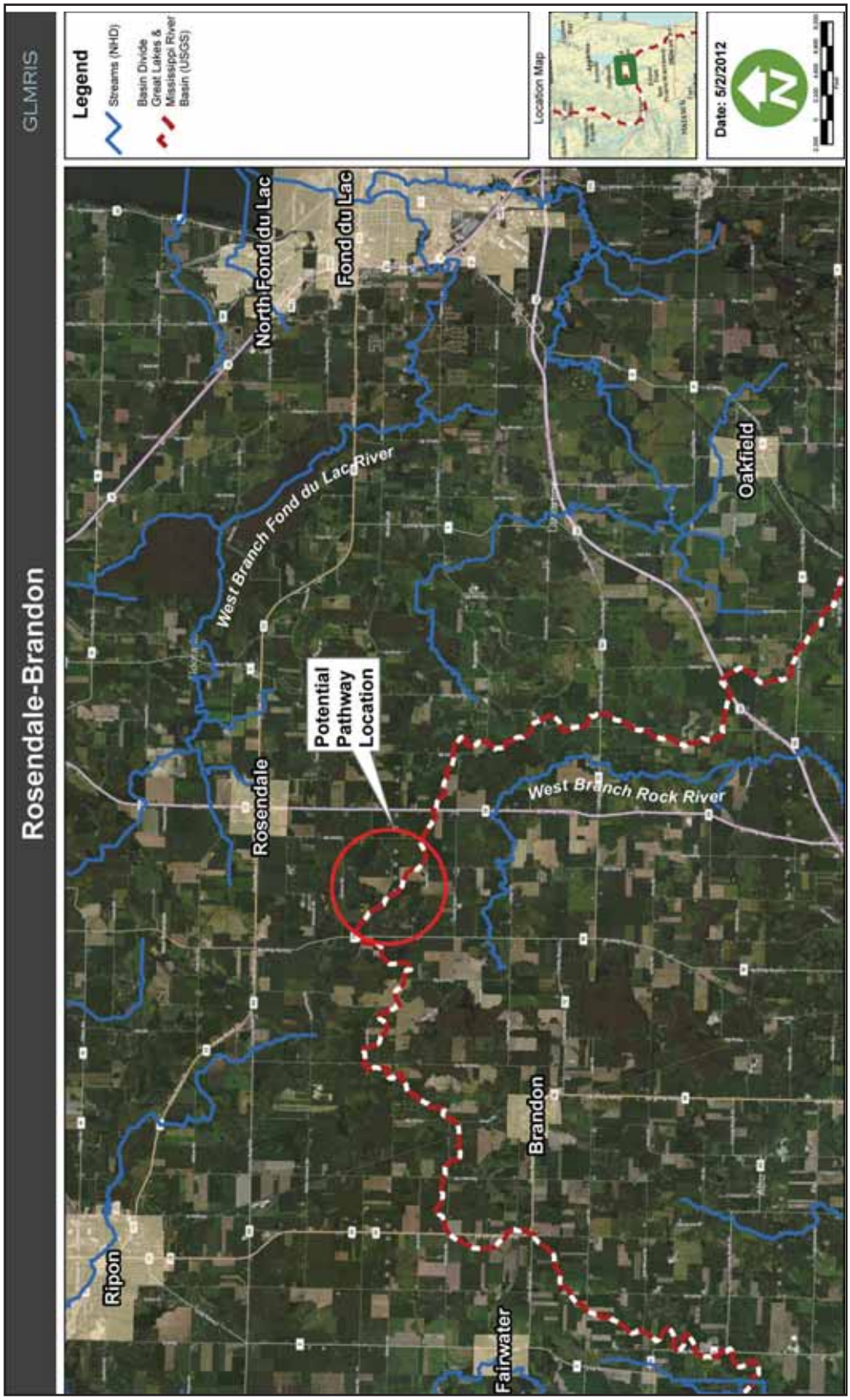


Figure 4. The Location of the Rosendale-Brandon potential pathway along the Great Lakes and Mississippi River Basin divide (12-digit hydrologic unit code). Background image coutesy of Bing Maps.

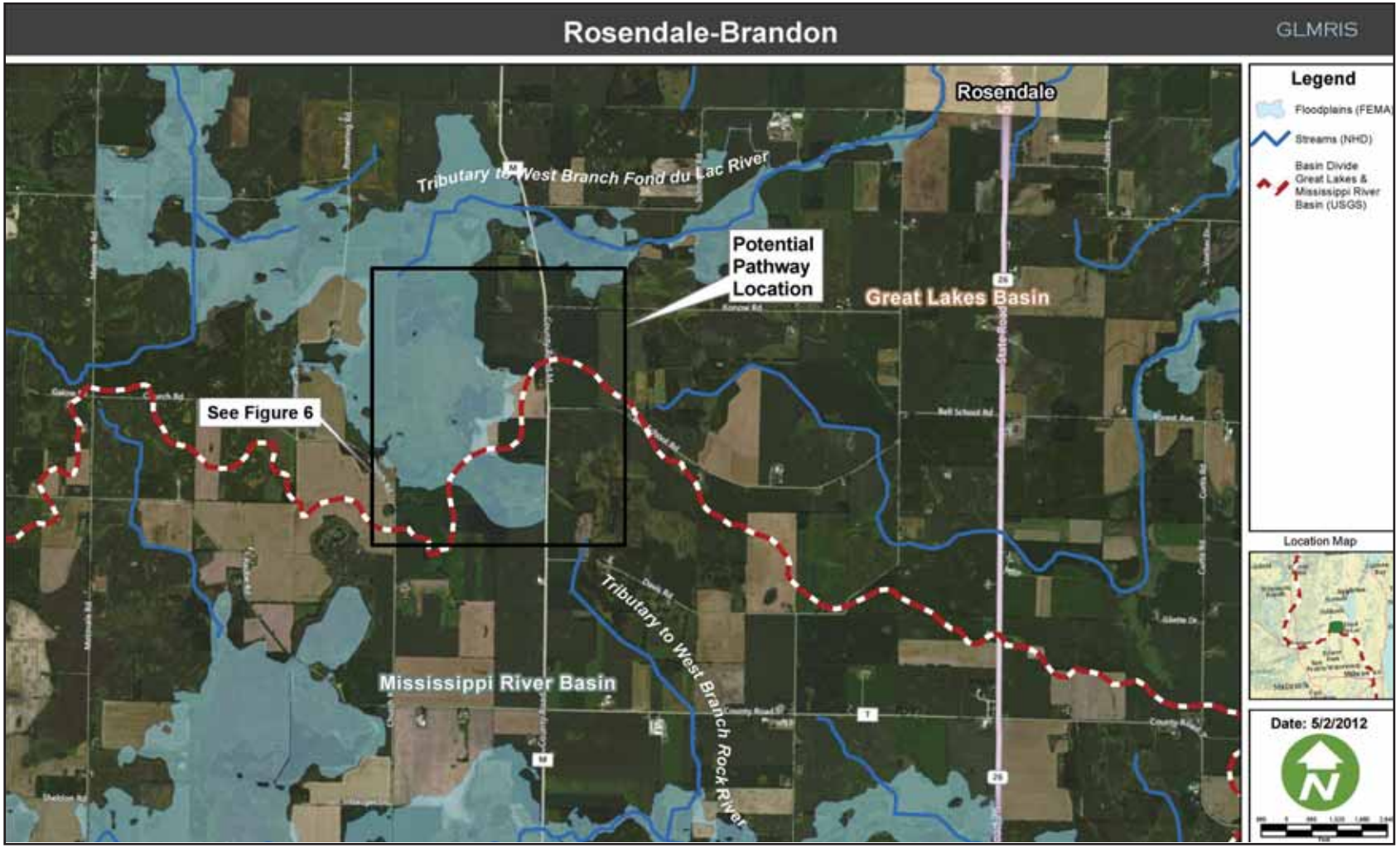


Figure 5. Larger scale view of the Rosendale-Brandon potential aquatic pathway. The red-white line is the basin divide. The blue lines are streams near the basin divide and the blue shaded areas are the FEMA one percent floodplains. Aerial imagery courtesy of Bing Maps.

Table 7: Climate Information for Rosendale-Brandon, Wisconsin (source: Midwestern Regional Climate Center (MRCC) – Station Fond du Lac, WI)

Element	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
Mean Temperature°F	16.6	21.4	32.3	45.1	57.9	67.1	71.8	69.5	61.3	49.6	35.4	22.3	45.9
Mean Temperature °C	-8.6	-5.9	0.2	7.3	14.4	19.5	22.1	20.8	16.3	9.8	1.9	-5.4	7.7
Normal Precip (in)	1.09	1.00	1.86	2.78	2.93	3.57	3.52	4.18	3.50	2.36	1.97	1.39	30.15
Normal Precip (cm)	2.8	2.5	4.7	7.1	7.4	9.1	8.9	10.6	8.9	6.9	5.0	3.5	76.6
Mean Snow (in)	11.2	7.8	6.9	1.9	0.1	0.0	0.0	0.0	0.0	0.1	3.4	9.3	40.7
Mean Snow (cm)	28.5	19.8	17.5	4.8	0.2	0	0	0	0	0.2	8.6	23.6	103.4

be most likely to occur at Rosendale-Brandon during either the spring when the soils are saturated and rain and snowmelt runoff occur or during a series of heavy summer rainstorm events. In addition, given that annual temperatures are at or below the freezing mark on an annual basis, climatic conditions alone will likely restrict the time during which any ANS movement might occur by natural vectors.

3.3 Location Specific Surface Water Features

This section is meant to present and interpret the readily available information for this location as it pertains to surface water conditions and any aspects that may influence the behavior of surface water. The FEMA Q3 base flood maps, which depict the FEMA Fond du Lac County Flood Insurance Study (FIS) mapping from 2009, shows that the one percent annual chance floodplain for the tributary of the Fond du Lac River (Great Lakes Basin) covers the entire wetland and has a southern terminus at County Road M. The one percent annual recurrence interval floodplain for the tributary of the West Branch Rock River (Mississippi River Basin) starts downstream (south) of Davis Road. These floodplains are shown in Figure 5 and Figure 6 along with the HUC12 basin boundary. The HUC12 basin divide is the red-white line in the center of the figures and is the best available representation of the divide.

The wetland west of County Road M forms the headwaters of the tributary to the West Branch Fond du Lac River and floods at the one percent event largely due to backwater effects of the tributary. This tributary is located approximately one-mile (1.6 km) from the basin divide and drains the wetland to the north. Water has been observed in the tributary during normal daily flow events. The tributary channel measures approximately six feet (1.8 m) wide by four feet (1.2 m) deep at Schmoldt Road and regularly has a depth of water about one to 1.5 feet (0.46 m) (Figure 6). Figure 7 is a comparison of two aerial photos of the wetland from 1992 and 2005, showing the area from the basin divide to the tributary of the West Branch Fond du Lac River. Some ponded areas and shallow, narrow drains appear visible in the aerial photos, as well as the general lack of land-use change over the represented 13 years, likely due to the wet soils.

This wetland west of County Road M is also connected to a tributary to the West Branch Rock River (Mississippi River Basin) north of Davis Road via a drain that forms in the wetland and continues eastward under County Road M, located approximately 2,500 feet (762 m) from the basin divide, and into the field on the east side of the road. It is not known for certain how far into the wetland west of County Road M this drain extends, but is estimated to be approximately 500 to 1000 feet (152 to 305 m). There is a four-foot (1.2 m) corregated metal pipe (CMP) culvert under County Road M (Figure 8) which is buried about 1.5 feet (0.46 m) and regularly has ponded water in it to a depth of about 0.5 to 1.0 foot (15 to 30 cm). From the culvert under County Road M, the drain continues to the

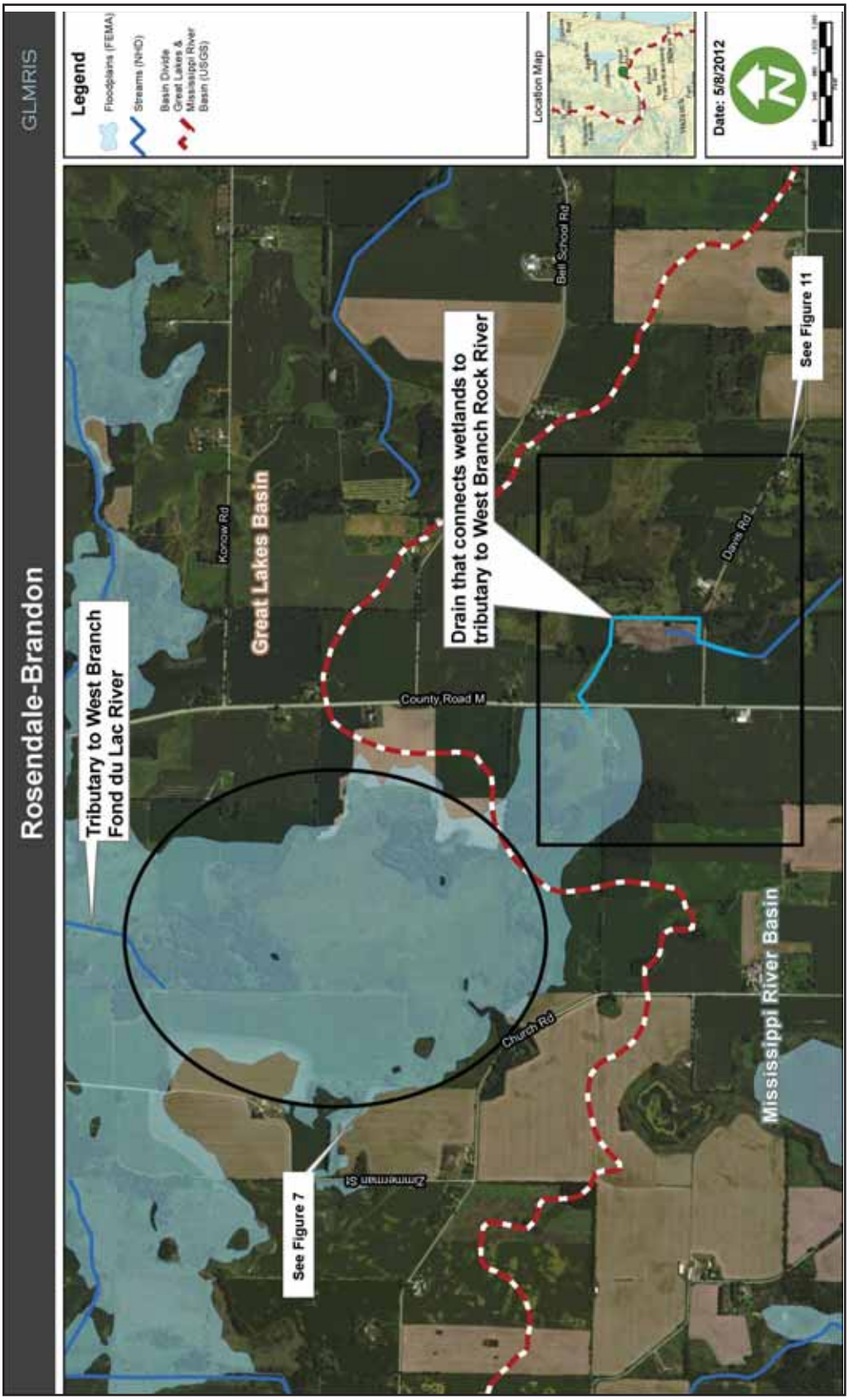


Figure 6. FEMA one percent floodplains for Rosendale-Brandon shaded in blue. Note tributaries draining the wetland complex into either basin. Aerial imagery courtesy of Bing Maps.

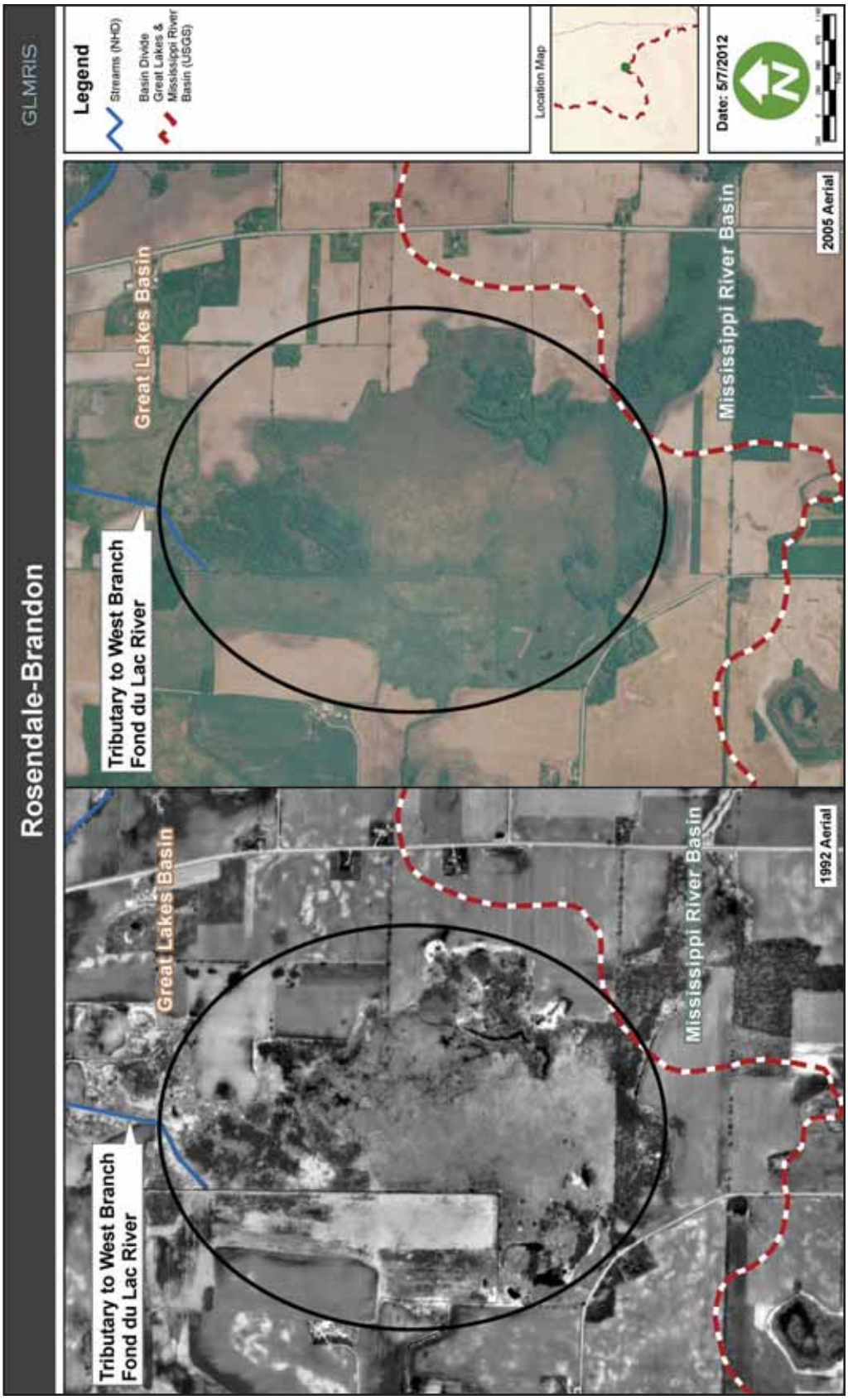


Figure 7. Aerial photos of the northern end of the wetland at Rosendale-Brandon. Left photo is from 1992 and right photo is from 2005. The red-white line is the basin divide and the blue line at the very top of the figure is a tributary to the West Branch Fond du Lac River. Aerial imagery courtesy of Bing Maps.

southeast and connects the wetland to the tributary of the West Branch Rock River. The channel for the drain measures approximately three feet (0.9 m) wide by two feet (0.6 m) deep, and also has a regular water depth of about 0.5 to 1.0 foot (Figure 9 and Figure 10). Figure 11 is a comparison of two aerial photos of the wetland and connecting drain from 1992 and 2005, showing the eastern portion of the wetland (west of County Road M) and the drain which extends southeast of the road. The drain forms the tributary to the West Branch Rock River just upstream (north) of Davis Road. There is a three-foot CMP culvert under Davis Road (Figure 12) that allows flow through to the other side. The aquatic pathway then continues unobstructed to the West Branch Rock River.

During the site visit on June 7, 2011, stagnant ponded water was observed in both the wetland and in the drain on either side of County Road M, and in the four-foot (1.2 m) CMP culvert under the road. Water was also observed in the tributary to the West Branch Rock River on either side of Davis Road, and in the three-foot (0.9 m) culvert under that road. The water was about 0.5 - 1.0 foot (15 to 30 cm) deep in the drain and the tributary to the West Branch Rock River, and was a few inches deep in the culvert. During the site visit, a predominant direction of flow could not be determined. The contours show the predominant direction of flow to be in the direction of the West Branch Rock River (Mississippi River Basin). Figures 8, 13, and 14 are photographs that were taken from County Road M and Figures 9, 10 and 12 were taken from Davis Road.

The site visit confirmed that both the tributary to the Great Lakes Basin and the tributary to the Mississippi River Basin are connected to the wetland that crosses the basin divide near County Road M. Therefore, a surface water connection at this site is considered likely.

The uniform and vegetated nature of the wetland is potentially an important attribute to note in evaluating the area's limited ability to facilitate ANS transfer, especially within the more heavily vegetated north and south ends of the wetland (Figure 13 and Figure 14). It should be noted that this wetland was not extensively evaluated for the presence of any channels or whether the flooding depths might allow an ANS with swimming ability to navigate through this wetland during flood events.

The USGS 10m Digital Elevation Model (DEM) was used to create one-meter contours shown over a Bing Maps aerial image in Figure 15 and also Figure 16, along with the location of the basin divide. Figure 15 indicates that the vertical accuracy for each elevation point in the USGS 10-meter DEM across the divide location is +/-13.123 feet (4 m). This level of accuracy may lead one to conclude that there is a high degree of uncertainty regarding the potential for watershed connections being established during flood events. However, the absolute vertical accuracy (specific elevation) is not nearly as important as the relative, or point-to-point, vertical accuracy (terrain) when evaluating terrain the divide location to try and predict hydrology. Point-to-point accuracy has been shown to be much greater than this margin of error regarding absolute elevation would indicate. Although the absolute elevation values may vary from the true value (i.e., 800 feet (244 m) above sea level), they tend to be off a comparable amount at adjacent points so that the terrain of the area is actually depicted relatively well. The grid size used to create the DEM can also affect the accuracy of the DEM. The larger the grid cell size (10-meter squares vs. 30-meter squares), the more blocky and less detailed the terrain appears and thus the less accurately the DEM depicts the actual terrain. The largest grid size used at any of the pathway locations is 10-meter squares with some pathway locations having more detailed information. Even though the 10-meter cell size does not depict every hummock or hollow in the terrain, it does provide sufficient detail regarding general terrain and relative elevations to provide some useful data in evaluating the potential for a hydrologic connection forming across the basin divide.

