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

Portage Downstream and Canal, Wisconsin

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Executive Summary

This assessment characterizes the probability of Aquatic Nuisance Species (ANS) spreading between the Great Lakes and Mississippi Rivers Basins through two potential aquatic pathways located downstream of Portage, Wisconsin. This was accomplished by evaluating the hydrologic and hydraulic characteristics of the sites based on readily available information, and conducting a species-specific assessment of the abilities of potential ANS to arrive at the pathways and cross into the adjacent basin. The Portage area has historically been an area with a high potential for interbasin exchange of water. Early settlers recognized this and actually established a navigable waterway and lock and dam system between the Fox and Wisconsin Rivers.

Portage Downstream was identified as having a medium probability of an aquatic pathway existing. A hydrologic connection exists for floods slightly greater than a ten percent annual recurrence interval event. Significant rates of flow can occur at this location from the Mississippi River Basin to the Great Lakes Basin during larger flood events (870 cubic feet per second (cfs) (24.6 cubic meters per second(cms)) at the two percent annual recurrence interval event). Since 1935, eight floods on the Wisconsin River have exceeded the ten percent annual recurrence interval flow event at this location. On average, flows that could have passed through the divide into the Great Lakes Basin lasted about three days for each event, and ranged from one to six days.

The Portage Canal has also been included in this evaluation as a potential pathway due to field observations by the pathway assessment team. There is no surface water connection to the canal from the Mississippi River Basin, but there are water supply pipes and a control structure intended to supply fresh water to the canal from the Wisconsin River. The canal does not currently pose a potential for transport of ANS between the basins, assuming that the water supply pipes are in fact buried in the bed of the Wisconsin River and the sluice gate on the control structure remains closed. The condition of the supply pipes is unknown and may warrant further investigation.

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 (VHSv)
Apocorophium lacustre	a Scud
Landoltia (Spirodela) punctata	Dotted Duckweed
Murdannia keisak	Marsh Dewflower
Oxycaryum cubense	Cuban Bulrush

After establishing where aquatic connections exist or may form, the aquatic pathway viability for specific ANS of concern was then evaluated by looking at the biological requirements and capabilities of the 13 ANS listed in the table above.

The divide location at Portage Downstream occurs well downstream of the headwaters of the Wisconsin River and where it carries a large amount of flow (base flow of about 5,000 cfs (142 cms). This presents a unique opportunity for any ANS established upstream of this pathway to be passively carried over the basin divide during flood events. Aquatic habitats upstream of this pathway on the Wisconsin River are high in diversity and quality, providing an opportunity for most ANS to find suitable habitat to colonize and act as a continuous source population to possibly take advantage of intermittent flood events. However, the Prairie du Sac Dam, which is located downstream on the Wisconsin River, currently functions as a permanent barrier to upstream movement of ANS and none of the ANS that are established in the Mississippi River Basin are currently known to exist upstream of the Prairie du Sac Dam or the Portage Upstream pathway (see separate report). Thus, the probability of a viable aquatic pathway

that would enable transfer of ANS across the divide at this site from the Mississippi River Basin to the Great Lakes Basin has been rated “low”. If one or more of these species were to become established upstream of this dam in the future, this rating would increase.

There was only one ANS that recieved a rating greater than "low". Viral hemorrhagic septicemia virus (VHSv), which is currently established in the Great Lakes Basin, was rated as having a “medium” likelihood of transfer across the basin divide into the Mississippi River Basin. Thus, it was determined that there is a “medium” overall aquatic pathway rating at the Portage Downstream location, and only toward the Mississippi River Basin. Any potential for ANS to reach this basin divide location by non-aquatic vectors is a separate pathway that did not factor into the overall rating of this site.

There are three main data gaps that exist at this location. First is a lack of detailed topography at the divide. Detailed topographical data would enable one to identify the presence or absence of a defined channel during flood events and the depth of open water habitats. This would help determine the ability of fish to swim through this area or survive in the limited open-water areas on the divide. Second, a lack of a continuous monitoring program in the large upstream area of the Wisconsin River. A monitoring program would provide more detailed information to help determine the presence or absence of ANS upstream of the Portage location, and the areas upstream of the Prairie du Sac Dam on the Wisconsin River. This would, however, be an extremely difficult task to perform and would likely be expensive to conduct. Third, a lack of information regarding the condition of the inlet supply pipes for the Portage Canal. An inspection of the pipes would help determine the likelihood that ANS could pass through them.

The most notable opportunity here for reducing the potential for ANS transfer at this site would be the construction of a physical barrier by closing the interbasin flow structure and raising the Portage levee, or by constructing a separate physical barrier to prevent flow across the divide.

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Acronyms

ANS . . . . . Aquatic Nuisance Species
ANSTF. . . . Aquatic Nuisance Species Task Force
BFE . . . . . Base Flood Elevation
CAWS . . . . Chicago Area Waterway System
CEQ. . . . . Council on Environmental Quality
DEM. . . . . Digital Elevation Model
FEMA. . . . . Federal Emergency Management Agency
FIS. . . . . Flood Insurance Study
FRM. . . . . Flood Risk Management
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
RCP. . . . . Reinforced Concrete Pipe
SWLA. . . . . Swan Lake Wildlife Area
USACE . . . U.S. Army Corps of Engineers
USFWS . . . U.S. Fish and Wildlife Service
USGS . . . . U.S. Geological Survey
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 Portage Downstream and Portage Canal location, in Columbia County, Wisconsin. 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 between the Great Lakes and Mississippi River Basins other than 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 kilometer) 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 Portage Downstream, Wisconsin location is shown as location 10 in south-central Wisconsin.

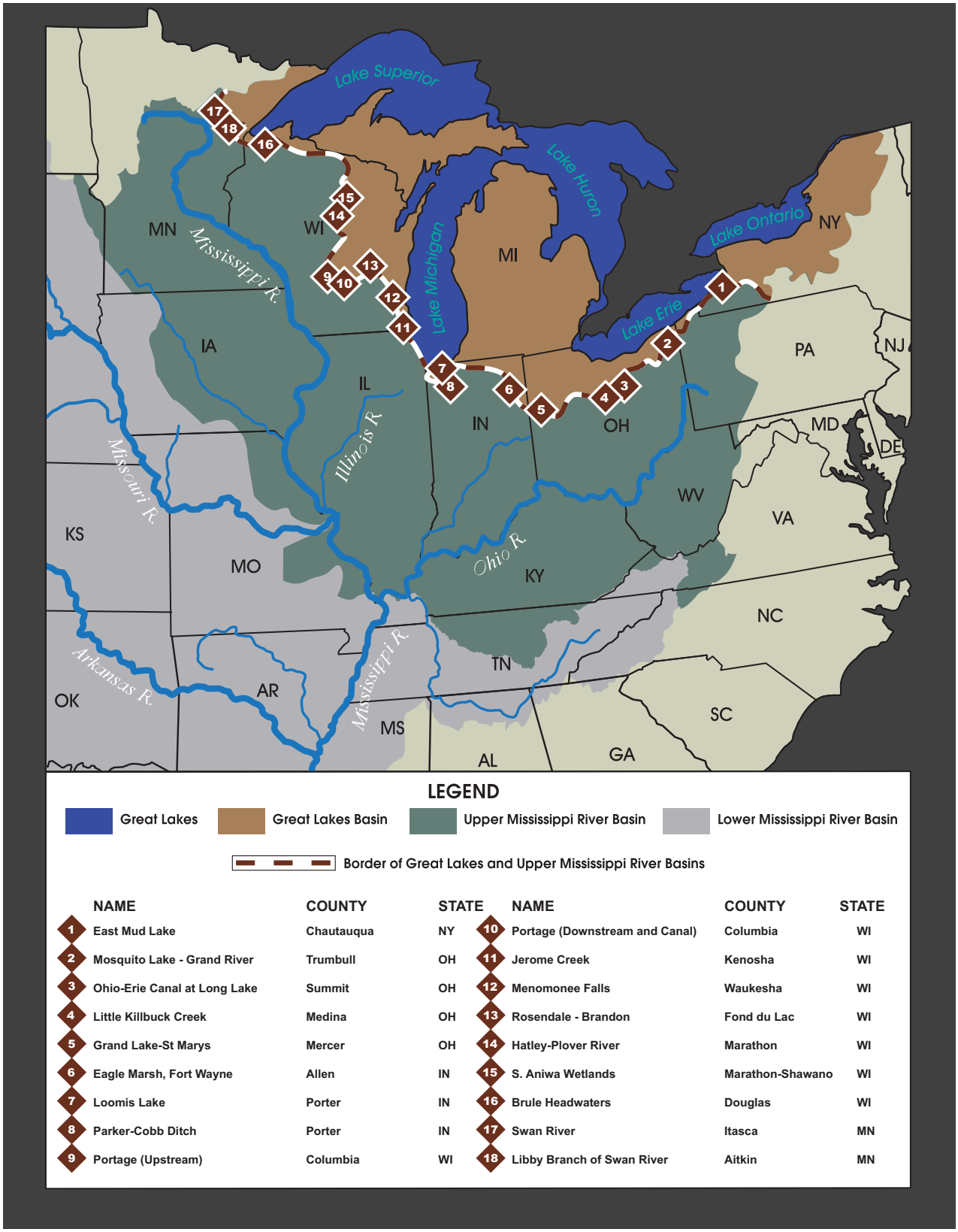
The GLMRIS is a very large and complicated task involving multiple USACE Districts and Divisions. Program Management of the study is conducted by the Great Lakes and Ohio River Division. The study considers several aquatic nuisance species (ANS) of concern, however, the proximity of Asian carp in the 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 interim GLMRIS report is the next step in a tiered approach to assess the risk associated with the spread of ANS between the Great Lakes and Mississippi River Basins, 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 that a viable aquatic pathway exists at the Portage Downstream and Portage Canal, Wisconsin 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 (USACE, 2011a) by including the following:

- A definitive determination of whether the Portage Downstream and Portage Canal



	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).

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 between the Great Lakes and the Mississippi River basins;

- A standalone report that characterizes the probability of aquatic pathway formation and the probability of interbasin spread of applicable ANS via the potential aquatic pathway at the Portage Downstream and Portage Canal location;

- 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 Portage Downstream and Portage Canal 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 Portage Downstream and Portage Canal location.

1.2 Summary of 2010 Preliminary Risk Characterization for Portage Downstream and Portage Canal, WI.

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 Portage Canal was built by the USACE between

1838 and 1876, and it connects the Wisconsin River in the Mississippi River Basin with the Fox River in the Lake Michigan drainage basin. Canal operations ceased in 1951, and the ownership was transferred to the state of Wisconsin. The Portage Canal is on the National and State Registers of Historic Places, and the Wisconsin DNR has managed the property since 1981. Although the preliminary risk characterization did not identify the Portage Downstream 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 interbasin flow, the connection of inundated areas of the Fox and Wisconsin Rivers in hydrologic modeling at the one percent recurrence interval flood event, and the 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 Portage Downstream and Canal.

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 interval 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.

The preliminary effort 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. That collaboration resulted in the following actions being taken in support of this current report:

- Federal, State, and local stakeholders (i.e. USGS Water Science Center, WDNR Division of Water, County Officials, and or 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 Portage Canal was added to this analysis as a result of these discussions with local stakeholders.

- The dams on the connecting streams to the Great Lakes and the 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 USACE, USGS, NRCS, and WDNR. The results also reflect the guidance, input, review comments, and concurrence of the multi-organization Agency Technical Review of experts from USACE, USGS, NRCS, and USFWS.

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 are Portage Downstream and Canal location 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 Portage Downstream Location

The Portage Downstream 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 Portage Downstream 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 Portage Downstream 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 Portage Downstream 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.

There have been two known occurrences of ANS within a 25 mile (40 km) radius of the Portage Downstream location. These were two separate collections of bighead carp below the Prairie du Sac Dam on the Wisconsin River, about 25 miles (40 km) downstream from Portage. The nearest occurrence of ANS from the Great Lakes Basin side of the divide is that of viral hemorrhagic septicemia virus (VHSv) in the Lake Winnebago system about 50 miles (80.5 km) northeast of Portage.

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 VHSv, 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). Viral hemorrhagic septicemia virus is known to occur in the Lake Winnebago system, which is in the Great Lakes Basin (Kipp and Ricciardi, 2010). Because of this, it was determined that VHSv would be considered a concern for passage over this divide location into the Mississippi River Basin.

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. The Portage site is located at the headwaters of a drainage basin on the Great Lakes Basin side of the divide. However, it is located along a major river on the Mississippi River Basin side. This results in the opportunity for ANS to be transported over this divide location by floodwaters of the Wisconsin River from the Mississippi River Basin to the Great Lakes Basin. As a result, even species without self-propelled mobility, such as plants and invertebrates, can be transported from the Mississippi River Basin to the Great Lakes Basin. Species that occur on the Great Lakes Basin side of the divide must possess either: self-propelled mobility or the ability to “hitchhike” on other organisms to travel upstream and over the divide into the Mississippi River Basin. This eliminates organisms on the Great Lakes Basin side that rely on current for dispersal such as plants, and most invertebrates. The parasitic copepod (Neoergasilus japonicas) was removed from consideration at this site because it is not yet reported from Lake Michigan or Lake Superior and the likelihood of it arriving at this pathway location seems too low.

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

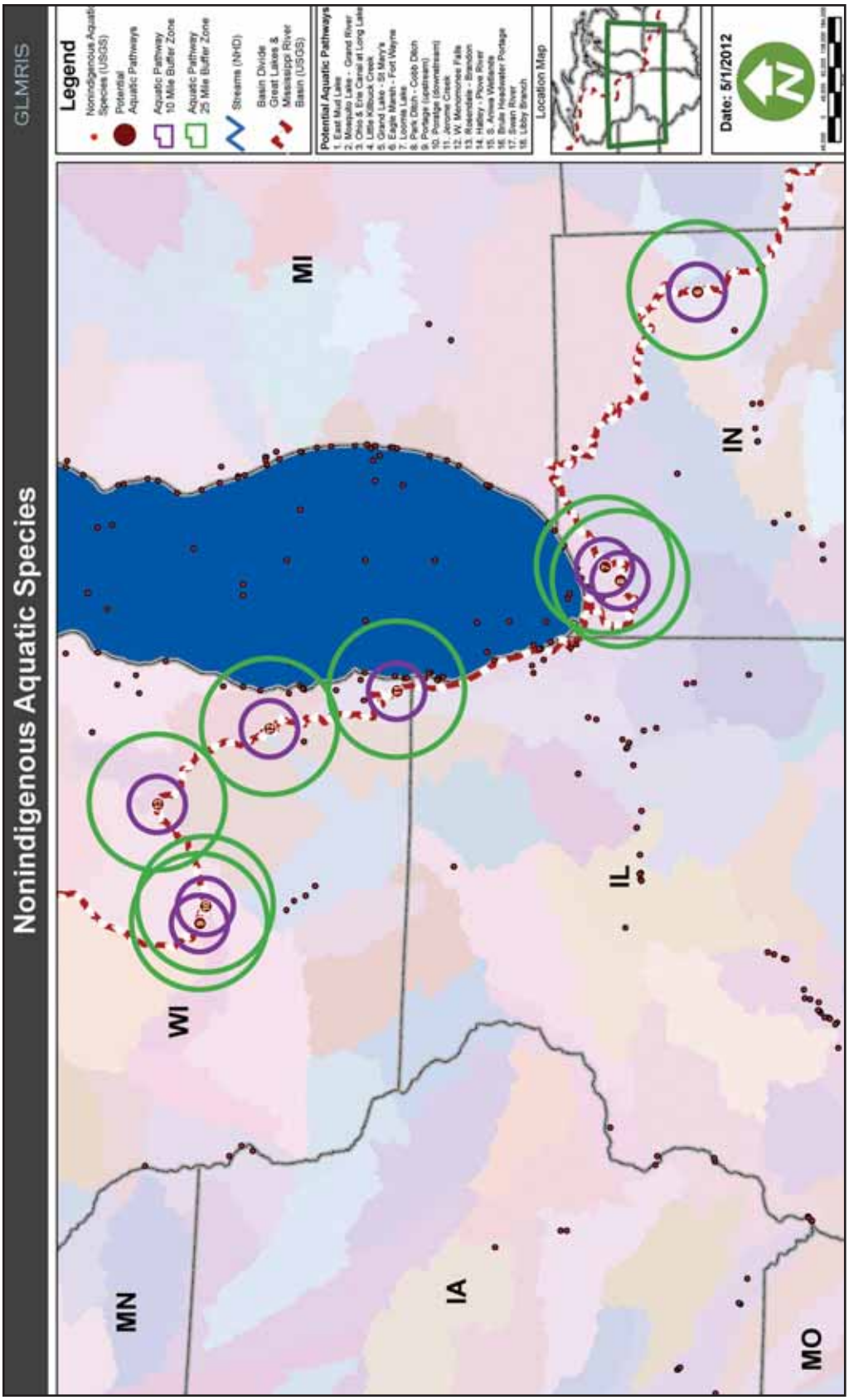


Figure 2. Map of ANS occurrence near Lake Michigan. Presence of bighead carp at Prairie du Sac dam is not shown (USGS, 2011).

No fishing or boating occurs directly within the wetlands in the divide location, which eliminates the threat of ANS transfer via water craft, associated equipment, or fishing gear. Dumping of ANS (discarded aquarium pets, religious ceremonies, etc.) within these wetlands is considered possible but unlikely because there would be more easily accessed and suitable habitat for such releases. Additionally, dumping of exotic pets is just as likely to occur in either basin or elsewhere along the basin divide. 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 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. In addition, the intestinal tract of warm-blooded animals inactivates the VHSv 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).

Based on the evaluation by subgroups, only fish and parasites of fish were considered to have the requisite means of reaching the divide location from the Great Lakes Basin. Additionally, plants and an invertebrate were considered a risk for transfer by floodwaters from the Mississippi River Basin to the Great Lakes Basin. In total, eight fish, three plants, a crustacean, and one virus were identified as species of concern for the Portage Downstream site (Table 4). These were chosen based on their relative proximity to the site, history of invasiveness, and physical capabilities to utilize this aquatic pathway within the next 20 years.

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

Table 4: Species of Greatest Concern for Transfer at Portage Downstream.

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	*Viral Hemorrhagic Septicemia virus*	VHSv	GL	pathogen to fish /water column
crustacean	*Apocorophium lacustre*	a scud	MS	ballast water
plant	*Landoltia (Spirodela) punctata*	dotted duckweed	MS	recreational boats & trailers
plant	*Murdannia keisak*	marsh dewflower	MS	recreational boats & trailers
plant	*Oxycaryum cubense*	Cuban bulrush	MS	recreational boats & trailers

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 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 Portage Downstream 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.

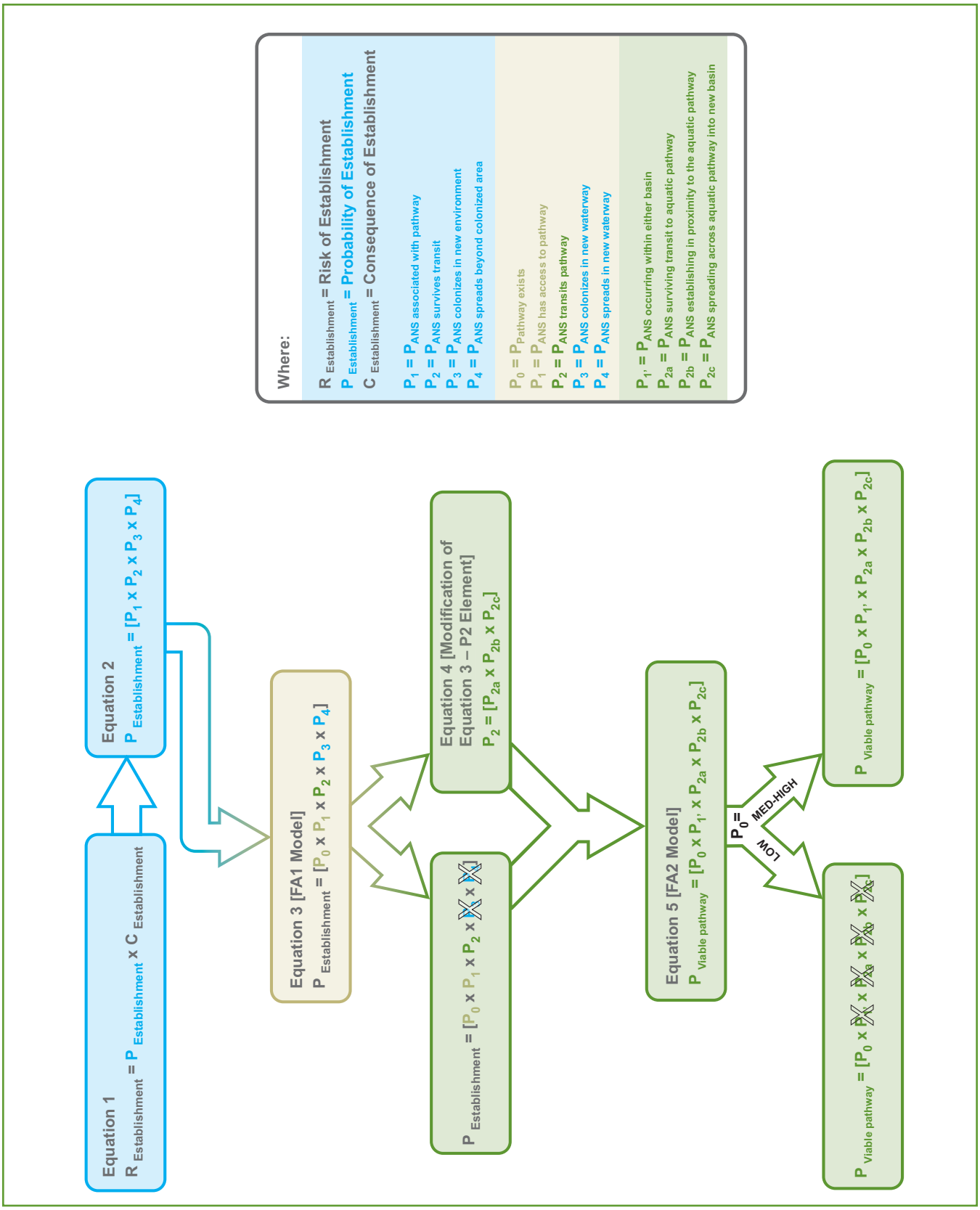


Figure 3. Diagram of the derivation of the GLMRIS Focus Area 2 aquatic pathway assessment model.

