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

Libby Branch of Swan River, Minnesota

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Executive Summary

This assessment characterizes the viability of an aquatic pathway existing at the Libby Branch of Swan River location near Wawina, Minnesota that would enable the transfer of Aquatic Nuisance Species (ANS) between the Great Lakes and Mississippi Rivers Basins. This was accomplished by evaluating the hydrologic and hydraulic characteristics of the site based on readily available information, and conducting a species-specific assessment of the ability of potential ANS to arrive at the pathway and cross into the adjacent basin. This location is at the headwaters of the West Branch of the Floodwood River (Great Lakes Basin) and at the Libby Branch of the Swan River (Mississippi River Basin). Habitat at this location includes a mixture of emergent and forested wetlands from which surface water flows downstream into both basins.

This site was determined to be capable of conveying surface water across the basin divide for days to weeks, multiple times per year, and was therefore given a "high" probability rating for being able to develop hydrologic conditions that could potentially facilitate the spread of ANS between the basins during an event up to a one percent annual recurrence interval flood. The area has multiple shallow, interconnected drainage ditches that convey water to both sides of the divide. Observations from three separate site visits (May 2010, July 2010, and May 2011) documented flow discharging from the wetland into the Great Lakes Basin through a drop structure and into the Mississippi River Basin through the culverts under 154th Avenue.

In order to further evaluate the likelihood of a viable aquatic pathway existing that would allow interbasin transfer of ANS at this location, a total of nine ANS were identified for a more focused evaluation of this site based on ANS biological requirements and capabilities. These species are listed in the table to the right.

Based on the hydrology of the potential pathway and consideration of the above species, ANS could transfer across the divide in either direction between the two basins at this location if the ANS were able to get to the divide location. However, several existing dams on connecting streams on both sides of the divide would preclude ANS from reaching the divide location on their own. VHSv and Asian carp have some potential to transfer, but both would depend on human facilitation, or some other terrestrial vector, to reach this divide where transfer could then occur. As such, the overall aquatic pathway viability rating for this site is "low." Any potential for ANS to reach this basin divide location by non-aquatic vectors is a separate pathway that did not factor into the rating of this site.

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)

The most notable opportunity for reducing the potential for ANS transfer at Libby Branch of Swan River is through continued activities that reduce the potential for introduction of ANS between basins. This could include the creation and/or enforcement of laws prohibiting the transfer and release of ANS, support of educational programs to encourage the public to avoid potential transfer of ANS, encourage the public to report sightings of ANS, and continue to manage the divide location as a state forest and natural area to promote maintenance of a healthy ecosystem at the divide location that favors strong, robust, native, wildlife and vegetative communities.

Libby Branch of Swan River Report

September 2012

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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 Libby Branch of Swan River location, located at the intersection of Itasca, Aitkin, and St. Louis Counties, Minnesota. This location is one of 18 locations identified in the Great Lakes and Mississippi River Interbasin Study Other Pathways Preliminary Risk Characterization (USACE, 2010) as a potential aquatic pathway spanning the watershed divide between the Great Lakes and Mississippi River Basins outside of the Chicago Area Waterway System (CAWS). This report is downloadable from the GLMRIS web site (glmris.anl.gov/).

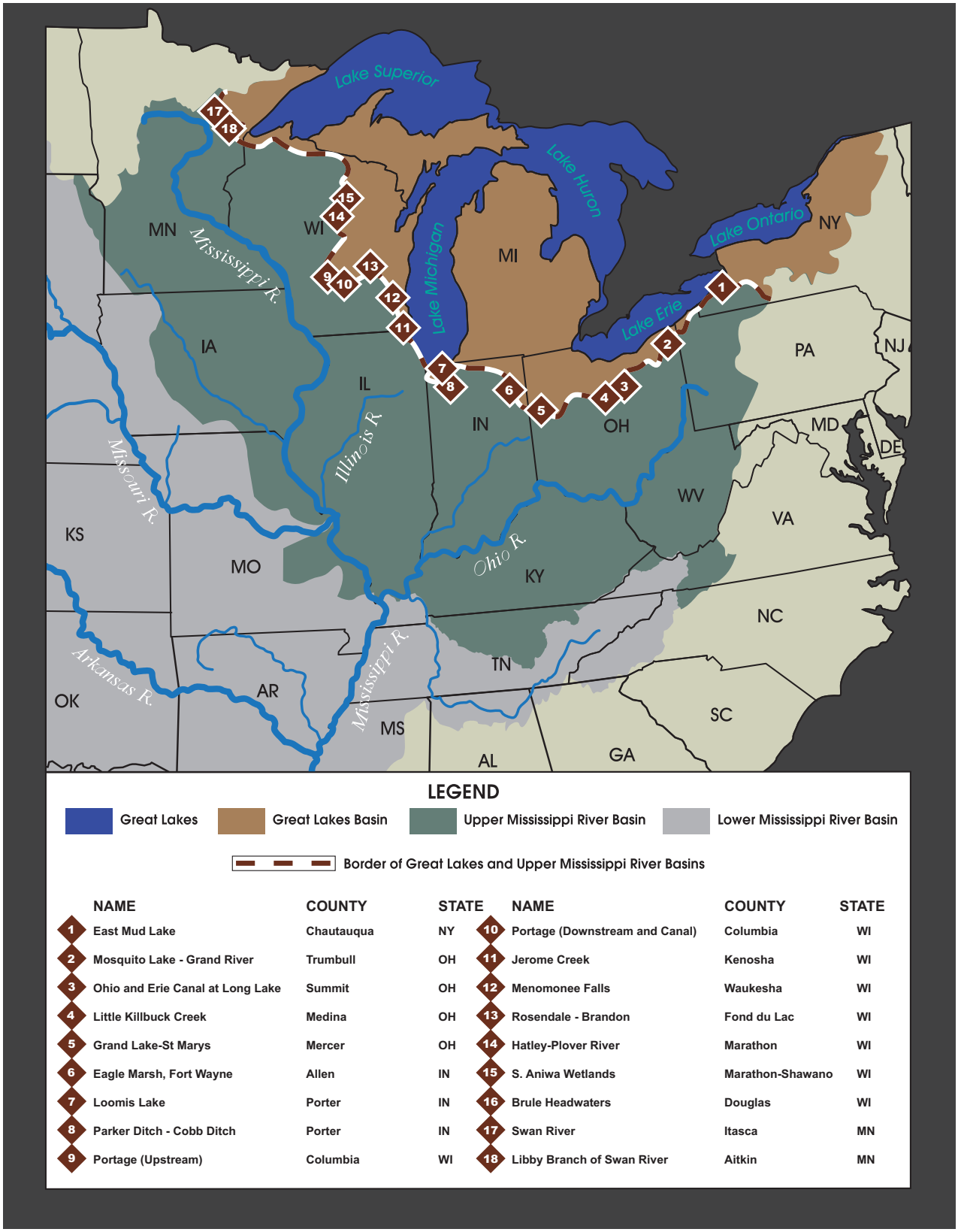
The dashed line in Figure 1 depicts the nearly 1,500-mile (2,414 km) basin divide from the New York - Pennsylvania state line to north eastern Minnesota, and it depicts each of the 18 potential aquatic pathway locations that were previously identified. The Libby Branch of Swan River location is shown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

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 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 from up to a one percent annual recurrence interval flood event, and to evaluate the probability that specific ANS would be able to 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.

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 frequency 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 return frequency 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 return



	NAME	COUNTY	STATE
1	East Mud Lake	Chautauqua	NY
2	Mosquito Lake - Grand River	Trumbull	OH
3	Ohio and 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 Ditch - 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).

frequency 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.

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

- A definitive determination of whether the Libby Branch of Swan River 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 Mississippi River basins;

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

- Development of clear problem statements that frame the means, constraints, and likelihood of the interbasin spread of ANS via the potential aquatic pathway at the Libby Branch of Swan River 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 Libby Branch of Swan River location.

1.2 Summary of Preliminary Risk Characterization for Libby Branch of Swan River

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 (i.e., greater magnitude and less frequency than a one percent annual recurrence interval) for an aquatic pathway to ever form across the basin divide. These were not recommended for further investigation because this was considered a tolerably 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 (IDNR) until a more complete assessment and remedy could be implemented.

The Libby Branch of Swan River is located in an area of east central Minnesota known as the Tamarack Lowlands. This area was identified as an ideal location where surface waters could flow in both directions across the basin divide due to a network of ditches and wetland habitat that intersect tributaries to the Libby Branch of the Swan River with perennial tributaries to the Floodwood River. The Libby Branch of the Swan River flows directly into the Mississippi River. The Floodwood River is a tributary of the Saint Louis River that enters the southwest corner of Lake Superior between Duluth, Minnesota and Superior, Wisconsin. Although the preliminary risk characterization did not identify the Libby Branch of Swan River Pathway as a location where there is a near term risk for the interbasin spread of ANS, there was some uncertainty with this rating. This was mainly due to the presence of the large wetland area and lack of readily available hydrological evidence found during the preliminary study effort to discern the relative frequency and potential magnitude of any aquatic pathway at this location. The preliminary effort recommended that a more detailed assessment be conducted at this location. This was subsequently done in collaboration with the Minnesota Department of Natural Resources (MNDNR), USFWS, USGS, and other government agencies. The following actions were taken:

- Federal, State, and local stakeholders (i.e., USGS Water Science Center, MNDNR, County Surveyor, and or local NRCS representatives) were briefed on the preliminary risk characterization results. Detailed site visits to observe potential connection locations were conducted and the available topographic mapping and flood hazard information was compiled and reviewed.

- The dams on the connecting streams to the Great Lakes and Mississippi River were evaluated relative to the potential for ANS passage through, around, or over each in-stream structure in both directions.

- Habitat and abiotic conditions in proximity to the location were analyzed relative to the needs and preferences of ANS in proximity to each location.

- The hydrologic risk and ANS risk ratings and characterization were revised for each site based on the new information.

- Measures that could be implemented at the local or state level were identified to mitigate significant likelihood of ANS transfer via this location.

1.3 Aquatic Pathway Team

Due to the large amount of unknowns and natural variability associated with the hydrology and biology of such a large geographic area, the Study Plan specified formation of a “team of teams”, combining the best available local, state and national hydrologists

and biologists to assess conditions at each potential aquatic pathway. The results of this assessment reflect the collective experience, expertise, and focused effort of these biologists and hydrologists from the NRCS, MNDNR, USGS, and the USACE Detroit and St. Paul District offices. The results also reflect the guidance, input, review comments, and concurrence of the Agency Technical Review which was comprised of experts from USACE.

2 Study Methodology

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

2.1 Coordination

The USACE identified interested parties and solicited input early in the process for Focus Area 2 and has included individual visits and discussions with the state agencies responsible for water resources, and fish and wildlife management in the eight states bordering the Great Lakes. The process used for the Focus Area 2 assessments has also been discussed in meetings with representatives of the Council on Environmental Quality (CEQ), USGS, USFWS, NOAA, NRCS, and Great Lakes Fishery Commission (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 ream 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 that it would likely require an epic storm and flooding event (i.e., greater than a one percent annual return frequency 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 tolerably low level of risk. This one percent threshold criteria 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 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 and 2012 in collaboration with USGS, NRCS, USFWS, state natural resource agencies, and county surveyors (where applicable), and the results are presented in this report.

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

2.3 Aquatic Nuisance Species of Concern

This report addresses the problem of ANS invading, via surface water pathways, the Great Lakes Basin from the Mississippi River Basin and vice versa. ANS is defined by the ANSTF as "… nonindigenous species that threaten the diversity or abundance of native species or the ecological stability of infested waters, or commercial, agricultural, aquacultural or recreational activities dependent on such waters." The USGS Nonindigenous Aquatic Species (NAS) information resource http://nas.er.usgs.gov/about/faq.aspx defines NAS as "…a species that enters a body of water or aquatic ecosystem outside of its historic or native range." (USGS, 2012). Based on discussions between the USACE, USGS, and USFWS the following definitions were established for the purposes of the GLMRIS. All nonindigenous 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 nonindigenous 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 nonindigenous aquatic species in this report.

2.3.1 Lists of Nonindigenous 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 nonindigenous 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.

2.3.3 List of ANS of Specific Concern at the Libby Branch of Swan River Location

The Libby Branch of Swan River 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 three 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 Libby Branch of Swan River 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 Libby Branch of Swan River 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 Libby Branch of Swan River location. However, the NOAA Watchlist was utilized as a resource, at the recommendation of agency team members, to identify any additional potential future species that could be introduced into either basin and possibly spread from there to the other basin.

Each Focus Area 2 aquatic pathway team was granted flexibility in determining whether to add additional species to their assessment based on their review of available information and the actual location of the specific potential pathway relative to the known location of those ANS being considered. Based on concerns from local agencies about the potential for spread of Viral Hemorrhagic Septicemia virus (VHSv, Novirhabdovirus sp), each Focus Area 2 aquatic pathway team evaluated whether VHSv should be included on the ANS of concern list for each of the Focus Area 2 aquatic pathways. Although VHSv has been identified in both basins (i.e., VHSv was confirmed in the Clark Fork Reservoir, Ohio, in the Ohio River Basin), it is yet to be determined that VHSv has established in the Mississippi River Basin. Minimizing the spread of VHSv remains a priority for the state of Minnesota (Great Lakes Commission, 2011; USGS, 2011b). It was therefore included as an ANS of concern threatening the Mississippi River Basin for the Libby Branch of Swan River aquatic pathways.

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

Based on the evaluation by subgroups, only fish, or fish pathogens, were considered to have the requisite means of reaching the Libby divide from either direction.

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 psuedoharengus*	alewife	GL	swimmer
crustacean	*Apocorophium lacustre*	a scud	MS	ballast water
algae	*Bangia atropupurea*	red macro-algae	GL	ballast / rec. 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 and trailers
crustacean	*Cercopagis pengoi*	fish-hook water flea	GL	ballast / rec. 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 / rec. boating
fish	*Gasterosteus aculeatus*	threespine stickleback	GL	swimmer
plant	*Glyceria maxima*	reed sweetgrass	GL	recreational boating and 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 and trailers
bryozoan	*Lophopodella carteri*	bryozoans	GL	with aquatic plants
fish	*Menidia beryllina*	inland silverside	MS	swimmer
plant	*Murdannia keisak*	marsh dewflower	MS	recreational boating and 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 and 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 and trailers
mollusk	*Valvata piscinalis*	European stream valvata	GL	ships

Table 2: ANS of Concern Threatening the Mississippi River Basin.			
Taxa	**Species**	**Common Name**	**Interbasin Dispersal Mechanism**
fish	*Alosa aestivalis*	blueback herring	swimmer
fish	*Alosa psuedoharengus*	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 and trailers
plant	*Glyceria maxima*	reed sweetgrass	recreational boats and trailers
plant	*Trapa natans*	water chestnut	recreational boats and 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.			
Taxa	**Species**	**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 and trailers
plant	*Murdannia keisak*	marsh dewflower	recreational boats and trailers
plant	*Oxycaryum cubense*	Cuban bulrush	recreational boats and trailers

To facilitate determination of the ANS transfer potential at this site, the team of biologists then selected a smaller group of representative species for focused assessment. The species selected may be those most likely to arrive at the divide, pose the greatest possibility of ecological damage, and/or exhibit a broad range of biological characteristics that provides a more thorough and conservative evaluation of potential probability that ANS could spread between the basins at this location. Of all species considered, the Libby Divide aquatic pathway team determined five ANS to be potentially significant threats to the Great Lakes Basin, and four of these ANS to be potentially significant threats to the Mississippi River Basin (Table 4).