Shown in Figure 16 are representative cross-sections through the area of interest, based on the best available Geographic Information System (GIS) data for this pathway (USGS 10-meter DEM) (Gesch, 2007). It shows a profile along the HUC boundary to depict the 'saddle point' along the basin divide and a cross-section that cuts through the HUC boundary to depict the typical and approximate ground elevation along the flow path. The saddle point is the location of the lowest elevation along the basin divide and the point at which a hydrologic connection is most likely to be established. This cross-section does not depict the drain known to be at this location east of County Road M. As explained above, these are only based off of approximate ground

Figure 8. Photo at County Rd M, looking at the four-foot CMP on the west face (wetland side) of the Culvert. Photo from USACE in 2011.

Figure 9. Photo at Davis Road, looking north towards the drain that connects the wetland to the tributary of the West Branch Rock River. Photo from USACE in 2011.

Figure 10. Photo at Davis Road, looking south towards the tributary to the West Branch Rock River and its floodplain. Photo from USACE in 2011.

elevations. As a result of the elevation difference between the road, and the wetland and drain on either side, there is potential for greater vertical inaccuracy around the roadbed. The basin divide location illustrated on Figure 16 represents the existing HUC12 basin boundary. However, based on the cross section through the pathway (yellow line), the actual (effective) basin divide is more likely located about 1,000 feet (305 m) to the northwest and cutting across the flat broad wetland shown in Figures 5 and 6.

The wetland classification and NRCS Soil Ponding Frequency Class for the Rosendale-Brandon potential pathway is illustrated in Figure 17. Three of the major soils in the area of interest are Houghton mucky peat (Hu), Palms mucky peat (Pc), and Pella silt loam (Pha). The Hu and Pc soils are listed as being very poorly drained with a very high runoff coefficient. The Pha soil is listed as being poorly drained with a high runoff coefficient. A NRCS soil scientist has stated that "there would be ponding in the Hu and southern Pc map unit. The Pha and Pc to the north looks like it would be drained by the ditch to the north, so I wouldn't expect there to be much standing water there. It (whether the ponding would be continuous or in separate depressions) would have to depend on the landscape position. Both soils are found in depressional areas. Without seeing the site, both Hu and Pc would have continuous ponding on them" (J. Ziegler, NRCS-SE, Juneau, WI, personal communication, September 28, 2011). As shown in this figure, the tributary to the Great Lakes Basin, the wetland crossing the basin divide, and the tributary to the Mississippi River Basin are all shaded blue, indicating frequent ponding in these areas. Since the blue shading is continuous between the tributaries, it is assumed that a surface water connection could form at this pathway during periods of ponding water following large storm events.

The site visit in June of 2011, the FEMA one percent floodplain mapping, and the NRCS soil survey information all indicate that a surface water connection at Rosendale-Brandon is likely to form during storm events less than or equal to the one percent annual recurrence interval, but it is not known at what frequency the connection starts.

3.4 Groundwater

Groundwater was investigated as part of determining the likelihood of a pathway existing because groundwater can serve as a source of baseflow for streams. Water levels in the aquifers typically fluctuate in response to seasonal variations in recharge and discharge. Groundwater levels commonly rise in spring, when areal recharge is greatest because of snowmelt, spring rain, and minimal evapotranspiration losses. This means that heavier rainfall events, when they coincide with frozen ground conditions, snowmelt, and higher groundwater conditions, may be more likely to facilitate formation of an aquatic connection between the basins. Groundwater levels generally decline in summer because evapotranspiration rates are high, continued discharge to streams, and withdrawals by wells collectively exceed recharge. Thus, groundwater likely plays very little role in any establishment of an aquatic connection. Net recharge to the aquifers also occurs in the fall of most years, due to rainfall and low evapotranspiration rates. The nearest available groundwater data for Rosendale-Brandon is from USGS Groundwater Watch site no. 434231088311801, located 11 miles (18 km) southeast of the pathway site. Although no groundwater data in the immediate vicinity of the pathway is available, groundwater conditions are not believed to increase the likelihood of a surface water connection being maintained between these watersheds.

3.5 Aquatic Pathway Temporal Characteristics

Characterizing the temporal variability of the pathway hydrology is an important aspect of understanding the likelihood of an ANS being able to traverse the basin divide at this location as flood events may coincide with species dispersal and reproduction patterns and abilities to survive and establish populations in various areas. Daily temperatures average below 32ºF (0ºC) for about 120 days of the year and above 40ºF (4.4ºC) for about 210 days. The Fond du Lac lakes are normally frozen from mid-December to early April. An aquatic pathway is most likely to occur at Rosendale-Brandon during either the spring when rain and snowmelt runoff occur or during summer rainstorm events.

The channel of the tributary of the West Branch Fond du Lac River near the potential pathway location measures approximately six feet (1.8 m) wide by four feet (1.2 m) deep and regularly has a depth of about one to 1.5 feet (0.46 m). The channel for the drain to the east of County Road M measures approximately three feet (0.9 m) wide by two feet (0.6 m) deep and regularly has a water depth of about 0.5 to 1.0 foot (15 to 30 cm). The tributary of the West Branch Rock River has the same approximate dimensions of the drain. These water levels were observed during a typical June precipitation month, so it would convey much more water (with a deeper depth) during higher flood events.

Based on the photographs of the emergent wetland site taken in June 2011, the field observations, and the aerial photographs, it is highly likely that the emergent wetland has saturated soil most of the year and some ponded or standing water at least during the springtime, and likely during heavy rain events throughout the year. It is assumed that water depths of up to six inches (15 cm) (possibly more) could be expected in this type of emergent wetland complex in the spring and early summer for a day or two on a recurring basis. In addition, given that the area is subjected to freezing temperatures on an annual basis for up 120 days or longer (Table 7), biological activity and water flow would likely be further restricted on a temporal basis.

3.6 Probability Aquatic Pathway Exists

The rating discussed in this section is only for the likelihood of an aquatic connection existing at this potential pathway (P_0) at up to a one percent annual return frequency storm. A surface water connection between the Great Lakes and Mississippi River Basins could form at the Rosendale-Brandon potential pathway based on the following points:

- During a June 2011 site visit, no continuous aquatic pathway, or evidence thereof (e.g., defined channel,

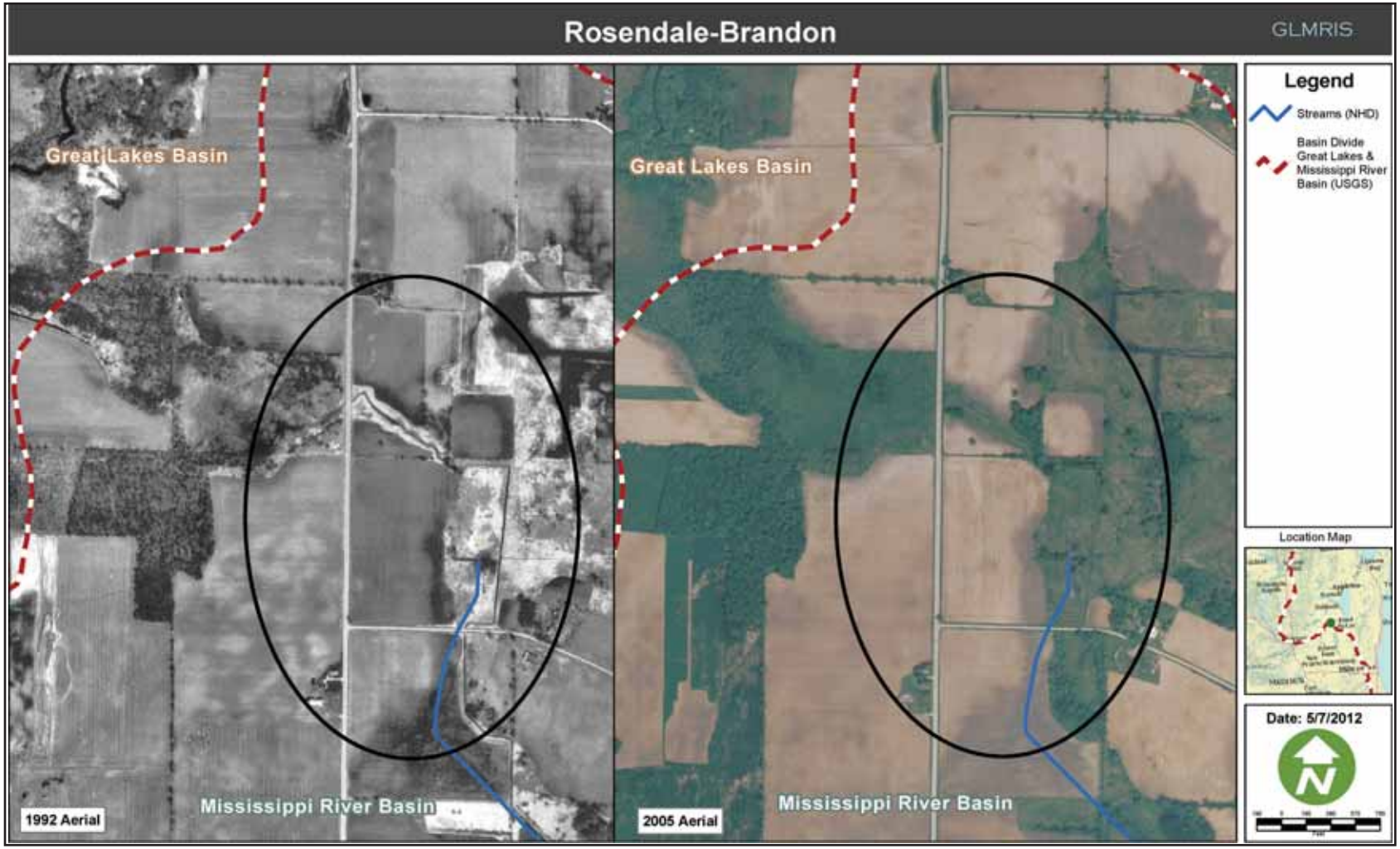


Figure 11. Aerial Photos of the eastern end of the wetland at Rosendale-Brandon and the drain that connects this wetland to the tributary of the West Branch Rock River. Left photo is from 1992 and right photo is from 2005. Aerial imagery courtesy of Bing Maps.

Figure 12. Photo at Davis Road, looking at the three-foot CMP on the south face of the culvert. Photo from USACE in 2011.

Figure 13. Photo at County Rd M, looking east towards the drain that connects the wetland to the tributary to the West Branch Rock River. Photo from USACE in 2011.

Figure 14. Photo at County Rd M, looking west towards the wetland. Photo from USACE in 2011.

drift patterns, water marks) was observed at the basin divide.

- Some level of flow is likely to be regularly occurring from the wetland into both watersheds from this potential pathway location. During the site visit in June of 2011, a predominant direction of flow could not be determined. The contours show the predominant direction of flow to be in the direction of the West Branch Rock River (Mississippi River Basin).

- During the site visit in June of 2011, it was also determined that the tributaries to the Great Lakes Basin and the Mississippi River Basin are both connected to the wetland that crosses the basin divide.

- The FEMA one percent floodplain mapping at this potential pathway crosses the basin divide and connects the tributaries to each basin via the wetland.

- The NRCS soil mapping indicates that a surface water connection is possible due to soils under the category of 'frequent flooding' covering the area of the wetland and connecting the tributaries to each basin.

- A cross section through the potential flow path shows the wetland to be along a high point near along the basin divide and draining to either basin. A culvert exists at County Road M.

The pathway assessment team determined that a surface water connection could form on a perennial or intermittent basis at this location that would convey water or have six-inch (15 cm) water depths for multiple days from a one to ten percent recurrence interval storm. Therefore, the probability of an aquatic pathway forming at Rosendale-Brandon is rated "medium" for both directions (Appendix A). This rating is based on the criteria of an "intermittent stream capable of maintaining a surface water connection to streams on both sides of the basin divide continuously for multiple days from a ten percent annual return frequency

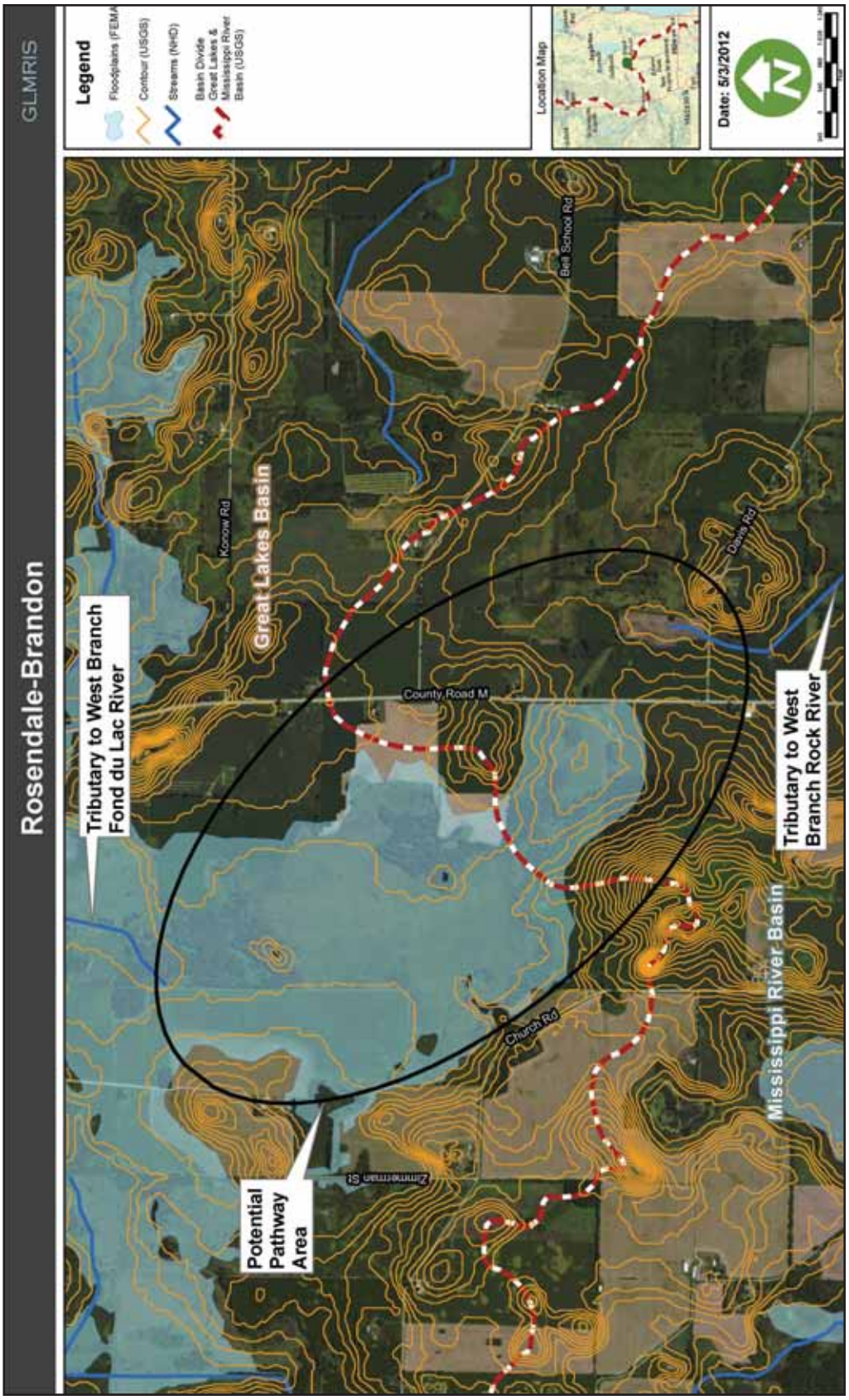


Figure 15. One-meter contours at the Rosendale-Brandon potential pathway. Blue lines are streams near the divide. Note topographic depressional area across basin divide at pathway. Aerial imagery courtesy of Bing Maps.

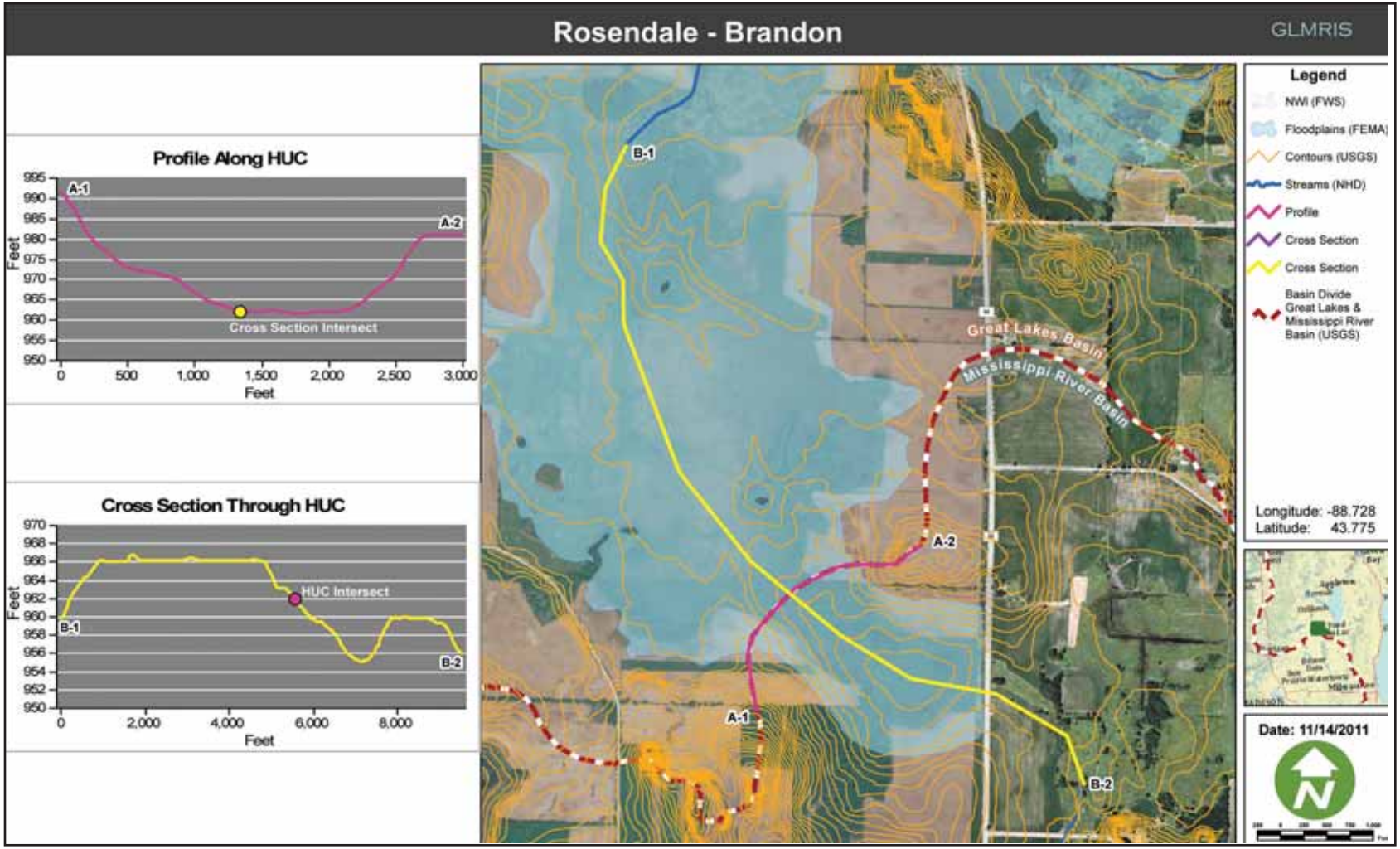


Figure 16. Typical location and HUC profile cross-sections, based on USGS 10-Meter DEM, with a vertical accuracy of +/- 13.123 feet (4 m). The pink line in the aerial photograph and the graph on the top left is the profile along the basin divide showing "saddle point." The yellow line that intersects the pink line in the photograph and the bottom left graph is the cross section through the basin divide and along any potential interbasin flow path. The blue lines in the photograph are streams near the basin divide and the red/white line is the basin divide. Background imagery courtesy of Bing Maps.

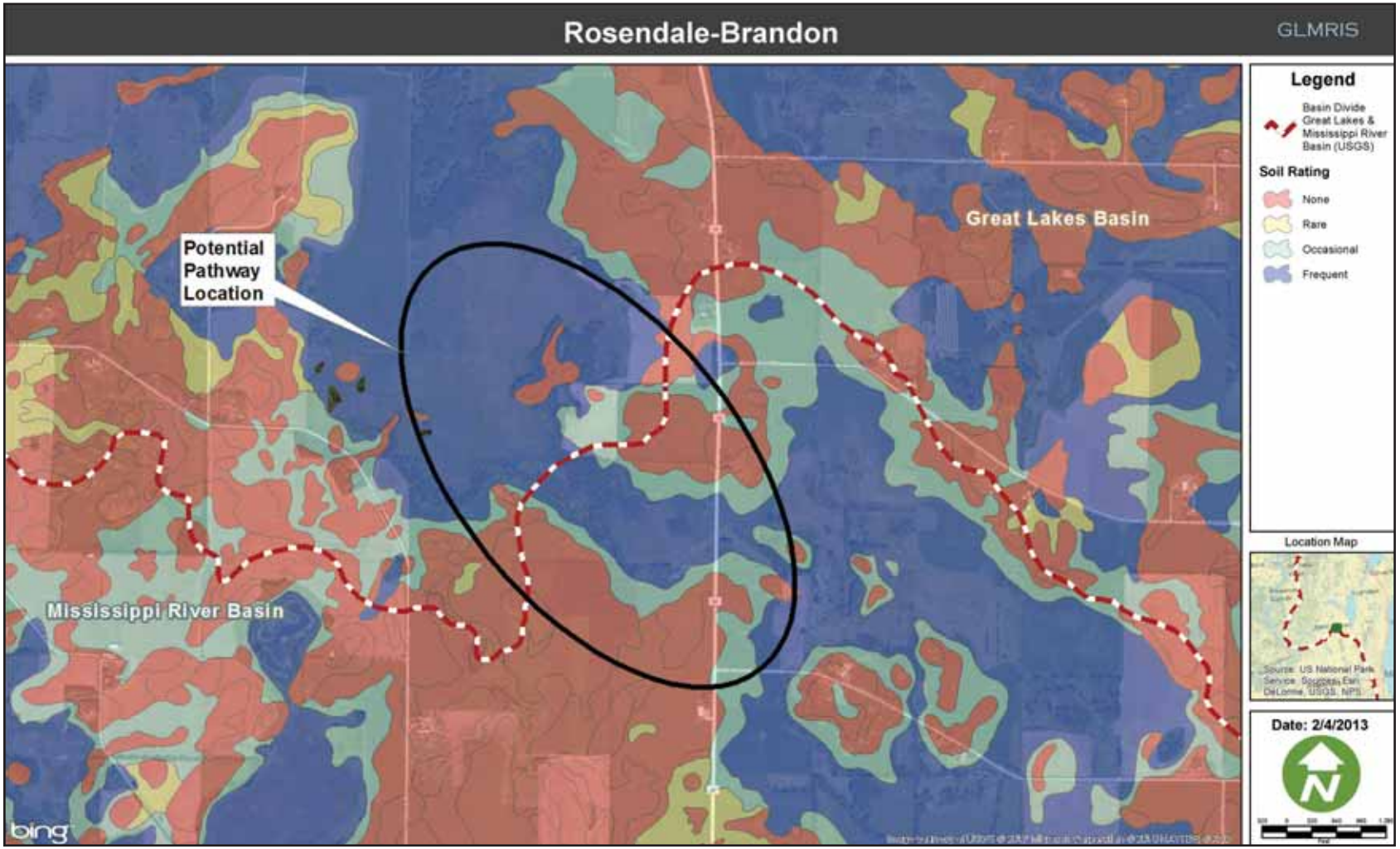


Figure 17. NRCS Soil Ponding Frequency Class for Rosendale-Brandon. The area of interest is the wetland (shaded blue) and circled. Notice that the blue category (labeled frequent flooding) extends from the tributary in the Great Lakes Basin through the wetland and to the tributary in the Mississippi River Basin. Aerial imagery courtesy of Bing Maps

storm, or a wetland spanning the basin divide which maintains significant ponds that are likely to become inter-connected and connect with streams on both sides of the basin divide from a ten percent annual recurrence interval storm."

