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

Little Killbuck Creek, Ohio

US Army Corps of Engineers®
BUILDING STRONG®

Executive Summary

This assessment characterizes the likelihood that a viable aquatic pathway exists at Little Killbuck Creek, Ohio, and that would allow 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 abilities of potential ANS to arrive at the pathway and cross into the adjacent basin. The potential aquatic pathway site is located in Medina County, Ohio, just north of the Wayne County boundary and approximately 30 miles (48 kilometers) southwest of Cleveland. At the north end of the location is the village of Lodi and at the southern end is the village of Burbank (in Wayne County). The land use in the vicinity of the Little Killbuck Creek location is primarily agriculture, patches of woodland, wetlands, and rural residential development.

There is a medium probability of an aquatic pathway existing at this location. The rating indicates two probabilities: there is an intermittent stream capable of maintaining a surface water connection to streams on both sides of the basin divide continuously for multiple days from a ten percent annual recurrence interval storm, and/or it is a location with a wetland spanning the basin divide which maintains significant ponds that are likely to become inter connected with streams on both sides of the basin divide from a ten percent annual recurrence interval storm. Based on site investigations, there is an existing agricultural ditch system at an active farm spanning the divide and connecting both basins from between a two and five percent annual recurrence interval event. Pumps within this drainage system are utilized to transfer water from the fields into either basin while check valves create the ability to bring water from either basin into the ditch system for irrigation. Additionally, roadside ditches in the vicinity of the pathway span the divide and allow wetland systems to become hydrologically connected during storm events.

As a result of this medium rating for the probability of an aquatic pathway existing at Little Killbuck Creek, the viability of this pathway for specific ANS of concern was then evaluated by looking at the biological requirements and capabilities of the 12 ANS listed in the table above.

Aquatic Nuisance Species of Concern	
Species	**Common Name**
Hypophthalmichthys molitrix	silver carp
Hypophthalmichthys nobilis	bighead carp
Mylopharyngodon piceus	black carp
Channa argus	northern snakehead
Alosa chrysochloris	skipjack herring
Menidia beryllina	inland silverside
Gasterosteus aculeatus	threespine stickleback
Gymnocephalus cernua	ruffe
Proterorhinus semilunaris	tubenose goby
Neoergasilus japonicus	parasitic copepod
Novirhabdovirus sp.	Viral Hemorrhagic Septicemia virus (VHSv)
Sphaerium corneum	European fingernail clam
Valvata piscinalis	European stream valvata

Based on the hydrology of the aquatic pathway and consideration of the above species, the biological evaluation found that ANS transfer between the basins by natural aquatic means could occur in either direction at Little Killbuck Creek. Accordingly, an overall pathway viability rating of “medium” was given to this pathway, which means in this case that while ANS transfer could occur it is estimated that none of the ANS would likely be able to reach the aquatic pathway within the next 20 years. However, this location does provide suitable temporary habitat, and in some cases permanent habitat, for a diversity of aquatic life including most of the species of concern that have been identified for this pathway. Both the quality and the hydrology of the streams on either side of the basin divide allow for the potential support of ANS at the Little Killbuck Creek site, and it is possible that multiple ANS could utilize this pathway to transfer between the Mississippi River and Great Lakes Basins.

There are some uncertainties associated with the rating of this location, such as the need for improved information regarding the location and distribution of the large array of ANS that have been introduced to the waters of the U.S. within both basins. The life history requirements of each of these ANS and the suitability

of the habitats within the connecting streams could also be better understood with further research. There is an opportunity to develop a comprehensive monitoring plan to accurately record the movement and presence of ANS which could be slowly spreading toward this, and potentially other aquatic pathways from both basins. This would allow for more informed decision making and help to better determine species capabilities. A contributing factor to the level of uncertainty in the hydraulic characterization of the area is the lack of site specific hydrologic and hydraulic modeling, making the understanding of the frequency, duration, and magnitude (width, depth, and flow velocity) of aquatic pathway formation more difficult. Adding to this uncertainty is the scarcity of stream gages and real data on water levels at, and in proximity to, this potential pathway location. A detailed survey of elevations and modeling of this location would provide additional certainty to this rating and may also be used to help identify possible measures to reduce or eliminate the interbasin transfer of ANS at Little Killbuck Creek.