2.5 Example Calculation of Overall Aquatic Pathway Viability

As described in Section 2.2, a list of ANS of concern for the Portage Downstream 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 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).

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 Spread-ing Across Aquatic Pathway into New Basin?**	**ANS/Path-way 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 Spread-ing Across Aquatic Pathway into New Basin?**	**ANS/Path-way 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**

3 Aquatic Pathway Characterization

This section describes and illustrates the topography and features in the vicinity of the potential pathway and is intended to help inform the biological evaluations contained in Section 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 Portage Downstream potential pathway is located downstream, or Southeast of Portage, Wisconsin, while the Portage Canal location is within the City of Portage, in Columbia County. Figure 4 shows an image of the Portage area with the Portage Upstream, Portage Downstream, and Portage Canal potential connections labeled. The Fox River drains to the Great Lakes Basin and the Wisconsin River drains to the Mississippi River Basin. The Portage area has historically been an area with high potential for interbasin exchange of water. Early settlers recognized this and actually established a navigable waterway and lock and dam system between the Fox and Wisconsin Rivers. This waterway, known as the Portage Canal, was rated in the 2010 Preliminary Risk Characterization Report as an unlikely aquatic connection between the basins due to the fact that the existing levee and water control structure at the upstream end of the canal restricts water exchange to only subsurface seepage. However, it has been carried on in this phase of the study because team members in 2011 felt that the subsurface seepage poses a potential for transferring some waterborne aquatic nuisance species.

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. Existing information about climate and future climate change (if available) are important considerations for predicting the frequency of interbasin flows. Based on streamflow gage data throughout the Upper Midwest, average annual flows and the number of peak flows is increasing. On the Wisconsin River, operation of upstream reservoirs may be masking changes in annual flows.

Climate is an important driver to precipitation, temperature, snow melt, and flooding. This area of south-central Wisconsin is classified as continental with large seasonal temperature variance, four distinct seasons, and relatively small or moderate precipitation. Temperatures in winter typically range from 12º F to 30º F (-11º C to -1º C), while summers are usually around 65º F to 75º F (18º F to 24º F). Normal annual precipitation is about 35 inches (89 cm) and the normal snowfall is around 39 inches (99 cm). Significant snowfall and accumulation of snow usually occurs during the months of December through March. Warmer temperatures in April and May produce snowmelt runoff which when combined with increasing rainfall usually results in the peak flow rates for the year. However, significant rainfall events can occur throughout the summer and fall producing high flow rates. For instance, the flood of record at Portage occurred in September of 2010 (Table 7).

The highest precipitation accumulation occurs in the summer months during June through 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. However, 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. Note that the average temperatures at this location during a portion of the year are below freezing and represent times during

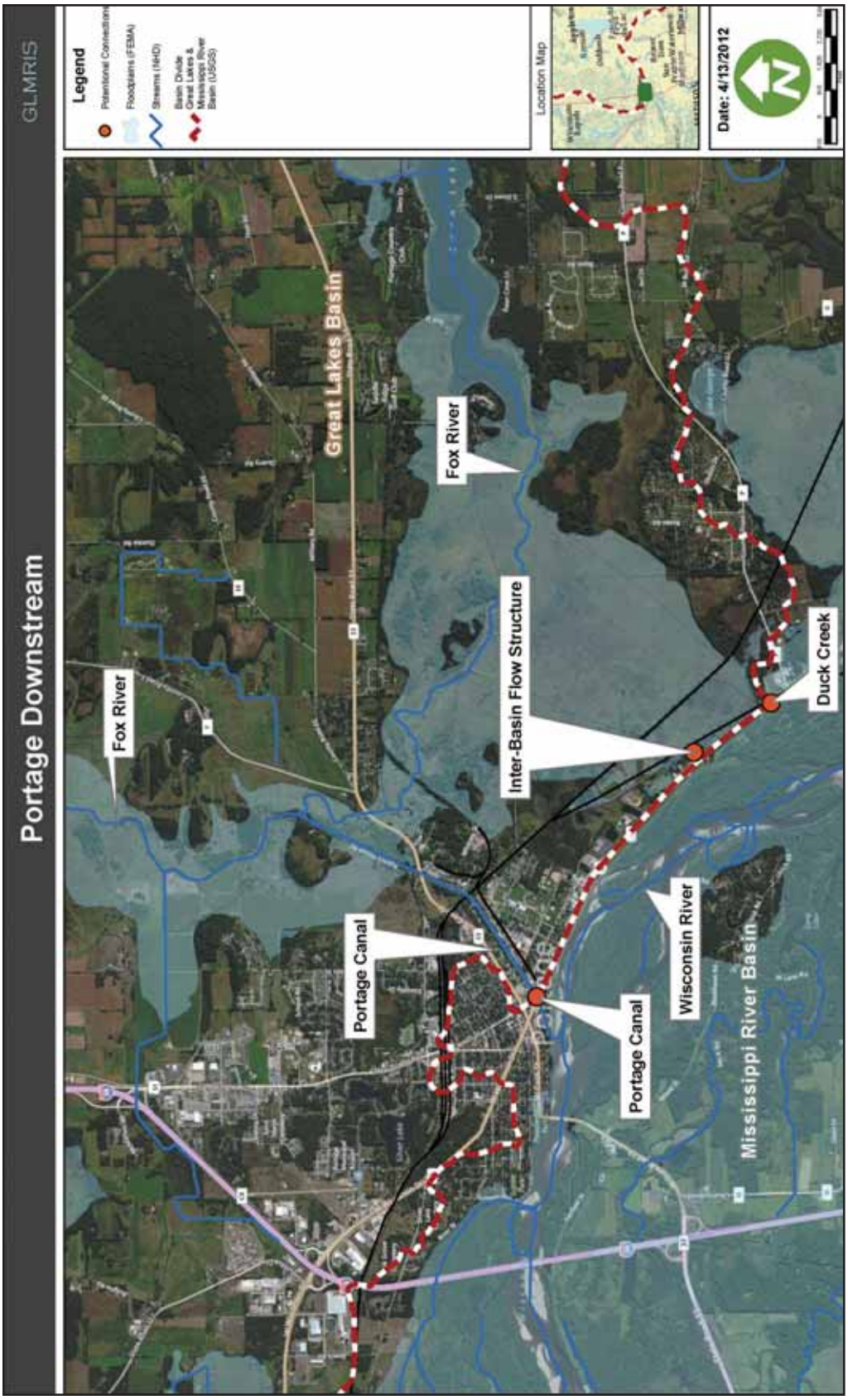


Figure 4: Portage, Wisconsin location map showing basin divide as red-white line, key features, and FEMA one percent floodplain areas. Background imagery courtesy of Bing Maps.

Table 7: Climate Information for Portage, WI (National Climate Data Center, 1971-2000) (Midwestern Regional Clmate Center – Station Portage, WI).

Element	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
Mean Temperature°F	15.2	20.6	32.0	45.2	57.1	66.6	70.6	68.2	59.3	48.1	34.3	21.5	44.9
Mean Temperature °C	-9.3	-6.3	0.0	7.3	13.9	19.2	21.4	20.1	15.2	8.9	1.3	-5.8	7.2
Normal Precip (in)	1.26	1.22	2.25	3.50	3.55	4.17	4.45	4.33	3.54	2.40	2.45	1.41	34.53
Normal Precip (cm)	3.2	3.1	5.7	8.9	9.0	10.6	11.3	11.0	9.0	6.1	6.2	3.6	87.7
Mean Snow (in)	11.4	7.5	5.8	2.1	0.0	0.0	0.0	0.0	0.0	0.3	3.4	8.4	38.9
Mean Snow (cm)	11.4	7.5	5.8	2.1	0.0	0.0	0.0	0.0	0.0	0.3	3.4	8.4	38.9

which interbasin flow is less likely to occur because of reduced flows and reduced biological activity.

3.3 Location Specific Surface Water Features

Surface water features are the most likely aquatic conduits for the transfer of ANS between basins. Some of the key features of the Portage Downstream Pathway, as well as the two specific locations where interbasin flows may potentially occur, are shown in Figures 4 and 5. The Portage Flood Risk Management (FRM) project included a levee to reduce flooding from the Wisconsin River, a gated culvert that provides small amounts of subsurface drainage to the Portage Canal, and an interbasin flow structure that maintains historic flow splits between the Wisconsin River and the Fox River.

3.3.1 Portage Downstream Potential Pathway Location

The construction of grades for the Soo Line Railroad and Highway 51 likely altered the frequency and magnitude of natural interbasin exchanges of water in this area. For existing conditions, the Federal Emergency Management Agency (FEMA) one percent annual chance base flood elevation (BFE) across the Portage Downstream pathway is elevation 783 feet (238.7 m) on the Fox River end, while the BFE on the Wisconsin River end of the pathway is 792 feet (241 m), which is 9 feet (2.7 m) higher. All elevations referenced in this report are based on the 1929 National Geodetic Vertical Datum (NGVD29). For this reason it is believed that hydrologic exchange between the basins (i.e. gravity flow) is from the Wisconsin River to the Fox River for most events.

The Portage FRM project by the USACE included an ungated interbasin flow structure to maintain the pre-project flow distribution between the Wisconsin and Fox Rivers. After being conveyed through the interbasin flow structure, which consists of two 5 by 10 foot (1.5 by 3.0 m) box culverts with an invert elevation of 783.0 feet (238.7 m) at the Portage Levee, water continues through a storage area (marsh) and two 7 by 8 foot (2.1 by 2.4 m) box culverts under the Soo Line railroad tracks, then through the Swan Lake State Wildlife Area (marsh) to the Fox River. Flow enters the interbasin flow structure (lower right picture on Figure 6) in one of two ways: it can flow over Highway 51 and the Soo Line railroad tracks, or it can back in from Duck Creek before entering the interbasin flow structure. An oblique aerial of interbasin flow occurring due to backwater from Duck Creek is shown in Figure 7. The photo in Figure 7 was taken in September 2010, which was the record flood based on stage, but was only about a ten percent annual recurrence interval flood based on discharge. Open channel flow can be seen in the ditch adjacent to the Soo Line railroad upstream of the interbasin flow structure (near top of Figure 7), and a pool of water can be seen in the preformed scour

hole on the downstream side of the structure (center of Figure 7). However, upon entering the Swan Lake Marsh downstream of the interbasin flow structure (lower left quadrant of Figure 7), a continuous open channel is not visible. Flow through this marsh could best be described as sheet flow (shallow and spread out) for this event. A representative geometry through the area of interest, based on the best available geographic information system (GIS) elevation data, is shown in Figure 8.

Also included in Figure 8 is a profile along the hydraulic unit code (HUC) boundary and a cross section across the HUC boundaries. The cross section provides information on the ground elevations from one side of the divide to the other. It also shows that there is less than a five foot (1.5 m) difference in elevation between Duck Creek and the top of the interbasin flow structure. The invert of the flow structure is shown as being approximately two feet (0.6 m) lower. For this pathway, the elevations are based on the USGS 10-meter Digital Elevation Model (DEM) with a vertical accuracy of +/- 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 at 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 (243.8 m) above sea level), they tend to vary 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 m squares vs. 30 m squares), the more block-like 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 m squares with some areas having more detailed information. Even though the 10 m 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 useful data in evaluating the potential for a hydrologic connection forming across the basin divide. Thus, it appears that a flood event that would result in raising the stage in the Duck Creek and the Wisconsin River approximately 5 feet (1.5 m) would result in flows across the basin divide.

The flooded area outline for the one percent annual recurrence interval flood, based on the Columbia County Flood Insurance Study (FIS), is shown in Figure 9. This flooded area outline extends across the basin divide at the location of the interbasin flow structure and indicates that the Portage Downstream pathway would be inundated. Thus water from Duck Creek and the Wisconsin River would flow across the divide and into the headwaters of the Fox River. Further discussion of the Columbia County FIS, including the frequency and duration of flooding at the basin divide and flows in the tributaries for various flood events, is discussed in Section 3.5, Aquatic Pathway Temporal Characteristics.

3.3.2 Portage Canal Potential Pathway Location

The preliminary risk characterization conducted in 2010 for the Portage Canal pathway found that this pathway likely existed only for flow toward the Great Lakes Basin when the control gate was open, and that this pathway did not exist for flow toward the Mississippi River Basin. However, because the 48-inch (122 cm) reinforced concrete pipe (RCP), Gatewell with sluice gate, and manhole at the Portage levee were designed to convey water into the Portage Canal, it was decided early in this study to keep this pathway in the study for a more thorough analysis of its features and potential to move water between the basins (Figure 10). Two 12-inch (30 cm) perforated pipes, which are covered by several feet of sand, provide subsurface water into the 48-inch (122 cm) RCP which then flows into the Portage Canal when the water surface elevation on the Wisconsin River exceeds elevation 781 feet (238 m) (the invert elevation of the 48-inch (122 cm) RCP). The amount of water conveyed through this structure is unknown. However, observations indicate a relatively small amount of water during low flow conditions. The original design included a grate on top of the manhole which could have provided direct flow to the Portage Canal when water levels exceeded 787 feet (239.9 m) (ie. the top of the manhole). However, a concrete cover has been placed

over the manhole inlet grate (Figure 10). This greatly reduces the chance of surface water flow entering the Portage Canal from the Wisconsin River. At a Wisconsin River elevation of 792 feet (242.4 m) the gate is closed.

A representative geometry through the area of interest, based on the best available GIS elevation data, is shown in Figure 11. Included in Figure 11 is a profile along the HUC boundary and a cross section across the HUC boundaries. The cross section provides information on the ground elevations from one side of the divide to the other. It should be noted that the inlet to the Portage Canal as shown in Figure 10 is not located along the indicated basin divide line, but approximately 1,500 feet (457 m) southeast near the edge of the Wisconsin River (Figure 11). It appears that there is less than a 5 foot (1.5 m) elevation difference between the Wisconsin River and the Portage Canal. As mentioned above, the elevations are based on the USGS 10-meter DEM with a vertical accuracy of +/- 13.123 feet (4 m). This does provide general terrain information which is useful for determining the potential for a hydrologic connection. However, in this instance there is additional information that provides additional details to aid in determining whether the Portage Canal pathway is a potentially viable connection.

The flooded area outline for the one percent annual recurrence interval flood, based on the Columbia County FIS, is shown in Figure 12. This outline includes the water in the canal. However, it is shown as being connected to the Fox River and there appears to be 500 feet (152 m) where there is no surface connection with Wisconsin River near the inlet culvert to the Portage Canal. Thus, this does not imply that there is a direct surfacewater connection at the culvert.

Figure 5. Location of Portage Downstream pathways. Red/White line indicates basin divide. Potential connections are orange dots. Background imagery courtesy of Bing Maps.

Figure 6. Location of Portage Downstream Canal pathway. Red/White line indicates basin divide and potential connection is indicated by an orange dot. Interbasin flow structure at Portage Canal shown on inset photograph. Background imagery courtesy of Bing Maps.

Figure 7. Aerial image of interbasin flow occurring due to backwater from Duck Creek during the September 2010 flood (10 percent annual recurrence interval flood). This image is oriented looking to the Southeast. The downstream end of the interbasin structure and pooled water in its stilling basin can be seen near the center of the photograph, just to the left of the Soo Line railroad. Imagery is courtesy of the Sand County Foundation.

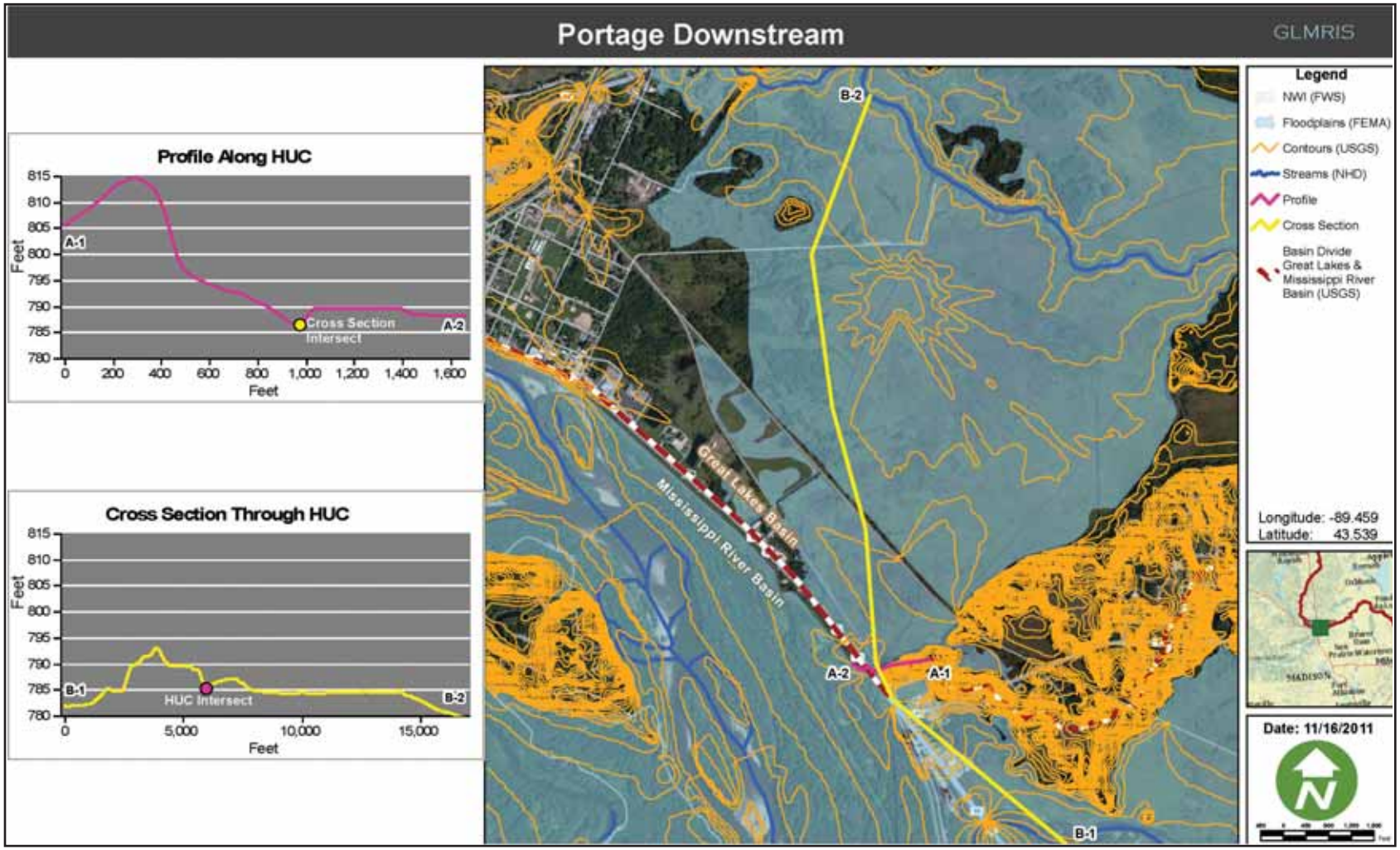


Figure 8. Typical location cross-sections, near interbasin flow structure based on 10m DEM, with a vertical accuracy of +/-13feet (4 m). The red/white line is the basin divide and the blue lines are streams near the basin divide. The pink line in the photograph and the graph on the top left is the cross section along the basin divide. The yellow line that intersects the pink line in the photograph and the graph on the bottom left is the cross section through the basin divide. The dots of opposite color in the graphs is the point where the lines intersect. Background imagery courtesy of Bing Maps.

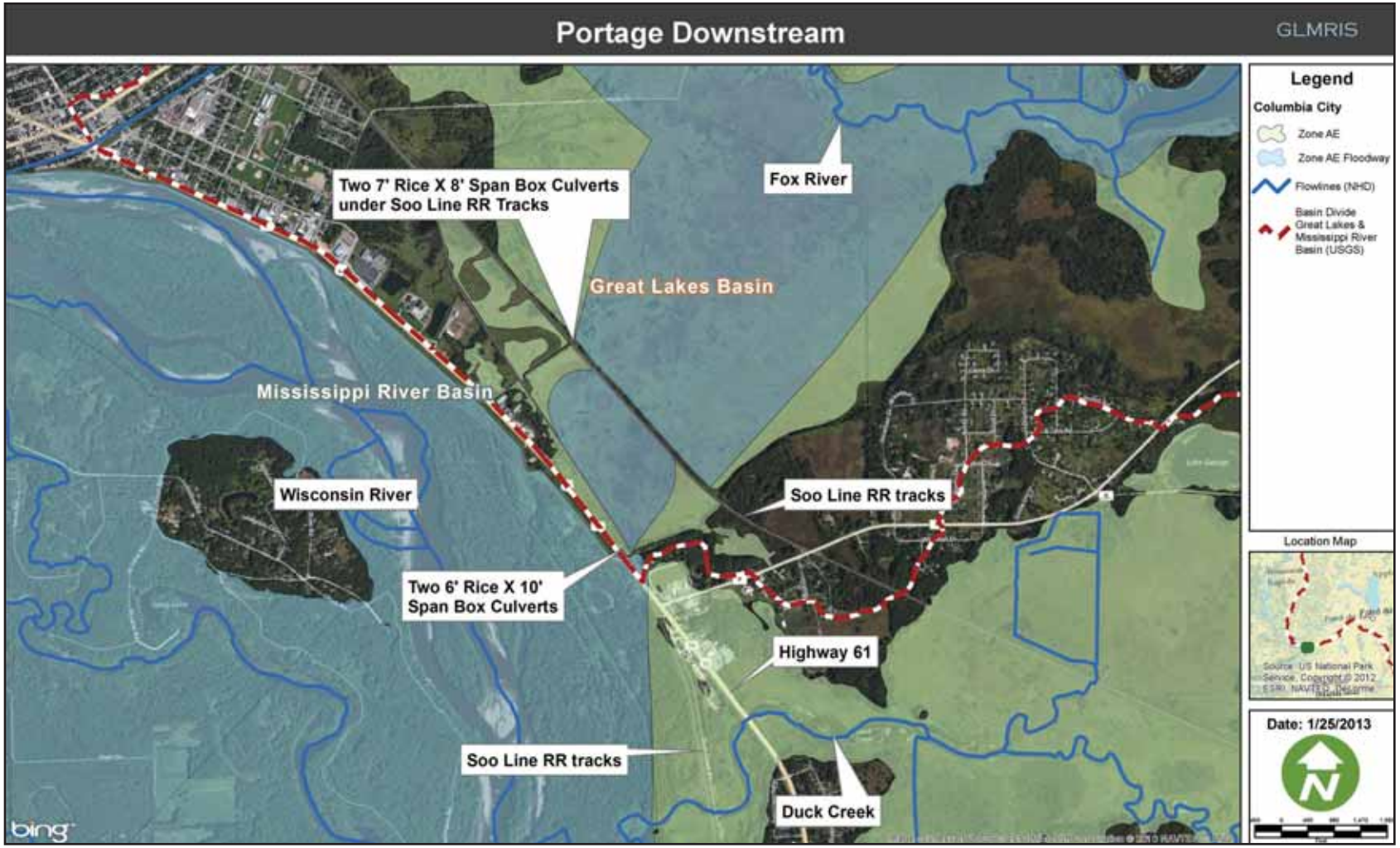


Figure 9. Flooded area outline for the one percent annual recurrence interval flood at the Portage Downstream Pathway. Basin divide is red-white line and shaded areas indicate one percent recurrence interval floodplain. Background imagery courtesy of Bing Maps.