A parasitic copepod found in the Great Lakes Basin (*N. japonicas*) could "hitch hike" to the divide location as a fish parasite. However, this species was not included in this anlaysis primarily because the species has not been observed in Lake Superior and is typically found in eutrophic, polluted aquatic habitats. The nearest observation of this species are limited to Saginaw Bay of Lake Huron. It is uncertain if or when it would move across Lake Superior toward the divide location. Therefore, the potential risk of this species did not appear as high as that posed by the Great Lakes species considered in the analysis.

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 and other relevant scientific literature (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 Indiana. Additional information was obtained from the USGS Nonindigenous Aquatic Species (NAS) website (USGS, 2011).

2.4 Pathway Assessment Process

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

Equation 1

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

Where:

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

Note the risk is defined as a multiplicative function. That means, if either of these components is zero or low, the overall risk will also be zero or low. In order to

Table 4: Species of Greatest Concern for Transfer at the Libby Branch of Swan River.

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

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 (VC), Reasonably Certain (RC), Moderately Certain (MC), Reasonably Uncertain (RU), Very Uncertain (VU)]. 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 at 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} = $P_{ANS\ establishing\ at\ the\ aquatic\ pathway}$

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" ($P_{Establishment}$) from Equation 3. The probability of establishment for certain aquatic pathways may be assessed in future studies by USACE or others, but likely only for those pathways with an unacceptable rating for the "probability of a viable pathway" existing. Note also that (P_1), ANS has access to pathway from Equation 3 has been renamed ($P_{1'}$), ANS occurring within either basin". This did not change the element being evaluated but made it clearer to team members what "access to the pathway" actually meant.

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

2.5 Example Calculation of Overall Aquatic Pathway Viability

As described in Section 2.3.1, a list of ANS of concern for the Libby Branch of Swan River pathway was developed with input from Federal, State, and local agencies responsible for water resources, and fish and wildlife management in the state of Minnesota 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 5. 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 6. 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

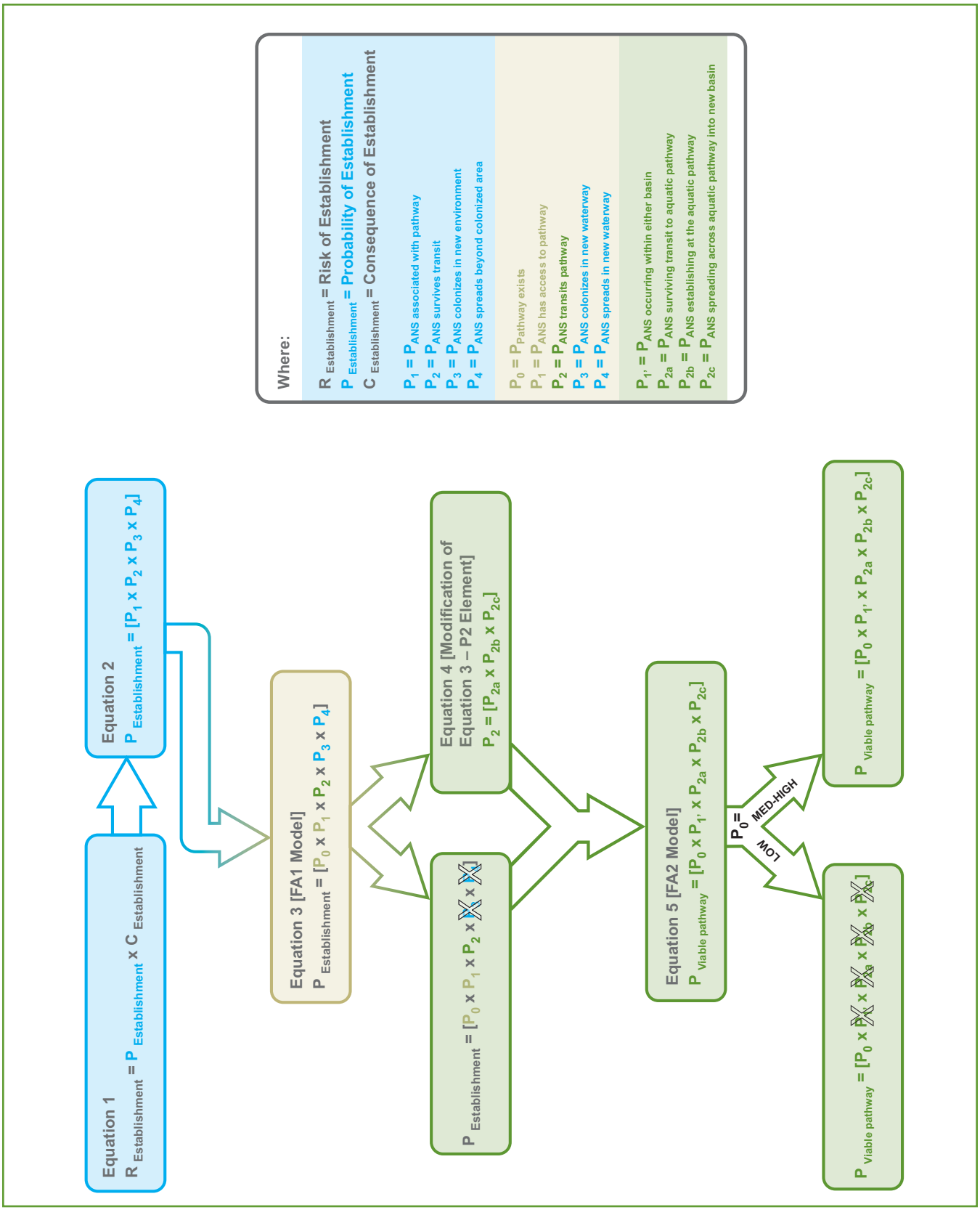


Figure 2. Diagram of the derivation of the GLMRIS Focus Area 2 aquatic pathway assessment model.

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 at 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**

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 at Aquatic Pathway?**	**ANS Spread-ing Across Aquatic Pathway into New Basin?**	**ANS/Path-way Viability Rating**
fish	three-spine 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**

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 regarding the probability rating (H, M, or L) and the level of certainty (VC, RC, MC, RU, or VU). Final agreement was reached on team ratings for each element through collaboration and sharing of applicable information with all team members. The level of certainty in these ratings was modified during these discussions to reflect the range of opinion.

3 Aquatic Pathway Characterization

This section describes and illustrates the topography and relevant features in the vicinity of the potential pathway, and is intended to help inform the biological evaluations contained later in this report with a compilation of 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 information and hydrologic modeling in the area of interest.

3.1 Location

The Libby Branch of Swan River potential pathway is located in an area of east central Minnesota known as the Tamarack Lowlands near Wawina, Minnesota. The specific area of interest generally stretches north and west from the intersection of U.S. Route 2 and MN-200, at 47° 0'31.59"N, 93° 4'8.35"W. This area spans the intersections of Itasca, Aitkin, and St. Louis Counties. Figure 3 shows the location of the potential pathway in northeastern Minnesota.

3.2 Climate

Climate is looked at in this section just in terms of identifying any applicable elements of climate (e.g., temperature, rainfall) and how they may influence the likelihood of an aquatic connection forming at the subject pathway that could be utilized by ANS to spread between basins. This area of northern Minnesota is classified as continental, with large seasonal temperature variance, four distinct seasons, and relatively small or moderate precipitation. Temperatures in the winter typically range from 0ºF to 21ºF (-18ºC - 6ºC), while summers are usually around 60º F to 70ºF (15.5ºC - 21ºC). Normal annual precipitation is about 30 inches and the normal snowfall is around 55 inches. See Table 7 for National Climatic Data Center (NCDC) normals, from 1971-2000. An aquatic pathway is most likely to occur at Libby Branch of Swan River during either the spring when rain and snowmelt runoff occur, or during summer rainstorm events.

The highest amount of precipitation occurs in the summer months during June and July. Although rainfall amounts do not always conform to averages, they are none the less suggestive that substantial precipitation does not occur frequently. Due to the nature of the wetlands and ditches at this site, the amount of rainfall may not significantly influence the probability of pathway formation. In addition, given that annual temperatures reach down to or below the freezing mark on an annual basis, purely climatic conditions will restrict the time during which any ANS movement might occur by natural vectors.

3.3 Location Specific Surface Water Features

The information contained in this section is meant to present and interpret the readily available information for this location as it pertains to surface water conditions and any aspects that may influence the behavior of surface water. The general area of interest has historically been mostly wetland habitat that has been gradually converted to agricultural and other uses since the early 20th century (Figure 4). This change in land use has resulted in many interconnected drainage ditches through the area as are evident in Figure 4 and Figure 5. The figures show the area of interest with the basin divide along the Hydrologic Unit Code (HUC) boundary (red and white line) and the Federal Emergency Management Agency (FEMA) one percent floodplain (red and/or yellow shaded area).

Table 7 - Climate Information for Libby Branch of Swan River vicinity (Midwestern Regional Climate Center (MRCC) – Station Sandy Lake Dam Libby, Minnesota)

Element	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
Mean Temperature°F	6.4	14.0	26.4	41.1	54.3	62.9	67.4	65.0	54.9	43.7	26.9	12.1	39.6
Mean Temperature °C	-14	-10	-3	5	12	17	19.6	18.3	12.7	6.5	-2.8	-11	4.2
Normal Precip (in)	1.01	0.61	1.25	1.84	2.90	4.60	4.60	3.70	3.08	2.74	1.59	0.86	28.78
Normal Precip (cm)	2.5	1.5	3.17	4.6	7.3	11.6	11.6	9.39	7.82	6.95	4.03	2.18	73.1
Mean Snow (in)	14.5	7.5	8.9	3.0	0.4	0.0	0.0	0.0	0.0	1.2	9.5	11.0	56.0
Mean Snow (cm)	36.83	19	22.6	7.62	1.01	0	0	0	0	3	24.13	27.94	142.24

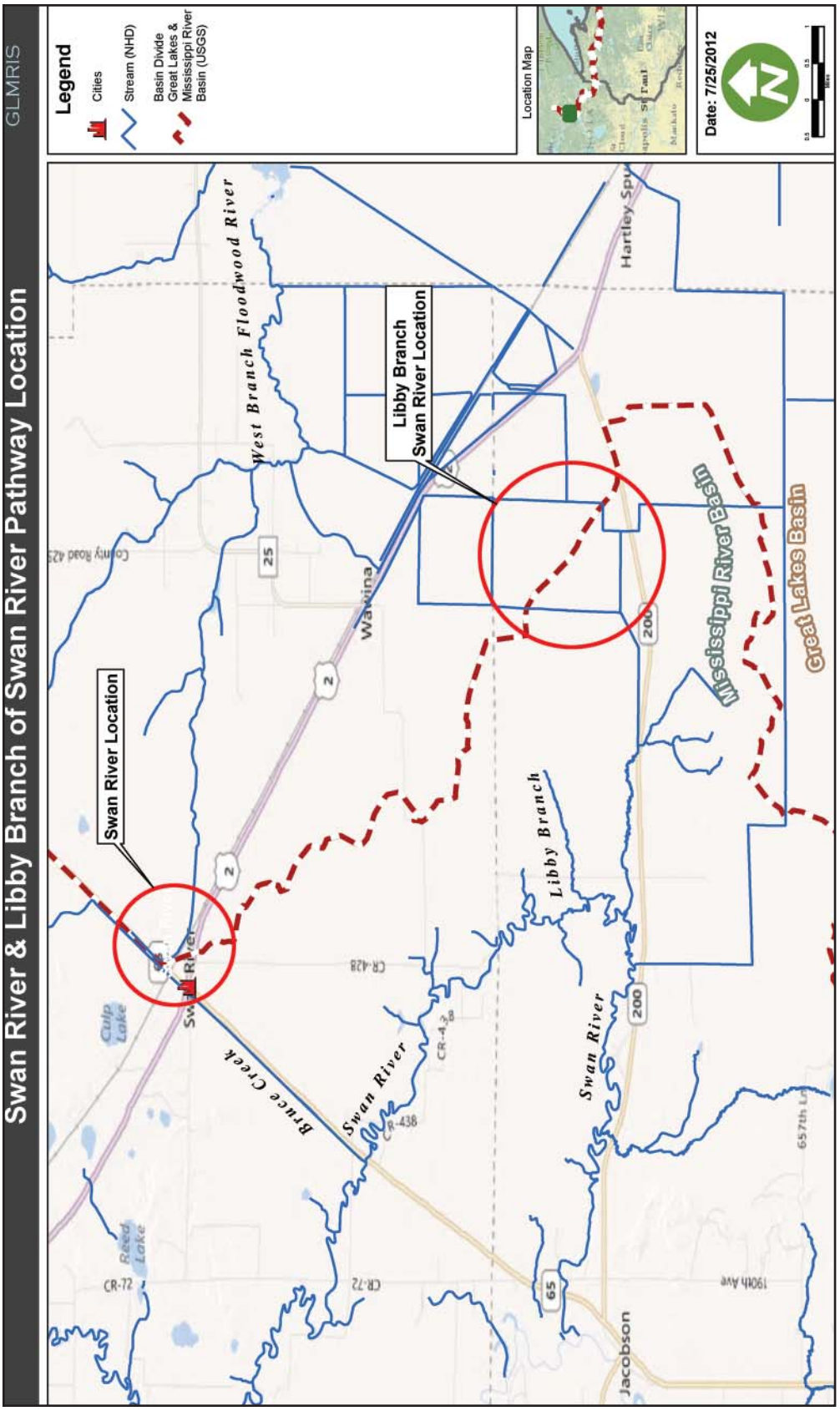


Figure 3. Location of Swan River and Libby Branch of Swan River potential aquatic pathway locations relative to one another and the Great Lakes and Mississippi River Basin divide. Base imagery courtesy of Bing Maps.