Some site specific and regional opportunities to reduce the potential for ANS transfer at the Little Killbuck Creek site include the construction of berms, reconfiguring drainage ditches, eliminating inter-basin pumping, and public education on the identification and reporting of ANS. In addition, increased field sampling and monitoring for the presence of ANS to support better informed water resource management decisions within the state and region, and ensuring that any proposed water resource projects account for how they might affect the potential for ANS movement to and across the basin divide.

Table of Contents

List of Tables

List of Figures

Acronyms

ANS . . . . . Aquatic Nuisance Species
ANSTF. . . . Aquatic Nuisance Species Task Force
CAWS . . . . Chicago Area Waterway System
CEQ. . . . . Council on Environmental Quality
CWH . . . . . Coldwater Habitat
DEM. . . . . Digital Elevation Model
FEMA. . . . . Federal Emergency Management Agency
FIRM . . . . . Flood Insurance Rate Map
FIS. . . . . Flood Insurance Study
GIS . . . . . Geographic Information System
GLFC. . . . . Great Lakes Fishery Commission
GLMRIS. . . Great Lakes and Mississippi River Interbasin Study
HUC. . . . . Hydrologic Unit Codes
INDNR. . . . Indiana Department of Natural Resources
NAS . . . . . Nonindigenous Aquatic Species
NCDC . . . . National Climatic Data Center
NEPA. . . . . National Environmental Policy Act
NID . . . . . National Inventory of Dams
NOAA. . . . . National Oceanic and Atmospheric Administration
NRCS . . . . Natural Resources Conservation Service
NWI . . . . . National Wetlands Inventory
ODNR . . . . Ohio Department of Natural Resources
USACE . . . U.S. Army Corps of Engineers
USFWS . . . U.S. Fish and Wildlife Service
USGS . . . . U.S. Geological Survey
WRDA . . . . Water Resources Development Act
WRP . . . . . Wetlands Reserve Program
WWH. . . . . Warmwater Habitat

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 (WRDA, 2007), and therein, it prescribes the following authority to the Secretary of the Army and the U.S. Army Corps of Engineers (USACE).

> *"(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 Little Killbuck Creek location, in Medina County, Ohio. This location is one of 18 locations identified in the Great Lakes and Mississippi River Interbasin Study Other Pathways Preliminary Risk Characterization 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) (USACE, 2010). 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) long 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 Little Killbuck Creek location is shown as location number 4, just north of the Wayne County boundary and approximately 30 miles (48 km) southwest of Cleveland.