This rating is considered "moderately certain" because of the following uncertainties:

- Accuracy of the vertical elevation of the USGS 10 m DEM for ground surface profiles at the basin divide.
- Any potential vertical elevation inaccuracy of the USGS 10m DEM for ground surface profiles at the basin divide.
- The stagnant nature of the standing water in the wetland and the drain channel leading to the tributary of the Mississippi River Basin observed on the site visit in June of 2011, making the predominate direction of flow uncertain.
- Lack of site-specific data that would allow a correlation to be established between different precipitation events to flow conditions in the wetland and connected tributaries.

3.7 Aquatic Pathway Habitat

3.7.1 Terrestrial and Riparian Plants and Land Use

The Rosendale-Brandon emergent and forested wetland divide provides a variety of habitat for wildlife in an otherwise predominately agricultural area (Figure 18). The normal assortment of birds, mammals and plant species associated with wetlands could be expected to be found in this wetland complex. The wetland west of County Road M also has various open water pockets within it which would likely provide habitat for fish, but no data has been identified that depicts water depths or suitability for fish or fish reproduction in these open water areas. The emergent wetlands at the divide (west of County Road M), and the ditches and streams leading from the divide are likely to provide access to and habitat for fish during periods of inundation. Fish should find suitable habitat to survive in the open water, but other than during flood events which could provide for possible passage of fish through the divide, the remainder of the wetlands would appear to be unsuitable for fish survival, particularly during the summer. This wetland can be viewed as an impediment to ANS transfer except under ideal conditions during spring spawning periods when common carp are moving upstream and a high volume storm event potentially inundates the emergent and forested divide and which may provide a continuous surface water depth of at least six inches.

The Rosendale-Brandon wetland divide consists of scattered open water pockets, emergent marsh, forested and shrub/scrub wetlands, and some ditch connections that drain the wetland toward the Great Lakes Basin and the Mississippi River Basin. The aquatic habitat within the ditches in the immediate vicinity of the divide would contain agricultural runoff which during the summer are likely unsuitable for fish because of temperature, excessive plant growth, intermittent nature of flow and low dissolved oxygen. However, these specific ditch features through agricultural lands may provide a pathway for common carp and other fish species during suitable runoff events. Common carp, a potential vector for VHSv, could access the divide by way of established ditches during spring runoff. However, passage of fish across the one mile (1.6 km) wetland divide, while possible, is considered less likely than under more channelized conditions. This is due to the length of passage required, the nature of the divide consisting of emergent wetlands, forested and scrub/shrub wetlands, and what appears to be a lack of constructed ditches to collect and direct discharge within the wetlands to the established tributaries leading to either basin. The USFWS National Wetlands Inventory (NWI) is unavailable for this location, but would likely list the wetland as a mixture of palustrine forested, scrub-shrub, and emergent wetland habitats.

3.7.2 Aquatic Resources

Any ANS (i.e., fish) invading from either the Mississippi River Basin or from the Great Lakes Basin by way of the ditches leading to the wetland at the basin divide would find low quality habitat in the immediate vicinity of the divide. Fish species from the Great Lakes Basin could likely only gain access into the divide during a spring runoff event during the spawning season. They would then have to pass across the wetland divide, which is not likely without a longer period of inundation for the fish to actually find the opposite side of the wetland and enter the tributary and the receding waters of the opposite basin.

A similar situation would exist for fish coming from the Mississippi River Basin. Asian carp would not likely access the drainage ditches for spawning as the habitat is not suitable. However, if a suitable runoff event occurred, it is possible that juvenile Asian carp could run upstream. The ability of the Asian carp to cross the emergent wetland divide is considered low as the fish would require at least six inches (15 cm) of continuous surface waters and a sufficient duration of inundation to make the passage. Then the fish would need to move downstream with the receding waters to suitable Great Lakes Basin habitat.

3.7.3 Water Quality

Surface water drainage at the divide to the Great Lakes Basin flows from the northeast corner of the wetland by way of drainage ditch and tributary to the West Branch Fond du Lac River, and then to the Fond du Lac River, Lake Winnebago, Lower Fox River and to Lake Michigan (Figure 19). There is also another possible Great Lakes Basin drainage connection from northwest end of the wetland by way of an unnamed tributary, and then to Silver Creek, the Puchyan River, the Upper Fox River, Lake Butte des Morts, Lake Winnebago, Lower Fox River, and then Lake Michigan. From the aerial photographs and USGS Quadrangle, the likelihood of a surface water connection existing through this northwest route is low, but roadside ditches and culverts under the roadways may make a possible connection at the one percent storm event. Three dams are on this river system and none appear to be total blockages to upstream fish passage. The drainage from the divide wetland complex to the Mississippi River Basin flows from the divide wetland under County Road M to the southeast through the unnamed tributary leading to the West Branch Rock River, then to the Rock River, and finally the Mississippi River.

3.7.4 Aquatic Organisms

The USGS 1980 Rosendale, Wisconsin Quadrangle Sheet depicts the drainage divide as part of a wetland complex (Figure 20). The overall wetland divide is approximately 500 acres (202 hectares) in size, with the specific area of interest being located where this wetland abuts County Road M. The drainage outlet to the north is depicted as a permanent stream and the drainage outlet to the southeast is depicted as wetlands until the outlet enters a permanent stream east of County Road M. The aerial photograph (Figure 11 dated 5/4/92) depicts a constructed drain outlet to the Mississippi River Basin from the divide. The 2011 site inspection confirmed a ditch connection to the east of County Road M. The limited drainage area feeding the divide tributary ditches would likely limit fish species (at least during the summer months) to downstream areas except for those fish (no known fish survey data) that may be residing in the open water pockets within the divide wetlands (Figure 20).

When runoff events occur, saturated soils and standing surface waters of unknown but shallow depth would likely form in the divide wetland. If the surface waters in the divide wetland were six inches (15 cm) or more in depth during the spring spawning period of April and May for common carp from the Great Lakes Basin, or during a suitable time period for the Mississippi River Basin, it is theoretically possible for ANS to transfer across the wetland divide. The ANS travel distance would be more than 1.5 miles (2.4 km). Common carp are known to move upstream more than five miles (eight kilometers) in a day or more than one mile (1.6 km) into flooded timber (H. Harrington, USACE, personal observation). Given sustained surface water depths exceeding six inches (15 cm) for a period of a few days, passage of common carp across the divide could occur. Other warm water fish species that could be carriers of VHSv would

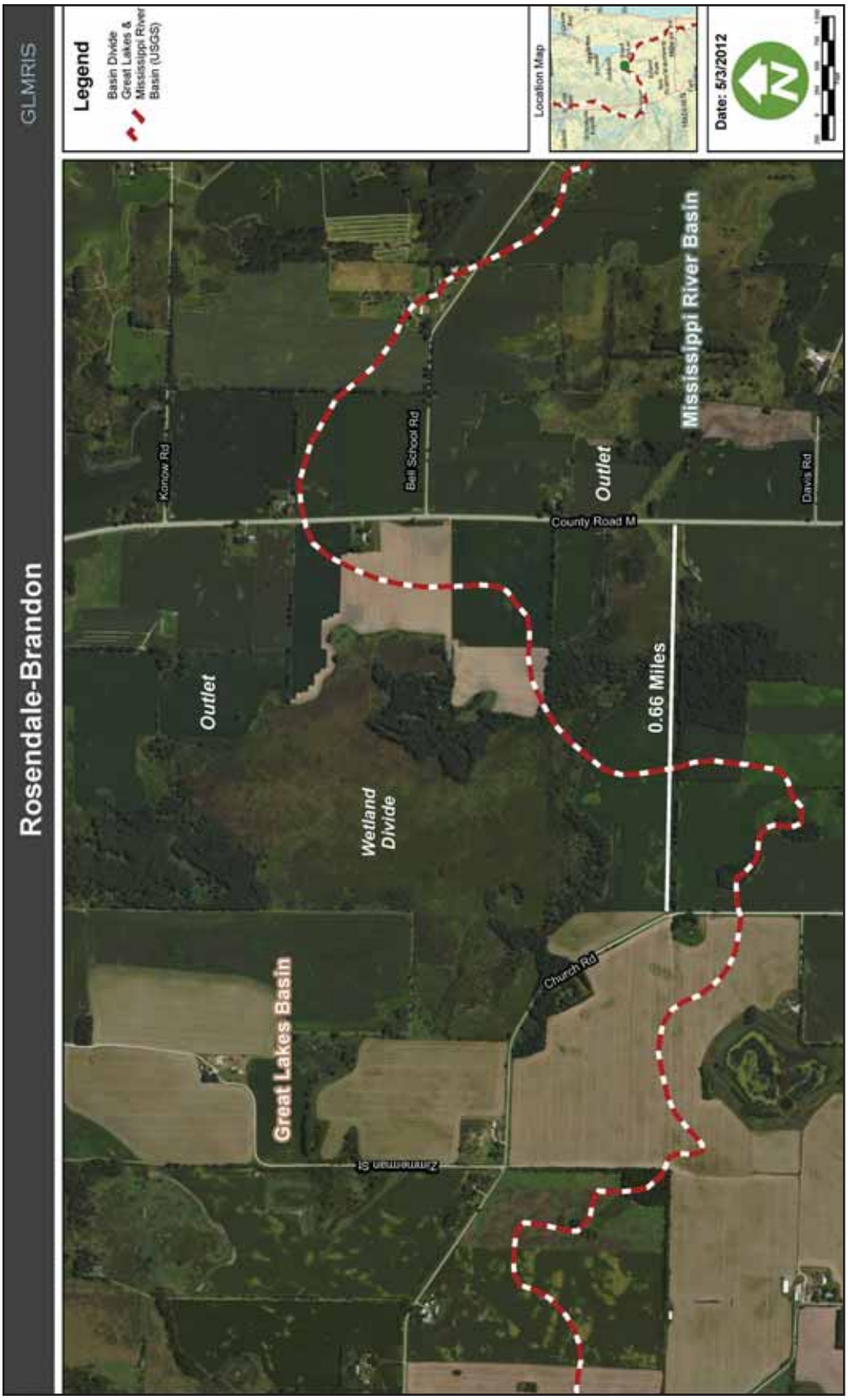


Figure 18. Aerial of wetland divide depicting emergent, scrub/shrub, and forested wetlands. Aerial imagery courtesy of Bing Maps

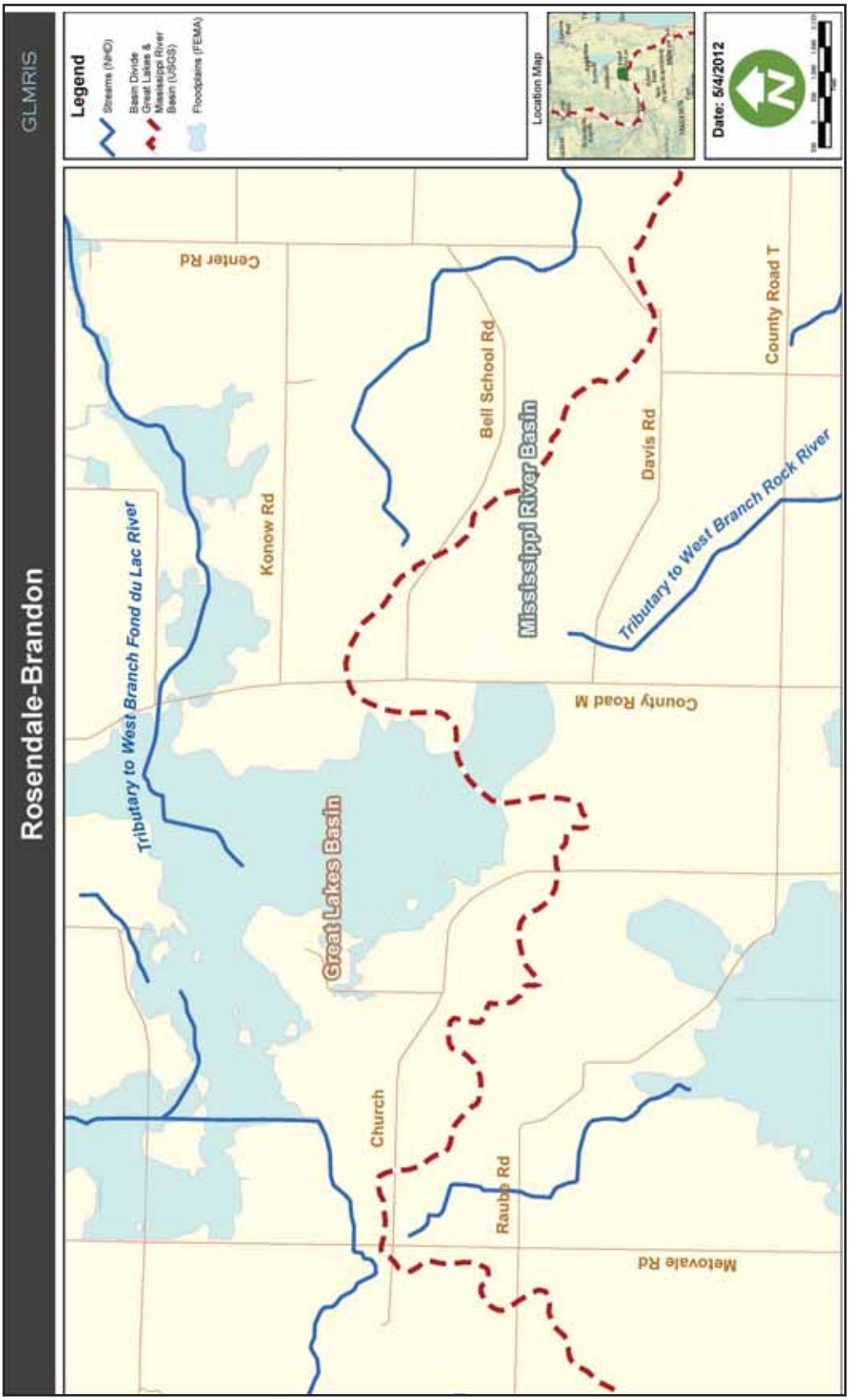


Figure 19. Surface water connections with the wetland area along the basin divide at the potential pathway location. Background imagery courtesy of Bing Maps.

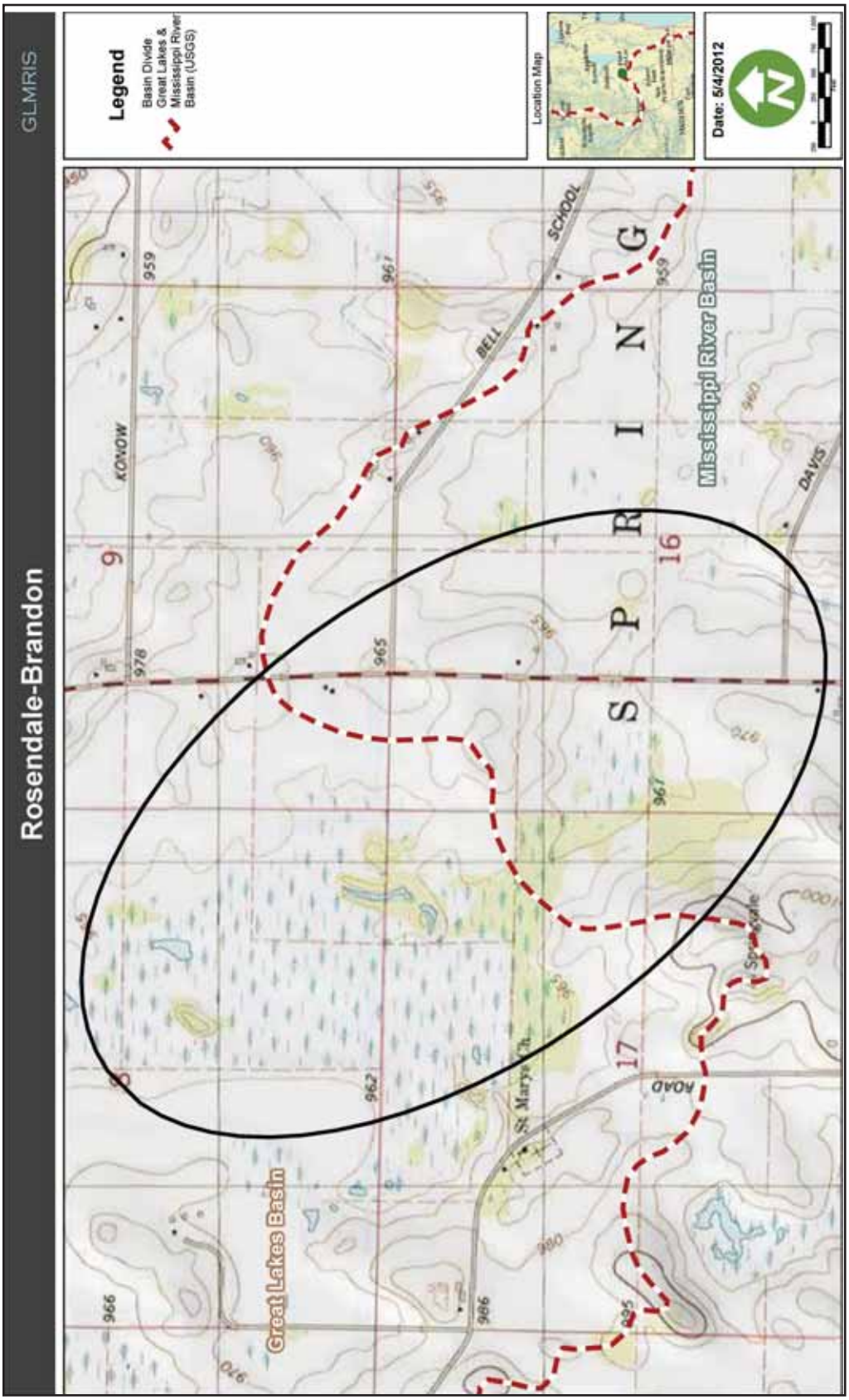


Figure 20. USGS Quad Map, Rosendale, WI (1980) with pathway area circled.

typically inhabit the streams, but would not be likely fish species to cross the divide wetland, such as minnows and chubs. Section 4 contains additional narrative for each species each of the species that were evaluated for the Rosendale-Brandon potential pathway.

3.8 Connecting Streams to Great Lakes and Mississippi or Ohio River

Since it has been determined that the probability an aquatic pathway exists is medium for flow going into both the Great Lakes and Mississippi River Basins, potential barriers to ANS spread have been identified. The Mississippi River connection for Rosendale-Brandon is from the unnamed stream starting at County Road M, to West Branch Rock River, to the Rock River, to the Mississippi River. There are two possible routes for the Great Lakes connection. The more likely path is from the unnamed stream starting at the north end the wetland west of County Road M, to West Branch Fond du Lac River, to Fond du Lac River, to Lake Winnebago, to Lower Fox River, to Lake Michigan. The second is from this unnamed stream, to Silver Creek, to the Puchyan River, to the Upper Fox River, to Lake Butte des Morts, to Lake Winnebago, to Lower Fox River, and to Lake Michigan. The location of potential instream obstructions (e.g., dams) downstream of the site is shown in Figure 21, along with available information from the National Inventory of Dams such as dam height, hydraulic dam height, and the elevation difference between the tail water and the dam sill (Table 8).

4 Aquatic Pathway Viability for ANS of Concern

The potential for species transfer was assessed by the project team for the ANS of concern for Rosendale-Brandon location in accordance with the procedures outlined in the Methodology Section of this report. This potential was characterized as high, medium, or low for the following categories:

- Probability that Pathway Exists (Section 2)
- Probability of ANS being within Either Basin
- Probability ANS Surviving Transit to Aquatic Pathway
- Probability of ANS Establishing in proximity to the aquatic Pathway
- Probability of ANS Spreading across Aquatic Pathway into New Basin

The criteria for designating probabilities of high, medium or low are provided under each category. In addition, a certainty rating is also assigned with each probability assessment. Certainty ratings associated with any given probability ratings include:

- Very Certain (As certain as we will get with this effort)
- Reasonably Certain
- Moderately Certain (More certain than not)
- Reasonably Uncertain
- Very Uncertain (An educated guess)
- A team rating is provided based on the professional collaboration of the interagency team of biologists.

These characterizations were completed by a team of agency biologists for each species under consideration. An overall team probability and certainty rating is also provided. The overall rating represents the most conservative probability assessment for each category considered. The forms describing the probability and certainty ratings from all agency professionals participating in this assessment is included at Appendix A.

Figure 21. Location of potential in-stream obstructions to ANS movement, denoted as triangles, along the flowpaths to the Great Lakes and Mississippi River Basins from the Rosendale-Brandon location. The potential pathway location is labeled as a yellow circle, and the basin divide is denoted as the red-white line. Background imagery courtesy of Bing Maps.

Table 8: Barriers to ANS Spread, Including Dam Heights and any Known Fish Passage (NID, 2010).