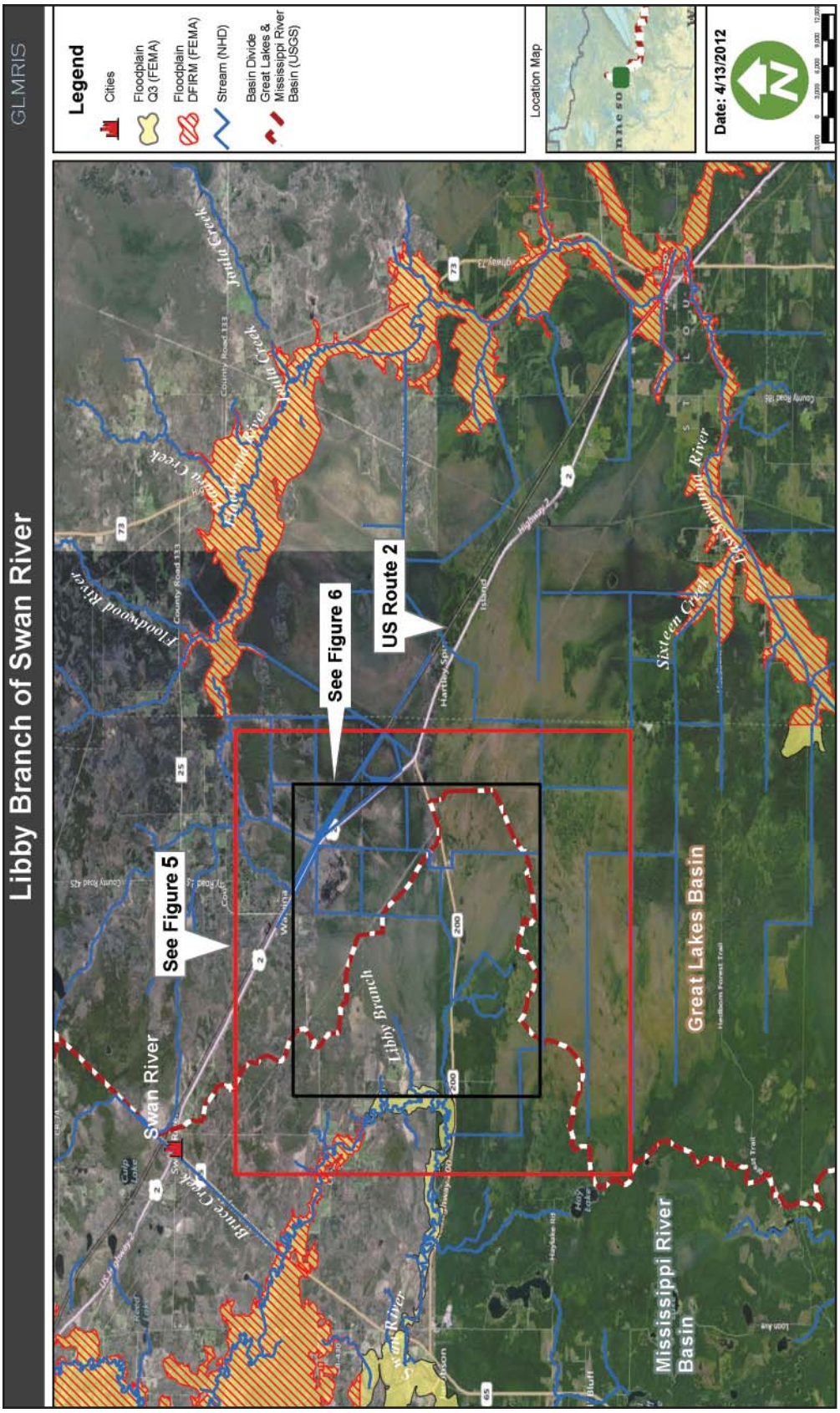


Figure 4: Area of interest for Libby Branch of Swan River aquatic pathway near Wawina, MN. Blue lines are streams near the basin divide. Some of these streams appear to be constructed drains that span the basin divide and are perennially with water. Red or Yellow shaded areas are FEMA one percent floodplain. Basin divide is along red and white dashed HUC-12 boundary just east of Libby Branch. Base imagery courtesy of Bing Maps.

Representative cross-sections through the area of interest based on the best available Geographic Information System (GIS) elevation data are shown in Figure 6. This figure shows a profile along the HUC boundary (A1 – A2) to depict the "saddle point" along the basin divide and the cross-section that cuts through the HUC boundary (B1 – B2) to depict the typical ground elevation along the potential flowpath. This saddle point is defined as the location on the basin divide where a hydrologic connection could most likely be established.

For this pathway, the elevations are based on the USGS 10 m (32.8 feet) Digital Elevation Model (DEM) with a vertical accuracy of +/- 13.1232 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, this is not the case since 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 (Gesch, 2007). As a result, although the absolute elevation values may differ from the true value (i.e., 800 feet (244 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 (32.8 feet) squares vs. 30 m (98.4 feet) squares), the more blocky and less detailed the terrain appears and thus the less accurately the DEM depicts the actual terrain. The largest grid size used at any of the pathway locations is 10 m (32.8 feet) squares with some areas having more detailed information. Even though the 10 m (32.8 feet) 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.

Evidence and observations indicate that the ditches seen in Figure 4 through Figure 7 were constructed in the early part of the 20th century to drain fields for agriculture or to the facilitate mining of peat. The construction of the raised road grade for US Route 2 severed a number of these ditch connections, with the only remaining connection to the wetland south of State Route 2 located at a drop structure that was constructed at the point indicated on Figure 6. This drop structure allows flow from the southwest side of the road to flow toward the northeast (into the Great Lakes Basin). Therefore, it is quite feasible that because of the road construction and culvert work on State Route 2, the basin divide line should be redrawn for this area to run along State Route 2 instead of toward the south where it is currently shown based on the HUC12 boundaries. There is also a concrete culvert under US Route 2 at 46°59'45.50"N, 93° 2'10.33"W that can be seen in Figure 8.

The drop structure on US Route 2 is shown in greater detail in Figure 9. According to the MNDNR, the structure was built prior to the mid-1990's by the Minnesota Department of Transportation (MNDOT) as part of a wetland restoration project. The structure is approximately 10 feet (3 m) wide. In May of 2011, the observed vertical elevation drop was 2.7 feet (0.8 m). Refer to Section 3.5 of this report for observed flow through this drop structure from a June 2012 storm event.

There are three sets of culverts under 154th Avenue (Figures 5 and 10) on the western side of the wetland area that allows flow to move unobstructed from the wetland toward the Swan River in the Mississippi River basin. The southernmost of these culverts is shown in Figure 10. The pictured culvert is a 48-inch (122 cm) rigid corrugated pipe (RCP). During the site visit on May 31, 2011, the depth of water in the culvert was measured at 2.9 feet (0.9 m) and the surface velocity was estimated at about one foot per second. The flow is to the west toward the Mississippi River Basin. Additionally, during the site visit, westward flow was observed upstream in the channel near MN-200 (approximately 46°59'49.78"N, 93° 8'50.56"W). Refer to Section 3.5 of this report for observed flow through through and across 154th Avenue from a June 2012 storm event.

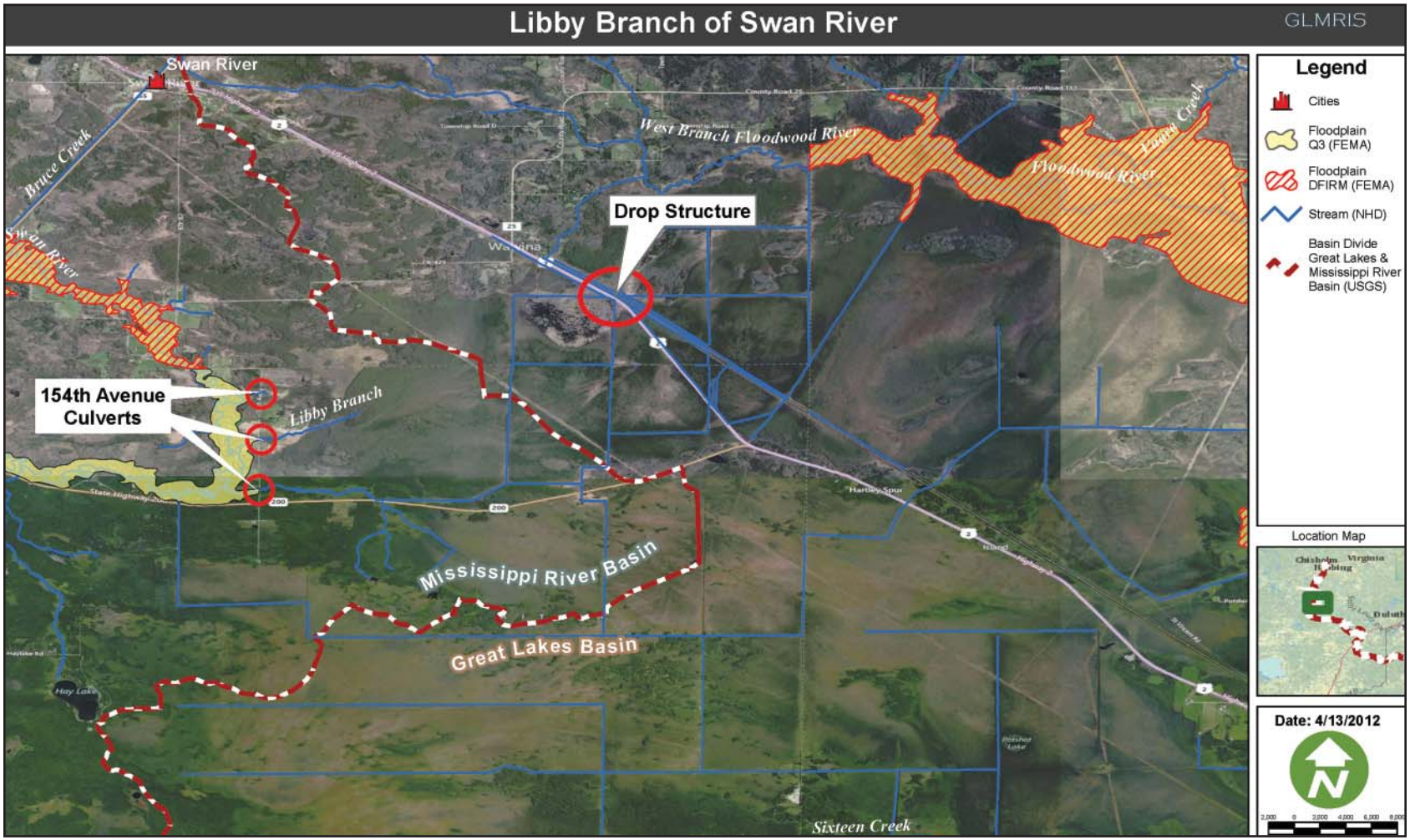


Figure 5. Enlarged image of area of primary interest for Libby Branch of Swan River aquatic pathway. The three culverts under 154th Ave are indicated on the left side of the picture (to Mississippi Basin) and the drop structure in the center (to Great Lakes Basin). Red and white dashed line is the basin divide and blue lines are streams and ditches near the basin divide. Background imagery courtesy of Bing Maps.

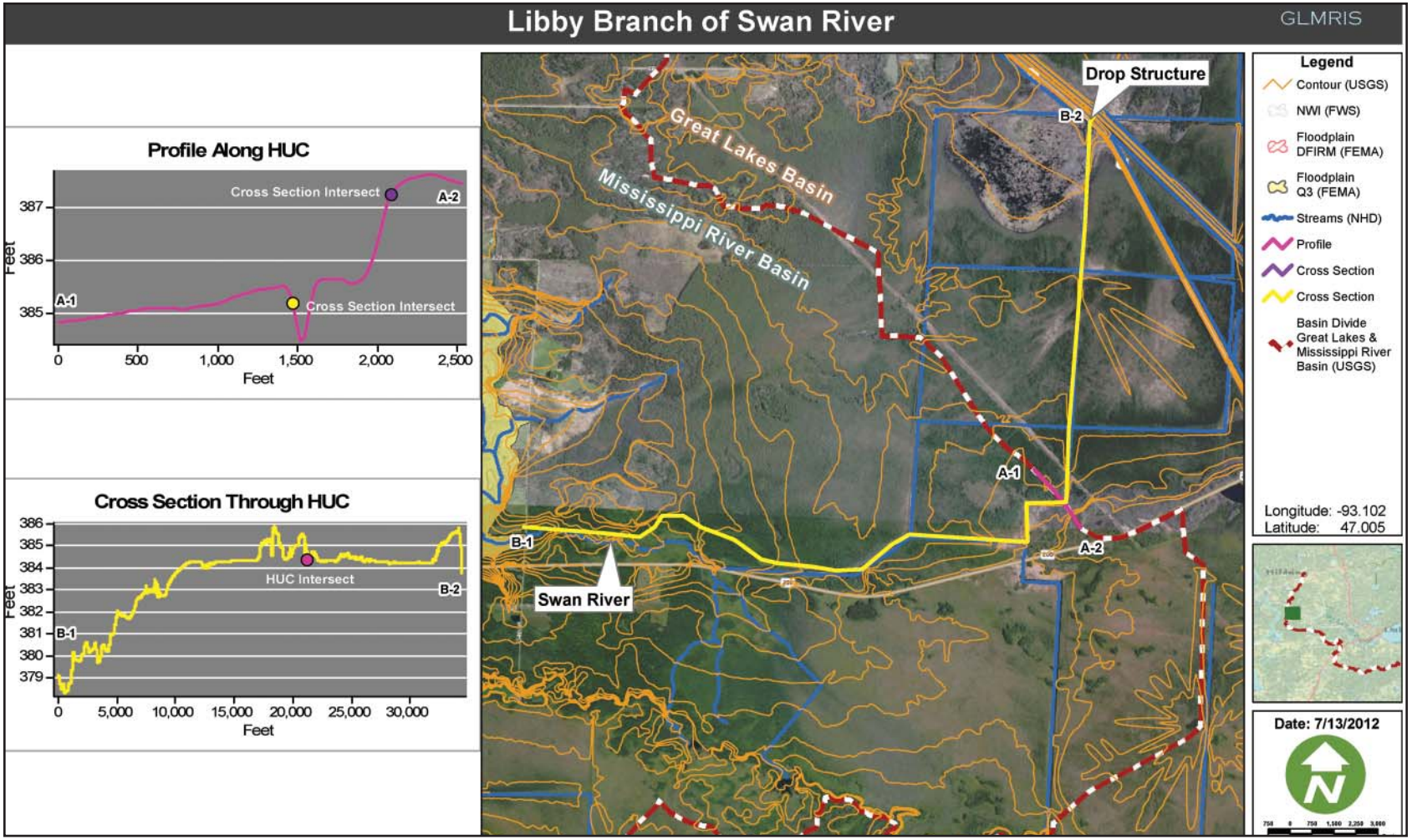


Figure 6. Typical location cross-sections, based on USGS 10m DEM, with a vertical accuracy of +/- 13.123ft (4 m). The red/white line is the basin divide and blue lines are streams and ditches near the basin divide. Pink line in the aerial photograph and graph on the top left is the cross section along 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 in the graphs are where the lines intersect. Background imagery courtesy of Bing Maps.