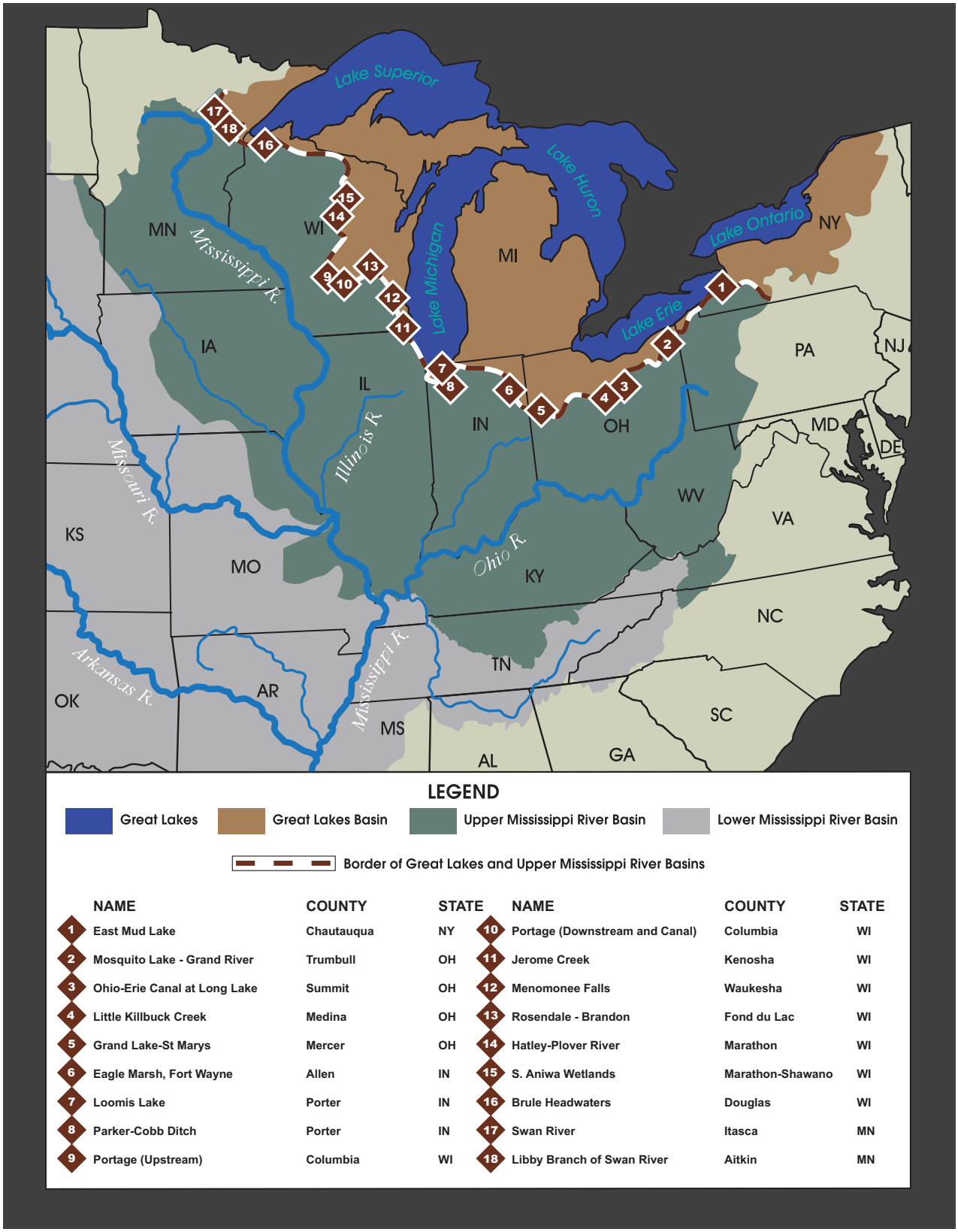
The GLMRIS is a very large and complicated task involving multiple USACE Districts and Divisions. Program Management of the study is conducted by the Great Lakes and Ohio River Division. The study considers several aquatic nuisance species (ANS) of concern, however, the proximity of Asian carp in the Mississippi River Basin to the basin divide near two locations lend a sense of urgency and national significance to completion of the GLMRIS. These two locations are the CAWS in Chicago, Illinois and Eagle Marsh in Fort Wayne, Indiana. To help accelerate completion of the feasibility study, the Great Lakes and Ohio River Division split management of the GLMRIS into two separate focus areas. Focus Area 1 is managed by the USACE, Chicago District and addresses the CAWS that open to Lake Michigan. 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 precipitation that flows into the Mississippi River and its tributaries from precipitation that flows into the Great Lakes and its tributaries.

1.1 Study Purpose

The preliminary report from 2010 and the subsequent analysis contained in this report have been produced for a broad audience ranging from the scientific community to the general public, and are specifically intended to identify any locations where an aquatic pathway exists or may form between the basins, and to evaluate the probability that specific ANS would be able 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.

This report is part of a tiered approach to assess the risk associated with the spread of ANS between the Great Lakes and Mississippi River Basins, and it was prepared in accordance with the detailed procedures and criteria specified in the GLMRIS Focus Area 2 Study Plan (USACE, 2011a). The primary purpose of this report is to present the evidence and explain the procedures used to qualitatively estimate the likelihood that a viable aquatic pathway exists at the Little Killbuck Creeklocation 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 Little



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

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

Killbuck Creek location should be included in the inventory of locations where a viable surface water connection between headwater streams on both sides of the drainage divide exists or is likely to form between the Great Lakes and the Mississippi River basins;

- A comprehensive report that characterizes the probability of aquatic pathway formation, probability that a viable aquatic pathway exists at the Little Killbuck Creek 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 Little Killbuck Creek 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 Little Killbuck Creek location.

1.2 Summary of 2010 Preliminary Risk Characterization for Little Killbuck Creek, Ohio

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

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

At 18 of these locations the interagency group determined that it would likely require an epic storm and flooding event for an aquatic pathway to ever form across the basin divide. These were not recommended for further investigation because this was considered a 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 (INDNR) until a more complete assessment and remedy could be implemented.