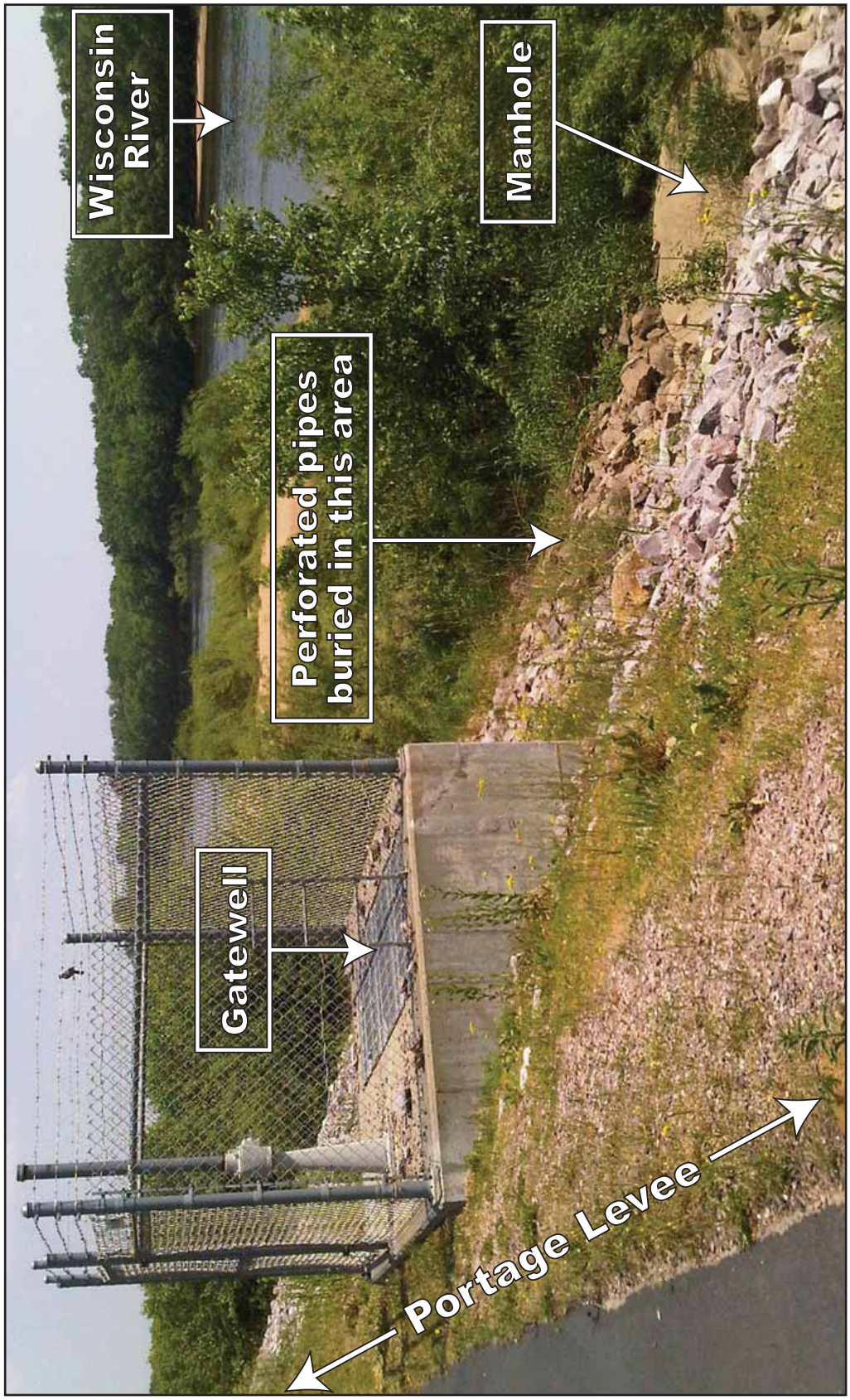


Figure 10. Portage Canal Inlet Structure. Photo by USACE.

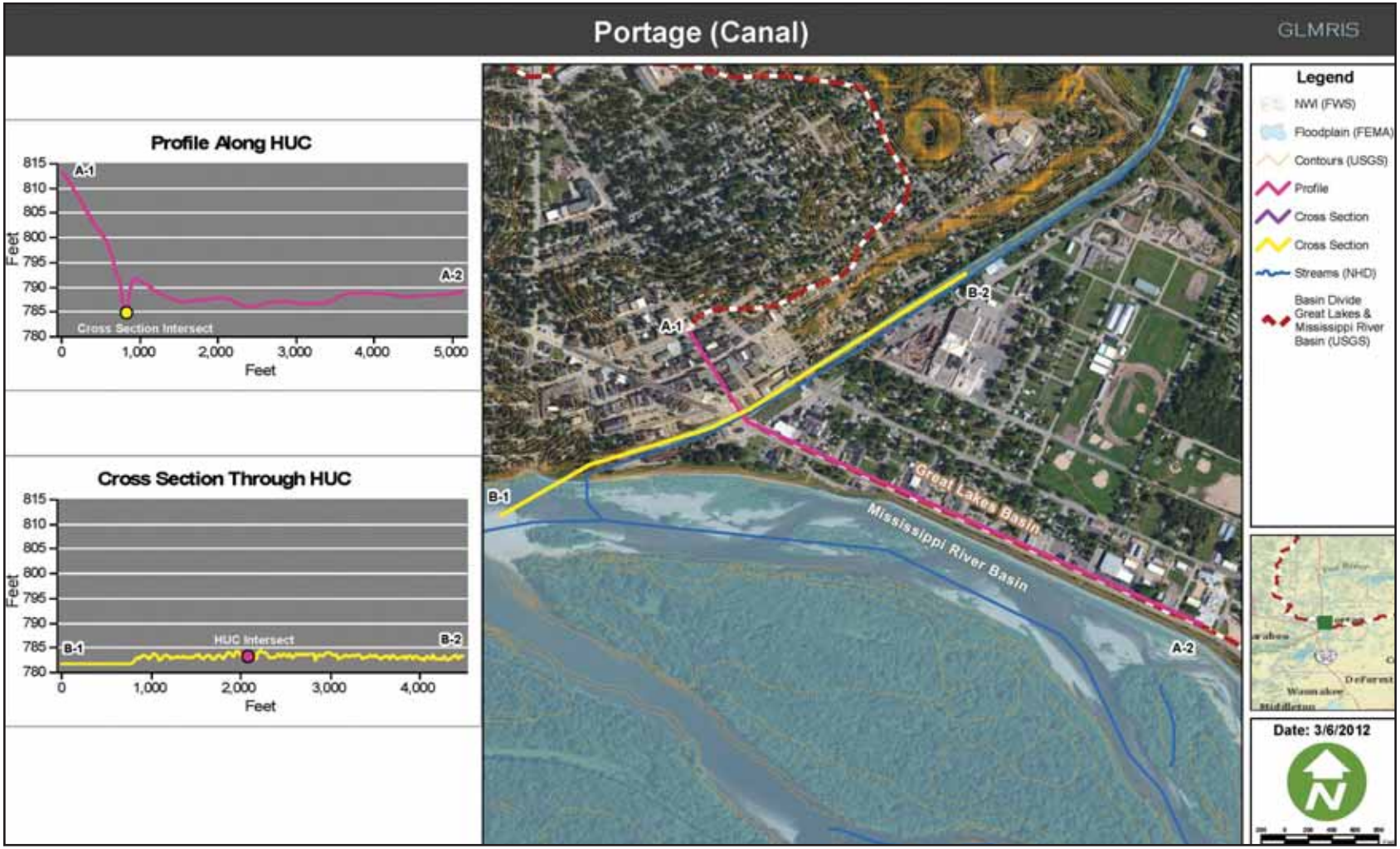


Figure 11. Typical location cross-sections near the Portage Canal, based on 10m DEM, with a vertical accuracy of +/-13feet (4 m). The red/white line is the basin divide and the blue lines are streams near the basin divide. The pink line in the photograph and the graph on the top left is the cross section along the basin divide. The yellow line that intersects the pink line in the photograph and the graph on the bottom left is the cross section through the basin divide. The dots of opposite color in the graphs is the point where the lines intersect. Background imagery courtesy of Bing Maps.

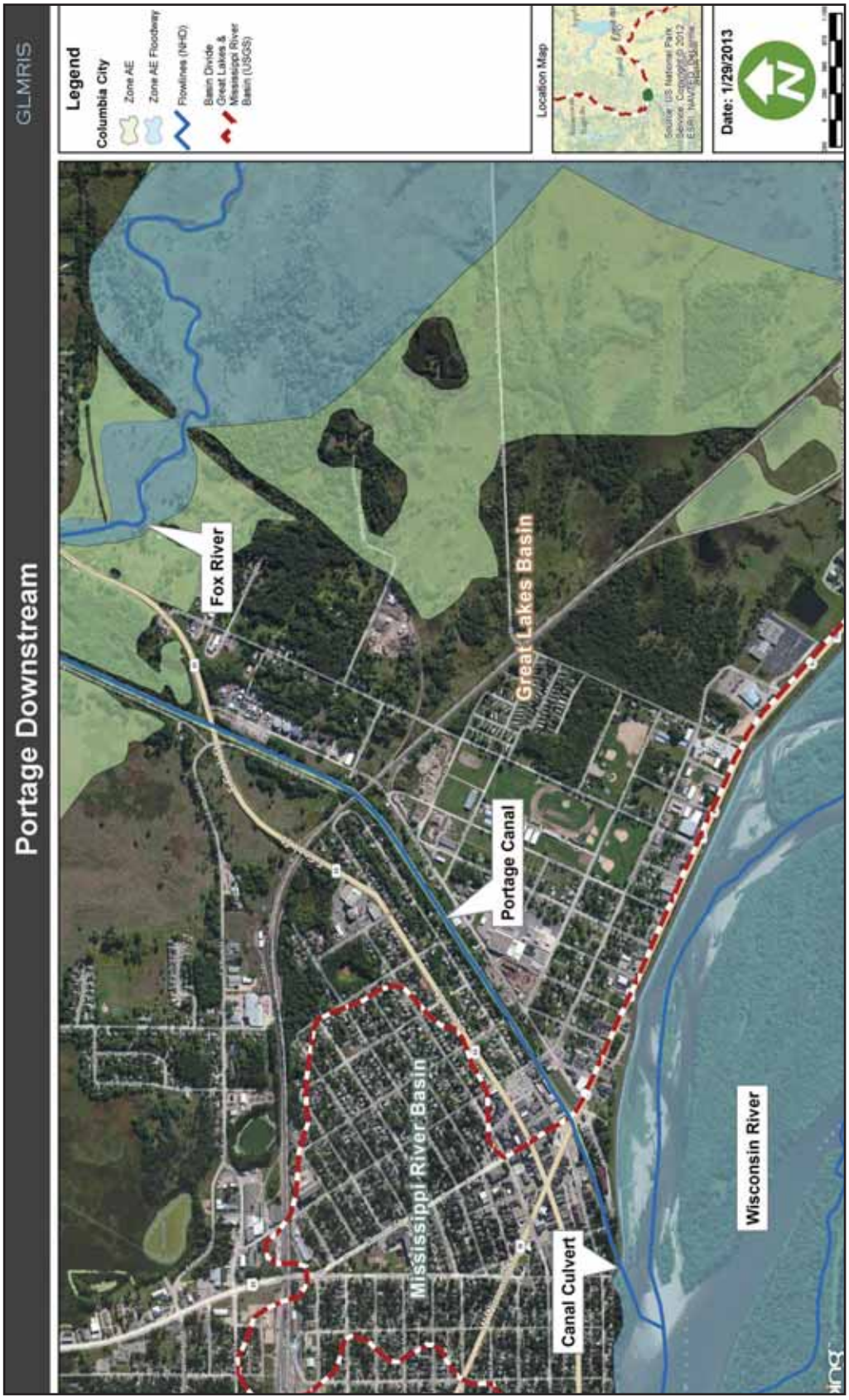


Figure 12. Flooded area outline at the Portage Canal Pathway for the one percent annual recurrence intervalflood (shaded areas). Background imagery courtesy of Bing Maps.

3.4 Groundwater

Surface water features (e.g. ditches and ponds) may at times be fed by groundwater, and during low flow periods of the year groundwater may even be the primary sources of water for these features.

Portage Downstream Sub-surface Flow

As mentioned previously for existing conditions, the one percent annual chance BFE across the Portage Downstream pathway is elevation 783 feet (239 m) on the Fox River end while the BFE on the Wisconsin River end of the pathway is elevation 792 feet (241 m), which is 9 feet (2.7 m) higher. The bed of the Wisconsin River varies from 765 to 778 feet (233-237 m) in the Portage downstream reach while the bed of the Fox River varies from 775 to 780 feet (236-238 m). Since the river bed elevations of the Fox and Wisconsin Rivers are similar in elevation, it is believed that sub-surface water exchange can occur in both directions for part of the year even although the one percent BFE is 9 feet (2.7 m) higher on the Wisconsin River. It should be noted that sub-surface water exchange includes seepage through levees, roadway embankments, and natural ground features along the pathway that may be caused due to rise and fall of water on either side of the pathway. This does not imply knowledge of movement within the deeper groundwater aquifer, which is discussed below.

Portage Canal Sub-Surface Flow

As designed and currently operated, the control structure provides a small amount of subsurface flow to the Portage Canal. Subsurface water on the Wisconsin River side of the Portage levee enters two buried perforated pipes that extend out radially from the structure. This seepage then enters the canal as surface water flow. As mentioned previously for existing conditions, the one percent annual recurrence interval BFE across the Portage Canal pathway is 782 feet (238 m) on the Fox River end while the BFE on the Wisconsin River end of the canal is 796 feet (242 m). Since the BFE on the Wisconsin River is 14 feet (4 m) higher, it is believed that subsurface water exchange is from the Wisconsin to the Fox River along this pathway.

Groundwater Aquifer

Groundwater was investigated as a part of determining the likelihood of a pathway existing at this location due to the fact that groundwater can be a source of baseflow for streams. Water levels in the aquifers typically fluctuate seasonally in response to 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 at that time 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 (i.e., USGS Groundwater Watch site 432921089245901) is two miles (3.2 km) south of the pathway site. This gage is far enough from the area of interest that it cannot provide direct data about the potential pahtway's groundwater conditions. 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.

Portage Downstream

The Portage Downstream potential aquatic pathway site is in the FEMA one percent floodplain with determined base flood elevations (Figure 9). Table 8 is derived from FEMA's FIS of Columbia County, Wisconsin, and indicates that when flood events of similar frequency occur on both rivers, flow across the pathway will be from the Wisconsin River to the Fox River. The FIS adopts the best estimate (or mean value) of the one percent annual recurrence interval flood elevation as the BFE in floodplain mapping. However, the actual one percent annaul recurrence interval flood elevation may be higher or lower than the mean value depending on the standard deviation of modeling parameters. These flood events usually occur in the spring due to snowmelt and rainfall. However, flood conditions can occur in the summer or fall as well. The flood of record (based on stage) occurred in September 2010. The mean monthly discharge from 2000 to 2010 on the Wisconsin River (USGS gage no. 05404000) just upstream of Portage, Wisconsin demonstrates that the highest flows usually occur in spring, but high flow events can occur in summer and fall (Figure 13). The magnitude of total interbasin flow at the Portage Downstream pathway is provided in Table 9 for concurrent flood events on the Wisconsin and Fox Rivers. This information is based on hydrologic and hydraulic simulations done for the Columbia County (Portage) FIS, which was completed in 2008.

The depth of water along this pathway is highly variable, and increases with larger flood events. Flow moves through open channels in the ditches, but is much shallower in the marsh areas. Taken during a ten percent annual recurrence interval flood, Figure 7 provides some insights on water depths for this magnitude of flow. Although there is open channel flow in the ditch near the top of the photograph, the flow in the Swan Lake Marsh area at the same time is sheet flow (shallow and wide).

The 2010 flood was the record stage at Portage. However, it is only the eighth highest discharge based on the USGS gage at Wisconsin Dells which is the nearest continuous gage upstream of the project. Whether this means there has been a long-term upward shift in the rating curve or that this is simply an anomaly associated with the 2010 flood is not known. This inconsistency of peak stage versus peak discharge relationship reduces the confidence in determining the threshold for the formation of an aquatic pathway, and may have to be investigated further in the future. As a result the formation of an aquatic pathway is more likely to occur if the 2010 flood data is shown to indicate an upward shift in the rating curve.

Information on the duration of flooding for each of the eight events that have exceeded the ten percent annual recurrence interval flood of 54,000 cfs (1,529 cms) during the time period 1935 to 2011 (USGS gage at Wisconsin Dells) is presented in Table 10. Although this is not a homogenous flow record since three large hydroelectric dams upstream of Portage were constructed after 1940, and mean daily flow is not directly comparable to the peak flows given in Table 8, this provides some insight as to the duration of major flood events. This gage is located just upstream of Portage and adequately represents conditions at Portage. For these eight events, the number of days that exceeded the ten percent annual recurrence interval flood averaged about three days, with a high of six days in 1973.

3.6 Probability Aquatic Pathway Exists

Portage Downstream

The rating discussed in this section is only for the likelihood of an aquatic connection existing at this potential pathway (P_0) up to a one percent annual recurrence interval storm. It is possible that a surface water connection could form at the Portage Downstream potential pathway between the Great Lakes and Mississippi River Basins based on the following:

- Gravity flow at this pathway will be from the Wisconsin to the Fox Rivers

- The September 2010 flood was only slightly larger than a 10-percent annual recurrence interval event based on discharge. However, it produced the highest recorded stage at the Portage gage. During this flood, interbasin flow occurred through the interbasin flow structure.

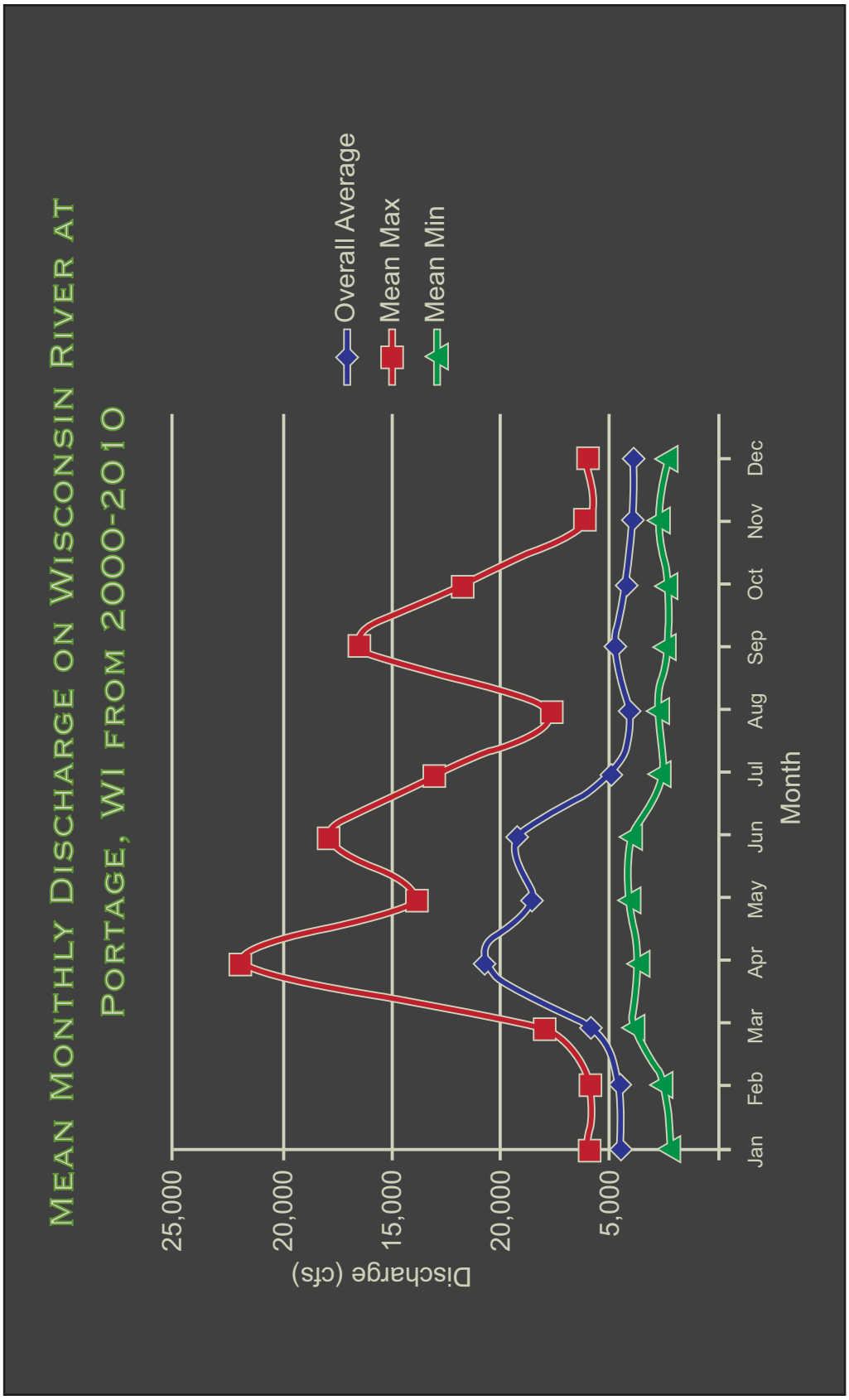


Figure 13. Monthly discharge on Wisconsin River at Portage, Wisconsin (USGS gage no. 05404000).