Figure 7. Typical ditch in wetland area. Due to their straight nature and the historical information gained about the area, it is presumed that these are man-made.

Figure 8. Culvert under US Route 2, southeast of intersection with MN-200.

Figure 9. View of drop structure at US Route 2, looking southwest.

Figure 10. Southern-most culvert under 154th Ave.

3.4 Groundwater

Groundwater was investigated as a part of determining the likelihood of a pathway existence 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 seasonal variations in recharge and discharge. Groundwater levels commonly rise in Spring, when areal recharge is greatest because of snowmelt, spring rain, and minimal evapotranspiration losses. This means that heavier rainfall events, when they coincide with frozen ground conditions, snowmelt, and higher groundwater conditions, may 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, USGS Groundwater Watch site 474921093144001, is 54 miles (87 km) north of the pathway site. Although no groundwater data in the immediate vicinity of the pathway is available, groundwater conditions are not believed to increase the likelihood of a surface water connection being maintained between these watersheds.

3.5 Aquatic Pathway Temporal Characteristics

Characterizing the temporal variability of the pathway hydrology is an important aspect of understanding the likelihood of an ANS being able to traverse the basin divide at this location as certain flood events may coincide with species movement and reproduction patterns and abilities to survive and establish populations in various areas. The area of the Libby Branch of Swan River potential aquatic pathway has been identified by FEMA to be Zone C, which is an area of minimal flooding. The one percent floodplain is near the basin divide, but does not cross the basin divide from either direction. A flood event less frequent than the one percent event may cross the basin divide, but no mapping is available to determine to what extent such flooding might occur. In addition, given that the area is subjected to freezing temperatures on an annual basis for about four to five months (Table 7), biological activity and water flow would likely be restricted on a temporal basis since the water would be frozen and biological activity of ANS (e.g., movement) would be restricted.

A two day storm event on June 19-20, 2012 produced approximately 4.09 and 4.68 (10.4 and 11.9 cm) inches of rain in the Swan and Floodwood River Watersheds, respectively. Most of this rain fell over a 24 hour period and represented a two percent annual recurrence interval storm event (HydroClim Minnesota, 2012; NOAA, 2012). A site visit to the Libby Branch of Swan River pathway location by the USACE on June 22, 2012 confirmed that substantial amounts of water were crossing the basin divide into both basins as a result of this storm event. On the Mississippi River Basin side of the divide, 154th Avenue was closed to vehicular traffic due to road flooding and observations were that about 120 cfs was flowing under and across the roadway. Flow through the drop structure at State Route 2 was estimated to be about 60 cfs.

3.6 Probability Aquatic Pathway Exists

The rating discussed in this section is only for the likelihood of an aquatic connection existing at this potential pathway (P_0) at up to a one percent annual recurrence interval storm. A surface water connection could form between the Great lakes and the Mississippi River Basins at the Libby Branch of Swan River potential pathway, based on the following:

- The streamlines from the National Hydrography Dataset (NHD) indicate that a direct surface water pathway exists between the Great Lakes and Mississippi River Basins;
- The area is traversed by numerous drainage channels and contiguous wetlands that convey flow in both directions from the basin divide;

- Topography along the flow path between the basins is very flat with a discernable, yet small, rise near the basin divide;

- Substanial flows across the basin divide were observed at the pathway two days after a two percent annual recurrence interval storm event;

- Three separate site visits (May 2010, July 2010, and May 2011) found flow leaving from the wetland area both to the Great Lakes Basin (through the drop structure) and to the Mississippi River Basin (through the culverts under 154th Ave).

Due to the above evidence, the project team has determined that there are perennial surface water connections and wetlands which convey water across the basin divide continuously for days to weeks, multiple times per year. Consequently, the probility of the existence of an aquatic pathway at Libby Branch of Swan River is rated "high" in either direction.

This rating is considered "reasonably certain" for the following reasons:

- The lack of site-specific ground surface elevation data (no surveying was done as part of this investigation) other than the USGS 10m DEM;

- Although interbasin flow was observed at the State Route 2 drop structure (toward Great Lakes Basin) and at the culverts under 154th Avenue (toward Mississippi River Basin), there is no data available for this site to correlate precipitation or flooding events to create flow between the basins;

- This pathway is part way down the Floodwood River Watershed and there remains some uncertainty in the rating because no specific modeling is available to determine for certain if any larger flood events from this river system could cause backflows through the drainage canals.

3.7 Aquatic Pathway Habitat

3.7.1 Terrestrial and Riparian Plants and Land Use

According to the USFWS National Wetlands Inventory (NWI), terrestrial and riparian habitat in the area of the divide contains a mixture of palustrine wetlands (NWI, 2011). This includes forested wetlands (both deciduous and conifer), scrub-shrub, and emergent wetlands. The drainage network in the area of the divide was likely constructed to help support agriculture or to facilitate mining of peat. However, review of 2009 aerial imagery suggests agricultural land use in the area is very limited.

3.7.2 Aquatic Resources

Aquatic resources near the divide include a network of drainage ditches that span across the basin divide (Figure 4 and Figure 5). These are shallow, narrow waterways that connect the Libby Branch of the Swan River (Mississippi River Basin) with the Floodwood River (Great Lakes Basin). Fish communities in the Libby Branch of Swan River, and the Swan River, are likely influenced by the nearby Mississippi River and would include a range of cool and warmwater fish species, especially in the more downstream reaches. Similarly, fish communities in the Floodwood River are likely influenced by the St. Louis River, and likewise are likely to include a variety of cool and warmwater species. Fish communities within the drainage network at the divide are likely more limited in comparison due to limited habitat quality. However, the ditches do likely support some fish and macroinvertebrate species, although no specific surveys were conducted as part of this study.

3.7.3 Water Quantity and Quality

The Swan River is identified as an "impaired" waterbody through its listing by the State of Minnesota pursuant to Section 303(d) of the Federal Clean Water Act (MPCA, 2011). It is identified as impaired for aquatic life with the stressor of dissolved oxygen, and impaired for aquatic consumption for mercury. Neither Libby Branch of the Swan River or the Floodwood River have any identified impairments.

3.7.4 Aquatic Organisms

Warm and coolwater aquatic species potentially occur at the divide location. No known federally-listed aquatic organisms are known to be at the divide location. Also, no known aquatic invasive species are present at the divide location, although flowering rush (*Butomus umbellatus*) has been identified from nearby Big Sandy Lake. Due to the water quality and general health of the aquatic habitats in this area, establishment and spread of ANS in this area are likely to be relatively more difficult as compared to lower quality more disturbed ecosystems.

3.8 Connecting Streams to Great Lakes and Mississippi or Ohio River

The Mississippi River Basin connection for Libby Branch of Swan River is through an unnamed creek to the Swan River and then into the Mississippi River. The Great Lakes Basin connection is through another unnamed creek to the West Branch Floodwood River, then to Floodwood River, and ultimately to the St. Louis River, and into Lake Superior.

Several dams exist on both the Mississippi and St. Louis Rivers that inhibit natural spread of ANS. For example, on the Upper Mississippi River five large dams are found in the reach near St. Cloud and Brainerd, Minnesota (Figure 11 through Figure 13; Table 8). Additional dams are found further downstream in the Twin Cities and Coon Rapids, Minnesota. The St. Louis River also has several large dams that prohibit natural movement of biota, which includes the Fond du Lac Dam just upstream of Lake Superior, which is over 70 feet high (Figure 13; Table 9). Figure 11 shows the location of the possible barriers to ANS spread and Tables 8 and 9 lists the possible barriers along with the hydraulic, structural, and dam heights, and in some cases, whether or not there is designed fish passage. For many of the dams, the ability for fish passage was based on opinion from MNDNR.

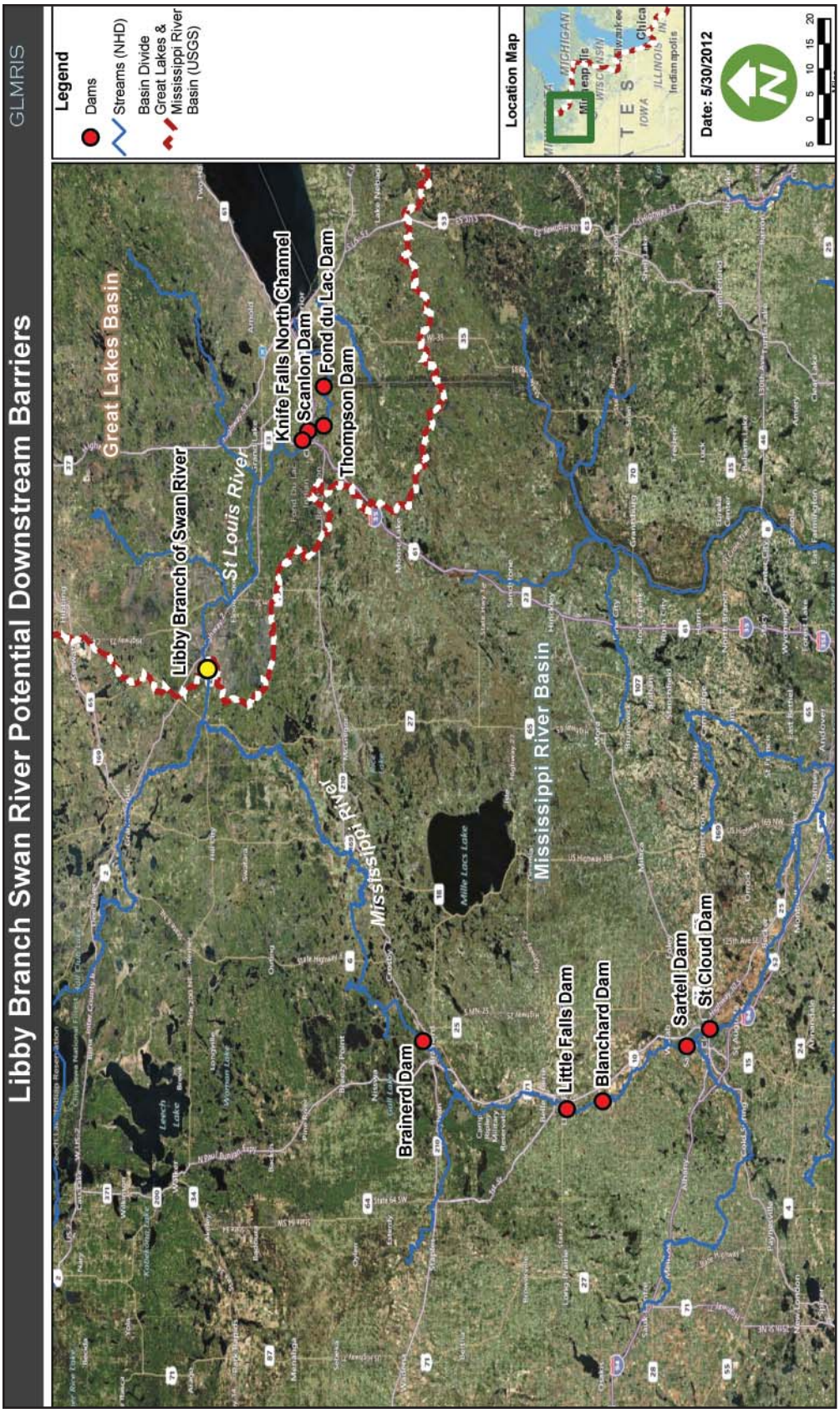


Figure 11: Location of dams downstream of the Libby Branch of Swan River pathway location (NID, 2010). Base imagery courtesy of Bing Maps.

Table 8. Mississippi Connection of Potential Barriers to ANS Spreading, Including Dam Heights, FEMA Elevations, and any Known Fish Passage (NID, 2010).

Mississippi Connection -								
	Mississippi Connection - Unnamed Creek; Swan 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	Brainerd	Mississippi River	20	20	-	-	-	Yes
Mississippi	Little Falls	Mississippi River	30	30	-	-	-	Not able to verify, no FEMA FIS. MDNR believes fish passage is possible and said a fish ladder is in progress
Mississippi	Blanchard	Mississippi River	46	46	-	-	-	Not able to verify, no FEMA FIS. MDNR believes fish passage not possible
Mississippi	Sartell	Mississippi River	19.5	46	16 to 17	12 to 13	9 to 10	Yes, at 500 year floods
Mississippi	St. Cloud	Mississippi River	15	22	14	11 to 12	9	Yes, at 500 year floods
Mississippi	Coon Rapids	Mississippi River	23	35	2	submerged	submerged	Yes
Mississippi	St. Anthony Falls Upper Lock and Dam	Mississippi River	86	82				Through lock
Mississippi	St. Anthony Falls Lower Lock and Dam	Mississippi River	39	41	-	-	-	Through lock
Mississippi	Lock and Dam #1 (St. Paul, MN)	Mississippi River	56	49	-	-	-	Through lock
Mississippi	Lock and Dam #2 (Hastings, MN)	Mississippi River	26	23	-	-	-	Through lock

Table 9. Great Lakes Connection of Potential Barriers to ANS Spreading, Including Dam Heights, FEMA Elevations, and any Known Fish Passage (NID, 2010).