Although the preliminary risk characterization did not identify the Little Killbuck Creek 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 agricultural

drainage network, nearby wetland areas, and the lack of readily available site specific hydrological evidence 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 Ohio Department of Natural Resources (ODNR), USFWS, USGS, and USACE. The following actions were taken:

- Federal, State, and local stakeholders (i.e., USGS Water Science Center, ODNR Division of Soil and Water Resources, County Surveyor, and/or local Natural Resource Conservation representatives) were briefed on the preliminary risk characterization results. Site visits to observe potential connection locations were made. The available topographic mapping and flood hazard information were compiled and reviewed.

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

- Conduct an evaluation of habitat and abiotic conditions in proximity to the location relative to the needs and preferences of ANS in proximity to each location.

- Prepare a set of revised ANS transfer probability ratings for each location based upon a more detailed evaluation of ANS transfer probability via the aquatic pathway in both directions.

- Revise both the hydrologic probability and ANS probability ratings and characterization for each site based on the new information.

- Identify measures that could be implemented at the local or state level to mitigate the likelihood of ANS spreading across the Mississippi River-Great Lakes Basin divide.

1.3 Aquatic Pathway Team

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

2 Study Methodology

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

2.1 Coordination

The USACE identified interested parties and solicited input early in the process for Focus Area 2 and has included individual visits and discussions with the state agencies responsible for water resources, and fish and wildlife management in the eight states bordering the Great Lakes. The process used for the Focus Area 2 assessments has also been discussed in meetings with representatives of the Council on Environmental Quality (CEQ), USGS, USFWS, NOAA, NRCS, and 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 team comprised of 16 senior level experts from the USACE and these external partner agencies, including NOAA and GLFC, was assembled to review and guide the work of these teams. Overall, extensive collaboration among partner agencies, the review team, and other subject matter experts has led to detailed Focus Area 2 pathway assessments.

2.2 Identification of Potential Pathways

At 18 of the potential aquatic pathways identified during the 2010 Preliminary Risk Characterization, it was determined it would likely require an epic storm and flooding event (i.e., greater than a one percent annual recurrence interval storm event) for an aquatic pathway to ever form across the basin divide. These locations were not recommended for further investigation because areas that might require a flooding event in excess (greater magnitude, less frequency) of the one percent annual recurrence interval flood are less likely, and therefore present a low level of risk. This one percent threshold 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 being able to utilize that pathway. At the remaining 18 locations, it was recommended that a more detailed assessment be conducted (Figure 1). This was subsequently done in 2011-2012 in collaboration with USGS, NRCS, USFWS, state natural resource agencies, and county surveyors (where applicable), and the results for the Little Killbuck Creek location are presented in this report.

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 recurrence interval storm is a rainfall event that has a one percent probability, one chance in 100, of being equaled or exceeded in any given year. This level of storm event was commonly referred to as a 100-year storm event, but this term has led people to incorrectly conclude that a 100-year storm event is one that only occurs once in any given 100 year period. A ten percent annual recurrence interval storm (formerly referred to as a ten year event) is a smaller event that has a one in ten chance of being exceed during any given year, and a 0.2 percent annual recurrence interval storm (formerly referred to as a 500-year event) is a larger event that has a one in 500 chance of being exceeded in any given year.

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 Little Killbuck Creek Location

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

Additionally, the Little Killbuck Creek 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 Little Killbuck Creek 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 Little Killbuck Creek location. However, the NOAA Watchlist was utilized as a resource, at the recommendation of agency team members, to identify any additional potential future species that could be introduced into either basin and possibly spread from there to the other basin.

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

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 Little Killbuck Creek potential pathway is positioned on the basin divide, well upstream of any know ANS listed in this assessment, any organism that moves solely through the aquatic pathway must possess either self-propelled mobility or the ability to hitchhike on other organisms to travel upstream. Thus, this eliminates organisms that rely on current for dispersal, such as plants and algae.

The Little Killbuck site is an active farm consisting of inter-connected drainage ditches. Fishing, boating, and access by the general public through and around the site is extremely limited. In addition, adjacent streams including Little Killbuck Creek, Repp Run, and Clear Creek have greater potential for recreational use, but still very limited.

Based on the evaluation by subgroups, only fish and parasites of fish were considered to have the requisite means of reaching the divide at the Little Killbuck Creek site from either direction. Nine fish, one parasitic copepod, one virus, and two mollusks were ultimately identified as high risk species for the Little Killbuck Creek site (Table 4). These were chosen based on their relative proximity to the site, history of invasiveness, and physical capabilities to reach and use this pathway to cross to the adjacent basin. Although mollusks were not considered to have the requisite means of reaching the pathway unassisted, they were included in the list of species of concern for biological assessment based on their close proximity to the pathway.