Mississippi Connection -								
	Unnamed stream starting at County Road M, West Branch Rock River, Rock River, Mississippi River.							
Connection	**Dam Name**	**River**	**Hydraulic Height of dam (ft) from NID**	**Dam height (ft) from NID**	**Elevation difference from tail water to dam sill from FEMA FIS Profiles**			**Fish passage?**
					10 year flood (ft)	**100 year flood (ft)**	**500 year flood (ft)**	
Mississippi	Hustisford Dam	Rock River	**7**	**11**	5	4.5	4	Yes
Mississippi	Upper Watertown Dam	Rock River	**-**	**-**	24	21	19	No
	Lower Watertown Dam	Rock River	**-**	**-**	17	13	11	No
Mississippi	Jefferson Dam	Rock River	**6**	**11**	1.5	submerged	submerged	Yes (has a fishway w/ steps)
Mississippi	Indianford Dam	Rock River	**6**	**13**	-	-	-	Not able to verify, no FEMA FIS. WDNR believes fish passage possible at high flows, when dam sub-merges.
Mississippi	Monterey Dam	Rock River	**7**	**10**	-	-	-	Not able to verify, no FEMA FIS. WDNR believes fish passage possible at high flows, when dam nearly submerges.
Mississippi	Rockton Dam	Rock River	**-**	**-**	1.5	submerged	submerged	Yes
Mississippi	Fordam Station Dam	Rock River	**12**	**12**	submerged	submerged	submerged	Yes
Mississippi	Oregon Dam	Rock River	**12**	**12**	submerged	submerged	submerged	Yes
Mississippi	Dixon Dam	Rock River	**9**	**9**	submerged	submerged	submerged	Yes
Great Lakes Connection -								
Connection	**Dam Name**	**River**	**Hydraulic Height of dam (ft) from NID**	**Dam height (ft) from NID**	**Elevation difference from tail water to dam sill from FEMA FIS Profiles**			**Fish passage?**
					10 year flood (ft)	**100 year flood (ft)**	**500 year flood (ft)**	
Great Lakes	Eldorado Marsh	Fond du Lac River	2	9	-	-	-	Not able to verify, no FEMA FIS. WDNR believes fish passage not possible
Great Lakes	Ripon Dam/Millpond Dam	Silver Creek	8	10	5	2.5	1.5	Yes
Great Lakes	Upper Green Lake Dam/Mill Dam	Puchyan River	5	8	7	5	3	Yes, at high flows
Great Lakes	Eureka	Upper Fox River	3	8	submerged	submerged	submerged	Yes (fish ladder)
Great Lakes	Menasha	Lower Fox River	9	16	-	-	-	through lock
Great Lakes	Neenah	Lower Fox River	9	15	-	-	-	through lock
Great Lakes	Upper Appleton Dam	Lower Fox River	14	18	-	-	-	through lock
Great Lakes	Middle Appleton Dam	Lower Fox River	10.5	11	-	-	-	through lock
Great Lakes	Lower Appleton Dam	Lower Fox River	9	19	-	-	-	through lock
Great Lakes	Cedars Lock and Dam	Lower Fox River	10	15	-	-	-	through lock
Great Lakes	Little Chute Dam	Lower Fox River	12	20	-	-	-	through lock
Great Lakes	Kaukauna Locks and Dam	Lower Fox River	13	22	-	-	-	through lock
Great Lakes	Lower Kaukauna	Lower Fox River	9	16	-	-	-	through lock
Great Lakes	Rapide Croche Lock and Dam	Lower Fox River	10	20	-	-	-	No*
Great Lakes	Little Kaukauna	Lower Fox River	7	16	-	-	-	through lock
Great Lakes	DePere	Lower Fox River	8	17	-	-	-	through lock

***The Rapide Croche Lock and Dam structure is scheduled for modification to allow vessel traffic to pass following decontamination. This modification is meant to prevent ANS transfer from vessel traffic approaching from the upstream direction while continuing to allow for recreational boat traffic between the Winnebago Pool System and Green Bay**

4.1 Probability of the ANS Being within Either Basin

General Considerations for Assigning Probability Ratings:

> **High** - Target ANS exists on connected waterways in close enough proximity to be capable of spreading to the aquatic pathway within 20 years.
>
> **Medium** - Target ANS exists on connected waterways, but based on current proximity and mobility, is considered incapable of spreading to the aquatic pathway within 20 years.
>
> **Low** - Target ANS is not known to exist on a connected waterway.

Certainty ratings were applied as outlined above.

Asian Carp

Silver carp and bighead carp are established throughout the middle and lower Mississippi River Basin. Bighead carp have been collected in the Rock River, just below the Fordam Dam in Rockford, Illinois (USGS, 2011). This was in 2005 and no other collections have since been made. Bighead carp are not yet known to be established in the Rock River and silver carp have not been collected in the Rock River to date. Black carp may be established in portions of the lower Mississippi River Basin (USGS, 2011). The known distribution of black carp is not as extensive as that of the silver and bighead carp.

Team Rating: **High/Medium**
Team Certainty Rating: Very Certain

Inland Silverside

The inland silverside's native range is eastern North America, including the Atlantic and Gulf Slopes (mostly near the coast) from Massachusetts to the Rio Grande drainage, Texas and southeastern New Mexico; north from the Mississippi River and major tributaries (mainly Arkansas and Red Rivers) to southern Illinois and eastern Oklahoma (Page & Burr, 1991). It is a marine species that ascends rivers and prefers estuaries, lagoons, brackish seas, and rivers (Fishbase, 2011). Inland silversides were stocked into the Kankakee River in Will County, Illinois, where they were collected in 1996 (Fuller & Nico, 2012; USGS, 2011). The species has also been collected in Illinois from Lake Baldwin, Lake of Egypt, Rend Lake, Cache River, Wabash River, and the Mississippi, Ohio, and Kankakee Rivers (Laird & Page, 1996). It is believed that the presence of the species in the Mississippi River in southern Illinois and in the lower Ohio River in Illinois and Kentucky are a result of natural dispersal (Fuller & Nico, 2012).

Team Rating: **Medium**
Team Certainty Rating: Reasonably Certain/Very Certain

Northern Snakehead

The northern snakehead was found in 2008 in Monroe, Arkansas, and has since established a reproducing population in the area. Expansion northward into the upper Mississippi River Basin has not been noted from the established population (USGS, 2011). A single specimen of giant snakehead (Channa micropeltes) was collected in the Rock River by the WDNR. This specimen was unintentionally released. However, the species is considered to be tropical to sub-trocpical and not able to survive winter temperatures encountered in the Rock River (Courtenay, Jr. and Williams, 2004).

Team Rating: **Medium/Low**

Team Certainty Rating: Reasonably Certain/Very Certain

Viral Hemorrhagic Septicemia Virus (VHSv)

Viral hemorrhagic septicemia virus can infect a wide range of host fish causing a variety of external and internal pathology, including death of the host fish. Variables such as host fish species and water temperature can impact the pathology of the virus. Seemingly healthy individuals that have been previously infected with VHSv can have chronic infections and be carriers of the disease (Skall et al., 2005). This virus

has been reported from throughout the Great Lakes Basin including Lake Michigan (USGS, 2011). Viral hemorrhagic septicemia virus has been found in many species of fish including common carp (*Cyprinus carpio*). The common carp is established in Lake Michigan, as well as in the rivers and streams leading to the pathway from Lake Michigan. While other host fish species are known to exist in the pathway system, the common carp was selected as the most likely host species because of the life cycle capabilities and the likelihood the common carp would use and survive in the pathway habitats. Viral hemorrhagic septicemia virus and a necessary host species are in the pathway. It should also be noted that VHSv has been found in 28 different host species in the Great Lakes Basin and that it can survive without a host in the water column (WDNR, 2012b).

Team Rating: **High**
Team Certainty Rating: Relatively Certain

Ruffe and Tubenose Goby

The ruffe and tubenose goby are located within the Great Lakes and are associated with river mouths and estuaries of large river systems entering the Great Lakes. The ruffe exists in northern Lake Michigan in Green Bay, but is not widespread and there are no high density populations in Lake Michigan (Bowen and Goehle, 2011). The ruffe prefers deep waters of lakes and pools of rivers, usually over sand and gravels, but has a tolerance for different habitats and environmental conditions (Gray and Best, 1989). The ruffe has a high reproductive rate and spawns in clean water. Females produce up to 200,000 eggs in the first batch, and up to 6,000 eggs per subsequent batch (Global invasive species database, 2012). The fish has extended its range rapidly and modeling predicts that it will find suitable habitat in all five Great Lakes. Literature reviews and actual fish survey data have not documented the collection of the ruffe in smaller upstream tributaries. The tubenose goby are benthic species whose introduced range covers three Great Lakes including Lakes Superior, Erie, and Huron (USGS, 2011). It has been collected in the lower reaches of larger Great Lakes rivers and estuaries. Literature from Europe and Russia indicate the tubenose goby does inhabit upper river systems, but no tubenose goby have been collected locally in upper Great Lakes river tributaries to date.

Team rating: **High**
Team Certainty Rating: Reasonably Certain /Very Certain

Threespine stickleback

The threespine stickleback is found in each of the Great Lakes and has been collected in some inland river systems (USGS, 2011). Literature indicates this species prefers to live in smaller streams but may occur in a variety of habitat including lakes and large rivers (Wootton, 1976).

Team Rating: **High**
Team Certainty Rating: Reasonably Certain

4.2 Probability Target ANS Survives Transit to Aquatic Pathway

4.2.1 Probability of ANS Surviving Transit to Aquatic Pathway Through Connecting Streams.

General considerations for assigning probability ratings:

High - Target ANS are established in relatively close proximity to the location and have ample opportunity, capability, and motivation to successfully navigate through the connecting streams to arrive at the subject pathway within 10 to 20 years.

Medium - Target ANS are established at locations in close enough proximity to the location and have limited capability to survive movement through the connecting streams to arrive at the subject pathway within 20 to 50 years.

Low - Target ANS are not in proximity to the pathway, and/or it is highly unlikely that they could survive transit from current locations through the connectin streams to arrive at the subject pathway within next 50 years.

The same certainty ratings identified above also apply here.

Asian Carp

Spawning of silver and bighead carp is initiated by rising water levels following heavy rains (Jennings, 1988; Verigin, 1978). Both species are strong swimmers and silver carp are capable of jumping considerable distances out of the water when startled (up to 12 feet or 3.6 meters). There are only a couple of dams on the Rock River that would prevent upstream passage of silver carp during high flow events (Upper and Lower Watertown Dams). All Asian carp species in the Mississippi River Basin would likely be able to bypass many of the other dams during high flow events when the tailwaters increase in elevation, and some dams become completely inundated. The proximity of silver and bighead carp in the Rock River, combined with their history of dispersal throughout the Mississippi River Basin, indicates these species may be capable of utilizing connecting streams to reach the pathway area if hydrologic conditions allow. Habitat present within most of the Rock River and tributaries is not ideal for silver and bighead carp, which are native to, and thrive in large rivers, but it is not known to what extent this may prevent movement or passage of adults or juveniles. While bighead and silver carp are highly opportunistic, bighead carp are primarily zooplanktivorous whereas silver carp primarily consume smaller phytoplankton and fine particulate organic matter (Dong and Li, 1994; Jirasek et al., 1981; Williamson and Garvey, 2005). Sufficient forage would appear to be available throughout the Rock River for both silver and bighead carp. Forage abundance and diversity decreases moving upstream and into the Rosendale-Brandon divide wetland as water volume decreases substantially at the divide.

Adult black carp are primarily molluscivores. However, they will opportunistically consume a wide variety of food items (USFWS, 2002). Juvenile black carp have a diet more similar to silver and bighead carp, consisting primarily of zooplankton (USACE, 2011b). The diet of juvenile black carp may allow them to survive in areas unsuitable for adults. The habitat of black carp is very similar to the grass carp (Ctenopharyngodon idella) (Nico et al., 2005). It is believed that black carp should be able to colonize the same areas of the United States where the grass carp have established (USFWS, 2002).

Asian carp were assigned a rating of low for their ability to reach the Rosendale-Brandon divide wetland connection based primarily on the downstream dams that block upstream movement. However, the exact dispersal capabilities of the species remains unknown. Juvenile, sexually immature Asian carp have been observed in the upmost reaches of small tributaries to large rivers attempting to pass over barriers, such as dams, to continue their upstream movement (D. Chapman, personal communication, September 12, 2011; N. Caswell, U.S. Fish and Wildlife Service, September 12, 2011). The gradient needed to prevent juvenile fish from moving upstream is unknown. It is important to note that young Asian carp tend to move laterally away from the river in which they were spawned and not back upstream (D. Chapman, personal communication, September 12, 2011). It has also been observed that Asian carp, as small as advanced fingerlings, have traveled up to 37 miles (60 km) through tributaries of the lower Missouri River. These tributaries were located laterally to the Missouri river segment in which these fish hatched (D. Chapman-USGS, personal communication, September 12, 2011). Adult, sexually mature Asian carp have occasionally been found in very small streams, which appear scarcely large enough to support the fishes at low water (D. Chapman, personal communication, September 12, 2011). The age of the fish when they arrived at these locations is unknown.

It is also unknown if adult fish will have any motivation to spread into the Rock River and eventually toward the Rosendale-Brandon divide area during a suitable runoff event. In summary, there are many uncertainties one must take into account when attempting to predict the temporal and spatial dispersal patterns of Asian carp. While research by INDNR and Purdue University may suggest that tagged Asian carp have no interest in ascending some of the smaller rivers, more long term studies are needed, and even these may not help explain the seemingly random movements of juveniles

that have been witnessed in Midwestern rivers and their tributaries (Coulter and Goforth, 2012; D. Chapman, personal communication, September 12, 2011).

Team Rating: **Low**
Team Certainty Rating: Reasonably Certain/Very Certain

Inland Silverside

The inland silverside moves in large schools that can number in the thousands and they can travel far up streams and rivers, especially in southern part of their range (NatureServe, 2010). The species' natural spread rate through the Mississippi River Basin is not known because they have been actively stocked in lakes. The average lifespan of the inland silverside is about 16 months, with few surviving their second winter (NatureServe, 2010). It is capable of producing 30,000 eggs per month (Stoeckel and Heidinger 1988). The dams on the Rock River impede upstream passage at low and normal flow rates. The effectiveness of these barriers lessens during high flow events when the dams can become inundated, but fish passage is still unlikely based on available data. As a relatively small fish (approximately five inches (12.7 cm) in total length at maturity), it is likely that this species would seek refuge from high water velocities during flood events, instead of attempting to move upstream. The habitat data suggests the inland silverside will colonize within rivers and streams but are usually found in clear, quiet water over sand or gravel. The tributary streams to the Rosendale-Brandon divide do not provide this type of habitat.

Team Rating: **Low**
Team Certainty Rating: Reasonably Certain/Very Certain

Northern Snakehead

The northern snakehead is an incredibly resilient species. If the Arkansas population does begin to expand up the Mississippi River, there are many barriers to spreading upstream, including dams. As obligate air breathers, northern snakeheads obtain required oxygen directly from the atmosphere. This species thrives in stagnant, oxygen depleted back-waters and marshes (Courtenay and Williams, 2004). The northern snakehead's preferred habitat is not flowing waters, which will likely slow its spread up the Mississippi River and its tributaries. Unlike the Asian carps, northern snakeheads do not make long upstream spawning runs and as a result, are not likely to spread quickly through the Mississippi River Basin without the aid of anthropogenic means.

Team Rating: **Low**
Team Certainty Rating: Reasonably Certain/Very Certain

Viral Hemorrhagic Septicemia Virus (VHSv)

Viral hemorrhagic septicemia virus has been found to infect common carp (USGS, 2011). During spring run-off events in April and May, common carp move into the shallow waters of bays and river systems to spawn. Within the rivers, common carp move upstream to spawn in suitable habitat such as marshes and even drainage ditches with as little as or less than one foot (30.5 cm) depth of water. Common carp are strong swimmers that can reach sustained speeds 0.4-1.2 m/s and burst speed of 1.2-2.6 m/s. Though they cannot jump (maximum height six feet or 1.8 m) like members of the salmon family, they can swim upstream during moderate flow events.

This Great Lakes aquatic pathway divide has a surface water connection during certain discharge events and has habitat that consists of emergent and forested wetland, small creeks and streams, and river connections to Lake Michigan. While there are obstacles on the lower Fox and Fond du Lac Rivers, these become less effective at impeding upstream passage as flow increases. While it is possible, it is unlikely that infected common carp could move to the watershed divide. The fish would have to pass the Rapid Croche Dam during a 10 percent or less recurrence interval flood event during spring runoff when the fish were moving upstream to spawn. The fish could make the five-foot (1.5 m) jump from the tailwater elevation over the sill and pass the four fps (1.2 mps) flow. Then is subsequent years, the VHSv would have to remain viable in common carp or other fish species above the Rapide Croche Lock and Dam. Infected fish would have to move all the way upstream and arrive at the Puchyan River divide during a one percent flood event during the spring spawning

season to enable a passage attempt across the mile wide watershed divide. The Fond du Lac passage from the Great Lakes Basin across the Eldorado Marsh is considered not passable by the WDNR because of the Eldorado Dam (Mr. David Stertz-WDNR Water Management, personal communication, June 2011).

The surface water connection from Lake Michigan to the Rosendale-Brandon divide provides suitable habitat for carp during run-off events. The divide wetland is an emergent wetland that also contains man-made ponds of unknown depth. Common carp have been documented in the Fox River. Common carp are a very resilient species and are capable of surviving a wide range of water quality parameters, but it is unknown if they are able to overwinter in the open water pockets within the divide wetland. Although access of infected common carp to the divide is fairly limited because of the structures downstream that would restrict passage, coupled with the requirement that a flood event happen during the spring spawning period, it is possible for common carp to access the pathway vicinity, and possibly get across the divide. While fish may move in response to floods and other environmental conditions, or for unknown reasons, the movement of common carp to the divide would most likely occur during spring spawning events.

The WDNR identified VHSv in freshwater drum in the Lake Winnebago system in 2007 above the Rapid Croche Lock and Dam. No additional fish collected from the Lake Winnebago system have been reported positive for VHSv through the summer of 2011, though the entire upstream river system has not been thoroughly sampled. Based on the positive report of VHSv in 2007 upstream of Rapid Croche Lock and Dam, the rating of low/medium is considered appropriate. If an infected common carp arrived at the emergent wetland divide or the open water pockets within the divide during the spring, a subsequent storm event sufficient to complete the intermittent aquatic pathway that same spring could facilitate common carp to disperse across the basin divide at that time. The confirmed finding of VHSv from a fish above the Rapid Croche Lock and Dam in 2007 indicates there to be the potential that VHSv could be present in fish at the Great Lakes/Mississippi River Basin divide.

Team Rating: **Low/Medium**
Team Certainty Rating: Reasonably Certain

Ruffe and Tubenose Goby

The ruffe prefers deep waters of lakes and pools of rivers, usually over sand and gravel areas, but has a tolerance for different habitats and environmental conditions (Gray and Best, 1989). Ballast water transport has been the key means for the spread of ruffe in the Great Lakes (USFWS, 1996). Natural rates of dispersion are not well known and ruffe have not spread beyond Green Bay in the nine years since its detection in that area, and populations have been trending down (Bowen and Goehle, 2011). The ruffe's ability to swim upstream during high flow events and pass over dams is questionable, especially since it prefers still or slow moving water (Fishbase, 2011). The ruffe has a high reproductive rate and spawns in clean water. The tubenose goby is found in the open lake waters and estuaries of slow flowing rivers and appears to be more capable of living in diverse types of riverine habitat than the ruffe (Dopazo, et al., 2008; Jude and DeBoe, 1996). The ability of the goby to swim upstream during high flow events and pass over dams is questionable, but it appears to be more capable of living in more varied types of riverine habitat than the ruffe. It also appears unlikely that either of the fish species would gain access to the basin divide through the small tributaries leading to the divide wetland.

Team Rating: **Low**
Team Certainty Rating: Reasonably Certain

Threespine Stickleback

The threespine stickleback has been found in the Great Lakes and in smaller river systems. While not having been identified within the lower Fox River system, its close proximity in Lake Michigan indicates that the potential exists for access and transfer to the Mississippi River Basin via the Rosendale-Brandon divide wetland. There are obstacles to upstream passage within the Fox River which should be sufficient at impeding passage of the threespine stickleback at normal and low flows. As these obstacles become inundated during high flow events, the stickleback may have the opportunity to move upstream. However, it is likely that this species will seek

refuge from high velocities instead of expending energy attempting to move upstream. It is likely that sufficient forage and habitat is available throughout the Fox River basin for the threespine stickleback. The wetland at the Rosendale pathway does not provide the preferred or suitable habitat for the threespine stickleback. However, the fish could potentially survive in the emergent wetland divide during a storm runoff event as they are tolerate of low dissolved oxygen down to two parts per million (ppm) and temperatures up to 68ºF (20ºC) (Wootton, 1976).

Team Rating: **Low**
Team Certainty Rating: Reasonably Certain

4.2.2 Probability of ANS Surviving Transit to Aquatic Pathway through Other Means

The ratings in this section do not influence the overall pathway rating outlined in this report, and are only included to point out potential other pathways (e.g., anthropogenic) and their potential influence on the same list of ANS as evaluated in Section 4.2.1. Any further analysis of these non-aquatic pathways outside of this study should develop a separate list of ANS that will likely differ from those which may exploit the aquatic pathway.

General considerations for assigning probability ratings:

High - Target ANS are established in relatively close proximity to the location and have ample opportunity, capability, and motivation to successfully navigate through a non-aquatic pathway to arrive at the subject pathway within 10 to 20 years.

Medium - Target ANS are established at locations in close enough proximity to the location and have limited capability to survive spreading through a non-aquatic pathway to arrive at the subject pathway within 20 to 50 years.

Low - Target ANS are not in proximity to the pathway, and/or it is highly unlikely that they could survive transit from current locations through a non-aquatic pathway to arrive at the subject pathway within next 50 years.

The same certainty ratings identified above also apply here.

Asian Carp

Although transit across the watershed divide by anthropogenic means is possible, state regulations prohibiting transport and possession of silver carp, bighead carp, and black carp should limit this likelihood. Since fishing and boating do not occur at the divide wetland complex and public access is limited, it is highly unlikely that the any species of Asian carp will arrive at the divide by anthropogenic means, such as livewell or aquarium releases.

Team Rating: **Low**
Team Certainty Rating: Reasonably Certain

Inland Silverside

Transit across the watershed divide by anthropogenic means is possible. However, since fishing and boating do not occur at the wetland divide and public access is limited, it is highly unlikely that inland silverside will arrive at the divide by anthropogenic means, such as livewell or aquarium releases even though the silverside has been stocked as a forage species.

Team Rating: **Low**
Team Certainty Rating: Reasonably Certain/Very Certain

Northern Snakehead

Many species of snakehead, including the northern snakehead, have been popular aquarium fish. However, the state of Wisconsin prohibits the possession and transport of this species. Since fishing and boating do not occur at the wetland divide and public access is limited, it is highly unlikely that the northern snakehead will arrive at the divide by anthropogenic means, such as livewell or aquarium releases. These regulations, coupled with the limited access for the public to the wetland divide, makes

human release of the northern snakehead in the wetland very unlikely. However, if the northern snakehead were released in the immediate vicinity of the divide, on either side, it is likely the fish would survive and establish a viable population in the open water pockets.

Team Rating: **Low**
Team Certainty Rating: Reasonably Certain

Viral Hemorrhagic Septicemia Virus (VHSv)

As discussed previously, many ANS could survive in the pathway if the species were dumped or discharged through anthropogenic means. Since fishing and boating do not occur in the wetland divide and public access is limited, it is highly unlikely that VHSv will arrive at the basin divide through anthropogenic means, such as livewell or aquarium releases.