Table 8. Elevation and discharge statistics for Fox River and Wisconsin River near the Portage downstream site. The discharges are based on the peak discharge-frequency relationships developed for the Columbia County FIS (FEMA 2008 FIS).

	10% Annual Recurrence	2% Annual Recurrence	1% Annual Recurrence	0.2% Annual Recurrence
Fox River at State Highway 33 Bridge	920 cfs (26 cms) 780-785 ft (237-239 m)	1,210 cfs (34 cms) 780-785 ft ft (237-239 m)	1,300 cfs (37 cms) 780-785 ft ft (237-239 m)	1,650 cfs (47 cms) 780-785 ft ft (237-239 m)
Wisconsin River downstream of Portage	53,919 cfs (1,527 cms) 790-800 ft (240-244 m)	69,200 cfs (1,959 cms) 790-800 ft (240-244 m)	75,765 cfs (2,145 cms) 790-800 ft (240-244 m)	87,794 cfs (2,486 cms) 790-800 ft (240-244 m)

Table 9. Magnitude of total interbasin flow at the Portage Downstream pathway for various concurrent flood events on the Wisconsin and Fox Rivers. The magnitude of river flow was obtained from HEC-2 and HEC-RAS split flow modeling for the Portage FRM Project and the Columbia County (Portage) FIS. Flows are given in cubic feet per second (cfs) and cubic meters per second (cms).

Flood Frequency on Wisconsin and Fox Rivers	10% Annual Recurrence	2% Annual Recurrence	1% Annual Recurrence	0.2% Annual Recurrence
Interbasin Flow (cfs/cms)	60 (1.7)	870 (25)	1,000 (28)	1,140 (32)

- Portage FRM and FEMA FIS show the one percent floodplain extending across the basin divide and connecting with tributaries in the Great Lakes and Mississippi River Basins.

- The profile and cross section of this potential pathway, along with knowledge that the interbasin flow structure was designed to begin conveying water for flood events approaching the ten percent annual recurrence interval flood, indicate that this is a likely aquatic connection point between the basins.

The interagency pathway assessment team determined that an aquatic connection exists between the two basins continuously for multiple days from an event with up to a ten percent annual recurrence interval. Consequently, the probility of the existence of an aquatic pathway at Portage Downstream is rated “medium” in either direction (Appendix A).

This rating is considered “very certain” based on the following:

- Although there is uncertainty in the vertical accuracy of the topographic data, observations at this location have concluded interbasin flow occurs.

- Contiguous FEMA floodplain mapping between the basins.

- Higher volume flows influence the connection at this location as compared to other potential aquatic pathway locations along the basin divide located higher up in the drainage basins and in headwater areas.

Portage Canal

The pathway assessment team did not rate the Portage Canal pathway, since the preliminary risk characterization conducted in 2010 concluded that a pathway was highly unlikely to exist at the Canal if the gated structure through the Portage levee was closed. However, further discussions with biologists on the interagency team indicated that this pathway should be re-evaluated in 2011-12 because of the subsurface flow that enters this structure and provides water to the Portage Canal. Since the Canal and interbasin flow structure at Portage Downstream are both part of the Portage FRM Study, and the Canal does receive water from the Wisconsin River, it was included in this report but was again dismissed after further analysis.

Table 10. Duration (days) of flooding for each of the eight events that had mean daily flows exceeding the 10-percent annual recurrence interval flood of 54,000 cfs (1,529 cms) during the time period 1935 to 2011 at the USGS gage at Wisconsin Dells. The 10-percent annual recurrence interval flood is approximately when interbasin flow begins at the Portage Downstream pathway.

Wisconsin River at Wisconsin Dells					
Agency	**Site No.**	**Year**	**Date**	**Mean Daily Flow (cfs/cms)**	**Number of days discharge exceeded 54,000 cfs (1529 cms) in a given year**
USGS	5404000	1935	03/26/1935	58,300 (1,651)	3
USGS	5404000		03/27/1935	63,400 (1,795)	
USGS	5404000		03/28/1935	60,800 (1,722)	
USGS	5404000	1938	09/13/1938	63,200 (1,790)	4
USGS	5404000		09/14/1938	71,200 (2,016)	
USGS	5404000		09/15/1938	65,400 (1,852)	
USGS	5404000		09/16/1938	55,400 (1,569)	
USGS	5404000	1943	06/04/1943	56,900 (1,611)	1
USGS	5404000	1951	04/11/1951	58,200 (1,648)	2
USGS	5404000		04/12/1951	58,300 (1,651)	
USGS	5404000	1960	05/09/1960	58,000 (1,642)	3
USGS	5404000		05/10/1960	62,800 (1,778)	
USGS	5404000		05/11/1960	57,600 (1,631)	
USGS	5404000	1973	03/15/1973	56,300 (1,594)	6
USGS	5404000		03/16/1973	61,900 (1,753)	
USGS	5404000		03/17/1973	61,500 (1,741)	
USGS	5404000		03/18/1973	57,200 (1,620)	
USGS	5404000		04/19/1973	54,000 (1,529)	
USGS	5404000		04/20/1973	54,000 (1,529)	
USGS	5404000	1993	06/22/1993	55,100 (1,560)	4
USGS	5404000		06/23/1993	57,500 (1,628)	
USGS	5404000		06/24/1993	58,300 (1,651)	
USGS	5404000		06/25/1993	54,700 (1,549)	
USGS	5404000	2010	09/26/2010	54,200 (1,535)	2
USGS	5404000			55,700 (1,577)	

3.7 Aquatic Pathway Habitat

3.7.1 Terrestrial and riparian plants and land use

The Portage Downstream and Canal location is immediately southeast of the city of Portage. Land use and land cover at the site. It is primarily agricultural, wetlands, and limited woodland habitat (Figure 5). The wetlands along the potential flow path are predominantly shallow marsh, with little apparent open water. Wetlands are predominately vegetated with cattail and reed canary grass, which would provide habitat for a limited number of wetland species relative to more diverse wetland habitats. The distance from the interbasin flow structure across these wetlands to the Fox River is roughly 1.75 miles (2.8 km).

The divide wetlands are mostly within the Swan Lake Wildlife Area (SLWA), which is managed by the WDNR for hunting and recreational uses (Figure 14). The SLWA is 2,335 acres (945 ha), of which 2,090 acres (846 ha) are wetlands, 145 acres (59 ha) are grassland, and 100 acres (40 ha) are wooded. The area is open for public use including hunting, but is not open for motorized vehicles.

Terrestrial and riparian habitat beyond the Portage Downstream and Canal divide location in the Mississippi River Basin and the Great Lakes Basin is similar to the Portage area in that it is mostly a patchwork of agriculture, woodland, and wetlands. The area also includes the extensive floodplain forest of the Wisconsin River.

The terrestrial and wetland habitats at the divide location would sustain populations of wildlife that typically do not require open water to fulfill their life histories. Numerous species would be expected to occur here, but the number of aquatic species such as furbearers and migratory waterfowl may be limited at this location by the limited availability of open water.

The USFWS lists five threatened and endangered species as occurring in Columbia County. Two are mussel species that occur in the Wisconsin River. Three species are terrestrial and could potentially be found in the immediate divide location. The whooping crane (*Grus americanus*) is typically found in wetlands and on lakeshores, and could be found in the divide location, especially during migration. Mead's milkweed (*Asclepias meadii*) and prairie bush-clover (*Lespedeza leptostachya*) are plant species typically found in drier upland habitats and while the plants could be present near this divide location, they are not expected to be.

3.7.2 Aquatic Resources

Aquatic habitat at the immediate divide location is limited, although based on a review of aerial photography there appear to be a few open-water wetlands or shallow basins at the divide location. It seems unlikely that these basins would be deep or large enough to reliably sustain a population of fish through the winter, and may not even be able to support most species of fish through the summer. However, more investigation of these basins would be required for an accurate assessment.

During a flood event, it is expected that the emergent wetlands at the divide location would be inundated to the point where they would be able to temporarily support most aquatic organisms. Based on limited observations during the September 2010 flood event (ten percent annual recurrence interval event), it appears that flow through the marsh area of this divide location would occur mostly as sheet flow. It is estimated that the interbasin flow for such an event is about 60 cfs (1.7 cms) (Table 9). Under sheet flow conditions the vegetation in the marsh may serve to reduce the passage of fish, but it is possible that a defined channel may be present, especially during larger flood events. Higher-resolution topographical information would be needed to better assess the ability of the location to pass fish.

Table 10 shows that during the period from 1935 to 2011, eight flooding events have occurred on the Wisconsin River that exceeded a 54,000 cfs (1,529 cms) (ten percent recurrence interval event), at which flow into the Great Lakes Basin would begin to occur. The duration of flows above 54,000 cfs (1,529 cms) ranged from one to six days, and averaged three days. This is very likely to

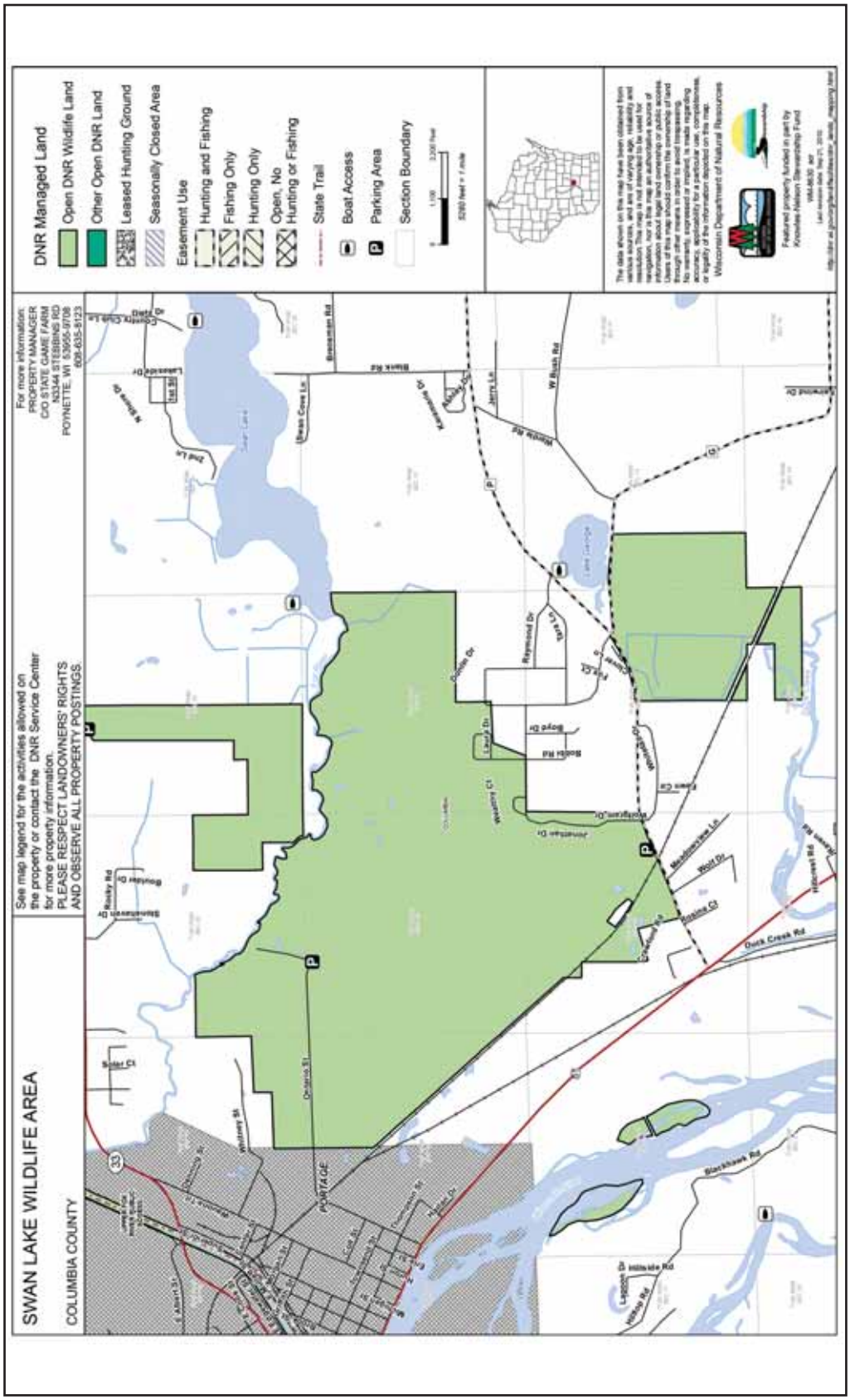


Figure 14. Map of Swan Lake Wildlife Area. Image courtesy of Wisconsin DNR: (http://dnr.wi.gov/maps/WM/SCR/8630swanlake.pdf).

be sufficient time for Asian carp to swim over the 1.75-mile (2.8 km) divide location, and possibly even enough time for other nuisance fish species that are less mobile. It would be adequate time for organisms carried on or within the water column to be passively carried over the divide.

Unlike many other pathway sites, the Portage sites are well downstream of the headwaters on the Mississippi River Basin side of the divide. This presents a unique opportunity for ANS in that there is a range of high-quality aquatic habitat available for colonization near the pathway location in the Mississippi River Basin on the Wisconsin River. The Wisconsin River at Portage is relatively large with a base flow of about 5,000 cfs (142 cms). The river at this location and upstream includes high-quality habitat types that range from lacustrine (reservoir), to riverine, to backwater, and emergent wetland types. This would provide an opportunity for nearly any ANS to find suitable habitat in relative close proximity to this pathway location.

The high-quality and diverse habitat of the Wisconsin River supports a wide variety of aquatic species and is well-known as a high-quality fishery. Fish species found there include walleye, northern pike, muskellunge, smallmouth bass, sunfishes, suckers, catfish, darters, and minnows. A wide variety of mussel species is also present, including the endangered Higgins eye (*Lampsilis higginsii*), and sheepnose (*Plethobasus cyphyus*).

The location of this pathway along a major river also presents another unique opportunity for ANS. As a result of the high flows that can pass from the Mississippi River Basin to the Great Lakes Basin during a flood event, any ANS established upstream of the pathway location may be transported over the divide by floodwaters, independent of that species' mobility. This means that small or even larval fish, invertebrates, or plants can be transported over this divide location if floating on or suspended within the water column. Flow from the Mississippi River Basin to the Great Lakes Basin is estimated to be about 870 cfs (24.6 cms) for the two percent recurrence interval event (Table 9).

Aquatic habitat leading from the Mississippi River up the Wisconsin River to the pathway site is high-quality and unobstructed except for the presence of the Prairie du Sac Dam. The Prairie du Sac Dam is about 25 river miles (40 km) downstream from Portage and is a power generating facility. There is about 38 feet (11.5 m) of head at the dam and it currently is an effective barrier to fish passage. Installation of fish passage at this dam is currently a licence requirement. Agencies are currently reviewing alternatives for fish passage and no final decisions have been made as of the date of this report.

Aquatic habitat on the Great Lakes Basin side leading away from the pathway location wetlands begins with the Fox River which flows into Lake Winnebago and then Green Bay. The distance between Lake Winnebago and the divide location is about 100-120 miles (161-193 km). The Lower Fox River, connecting Lake Winnebago to Green Bay, is 39 miles (63 km) long. The USGS gage (no. 04073365) on the Fox River at Princeton, Wisconsin (about 50 miles (80.5 km) from the watershed divide) shows that the average river discharge ranges from 1,300 cfs (37 cms) in June to 550 cfs (15.6 cms) low flow in September. There are numerous dams on the Fox River that can impede upstream fish passage (Table 11, Figure 15).

3.7.3 Water quantity and quality

Water quantity and quality are likely limiting factors in the suitability of habitat at the immediate divide location during non-flooding periods. Based on aerial photography, there appears to be little open water within the wetland complex at the divide location, and what is available are likely to be relatively shallow wetland basins. If this is in fact the case, it is likely that these basins would experience winter freeze-out and/or winter and summer oxygen depletion problems, either of which would greatly limit their use by aquatic species.

Beyond the immediate divide location, water quantity and quality are unlikely to be limiting factors. The Wisconsin River certainly has enough water and the quality is high as evidenced by the numerous aquatic species it supports. The Fox River also supports a valued fishery similar to the Wisconsin River, and likely has suitable water quality to support most aquatic organisms.

3.7.4 Aquatic Organisms

Aquatic vegetation at the divide location appears to be dominated by cattail (*Typha* spp.) and reed canary grass (*Phalaris arundinacea*). Reed canary grass is an invasive species, and combined with cattail, can create a persistent vegetation community that may not be easily invaded by other invasive vegetation types. However, this does not mean that other aggressive invasive plant species would be unable to colonize the divide location.

The immediate divide location may not be suitable to many aquatic species due to a lack of open water. However, it does seem likely that the location would readily support and be able to pass aquatic species during larger flood events. Aquatic habitat adjacent to the divide location in the Mississippi River Basin on the Wisconsin River and in the Great Lakes Basin on the Fox River is diverse, of high quality and supports a multitude of aquatic species.

Two aquatic species are listed as threatened and endangered in Columbia County by the USFWS. These are the endangered Higgins eye (*Lampsilis higginsii*), and sheepnose (*Plethobasus cyphyus*) mussels. Both species are found in the Wisconsin River and would not be present in the immediate divide location.

3.8 Connecting streams to Great Lakes and Mississippi or Ohio River

Since it has been determined that a viable hydrologic connection between both basins can be established during a 10 percent recurrence interval flood, potential barriers to ANS spread have been identified.

The Mississippi River connection for Portage Downstream and Portage Canal pathway is from the Wisconsin River to the Mississippi River.

The Great Lakes Connection for Portage Downstream is:

Floodplain of Duck Creek and the Swan Lake Wildlife area ► Upper Fox River ► Lake Butte des Morts ► Lake Winnebago ► Lower Fox River ► Lake Michigan

The Great Lakes Connection for Portage Canal is:

Through the Portage Levee ► Portage Canal ► Upper Fox River ► Lake Butte des Morts ► Lake Winnebago ► Lower Fox River ► Lake Michigan

Figure 15 shows the location of the possible barriers to ANS spread and Figure 16 shows the Fox River and Wisconsin River longitudinal profile. The Portage Downstream stream pathway is shown in the approximate center of the figure at the break in drainage between the Lower Wisconsin River and Fox River. The possible barriers along with the hydraulic, structural, and dam heights, and whether or not there is fish passage at each location, are listed in Table 11.

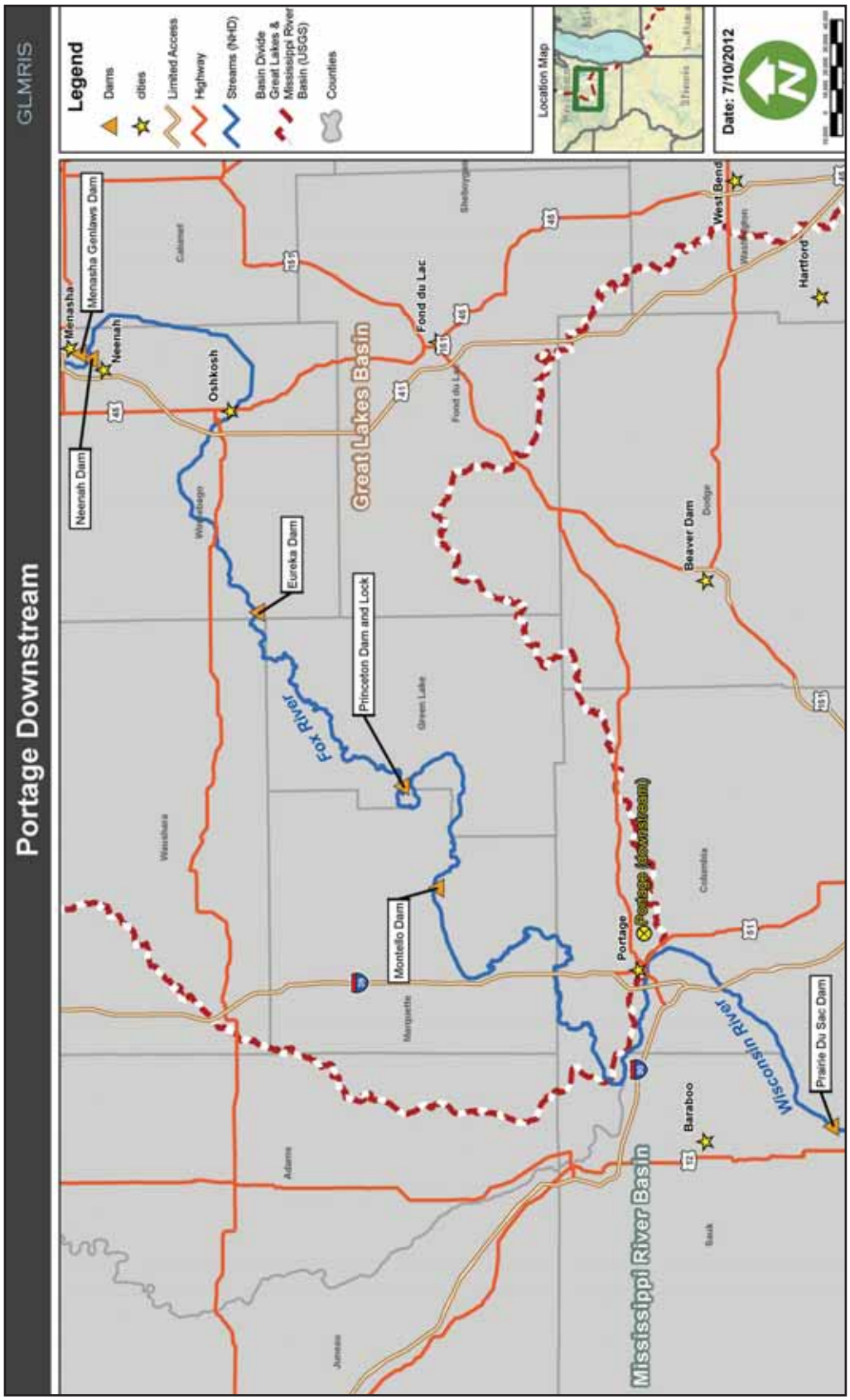


Figure 15. Location of potential barriers to ANS spread indicated by orange triangles. Blue line shows flowpaths from potential pathway to Mississippi River and Great Lakes. Background imagery courtesy of Bing Maps.