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

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

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

Table 4: Species of Greatest Concern at Little Killbuck Creek				
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	*Alosa chrysochloris*	skipjack herring	MS	swimmer
fish	*Gasterosteus aculeatus*	threespine stickleback	GL	swimmer
fish	*Gymnocephalus cernua*	ruffe	GL	swimmer
fish	*Proterorhinus semilunaris*	tubenose goby	GL	swimmer
copepod	*Neoergasilus japonicus*	parasitic copepod	GL	parasite to fish
virus	*Novirhabdovirus sp.*	Viral Hemorrhagic Septicemia virus (VHSv)	GL	Pathogen to fish/water column
mollusk	*Sphaerium corneum*	European fingernail clam	GL	floater
mollusk	*Valvata piscinalis*	European stream valvata	GL	floater

2.3.4 Key Attributes of Selected Organisms

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

2.4 Pathway Assessment Process

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

Equation 1

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

Where:

$R_{Establishment}$ = Risk of Establishment

$P_{Establishment}$ = Probability of Establishment

$C_{Establishment}$ = Consequence of Establishment

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

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

Equation 2

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

Where:

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

Each of the four elements of Equation 2 is qualitatively rated a High (H), Medium (M), or Low (L) based on the available evidence. They are also qualitatively assigned a level of certainty [Very Certain (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 in proximity to the aquatic pathway*
P_{2c} = P *ANS spreading across aquatic pathway into new basin*

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

Equation 5 [FA2 Modified]

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

Where:

P_0 = $P_{Pathway\ exists}$

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

P_{2a} = $P_{ANS\ surviving\ transit\ to\ aquatic\ pathway}$

P_{2b} = $P_{ANS\ establishing\ in\ proximity\ to\ the\ aquatic\ pathway}$

P_{2c} = $P_{ANS\ spreading\ across\ aquatic\ pathway\ into\ new\ basin}$

Notice the overall probability is now the "probability a viable pathway exists" ($P_{Viable\ pathway}$) and is no longer the original "probability of establishment" ($P_{Establishment}$) 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 Little Killbuck Creek 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.