Team Rating: **Low**
Team Certainty Rating: Reasonably Certain

Ruffe and Tubenose Goby

The ruffe and tubenose goby are listed among the "established nonnative fish species" (see WI NR 40.02(17)), which is one of four groups of "restricted" non-native fish species. Fish species in this restricted group may not be possessed, transported, transferred, or introduced without a permit from the DNR. Although transit across the watershed divide by anthropogenic means is possible, since fishing and boating do not occur at the wetland divide and public access is limited, it is highly unlikely that the either species will arrive at the divide by anthropogenic means, such as livewell or aquarium releases. These two fish species are not normally used as live bait for river fishing.

Team Rating: **Low**
Team Certainty Rating: Reasonably Certain/Very Certain

Threespine Stickleback

The threespine stickleback can tolerate dissolved oxygen levels as low as two ppm at 68ºF (20ºC) which may not be met in the wetland pond in late summer. Threespine stickleback passage to the emergent wetland basin divide even after a large storm event is considered a low probability based on the habitat requirements of the threespine stickleback. Bait-bucket transport has likely aided in the movement of the threespine stickleback in the past. Wisconsin regulations do prohibit possession and transport of this species. However, since fishing and boating do not occur at the wetland divide and public access is limited, it is highly unlikely that the species will arrive at the divide by anthropogenic means.

Team Rating: **Low**
Team Certainty Rating: Reasonably Certain

4.3 Probability of ANS Establishment in Proximity to the Aquatic Pathway

General Considerations for Assigning Probability Ratings:

High - Sources of food and habitat suitable to the ANS are plentiful in close proximity to support all life stages from birth to adult, abiotic conditions align with native range and there are no known predators or conditions that would significantly impede survivability or reproduction.

Medium - Limited and disconnected areas and sources of food and habitat suitable to the ANS are available in proximity, abiotic conditions are within latitude limits of native range, but only a portion of the healthy individuals arriving at location can be expected to effectively compete and survive.

Low - Habitat and abiotic conditions in proximity are outside the range where ANS has been known to survive. There is very limited available habitat area suitable for ANS cover, sustainable food supply, and reproduction; or native predators or competition with native species would likely prevent establishment of a sustainable population.

Asian Carp

Silver and bighead carp are fast growing species that are capable of surviving a wide range of water temperatures and reproducing quickly, provided that suitable habitat is available. Life history habitat requirements generally include diverse needs for areas with current, backwater habitats, deep overwintering holes, and other habitat types needed for survival (Nico et al., 2005). In some stretches of the Illinois River, silver and bighead carp make up as much as 90 percent of the biomass (MICRA, 2002). While the open water pockets within the Rosendale-Brandon wetland divide can experience ice cover in winter and high temperatures in the summer, it may still be possible for silver and bighead carp to survive until another high water event connects the basins. If silver or bighead carp were able to survive in the open water pockets of Rosendale-Brandon, successful spawning and recruitment is highly unlikely and would prevent establishment. Silver and bighead carp require sufficient flow to keep fertilized eggs suspended for successful reproduction (Gorbach and Krykhtin, 1980). Black carp reach sexual maturity in as little as five years and adult females can produce up to one million eggs per spawning event. It is unlikely that spawning would occur within the wetland divide; however, if adult black carp reach the marsh they would most likely be able to survive for long periods of time within the marsh open water areas.

Team Rating: **Low**
Team Certainty Rating: Reasonably Certain/Very Certain

Inland Silverside

As a size-selective planktivore, the inland silverside relies primarily on sight for feeding (Elston and Bachen, 1976). In the Rock River, visibility may be severely restricted in the turbid water, hindering the silverside's ability to find prey. The divide location would also unlikely be able to support the species because of cold winter temperatures. Hubbs et al. (1971) inferred that the native inland range for the inland silverside does not extend beyond the confluence of the Ohio and Mississippi Rivers because it cannot withstand winters farther north. Richards (1977), however, showed that the inland silverside can survive for at least two weeks at 34.7ºF (1.5ºC). Stoeckel and Heidinger (1988) demonstrated that inland silversides can be maintained over winter in aquaculture systems at temperatures above 59ºF (15ºC), when they were fed a prepared diet. They also demonstrated that inland silversides have a high mortality during extended periods of cold during the winter in unheated ponds and reservoirs. Overwintering mortality in the 80-90 percent range has been reported for the inland silverside in Rhode Island waters (Bengtson, 1982). Spawning occurs in shallow water in areas with abundant vegetation, and includes all forms of plants, including dead leaves, tree roots, algal mats, or rooted aquatic plants of marshes (Hildebrand, 1922; Weinstein, 1986). The Rosendale-Brandon wetland complex and ditches at the divide therefore do not provide suitable habitat for establishment of a viable population.

Team Rating: **Low**
Team Certainty Rating: Reasonably Certain

Northern Snakehead

The northern snakehead's native range (latitude 24-53º N) and temperature tolerance (0-30 ºC) indicates a species that, if introduced, could establish populations throughout most of the contiguous United States (Courtenay, Jr. and Williams, 2004). Northern snakeheads are naturally aggressive predators that could easily acclimate to the conditions in and around the wetland divide as long as there is an ample food supply, which appears to be the case. They prefer shallow ponds and marshes with aquatic vegetation, which is similar to the aquatic habitat at the wetland divide. They can be very opportunistic in their feeding habits, preying on everything from insect larvae to fish, frogs, and crustaceans. Additionally, northern snakeheads aggressively defend their nest and young fry, reducing predation on young snakehead by other fish. Establishment of a population is possible in the divide if the fish arrived at the divide.

Team Rating: **Medium**
Team Certainty Rating: Moderately Certain/ Reasonably Certain

Viral Hemorrhagic Septicemia Virus (VHSv)

VHSv is capable of persisting outside of a host in the water column for at least 14 days and grows best in

fish when water temperatures are 37ºF - 54ºF (2.8ºC - 12.2ºC) (WDNR, 2012b). The virus demonstrates a rapid reproductive cycle and is capable of utilizing many different host species (up to 28 known in the Great Lakes Basin), including common carp which could likely survive at the pathway location in areas of deeper water (WDNR, 2012b). It is highly likely that VHSv would be successful in establishing in fish populations in the open water areas at the wetland divide.

Team Rating: **Medium**
Team Certainty Rating: Reasonably Certain

Ruffe and Tubenose Goby

The ruffe is an aggressive species that possesses the ability to feed in darkness, cold temperatures, and turbid conditions. Tubenose gobies are benthic species that consume a wide variety of invertebrates (USGS, 2011). They are often quite abundant in backwaters and lakes and seem to prefer dense vegetation. However, survival of a viable, reproducing population of ruffe and tubenose goby within the open water pockets of the Rosendale-Brandon wetland divide appears to be unlikely due lack of flowing waters, potentially low water quality, and high temperatures in summer months. However, further analysis would be needed to deterimine if any open water pockets within the wetland divide could provide the necessary habitat for these species. Pending a suitable storm event, the fish could pass through the pathway and then spread downstream toward habitat which may be more suitable for all life stages of the species in the Mississippi River Basin.

Team Rating: **Low**
Team Certainty Rating: Relatively Certain

Threespine Stickleback

As a visual predator, the wetlands at the basin divide may be unsuitable for survival and establishment of the threespine stickleback (Walker, 1997). However, the ponds may provide sufficient habitat for this species until a suitable storm event occurred and the fish could pass into the tributary and spread downstream to habitat suitable for all life stages of the species in the Mississippi River Basin.

Team Rating: **Low**
Team Certainty Rating: Relatively Certain

4.4 Probability of ANS Spreading Across Aquatic Pathway into the New Basin

General Considerations for Assigning Probability Ratings:

> **High** - Sources of food and habitat suitable to the ANS are available, and the species has demonstrated capabilities to significantly expand range from locations where initially introduced.
>
> **Medium** - There are limited sources of food and suitable habitat, and/or the species has demonstrated limited ability to spread significant distances beyond areas where it has been introduced.
>
> **Low** - There are severely limited sources of food and suitable habitat, and/or the species has demonstrated very limited ability to spread beyond areas where it has been introduced.

Asian Carp

Asian carp have demonstrated exceptional capabilities of spreading through large river systems. It is still uncertain whether they will attempt to travel up the Rock River and tributary stream, but if these species reach the basin divide and surface water conditions permit, it is highly likely that they would be able to spread through the aquatic pathway into the Great Lakes Basin.

Team Rating: **High**
Team Certainty Rating: Reasonably Certain/ Very Certain

Inland Silverside

Due to its small size, the inland silverside may be capable of utilizing minor hydrologic connections to move to new areas. It is possible, but unlikely, that inland silversides

would be able spread across the pathway and into the Great Lakes basin during high flow events, especially given the unlikelyhood of them being able to establish near the pathway in significant numbers.

Team Rating: **Low**
Team Certainty Rating: Moderately Certain/Moderately Certain

Northern Snakehead

It is very likely that the northern snakehead possesses the ability to spread from the Rosendale-Brandon wetland divide if a population were established. As an air breather that has even been known to move short distances over land, it is likely this species would be able to quickly move into the tributary from the wetland divide (Courtenay, Jr. and Williams, 2004). Under proper environmental conditions, this species could potentially transfer into the Great Lakes Basin from the wetland divide even if a hydrologic connection is not present.

Team Rating: **High/Medium**
Team Certainty Rating: Reasonably Certain

Viral Hemorrhagic Septicemia Virus (VHSv)

Surface water connections have been documented at the divide. During these connections, it is likely that VHSv could spread beyond the wetland divide into the Mississippi River Basin either through a host fish or if present in the water column, and given if low enough water temperatures persist at that time. Since fish are found in high numbers in the Fox River system, it is possible that the virus could be passed through water to new host fish across the divide. The likelihood is unknown, but with spawning carp at the Fox River and in ditches/streams leading from the Fox River, passing of VHSv is possible.

Team Rating: **High/Medium**
Team Certainty Rating: Reasonably Certain

Ruffe and Tubenose Goby

Ruffe and the tubenose goby have not been found in river systems similar to the Fond du Lac River and tributaries. If the fish were successful in passing downstream through these river segments, it is feasible the fish could spread into the Mississippi River Basin.

Team Rating: **Medium/Low**
Team Certainty Rating: Moderately Certain/Reasonably Certain

Threespine Stickleback

The threespine stickleback has been found in smaller river systems and movement across the Rosendale-Brandon pathway is possible, especially for shorter periods of time when flow conditions are higher and forage is more prevalent.

Team Rating: **Medium/Low**
Team Certainty Rating: Reasonably Certain

5 Overall Aquatic Pathway Viability

As discussed in Sections 2.4 and 2.5, the determination of the likelihood of a viable aquatic pathway occurring at the Rosendale-Brandon location for each ANS of concern is the product of five probability elements (Equation 5). Thus, the probability of a viable pathway for a particular ANS of concern is equal to the lowest rating determined for each of the five probability elements (Table 9 and Table 10). The overall pathway viability for transferring ANS of concern from the Mississippi River Basin to the Great Lakes Basin was equal to the highest probability of a viable pathway for each ANS of concern in Table 9. At the Rosendale-Brandon location, all were rated “low” and thus the overall pathway viability for transferring species from the Mississippi River Basin to the Great Lakes Basin is “low”. The overall pathway viability for transferring species from the Great Lakes Basin is calculated the same way and is shown in Table 10. The overall pathway viability for transferring species from the Great Lakes Basin to the Mississippi River Basin is “medium”. The last calculation is to determine the overall pathway viability for interbasin spread of ANS which is calculated by taking the highest of the overall ANS ratings for unidirectional transfer which were calculated in Tables 9 and 10. Thus, in Table 10,

Table 9: Pathway Viability for ANS Spreading from the Mississippi River Basin to the Great Lakes Basin. Uncertainty rating in parantheses

			Form 1	Form 2	Form 3a	Form 4	Form 5	
Group	Common Name	Mode of Dispersal	Pathway Exists? (Sect. 2.6)	Within Either Basin? (Sect. 4.1)	Survive Independent Transit to Pathway? (Sect. 4.2.1)	Establishment in Proxim-ity to Aquatic Pathway?	Cross Path-way into New Basin? (Sect. 4.4)	Aquatic Pathway Viability Rating
fish	Asian Carp, silver carp, bighead carp, black carp	swimmer	M (MC)	M/H (VC)	L (RC/VC)	L (RC/VC)	H (RC/VC)	**L**
fish	inland silverside	swimmer		M (RC/VC)	L (RC/VC)	L (RC)	L (MC/RC)	**L**
fish	northern snakehead	swimmer		L/M (RC/VC)	L (RC/VC)	M (MC/RC)	M/H (RC)	**L**
Overall Pathway Viability for Spread of ANS from Mississippi River Basin to Great Lakes Basin								**L**

Table 10: Pathway Viability for ANS Spreading from the Great Lakes Basin to the Mississippi River Basin. Uncertainty rating in parantheses

			Form 1	Form 2	Form 3a	Form 4	Form 5	
Group	Common Name	Mode of Dispersal	Pathway Exists? (Sect. 2.6)	Within Either Basin? (Sect. 4.1)	Survive Independent Transit to Pathway? (Sect. 4.2.1)	Establishment in Proxim-ity to Aquatic Pathway?	Cross Path-way into New Basin? (Sect. 4.4)	Aquatic Pathway Viability Rating
fish	threespine stickleback	fish pathogen /water colmumn	M (MC)	H (RC)	L (RC)	L (RC)	L/M (RC)	**L**
fish	Benthic Fish ruffe and tubenose goby	swimmer		H (RC/VC)	L (RC)	L(RC)	L/M (RC/MC)	**L**
virus	viral hemorrhagic septicemia	pathogen		H (RC)	L/M (RC)	M (RC)	M/H (RC)	**L/M**
Overall Pathway Viability for Spread of ANS from Great Lakes Basin to Mississippi River Basin								**M**

the overall probability that a viable aquatic pathway exists at the Rosendale-Brandon Pathway is “medium”. However, caution should be exercised with this rating; VHSv is a very unique species that, because of its life history and persistence, makes it highly susceptible to transfer. This rating is identified only for transfer from the Great Lakes Basin to the Mississippi River Basin. Given its unique life history characteristics, this species is also highly likely to be transported across the basin divide by anthropogenic means, however, this did not factor into the rating for this report. Recreational fisherman and boat users can easily move this species accidentally between water bodies of both basins. While this pathway assessment did not address this likelihood, it is possible that this probability for human transfer across the divide is substantially greater than the transfer of VHSv at the divide location by natural aquatic means.

6 Conclusions

This pathway assessment found that a viable aquatic pathway could develop across the Rosendale-Brandon wetland divide during significant storm events, and that there is a possibility that VHSv could potentially utilize this pathway at such times in order to transfer from the Great Lakes Basin to the Mississippi River Basin. Although the only threat of ANS transfer at this location by natural means is VHSv, other species could be introduced to the pathway area by anthropogenic means, although this is deemed unlikely based on existing land usage in the area. There were a number of actions identified in the course of this pathway assessment that might be taken within either basin that individually or cumulatively could reduce or eliminate the probability of ANS transfer. Below are various problem statements, or possible constraints, in developing measures to reduce the probability of ANS spreading between the basins at Rosendale-Brandon. Following these are opportunity statements which reflect some of the authorities, capabilities, and resources of the USACE, other federal agencies, WDNR, and other stakeholders to implement measures that could contribute to preventing and reducing the likelihood of ANS spreading through the Rosendale-Brandon pathway.

6.1 Rosendale-Brandon Problem Statements

- The interagency team evaluating the hydrology of the Rosendale-Brandon wetland divide rated it as a location where there is a medium probability for the occurrence of a viable aquatic pathway between the basins, estimated to have a depth of up to a few inches (5-10 cm) from a one percent annual return frequency storm. However, there is significant uncertainty with this rating as there is no modeling available to provide site specific data on the frequency, duration and depth of the water column when the aquatic pathway forms, even though standing water was noted in the divide wetland and outlet to the Mississippi River Basin during the June of 2011 inspection.

- The primary ANS of concern for interbasin transfer from the Great Lakes basin through the Rosendale-Brandon wetland divide into the Mississippi River Basin is VHSv. The low/medium rating was reached through significant collaboration among the interagency team, which assigned a low rating for VHSv based on the structural restrictions within the aquatic pathway, but noted that VHSv has been reported above the Rapid Croche Lock and Dam, thus resulting in the low/medium rating.

- A contributing factor to the level of uncertainty in the hydraulic characterization of the area is the lack of site-specific hydrologic and hydraulic models, making the understanding of the frequency, duration, and magnitude (width, depth, and flow velocity) of the intermittent aquatic pathway difficult. Another factor is the scarcity of stream gages and real data on water levels at and in proximity to the basin divide. Due to these uncertainties, additional and better information would be needed to support design and construction of any structural measure to prevent ANS transfer through this location.

- There was uncertainty associated with portions of the biological assessment due to a variety of unknowns regarding the location and distribution of the large array of ANS that have been introduced to the waters of the U.S. In addition, the life history requirements of some of these ANS and the suitability of the habitat within the waterways between the current nearest locations of the ANS and Rosendale-Brandon. The dams on the access routes from both the Great Lakes Basin and the Mississippi River Basin were critical in determining whether ANS could likely access the divide wetlands.

- There are other ways that humans could facilitate ANS bypassing the Rosendale-Brandon wetland divide and transfer between the basins, including but not limited to: collection of bait in one basin and release in the adjacent basin, ANS adhering to recreational boats in one basin and then being released when the vessel is placed in a water body in the adjacent basin, release of imported aquaria fish and other exotic species, ceremonial releases, etc.

6.2 Rosendale-Brandon Opportunity Statements

While it is not the purpose of this assessment to produce and evaluate an exhaustive list of potential actions to prevent ANS transfer at this location, some opportunities were still identified that, if implemented, could prevent or reduce the probability of ANS transfer between the basins at the Rosendale-Brandon site. The following list of opportunities is not specific to the USACE, but incorporates a wide range of possible applicable authorities, capabilities, and jurisdictions at the Federal, state, and local levels. These are as follows:

Structural solutions could provide the highest level of confidence in preventing interbasin transfer of ANS through the Rosendale-Brandon wetland divide from either direction, provided adverse flooding impacts can be avoided to the surrounding properties. The interagency team has tentatively identified the following range of potential structural measures to prevent ANS transfer through Rosendale-Brandon:

- Install an engineered levee or lowhead dam within the wetland divide that would separate the basin discharge into Great Lakes Basin and Mississippi River Basin flows.
- Build a drop inlet structure for water discharge from the wetland divide in either direction to the tributary streams.
- Manipulation of the culvert under County Road M, through drop structures, grates, or other means, to preclude ANS entry into the culvert.

In addition to the above structural opportunities for the Rosendale-Brandon wetland divide, other non-structural opportunities that may prevent the spread of ANS were also considered, many of which are beyond the jurisdiction of the USACE to implement, but that might be implementable by other organizations. These include, but are not limited to the following:

- Regulations or ordinances prohibiting the establishment of drainage ways that connect the Mississippi River tributaries with tributaries of Lake Michigan
- Explore and support measures to reduce the potential source populations of ANS.
    - Increase commercial and recreational harvest, specifically bighead and silver carp
    - Implement measures to interfere with successful reproduction of ANS
    - Introduce biological controls such as diseases specific to particular ANS
- Educate the public to:
    - Prevent bait bucket transfers of ANS
    - Prevent transfer via boating and recreational equipment
    - Prevent transfer due to religious or cultural ceremonies
    - Identify and report the observation and collection of ANS to the appropriate authorities
- Support research on the biology of ANS so their requirements can be better understood.
    - Life history
    - Habit requirements
    - History of invasiveness
- Improve and increase field sampling and monitoring for the presence of ANS to support better informed water resource management decisions within the state and region.
    - Target, encourage, and train recreational fishermen, boaters and other direct users of the surface waters of the state of Wisconsin to identify, report, collect,and deliver ANS to the appropriate agencies

- Prevent introductions of additional ANS.
    - Improve regulations for bilge releases
    - Improve regulations on the pet industry
    - Impose regulations on the live bait industry
    - Improve regulations on the aquaculture industry

None of the opportunities identified above are exclusive of the others. In fact, any single structural measure to prevent ANS transfer through the Rosendale-Brandon wetland divide would likely benefit from corresponding development and implementation of one or more of the other types of opportunities identified. The results of this assessment may aid in the implementation of, and future updates to, the Wisconsin Aquatic comprehensive management plan.

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Appendix A

Evaluation Forms for each ANS of Concern Selected for the Rosendale-Brandon Pathway

Rosendale-Brandon Report

May, 2013

Rosendale-Brandon, Fond du Lac County, WI - Asian Carp

1. Probability of aquatic pathway existence

Aquatic Pathway Team	Expertise Position title or team role	Rating Flow into GLB	Certainty	Rating Flow into MRB	Certainty
	USACE, Detroit - Hydraulic Engineer	Medium	MC	Medium	MC
	USACE, Rock Island - Hydraulic Engineer	Medium	MC	Medium	MC
	NRCS - Hydraulic Engineer	Medium	MC	Medium	MC
	Team Ratings	**Medium**	**MC**	**Medium**	**MC**

1. How do you rate the likelihood of the existence of a viable aquatic pathway at the subject location? Assume a viable aquatic pathway is any location where untreated surface water flow across the divide is deemed likely to occur and connect headwater streams in both basins from any storm up to the 1% annual return frequency storm.

Qualitative Rating	Qualitative Rating Category Criteria
High	Perennial streams and wetlands or intermittent stream known/documented to convey significant volumes of water across the basin divide for days to weeks multiple times per year.
Medium	Intermittent stream capable of maintaining a surface water connection to streams on both sides of the basin divide continuously for multiple days from a 10% annual return frequency storm; or, location of wetland spanning basin divide which maintains significant ponds that are likely to become inter connected and connect with streams on both sides of the basin divide from a 10% annual return frequency storm.
Low	Intermittent stream or marsh forming a surface water connection between streams on either side of the basin divide from larger than a 1.0% annual return frequency storm.

	Symbol	
Very Certain	VC	As certain as I am going to get.
Reasonably Certain	RC	Reasonably certain.
Moderately Certain	MC	More certain than not.
Reasonably Uncertain	RU	Reasonably uncertain
Very Uncertain	VU	A guess

Remarks: Tule: Fond du Lac County FIS mapping from 2009 shows that the 1% annual chance floodplain for the tributary of the West Branch Fond du Lac River (Great Lakes Basin) covers the entire wetland at the headwaters of the tributary and ends at County Hwy M. The basin divide is located in the wetland just northwest of County Hwy M. Aerial photographs, show that there is a drain that connects the wetland to the tributary of the West Branch Rock River (Mississippi River Basin) and its 1% annual chance floodplain. During the site visit on 07-June-2011, stagnate ponded water was observed in both the wetland and in the drain. Standing water was on both sides of the 4' CMP under County Hwy M. The culvert is buried about 1.5' and had ponded water in it. A predominant direction of flow could not be determined. NRCS: Note that from the 1 m contour maps, the basin divide appears to be to the NW of Highway M. Is there an indication of a channel through this area (the wetland area at the basin divide)? I was not able to distinguish one on Google Earth imagery. To me this indicates that the Rating should be "Medium" in order to be more consistent with the other sites.