Great Lakes Connection -								
	Unnamed stream, Menomonee River, Kinnickinnic 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	Knife Falls North Channel	St. Louis River	18	18				Not able to verify for dams on St. Louis River, no FEMA FIS. MDNR believes fish passage not possible
Great Lakes	Knife Falls South Channel	St. Louis River	18	18	-	-	-	
Great Lakes	Cloquet	St. Louis River	47	47	-	-	-	
Great Lakes	Scanlon East Channel Dam	St. Louis River	15	15	-	-	-	
Great Lakes	Scanlon East Zigzag Plug Dam	St. Louis River	15	15				
Great Lakes	Scanlon West Channel Dam	St. Louis River	20	20	-	-	-	
Great Lakes	Scanlon West Channel Plug Dam	St. Louis River	15	15	-	-	-	
Great Lakes	Thompson	St. Louis River	15	15	-	-	-	
Great Lakes	Thompson No 1-1/2	St. Louis River	10	10				
Great Lakes	Thompson No 2a and 2b	St. Louis River	23	23	-	-	-	
Great Lakes	Thompson No 2-1/2	St. Louis River	9	9	-	-	-	
Great Lakes	Thompson No 3	St. Louis River	38	38	-	-	-	
Great Lakes	Thompson No 5	St. Louis River	23	23				
Great Lakes	Thompson No 5-1/2	St. Louis River	23	23	-	-	-	
Great Lakes	Thompson No 6	St. Louis River	51.6	51	-	-	-	
Great Lakes	Thompson No 8	St. Louis River	12	12	-	-	-	
Great Lakes	Thompson No 9	St. Louis River	11	11	-	-	-	
Great Lakes	Thompson No 10	St. Louis River	11	11				
Great Lakes	Thompson No 11	St. Louis River	17	17	-	-	-	
Great Lakes	Thompson No 12	St. Louis River	12	12	-	-	-	
Great Lakes	Fond Du Lac	St. Louis River	73	80	-	-	-	

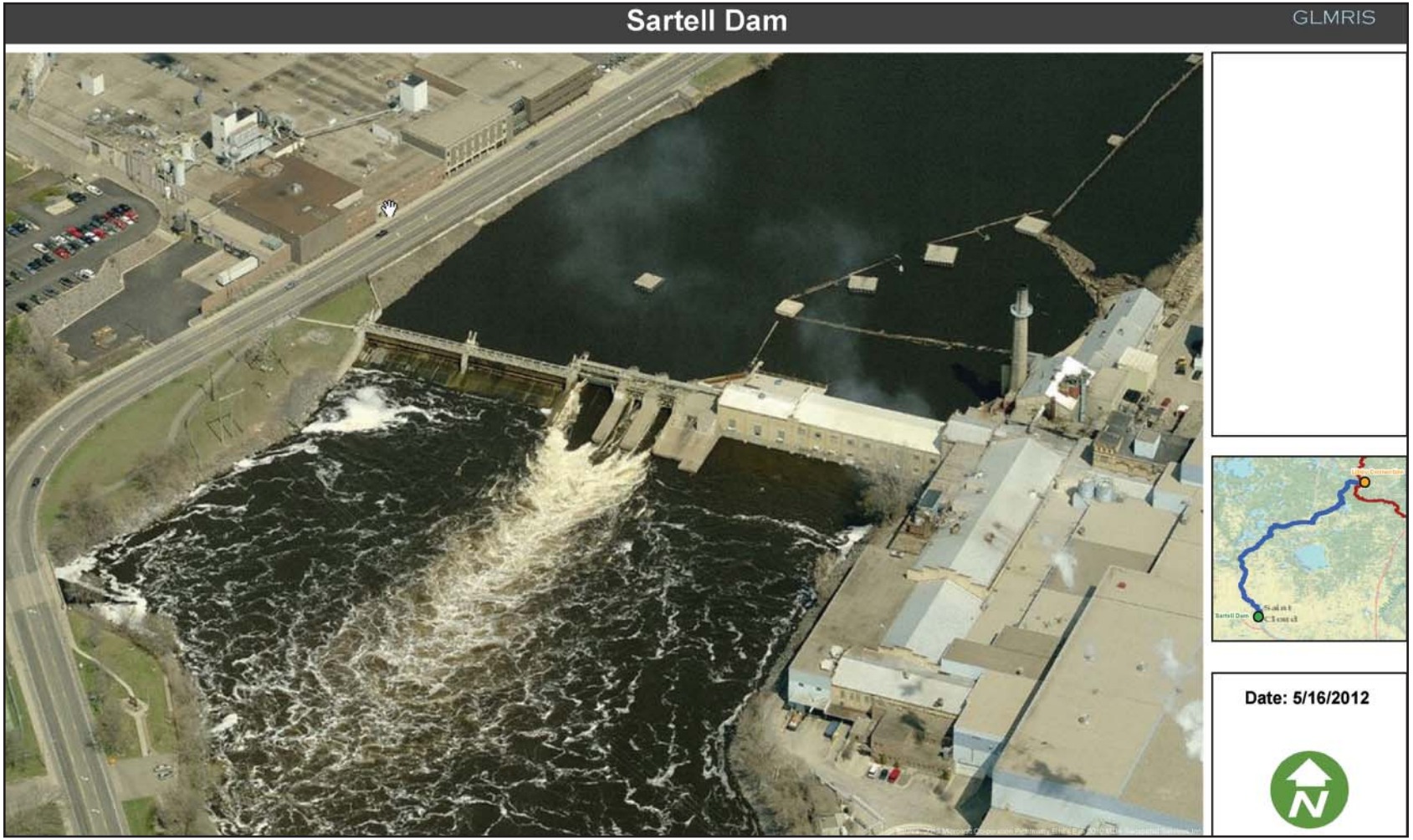


Figure 12: Aerial photo of Sartell Dam on the Mississippi River in Sartell, Minnesota.

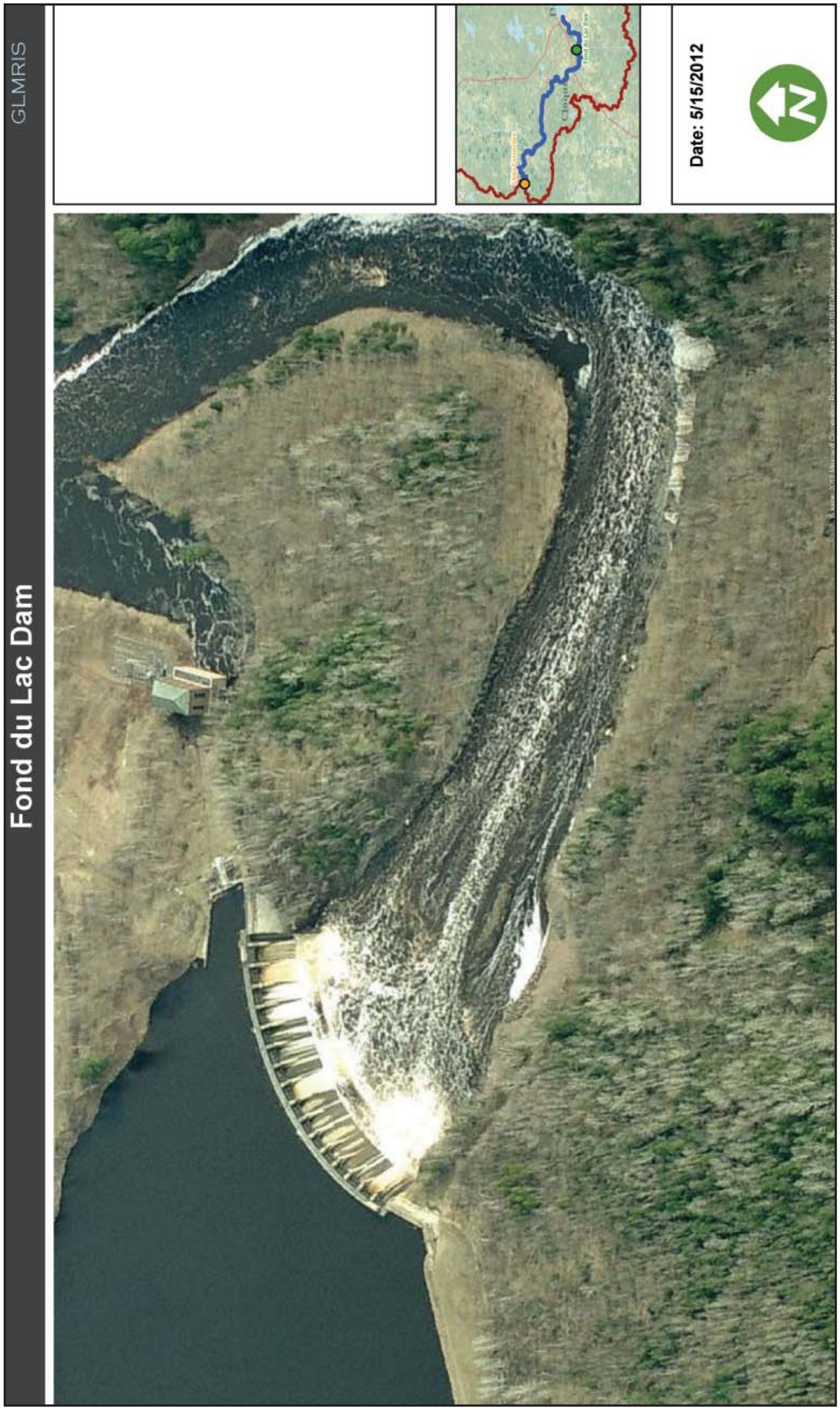


Figure 13: Aerial photo of Fond du Lac Dam on the St. Louis River, just upstream of Lake Superior. Photo available from www.bing.com/maps.

4 Aquatic Pathway Viability for ANS of Concern

The viability of the aquatic pathway was assessed by the project team for the ANS of concern for Libby Branch Swan River location in accordance with the procedures outlined in the Methodology Section of this report. This potential was characterized as high, medium, or low for the following categories:

- Probability that pathway exists
- Probability of the target ANS occurring within either basin
- Probability target ANS survive transit to reach aquatic pathway
- Probability of ANS establishment at 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. A team probability and certainty rating also is provided. The 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 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.

Certainty ratings were applied as outlined above.

Asian Carp

Silver carp and bighead carp are established throughout the middle and lower Mississippi River, with some being found further up the Mississippi River Basin. There does not appear to be any reproducing populations of Asian carp within several hundred miles of Upper Mississippi River below its confluence with the Swan River. However, bighead carp have been occasionally collected from Minnesota waters of the Mississippi River since 1996, including a capture at the confluence of the Mississippi and St. Croix River in 2011. The first silver carp was captured from Minnesota waters of the Mississippi River (near Winona, MN) during March 2011. Silver carp eDNA also was collected above the Coon Rapids Dam

on the Mississippi River in 2011. The technique of using eDNA is useful for the detection of Asian carp DNA in water when species populations are at very low levels of abundance (Jerde et al., 2011; Dejean et al, 2011; and Minamoto et al, 2011). Assuming accurate results, a positive eDNA sample indicates the presence of Asian carp DNA and the possible presence of live fish.

Spawning and the subsequent movement of silver and bighead carp is initiated by rising water levels following heavy rains (Jennings, 1988; Verigin, 1978). Both species are strong swimmers and silver carp are capable of jumping considerable distances out of the water. While both species are highly opportunistic, bighead carp are primarily zooplanktivorous, whereas silver carp primarily consume smaller phytoplankton and fine particulate organic matter (Dong and Li, 1994; Jirasek et al., 1981; Williamson and Garvey, 2005).

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

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

Inland Silverside

The inland silverside's native range is eastern North America, including the Atlantic and Gulf Slopes (mostly near the coast) from Massachusetts to the Rio Grande drainage, Texas and southeastern New Mexico; north from the Mississippi River and major tributaries (mainly Arkansas and Red Rivers) to southern Illinois and eastern Oklahoma (Page and Burr, 1991). It is a marine species that ascends rivers and prefers estuaries, lagoons, brackish seas, and rivers (Fishbase, 2011). 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, 1984). Inland silverside have not been collected in the Upper Mississippi River in Minnesota. 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 (Fuller and Nico, 2012a; 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, 2012b). There is no evidence that the species has expanded beyond these areas, and these areas are a fair distance from the divide location. There are also many dams between existing populations and the divide location, meaning the likelihood of reaching the divide location in the next 20 years is extremely low.

Team rating: **Medium**
Team Certainty rating: Reasonably Certain

Northern snakehead

The closest established population of northern snakehead 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. These areas also are hundreds of miles from the Upper Mississippi River and its headwaters. There are also many dams between existing populations and the divide location, meaning the likelihood of reaching the divide location in the next 20 years is extremely low.

Team rating: **Medium**
Team Certainty rating: Reasonably Certain

Viral Hemorrhagic Septicemia virus (VHSv)

VHSv has been reported throughout the Great Lakes Basin, including Lake Superior (USGS, 2011). VHSv has been found in many species of fish including northern pike (*Esox lucius*) and common carp (*Cyprinus carpio*). The common carp is established in Lake Superior but no common carp have been reported within the areas close to the divide according to MNDNR as of October, 2011. Northern pike is another host fish species known to exist in the pathway system, and was selected as the most likely potential host species because of the life cycle capabilities of the northen pike to use wetland complexes to spawn and the likelihood the northen pike would use and survive in the pathway habitats. VHSv and a necessary host species are in the pathway.

Team rating: **High**
Team certainty rating: Reasonably Certain

Ruffe and tubenose goby

The ruffe and tubenose goby are located within the Great Lakes and are associated with river mouths and estuaries of large river systems entering the Great Lakes. The ruffe 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 reproduction 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 predicts it will find suitable habitat in all five Great Lakes (USGS, 2012). Literature reviews and actual fish survey data have not documented the collection of the ruffe in smaller upstream tributaries. The tubenose goby's introduced range includes Lake St. Clair, Erie, Huron, Superior, and Ontario and 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. 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 (USGS, 2011).

Team rating: **High**
Team certainty rating: Very Certain

Threespine stickleback

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

Team rating: **High**
Team certainty rating: Very Certain

4.2 Probability ANS Surviving 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 location and have ample opportunity, capability and motivation to successfully navigate through the connecting streams to arrive at the subject pathway within 10 to 20 years.

Medium - Target ANS are established at locations in close enough proximity to location and have limited capability to survive passage 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.

Asian Carp, Inland Silverside, and Northern Snakehead

Movement of invasive fish species from the Mississippi River Basin up to the divide location would not occur on their own, unassisted, because of several impassible dams. This includes up to five dams in the reach from St. Cloud to Brainerd, Minnesota, that are impassable to fish (J. Lindgren-MNDNR, personal communication, January 3, 2012). All of these dams are upstream of where any of these species have been observed (including observations of Asian carp eDNA). Additional dams further downstream reduce, if not completely impede, upstream fish passage. This eliminates the potential for all fish to move on their own up the Mississippi River, through the Swan River, and up to the divide location. Although northern snakehead can move across wet terrestrial areas, the area around several of these dams is fairly wide and steep, and would seem to prevent overland movement around many dams for this species. Ultimately, the ANS outlined here would not be able to move to the divide locations without the aid of anthropogenic means, or some other non-aquatic vector.