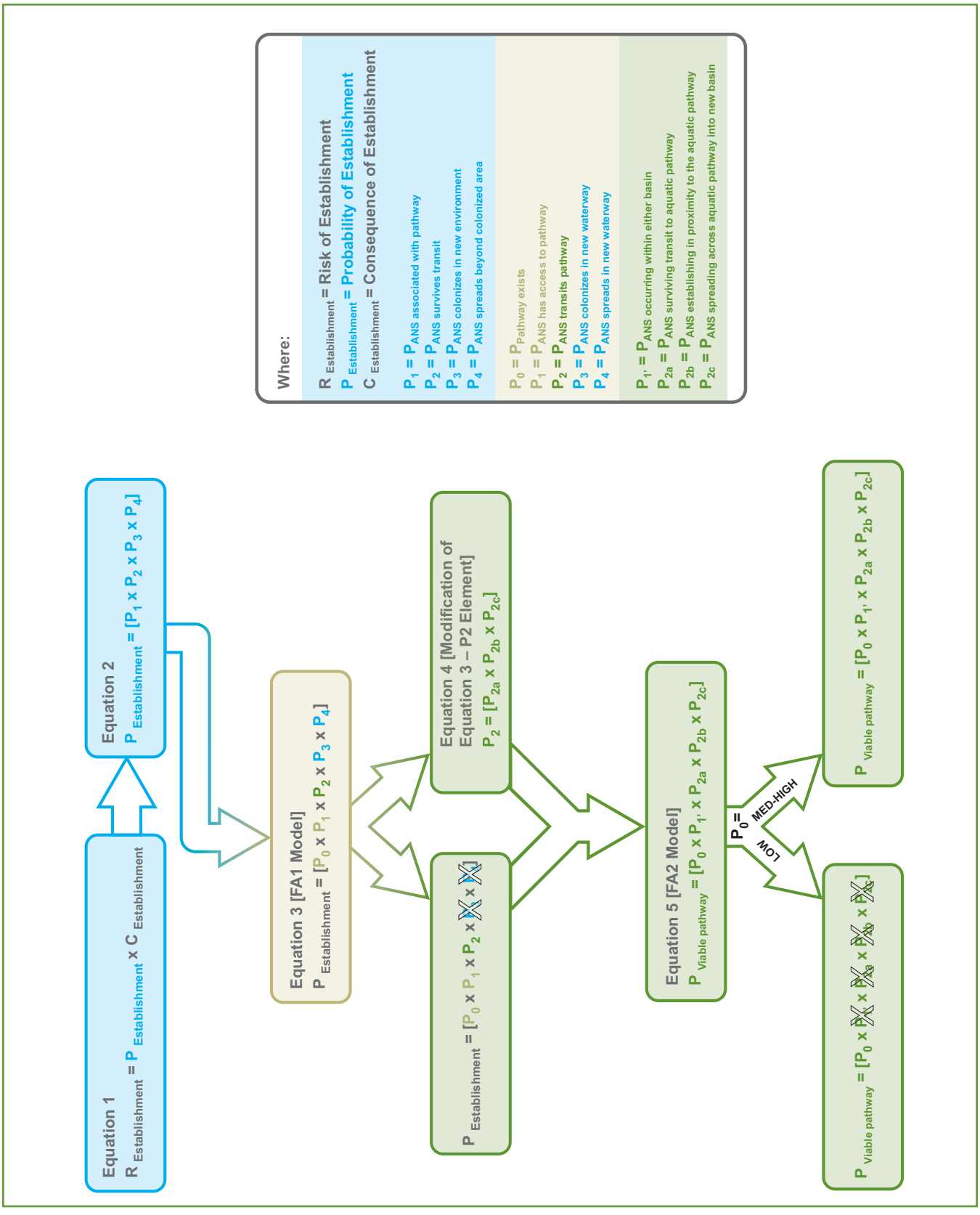


Figure 2. Diagram of the derivation of the GLMRIS Focus Area 2 aquatic pathway assessment model.

2.5 Example Calculation of Overall Aquatic Pathway Viability

As described in Section 2.2, a list of ANS of concern for the Little Killbuck Creek pathway was developed with input from Federal, State, and local agencies responsible for water resources, and fish and wildlife management in the state of Ohio 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

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

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

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

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

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

to the Great Lakes Basin is “low”. The overall pathway viability for transferring species from the Great Lakes Basin is calculated the same way and is shown in Table 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 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 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 any readily available and applicable information of this area as it may influence local hydrology. Maps, photographs, and figures are included to aid understanding of the hydrologic and hydraulic conditions near the drainage divide. Also, this section identifies any significant data gaps and uncertainties related to this topographic information and hydrologic modeling in the area of interest.

3.1 Location

This potential aquatic pathway is located in Medina County, Ohio, just north of the Wayne County boundary and approximately 38 miles (61 km) southwest of Cleveland (Figure 3). Just to the north of the study area is the village of Lodi and just to the south is the village of Burbank (in Wayne County). The land use in the vicinity is primarily agriculture, patches of woodland, wetlands, and rural residential development.

The roads surrounding the site are Lodi Road and Congress Road (west side), Willow Road (south side), Bank and Wooster Streets (north side), and Avon Lake Road (east side). Franchester Road (western portion) and Garden Isle Road (center portion) are within the potential pathway area (Figure 4). The headwater streams in the Mississippi River Basin at this location are Little Killbuck Creek, which generally flows from east to west, and Repp Run which generally flows from west to east. These two streams join just south of the basin divide to form Killbuck Creek, just north of Interstate Highway 71. An intricate network of agricultural ditches exists on the Great Lakes side of the basin which drain to Clear Creek and West Fork East Branch Black River. These streams flow north from the location and converge to form the East Branch Black River. The general latitude and longitude of this pathway is at N41.01547, W082.01824.

The red-white line in Figure 4 is the 12-digit Hydrologic Unit Code (HUC) boundary, which depicts the divide between the Great Lakes Basin (HUC 04110001) and Mississippi River Basin (HUC 05040003) (USGS, 2010). There is the possibility of interbasin surface water flow along an approximate 2.5 mile (4 km) distance, as the divide between the Great Lakes and Mississippi River Basins in this location is formed by an agricultural levee. This levee provides as little as 20 feet (6.1 m) of separation between agricultural ditches that appear to maintain perennial flows to the north and portions of Little Killbuck Creek and Repp Run to the south.