Rosendale-Brandon, Fond du Lac County, WI - Asian Carp

2. Probability of ANS occurring within either basin

Aquatic Pathway Team	Expertise Position title or team role	Rating	Certainty		
	USACE, St. Paul	High	VC		
	USACE, Detroit	High	VC		
	Wisconsin DNR, Fisheries	Medium	VC		
	Team Rating	**High/Med**	**VC**		

2. How do you rate the probability of ANS occuring within either basin?

Qualitative Rating	Qualitative Rating Category Criteria
High	Target ANS exists on connected waterways in close enough proximity to be capable of migrating to the aquatic pathway within 20 years.
Medium	Target ANS exists on connected waterways, but based on current proximity and mobility, is considered incapable of migrating to the aquatic pathway within 20 years.
Low	Target ANS is not known to exist on a connected waterway.

	Symbol					
Very Certain	VC	As certain as I am going to get.				
Reasonably Certain	RC	Reasonably certain.				
Moderately Certain	MC	More certain than not.				
Reasonably Uncertain	RU	Reasonably uncertain				
Very Uncertain	VU	A guess				

Remarks: Silver carp (Hypophthalmichthys molitrix) and bighead carp (Hypophthalmichthys nobilis) are established throughout the Mississippi River basin. Bighead carp have been collected in the Rock River, just below the Fordam Dam in Rockford, IL. This was in 2005 and no other collections have been made. It is assumed that this species is not yet established in the Rock River. Silver carp have not been collected in the Rock River to date. However, there seems to be a connection between the Illinois River and the Rock River via man-made canals that are part of the historic Hennepin Canal complex in Western Illinois. This canal connects to the Rock River above 2 large dams in Sterling, IL. The connection with the Illinois River is near Hennepin and Bureau Junction, IL. This connection could make it easier for Asian carp species to access areas of the Rock River. Black carp (Mylopharyngodon piceus) may be established in portions of the lower Mississippi River basin. The known distribution of black carp is not as extensive as that of the silver and bighead carp. WDNR comments: The Rock and Mississippi River sites are 100's of river miles downstream from Rosendale with multiple impassable dams in between. Moreover, Asian carp are large river species and the streams at the crossover area are very small, thus the medium rating instead of high.

Rosendale-Brandon, Fond du Lac County, WI - Asian Carp

3. Probability of ANS surviving transit to aquatic pathway

Aquatic Pathway Team	Expertise Position title or team role	3A Rating	Certainty	3B Rating	Certainty
	USACE, St. Paul	Low	RC	Low	RC
	USACE, Detroit	Low	RC	Low	RC
	Wisconsin DNR, Fisheries	Low	VC	Low	RC
	Team Ratings	**Low**	**RC/VC**	**Low**	**RC**

3A. How do you rate the probability of ANS surviving transit to aquatic pathway through connecting streams?

3B. How do you rate the probability of ANS surviving transit to aquatic pathway through other means?

Qualitative Rating	Qualitative Rating Category Criteria
High	Target ANS are established in relatively close proximity to location and have ample opportunity, capability and motivation to successfully navigate through the aquatic pathway and/or through other means to arrive at the subject pathway within 10-20 years.
Medium	Target ANS are established at locations in close enough proximity to location and have limited capability to survive migration through the aquatic pathway or through other means to arrive at the subject pathway within 20-50 years.
Low	Target ANS are not in proximity to the pathway, and/or it is highly unlikely that they could survive transit from current locations by aquatic pathway or other means to arrive at subject pathway within next 50 years.

	Symbol	
Very Certain	VC	As certain as I am going to get.
Reasonably Certain	RC	Reasonably certain.
Moderately Certain	MC	More certain than not.
Reasonably Uncertain	RU	Reasonably uncertain
Very Uncertain	VU	A guess

Remarks: 3A. Probability of ANS Surviving Transit to Aquatic Pathway Through Connecting Streams.

3A. Bighead carp have been collected in the Rock River and silver carp are in the Mississippi River not far from the mouth of the Rock River. More pressing is the fact that both of these species are established in the Illinois River near the connection with the Hennepin Canal. If either species could navigate the Hennepin Canal to the Rock River, this would give them an extreme advantage to reach the basin connection. The connection enters the Rock River above both dams in Sterling, IL. However, there are still several large dams on the Rock River upstream that would limit the migration of Asian Carp as they are incapable of surmounting impassable dams unless carried around them by people, which would have to happen multiple times in the Rock River to even have access to Rosendale.

Remarks: 3B. Probability of ANS Surviving Transit to Aquatic Pathway Through Other Means

3B. As far as anthropogenic sources of migration to this site, there doesn't seem to be a sport fishery in this area, nor does it seem to be a likely place to release a pet or for a ceremonial release. Asian carp are specifically prohibited species by name in WI.

Rosendale-Brandon, Fond du Lac County, WI - Asian Carp

4. Probability of ANS establishing in proximity to the aquatic pathway

Aquatic Pathway Team	Expertise Position title or team role	Rating	Certainty		
	USACE, St. Paul	Low	RC		
	USACE, Detroit	Low	RC		
	Wisconsin DNR, Fisheries	Low	VC		
	Team Ratings	**Low**	**RC/VC**		

4. How do you rate the probability of ANS establishing in proximity to the aquatic pathway?

Qualitative Rating	Qualitative Rating Category Criteria
High	Sources of food and habitat suitable to the ANS are plentiful in close proximity to support all life stages from birth to adult, abiotic conditions align with native range and there are no known predators or conditions that would significantly impede survivability or reproduction.
Medium	Limited and disconnected areas and sources of food and habitat suitable to the ANS are available in proximity, abiotic conditions are within latitude limits of native range, but only a portion of the healthy individuals arriving at location can be expected to effectively compete and survive.
Low	Habitat and abiotic conditions in proximity are outside the range where ANS has been known to survive; there is very limited availability habitat area suitable for ANS cover, sustainable food supply and reproduction; or native predators or competition with native species would likely prevent establishment of a sustainable population.

	Symbol	
Very Certain	VC	As certain as I am going to get.
Reasonably Certain	RC	Reasonably certain.
Moderately Certain	MC	More certain than not.
Reasonably Uncertain	RU	Reasonably uncertain
Very Uncertain	VU	A guess

Remarks: Based on the hydrologic description and photos of this site, it does not seem plausible that a population of any Asian carp species can be established at this connection. There does not seem to be enough water to support any type of quality aquatic communities or provide enough food or habitat for a large bodied fish species to establish a new community. However, during periods of high water, mature Asian carp or juveniles may be able to use the connection as a conduit to cross the watershed divide.

Rosendale-Brandon, Fond du Lac County, WI - Asian Carp

5. Probability of ANS spreading across aquatic pathway into the new basin

Aquatic Pathway Team	Expertise Position title or team role	Rating	Certainty
	USACE, St. Paul	High	VC
	USACE, Detroit	High	RC
	Wisconsin DNR, Fisheries	High	RC
	Team Ratings	**High**	**RC/VC**

5. How do you rate the probability of ANS spreading across aquatic pathway into the new basin?

Qualitative Rating	Qualitative Rating Category Criteria
High	Sources of food and habitat suitable to the ANS are available, and the species has demonstrated capabilities to significantly expand range from locations where initially introduced.
Medium	There are limited sources of food and suitable habitat, and/or the species has demonstrated limited ability to spread significant distances beyond areas where it has been introduced.
Low	There are severely limited sources of food and suitable habitat, and/or the species has demonstrated very limited ability to spread beyond areas where it has been introduced.

	Symbol	
Very Certain	VC	As certain as I am going to get.
Reasonably Certain	RC	Reasonably certain.
Moderately Certain	MC	More certain than not.
Reasonably Uncertain	RU	Reasonably uncertain
Very Uncertain	VU	A guess

Remarks: Asian Carp have showed no signs of slowing their expansion throughout the United States. While the immediate area near the basin connection is not conducive to Asian Carp establishing a population, the site could provide a link to the Great Lakes Basin.

Rosendale-Brandon, Fond du Lac County, WI - Inland Silverside (*Menidia beryllina*)

1. Probability of aquatic pathway existence

Aquatic Pathway Team	Expertise Position title or team role	Rating Flow into GLB	Certainty	Rating Flow into MRB	Certainty
	USACE, Detroit - Hydraulic Engineer	Medium	MC	Medium	MC
	USACE, Rock Island - Hydraulic Engineer	Medium	MC	Medium	MC
	NRCS - Hydraulic Engineer	Medium	MC	Medium	MC
	Team Ratings	**Medium**	**MC**	**Medium**	**MC**

1. How do you rate the likelihood of the existence of a viable aquatic pathway at the subject location? Assume a viable aquatic pathway is any location where untreated surface water flow across the divide is deemed likely to occur and connect headwater streams in both basins from any storm up to the 1% annual return frequency storm.

Qualitative Rating	Qualitative Rating Category Criteria
High	Perennial streams and wetlands or intermittent stream known/documented to convey significant volumes of water across the basin divide for days to weeks multiple times per year.
Medium	Intermittent stream capable of maintaining a surface water connection to streams on both sides of the basin divide continuously for multiple days from a 10% annual return frequency storm; or, location of wetland spanning basin divide which maintains significant ponds that are likely to become inter connected and connect with streams on both sides of the basin divide from a 10% annual return frequency storm.
Low	Intermittent stream or marsh forming a surface water connection between streams on either side of the basin divide from larger than a 1.0% annual return frequency storm.

	Symbol	
Very Certain	VC	As certain as I am going to get.
Reasonably Certain	RC	Reasonably certain.
Moderately Certain	MC	More certain than not.
Reasonably Uncertain	RU	Reasonably uncertain
Very Uncertain	VU	A guess

Remarks: Tule: Fond du Lac County FIS mapping from 2009 shows that the 1% annual chance floodplain for the tributary of the West Branch Fond du Lac River (Great Lakes Basin) covers the entire wetland at the headwaters of the tributary and ends at County Hwy M. The basin divide is located in the wetland just northwest of County Hwy M. Aerial photographs, show that there is a drain that connects the wetland to the tributary of the West Branch Rock River (Mississippi River Basin) and its 1% annual chance floodplain. During the site visit on 07-June-2011, stagnate ponded water was observed in both the wetland and in the drain. Standing water was on both sides of the 4' CMP under County Hwy M. The culvert is buried about 1.5' and had ponded water in it. A predominant direction of flow could not be determined. NRCS: Note that from the 1 m contour maps, the basin divide appears to be to the NW of Highway M. Is there an indication of a channel through this area (the wetland area at the basin divide)? I was not able to distinguish one on Google Earth imagery. To me this indicates that the Rating should be "Medium" in order to be more consistent with the other sites.

Rosendale-Brandon, Fond du Lac County, WI - Inland Silverside (*Menidia beryllina*)

2. Probability of ANS occurring within either basin

Aquatic Pathway Team	Expertise Position title or team role	Rating	Certainty		
	USACE, St. Paul	Medium	VC		
	USACE, Detroit	Medium	RC		
	Wisconsin DNR, Fisheries	Low	VC		
	Team Rating	**Medium**	**RC/VC**		

2. How do you rate the probability of ANS occuring within either basin?

Qualitative Rating	Qualitative Rating Category Criteria
High	Target ANS exists on connected waterways in close enough proximity to be capable of migrating to the aquatic pathway within 20 years.
Medium	Target ANS exists on connected waterways, but based on current proximity and mobility, is considered incapable of migrating to the aquatic pathway within 20 years.
Low	Target ANS is not known to exist on a connected waterway.

	Symbol	
Very Certain	VC	As certain as I am going to get.
Reasonably Certain	RC	Reasonably certain.
Moderately Certain	MC	More certain than not.
Reasonably Uncertain	RU	Reasonably uncertain
Very Uncertain	VU	A guess

Remarks: Inland silversides were stocked into the Kanakakee River in Will County, Illinois. They were collected there in 1996 (USGS 2009). It appears that the majority of the locations in which this species is collected outside of its native range is due to stocking and the species is not being collected far from the initial stocking area. There is no evidence that this species is expanding beyond these stocking areas. The WDNR stated the Kankakee River has a water connection with the Rosendale area but this is so far away with so many intervening dams that the likelihood of inland silverside reaching Rosendale is almost nonexistent, thus the low rating. However, the team rating was medium for Form 2 since WDNR's comment had more to do with how the silverside might get to the pathway versus whether they exist in connecting streams/waterbodies.

Rosendale-Brandon, Fond du Lac County, WI - Inland Silverside (*Menidia beryllina*)

3. Probability of ANS surviving transit to aquatic pathway

Aquatic Pathway Team	Expertise Position title or team role	3A Rating	Certainty	3B Rating	Certainty
	USACE, St. Paul	Low	RC	Low	RC
	USACE, Detroit	Low	RC	Low	RC
	Wisconsin DNR, Fisheries	Low	VC	Low	VC
	Team Ratings	**Low**	**RC/VC**	**Low**	**RC/VC**

3A. How do you rate the probability of ANS surviving transit to aquatic pathway through connecting streams?

3B. How do you rate the probability of ANS surviving transit to aquatic pathway through other means?

Qualitative Rating	Qualitative Rating Category Criteria
High	Target ANS are established in relatively close proximity to location and have ample opportunity, capability and motivation to successfully navigate through the aquatic pathway and/or through other means to arrive at the subject pathway within 10-20 years.
Medium	Target ANS are established at locations in close enough proximity to location and have limited capability to survive migration through the aquatic pathway or through other means to arrive at the subject pathway within 20-50 years.
Low	Target ANS are not in proximity to the pathway, and/or it is highly unlikely that they could survive transit from current locations by aquatic pathway or other means to arrive at subject pathway within next 50 years.

	Symbol	
Very Certain	VC	As certain as I am going to get.
Reasonably Certain	RC	Reasonably certain.
Moderately Certain	MC	More certain than not.
Reasonably Uncertain	RU	Reasonably uncertain
Very Uncertain	VU	A guess

Remarks: 3A. Probability of ANS Surviving Transit to Aquatic Pathway Through Connecting Streams.

3A. Inland silversides have not expanded greatly outside of areas where they have been stocked outside of their native range. The connection between the Illinois River and Rock River via the Hennepin Canal could allow this species to migrate to the Brandon-Rosendale site quicker instead of migrating all the way down the Illinois River and back up the Mississippi River to the Rock River. This site is at the northern limit of the native range for this species. The USGS website shows that a stocking near St. Paul, MN failed. Direct migration to the area is extremely unlikely, thus the low rating.

Remarks: 3B. Probability of ANS Surviving Transit to Aquatic Pathway Through Other Means

3B. There would be a low probability of bait-bucket release as this area does not support a recreational fishery. Bait bucket transfers are also extremely unlikely, as silversides are very fragile and can only be transported successfully with specialized equipment and will not survive more than a few minutes in a typical bait bucket (WDNR). The inland silverside is a non-native fish species that is not established in WI and thus prohibited by WI statute.

Rosendale-Brandon, Fond du Lac County, WI - Inland Silverside (*Menidia beryllina*)

4. Probability of ANS establishing in proximity to the aquatic pathway

Aquatic Pathway Team	Expertise Position title or team role	Rating	Certainty		
	USACE, St. Paul	Low	RC		
	USACE, Detroit	Low	RC		
	Wisconsin DNR, Fisheries	Low	RC		
	Team Ratings	**Low**	**RC**		

4. How do you rate the probability of ANS establishing in proximity to the aquatic pathway?

Qualitative Rating	Qualitative Rating Category Criteria
High	Sources of food and habitat suitable to the ANS are plentiful in close proximity to support all life stages from birth to adult, abiotic conditions align with native range and there are no known predators or conditions that would significantly impede survivability or reproduction.
Medium	Limited and disconnected areas and sources of food and habitat suitable to the ANS are available in proximity, abiotic conditions are within latitude limits of native range, but only a portion of the healthy individuals arriving at location can be expected to effectively compete and survive.
Low	Habitat and abiotic conditions in proximity are outside the range where ANS has been known to survive; there is very limited availability habitat area suitable for ANS cover, sustainable food supply and reproduction; or native predators or competition with native species would likely prevent establishment of a sustainable population.

	Symbol	
Very Certain	VC	As certain as I am going to get.
Reasonably Certain	RC	Reasonably certain.
Moderately Certain	MC	More certain than not.
Reasonably Uncertain	RU	Reasonably uncertain
Very Uncertain	VU	A guess

Remarks: Site may be too far north for inland silversides to survive. Currently there are no records of established populations at this latitude. The lack of quality habitat at this basin connection would make it difficult for this species to colonize and become established in this location.

Rosendale-Brandon, Fond du Lac County, WI - Inland Silverside (*Menidia beryllina*)

5. Probability of ANS spreading across aquatic pathway into the new basin

Aquatic Pathway Team	Expertise Position title or team role	Rating	Certainty		
	USACE, St. Paul	Low	MC		
	USACE, Detroit	Low	MC		
	Wisconsin DNR, Fisheries	Low	RC		
	Team Ratings	**Low**	**MC/RC**		

5. How do you rate the probability of ANS spreading across aquatic pathway into the new basin?

Qualitative Rating	Qualitative Rating Category Criteria
High	Sources of food and habitat suitable to the ANS are available, and the species has demonstrated capabilities to significantly expand range from locations where initially introduced.
Medium	There are limited sources of food and suitable habitat, and/or the species has demonstrated limited ability to spread significant distances beyond areas where it has been introduced.
Low	There are severely limited sources of food and suitable habitat, and/or the species has demonstrated very limited ability to spread beyond areas where it has been introduced.

	Symbol	
Very Certain	VC	As certain as I am going to get.
Reasonably Certain	RC	Reasonably certain.
Moderately Certain	MC	More certain than not.
Reasonably Uncertain	RU	Reasonably uncertain
Very Uncertain	VU	A guess

Remarks: The likelihood of Inland silversides reaching this basin connection is low. This species has not shown much propensity to expand beyond area of stocking. This site is at the northern limit of the inland silverside range, thus the low rating.

Rosendale-Brandon, Fond du Lac County, WI - Northern Snakehead (*Channa argus*)

1. Probability of aquatic pathway existence

Aquatic Pathway Team	Expertise Position title or team role	Rating Flow into GLB	Certainty	Rating Flow into MRB	Certainty
	USACE, Detroit - Hydraulic Engineer	Medium	MC	Medium	MC
	USACE, Rock Island - Hydraulic Engineer	Medium	MC	Medium	MC
	NRCS - Hydraulic Engineer	Medium	MC	Medium	MC
	Team Ratings	**Medium**	**MC**	**Medium**	**MC**

1. How do you rate the likelihood of the existence of a viable aquatic pathway at the subject location? Assume a viable aquatic pathway is any location where untreated surface water flow across the divide is deemed likely to occur and connect headwater streams in both basins from any storm up to the 1% annual return frequency storm.

Qualitative Rating	Qualitative Rating Category Criteria
High	Perennial streams and wetlands or intermittent stream known/documented to convey significant volumes of water across the basin divide for days to weeks multiple times per year.
Medium	Intermittent stream capable of maintaining a surface water connection to streams on both sides of the basin divide continuously for multiple days from a 10% annual return frequency storm; or, location of wetland spanning basin divide which maintains significant ponds that are likely to become inter connected and connect with streams on both sides of the basin divide from a 10% annual return frequency storm.
Low	Intermittent stream or marsh forming a surface water connection between streams on either side of the basin divide from larger than a 1.0% annual return frequency storm.

	Symbol	
Very Certain	VC	As certain as I am going to get.
Reasonably Certain	RC	Reasonably certain.
Moderately Certain	MC	More certain than not.
Reasonably Uncertain	RU	Reasonably uncertain
Very Uncertain	VU	A guess

Remarks: Tule: Fond du Lac County FIS mapping from 2009 shows that the 1% annual chance floodplain for the tributary of the West Branch Fond du Lac River (Great Lakes Basin) covers the entire wetland at the headwaters of the tributary and ends at County Hwy M. The basin divide is located in the wetland just northwest of County Hwy M. Aerial photographs, show that there is a drain that connects the wetland to the tributary of the West Branch Rock River (Mississippi River Basin) and its 1% annual chance floodplain. During the site visit on 07-June-2011, stagnate ponded water was observed in both the wetland and in the drain. Standing water was on both sides of the 4' CMP under County Hwy M. The culvert is buried about 1.5' and had ponded water in it. A predominant direction of flow could not be determined. NRCS: Note that from the 1 m contour maps, the basin divide appears to be to the NW of Highway M. Is there an indication of a channel through this area (the wetland area at the basin divide)? I was not able to distinguish one on Google Earth imagery. To me this indicates that the Rating should be "Medium" in order to be more consistent with the other sites.

Rosendale-Brandon, Fond du Lac County, WI - Northern Snakehead (*Channa argus*)

2. Probability of ANS occurring within either basin

Aquatic Pathway Team	Expertise Position title or team role	Rating	Certainty		
	USACE, St. Paul	Medium	RC		
	USACE, Detroit	Medium	RC		
	Wisconsin DNR, Fisheries	Low	VC		
	Team Rating	**Medium**	**RC/VC**		

2. How do you rate the probability of ANS occuring within either basin?

Qualitative Rating	Qualitative Rating Category Criteria
High	Target ANS exists on connected waterways in close enough proximity to be capable of migrating to the aquatic pathway within 20 years.
Medium	Target ANS exists on connected waterways, but based on current proximity and mobility, is considered incapable of migrating to the aquatic pathway within 20 years.
Low	Target ANS is not known to exist on a connected waterway.

	Symbol					
Very Certain	VC	As certain as I am going to get.				
Reasonably Certain	RC	Reasonably certain.				
Moderately Certain	MC	More certain than not.				
Reasonably Uncertain	RU	Reasonably uncertain				
Very Uncertain	VU	A guess				

Remarks: The closest established population of northern snakeheads is in Lee Co., AR.

Rosendale-Brandon, Fond du Lac County, WI - Northern Snakehead (*Channa argus*)

3. Probability of ANS surviving transit to aquatic pathway

Aquatic Pathway Team	Expertise Position title or team role	3A Rating	Certainty	3B Rating	Certainty
	USACE, St. Paul	Low	RC	Low	RC
	USACE, Detroit	Low	RC	Low	RC
	Wisconsin DNR, Fisheries	Low	VC	Low	RC
	Team Ratings	**Low**	**RC/VC**	**Low**	**RC**

3A. How do you rate the probability of ANS surviving transit to aquatic pathway through connecting streams?

3B. How do you rate the probability of ANS surviving transit to aquatic pathway through other means?