Team rating: **Low for all species**
Team certainty rating: Reasonably to Very Certain for all species

VHSv, Ruffe, Tubenose Goby, and Threespine Stickleback

Movement of invasive fish species from Lake Superior up the St. Louis River to the divide location would not occur on their own because of several impassible dams. This includes the Fond du Lac Dam near Lake Superior which is over 70 feet (21 m) high and impassable to fish. VHSv is not known to be present or to have been collected in nearby waters (or host fish) upstream from the potential pathway area in the Great Lakes Basin. Ultimately, the invasive species outlined here would not be able to move to the divide locations without the aid of anthropogenic means, or some other non-aquatic vector.

Team rating: **Low for all species**
Team certainty rating: Very certain for all species

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

This section does not influence the overall pathway rating outlined in this report and is only included to point out other potential pathways (e.g., anthropogenic) that may be important to different audiences. Any further analysis of 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 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 location and have limited capability to survive passage 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.

Asian Carp

Although transit across the watershed divide by anthropogenic means is possible, Minnesota state regulations prohibit transport and possession of live silver carp, bighead carp, and black carp. This should limit the liklihood of transfer, but would not eliminate it entirely. Since fishing and boating likely do not occur within the drainage network at the divide, and the wetland complex appears to have limited standing water, it appears unlikely that any species of Asian carp will arrive at the divide by anthropogenic means, such as livewell or aquarium releases.

The probability of Asian carp arriving at the pathway through anthropogenic means is higher than in the preceeding section due to adjacent lakes in the Mississippi River headwaters that receive heavy recreational use. Should Asian carp became established in nearby Big Sandy Lake, they could eventually move to the divide location. There is uncertainty about how quickly Asian carp may spread to this area. However, given the current distance to the divide loation, the likelihood of them arriving at the divide location in the next 20 to 50 years is considered to be possible.

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

Inland Silverside

Transit of this species to the watershed divide by anthropogenic means is possible. The watershed area adjacent to the divide includes lakes and rivers with a fair amount of recreational use. Given its' small size, the inland silverside could be a potential accidental bait bucket release. However, there is no source population of inland silverside anywhere near the upper watershed. Given limited expansion to date, and the failed stocking of this species within a nearby Minnesota lake, it is highly uncertain if anthropogenic movement could result in the species being brought near the divide in the next 50 years.

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

Northern Snakehead

Many species of snakehead, including the northern snakehead, have been popular aquarium fish. However, education efforts by the state of Minnesota have aimed to reduce aquarium releases and other methods of human transfer. Since fishing and boating do not occur at the basin divide wetland, it is highly unlikely that the northern snakehead will arrive at the divide by anthropogenic means, such as livewell or aquarium releases. They could arrive however, at other lakes near the divide. Intentional release by humans of the northern snakehead in the divide location appears unlikely. Moreover, the probability of human release of this speces is likely, if not more probable, in other aquatic areas at or near the basin divide within many states along the Great Lakes and Mississippi River Basin boundary.

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

VHSv

VHSv could be transported by anthropogenic means. Minnesota does currently test its fish hatcheries and rearing systems for VHS yearly. Minnesota Department of Natural Resources no longer uses St. Louis River walleye eggs for inland fish stocking operations. Minnesota state law prohibits transport of fishing bait across state lines, with additional laws also reducing the risk of the spread of VHS due to sport fishing.

There is no evidence or information to suggest the emergent wetland and ditches at the basin divide are recreational areas used by fishermen or boaters, so there appears to be a low probability for ANS to be transported to the proximity of the basin divide at this location by anthropogenic means. However, sport angling does occur in the St. Louis River, and there is potential that VHSv could be moved upstream of existing barriers, where it could be carried to the divide location by host fish. This consideration is the primary basis for the assigment of a "medium" rating for the probability VHSv will survive transit to the aquatic pathway by other means.

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

Ruffe and Tubenose Goby

There is no evidence or information to suggest the wetland is used by fishermen or recreational 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. Moreover, these two fish species are not normally used as live bait for river fishing or aquarium species. In the unlikely event these ANS are introduced into the wetland, the aquatic habitat is considered marginally suitable for survival. During the summer months the wetland would not likely provide the necessary habitat for occupation. Transit across the wetland divide by other anthropogenic means is possible but unlikely.

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

Threespine Stickleback

It is believed that bait-bucket transport has aided in the movement of the threespine stickleback in the past. Minnesota state regulations do not prohibit transport or possession of this species, but it cannot be released in the wild. Since public access, fishing, and boating do not occur on the ditches within the divide, the probability of introduction by anthropogenic means is considered low. If the fish was dumped into the wetlands at the divide, it is likely they could move downstream to suitable Mississippi River Basin habitat during a suitable storm event. Education will be important to minimizing accidental introductions through this pathway.

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

4.3 Probability of ANS Establishment at 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 the target 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.

Asian Carp

Silver and bighead carp are fast growing species that are capable of surviving in a wide range of water temperatures and reproducing quickly, providing suitable habitat is available. This suitable habitat includes the need for current, backwater habitats, deep overwintering holes, and other habitat types needed for survival (Nico, et al., 2005). It is believed that silver and bighead carp require sufficient flow to keep fertilized eggs suspended for successful reproduction (Gorbach and Krykhtin, 1980). Black carp reach sexual maturity in as little as five years and adult females can produce up to one million eggs per spawning event.

Habitat at the divide location is a wetland with drainage ditches crossing the divide. Though habitat appears poor, Asian carp may be able to live long-term and reproduce in these areas, particularly if they can move back and forth to larger rivers to meet seasonal needs since all species of Asian carp require lowland rivers to complete their life cycles (Nico and Jelks, 2011). Successful spawning and recruitment is uncertain, but appears possible. Physical space within the aquatic habitat at the divide location

would be limited but may not preclude Asian carp from establishing a population.

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

Inland Silverside

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 cold winter temperatures. Hubbs, et al. (1971) inferred that the native inland range for the inland silverside does not extend beyond the confluence of the Ohio and Mississippi Rivers because it cannot withstand winters farther north. Richards (1977) however, showed that the inland silverside can survive for at least two weeks at 34.7ºF (1.5ºC). Stoeckel and Heidinger (1988) demonstrated that inland silversides can be maintained over winter in aquaculture systems at temperatures above 59ºF (15ºC), when they were fed a prepared diet. They also demonstrated that inland silversides have a high mortality during extended periods of cold during the winter in unheated ponds and reservoirs. Overwintering mortality in the 80-90% range has been reported for the inland silverside in Rhode Island waters (Bengtson, 1982). Spawning occurs in shallow water in areas with abundant vegetation, and includes all forms of plants, including dead leaves, tree roots, algal mats, or rooted aquatic plants of marshes (Hildebrand, 1922; Weinstein, 1986). The 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 subject location 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. Habitat at the divide location is also limited.

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

Northern Snakehead

The northern snakehead's native range (latitude 24-53ºN) and temperature tolerance 32ºF-86ºF (0-30ºC) indicates a species that, if introduced, could establish populations throughout most of the contiguous United States (Courtenay and Williams, 2004). Northern snakeheads prefer shallow ponds and marshes with aquatic vegetation, which is similar to the shallow water aquatic habitat around this divide. Northern snakeheads are naturally aggressive predators that could acclimate to the conditions in and around ditches around the divide as long as there is an ample food supply, which appears to be the case. They can be very opportunistic in their feeding habits, preying on everything from insect larvae to fish, frogs, and crustaceans.

Team rating: **High**
Team certainty rating: Reasonably Certain

VHSv

The wetland at the divide is considered suitable for establishment of a viable population of fish, at least during higher water events in the spring. The habitat on the Mississippi River Basin side of the divide is considered suitable for common carp and northern pike in the spring and for other fish species that are potential host species of this virus. The virus is also capable of persisting outside of a host for several days when water temperatures are cool 37º F - 54ºF (2.8ºC - 12.2ºC) (USGS, 2011). It also demonstrates a rapid reproductive cycle and is capable of utilizing many different host species, including the common carp (WDNR, 2012). The drop inlet structure at State Route 2 appears to be the mechanism that restricts fish passage between basins, but without As-Built design plans, reasonable uncertainty exists as to whether the structure is a true barrier to fish passage from the Great Lakes Basin side of the divide. It is likely that if any invasive fish species crossed the divide, they would survive the transfer to the Mississippi River Basin and find suitable habitat to flourish. It is highly likely that VHSv could be successful in establishing in fish populations already on the Mississippi River Basin side of the wetland basin divide.

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

Ruffe and Tubenose Goby

Survival of a viable and reproducing population of ruffe and tubenose goby within the wetland divide is unlikely

due to unsuitable habitat in the wetland and the severity of the winters. 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 divide and the moderate certainty assigned to the rating.

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

Threespine Stickleback

As a visual predator, the turbid waters of the connecting ditches in the wetland complex may be unsuitable for the threespine stickleback. However, the ditches could provide sufficient habitat for this species during the spring months during higher flows. If the fish were able to get to the Mississippi River Basin side of the divide, they could pass downstream to habitat suitable for all life stages of the species in the Mississippi River Basin, thus the rating and certainty.

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

During a flood event there would likely be favorable conditions for a sufficient period of time to allow Asian carp to move through the pathway. Asian carp have demonstrated strong capabilities of spreading through large river systems and are ranked medium for their ability to transfer across the basin divide into the Great Lakes Basin via the drop structure at State Route 2, although further evaluation of this structure is warranted regarding its actual ability to allow fish passage. In addition, this drop structure is a very narrow transfer point between the basins and could potentially be difficult for limited numbers of fish to locate randomly. The St. Louis River estuary at Duluth may provide the diversity of habitat necessary to allow Asian carp to reproduce and establish populations. Lake Superior is an extremely coldwater, oligotrophic lake.

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

Inland Silverside

It is unlikely that this species would be able to establish itself at these latitudes and thus be able to cross over the basin divide due to surface water characteristics and water temperatures at the pathway site. Given the lack of success to date with expansion, it appears the likelihood of establishing a population that would be able to pass across this site is low.

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

Northern Snakehead

It is very likely that the northern snakehead possess the ability to spread across the Libby Branch of the Swan River pathway location into the Great Lakes Basin. However, it is uncertain if or how quickly the northern snakehead could move through the pathway. As an air breather that has been known to move short distances over land, it is likely this species would be able to

move into suitable adjacent habitat. Under proper environmental conditions, this species could potentially transfer from ditches around this potential pathway location into the Great Lakes Basin.

Team rating: **High**
Team certainty rating: Reasonably Certain

VHSv

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 any exposed fish populations already on both sides of the basin divide in the event infected fish reached the Libby pathway. The only area of uncertainty with this rating is the unknown likelihood and ability of infected fish or contaminated water to transfer through the drop structure at State Route 2 into the Mississippi River Basin.

Team rating: **High**
Team certainty rating: Reasonably Certain

Ruffe and Tubenose Goby

Ruffe and the tubenose goby have not been found in upper river systems within the Great Lakes Basin. However, if the fish were introduced into the divide during spring runoff, it is likely they would be successful in passing into the Mississippi River Basin.

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

Threespine Stickleback

The three spine stickleback has been found in small river systems. Sufficient habitat at or near the potential pathway is available to provide for all necessary life stages for the threespine stickleback.

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 Libby Branch of Swan River 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 10 and Table 11). 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 10. At the Libby Branch of Swan River 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 11. At the Libby Branch of Swan River location, the overall pathway viability for transferring species from the Great Lakes Basin to the Mississippi River Basin is also “low”. 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 10 and 11. In this particular case, the ratings were the same and thus the overall aquatic pathway viability is “low”.

6 Conclusions

Outside vectors (e.g., anthropogenic, terrestrial) would be needed to transport ANS to the divide location and would have to bypass downstream several dams. Given that such non-aquatic vectors are not part of the scope of this study, the overall aquatic pathay viability rating is ”low” for the site, with the main limitation to ANS movement being species inability to navigate to the divide area on their own. However, if any of the ANS were somehow able to be made present at the divide, the level of hydraulic connectivity would support the possibility that the species could then move across the divide and into the adjacent basin from this location. Given that outside vectors are a possibility in facilitating

ANS movement to this location, it is possible that one or more ANS could arrive at the divide location within the next 20 to 50 years by such means. In addition, there may therefore be an equal potential that ANS could just as easily be transported across the basin divide and into the adjacent basin at other locations by these same outside vectors.

7 Opportunities

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 Libby Branch of Swan River site if warranted by future ANS population changes or any modifications are made to the downstream dams. Given the blockage presented by many downstream dams in both watersheds, the immediate need for implementation of structural measures at this location appears to be low. 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:

- There are broad categories of technology for potential active measures to prevent ANS transfer at this location or in connecting downstream waters, such as:

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

			Form 1	Form 2	Form 3a	Form 4	Form 5	
Group	**Common Name**	**Mode of Dispersal**	**Pathway Exists? (Sect. 3.6)**	**Within Either Basin? (Sect. 4.1)**	**Survive Independent Transit to Pathway? (Sect. 4.2.1)**	**Establish at or Near Pathway? (Sect. 4.3)**	**Cross Path-way into New Basin? (Sect. 4.4)**	**Aquatic Pathway Viability Rating**
fish	*Asian carp* *silver carp, bighead carp, black carp*	swimmer	H (RC)	H (VC)	L (RC/VC)	M (MC)	M (RU/RC)	L
fish	*inland silverside*	swimmer		M (RC)	L (RC/VC)	L (RU)	L (RU)	L
fish	*northern snakehead*	swimmer		M (RC)	L (RC/VC)	H (RC)	H (RC)	L
Overall Pathway Viability for Spread of ANS from Mississippi River Basin to Great Lakes Basin:								**L**

Table 11: Pathway viability for ANS spreading from the Great Lakes Basin to the Mississippi River Basin. Uncertainty rating in parantheses

			Form 1	Form 2	Form 3a	Form 4	Form 5	
Group	**Common Name**	**Mode of Dispersal**	**Pathway Exists? (Sect. 3.6)**	**Within Either Basin? (Sect. 4.1)**	**Survive Independent Transit to Pathway? (Sect. 4.2.1)**	**Establish at or Near Pathway? (Sect. 4.3)**	**Cross Path-way into New Basin? (Sect. 4.4)**	**Aquatic Pathway Viability Rating**
virus	*VHSv*	fish pathogen/ water column	H (RC)	H (RC)	L (VC)	M (RC)	H (RC)	L
fish	*ruffe and tubenose goby*	swimmer		H (VC)	L (VC)	L (MC)	M (RC)	L
fish	*three-spine stickleback*	swimmer		H (VC)	L (VC)	M (MC)	H (RC)	L
Overall Pathway Viability for Spread of ANS from Great Lakes Basin to Mississippi River Basin:								**L**

- Chemical deterrents in order to reduce habit suitability at or near the pathway.
- Biological control measures that prevent ANS reproduction or prevent the ability of ANS to establish a sustainable population in the vicinity of the pathway.
- Physical Removal of ANS at their current locations within each basin.
- Increase commercial and recreational harvest, specifically of bighead and silver carp, in the Mississippi River Basin.