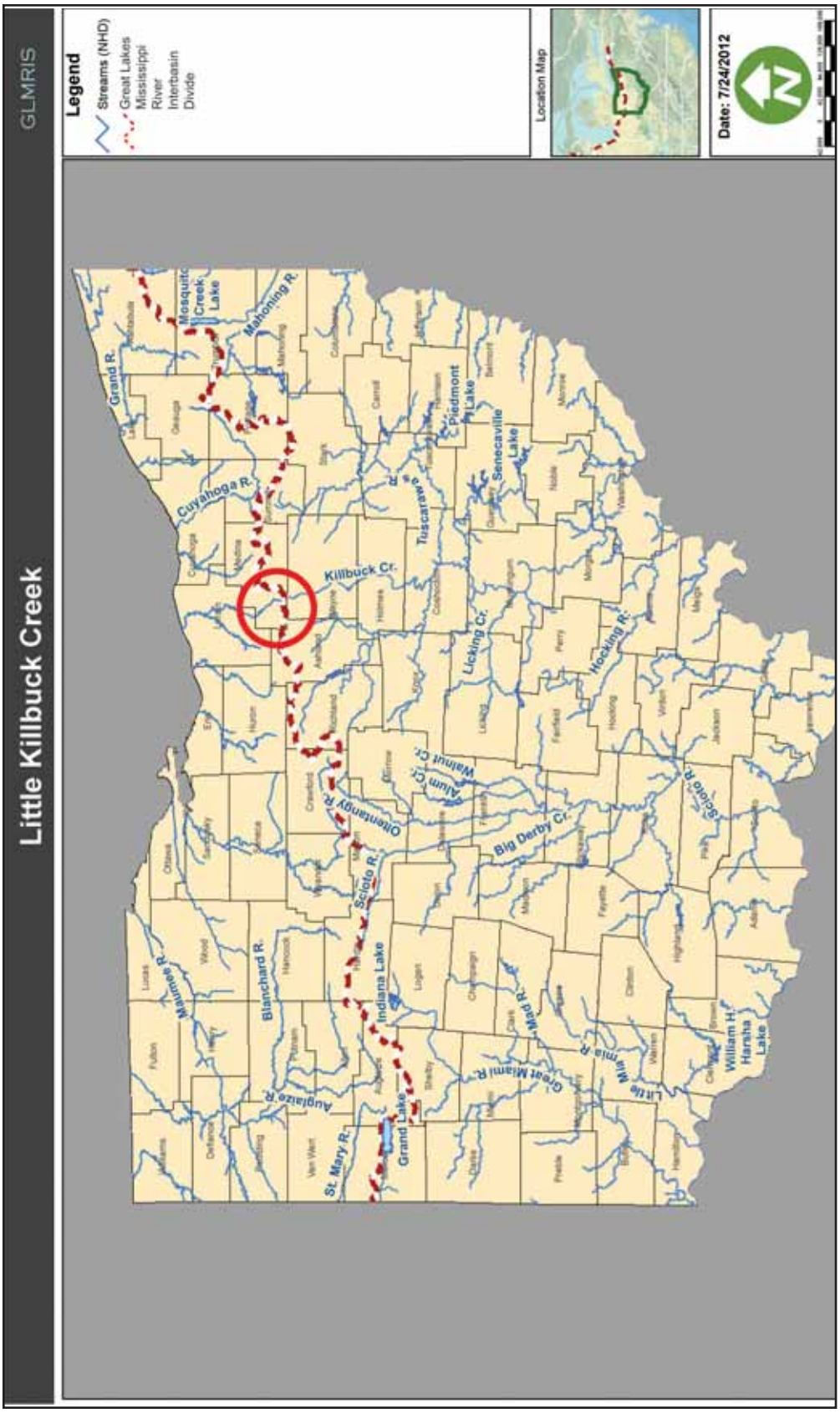


Figure 3. Location of Little Killbuck Creek in the northern Ohio and location of the divide between the Great Lakes and Mississippi River Basin within the state of Ohio. Background imagery courtesy of Bing Maps.