Qualitative Rating	Qualitative Rating Category Criteria
High	Target ANS are established in relatively close proximity to location and have ample opportunity, capability and motivation to successfully navigate through the aquatic pathway and/or through other means to arrive at the subject pathway within 10-20 years.
Medium	Target ANS are established at locations in close enough proximity to location and have limited capability to survive migration through the aquatic pathway or through other means to arrive at the subject pathway within 20-50 years.
Low	Target ANS are not in proximity to the pathway, and/or it is highly unlikely that they could survive transit from current locations by aquatic pathway or other means to arrive at subject pathway within next 50 years.

	Symbol	
Very Certain	VC	As certain as I am going to get.
Reasonably Certain	RC	Reasonably certain.
Moderately Certain	MC	More certain than not.
Reasonably Uncertain	RU	Reasonably uncertain
Very Uncertain	VU	A guess

Remarks: 3A. Probability of ANS Surviving Transit to Aquatic Pathway Through Connecting Streams.

3A. If the Arkansas population does begin to expand into and up the Mississippi River, there are many barriers to migration including dams on the river and its tributaries. Habitat preferred by northern snakeheads includes stagnant, shallow ponds or swamps with mud substrate and aquatic vegetation; slow muddy streams (Courtenay and Williams, 2004). The main stem of the Mississippi River may not provide adequate habitat to this species to maintain a viable population to attempt a migration towards the Great Lakes.

Remarks: 3B. Probability of ANS Surviving Transit to Aquatic Pathway Through Other Means

3B. Snakeheads are specifically prohibited species by name in WI. Anthropogenic releases seem unlikey at this location.

Rosendale-Brandon, Fond du Lac County, WI - Northern Snakehead (*Channa argus*)

4. Probability of ANS establishing in proximity to the aquatic pathway

Aquatic Pathway Team	Expertise Position title or team role	Rating	Certainty		
	USACE, St. Paul	Medium	MC		
	USACE, Detroit	Medium	RC		
	Wisconsin DNR, Fisheries	Medium	RC		
	Team Ratings	**Medium**	**MC/RC**		

4. How do you rate the probability of ANS establishing in proximity to the aquatic pathway?

Qualitative Rating	Qualitative Rating Category Criteria
High	Sources of food and habitat suitable to the ANS are plentiful in close proximity to support all life stages from birth to adult, abiotic conditions align with native range and there are no known predators or conditions that would significantly impede survivability or reproduction.
Medium	Limited and disconnected areas and sources of food and habitat suitable to the ANS are available in proximity, abiotic conditions are within latitude limits of native range, but only a portion of the healthy individuals arriving at location can be expected to effectively compete and survive.
Low	Habitat and abiotic conditions in proximity are outside the range where ANS has been known to survive; there is very limited availability habitat area suitable for ANS cover, sustainable food supply and reproduction; or native predators or competition with native species would likely prevent establishment of a sustainable population.

	Symbol	
Very Certain	VC	As certain as I am going to get.
Reasonably Certain	RC	Reasonably certain.
Moderately Certain	MC	More certain than not.
Reasonably Uncertain	RU	Reasonably uncertain
Very Uncertain	VU	A guess

Remarks: The ditches and wetlands that comprise the basin connection seem conducive to the establishment of a northern snakehead population in the area. These waterways seem to be agricultural drains and may not have high water quality or be able to support a large number of individual organisms. Food sources could be a limiting factor to the success of northern snakeheads becoming established at this location.

Rosendale-Brandon, Fond du Lac County, WI - Northern Snakehead (*Channa argus*)

5. Probability of ANS spreading across aquatic pathway into the new basin

Aquatic Pathway Team	Expertise Position title or team role	Rating	Certainty
	USACE, St. Paul	High	RC
	USACE, Detroit	High	RC
	Wisconsin DNR, Fisheries	Medium	RC
	Team Ratings	**Med/High**	**RC**

5. How do you rate the probability of ANS spreading across aquatic pathway into the new basin?

Qualitative Rating	Qualitative Rating Category Criteria
High	Sources of food and habitat suitable to the ANS are available, and the species has demonstrated capabilities to significantly expand range from locations where initially introduced.
Medium	There are limited sources of food and suitable habitat, and/or the species has demonstrated limited ability to spread significant distances beyond areas where it has been introduced.
Low	There are severely limited sources of food and suitable habitat, and/or the species has demonstrated very limited ability to spread beyond areas where it has been introduced.

	Symbol	
Very Certain	VC	As certain as I am going to get.
Reasonably Certain	RC	Reasonably certain.
Moderately Certain	MC	More certain than not.
Reasonably Uncertain	RU	Reasonably uncertain
Very Uncertain	VU	A guess

Remarks: If northern snakeheads make it to this connection, there is reason to believe that if the hydraulic conditions are right, this species will pass to the GLB.

Rosendale-Brandon, Fond du Lac County, WI - Viral Hemmorhagic Septicemia virus (VHSv)

1. Probability of aquatic pathway existence

Aquatic Pathway Team	Expertise Position title or team role	Rating Flow into GLB	Certainty	Rating Flow into MRB	Certainty
	USACE, Detroit - Hydraulic Engineer	Medium	MC	Medium	MC
	USACE, Rock Island - Hydraulic Engineer	Medium	MC	Medium	MC
	NRCS - Hydraulic Engineer	Medium	MC	Medium	MC
	Team Ratings	**Medium**	**MC**	**Medium**	**MC**

1. How do you rate the likelihood of the existence of a viable aquatic pathway at the subject location? Assume a viable aquatic pathway is any location where untreated surface water flow across the divide is deemed likely to occur and connect headwater streams in both basins from any storm up to the 1% annual return frequency storm.

Qualitative Rating	Qualitative Rating Category Criteria
High	Perennial streams and wetlands or intermittent stream known/documented to convey significant volumes of water across the basin divide for days to weeks multiple times per year.
Medium	Intermittent stream capable of maintaining a surface water connection to streams on both sides of the basin divide continuously for multiple days from a 10% annual return frequency storm; or, location of wetland spanning basin divide which maintains significant ponds that are likely to become inter connected and connect with streams on both sides of the basin divide from a 10% annual return frequency storm.
Low	Intermittent stream or marsh forming a surface water connection between streams on either side of the basin divide from larger than a 1.0% annual return frequency storm.

	Symbol	
Very Certain	VC	As certain as I am going to get.
Reasonably Certain	RC	Reasonably certain.
Moderately Certain	MC	More certain than not.
Reasonably Uncertain	RU	Reasonably uncertain
Very Uncertain	VU	A guess

Remarks: Tule: Fond du Lac County FIS mapping from 2009 shows that the 1% annual chance floodplain for the tributary of the West Branch Fond du Lac River (Great Lakes Basin) covers the entire wetland at the headwaters of the tributary and ends at County Hwy M. The basin divide is located in the wetland just northwest of County Hwy M. Aerial photographs, show that there is a drain that connects the wetland to the tributary of the West Branch Rock River (Mississippi River Basin) and its 1% annual chance floodplain. During the site visit on 07-June-2011, stagnate ponded water was observed in both the wetland and in the drain. Standing water was on both sides of the 4' CMP under County Hwy M. The culvert is buried about 1.5' and had ponded water in it. A predominant direction of flow could not be determined. NRCS: Note that from the 1 m contour maps, the basin divide appears to be to the NW of Highway M. Is there an indication of a channel through this area (the wetland area at the basin divide)? I was not able to distinguish one on Google Earth imagery. To me this indicates that the Rating should be "Medium" in order to be more consistent with the other sites.

Rosendale-Brandon, Fond du Lac County, WI - Viral Hemmorhagic Septicemia virus (VHSv)

2. Probability of ANS occurring within either basin

Aquatic Pathway Team	Expertise Position title or team role	Rating	Certainty		
	USACE, St. Paul	High	RC		
	USACE, Detroit	High	RC		
	Wisconsin DNR, Fisheries	High	RC		
	Team Rating	**High**	**RC**		

2. How do you rate the probability of ANS occuring within either basin?

Qualitative Rating	Qualitative Rating Category Criteria
High	Target ANS exists on connected waterways in close enough proximity to be capable of migrating to the aquatic pathway within 20 years.
Medium	Target ANS exists on connected waterways, but based on current proximity and mobility, is considered incapable of migrating to the aquatic pathway within 20 years.
Low	Target ANS is not known to exist on a connected waterway.

	Symbol					
Very Certain	VC	As certain as I am going to get.				
Reasonably Certain	RC	Reasonably certain.				
Moderately Certain	MC	More certain than not.				
Reasonably Uncertain	RU	Reasonably uncertain				
Very Uncertain	VU	A guess				

Remarks: Viral Hemorrhagic Septicemia virus (VHSv) can infect a wide range of host fish causing a variety of external and internal pathology including death of the host fish. Variables such as host fish species and water temperature can impact the pathology of the virus. Seemingly healthy individuals that have been previously infected with VHSv can have chronic infections and be carriers of the disease (Skall et al. 2005). This virus has been reported from throughout the Great Lakes Basin including Lake Michigan (USGS 2009a). Viral Hemorrhagic Septicemia (VHSv) has been found in many species of fish including common carp (Cyprinus carpio). The common carp is established in Lake Michigan, as well as the Fond du Lac River leading to the divide. While other host fish species are known to exist in the pathway system, the common carp was selected as the most likely host species for VHSv because of the life cycle capabilities of the common carp and the likelihood the common carp could use and survive in the pathway habitats. VHSv and a necessary host species, the common carp, are in the pathway.

Rosendale-Brandon, Fond du Lac County, WI - Viral Hemmorhagic Septicemia virus (VHSv)

3. Probability of ANS surviving transit to aquatic pathway

Aquatic Pathway Team	Expertise Position title or team role	3A Rating	Certainty	3B Rating	Certainty
	USACE, St. Paul	Low/Med	RC	Low	RC
	USACE, Detroit	Low/Med	RC	Low	RC
	Wisconsin DNR, Fisheries	Low/Med	RC	Low	RC
	Team Ratings	**Low/Med**	**RC**	**Low**	**RC**

3A. How do you rate the probability of ANS surviving transit to aquatic pathway through connecting streams?

3B. How do you rate the probability of ANS surviving transit to aquatic pathway through other means?

Qualitative Rating	Qualitative Rating Category Criteria
High	Target ANS are established in relatively close proximity to location and have ample opportunity, capability and motivation to successfully navigate through the aquatic pathway and/or through other means to arrive at the subject pathway within 10-20 years.
Medium	Target ANS are established at locations in close enough proximity to location and have limited capability to survive migration through the aquatic pathway or through other means to arrive at the subject pathway within 20-50 years.
Low	Target ANS are not in proximity to the pathway, and/or it is highly unlikely that they could survive transit from current locations by aquatic pathway or other means to arrive at subject pathway within next 50 years.

	Symbol	
Very Certain	VC	As certain as I am going to get.
Reasonably Certain	RC	Reasonably certain.
Moderately Certain	MC	More certain than not.
Reasonably Uncertain	RU	Reasonably uncertain
Very Uncertain	VU	A guess

Remarks: 3A. Probability of ANS Surviving Transit to Aquatic Pathway Through Connecting Streams.

3A.The distance from Lake Michigan to the watershed divide is approximately 65 miles. From Lake Winnebago to the watershed divide at Rosendale-Brandon along Fond du Lac River and West Branch Fond du Lac River is about 20-30 miles. The Lower Fox River, connecting Lake Winnebago and Green Bay, is 39 miles long. The Wisconsin DNR Surface water data viewer shows that the unnamed tributary stream, which originates at the north end of a 1.5 mile long forested and emergent wetland complex (T15N, R15E, Section 7), contains open water bodies on the USGS Quadrangle. The Fond du Lac River at USGS gage 04083545 is located approximately 25 miles downstream of the divide in Fond du Lac, WI. The gage shows the average river discharge varies from about 450 cfs in March to about 10 cfs low flow in November. The extensive emergent and forested wetland complex at the divide is considered a major restriction to fish passage, including common carp. The Rapid Croche lock and dam is considered a block to upstream ANS migration by the WDNR. However, fish can theoretically pass at the 10 year flood event. Further blockage occurs at Eldorado Marsh where the WDNR fish biologist considered the dam as a blockage to passage. The only other route to the divide is along Silver Creek/Puchyan River where access to the divide only occurs in the 1% and greater flood event, then the fish must successfully pass the mile wide divide wetland complex to the MRB. The manmade structures and the wetland divide provides a significant impediment to carp migration from downstream of the Rapid Croche lock and dam and is the primary basis for the assignment of the low rating. The WDNR identified VHSv in the Lake Winnebago system in 2007 in freshwater drum which is above the Rapid Croche lock and dam. No additional fish collected from the Lake Winnebago system have been reported positive for VHSv through the summer of 2011 though the entire upstream river system has not been thoroughly sampled. Based on the positive report of VHSv in 2007 upstream of Rapid Croche lock and dam (though not documented since 2007), the rating of medium is considered appropriate. If an infected common carp arrived at the emergent wetland divide or the open waters within the divide during the spring, a subsequent storm event sufficient to complete the intermittent aquatic pathway that same spring, could facilitate the infected common carp to disperse across the basin divide at that time. The confirmed VHSv from a fish above the Rapid Croche lock and dam in 2007 results in the potential that VHSv may be present in fish at the GLB/MRB divide, thus the overall low/medium rating. Without the confirmed report of VHSv in a fish above the Rapid Croche lock and dam in 2007, the rating would have remained low.

Remarks: 3B. Probability of ANS Surviving Transit to Aquatic Pathway Through Other Means

3B. There is no evidence or information to suggest the emergent and forested wetland and the open waters at the divide are recreational areas used by fishermen or boaters, so there appears to be a low probability for ANS to be transported to the proximity of the basin divide at this location by anthropogenic means. Further, in the unlikely event an infested carp is introduced into the wetlands other than the gravel pits, the aquatic habitat is considered marginally suitable for survival of the host common carp for at least the late summer during most years. Common carp are very tolerant fish, and survival of VHSv infected carp in the open waters through the late summer is possible. The distance at the divide between the unnamed tributary and the West Branch of the Rock River is 1.5 miles, consisting of 1.15 miles of emergent wetlands and 0.35 miles of forested wetland complex. However, as previously stated, if VHSv infected carp were introduced during the spring of the year to the wetlands and a sufficiently large storm event occurs to form an aquatic pathway spanning the divide later that same spring, there would be a reasonable chance that VHSv infected carp could migrate into the Mississippi River basin through the emergent wetland surface water connection. The probability of common carp getting through the divide is fairly low but if they arrived at the divide and a suitable storm event occurred, they could cross the divide. These considerations were the primary basis for the assignment of a Low rating to the probability ANS will survive transit to the aquatic pathway by other means and the Reasonable certainty assigned to the rating.

Rosendale-Brandon, Fond du Lac County, WI - Viral Hemmorhagic Septicemia virus (VHSv)

4. Probability of ANS establishing in proximity to the aquatic pathway

Aquatic Pathway Team	Expertise Position title or team role	Rating	Certainty		
	USACE, St. Paul	Medium	RC		
	USACE, Detroit	Medium	RC		
	Wisconsin DNR, Fisheries	Medium	RC		
	Team Ratings	**Medium**	**RC**		

4. How do you rate the probability of ANS establishing in proximity to the aquatic pathway?

Qualitative Rating	Qualitative Rating Category Criteria
High	Sources of food and habitat suitable to the ANS are plentiful in close proximity to support all life stages from birth to adult, abiotic conditions align with native range and there are no known predators or conditions that would significantly impede survivability or reproduction.
Medium	Limited and disconnected areas and sources of food and habitat suitable to the ANS are available in proximity, abiotic conditions are within latitude limits of native range, but only a portion of the healthy individuals arriving at location can be expected to effectively compete and survive.
Low	Habitat and abiotic conditions in proximity are outside the range where ANS has been known to survive; there is very limited availability habitat area suitable for ANS cover, sustainable food supply and reproduction; or native predators or competition with native species would likely prevent establishment of a sustainable population.

	Symbol	
Very Certain	VC	As certain as I am going to get.
Reasonably Certain	RC	Reasonably certain.
Moderately Certain	MC	More certain than not.
Reasonably Uncertain	RU	Reasonably uncertain
Very Uncertain	VU	A guess

Remarks: During spring run-off events in April/May, common carp migrate into the shallow waters of bays and river systems to spawn. Within the rivers, common carp migrate upstream to spawn in suitable habitat such as marshes and even drainage ditches and emergent wetlands with as little as or less than one foot depth of water. Common carp are strong swimmers and though they cannot jump like members of the salmon family, they can migrate upstream during moderate flow events and across emergent wetlands and even through flooded timber. Survival of common carp as a carrier of VHSv is considered medium at this location during the spring. During spring runoff, the wetland divide and connecting ditches/streams would provide the necessary habitat for occupation of any VHSv carrier/host fish species, at least temporarily. However, there is significant uncertainty regarding the suitability of the aquatic habitat to sustain a population of VHSv infected common carp during the drier and hotter periods of the year in proximity to this divide location, except possibly in the open water areas. These considerations were the primary basis for the medium rating assigned to the probability that VHSv could become established in close proximity to the basin divide and the reasonable certainty assigned to the rating.

Rosendale-Brandon, Fond du Lac County, WI - Viral Hemmorhagic Septicemia virus (VHSv)

5. Probability of ANS spreading across aquatic pathway into the new basin

Aquatic Pathway Team	Expertise Position title or team role	Rating	Certainty		
	USACE, St. Paul	High	RC		
	USACE, Detroit	High	RC		
	Wisconsin DNR, Fisheries	Medium	RC		
	Team Ratings	**Med/High**	**RC**		

5. How do you rate the probability of ANS spreading across aquatic pathway into the new basin?

Qualitative Rating	Qualitative Rating Category Criteria
High	Sources of food and habitat suitable to the ANS are available, and the species has demonstrated capabilities to significantly expand range from locations where initially introduced.
Medium	There are limited sources of food and suitable habitat, and/or the species has demonstrated limited ability to spread significant distances beyond areas where it has been introduced.
Low	There are severely limited sources of food and suitable habitat, and/or the species has demonstrated very limited ability to spread beyond areas where it has been introduced.

	Symbol	
Very Certain	VC	As certain as I am going to get.
Reasonably Certain	RC	Reasonably certain.
Moderately Certain	MC	More certain than not.
Reasonably Uncertain	RU	Reasonably uncertain
Very Uncertain	VU	A guess

Remarks: VHSv is capable of persisting outside of a host for several days. The WDNR noted that VHSv is expressed and contagious primarily when water temperatures are below 60 F. Carp migration and spawning usually begins after temperatures exceed 60 F (generally 18.5C/65F-20C/68F but Carlander (1969) noted some carp begin spawning as early as 14.5C/58F-17C/62F). Carp might be able to traverse the divide under very favorable conditions, but the virus might not be active.The virus demonstrates a rapid reproductive cycle and is capable of utilizing many different host species. It is highly likely that VHSv would be successful in establishing in exposed fish populations already on both sides of the wetland basin divide. The emergent wetland at the divide is the type of habitat that carp seek in the spring during spawning season and would be considered good to excellent carp spawning habitat with 1-2 feet of inundation. Water depths of one foot or less spanning the basin divide would appear to be suitable for the passage of carp. This condition would most likely occur with heavy rains in later spring in the April/May time frame after the ground has been saturated during the melting of deep snowpack and several heavy rain events. If any VHSv infected fish species were present in the wetlands or open waters in proximity to the divide when such an event occurs, it is likely the fish would disperse across the basin divide into the Mississippi River Basin (MRB). This is the primary information that supported the assignment of a High/Medium rating to the probability that VHSv would spread across the basin divide if it were established in a common carp population in close proximity to this location.

Rosendale-Brandon, Fond du Lac County, WI - Ruffe (*Gymnochephalus cernuus*) / Tubenose Goby (*Proterorhinus semilunaris*)

1. Probability of aquatic pathway existence

Aquatic Pathway Team	Expertise Position title or team role	Rating Flow into GLB	Certainty	Rating Flow into MRB	Certainty
	USACE, Detroit - Hydraulic Engineer	Medium	MC	Medium	MC
	USACE, Rock Island - Hydraulic Engineer	Medium	MC	Medium	MC
	NRCS - Hydraulic Engineer	Medium	MC	Medium	MC
	Team Ratings	**Medium**	**MC**	**Medium**	**MC**

1. How do you rate the likelihood of the existence of a viable aquatic pathway at the subject location? Assume a viable aquatic pathway is any location where untreated surface water flow across the divide is deemed likely to occur and connect headwater streams in both basins from any storm up to the 1% annual return frequency storm.

Qualitative Rating	Qualitative Rating Category Criteria
High	Perennial streams and wetlands or intermittent stream known/documented to convey significant volumes of water across the basin divide for days to weeks multiple times per year.
Medium	Intermittent stream capable of maintaining a surface water connection to streams on both sides of the basin divide continuously for multiple days from a 10% annual return frequency storm; or, location of wetland spanning basin divide which maintains significant ponds that are likely to become inter connected and connect with streams on both sides of the basin divide from a 10% annual return frequency storm.
Low	Intermittent stream or marsh forming a surface water connection between streams on either side of the basin divide from larger than a 1.0% annual return frequency storm.

	Symbol	
Very Certain	VC	As certain as I am going to get.
Reasonably Certain	RC	Reasonably certain.
Moderately Certain	MC	More certain than not.
Reasonably Uncertain	RU	Reasonably uncertain
Very Uncertain	VU	A guess

Remarks: Tule: Fond du Lac County FIS mapping from 2009 shows that the 1% annual chance floodplain for the tributary of the West Branch Fond du Lac River (Great Lakes Basin) covers the entire wetland at the headwaters of the tributary and ends at County Hwy M. The basin divide is located in the wetland just northwest of County Hwy M. Aerial photographs, show that there is a drain that connects the wetland to the tributary of the West Branch Rock River (Mississippi River Basin) and its 1% annual chance floodplain. During the site visit on 07-June-2011, stagnate ponded water was observed in both the wetland and in the drain. Standing water was on both sides of the 4' CMP under County Hwy M. The culvert is buried about 1.5' and had ponded water in it. A predominant direction of flow could not be determined. NRCS: Note that from the 1 m contour maps, the basin divide appears to be to the NW of Highway M. Is there an indication of a channel through this area (the wetland area at the basin divide)? I was not able to distinguish one on Google Earth imagery. To me this indicates that the Rating should be "Medium" in order to be more consistent with the other sites.

Rosendale-Brandon, Fond du Lac County, WI - Ruffe (*Gymnochephalus cernuus*) / Tubenose Goby (*Proterorhinus semilunaris*)

2. Probability of ANS occurring within either basin

Aquatic Pathway Team	Expertise Position title or team role	Rating	Certainty		
	USACE, St. Paul	High	RC		
	USACE, Detroit	High	RC		
	Wisconsin DNR, Fisheries	Low	VC		
	Team Rating	**High**	**RC/VC**		

2. How do you rate the probability of ANS occuring within either basin?

Qualitative Rating	Qualitative Rating Category Criteria
High	Target ANS exists on connected waterways in close enough proximity to be capable of migrating to the aquatic pathway within 20 years.
Medium	Target ANS exists on connected waterways, but based on current proximity and mobility, is considered incapable of migrating to the aquatic pathway within 20 years.
Low	Target ANS is not known to exist on a connected waterway.