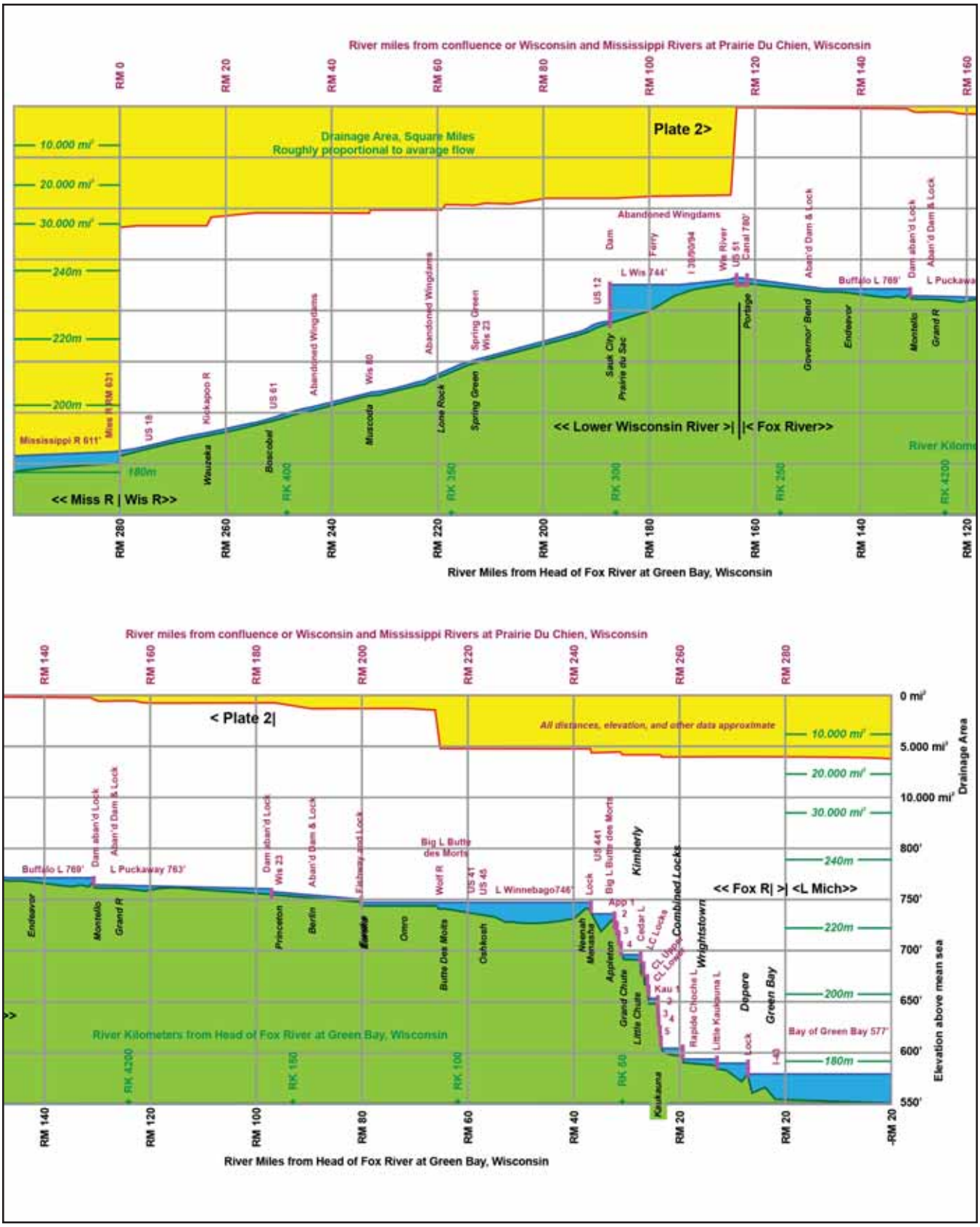


Figure 16. Longitudinal profile between Green Bay, Wisconsin and the Mississippi River, via the Fox and Wisconsin Rivers.

Table 11. Potential Barriers to ANS Spread, Including Dam Heights, FEMA Elevations, and any Known Fish Passage (NID, 2010).

Mississippi Connection -								
	Wisconsin 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	Prairie Du Sac	Wisconsin River	38	25	27	24	22	Installation of fish passage currently a license requirement.
Great Lakes Connection -								
	Portage Upstream- Big Slough, Neenah Creek, Upper Fox River, Lake Puckaway, Upper Fox River, Lake Butte des Morts, Lake Winnebago, Lower Fox River, Lake Michigan							
	Portage Downstream- Upper Fox River, Lake Puckaway, Upper Fox River, Lake Butte des Morts, Lake Winnebago, Lower Fox River, Lake Michigan							
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	* Fox River lower than Wisconsin River by about 15ft, lock channel (Portage canal) is permanently closed between the two rivers							
Great Lakes	Montello / Buffalo Lake Dam	Upper Fox River	5	13	-	0	-	Yes (fish ladder to be installed in next few years)
Great Lakes	Princeton	Upper Fox River	2	8	submerged	submerged	submerged	Yes
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	-	-	-	has Sea Lamprey Barrier, lock blocked
Great Lakes	Little Kaukauna	Lower Fox River	7	16	-	-	-	through lock
Great Lakes	DePere	Lower Fox River	8	17	-	-	-	through lock

4 Aquatic Pathway Viability for ANS of Concern

The potential for species transfer considered here is only for the Portage Downstream divide location and not the Portage Canal. This is because the potential for passing ANS through the Portage Canal is very low because of the sluice gate being closed. Even if the gate were open, water is supplied to the canal through perforated pipes buried several feet under the bed of the Wisconsin River, although this would need to be confirmed by further investigation. Assuming these pipes are in fact completely buried, ANS would have to be capable of passing through this overburden of sediment to successfully pass through the pipes to the Canal. The only ANS of concern here that may have that capability is VHSv if it is free from a host fish and water temperatures allow it to persist in the water column long enough to make this journey. However, VHSv is located on the Great Lakes Basin side of the divide and does not possess independent mobility. Since water flows from the Mississippi River Basin to the Great Lakes Basin through this pathway, there is no means for VHSv to be transported from the Great Lakes Basin through the canal, the collection pipes, the river bed sand, and into the Wisconsin River. Furthermore, the virus must complete such passage outside of a host and then find a host fish within a matter of days, prior to it becoming non-viable.

If the water supply collection pipes for the canal are, or become exposed, there is the potential that other small ANS may be able to enter the canal. But in such a case, the closed sluice gate would help prevent the successful passage of ANS to the Great Lakes Basin. Inspection of the inlet to verify the sand cover is appropriate. The greatest unknown regarding the Portage Canal as a potential pathway is the integrity of the buried collection pipes, such as whether or not they will remain buried or the river will migrate over this area and scour out the sediments. The collection pipes were originally covered with sand to act as filtration. An investigation of these pipes may be warranted, but it may also be appropriate to consider the possibility of simply removing this connection. Even if a connection were established via these pipes, there is a sluice gate that can be closed to prevent a connection from establishing.

Thus, the potential for species transfer was assessed by the project team for the ANS of concern for Portage Downstream only, and not Portage Canal, 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 3)
- 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 Attachment A.

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 (from MRB to GLB)

Silver carp and bighead carp are established in the middle and lower Mississippi River Basin. Single individuals have been collected at a number of places in the Upper Mississippi River Basin, but there is no evidence of successful reproduction or self-sustaining populations. Two bighead carp have been collected in the Wisconsin River below the Prairie du Sac Dam in 2011 (USGS, 2011). Silver carp have been collected in the Mississippi River well upstream of the mouth of the Wisconsin River and would likely be able to reach the Prairie du Sac Dam as evidenced by the collection of bighead carp there. The Prairie du Sac Dam is currently a complete barrier to Asian carp upstream movement and prevents them from reaching the Portage area. However, discussions with WDNR indicate that there is a proposed fish passage project at this dam being designed, which is discussed in greater detail under Asian carp in the following section. Black carp have a more limited distribution and are less likely to reach the Prairie du Sac Dam in the near-term. Barring deliberate or unintentional movement of Asian carp by human transport it is unlikely that Asian carp will reach Portage within the next 20 years.

Team rating: **Medium**
Team certainty rating: Reasonably Certain

Inland Silverside (from MRB to GLB)

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 have not been collected in the Wisconsin River. Recently, its most northern known occurrence in the Mississippi River Basin is on the Kankakee River in Will County Illinois, where they were collected in 1996 (USGS, 2011). The species was stocked in Turtle Lake in Ramsey County, Minnesota in 1950, but that population failed. 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 and 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 and Nico, 2012D).

Team rating: **Medium**
Team certainty rating: Reasonably Certain

Northern Snakehead (from MRB to GLB)

The closest established population of northern snakeheads is in Lee County, Arkansas. While this is in the Mississippi River Watershed, this population does not seem to be spreading at a high rate at this time (USGS, 2011). A single specimen of giant snakehead (*Channa micropeltes*) was collected in the Rock River by the WDNR (a watershed not directly connected with the Portage Downstream pathway). 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 and Williams, 2004).

Team rating: **Medium**
Team certainty rating: Reasonably Certain

Scud (from MRB to GLB)

This is a species of scud that is native to the Atlantic coast of North America And is established in the Illinois River Basin (USGS, 2011). It does not densely populate the Mississippi River Basin, but it can be locally abundant. It was first reported in the Lower Mississippi River in 1987-1988, and then later found in the Ohio River in 1996, and it moved 714 miles (1,150 km) up the Ohio River within a year, likely due to shipping (Grigorovich, et al., 2008). It is currently unknown to exist in the Great Lakes Basin. The species is unable to move upstream significant distances under its own power, so it is unable to use the Mississippi River as a waterway to move into the Wisconsin River.

Team rating: **Medium**
Team certainty rating: Moderately Certain

Plant ANS (from MRB to GLB)

Plant ANS are being evaluated for the Portage Downstream site because of its unique geographic position in the watershed in that it is not at the upper headwaters of the two drainage basins. Instead, it occurs along the Wisconsin River at point with a large upstream drainage area. This results in the potential for upstream floodwaters in the Wisconsin River Basin to flow into the Great Lakes Basin, thereby permitting any material, including plant material, to be carried to and over the divide by floodwaters. It also means that there is a large source area upstream of the divide location that can be colonized by ANS, and provide a consistent source of ANS material during floods.

Three plant species that were listed as being of concern to the Great Lakes Basin include dotted duckweed, marsh dewflower, and Cuban bulrush. Additional plant species have also been determined to be of concern by professionals in the field, but for the purpose of this assessment all are being treated collectively as nuisance plant species. Only those species found in the Mississippi River Basin but not in the Great Lakes Basin have been considered here because water from the Great Lakes Basin would not flow into the Mississippi River Basin except possibly under extremely rare occasions. None of the three listed species have been found in Wisconsin, but dotted duckweed is the species in closest proximity, having been established in Senachwine Lake in Bureau County, Illinois (Illinois River drainage) since 1986 (Jacono, 2002). Dotted duckweed has a high rate of vegetative propagation and mainly occurs via vegetative budding of daughter fronds from two pouches at the base of the frond (Jacono, 2002). It is native to Australia and Southeast Asia thrives in nutrient rich waters and prefers slow moving or stagnant ponds (Jacono, 2002). It is frequently found in stagnant small ponds or ditches rich in organic matter, or near sewer outlets (Hillman, 1961). Marsh dewflower was reported in Louisiana in the 1920's but has not spread very far up the Mississippi River (Dunn and Sharitz, 1990a).

Team rating: **Medium**
Team certainty rating: Reasonably Uncertain

Viral Hemorrhagic Septicemia Virus (from GLB to MRB)

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 throughout the Great Lakes Basin including Lake Michigan and was found in Lake Winnebago in 2007, but not since (USGS 2011).

Viral hemorrhagic septicemia 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 Fox 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. It should also be noted that VHSv has been found in 28 different host fish species in the Great Lakes Basin and that it can survive without a host in the water column (WDNR, 2012b).

Carp from Lake Winnebago have access to the Upper Fox (although several low-head dams along the way

provide substantial barriers), but the river is warm, and it's uncertain whether VHSv could persist in the system even if infected fish swam up the Fox River from Lake Michigan.

Team rating: **Medium**
Team certainty rating: Reasonably Certain

Ruffe and Tubenose Goby (from GLB to MRB)

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 ruffe is an aggressive species that possesses the ability to feed in darkness, cold temperatures, and turbid conditions. The ruffe has extended its range rapidly and modeling (USGS, 2012) predicts it will find suitable habitat in all five Great Lakes. The tubenose goby is a benthic species that consumes a wide variety of invertebrates (USGS, 2011). They are found in the open waters and estuaries of slow flowing rivers and are often quite abundant in backwaters and lakes and seem to prefer dense vegetation. The tubenose goby's introduced range covers three Great Lakes including Lake Superior, Erie, and Huron (USGS, 2011). It has been collected in the lower reaches of larger Great Lakes rivers and estuaries, but no tubenose goby have been collected locally in upper Great Lakes river tributaries to date. Tubenose gobies have exhibited a much slower rate of expansion in the Great Lakes than the round goby (*Neogobius melanostomus*), also an invasive species in the Great Lakes and now located within both the Great Lakes Basin and the Mississippi River Basin. The tubenose goby's nearest locations are in Lake Superior and Lake Huron.

Team rating: **Medium**
Team certainty rating: Reasonably Certain

Threespine Stickleback (from GLB to MRB)

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 habitats including lakes and large rivers. The threespine stickleback was first encountered in lower Green Bay and the Lower Fox River (below DePere Dam) about 25 years ago, but has never been seen upstream from this area. Great Lakes populations of this species tend to be potadromous (truly migratory but within fresh water only) and only enter the lower reaches of streams briefly during spring spawning.

Team rating: **Medium**
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, capabilityy 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 spreading 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 (from MRB to GLB)

An aspect that may slow the rate of Asian carp expansion toward the Portage Downstream Pathway is that these fish need long free-flowing reaches of stream to spawn that is initiated by rising water levels following heavy rains. Bighead and silver carp need 35-40 miles (56-64 km) of open river to successfully spawn (Jennings, 1988; Verigin, 1978; Nico and Jelks, 2011). While silver and bighead carp are highly opportunistic on their diet, 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). 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 and Jelks, 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).

However, the exact dispersal capability of these 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) though 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 these fish when they arrived at these locations is unknown. While ongoing research by IDNR 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).

Passage of Asian carp upstream of the Prairie du Sac Dam is unlikely because it is reported to currently be a complete fish barrier by the WDNR due to its high hydraulic head (38 feet or 11.6 m) and lack of fish passage. However, installation of fish passage is currently a licence requirement for Prairie du Sac Dam and agencies are currently reviewing alternatives for this, although no final decisions have been made as of the date of this report. The low rating for Asian carp in this section is reflective only of existing conditions and does not take into consideration any future fish passage project at the dam.

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

Inland Silverside (from MRB to GLB)

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, 1988). The ability of this species to reach the divide at Portage Downstream is low for at least two reasons. First, it has apparently been unable to successfully colonize areas in the upper Mississippi River Basin beyond where it has been stocked, and stocking had failed at Turtle Lake in Minnesota. Second, as a small fish it is unlikely to be able to move great distances upstream to the Prairie du Sac Dam.

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

Northern Snakehead (from MRB to GLB)

If the Arkansas population does begin to expand into and up the Mississippi River, there are many barriers to movement including dams on the river and its tributaries. Habitat preferred by northern snakeheads includes stagnant, shallow ponds or swamps with mud substrate, aquatic vegetation, and slow muddy streams (Courtenay and Williams, 2004). The northern snakehead likely possesses the ability to spread through portions of interconnecting tributary streams. Its preferred habit is not flowing waters, which will likely slow its spread up the Mississippi River and its tributaries. Unlike the Asian carp, 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. The main stem of much of the Mississippi River may not provide adequate habitat to this species to maintain a viable population to attempt a spread towards the Great Lakes.

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

Scud (from MRB to GLB)

The species is not in proximity to the pathway and is small and minimally mobile, and therefore, does not likely have the ability to move upstream to the pathway under its own power in the next 50 years. While upstream dispersal has been observed on the Illinois River (USACE, 2011b), it is unlikely that this species can move upstream significant distances under its own power. It is not found in fast flowing or turbid water and typically moves downstream, not upstream (Grigorovich, et al., 2008).

Team rating: **Low**
Team certainty rating: Moderately Certain

Plant ANS (from MRB to GLB)

As discussed above, it is highly unlikely that a plant ANS would reach the divide location without assistance from some non-aquatic vector in the next 50 years. However, some ANS plant species such as the marsh dewflower exhibit vigorous growth and can spread by root fragments during flood events (Swearingen, 2010). Expansion in the Southeastern United States has been slowly over many decades (Dunn and Sharitz, 1990b). Dotted duckweed is in closest proximity to Portage, Wisconsin but in the Illinois River Watershed in Illinois. Dotted duckweed was first documented in Missouri in 1934 and is now well naturalized in the southeastern United States. It is a tiny free floating plant that is distributed easily and colonizes quickly (Jacono, 2002). Dotted duckweed may be limited due to its sensitivity to severe frosts and the plants are not known to survive cold temperatures (e.g., 0º C for several weeks) (Jacono, 2002; Landolt, 1986).

Team rating: **Low**
Team certainty rating: Reasonably Certain

Viral Hemorrhagic Septicemia (VHSv) (from GLB to MRB)

From Lake Winnebago to the watershed divide at Portage Downstream along the Upper Fox River is approximately 100-120 miles (161-193 km). The Lower Fox River, connecting Lake Winnebago and Green Bay, is 39 miles (63 km) long. The USGS gage (No. 04073365) on the Fox River at Princeton, Wisconsin (about 50 miles (80.5 km) from the watershed divide) shows average river discharge ranges from 1,300 cfs (37 cms) in June to 550 cfs (16 cms) low flow in September.

Viral hemorrhagic septicemia virus has been identified in Lake Winnebago and so has the common carp, which is also present in the Fox River. Infected common carp, as a potential carrier of VHSv (and potentially the parasitic copepod, have not been identified within the Upper Fox River. Common carp are strong swimmers that can reach sustained speeds of 1.3-3.9 fps (0.4-

1.2 mps) and burst speed of 3.9-8.5 fps (1.2-2.6 mps). Though they cannot jump (maximum height six feet or 1.8 m) like members of the salmon family, they can move upstream during moderate flow events. The lock and dam system, and dam heights on the Fox River appear to be insufficient to prevent the upstream dispersal of fish from Lake Winnebago that could carry VHSv. As a result, VHSv could reach the divide location assuming it is still present in Lake Winnebago.

If VHSv is no longer present in Lake Winnebago there would be less risk of VHSv reaching the divide because fish cannot readily reach Lake Winnebago from Lake Michigan because of the permanently closed lock at the impassable Rapid Croche Dam on the Lower Fox River. However, the dam may be passable by common carp during a 10 percent annual recurrence interval flood event with the difference in elevation between the sill and tailwater at five feet (1.5 m) and less than fps (1.2 mps) velocity. At the one percent recurrence interval discharge event, with a tailwater elevation difference of 3 feet (0.9 m), it is not considered to be passable by fish.

During spring run-off events in April and May, common carp move into the shallow waters of bays and river systems to spawn. The lack of a ditch connection across the mile (1.6 km) wide wetland that would direct flowing waters across the divide to the Fox River during an overflow event across Highway 51 or the Duck Creek backwater would likely minimize access to the Mississippi River Basin for the typical fish species that would use the shallow water wetlands in the spring for spawning, such as the common carp and northern pike. However, the divide, consisting of more than a mile (1.6 km) wide emergent wetland complex off the Fox River, could be a viable pathway to further dispersal across the divide for certain species during longer duration storm events, particularly if the runoff occurs in the spring. Though northern pike spawn in shallow water wetlands, it is unlikely this fish species would cross the divide. However, if sufficient water depths of a foot (30 cm) or more were maintained in the wetland complex for several days during spring spawning season, common carp could possibly find a path through the wetland divide, roadside ditches, or sheet flow and into the Mississippi River Basin. The emergent wetland divide provides suitable habitat for common carp and other species at certain times of the year, sufficient ponds, and forage is available for survival. If common carp were present in the wetland divide, it is likely that they could survive the transfer to the Mississippi River Basin.

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

Ruffe and Tubenose Goby (from GLB to MRB)

From Lake Winnebago to the watershed divide at Portage along the Upper Fox River is approximately 100-120 miles (161-193 km). The Lower Fox River, connecting Lake Winnebago and Green Bay, is 39 miles (63 km). The USGS gage (No. 04073365) on the Fox River at Princeton, Wisconsin (about 50 miles (80.5 km) from the watershed divide) shows average river discharge ranges from 1,300 cfs (37 cms) in June to 550 cfs (15.5 cms) low flow in September. 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 vicinity of the divide within the Great Lakes Basin, consisting of more than a mile (1.6 km) wide emergent wetland complex off the Fox River, appears to be a barrier to further movement toward the divide . The emergent wetland complex is not a preferred habitat for either the ruffe or the tubenose goby and the likelihood of either fish species crossing emergent wetlands during a flood event is considered low as the flow of water is from the Mississippi River Basin to the Great Lakes Basin.

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

Threespine Stickleback (from GLB to MRB)

The threespine stickleback has been found in the Great Lakes and in smaller river systems. While not having been identified within the Upper Fox River, its

close proximity in the Great Lakes indicates potential for access and transfer to the Mississippi River Basin. Section 2.7 describes the dams as potential obstacles to upstream movement to the basin divide. Sufficient forage and habitat appear to be available throughout the Upper Fox River for the threespine stickleback. However, the literature does not indicate a propensity to move upstream during runoff events and it is unlikely that this species would reach the basin divide at Portage Downstream by natural means. The Swan Lake Marsh and wetland area is a mile (1.6 km) wide emergent wetland complex, which should be sufficient in impeding spread of the threespine stickleback at all flow conditions as an emergent wetland complex is not a preferred habitat. However, the fish could potentially survive in the emergent wetland divide during a storm runoff event as they are tolerant 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 spread 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 (from MRB to GLB)

The probability of Asian carp arriving at the pathway through other non-aquatic means is higher for aquatic vectors due to the large area upstream of the Prairie du Sac Dam and the Portage Downstream location, and the high recreational use of the Wisconsin River and its flowages. This could result in accidental bait bucket transfers of juvenile Asian carp, though the chance of a transfer seems small because carp grow quickly and would likely be mistaken for bait only when very young. A greater consideration in this rating is the fact that there is a large and accessible area of river and flow upstream of the Prairie du Sac Dam, which would increase the potential for intentional or accidental releases of Asian carp. Those flowages could provide suitable habitat for the fish and any established population of Asian carp there would likely have continuous access to this pathway location because most dams do not substantially inhibit the downstream movement of fish. Asian carp are specifically prohibited species by name in Wisconsin, which would help prevent the intentional or unintentional release of fish.