- New or improved regulations or ordinances prohibiting the establishment of drainage ways that would connect the Mississippi River tributaries with Great Lakes tributaries (e.g., ditch construction, culvert installation).
- Further analysis of the drop structure at State Route 2 to determine if any modification to that structure would further limit ANS movement.
- Installation of additional in-stream barriers downstream of the pathway to further restrict the probability of upstream ANS movement.
- Take ANS transfer potential into account for proposed water resource projects (e.g., ecosystem restoration, dam removal, stream restoration, water management).
- 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 full potential of an aquatic pathway existing at the Libby site.
- Site-specific hydrologic and hydraulic investigations to better understand potential for any backflow events to occur through the drainage channels of the pathway from the Floodwood River.
- Where possible, maintain pristine habitats as whole, intact ecosystems to help prevent any ANS establishment at or near the basin divide.
- 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.
  - Improve identification and reporting of ANS to the appropriate authorities.
- Support research on the biology of ANS so transfer potential can be better understood.
  - Life history.
  - Habitat requirements and tolerances.
  - 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 an integrated ANS sampling and analysis plan for execution during times when ANS would be expected to be present in an 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.
- Prevent introductions of additional ANS within the region.
  - 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 addition, the results of this pathway assessment should be taken into consideration during the next update to the Minnesota Aquatic Nuisance Species (ANS) Management Plan.

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Appendix A

Evaluation Forms for each ANS of Concern Selected for the Libby Branch of Swan River

Libby Branch, Itasca/Aitkin/St. Louis Counties, MN - 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	High	RC	High	RC
	USACE, St. Paul- Hydraulic Engineer	High	RC	High	RC
	Team Ratings	**High**	**RC**	**High**	**RC**

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: During the site visit on 31-May-2011, as well as previous visits in May and July of 2010, flow was visible through the drop structure, under US-2, to the Northeast and the Great Lakes Basin. Just over a mile East of 154th Ave on MN-200, the surface flow is to the West. This flow path crosses under 154th Ave through a large culvert. Aerial photography show an extensive network of ditches between these flow locations, indicating a high likelihood of hydrologic connection.

Libby Branch, Itasca/Aitkin/St. Louis Counties, MN - 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	High	VC		
	USACE, Detroit - Biologist	High	VC		
	Team Rating	**High**	**VC**		

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

Qualitative Rating	Qualitative Rating Category Criteria
High	Target ANS exists on connected waterways in close enough proximity to be capable of 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 (*Hypophthalmichthys molitrix*) and bighead carp (*Hypophthalmichthys nobilis*) are established throughout the Mississippi River basin. A bighead carp was collected in the lower St. Croix River, at the confluence of the Mississippi River, in 2011. Silver Carp eDNA also was collected above Coon Rapids dam upstream of Minneapolis, during 2011. Although they may not be established within the Mississippi River in MN, individuals of bighead, and likely silver carp as well, are present. Black carp have a more limited distribution and are less likely to reach the Upper Mississippi River in the next few years.

Libby Branch, Itasca/Aitkin/St. Louis Counties, MN - 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	VC	Medium	RC
	USACE, Detroit - Biologist	Low	RC	Medium	RC
	Team Ratings	**Low**	**RC/VC**	**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. Direct passage of Asian carp upstream to the divide location, via swimming, would not occur because of several high hydraulic head dams (up to approximately 50 feet). This eliminates the potential for Asian carp to move on their own account up the Mississippi River to the divide location.

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

3B.Although transit across the watershed divide by other anthropogenic means is possible, Minnesota state regulations prohibiting transport and possession of live silver carp, bighead carp, and black carp. This should limit these chances of transfer, but would not eliminate them entirely. Since fishing and boating do not occur in the GLB/MRB emergent wetland divide and the wetland complex appears to have limited standing water, it is highly unlikely that the any species of Asian carp will arrive at the divide by anthropogenic means, such as livewell or aquarium releases.

The probability of Asian carp arriving at the pathway through anthropogenic means is higher due adjacent lakes in the Mississippi River headwaters that receive heavy recreational use. Should Asian carp became established in nearby Big Sandy Lake, they could eventually move to the divide location. There is uncertainty about how quickly Asian carp may spread to this area. However, given the current distance to the divide loation, the likelihood of them arriving at the divide location in the next 20 to 50 years is considered to be possible.

Libby Branch, Itasca/Aitkin/St. Louis Counties, MN - Asian Carp

4. Probability of ANS establishing at the aquatic pathway

Aquatic Pathway Team	Expertise Position title or team role	Rating	Certainty		
	USACE, St. Paul - Biologist	Medium	MC		
	USACE, Detroit - Biologist	Medium	RC		
	Team Ratings	**Medium**	**MC**		

4. How do you rate the probability of ANS establishing at 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 in a wide range of water temperatures and reproducing quickly, providing suitable habitat is available. This suitable habitat includes diverse needs for current areas, backwater habitats, deep overwintering holes, and other habitat types needed for year-round life-history requirements.
Habitat at the divide location is a wetland with drainage ditches crossing the divide. Asian carp may be able to live long-term and reproduce in these areas. Successful spawning and recruitment is uncertain by appears possible. Physical space within the aquatic habitat at the divide location would be limited but probably wouldn't preclude Asian Carp from establishing a population.

Libby Branch, Itasca/Aitkin/St. Louis Counties, MN - 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	Medium	RU		
	USACE, Detroit - Biologist	Medium	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: Asian carp have demonstrated strong capabilities of spreading through large river systems, and will likely continue to do so. However it is uncertain whether they could establish populations in the St. Louis River, or downstream in Lake Superior. The St. Louis estuary at Duluth may provide the diversity of habitat necessary to allow Asian carp to reproduce and establish populations. Lake Superior is an extremely coldwater, oligotrophic lake. It is uncertain if Asian carp could establish populations in the main lake. However, other rivers entering Lake Superior also might provide enough habitat requirements to meet the needs of Asian Carp. Ultimately, the presence of adequate near-by habitat is highly uncertain on the Great Lakes side of this divide location. If the Asian carp were successful in crossing the divide, they also could potentially migrate downstream through the Soo Locks to more suitable habitat in the lower Great Lakes. The risk is identified as a "medium" risk at this location due to great uncertainty.

Libby Branch, Itasca/Aitkin/St. Louis Counties, MN - 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	High	RC	High	RC
	USACE, St. Paul- Hydraulic Engineer	High	RC	High	RC
	Team Ratings	**High**	**RC**	**High**	**RC**

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: During the site visit on 31-May-2011, as well as previous visits in May and July of 2010, flow was visible through the drop structure, under US-2, to the Northeast and the Great Lakes Basin. Just over a mile East of 154th Ave on MN-200, the surface flow is to the West. This flow path crosses under 154th Ave through a large culvert. Aerial photography show an extensive network of ditches between these flow locations, indicating a high likelihood of hydrologic connection.

Libby Branch, Itasca/Aitkin/St. Louis Counties, MN - 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		
	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 has not been collected in the Upper Mississippi River in MN. Recently, its most northern know occurrence in the MRB is on the Kankakee River in Will County Illinois, where they were collected in 1996 (USGS 2009a). The species was stocked in Turtle Lake in Ramsey County, MN in 1950, but that population failed. There is no evidence that the species has expanded beyond these areas. There are also many dams between existing populations and the divide location, meaning the likelihood of reaching the divide location in the next 20 years is extremely low.

Libby Branch, Itasca/Aitkin/St. Louis Counties, MN - 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	VC	Low	RC
	USACE, Detroit - Biologist	Low	RC	Low	RC
	Team Ratings	**Low**	**RC/VC**	**Low**	**RC**

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

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

Qualitative Rating	Qualitative Rating Category Criteria
High	Target ANS are established in relatively close proximity to location and have ample opportunity, capability and motivation to successfully navigate through the aquatic pathway and/or through other means to arrive at the subject pathway within 10-20 years.
Medium	Target ANS are established at locations in close enough proximity to location and have limited capability to survive 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. Direct passage of Inland Silverside upstream to the divide location, via swimming, would not occur because of several high hydraulic head dams (up to approximately 50 feet). This eliminates the potential for Inland Silverside to move on their own account up the Mississippi River to the divide location.

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

3B. Transit up to the watershed divide by other anthropogenic means is possible. The watershed area adjacent to the divide includes lakes and rivers with a fair amount of recreational use. Given it's small size, the Inland Silverside could be a potential bait bucket mistakenly released. However, there is no source population of inland silverside anywhere near the upper watershed. Given limited expansion to date; and the failed stocking of this species within a near-by MN lake, it's highly uncertain if anthropogenic movement could result in the species being near the divide in the next 40 years.

Libby Branch, Itasca/Aitkin/St. Louis Counties, MN - Inland Silverside (*Menidia beryllina*)

4. Probability of ANS establishing at 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		
	Team Ratings	**Low**	**RC**		

4. How do you rate the probability of ANS establishing at 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 divide location could potentially support the species. However, 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.

Libby Branch, Itasca/Aitkin/St. Louis Counties, MN - 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	RC		
	USACE, Detroit - Biologist	Low	RC		
	Team Ratings	**Low**	**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: Its unlikely that this species would be able to establish itself at these latitudes. If not limited by latitude, the St. Louis River and it's estuary to Lake Superior may provide adequate habitat diversity to allow for expansion of Inland Silverside. Given the lack of success to date with expansion, it appears the risk for establishing a population is low.

Libby Branch, Itasca/Aitkin/St. Louis Counties, MN - 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	High	RC	High	RC
	USACE, St. Paul- Hydraulic Engineer	High	RC	High	RC
	Team Ratings	**High**	**RC**	**High**	**RC**

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: During the site visit on 31-May-2011, as well as previous visits in May and July of 2010, flow was visible through the drop structure, under US-2, to the Northeast and the Great Lakes Basin. Just over a mile East of 154th Ave on MN-200, the surface flow is to the West. This flow path crosses under 154th Ave through a large culvert. Aerial photography show an extensive network of ditches between these flow locations, indicating a high likelihood of hydrologic connection.

Libby Branch, Itasca/Aitkin/St. Louis Counties, MN - 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		
	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, AR. While this is in the Mississippi River watershed, this population does not seem to be spreading at a high rate at this time.

Libby Branch, Itasca/Aitkin/St. Louis Counties, MN - 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	Low	RC
	USACE, Detroit - Biologist	Low	RC	Low	RC
	Team Ratings	**Low**	**RC/VC**	**Low**	**RC**

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

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

Qualitative Rating	Qualitative Rating Category Criteria
High	Target ANS are established in relatively close proximity to location and have ample opportunity, capability and motivation to successfully navigate through the aquatic pathway and/or through other means to arrive at the subject pathway within 10-20 years.
Medium	Target ANS are established at locations in close enough proximity to location and have limited capability to survive 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. 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. Moreover, direct passage of northern snakehead through the Mississippi River, upstream of the Twin Cities, via swimming, would not occur because of several high hydraulic head dams. This eliminates the potential for northern snakehead to move on their own account from the Mississippi River through the St. Croix River past Taylors Falls. Although snakehead can move across wet terrestrial areas, the area around these dams are steep and would require a fair distance of movement across land. This should prevent overland movement around these dams.

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

3B. Many species of snakehead, including the northern snakehead, have been popular aquarium fish. However, education efforts by MN have aimed to reduce aquarium releases, and other methods of human transfer. Since fishing and boating do not occur in the basin divide wetland, it is highly unlikely that the northern snakehead will arrive at the divide by anthropogenic means, such as livewell or aquarium releases. They could arrive at lakes adjacent, connected lakes at the divide location. However, intentional release by humans of the northern snakehead in the divide location appears unlikely. Moreover, human release would likely occur with the same level of risk on the GLB side of the divide, making the issue of anthropogenic release at the divide more or less moot.

Libby Branch, Itasca/Aitkin/St. Louis Counties, MN - Northern Snakehead (*Channa argus*)

4. Probability of ANS establishing at the aquatic pathway

Aquatic Pathway Team	Expertise Position title or team role	Rating	Certainty		
	USACE, St. Paul - Biologist	High	RC		
	USACE, Detroit - Biologist	High	RC		
	Team Ratings	**High**	**RC**		

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

Libby Branch, Itasca/Aitkin/St. Louis Counties, MN - 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		
	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: It is very likely that the northern snakehead possesses the ability to spread from Libby Branch divide if a population were established; however, it is uncertain if or how quickly the northern snakehead could reach the pathway. As an air breather that has even been known to move short distances over land, it is likely this species would be able to quickly move into suitable adjacent habitat. Under proper environmental conditions, this species could potentially transfer in either direction from ditches around Libby Branch.

Libby Branch, Itasca/Aitkin/St.Louis Counties, MN - 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	High	RC	High	RC
	USACE, St. Paul- Hydraulic Engineer	High	RC	High	RC
	Team Ratings	**High**	**RC**	**High**	**RC**

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: During the site visit on 31-May-2011, as well as previous visits in May and July of 2010, flow was visible through the drop structure, under US-2, to the Northeast and the Great Lakes Basin. Just over a mile East of 154th Ave on MN-200, the surface flow is to the West. This flow path crosses under 154th Ave through a large culvert. Aerial photography show an extensive network of ditches between these flow locations, indicating a high likelihood of hydrologic connection.

Libby Branch, Itasca/Aitkin/St.Louis Counties, MN - Viral Hemmorhagic Septicemia virus (VHSv)

2. Probability of ANS occurring within either basin

Aquatic Pathway Team	Expertise	Rating	Certainty		
	USACE, St. Paul - Biologist	High	RC		
	USACE, Detroit - Biologist	High	RC		
	Team Rating	**High**	**RC**		

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

Qualitative Rating	Qualitative Rating Category Criteria
High	Target ANS exists on connected waterways in close enough proximity to be capable of 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 (VHSv) can infect a wide range of host fish causing a variety of external and internal pathology including death of the host fish. Variables such as host fish species and water temperature can impact the pathology of the virus. Seemingly healthy individuals that have been previously infected with VHSv can have chronic infections and be carriers of the disease (Skall et al. 2005). This VHS virus has been reported from throughout the Great Lakes Basin including Lake Superior (USGS 2009a). Viral Hemorrhagic Septicemia (VHSv) has been found in many species of fish including common carp (*Cyprinus carpio*), brown trout and northern pike. The common carp is established in Lake Superior but no common carp have been reported within the areas close to the divide (MNDNR personal communication October 2011). Northern pike is another host fish species known to exist in the pathway system, and was selected as the most likely host species because of the life cycle capabilities of the northern pike to use wetland complexes to spawn and the likelihood the northen pike would use and survive in the pathway habitats. Viral Hemorrhagic Septicemia (VHSv) and a necessary host species are in the pathway.