	Symbol	
Very Certain	VC	As certain as I am going to get.
Reasonably Certain	RC	Reasonably certain.
Moderately Certain	MC	More certain than not.
Reasonably Uncertain	RU	Reasonably uncertain
Very Uncertain	VU	A guess

Remarks: The ruffe and tubenose goby are located within the Great Lakes and associated with river mouths and estuaries of large river systems entering the Great Lakes. The ruffe prefers deep waters of lakes and pools of rivers, usually over sand and gravels but has a tolerance for different habitats and environmental conditions (Gray and Best, 1989). The ruffe has a high fecundity rate and spawns in clean water. The ruffe's ability to swim upstream during high flow events and migrate over dams is questionable. The ruffe has been identified within Lake Michigan but so far found in a very limited area of Lake Michigan, near Escanaba, MI, and has shown little propensity to spread. It also has not moved far up tributary streams. The ruffe is an aggressive species that possesses the ability to feed in darkness, cold temperatures and turbid conditions. The fish has extended its range, in some cases, rapidly and modeling predicts it will find suitable habitat in all five Great Lakes. The tubenose goby's introduced range covers three Great Lakes including Lake Superior, Erie and Huron . It has been collected in the lower reaches of larger Great Lakes rivers and estuaries. The tubenose goby is found in the open waters and estuaries of slow flowing rivers. Tubenose gobies are benthic species that consume a wide variety of invertebrates (USGS, 2009a). They are often quite abundant in backwaters and lakes and seem prefer dense vegetation. Tubenose gobies have exhibited a much slower rate of expansion in the Great Lakes than the round goby, also an invasive species in the Great Lakes and now located within both the GLB and the MRB. The WDNR indicates the likelihood of either fish passing along the Lake Michigan shoreline and up the Fox River seems slim at best, however, this has more to do with the rating of the next element on Form 3 than whether or not the species exists within connecting waterways (e.g. Lake Michigan).

Rosendale-Brandon, Fond du Lac County, WI - Ruffe (*Gymnochephalus cernuus*) / Tubenose Goby (*Proterorhinus semilunaris*)

3. Probability of ANS surviving transit to aquatic pathway

Aquatic Pathway Team	Expertise Position title or team role	3A Rating	Certainty	3B Rating	Certainty
	USACE, St. Paul	Low/Med	RC	Low	RC
	USACE, Detroit	Low/Med	RC	Low	RC
	Wisconsin DNR, Fisheries	Low/Med	RC	Low	RC
	Team Ratings	**Low/Med**	**RC**	**Low**	**RC**

3A. How do you rate the probability of ANS surviving transit to aquatic pathway through connecting streams?

3B. How do you rate the probability of ANS surviving transit to aquatic pathway through other means?

Qualitative Rating	Qualitative Rating Category Criteria
High	Target ANS are established in relatively close proximity to location and have ample opportunity, capability and motivation to successfully navigate through the aquatic pathway and/or through other means to arrive at the subject pathway within 10-20 years.
Medium	Target ANS are established at locations in close enough proximity to location and have limited capability to survive migration through the aquatic pathway or through other means to arrive at the subject pathway within 20-50 years.
Low	Target ANS are not in proximity to the pathway, and/or it is highly unlikely that they could survive transit from current locations by aquatic pathway or other means to arrive at subject pathway within next 50 years.

	Symbol	
Very Certain	VC	As certain as I am going to get.
Reasonably Certain	RC	Reasonably certain.
Moderately Certain	MC	More certain than not.
Reasonably Uncertain	RU	Reasonably uncertain
Very Uncertain	VU	A guess

Remarks: 3A. Probability of ANS Surviving Transit to Aquatic Pathway Through Connecting Streams.

3A.The distance from Lake Michigan to the watershed divide is approximately 65 miles. From Lake Winnebago to the watershed divide at Rosendale-Brandon along Fond du Lac River and West Branch Fond du Lac River is about 20-30 miles. The Lower Fox River, connecting Lake Winnebago and Green Bay, is 39 miles long. The Wisconsin DNR Surface water data viewer shows that the unnamed tributary stream, which originates at the north end of a 1.5 mile long forested and emergent wetland complex (T15N, R15E, Section 7), contains open water bodies identified as ponds on the USGS Quadrangle. The Fond du Lac River at USGS gage 04083545 is located approximately 25 miles downstream of the divide in Fond du Lac, WI. The gage shows the average river discharge varies from about 450 cfs in March to about 10 cfs low flow in November. The extensive emergent and forested wetland complex at the divide is considered a major restriction to fish passage. Therefore, it is considered highly unlikely that ruffe/tubenose goby could transfer through this pathway by natural means. If ruffe/tubenose goby arrived at the emergent wetland divide or the ponds during the spring, it is still considered unlikely the fish would cross the emergent wetland complex and the basin divide. The life histories of these two fish and the impediment that the wetland divide provides is the primary basis for the assignment of the low rating to the probability ruffe/tubenose goby could survive transit solely through the aquatic pathway to the basin divide at this location. Neither ruffe nor tubenose gobies have been collected in the United States in similar upstream tributary river habitat. The life history of these ANS species, the nature of the wetland divide, an impassable dam and sealed navigation lock at Rapid Croche on the Fox River keep these ANS from entering the Lake Winnebago system and having access to the Fond du Lac River, thus the low rating.

Remarks: 3B. Probability of ANS Surviving Transit to Aquatic Pathway Through Other Means

3B. There is no evidence or information to suggest the emergent wetland located at the basin divide are recreational areas used by fishermen or boaters, so there appears to be a low probability for ANS to be transported to the proximity of the basin divide at this location by anthropogenic means. The ruffe/tubenose goby are listed among the "established nonnative fish species" (see WI NR 40.02(17)), which is one of four groups of "restricted" non-native fish species. Fish species in this restricted group may not be possessed, transported, transferred, or introduced without a permit from the DNR. The ruffe/tubenose goby are not normally used as live bait for river fishing or aquarium species. Further, in the unlikely event ruffe/tubenose goby were introduced into the wetlands at the divide, the aquatic habitat is considered marginally suitable for survival for at least the late summer during most years when water temperatures in the small water body become elevated and dissolved oxygen content in the water diminishes. The 1.5 mile distance at the divide between the ditches is considered a substantial obstacle for crossing the divide by ruffe/tubenose goby. Even if the ruffe/tubenose goby were introduced during the spring of the year to the basin divide, and a sufficiently large storm event occured to form an aquatic pathway spanning the divide later that same spring, the likelihood of fish migrating through the emergent wetland complex to the MRB is considered low. These considerations were the primary basis for the assignment of a low rating to the probability ANS will survive transit to the aquatic pathway by other means and the reasonable certainty assigned to the rating.

Rosendale-Brandon, Fond du Lac County, WI - Ruffe (*Gymnochephalus cernuus*) / Tubenose Goby (*Proterorhinus semilunaris*)

4. Probability of ANS establishing in proximity to the aquatic pathway

Aquatic Pathway Team	Expertise Position title or team role	Rating	Certainty		
	USACE, St. Paul	Low	RC		
	USACE, Detroit	Low	RC		
	Wisconsin DNR, Fisheries	Low	RC		
	Team Ratings	**Low**	**RC**		

4. How do you rate the probability of ANS establishing in proximity to the aquatic pathway?

Qualitative Rating	Qualitative Rating Category Criteria
High	Sources of food and habitat suitable to the ANS are plentiful in close proximity to support all life stages from birth to adult, abiotic conditions align with native range and there are no known predators or conditions that would significantly impede survivability or reproduction.
Medium	Limited and disconnected areas and sources of food and habitat suitable to the ANS are available in proximity, abiotic conditions are within latitude limits of native range, but only a portion of the healthy individuals arriving at location can be expected to effectively compete and survive.
Low	Habitat and abiotic conditions in proximity are outside the range where ANS has been known to survive; there is very limited availability habitat area suitable for ANS cover, sustainable food supply and reproduction; or native predators or competition with native species would likely prevent establishment of a sustainable population.

	Symbol	
Very Certain	VC	As certain as I am going to get.
Reasonably Certain	RC	Reasonably certain.
Moderately Certain	MC	More certain than not.
Reasonably Uncertain	RU	Reasonably uncertain
Very Uncertain	VU	A guess

Remarks: Survival of a viable, reproducing population of ruffe and tubenose goby within the emergent wetland at the divide is unlikely due low water quality and high temperatures in summer months. The ability of either species to migrate across a flooded, emergent wetland complex and through farm/roadside ditches is considered low. These considerations were the primary basis for the low rating assigned to the probability that ruffe/tubenose goby could become established in close proximity to the basin divide and the reasonable certainty assigned to the rating.

Rosendale-Brandon, Fond du Lac County, WI - Ruffe (*Gymnochephalus cernuus*) / Tubenose Goby (*Proterorhinus semilunaris*)

5. Probability of ANS spreading across aquatic pathway into the new basin

Aquatic Pathway Team	Expertise Position title or team role	Rating	Certainty		
	USACE, St. Paul	Medium	RC		
	USACE, Detroit	Medium	MC		
	Wisconsin DNR, Fisheries	Low	RC		
	Team Ratings	**Low/Med**	**MC/RC**		

5. How do you rate the probability of ANS spreading across aquatic pathway into the new basin?

Qualitative Rating	Qualitative Rating Category Criteria
High	Sources of food and habitat suitable to the ANS are available, and the species has demonstrated capabilities to significantly expand range from locations where initially introduced.
Medium	There are limited sources of food and suitable habitat, and/or the species has demonstrated limited ability to spread significant distances beyond areas where it has been introduced.
Low	There are severely limited sources of food and suitable habitat, and/or the species has demonstrated very limited ability to spread beyond areas where it has been introduced.

	Symbol	
Very Certain	VC	As certain as I am going to get.
Reasonably Certain	RC	Reasonably certain.
Moderately Certain	MC	More certain than not.
Reasonably Uncertain	RU	Reasonably uncertain
Very Uncertain	VU	A guess

Remarks: If the fish were somehow able to arrive and establish at the pathway or were somehow introduced adjacent to the divide during a spring runoff event, the fish would likely survive and could move along established roadside ditches and waterways to the MRB.

Rosendale-Brandon, Fond du Lac County, WI - Threespine Stickleback (*Gasterosteus aculeatus*)

1. Probability of aquatic pathway existence

Aquatic Pathway Team	Expertise Position title or team role	Rating Flow into GLB	Certainty	Rating Flow into MRB	Certainty
	USACE, Detroit - Hydraulic Engineer	Medium	MC	Medium	MC
	USACE, Rock Island - Hydraulic Engineer	Medium	MC	Medium	MC
	NRCS - Hydraulic Engineer	Medium	MC	Medium	MC
	Team Ratings	**Medium**	**MC**	**Medium**	**MC**

1. How do you rate the likelihood of the existence of a viable aquatic pathway at the subject location? Assume a viable aquatic pathway is any location where untreated surface water flow across the divide is deemed likely to occur and connect headwater streams in both basins from any storm up to the 1% annual return frequency storm.

Qualitative Rating	Qualitative Rating Category Criteria
High	Perennial streams and wetlands or intermittent stream known/documented to convey significant volumes of water across the basin divide for days to weeks multiple times per year.
Medium	Intermittent stream capable of maintaining a surface water connection to streams on both sides of the basin divide continuously for multiple days from a 10% annual return frequency storm; or, location of wetland spanning basin divide which maintains significant ponds that are likely to become inter connected and connect with streams on both sides of the basin divide from a 10% annual return frequency storm.
Low	Intermittent stream or marsh forming a surface water connection between streams on either side of the basin divide from larger than a 1.0% annual return frequency storm.

	Symbol	
Very Certain	VC	As certain as I am going to get.
Reasonably Certain	RC	Reasonably certain.
Moderately Certain	MC	More certain than not.
Reasonably Uncertain	RU	Reasonably uncertain
Very Uncertain	VU	A guess

Remarks: Tule: Fond du Lac County FIS mapping from 2009 shows that the 1% annual chance floodplain for the tributary of the West Branch Fond du Lac River (Great Lakes Basin) covers the entire wetland at the headwaters of the tributary and ends at County Hwy M. The basin divide is located in the wetland just northwest of County Hwy M. Aerial photographs, show that there is a drain that connects the wetland to the tributary of the West Branch Rock River (Mississippi River Basin) and its 1% annual chance floodplain. During the site visit on 07-June-2011, stagnate ponded water was observed in both the wetland and in the drain. Standing water was on both sides of the 4' CMP under County Hwy M. The culvert is buried about 1.5' and had ponded water in it. A predominant direction of flow could not be determined. NRCS: Note that from the 1 m contour maps, the basin divide appears to be to the NW of Highway M. Is there an indication of a channel through this area (the wetland area at the basin divide)? I was not able to distinguish one on Google Earth imagery. To me this indicates that the Rating should be "Medium" in order to be more consistent with the other sites.

Rosendale-Brandon, Fond du Lac County, WI - Threespine Stickleback (*Gasterosteus aculeatus*)

2. Probability of ANS occurring within either basin

Aquatic Pathway Team	Expertise Position title or team role	Rating	Certainty		
	USACE, St. Paul	High	RC		
	USACE, Detroit	High	RC		
	Wisconsin DNR, Fisheries	Medium	RC		
	Team Rating	**Med/High**	**RC**		

2. How do you rate the probability of ANS occuring within either basin?

Qualitative Rating	Qualitative Rating Category Criteria
High	Target ANS exists on connected waterways in close enough proximity to be capable of migrating to the aquatic pathway within 20 years.
Medium	Target ANS exists on connected waterways, but based on current proximity and mobility, is considered incapable of migrating to the aquatic pathway within 20 years.
Low	Target ANS is not known to exist on a connected waterway.

	Symbol	
Very Certain	VC	As certain as I am going to get.
Reasonably Certain	RC	Reasonably certain.
Moderately Certain	MC	More certain than not.
Reasonably Uncertain	RU	Reasonably uncertain
Very Uncertain	VU	A guess

Remarks: The threespine stickleback (Gasterosteus aculeatus) is found in each of the Great Lakes and has been collected in some inland river systems (USGS 2009a). While not having been identified within the West Branch Fond du Lac River, its close proximity indicate potential for access and transfer to the Mississippi River Basin via connecting rivers. Literature indicates this species prefers to live in the backwaters of smaller streams but also occur in a variety of habitat including lakes and large rivers and occupies a more varied habitat than the brook stickleback (Wootton, 1976). The WDNR notes that although threespine stickleback move into the lower Fox River during spring spawning, the Lake Michigan populations seem to be potadromous lake dwellers that to date have demonstrated little propensity to permanently occupy stream habitats. Moreover, the great distance (> 100 miles) and dams between the lower Fox and Rosendale make fish access and colonization unlikely and thus the lower rating by the WDNR. However, this has more to do with the stickleback's probability of surviving transit to the pathway than whether or not they currently existin within connecting streams/waters.

Rosendale-Brandon, Fond du Lac County, WI - Threespine Stickleback (*Gasterosteus aculeatus*)

3. Probability of ANS surviving transit to aquatic pathway

Aquatic Pathway Team	Expertise Position title or team role	3A Rating	Certainty	3B Rating	Certainty
	USACE, St. Paul	Low	RC	Low	RC
	USACE, Detroit	Low	RC	Low	RC
	Wisconsin DNR, Fisheries	Low	VC	Low	RC
	Team Ratings	**Low**	**RC/VC**	**Low**	**RC**

3A. How do you rate the probability of ANS surviving transit to aquatic pathway through connecting streams?

3B. How do you rate the probability of ANS surviving transit to aquatic pathway through other means?

Qualitative Rating	Qualitative Rating Category Criteria
High	Target ANS are established in relatively close proximity to location and have ample opportunity, capability and motivation to successfully navigate through the aquatic pathway and/or through other means to arrive at the subject pathway within 10-20 years.
Medium	Target ANS are established at locations in close enough proximity to location and have limited capability to survive migration through the aquatic pathway or through other means to arrive at the subject pathway within 20-50 years.
Low	Target ANS are not in proximity to the pathway, and/or it is highly unlikely that they could survive transit from current locations by aquatic pathway or other means to arrive at subject pathway within next 50 years.

	Symbol	
Very Certain	VC	As certain as I am going to get.
Reasonably Certain	RC	Reasonably certain.
Moderately Certain	MC	More certain than not.
Reasonably Uncertain	RU	Reasonably uncertain
Very Uncertain	VU	A guess

Remarks: 3A. Probability of ANS Surviving Transit to Aquatic Pathway Through Connecting Streams.

3A.The distance from Lake Michigan to the watershed divide is approximately 65 miles. From Lake Winnebago to the watershed divide at Rosendale-Brandon along Fond du Lac River and West Branch Fond du Lac River is about 20-30 miles. The Lower Fox River, connecting Lake Winnebago and Green Bay, is 39 miles long. The Wisconsin DNR Surface water data viewer shows that the unnamed tributary stream, which originates at the north end of a 1.5 mile long forested and emergent wetland complex serving as the watershed divide (T15N, R15E, Section 7), contains open water bodies on the USGS Quadrangle. The Fond du Lac River at USGS gage 04083545 is located approximately 25 miles downstream of the divide in Fond du Lac, WI. The gage shows the average river discharge varies from about 450 cfs in March to about 10 cfs low flow in November. The Rapid Croche lock and dam and Eldorado Marsh dam are also considered obstacles to any ANS migration. The extensive emergent and forested wetland complex at the divide is considered a major obstruction to fish passage. Therefore, it is considered highly unlikely that threespine stickleback could transfer through this pathway by natural means. If threespine stickleback arrived at the emergent wetland divide during the spring, it is still considered unlikely the fish would cross the emergent wetland complex and the basin divide. The life histories of these fish and the impediment that the wetland divide provides is the primary basis for the assignment of the low rating to the probability the threespine stickleback could survive transit solely through the aquatic pathway to the basin divide at this location and the certainty of the rating. Threespine stickleback have been collected in the United States in river habitat.

Remarks: 3B. Probability of ANS Surviving Transit to Aquatic Pathway Through Other Means

3B. There is no evidence or information to suggest the emergent wetland located at the basin divide are recreational areas used by fishermen or boaters, so there appears to be a low probability for ANS to be transported to the proximity of the basin divide at this location by anthropogenic means. It is believed that bait-bucket transport has aided in the movement of the threespine stickleback in the past. The threespine stickleback are listed among the "established nonnative fish species" (see WI NR 40.02(17)), which is one of four groups of "restricted" non-native fish species. Fish species in this restricted group may not be possessed, transported, transferred, or introduced without a permit from the DNR. Further, in the unlikely event threespine stickleback were introduced into the open waters or wetlands at the divide, the aquatic habitat is considered marginally suitable for survival for at least the late summer during most years when water temperatures in the small water body become elevated and dissolved oxygen content in the water diminishes. The 1.5 mile distance at the divide between the ditches is considered a substantial obstacle for crossing the divide. Even if the threespine stickleback were introduced during the spring of the year to the basin divide, and a sufficiently large storm event occurs to form an aquatic pathway spanning the divide later that same spring, the likelihood of these fish migrating through the emergent wetland complex to the MRB is considered low. These considerations were the primary basis for the assignment of a low rating to the probability ANS will survive transit to the aquatic pathway by other means and the reasonable certainty assigned to the rating.

Rosendale-Brandon, Fond du Lac County, WI - Threespine Stickleback (*Gasterosteus aculeatus*)

4. Probability of ANS establishing in proximity to the aquatic pathway

Aquatic Pathway Team	Expertise Position title or team role	Rating	Certainty		
	USACE, St. Paul	Low	RC		
	USACE, Detroit	Low	RC		
	Wisconsin DNR, Fisheries	Low	VC		
	Team Ratings	**Low**	**RC**		

4. How do you rate the probability of ANS establishing in proximity to the aquatic pathway?

Qualitative Rating	Qualitative Rating Category Criteria
High	Sources of food and habitat suitable to the ANS are plentiful in close proximity to support all life stages from birth to adult, abiotic conditions align with native range and there are no known predators or conditions that would significantly impede survivability or reproduction.
Medium	Limited and disconnected areas and sources of food and habitat suitable to the ANS are available in proximity, abiotic conditions are within latitude limits of native range, but only a portion of the healthy individuals arriving at location can be expected to effectively compete and survive.
Low	Habitat and abiotic conditions in proximity are outside the range where ANS has been known to survive; there is very limited availability habitat area suitable for ANS cover, sustainable food supply and reproduction; or native predators or competition with native species would likely prevent establishment of a sustainable population.

	Symbol	
Very Certain	VC	As certain as I am going to get.
Reasonably Certain	RC	Reasonably certain.
Moderately Certain	MC	More certain than not.
Reasonably Uncertain	RU	Reasonably uncertain
Very Uncertain	VU	A guess

Remarks: Survival of a viable, reproducing population of threespine stickleback within the emergent wetland at the divide is unlikely due low water quality and high temperatures in summer months. The ability of threespine stickleback to migrate across a flooded, emergent wetland complex and through farm/roadside ditches is considered low. These considerations were the primary basis for the low rating assigned to the probability that threespinse stickleback could become established in close proximity to the basin divide and the reasonable certainty assigned to the rating.

Rosendale-Brandon, Fond du Lac County, WI - Threespine Stickleback (*Gasterosteus aculeatus*)

5. Probability of ANS spreading across aquatic pathway into the new basin

Aquatic Pathway Team	Expertise Position title or team role	Rating	Certainty		
	USACE, St. Paul	Medium	RC		
	USACE, Detroit	Medium	RC		
	Wisconsin DNR, Fisheries	Low	RC		
	Team Ratings	**Low/Med**	**RC**		

5. How do you rate the probability of ANS spreading across aquatic pathway into the new basin?

Qualitative Rating	Qualitative Rating Category Criteria
High	Sources of food and habitat suitable to the ANS are available, and the species has demonstrated capabilities to significantly expand range from locations where initially introduced.
Medium	There are limited sources of food and suitable habitat, and/or the species has demonstrated limited ability to spread significant distances beyond areas where it has been introduced.
Low	There are severely limited sources of food and suitable habitat, and/or the species has demonstrated very limited ability to spread beyond areas where it has been introduced.

	Symbol	
Very Certain	VC	As certain as I am going to get.
Reasonably Certain	RC	Reasonably certain.
Moderately Certain	MC	More certain than not.
Reasonably Uncertain	RU	Reasonably uncertain
Very Uncertain	VU	A guess

Remarks: If the fish were somehow introduced at the basin divide during a spring runoff event, the fish would likely survive and could move along established roadside ditches and waterways to the MRB. This is the primary information that supported the assignment of a medium rating to the probability that threespine stickleback could cross the aquatic pathway to the MRB.