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

Inland Silverside (from MRB to GLB)

The likelihood that this species reaches the basin divide at Portage Downstream through non-aquatic means such as bait bucket transfer, was also rated low due to the inland silverside's absence in Wisconsin. However,

the certainty of this rating is lower because bait bucket transfer would still be possible due to the high recreational use of the Wisconsin River, even though this species is prohibited under Wisconsin law (NR 40.02(17)). The WDNR has indicated that silverside mortality is high in normal bait buckets.

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

Northern Snakehead (from MRB to GLB)

It is also more likely that this species would be transported to the pathway location by non-aquatic means. Bait bucket transfer seems unlikely due to the snakehead's size and physical appearance (it does not look like a bait species). However, there is a possibility that the species would be released into waters intentionally, as has been the case in other introductions in the U.S. There is a large area of the Wisconsin River upstream of the pathway location, that is easily accessed by the public. The certainty of such a release is only moderate, because numerous efforts have been made to prevent such releases from happening, including the fact that the species is prohibited under Wisconsin law (NR 40.02(17)).

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

Scud (from MRB to GLB)

There is a large area upstream of the pathway that is heavily utilized for recreation, and it is possible for the species to be carried from its current location to the Wisconsin River in water within recreational vessels or in bait buckets, as it can readily be transported by attaching to boat hulls (Grigorovich, et al., 2008).

Team rating: **Medium**
Team certainty rating: Moderately Certain

Plant ANS (from MRB to GLB)

There is a reasonable certainty that an ANS plant species could be introduced to the divide location by non-aquatic means, either natural or anthropogenic, within the next 20-50 years. The fact that there is a large area upstream of the divide location that could be colonized by plant ANS, and those plant colonies could then provide a continuous source of plant material to the divide location, is of major importance at this site. Any of these species could be transported to or upstream of the divide location through recreational boats and trailers. Education is an important factor in reducing human transport, and this vector is not hampered by watershed divides.

Dotted duckweed is a small, inconspicuous duckweed species which could be unintentionally transported by boats or trailers traveling into Wisconsin from surrounding states. It could also be spread through the migration and movement of waterfowl or small mammals (ISSG, 2006; Jacono, 2002). Marsh dewflower and Cuban bulrush also produce both seeds and vegetative fragments which could be transported by human or animal means. However, neither species is currently reported from any states in close proximity to Wisconsin. At least one of these species, the Cuban bulrush, can also be transported in the gut of migratory birds.

Team rating: **Medium**
Team certainty rating: Reasonably Certain

Viral Hemorrhagic Septicemia Virus (from GLB to MRB)

There is no evidence or information to suggest the emergent wetlands at the divide is a recreational area 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. Furthermore, in the unlikely event an infected common carp is introduced into the divide, the aquatic habitat is considered marginally suitable for survival of the host common carp for at least the summer during most years. While the common carp is a very tolerant fish, survival of infected carp in the emergent wetland when water temperatures in the small water bodies become elevated, and dissolved oxygen content diminishes, is considered unlikely. Establishment of VHSv within the divide 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.

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

Ruffe and Tubenose Goby (from GLB to MRB)

There is no evidence or information to suggest the emergent wetlands 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. Furthermore, in the unlikely event ruffe or tubenose goby were introduced into the divide, the aquatic habitat is considered marginally suitable for survival of the ruffe and tubenose goby for at least the summer during most years. Transit across the watershed divide by other anthropogenic means is possible, but unlikely because fishing and recreational boating do not occur at the divide. The ruffe and tubenose goby are listed among the "established non-native fish species" (see WDNR 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 WDNR. While it is feasible that either species could arrive at the divide by anthropogenic means, such as livewell or aquarium releases, this is also unlikely as these two fish species are not normally used as live bait for river fishing or aquarium species.

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

Threespine Stickleback (from GLB to MRB)

The threespine stickleback can tolerate dissolved oxygen levels as low as two ppm at 68ºF (20ºC), which might not be met at all connecting waterways to the Portage Downstream site in late summer. There is no evidence or information to suggest the emergent wetland is a recreational area 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 is listed among the "established non-native 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 WDNR. Since fishing and boating are not recreational uses that occur at the divide, it is unlikely that the species would arrive at the divide by anthropogenic means. Education will be critical to minimizing accidental introductions through this pathway, thus the rating and certainty.

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 (from MRB to GLB)

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 and habitat requirements generally include diverse needs for current areas, backwater habitats, deep overwintering holes, and other habitat types needed for survival (Nico, et al., 2005). Silver and bighead carp require sufficient flow to keep fertilized eggs suspended for successful reproduction (Gorbach and Krykhtin, 1980). It is unlikely that Asian carp would be able to survive for longperiods of time on the pathway because it is a shallow wetland habitat that would likely freeze-out during winter, or reach high temperatures with low oxygen levels during the summer. However, it seems more likely that these species would be able to survive on the Wisconsin River in proximity to the pathway, as it would likely provide suitable habitat for adults and may even provide habitat for spawning and rearing in some reaches.

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

Inland Silverside (from MRB to GLB)

As a size-selective planktivore, the inland silverside relies primarily on sight for feeding, which could be limited within and around the wetlands at the divide (Elston and Bachen, 1976). The divide location would likely be unable to support the species because of winter freeze-out and/or low dissolved oxygen levels in the summer. 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. However, Richards (1977) 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). Currently there are no records of established populations at this latitude. 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 lack of quality habitat for this species at these basin connections would make it difficult for this species to colonize and become established in this location. The Wisconsin River at this location may have suitable habitat, but the site may be too far north for the species to survive, which is supported by the lack of successful populations being reported this far north, even after intentional stocking. It is possible that individuals could pass through the pathway during flood events, but this would be less likely than with larger more mobile fish species.

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

Northern Snakehead (from MRB to GLB)

The northern snakehead's native range (latitude 24-53ºN) and temperature tolerance of 32ºF-86º F (0-30ºC) indicates a species that, if introduced, could establish populations throughout most of the contiguous United States (Courtenay 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. They prefer shallow ponds and marshes with aquatic vegetation, which is similar to the aquatic habitat at the wetland divide. The snakehead's preference for shallow aquatic and wetland habitats, coupled with its ability to breath air, make it possible for this species to colonize deeper wetlands in the divide location. It still may succumb to winter freeze-out, but it does have the ability to survive under the ice. Food may be a limiting factor for the establishment of a population here. The propensity for this species to quickly move through an area such as the divide during flooding is less certain, though the species is not known for moving long distances. This species is not known to readily move over dry land in response to declining water levels as some species of snakehead are.

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

Scud (from MRB to GLB)

Suitable habitat includes rocky and/or sandy shoals (Angradi et al., 2009; Grigorovich et al., 2008). It seems likely that, if introduced, the species would be able to colonize waters near the pathway. The scud appears to have successfully established throughout the Illinois River, and the pathway location is within the latitudinal limits of it native range. The scud is also tolerant of a wide range of temperatures based on its current distribution (Ysebaert et al., 2000). It is less certain that it would be able to colonize the wetlands at the divide location.

Team rating: **Medium**
Team certainty rating: Moderately Certain

Plant ANS (from MRB to GLB)

If a plant ANS were to become established at or above the pathway location, it would likely be able to colonize the divide location or at the very least be able to be carried to the divide location by floodwaters. The wetland habitat found at the divide location would likely be suitable for at least one, if not all, of the of the target plant ANS of concern for this site. At a 50-year event, there would be about 870 cfs (24.6 cms) flowing from the Wisconsin River to the Great Lakes Basin. This amount of flow would easily carry plant material into the divide location. This would especially be true for floating material such as dotted duckweed or the floating achenes of the Cuban bulrush. However, the ability of these species to grow and overwinter in Wisconsin would play an important factor in whether they would be able to establish a sustainable population. Dotted duckweed exhibits a low winter tolerance and is unable to form turions (over-winter buds) like many of our native duckweeds (Jacono, 2002). The native and current adventive range of Cuban bulrush is tropical to sub-tropical in climate (Bryson et al., 2008), and little is known about its basic biological and ecological characteristics. Marsh dewflower is most prevalent in the southeastern United States, although some sparse populations have been reported in the temperate climates of the Pacific Northwestern U.S. (Christy, 1994), and its survival ability in Wisconsin is uncertain. Habitats of marsh dewflower include forested, emergent, and shrub scrub wetlands (Bason, 2004).

Team rating: **Medium**
Team certainty rating: Reasonably Certain

Viral Hemorrhagic Septicemia Virus (from GLB to MRB)

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 and emergent wetlands with as little as or less than one foot (30 cm) depth of water. Common carp are strong swimmers and though they cannot jump like members of the salmon family, they can move upstream during moderate flow events. Survival and reproduction of common carp as a potential carrier of VHSv is considered fairly good at this location during the spring. During spring runoff, the wetland divide, and connecting ditches and streams would provide the necessary habitat for occupation of any VHSv carrier or host fish species, at least temporarily. The adjacent rivers provide suitable habitat for all life stages of the common carp. The virus 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 37º-54ºF (2.8ºC - 12.2ºC). It also demonstrates a rapid reproductive cycle and is capable of utilizing up to 28 known fish species in the Great Lakes Basin, including common carp (WDNR, 2012b). These considerations were the primary basis for the medium rating assigned to the probability that VHSv could become established in close proximity to the lower Portage divide.

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

Ruffe and Tubenose Goby (from GLB to MRB)

There is uncertainty regarding the suitability of the aquatic habitat to sustain a population of ruffe or tubenose goby in the Upper Fox River and Portage Downstream divide wetland area. 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. Survival of a viable,

reproducing population of ruffe and tubenose goby within the wetlands at the divide location is unlikely due to low water quality and high temperatures in summer months. These considerations were the primary basis for the low rating assigned to the probability that ruffe and tubenose goby could become established in close proximity to the basin divide at the upper Portage location.

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

Threespine Stickleback (from GLB to MRB)

As a visual predator, the sometimes turbid waters of the Upper Fox River at the divide may be unsuitable for the threespine stickleback. Survival of a viable, reproducing population of threespine stickleback within the rivers adjacent to the divide is feasible. The Upper Fox River would appear to provide sufficient habitat for colonization by this species.

Team rating: **Medium**
Team certainty rating: Reasonably 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 (from MRB to GLB)

During a flood event there may be favorable conditions for a sufficient period of time to allow Asian carp to move through the pathway. The path from the Wisconsin River through Duck Creek to the interbasin structure is well defined and the pathway is projected to have a flow of 870 cfs (24.6 cms) at a two percent recurrence interval flood event. This would easily allow the passage of Asian carp up to this point. Passage beyond the interbasin structure to the Fox River could be more difficult, as there is no apparent defined channel through the SLWA. However, it is assumed that there would be a flow path for fish to follow and the distance to the Fox River is about a mile, which could be traversed by carp during a flood event.

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

Inland Silverside (from MRB to GLB)

The chance of inland silversides getting to the basin divide and then establishing a population at the site seems highly unlikely. The likelihood of establishment and subsequent crossing to the adjacent basin is limited by its ability to survive in northern latitudes.

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

Northern Snakehead (from MRB to GLB)

If snakehead were to colonize the basin divide, it is highly likely that they would be able to successfully spread across the Portage Downstream pathway and into the Great Lakes Basin since there is likely sufficient suitable habitat within the pathway.

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

Scud (from MRB to GLB)

Simply based on the species' apparent ability to spread through the Illinois River, and its existence at higher latitudes in its native range, there is a high probability that it would be capable of spreading through the aquatic pathway into the Great Lakes Basin. Due to the

limited knowledge of this species' life history, and its ability to colonize habitats outside its native range, there is only a moderate certainty of this rating. If the species were to colonize areas of the Wisconsin River upstream of the pathway location, it could be carried through this divide location by flood waters, as a two percent recurrence interval flood creates a substantial flow of 870 cfs (24.6 cms). At this rate of flow, it seems likely that some individuals could pass the divide location.

Team rating: **High**
Team certainty rating: Moderately Certain

Plant ANS (from MRB to GLB)

Once a target plant ANS crosses the divide location, it is possible that it would be able to colonize waters within the Portage Downstream pathway and thus enter the Great Lakes Basin. However the uncertain ability of these species to form sustainable populations this far north of their current range would determine whether or not they were capable of spreading and colonizing beyond this area.

Team rating: **Medium**
Team certainty rating: Moderately Certain

Viral Hemorrhagic Septicemia Virus (from GLB to MRB)

This virus is capable of persisting outside of a host for several days, demonstrates a rapid reproductive cycle, and is capable of utilizing many different host species. It is highly probable that VHSv would be successful in spreading into exposed fish populations already on both sides of the wetland basin divide in the event infected fish reach the Portage Downstream pathway. Common carp and other host species have been found in smaller rivers and lakes. If infected fish or water containing viable VHSv were successful in reaching the divide during spring runoff, it is feasible the virus could pass into the Mississippi River Basin. The common carp have been found in smaller river systems and in the Mississippi River.

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

Ruffe and Tubenose Goby (from GLB to MRB)

Ruffe and the tubenose goby have not been found in river systems similar to the Upper Fox River. If the fish were introduced into the divide, they may be successful in passing through the pathway into the Mississippi River Basin.

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

Threespine Stickleback (from GLB to MRB)

If the threespine stickleback were introduced into the rivers adjacent the divide, it is highly likely that the fish would survive and pass through the Portage Downstream pathway into the Mississippi River Basin during a suitable flood event.

Team Rating: **High**
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 Portage Downstream 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 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 12. At the Portage Downstream 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 13. At the Portage Downstream location, 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 12 and 13. Thus, in Table 13, the overall probability that a viable aquatic pathway exists at the Portage Downstream 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

Table 12. Summary of individual probability elements and overall pathway viability (Mississippi River Basin to Great Lakes Basin). Certainty ratings for each element are in parentheses.

			Form 1	Form 2	Form 3a	Form 4	Form 5	
Group	**Common Name**	**Mode of Dispersal**	**Pathway Exists? (Sect. 3.6)**	**Within Either Basin? (Sect. 4.1)**	**Survive Independent Transit to Pathway? (Sect. 4.2.1)**	**Establishment in Proximity to Aquatic Pathway? (Sect. 4.3)**	**Cross Pathway into New Basin? (Sect. 4.4)**	**Aquatic Pathway Viability Rating**
fish	Asian Carp, silver carp, bighead carp, black carp	swimmer	M (VC)	M (RC)	L (RC)	M (MC)	H (RC)	L
fish	inland silverside	swimmer		M (RC)	L (RC)	L (RC)	L (MC)	L
fish	northern snakehead	swimmer		M (RC)	L (RC)	M (RC)	H (RC)	L
crustacean	scud	ballast water		M (MC)	L (MC)	M (MC)	H (MC)	L
plant	dotted duckweed, marsh dewflower, cuban bulrush	rec boats and trailers		M (RU)	L (RC)	M (RC)	M (MC)	L
Overall Pathway Viability for Spread of ANS from Mississippi River Basin to Great Lakes Basin								**L**

***Though the rating from the Mississippi River Basin to the Great Lakes Basin is low, there is a much higher probability of ANS passage from the Mississippi River Basin if ANS are established in the Wisconsin River or tributaries based on the frequency of discharge events that enter the Great Lakes Basin from the Mississippi River Basin.**

Table 13. Summary of individual probability elements and overall pathway viability rating (Great Lakes Basin to Mississippi River Basin). Certainty ratings for each element are in parentheses.

			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? (Sect. 3.6)**	**Within Either Basin? (Sect. 4.1)**	**Survive Independent Transit to Pathway? (Sect. 4.2.1)**	**Establishment in Proximity to Aquatic Pathway? (Sect. 4.3)**	**Cross Pathway into New Basin? (Sect. 4.4)**	**Aquatic Pathway Viability Rating**
fish	threespine stickleback	swimmer	M (VC)	M (RC)	L (RC)	M (RC)	H (RC)	L
fish	Benthic fish ruffe, tubenose goby	swimmer		M (RC)	L (RC)	L (RC)	M (RC)	L
virus	viral hemorrhagic septicemia	pathogen		M (RC)	M (MC)	M (RC)*	H (RC)	M
Overall Pathway Viability for Spread of ANS from Great Lakes Basin to Mississippi River Basin								**M**

***The WDNR recommended a lower certainty rating (i.e., relatively uncertain) based on a lack of sufficient cold water tributaries to support VHSv during summer months in the proximity of the pathway.**

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

An aquatic pathway exists at the Portage Downstream location during flood events that exceed a 10 percent recurrence interval, and there is a possibility that VHSv could utilize this pathway to transfer from the Great Lakes Basin into the Mississippi River Basin. The ANS of concern for Portage Downstream from the Mississippi River Basin would not be able to reach the pathway because of downstream obstructions, and the only ANS of concern that could reach the pathway from the Great Lakes Basin would need to be able to self-propel or attach to species that are able to move. For this reason, and because it can infect numerous fish species, VHSv was the only species from the Great Lakes Basin to be a threat to interbasin transfer at this location. For ANS other than VHSv to arrive at the divide in numbers substantial enough to establish a population, movement to this location would likely require human facilitation or similar mechanisms. As a result, there could be an equal potential that ANS could be transported across the basin divide and into the adjacent basin at other locations along the basin divide.

6.1 Portage Downstream Problem Statements

This section uses the results of the assessment to develop a list of statements that define and frame the nature and extent of the problems associated with the potential for spread of ANS through the Portage Downstream pathway, in either direction between the Great Lakes and Mississippi River Basins.

- The interagency team of experts evaluating the hydrology of Portage Downstream rated it as a location where there is a medium probability for the occurrence of an aquatic pathway existing between the basins, but information regarding water depths across the divide during flood events is unavailable. It is likely that most of the flow during flood events would be relatively shallow sheet-flow. The rate of flow during a two percent recurrence interval event across the divide from the Mississippi River Basin to the Great Lakes Basin would be about 870 cfs (24.6 cms).

- Unlike most pathway locations, Portage Downstream exists along a major waterway on the Mississippi River Basin side, rather than near the headwaters of both basins. This provides the means to passively-transport any ANS (i.e., plants) that can disperse within or on the water column present on the Wisconsin River upstream of the pathway location. As a result, any ANS established at or above the pathway location on the Wisconsin River would be afforded the opportunity to cross the divide into the Great Lakes Basin during every flood event that inundates the divide.

- The primary ANS of concern for interbasin transfer from the Mississippi River Basin through Portage Downstream into the Great Lakes Basin are fish. An interagency team that conducted the biological ratings characterized the likelihood of ANS transfer from the Mississippi River Basin through Portage Downstream into Great Lakes Basin as "low". The three species of Asian carp are prolific swimmers and are of most concern. The northern snakehead is not as prolific a swimmer, so it is not expected to be a near-term threat. However, its affinity for ditch and wetland types of habitats and its amphibious traits make it a species with a higher likelihood of being able to establish a population and spread across the basin divide if it reaches Portage Downstream. The inland silverside has a questionable ability to colonize habitats at this latitude.

- The primary ANS of concern for interbasin transfer from the Great Lakes Basin through Portage Downstream into the Mississippi River Basin are: VHSv, a pathogen; and the threespine stickleback,

ruffe, and tubenose goby; all small fish. However, an interagency team that evaluated the hydrology and conducted the biological characterizations rated the likelihood of ANS transfer (specifically VHSv) from the Great Lakes Basin to the Mississippi River Basin as "medium".

- Invertebrates and plants are also ANS of concern for interbasin transfer from the Mississippi River Basin through Portage Downstream and into the Great Lakes Basin. The team rating for the transfer of these groups of ANS is low, primarily due to the fact that these ANS do not yet occur on the Wisconsin River at, or upstream of this pathway location. Should any of these ANS become established there, the rating would likely increase.

- A contributing factor to the level of uncertainty in the hydraulic model estimates for the frequency, duration, and magnitude (width, depth and flow velocity) of the intermittent aquatic pathway spanning the divide at this location is the variation in hydraulic parameters used to determine flood elevations, and the lack of detailed ground surveys and stream gage data at the basin divide. In addition, further analysis is required to determine why the 2010 flood, which had the eighth highest discharge on record, resulted in the highest recorded stage at Portage. Due to these uncertainties, additional and better information would be needed to support any design and possible future construction of any structural measure(s) to prevent ANS spread through this location.

- There was uncertainty associated with biological ratings due to a variety of unknowns and uncertainties regarding the location and distribution of the large array of ANS that have been introduced to the waters of the U.S., as well as the life history requirements of each of these ANS, and the suitability of the habitat within the waterways between the current nearest locations of the ANS and Portage Downstream.

- The greatest unknown regarding Portage Canal is the integrity of the buried collection pipes, such as whether or not they will remain buried or the river will migrate over this area and scour out the sediments. An investigation of these pipes may be warranted, but it may also be appropriate to consider the possibility of simply removing this connection. Even if a connection were established via these pipes, there is a sluice gate that can be closed to prevent a connection from establishing.

- There are ways that human beings could facilitate ANS bypassing the Portage Downstream and transferring 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; etc.

6.2 Portage Downstream 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 spread between the basins at the Portage Downstream 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 Portage Downstream from either direction, provided adverse flood impacts can be avoided. The interagency team has tentatively identified the following range of potential structural measures to prevent ANS spread through Portage Downstream.

    - Raise the Portage Levee and permanently close culverts.

    - Construct one or more impermeable or permeable barrier(s) or floodwalls.

    - Completely and permanently close the water inlet pipe to the Portage Canal

- There are other broad categories of technology for potential active measures that may or may not require a structure to prevent ANS transfer at this locations, such as:

    - Chemical deterrents in order to reduce habitat suitability at or near the pathway, or on connecting streams.

    - Biological control measures that prevent ANS reproduction or prevent the ability of ANS to establish a sustainable population in the vicinity of the pathway or on connecting streams.

    - Physical removal of ANS at their current locations.

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

- New or modified regulations or ordinances prohibiting the establishment of drainage ways that connect the Mississippi River tributaries with tributaries of Lake Michigan (e.g., ditch construction, culvert installation).

- Maintenance of the Prairie du Sac Dam without fish passage, although installation of fish passage at this dam is currently a licence requirement.