Libby Branch, Itasca/Aitkin/St.Louis Counties, MN - Viral Hemmorhagic Septicemia virus (VHSv)

3. Probability of ANS surviving transit to aquatic pathway

Aquatic Pathway Team	Expertise	3A Rating	Certainty	3B Rating	Certainty
	USACE, St. Paul - Biologist	Low	VC	Medium	RU
	USACE, Detroit - Biologist	Low	VC	Medium	RU
	Team Ratings	**Low**	**VC**	**Medium**	**RU**

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 Superior to the watershed divide along the St. Louis River, Floodwood River, West Branch Floodwood River and an unnamed tributary is roughly 85 to 100 miles. According to USGS gage 04024000 on the St. Louis River at Scanlon, MN (about 60 miles from the watershed divide), average river discharge ranges from 5,500 cfs in the spring (April) to 900 cfs low flow in August. During spring run-off events as soon as the ice is off the rivers in April/May, northern pike migrate into the shallow waters of bays and river systems to spawn. Within the rivers, northern pike migrate upstream to spawn in suitable habitat such as marshes or flooded fields with vegetation, with as little as or less than one foot depth of water. Northern pike are strong swimmers and though they cannot jump like members of the salmon family, they can migrate upstream during moderate flow events. All five dams on the Lower St. Louis River below Cloquet are considered to be migration barriers. Most certainly, at approximately 100 feet, the first dam above Lake Superior (Fond du Lac) is an upstream migration barrier (MnDNR, personal communication, January 2012). The northern pike, as a carrier of VHSv has been identified in the Lake Superior pathway. It is likely that northern pike could access the divide through ditches during a suitable spring runoff event. It is unlikely that the fish would cross the divide through the drop inlet structure to the MRB side of the divide but possible. If any of the carrier fish species crossed the GLB/MRB divide during a spring runoff event, sufficient forage, ranging from zooplankton to fish, is available downstream for survival. If infected fish were found in the St. Louis River above the dams, there is a high probability ANS will survive transit to the aquatic pathway and the certainty assigned to the rating. However, the rating is low because of the impassable dams on the river system.

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 and ditches at the basin divide are recreational areas used by fishermen or boaters, so there appears to be a low probability for ANS to be transported to the proximity of the basin divide at this
36 Libby Branch of Swan River Report August 2012 location by anthropogenic means. However, sport angling does occur in the St. Louis River, and there is potential that VHSv could be moved upstream of existing barriers, where it could be carried to the divide location
by host fish. This consideration is the primary basis for the assigment of a ”medium” rating for the probability VHSv will survive transit to the aquatic pathway by other means.

Libby Branch, Itasca/Aitkin/St.Louis Counties, MN - Viral Hemmorhagic Septicemia virus (VHSv)

4. Probability of ANS establishing at the aquatic pathway

Aquatic Pathway Team	Expertise	Rating	Certainty
	USACE, St. Paul - Biologist	Medium	RC
	USACE, Detroit - Biologist	Medium	RC
	Team Ratings	**Medium**	**RC**

4. How do you rate the probability of ANS establishing at 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 wetland is considered suitable for establishment of a viable population of fish, at least in the spring. The habitat on the MRB side of the divide is considered suitable for common carp and northern pike in the spring and for other fish species, as carriers of VHSv. VHSv is capable of persisting outside of a host for several days. The virus demonstrates a rapid reproductive cycle and is capable of utilizing many different host species. The drop inlet structure appears to be the mechanism that restricts fish passage but without "As Built" design plans, reasonable uncertainty exists as to whether the structure is a true barrier to fish passage from the GLB side of the divide. If any invasive fish species were passed across the divide, it is likely that fish would survive the transfer to the MRB and find suitable habitat to flourish. It is highly likely that VHSv would be successful in establishing in fish populations already on the MRB side of the wetland basin divide, thus the rating and certainty.

Libby Branch, Itasca/Aitkin/St.Louis Counties, MN - Viral Hemmorhagic Septicemia virus (VHSv)

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

Aquatic Pathway Team	Expertise	Rating	Certainty
	USACE, St. Paul - Biologist	High	RC
	USACE, Detroit - Biologist	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: Northern pike, common carp and other host species have been found in smaller rivers and lakes. If the fish were successful in passing downstream from the divide into the MRB system, it is feasible that VHSv would establish in a viable fish population. The common carp have been found in smaller river systems and after migration, the carp or other carrier fish could be established in the Mississippi River. This is the primary information that supported the assignment of a High rating to the probability that VHSv would spread across the basin divide if it were established in northern pike or common carp in close proximity to this location.

Libby Branch, Itasca/Aitkin/St.Louis Counties, MN - Ruffe (*Gymnochephalus cernua*) / 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	High	RC	High	RC
	USACE, St. Paul- Hydraulic Engineer	High	RC	High	RC
	Team Ratings	**High**	**RC**	**High**	**RC**

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: During the site visit on 31-May-2011, as well as previous visits in May and July of 2010, flow was visible through the drop structure, under

Libby Branch, Itasca/Aitkin/St.Louis Counties, MN - Ruffe (*Gymnochephalus cernua*) / Tubenose Goby (*Proterorhinus semilunaris*)

2. Probability of ANS occurring within either basin

Aquatic Pathway Team	Expertise	Rating	Certainty		
	USACE, St. Paul - Biologist	High	VC		
	USACE, Detroit - Biologist	High	VC		
	Team Rating	**High**	**VC**		

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

Qualitative Rating	Qualitative Rating Category Criteria
High	Target ANS exists on connected waterways in close enough proximity to be capable of 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 (*Gymnochephalus cernua*) and tubenose goby (*Proterorhinus semilunaris*) are located within the Great Lakes and associated with river mouths and estuaries of large river systems entering the Great Lakes. The ruffe prefers deep waters of lakes and pools of rivers, usually over sand and gravels but has a tolerance for different habitats and environmental conditions (Gray and Best 1989). The ruffe has a high fecundity rate and spawns in clean water. The ruffe's ability to swim upstream during high flow events and migrate over dams is questionable. The ruffe has been identified within Lake Superior. The ruffe is an aggressive species that possesses the ability to feed in darkness, cold temperatures and turbid conditions. The fish has extended its range rapidly and modeling predicts it will find suitable habitat in all five Great Lakes. The tubenose goby's introduced range covers three Great Lakes including Lake Superior, Erie and Huron (USGS 2009a). It has been collected in the lower reaches of larger Great Lakes rivers and estuaries. The tubenose goby is found in the open waters and estuaries of slow flowing rivers. Tubenose gobies are benthic species that consume a wide variety of invertebrates (USGS 2009a). They are often quite abundant in backwaters and lakes and seem prefer dense vegetation. Literature from Europe and Russia indicate the tubenose goby does inhabit upper river systems but no tubenose goby have been collected locally in upper Great Lakes river tributaries to date. 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 GLB and the MRB.

Libby Branch, Itasca/Aitkin/St.Louis Counties, MN - Ruffe (*Gymnochephalus cernua*) / Tubenose Goby (*Proterorhinus semilunaris*)

3. Probability of ANS surviving transit to aquatic pathway

Aquatic Pathway Team	Expertise	3A Rating	Certainty	3B Rating	Certainty
	USACE, St. Paul - Biologist	Low	VC	Low	RC
	USACE, Detroit - Biologist	Low	VC	Low	RC
	Team Ratings	**Low**	**VC**	**Low**	**RC**

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

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

Qualitative Rating	Qualitative Rating Category Criteria
High	Target ANS are established in relatively close proximity to location and have ample opportunity, capability and motivation to successfully navigate through the aquatic pathway and/or through other means to arrive at the subject pathway within 10-20 years.
Medium	Target ANS are established at locations in close enough proximity to location and have limited capability to survive 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 Superior to the watershed divide along the St. Louis River, Floodwood River, West Branch Floodwood River and an unnamed tributary is roughly 85 to 100 miles. All five dams on the Lower St. Louis River below Cloquet are considered to be migration barriers. Most certainly, at approximately 100 feet, the first dam above Lake Superior (Fond du Lac) is an upstream migration barrier (John Lindgren, MnDNR, personal communication, January 2012). According to USGS gage 04024000 on the St. Louis River at Scanlon, MN (about 60 miles from the watershed divide), average river discharge ranges from 5,500 cfs in the spring (April) to 900 cfs low flow in August. The ruffe prefers deep waters of lakes and pools of rivers, usually over sand and gravels but has a tolerance for different habitats and environmental conditions (Gray and Best 1989). The ruffe has a high fecundity rate and spawns in clean water. The ruffe's ability to swim upstream during high flow events and migrate over low dams or through culverts is questionable. The tubenose goby is found in the open waters and estuaries of slow flowing rivers. The ability of the goby to swim upstream during high flow events is questionable but appears to be more capable of living in more varied types of riverine habitat than the ruffe. The dams that prevent fish access from Lake Superior and the habitat preferred by the ruffe and goby are the reason for the low rating.

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

3B.There is no evidence or information to suggest the wetland is used by fishermen or recreational 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 these ANS are introduced into the bog wetland, the aquatic habitat is considered marginally suitable for survival. Transit across the wetland divide by other anthropogenic means is possible but unlikely. During the summer months the wetland would not likely provide the necessary habitat for occupation. 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. 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.

Libby Branch, Itasca/Aitkin/St.Louis Counties, MN - Ruffe (*Gymnochephalus cernua*) / Tubenose Goby (*Proterorhinus semilunaris*)

4. Probability of ANS establishing at the aquatic pathway

Aquatic Pathway Team	Expertise	Rating	Certainty
	USACE, St. Paul - Biologist	Low	MC
	USACE, Detroit - Biologist	Low	MC
	Team Ratings	**Low**	**MC**

4. How do you rate the probability of ANS establishing at 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 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 2009a). They are often quite abundant in backwaters and lakes and seem to prefer dense vegetation. However, survival of a viable, reproducing population of ruffe and tubenose goby within the wetland divide is unlikely due the physical habitat in the wetland and the severity of the winters. Even if these fish occupied the wetland, it is unlikely they would cross the divide during a storm event. If the fish did pass into the MRB overflow and migrate downstream, the fish would not find suitable habitat for all life stages of the species in the immediate vicinity. 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 divide and the moderate certainty assigned to the rating.

Libby Branch, Itasca/Aitkin/St.Louis Counties, MN - Ruffe (*Gymnochephalus cernua*) / Tubenose Goby (*Proterorhinus semilunaris*)

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

Aquatic Pathway Team	Expertise	Rating	Certainty
	USACE, St. Paul - Biologist	Medium	RC
	USACE, Detroit - Biologist	Medium	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 upper river systems within the Great Lakes basins. If the fish were introduced into the divide during spring runoff, it is likely they would be successful in passing downstream through these river segments and establish in the MRB larger tributaries, thus the certainty and rating.

Libby Branch, Itasca/Aitkin/St.Louis Counties, MN - 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	High	RC	High	RC
	USACE, St. Paul- Hydraulic Engineer	High	RC	High	RC
	Team Ratings	**High**	**RC**	**High**	**RC**

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: During the site visit on 31-May-2011, as well as previous visits in May and July of 2010, flow was visible through the drop structure, under US-2, to the Northeast and the Great Lakes Basin. Just over a mile East of 154th Ave on MN-200, the surface flow is to the West. This flow path crosses under 154th Ave through a large culvert. Aerial photography show an extensive network of ditches between these flow locations, indicating a high likelihood of hydrologic connection.

Libby Branch, Itasca/Aitkin/St.Louis Counties, MN - Threespine Stickleback (*Gasterosteus aculeatus*)

2. Probability of ANS occurring within either basin

Aquatic Pathway Team	Expertise	Rating	Certainty		
	USACE, St. Paul - Biologist	High	VC		
	USACE, Detroit - Biologist	High	VC		
	Team Rating	**High**	**VC**		

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

Qualitative Rating	Qualitative Rating Category Criteria
High	Target ANS exists on connected waterways in close enough proximity to be capable of 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 (*Gasterosteus aculeatus*) is found in each of the Great Lakes and has been collected in some inland river systems (USGS 2009a). Literature indicates this species prefers to live in smaller streams but may occur in a variety of habitat including lakes and large rivers.

Libby Branch, Itasca/Aitkin/St.Louis Counties, MN - Threespine Stickleback (*Gasterosteus aculeatus*)

2. Probability of ANS occurring within either basin

Aquatic Pathway Team	Expertise	Rating	Certainty		
	USACE, St. Paul - Biologist	High	VC		
	USACE, Detroit - Biologist	High	VC		
	Team Rating	**High**	**VC**		

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

Qualitative Rating	Qualitative Rating Category Criteria
High	Target ANS exists on connected waterways in close enough proximity to be capable of 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 (*Gasterosteus aculeatus*) is found in each of the Great Lakes and has been collected in some inland river systems (USGS 2009a). Literature indicates this species prefers to live in smaller streams but may occur in a variety of habitat including lakes and large rivers.

Libby Branch, Itasca/Aitkin/St.Louis Counties, MN - Threespine Stickleback (*Gasterosteus aculeatus*)

4. Probability of ANS establishing at the aquatic pathway

Aquatic Pathway Team	Expertise	Rating	Certainty		
	USACE, St. Paul - Biologist	Medium	MC		
	USACE, Detroit - Biologist	Medium	MC		
	Team Ratings	**Medium**	**MC**		

4. How do you rate the probability of ANS establishing at 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 rivers may be unsuitable for the threespine stickleback. Survival of a viable, reproducing population of threespine stickleback within downstream MRB rivers is likely. The ditches within the wetland complex could provide sufficient habitat for occupation by this species during the spring months and if a suitable storm event occurred in the spring, the fish could pass downstream to habitat suitable for all life stages of the species in the MRB, thus the rating and certainty.

Libby Branch, Itasca/Aitkin/St.Louis Counties, MN - Threespine Stickleback (*Gasterosteus aculeatus*)

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

Aquatic Pathway Team	Expertise	Rating	Certainty
	USACE, St. Paul - Biologist	High	RC
	USACE, Detroit - Biologist	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: Sufficient downstream habitat is available within the MRB to provide for all necessary life stages of the threespine stickleback, thus the rating and certainty.