- Explore and support measures to reduce the potential source populations of certain ANS downstream of the pathway:

    - 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

    - A specific stage discharge analysis could be completed to determine if there has been a shift in the rating curve over time to better identify the threshold for the formation of an aquatic pathway. To do this, all of the stage and discharge data at the Wisconsin Dells gage just upstream of Portage would have to be assessed to determine if a shift occurred or if 2010 was just an anomaly. Ensuring a homogenous historic record for this (e.g., the gage wasn't move around) would be critical. Public education near the pathway and at downstream locations 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

- Site-specific elevation surveys and hydrologic and hydraulic investigations to better correlate precipitation events to surface flows in order to gain an improved understanding of the depth and location of surface water at different flood events.

- Take ANS transfer potential into account for proposed water resource projects (e.g., ecosystem restoration, dam removal, stream restoration, water management).

- Where possible, maintain pristine habitats as whole, intact ecosystems to help prevent any ANS establishment at or near the basin divide;

- Support research on the biology of ANS so risk of transfer can be better understood.

    - Life history

    - Habitat 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:
    - Develop integrated ANS sampling and analysis plan utilizing eDNA and conventional biological sampling events at times when ANS would be expected to be present in the area, such as during flood events.
    - 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.
    - Integrated ANS monitoring focusing on the Wisconsin River downstream of the Prairie du Sac Dam would improve the effectiveness of fish passage sorting that may occur if fish passage is installed at this location by alerting those sorting fish when any undesirable species might soon be encountered.
- 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 Portage Downstream would likely benefit from corresponding development and implementation of one or more of the other types of non-structural opportunities identified. The results of this assessment may also aid in the implementation of, and future updates to, the Wisconsin ANS comprehensive management plan.

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Appendix A.

Evaluation Forms for each ANS of Concern Selected for the Portage Downstream and Canal Pathway

Portage Downstream and Canal, Columbia 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	VC	Medium	VC
	USACE, Rock Island - Hydraulic Engineer	Medium	VC	Medium	VC
	NRCS - Hydraulic Engineer	Medium	RC	Medium	RC
	Team Ratings	**Medium**	**VC**	**Medium**	**VC**

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: Interbasin flows at the Portage downstream interbasin flow structure are well documented as part of the Portage FRM project and FIS update. This structure consists of 2-5'Hx10'W box culverts through the Portage Levee. For a 10% chance flood, 60 to 80 cfs is conveyed through this structure, with greater amounts of flow for larger floods. The Columbia County FIS mapping clearly shows a connection between the Wisconsin and Fox River basins. During the site visit on 06-June-2011, no flow was occuring through the interbasin structure. Observations suggest that when flow does occur through the structure, it is conveyed through a marsh (reed canary grass) then through 2-7'Hx8'W box culverts through the Sioux Line RR, then through another marsh (the Swan Lake State Wildlife Area) to the Fox River. No continuous channels or ditches were observed between the interbasin flow structure and the box culverts at the Sioux Line RR during the site visit, however grassy vegetation may have obscured this evidence. Aerial photography indicates intermittent ditches along the flow path, with a large ditch on the East side of the Swan Lake Wildlife area with a connection to the Fox River.

Portage Downstream and Canal, Columbia 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 - Biologist	Medium	RC		
	USACE, Detroit - Biologist	Medium	RC		
	Wisconsin DNR, Fisheries Research Scientist	Medium	RC		
	Team Rating	**Medium**	**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 moving 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 moving 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 and bighead carp are established in the middle and lower Mississippi River Basin. The nearest known reproducing populations are found at the Quad Cites, over 100 miles (161 km) south of the Wisconsin River. Single individuals have been collected from the Mississippi River at a number of places upstream of this, but there is no evidence of successful reproduction or self-sustaining populations. Two bighead carp have been collected in the Wisconsin River below the Prairie du Sac dam in 2011 (USGS, 2011). Silver carp have been collected in the Mississippi River well upstream of the mouth of the Wisconsin River and would likely be able to reach the Prairie du Sac dam as evidenced by the collection of bighead carp there. However, the Prairie du Sac (PdS) Dam is a complete barrier to Asian carp upstream movement and prevents them from reaching the Portage area. Even when upstream fish passage is installed at PdS Dam, estimated to be constructed in 2013 or 2014, the design and operation of the facility will prevent upstream movement of Asian carp. A fish elevator will be installed and all fish in the elevator will be identified and sorted so that only select species (native) of fish are allowed move over the dam. All unwanted species, including Asian carp, will not be allowed to pass upstream of the dam. Black carp have a more limited distribution and are less likely to reach the Prairie du Sac dam in the near-term. Barring deliberate or unintentional movement of Asian carp by human transportit is unlikely that Asian carp will reach Portage within the next 20 years.

Portage Downstream and Canal, Columbia 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 - Biologist	Low	RC	Medium	RC
	USACE, Detroit - Biologist	Low	RC	Medium	RC
	Wisconsin DNR, Fisheries Research Scientist	Low	RC	Medium	RC
	Team Ratings	**Low**	**RC**	**Medium**	**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 passage 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. Passage of Asian carp upstream of the Prairie du Sac (PdS) dam is unlikely because it is reported to be a complete fish barrier by the DNR, presumably due to it high hydraulic head (39 feet) and lack of a fishway. However, a fishway at this dam is planned for construction (completion estimated for 2013 or 2014), but the fishway would be a fish elevator used to only provide passage for desirable species. Assuming it is operated to only pass desirable species, this would nearly eliminate the potential for Asian carp to move upstream of the PdS dam. However, operation of such a fishway would be subject to human error, which is why a reasonable certainty (RC) was applied to this rating.

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

3B. The probability of Asian carp arriving at the pathway through other means is higher due to the large area upstream of the PdS dam and the Portage site, coupled with the high recreational use of the Wisconsin River and its flowages there. This could result in bait bucket transfers of juvenile Asian carp, though the chance of such a transfer seems small because carp grow quickly and would likely be mistaken for bait only when very young. A greater consideration in the rating is the fact that there is a large and accessible area of river and flowages upstream of the PdS dam, which would increase the potential for intentional or accidental releases of Asian carp. Those flowages would provide suitable habitat for the fish and any established population of Asian carp there would likely have continuous access to this pathway location because most dams do not substantially inhibit the downstream migration of fish. Asian carp are specifically prohibited species by name in WI, which would help prevent the intentional or unintentional release of fish.

Portage Downstream and Canal, Columbia 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 - Biologist	Medium	MC		
	USACE, Detroit - Biologist	Medium	MC		
	Wisconsin DNR, Fisheries Research Scientist	High	RC		
	Team Ratings	**Medium**	**MC**		

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: 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 and habitat requirements generally include diverse needs for current areas, backwater habitats, deep overwintering holes, and other habitat types needed for survival (Nico, et al., 2005). Silver and bighead carp require sufficient flow to keep fertilized eggs suspended for successful reproduction (Gorbach and Krykhtin, 1980). It is unlikely that Asian carp would be able to survive for longperiods of time on the pathway because it is a shallow wetland habitat that would likely freeze-out during winter, or reach high temperatures with low oxygen levels during the summer. However, it seems more likely that these species would be able to survive on the Wisconsin River in proximity to the pathway, as it would likely provide suitable habitat for adults and may even provide habitat for spawning and rearing in some reaches.

Portage Downstream and Canal, Columbia 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 - Biologist	High	RC		
	USACE, Detroit - Biologist	High	RC		
	Wisconsin DNR, Fisheries Research Scientist	High	RC		
	Team Ratings	**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: During a flood event there may be favorable conditions for a sufficient period of time to allow Asian carp to move through the pathway. The path from the Wisconsin River through Duck Creek to the interbasin structure is well defined and the pathway is projected to have a flow of 870 cfs (24.6 cms) at a two percent recurrence interval flood event. This would easily allow the passage of Asian carp up to this point. Passage beyond the interbasin structure to the Fox River could be more difficult, as there is no apparent defined channel through the Swan Lake Wildlife area. However, it is assumed that there would be a flow path for fish to follow and the distance to the Fox River is about a mile, which could be traversed by carp during a flood event.

Portage Downstream and Canal, Columbia 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	VC	Medium	VC
	USACE, Rock Island - Hydraulic Engineer	Medium	VC	Medium	VC
	NRCS - Hydraulic Engineer	Medium	RC	Medium	RC
	Team Ratings	**Medium**	**VC**	**Medium**	**VC**

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: Interbasin flows at the Portage downstream interbasin flow structure are well documented as part of the Portage FRM project and FIS update. This structure consists of 2-5'Hx10'W box culverts through the Portage Levee. For a 10% chance flood, 60 to 80 cfs is conveyed through this structure, with greater amounts of flow for larger floods. The Columbia County FIS mapping clearly shows a connection between the Wisconsin and Fox River basins. During the site visit on 06-June-2011, no flow was occuring through the interbasin structure. Observations suggest that when flow does occur through the structure, it is conveyed through a marsh (reed canary grass) then through 2-7'Hx8'W box culverts through the Sioux Line RR, then through another marsh (the Swan Lake State Wildlife Area) to the Fox River. No continuous channels or ditches were observed between the interbasin flow structure and the box culverts at the Sioux Line RR during the site visit, however grassy vegetation may have obscured this evidence. Aerial photography indicates intermittent ditches along the flow path, with a large ditch on the East side of the Swan Lake Wildlife area with a connection to the Fox River.

Portage Downstream and Canal, Columbia 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 - Biologist	Medium	RC		
	USACE, Detroit - Biologist	Medium	RC		
	Wisconsin DNR, Fisheries Research Scientist	Medium	RC		
	Team Rating	**Medium**	**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 moving 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 moving 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 have not been collected in the Wisconsin River. Recently, its most northern known occurrence in the Mississippi River Basin is on the Kankakee River in Will County Illinois, where they were collected in 1996 (USGS, 2011). The species was stocked in Turtle Lake in Ramsey County, Minnesota in 1950, but that population failed. It appears that the majority of the locations in which this species is collected outside of its native range is a result of stocking, and the species is not being collected far from the initial stocking area. There is no evidence that the species has expanded beyond these areas and it is unlikely it would reach the pathway on its own within the next 20 years.

Portage Downstream and Canal, Columbia 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 - Biologist	Low	RC	Low	RC
	USACE, Detroit - Biologist	Low	RC	Low	RC
	Wisconsin DNR, Fisheries Research Scientist	Low	VC	Low	RC
	Team Ratings	**Low**	**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 passage 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 ability of this species to reach the divide at Portage is low for at three reasons. First, it has apparently been unable to successfully colonize areas in the upper MRB beyond where it has been stocked, and stocking had failed at Turtle Lake in Minnesota. Second, as a small fish it is unlikely to be able to move great distances upstream to the Prairie du Sac dam. Third, the PdS dam would likely serve as an effective barrier to upstream travel.

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

3B. The likelihood that the species reaches the divide through other means such as bait bucket transfer was also rated as low due to its absence in WI, but the certainty of this rating is lower because bait bucket transfer would still be possible due to the high recreational use of the Wisconsin River, even though this species is prohibited under WI law (NR 40.02(17)). 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).

Portage Downstream and Canal, Columbia 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 - Biologist	Low	RC
	USACE, Detroit - Biologist	Low	RC
	Wisconsin DNR, Fisheries Research Scientist	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: As a size-selective planktivore, the inland silverside relies primarily on sight for feeding, which could be limited within and around the wetlands at the divide (Elston and Bachen, 1976). The divide location would likely be unable to support the species because of winter freeze-out and/or low dissolved oxygen levels in the summer. 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. However, Richards (1977) showed that the inland silverside can survive for at least two weeks at 34.7 F (1.5 C). Stoeckel and Heidinger (1988) demonstrated that inland silversides can be maintained over winter in aquaculture systems at temperatures above 59 F (15 C), 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. Currently there are no records of established populations at this latitude. The lack of quality habitat for this species at these basin connections would make it difficult for this species to colonize and become established in this location. The Wisconsin River at this location may have suitable habitat, but the site may be too far north for the species to survive, which is supported by the lack of successful populations being reported this far north, even after intentional stocking. It is possible that individuals could pass through the pathway during flood events, but this would be less likely than with larger more mobile fish species.

Portage Downstream and Canal, Columbia 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 - Biologist	Low	MC		
	USACE, Detroit - Biologist	Low	MC		
	Wisconsin DNR, Fisheries Research Scientist	Low	RC		
	Team Ratings	**Low**	**MC**		

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 chance of inland silversides getting to the basin divide and then establishing a population at the site seems highly unlikely. The likelihood of establishment and subsequent crossing to the adjacent basin is limited by its ability to survive in northern latitudes.

Portage Downstream and Canal, Columbia 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	VC	Medium	VC
	USACE, Rock Island - Hydraulic Engineer	Medium	VC	Medium	VC
	NRCS - Hydraulic Engineer	Medium	RC	Medium	RC
	Team Ratings	**Medium**	**VC**	**Medium**	**VC**

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: Interbasin flows at the Portage downstream interbasin flow structure are well documented as part of the Portage FRM project and FIS update. This structure consists of 2-5'Hx10'W box culverts through the Portage Levee. For a 10% chance flood, 60 to 80 cfs is conveyed through this structure, with greater amounts of flow for larger floods. The Columbia County FIS mapping clearly shows a connection between the Wisconsin and Fox River basins. During the site visit on 06-June-2011, no flow was occuring through the interbasin structure. Observations suggest that when flow does occur through the structure, it is conveyed through a marsh (reed canary grass) then through 2-7'Hx8'W box culverts through the Sioux Line RR, then through another marsh (the Swan Lake State Wildlife Area) to the Fox River. No continuous channels or ditches were observed between the interbasin flow structure and the box culverts at the Sioux Line RR during the site visit, however grassy vegetation may have obscured this evidence. Aerial photography indicates intermittent ditches along the flow path, with a large ditch on the East side of the Swan Lake Wildlife area with a connection to the Fox River.

Portage Downstream and Canal, Columbia 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 - Biologist	Medium	RC		
	USACE, Detroit - Biologist	Medium	RC		
	Wisconsin DNR, Fisheries Research Scientist	Medium	VC		
	Team Rating	**Medium**	**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 moving 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 moving 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 County, Arkansas. While this is in the Mississippi River Watershed, this population does not seem to be spreading at a high rate at this time (USGS, 2011). A single specimen of giant snakehead (Channa micropeltes) was collected in the Rock River by the WDNR (a watershed not directly connected with the Portage Downstream pathway). 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).

Portage Downstream and Canal, Columbia 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 - Biologist	Low	RC	Medium	MC
	USACE, Detroit - Biologist	Low	RC	Medium	MC
	Wisconsin DNR, Fisheries Research Scientist	Low	VC	Low/Med	MC
	Team Ratings	**Low**	**RC**	**Medium**	**MC**

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 passage 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 much 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. Furthermore, this species has not demonstrated a tendency to migrate over great distances.

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

3B. It is more likely that the species would be transported to the pathway location by other means. Bait bucket transfer seems unlikely due to the snakehead's size and physical appearance (it does not look like a bait species). However, there is a reasonable possibility that the species would be released into waters intentionally, as has been the case in other introductions. There is a large area of the Wisconsin River and its flowages upstream of the pathway location easily accessed by the public. The certainty of such a release is only moderate, because numerous efforts have been made to prevent such things from happening including the fact that the species is prohibited under Wisconsin law (NR 40.02(17)).

Portage Downstream and Canal, Columbia 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 - Biologist	Medium	RC
	USACE, Detroit - Biologist	Medium	RC
	Wisconsin DNR, Fisheries Research Scientist	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: The northern snakehead's native range (latitude 24-53º N) and temperature tolerance 32º F-86º F (0-30 º C) 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. They prefer shallow ponds and marshes with aquatic vegetation, which is similar to the aquatic habitat at the wetland divide. The snakehead's preference for shallow aquatic and wetland habitats, coupled with its ability to breath air, make it possible for this species to colonize deeper wetlands in the divide location. It still may succumb to winter freeze-out, but it does have the ability to survive under the ice. Food may be a limiting factor for the establishment of a population here. The propensity for this species to quickly move through an area such as the divide during flooding is less certain, though the species is not known for migrating long distances. This species is not known to readily move over dry land in response to declining water levels as some species of snakehead are.

Portage Downstream and Canal, Columbia 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 - Biologist	High	RC		
	USACE, Detroit - Biologist	High	RC		
	Wisconsin DNR, Fisheries Research Scientist	High	RC		
	Team Ratings	**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 snakehead were to colonize the basin divide, it is highly likely that they would be able to successfully spread across the Portage Downstream pathway and into the Great Lakes Basin since there is likely sufficient suitable habitat within the pathway.

Portage Downstream and Canal, Columbia County, WI - Scud (*Apocorophium lacustre*)

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	VC	Medium	VC
	USACE, Rock Island - Hydraulic Engineer	Medium	VC	Medium	VC
	NRCS - Hydraulic Engineer	Medium	RC	Medium	RC
	Team Ratings	**Medium**	**VC**	**Medium**	**VC**

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: Interbasin flows at the Portage downstream interbasin flow structure are well documented as part of the Portage FRM project and FIS update. This structure consists of 2-5'Hx10'W box culverts through the Portage Levee. For a 10% chance flood, 60 to 80 cfs is conveyed through this structure, with greater amounts of flow for larger floods. The Columbia County FIS mapping clearly shows a connection between the Wisconsin and Fox River basins. During the site visit on 06-June-2011, no flow was occuring through the interbasin structure. Observations suggest that when flow does occur through the structure, it is conveyed through a marsh (reed canary grass) then through 2-7'Hx8'W box culverts through the Sioux Line RR, then through another marsh (the Swan Lake State Wildlife Area) to the Fox River. No continuous channels or ditches were observed between the interbasin flow structure and the box culverts at the Sioux Line RR during the site visit, however grassy vegetation may have obscured this evidence. Aerial photography indicates intermittent ditches along the flow path, with a large ditch on the East side of the Swan Lake Wildlife area with a connection to the Fox River.

Portage Downstream and Canal, Columbia County, WI - Scud (*Apocorophium lacustre*)

2. Probability of ANS occurring within either basin

Aquatic Pathway Team	Expertise Position title or team role	Rating	Certainty		
	USACE, St. Paul - Biologist	Medium	MC		
	USACE, Detroit - Biologist	Medium	MC		
	Wisconsin DNR, Fisheries Research Scientist	Medium	RU		
	Team Rating	**Medium**	**MC**		

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 moving 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 moving 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: *Apocorophium lacustre* is a species of scud that is native to the Atlantic coast of North America And is established in the Illinois River Basin (USGS, 2011). It does not densely populate the Mississippi River Basin, but it can be locally abundant. It was first reported in the Lower Mississippi River in 1987-1988, and then later found in the Ohio River in 1996, and it moved 714 miles (1,150 km) up the Ohio River within a year, likely due to shipping (Grigorovich, et al., 2008). It is currently unknown to exist in the Great Lakes Basin. The species is unable to move upstream significant distances under its own power, so it is unable to use the Mississippi River as a waterway to move into the Wisconsin River. For these reasons, it was determined that the species would be unlikely to reach the Portage Downstream Pathway within the next 20 years.

Portage Downstream and Canal, Columbia County, WI - Scud (*Apocorophium lacustre*)

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 - Biologist	Low	RC	Medium	MC
	USACE, Detroit - Biologist	Low	RC	Medium	RC
	Wisconsin DNR, Fisheries Research Scientist	Low	RU	Medium	MC
	Team Ratings	**Low**	**RC**	**Medium**	**MC**

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 passage 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 species is not in proximity to the pathway and is small and minimally mobile and, therefore, does not likely have the ability to migrate upstream to the pathway under its own power in the next 25 years. While upstream dispersal has been observed on the Illinois River (USACE, 2011a), it is unlikely that this species can move upstream significant distances under its own power.

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

3B. It is more likely that the species would be transported to the pathway and/or a location on the Wisconsin River upstream of the pathway through anthropogenic means than by natural means. There is a large area upstream of the pathway that is heavily utilized for recreation, and it is possible for the species to be carried from its current location to the Wisconsin River in water within recreational vessels or in bait buckets.

Portage Downstream and Canal, Columbia County, WI - Scud (*Apocorophium lacustre*)

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 - Biologist	Medium	MC		
	USACE, Detroit - Biologist	Medium	MC		
	Wisconsin DNR, Fisheries Research Scientist	Medium	RU		
	Team Ratings	**Medium**	**MC**		

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: Suitable habitat includes rocky and/or sandy shoals (Angradi, 2009; Grigorovich, et al., 2008). It seems likely that, if introduced, the species would be able to colonize waters near the pathway, as it seems to have successfully established throughout the Illinois River, and the pathway location is within the latitudinal limits of it native range and it appears to be tolerant of a wide range of temperatures based on its current distribution (Ysebaert, et al., 2000). It is less certain that it would be able to colonize the wetlands at the divide location.

Portage Downstream and Canal, Columbia County, WI - Scud (*Apocorophium lacustre*)

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 - Biologist	High	MC
	USACE, Detroit - Biologist	High	MC
	Wisconsin DNR, Fisheries Research Scientist	High	MC
	Team Ratings	**High**	**MC**

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: Simply based on the species' apparent ability to spread through the Illinois River, and its existence at higher latitudes in its native range, there is a high probability that it would be capable of spreading through the aquatic pathway into the Great Lakes Basin. Because of the limited knowledge of this species' life history, and its ability to colonize habitats outside its native range, there is only a moderate certainty of this rating. If the species were to colonize areas of the Wisconsin River upstream of the pathway location, it could be carried through this divide location by flood waters, as a two percent recurrence interval flood passes a substantial flow (870 cfs or 24.6 cms). At such a rate of flow, it seems likely that some individuals could pass the divide location.

Portage Downstream and Canal, Columbia County, WI - ANS Plant from MRB

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	VC	Medium	VC
	USACE, Rock Island - Hydraulic Engineer	Medium	VC	Medium	VC
	NRCS - Hydraulic Engineer	Medium	RC	Medium	RC
	Team Ratings	**Medium**	**VC**	**Medium**	**VC**

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: Interbasin flows at the Portage downstream interbasin flow structure are well documented as part of the Portage FRM project and FIS update. This structure consists of 2-5'Hx10'W box culverts through the Portage Levee. For a 10% chance flood, 60 to 80 cfs is conveyed through this structure, with greater amounts of flow for larger floods. The Columbia County FIS mapping clearly shows a connection between the Wisconsin and Fox River basins. During the site visit on 06-June-2011, no flow was occuring through the interbasin structure. Observations suggest that when flow does occur through the structure, it is conveyed through a marsh (reed canary grass) then through 2-7'Hx8'W box culverts through the Sioux Line RR, then through another marsh (the Swan Lake State Wildlife Area) to the Fox River. No continuous channels or ditches were observed between the interbasin flow structure and the box culverts at the Sioux Line RR during the site visit, however grassy vegetation may have obscured this evidence. Aerial photography indicates intermittent ditches along the flow path, with a large ditch on the East side of the Swan Lake Wildlife area with a connection to the Fox River.

Portage Downstream and Canal, Columbia County, WI - ANS Plant from MRB

2. Probability of ANS occurring within either basin

Aquatic Pathway Team	Expertise Position title or team role	Rating	Certainty		
	USACE, St. Paul - Biologist	Medium	RU		
	USACE, Detroit - Biologist	Medium	RU		
	Wisconsin DNR, Fisheries Research Scientist	Medium	RC		
	Team Rating	**Medium**	**RU**		

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 moving 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 moving 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: Plant ANS are being evaluated for the Portage Downstream site because of its unique geographic position in the watershed in that it is not at the upper headwaters of the two drainage basins. Instead, it occurs along the Wisconsin River at point with a large upstream drainage area. This results in the potential for upstream floodwaters in the Wisconsin River Basin to flow into the Great Lakes Basin, thereby permitting any material, including plant material, to be carried to and over the divide by floodwaters. It also means that there is a large source area upstream of the divide location that can be colonized by ANS, and provide a consistent source of ANS material during floods.
Three plant species that were listed as being of concern to the Great Lakes Basin include dotted duckweed, marsh dewflower, and Cuban bulrush. Additional plant species have also been determined to be of concern by professionals in the field, but for the purpose of this assessment all are being treated collectively as nuisance plant species. Only those species found in the Mississippi River Basin but not in the Great Lakes Basin have been considered here because water from the Great Lakes Basin would not flow into the Mississippi River Basin except possibly under extremely rare occasions. None of the three listed species have been found in Wisconsin, but dotted duckweed is the species in closest proximity, having been found in Bureau County, Illinois. Marsh dewflower was reported in Louisiana in the 1920's but has not spread very far up the Mississippi River (Dunn and Sharitz, 1990a). Because these plants are unable to "migrate" upstream unassisted, it is believed that they are unlikely to be found within or above this pathway location within the next 20 years without human transport. However, there is reasonable uncertainty in this rating because there is a large area potentially suitable for such plants species to establish upstream of the pathway location.

Portage Downstream and Canal, Columbia County, WI - ANS Plant from MRB

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 - Biologist	Low	RC	Medium	RC
	USACE, Detroit - Biologist	Low	RC	Medium	RC
	Wisconsin DNR, Fisheries Research Scientist	Low	RC	Medium	RC
	Team Ratings	**Low**	**RC**	**Medium**	**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 passage 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. As discussed above, it is highly unlikely that a plant ANS would reach the divide location without assistance in the foreseeable future.

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

3B. There seems to be a reasonable certainty that an ANS plant species could be introduced to the divide location by some other means, either natural or anthropogenic, within the next 20 years. The fact that there is a large area upstream of the divide location that could be colonized by plant ANS, and those plant colonies could then provide a continuous source of plant material to the divide location is of major importance at this site. Any of these species could be transported to or upstream of the divide location through recreational boats and trailers, and there are numerous instances such introductions. Education is an important factor in reducing human transport, and this means of introduction is not hampered by watershed divides.
Dotted duckweed is a small, inconspicuous duckweed species which could relatively easily be unintentionally transported by boats/trailers traveling into WI from surrounding states. It could also be spread through the migration/movement of waterfowl or small mammals (ISSG, 2006; Jacono, 2002). Marsh dewflower and Cuban bulrush also produce both seeds and vegetative fragments which could be transported by human/animal means; however, neither species is currently reported from any states in close proximity to WI. At least one of these species, the Cuban bulrush, can also be transported in the gut of migratory birds.

Portage Downstream and Canal, Columbia County, WI - ANS Plant from MRB

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 - Biologist	Medium	RC		
	USACE, Detroit - Biologist	Medium	RC		
	Wisconsin DNR, Fisheries Research Scientist	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: If a plant ANS were to become established at or above the pathway location, it would likely be able to colonize the divide location or at the very least be able to be carried to the divide location by floodwaters. The wetland habitat found at the divide location would likely be suitable for at least one, if not all, of the of the target plant ANS of concern for this site. At a 50-year event, there would be about 870 cfs (24.6 cms) flowing from the Wisconsin River to the Great Lakes Basin. This amount of flow would easily carry plant material into the divide location. This would especially be true for floating material such as dotted duckweed or the floating achenes of the Cuban bulrush. However, the ability of these species to grow and overwinter in Wisconsin would play an important factor in whether they would be able to establish a sustainable population. Dotted duckweed exhibits a low winter tolerance and is unable to form turions (over-winter buds) like many of our native duckweeds (Jacono, 2002). The native and current adventive range of Cuban bulrush is tropical to sub-tropical in climate (Bryson et al., 2008), and little is known about its basic biological and ecological characteristics. Marsh dewflower is most prevalent in the southeastern United States, although some sparse populations have been reported in the temperate climates of the Pacific Northwestern U.S. (Christy, 1994), and its survival ability in Wisconsin is uncertain. Habitats of marsh dewflower include forested, emergent and shrub scrub wetlands (Bason, 2004).

Portage Downstream and Canal, Columbia County, WI - ANS Plant from MRB

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 - Biologist	Medium	MC		
	USACE, Detroit - Biologist	Medium	MC		
	Wisconsin DNR, Fisheries Research Scientist	Medium	RC		
	Team Ratings	**Medium**	**MC**		

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: Once a target plant ANS crosses the divide location, it is possible that it would be able to colonize waters within the Portage Downstream pathway and thus enter the Great Lakes Basin. However the uncertain ability of these species to form sustainable populations this far north of their current range would determine whether or not they were capable of spreading and colonizing beyond this area.

Portage Downstream and Canal, Columbia 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	VC	Medium	VC
	USACE, Rock Island - Hydraulic Engineer	Medium	VC	Medium	VC
	NRCS - Hydraulic Engineer	Medium	RC	Medium	RC
	Team Ratings	**Medium**	**VC**	**Medium**	**VC**

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: Interbasin flows at the Portage downstream interbasin flow structure are well documented as part of the Portage FRM project and FIS update. This structure consists of 2-5'Hx10'W box culverts through the Portage Levee. For a 10% chance flood, 60 to 80 cfs is conveyed through this structure, with greater amounts of flow for larger floods. The Columbia County FIS mapping clearly shows a connection between the Wisconsin and Fox River basins. During the site visit on 06-June-2011, no flow was occuring through the interbasin structure. Observations suggest that when flow does occur through the structure, it is conveyed through a marsh (reed canary grass) then through 2-7'Hx8'W box culverts through the Sioux Line RR, then through another marsh (the Swan Lake State Wildlife Area) to the Fox River. No continuous channels or ditches were observed between the interbasin flow structure and the box culverts at the Sioux Line RR during the site visit, however grassy vegetation may have obscured this evidence. Aerial photography indicates intermittent ditches along the flow path, with a large ditch on the East side of the Swan Lake Wildlife area with a connection to the Fox River.

Portage Downstream and Canal, Columbia 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 - Biologist	Medium	RC		
	USACE, Detroit - Biologist	Medium	RC		
	Wisconsin DNR, Fisheries Research Scientist	Medium	RC		
	Team Rating	**Medium**	**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 moving 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 moving 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 can infect a wide range of host fish causing a variety of external and internal pathology, including death of the host fish (Attachment B). 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 and was found in Lake Winnebago in 2007, but not since (USGS 2011).

Viral Hemorrhagic Septicemia 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 Fox 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. It should also be noted that VHSv has been found in 28 different host fish species in the Great Lakes Basin and that it can survive without a host in the water column (WDNR, 2012b).

Carp from Lake Winnebago have access to the Upper Fox (although several low-head dams along the way provide substantial barriers), but the river is warm, and it's uncertain whether VHSv could persist in the system even if infected fish swam up the Fox River from Lake Michigan.

Portage Downstream and Canal, Columbia 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 - Biologist	Medium	MC	Low	RC
	USACE, Detroit - Biologist	Medium	MC	Low	RC
	Wisconsin DNR, Fisheries Research Scientist	Low	RC	Low	RC
	Team Ratings	**Medium**	**MC**	**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 passage 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. From Lake Winnebago to the watershed divide at Portage along the Upper Fox River is approximately 100-120 miles. The Lower Fox River, connecting Lake Winnebago and Green Bay, is 39 miles long. USGS gage 04073365 on the Fox River at Princeton, Wisconsin (about 50 miles from the watershed divide) shows average river discharge ranges from 1,300 cfs in June to 550 cfs low flow in September. The common carp has been identified in Lake Michigan and within the Fox River. Infected common carp, as a carrier of VHSv [and potentially the parasitic copepod (N. japonicus)] have not been identified within the Upper Fox River. The lock and dam system and dam heights on the Fox River appear to be insufficient to prevent the upstream migration of fish that could carry VHSv. During spring run-off events in April/May, common carp migrate into the shallow waters of bays and river systems to spawn. The lack of a ditch connection across the mile wide wetland that would direct flowing waters across the divide to the Fox River during an overflow event across Highway 51 or the Duck Creek backwater would likely minimize access to the MRB for the typical fish species that would use the shallow water wetlands in the spring for spawning, such as the common carp and northern pike. However, the divide, consisting of more than a mile wide emergent wetland complex off the Fox River could be a viable pathway to further migration across the divide for certain species during longer duration storm events, particularly if the runoff occurs in the spring. Though northern pike and common carp spawn in shallow water wetlands, it is unlike this fish species would cross the divide. However, if sufficient water depths of a foot or more were maintained in the wetland complex for several days during spring spawning season, spawning fish could possibly find a path through the wetland divide and the roadside ditches or sheet flow and into the MRB, thus the rating of medium. If any of the fish species arrived at the emergent wetland divide, which provides suitable habitat for common carp and other species at certain times of the year, sufficient ponds and forage is available for survival. Thus the rating and certainty. If any invasive species were present in the wetland divide, it is likely that fish, plants and invertebrate species could survive the transfer to the MRB and find suitable habitat to flourish.

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

3B. There is no evidence or information to suggest the emergent wetlands at the divide is a recreational area 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. Furthermore, in the unlikely event an infected carp is introduced into the divide, the aquatic habitat is considered marginally suitable for survival of the host common carp for at least the summer during most years. While the common carp is a very tolerant fish, survival of VHSv infected carp in the emergent wetland when water temperatures become elevated and dissolved oxygen content diminishes is considered unlikely. Establishment of a population within the divide 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. Any invasive species that arrive at the divide by anthropogenic means, such as livewell, hitchhikers on boats or aquarium releases, would have suitable habitat to survive and migrate to either watershed. Access to and accidental introduction are considered low risk in the divide. Education is the key to prevention of accidental invasive species transfer at the emergent wetland divide.

Portage Downstream and Canal, Columbia 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 - Biologist	Medium	RC
	USACE, Detroit - Biologist	Medium	RC
	Wisconsin DNR, Fisheries Research Scientist	Medium	RU
	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. Survival and reproduction of common carp as a potential carrier of VHSv is considered fairly good 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. The adjacent rivers provide suitable habitat for all life stages of the common carp. The virus 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 37º F - 54 º F (2.8 º C - 12.2 º C). It also demonstrates a rapid reproductive cycle and is capable of utilizing up to 28 known fish species in the Great Lakes Basin, including common carp (WDNR, 2012b). These considerations were the primary basis for the medium rating assigned to the probability that VHSv could become established in close proximity to the lower Portage divide.

Portage Downstream and Canal, Columbia 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 - Biologist	High	RC
	USACE, Detroit - Biologist	High	RC
	Wisconsin DNR, Fisheries Research Scientist	Medium	RC
	Team Ratings	**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: This virus is capable of persisting outside of a host for several days, demonstrates a rapid reproductive cycle, and is capable of utilizing many different host species. It is highly probable that VHSv would be successful in spreading into exposed fish populations already on both sides of the wetland basin divide in the event infected fish reached the Portage Downstream pathway. Common carp and other host species have been found in smaller rivers and lakes. If infected fish or water containing viable VHSv were successful in reaching the divide during spring runoff, it is feasible the virus could pass into the Mississippi River Basin. The common carp have been found in smaller river systems and in the Mississippi River.

Portage Downstream and Canal, Columbia 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	VC	Medium	VC
	USACE, Rock Island - Hydraulic Engineer	Medium	VC	Medium	VC
	NRCS - Hydraulic Engineer	Medium	RC	Medium	RC
	Team Ratings	**Medium**	**VC**	**Medium**	**VC**

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: Interbasin flows at the Portage downstream interbasin flow structure are well documented as part of the Portage FRM project and FIS update. This structure consists of 2-5'Hx10'W box culverts through the Portage Levee. For a 10% chance flood, 60 to 80 cfs is conveyed through this structure, with greater amounts of flow for larger floods. The Columbia County FIS mapping clearly shows a connection between the Wisconsin and Fox River basins. During the site visit on 06-June-2011, no flow was occuring through the interbasin structure. Observations suggest that when flow does occur through the structure, it is conveyed through a marsh (reed canary grass) then through 2-7'Hx8'W box culverts through the Sioux Line RR, then through another marsh (the Swan Lake State Wildlife Area) to the Fox River. No continuous channels or ditches were observed between the interbasin flow structure and the box culverts at the Sioux Line RR during the site visit, however grassy vegetation may have obscured this evidence. Aerial photography indicates intermittent ditches along the flow path, with a large ditch on the East side of the Swan Lake Wildlife area with a connection to the Fox River.

Portage Downstream and Canal, Columbia 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 - Biologist	Medium	RC		
	USACE, Detroit - Biologist	Medium	RC		
	Wisconsin DNR, Fisheries Research Scientist	Medium	RC		
	Team Rating	**Medium**	**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 moving 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 moving 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 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 fecundity 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 ruffe is an aggressive species that possesses the ability to feed in darkness, cold temperatures, and turbid conditions. The ruffe has extended its range rapidly and modeling (USGS, 2012) predicts it will find suitable habitat in all five Great Lakes. The Tubenose goby is a benthic species that consumes a wide variety of invertebrates (USGS, 2011). They are found in the open waters and estuaries of slow flowing rivers and are often quite abundant in backwaters and lakes and seem to prefer dense vegetation. The tubenose goby's introduced range covers three Great Lakes including Lake Superior, Erie, and Huron (USGS, 2011). It has been collected in the lower reaches of larger Great Lakes rivers and estuaries, but no tubenose goby have been collected locally in upper Great Lakes river tributaries to date. Tubenose gobies have exhibited a much slower rate of expansion in the Great Lakes than the round goby (Neogobius melanostomus), also an invasive species in the Great Lakes and now located within both the Great Lakes Basin and the Mississippi River Basin. The tubenose goby's nearest locations are in Lake Superior and Lake Huron.
Both species are present on connected waterways, but neither tends to move up streams very far, so their likelihood of getting to the Portage Area within the next 20 years is unlikely.

Portage Downstream and Canal, Columbia 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 - Biologist	Low	RC	Low	RC
	USACE, Detroit - Biologist	Low	RC	Low	RC
	Wisconsin DNR, Fisheries Research Scientist	Low	RC	Low	RC
	Team Ratings	**Low**	**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 passage 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. From Lake Winnebago to the watershed divide at Portage along the Upper Fox River is approximately 100-120 miles. The Lower Fox River, connecting Lake Winnebago and Green Bay, is 39 miles long. USGS gage 04073365 on the Fox River at Princeton, Wisconsin (about 50 miles from the watershed divide) shows average river discharge ranges from 1,300 cfs in June to 550 cfs low flow in September. The divide, consisting of more than a mile wide emergent wetland complex off the Fox River appears to be a viable pathway to further migration across the divide for certain species during longer duration storm events, particularly if the runoff occurs in the spring. The emergent wetland complex is not a preferred habitat for either the ruffe or the tubenose goby and the likelihood of either fish species crossing emergent wetlands during a flood event is considered low as the flow of water is from the MRB to the GLB. If either of the fish species crossed the basin divide, sufficient forage, ranging from zooplankton to fish, is available after traversing the wetland divide during a suitable storm event to survive and prosper in the wider river segments in the MRB. Thus the rating and certainty of the 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 wetlands 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 ruffe/tubenose goby were introduced into the divide, the aquatic habitat is considered marginally suitable for survival of the ruffe/tubenose goby for at least the summer during most years. Transit across the watershed divide by other anthropogenic means is possible, but unlikely because fishing and recreational boating do not occur at the divide. 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 WDNR. While it is feasible that either species could arrive at the divide by anthropogenic means, such as livewell or aquarium releases, that is also unlikely as these two fish species are not normally used as live bait for river fishing or aquarium species. Thus the rating and certainty of the rating.

Portage Downstream and Canal, Columbia 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 - Biologist	Low	RC		
	USACE, Detroit - Biologist	Low	RC		
	Wisconsin DNR, Fisheries Research Scientist	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: There is uncertainty regarding the suitability of the aquatic habitat to sustain a population of ruffe/tubenose goby in the Upper Fox River and Portage Upstream divide wetland area. 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. Survival of a viable, reproducing population of ruffe and tubenose goby within the wetlands at the divide location is unlikely due to likely low water quality and high temperatures in summer months. 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 at the upper Portage location.

Portage Downstream and Canal, Columbia 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 - Biologist	Medium	RC		
	USACE, Detroit - Biologist	Medium	RC		
	Wisconsin DNR, Fisheries Research Scientist	Low	RC		
	Team Ratings	**Medium**	**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: Ruffe and the tubenose goby have not been found in river systems similar to the Upper Fox River. If the fish were introduced into the divide, they may be successful in passing through the pathway into the Mississippi River Basin.

Portage Downstream and Canal, Columbia 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	VC	Medium	VC
	USACE, Rock Island - Hydraulic Engineer	Medium	VC	Medium	VC
	NRCS - Hydraulic Engineer	Medium	RC	Medium	RC
	Team Ratings	**Medium**	**VC**	**Medium**	**VC**

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: Interbasin flows at the Portage downstream interbasin flow structure are well documented as part of the Portage FRM project and FIS update. This structure consists of 2-5'Hx10'W box culverts through the Portage Levee. For a 10% chance flood, 60 to 80 cfs is conveyed through this structure, with greater amounts of flow for larger floods. The Columbia County FIS mapping clearly shows a connection between the Wisconsin and Fox River basins. During the site visit on 06-June-2011, no flow was occuring through the interbasin structure. Observations suggest that when flow does occur through the structure, it is conveyed through a marsh (reed canary grass) then through 2-7'Hx8'W box culverts through the Sioux Line RR, then through another marsh (the Swan Lake State Wildlife Area) to the Fox River. No continuous channels or ditches were observed between the interbasin flow structure and the box culverts at the Sioux Line RR during the site visit, however grassy vegetation may have obscured this evidence. Aerial photography indicates intermittent ditches along the flow path, with a large ditch on the East side of the Swan Lake Wildlife area with a connection to the Fox River.

Portage Downstream and Canal, Columbia 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 - Biologist	Medium	RC		
	USACE, Detroit - Biologist	Medium	RC		
	Wisconsin DNR, Fisheries Research Scientist	Medium	RC		
	Team Rating	**Medium**	**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 moving 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 moving 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 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 habitats including lakes and large rivers. The threespine stickleback was first encountered in lower Green Bay and the Lower Fox River (below DePere Dam) about 25 years ago, but has never been seen upstream from this area. Great Lakes populations of this species tend to be potadromous (truly migratory but within fresh water only) and only enter the lower reaches of streams briefly during spring spawning. Because of this, they are found on connected waters, but migration to the divide location within the next 20 years is very unlikely.

Portage Downstream and Canal, Columbia 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 - Biologist	Low	RC	Low	RC
	USACE, Detroit - Biologist	Low	RC	Low	RC
	Wisconsin DNR, Fisheries Research Scientist	Low	RC	Low	RC
	Team Ratings	**Low**	**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 passage 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. From Lake Winnebago to the watershed divide at Portage along the Upper Fox River is approximately 100-120 miles. The Lower Fox River, connecting Lake Winnebago and Green Bay, is 39 miles long. USGS gage 04073365 on the Fox River at Princeton, Wisconsin (about 50 miles from the watershed divide) shows average river discharge ranges from 1,300 cfs in June to 550 cfs low flow in September. The threespine stickleback has been found in the Great Lakes and in smaller river systems. While not having been identified within the Upper Fox River, its close proximity in the Great Lakes indicate potential for access and transfer to the Mississippi River Basin. Section 2.7 describes the dams as potential obstacles to upstream migration to the MRB/GLB divide. Sufficient forage and habitat appear to be available throughout the Upper Fox River and MRB for the threespine stickleback; however, the literature does not indicate a propensity to migrate upstream during runoff events. The Swan Lake Marsh, a mile wide emergent wetland complex, should be sufficient in impeding migration of the threespine stickleback at all flow conditions as an emergent wetland complex is not a preferred habitat. Sufficient forage and habitat is available throughout the Upper Fox River and MRB for the threespine stickleback, thus the rating and certainty.

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 is a recreational area 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 is 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 WDNR. Since fishing and boating are not recreational uses that occur at the divide, it is unlikely that the species would arrive at the divide by anthropogenic means. Education will be critical to minimizing accidental introductions through this pathway, thus the rating and certainty.

Portage Downstream and Canal, Columbia 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 - Biologist	Medium	RC		
	USACE, Detroit - Biologist	Medium	RC		
	Wisconsin DNR, Fisheries Research Scientist	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: As a visual predator, the sometimes turbid waters of the Upper Fox River at the divide may be unsuitable for the threespine stickleback. Survival of a viable, reproducing population of threespine stickleback within the rivers adjacent the divide is feasible. The Upper Fox River would appear to provide sufficient habitat for colonization by this species.

Portage Downstream and Canal, Columbia 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 - Biologist	High	RC		
	USACE, Detroit - Biologist	High	RC		
	Wisconsin DNR, Fisheries Research Scientist	Medium	RC		
	Team Ratings	**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 the threespine stickleback were introduced into the rivers adjacent the divide, it is highly likely that the fish would survive and pass through the Portage Downstream pathway into the Mississippi River Basin during a suitable flood event.