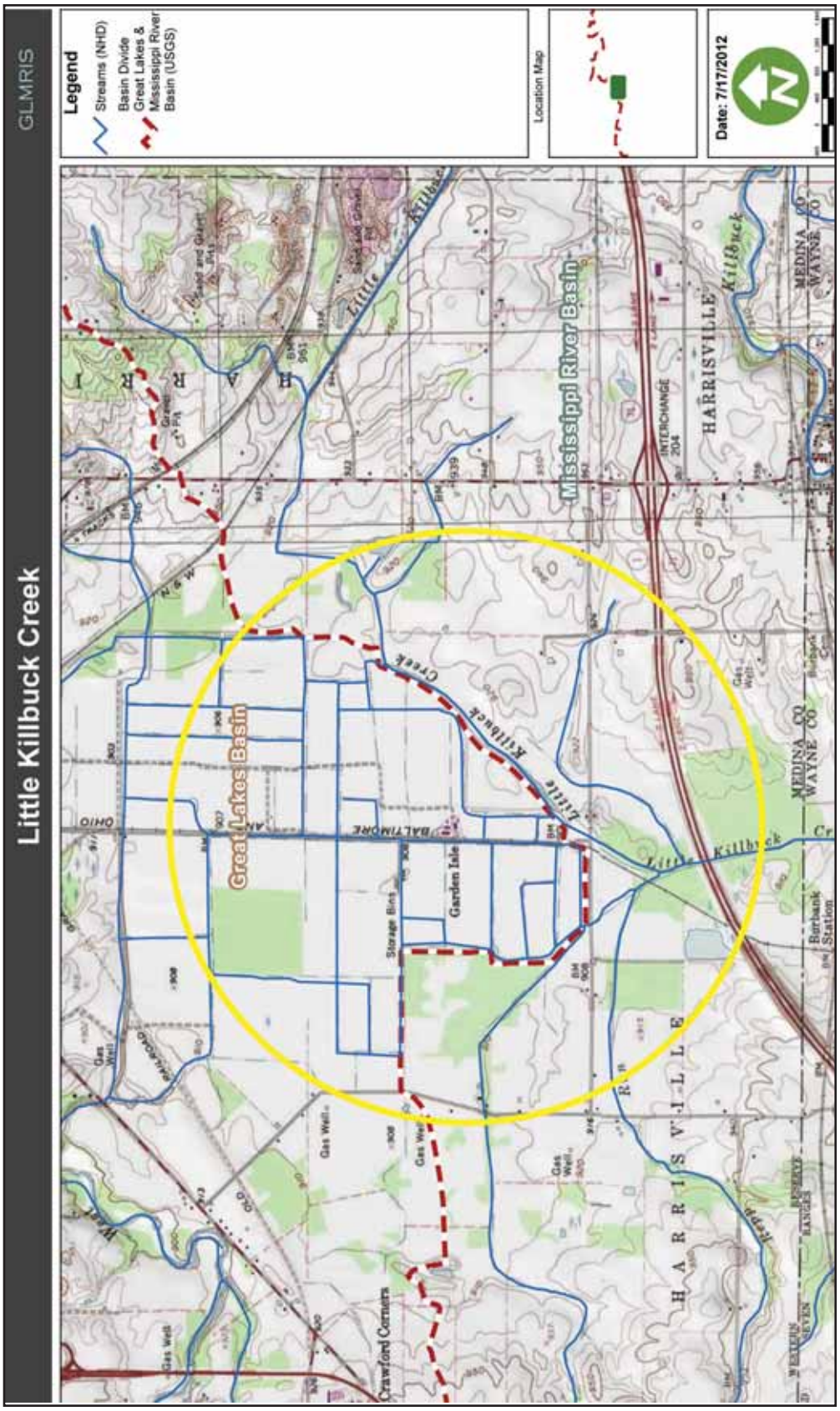


Figure 4. Little Killbuck detailed site location map in Medina County, Ohio over USGS topographic map.

3.2 Climate

Climate is looked at in this section just to identify 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 the basins. Climate data for the Little Killbuck Creek area was obtained from the Midwestern Regional Climate Center (MRCC) at four stations in the site vicinity, with the mean temperature and precipitation amounts for the locations shown in Table 7 and Table 8 (MRCC, 2011). The period of record for all four stations is from 1971 to 2000, and the location of these stations relative to the study area is shown in Figure 5.

The lowest temperature recorded was in January at -26°F (-32°C). The highest temperature recorded was in July at plus 104°F (40°C). The average mean low is 25° F in January and the average mean high is 72°F (22° C) degrees in July. Average mean precipitation ranges from 2.10 to 3.96 inches (5.3–10 cm) per month over the year. The lowest mean precipitation amount occurred in February and the highest in July. The four months with the lowest average mean precipitation, from lowest to highest, are February, January, October, and December. The highest precipitation accumulation occurs in the summer months during July and August. On the afternoon and evening just before the May 2011 site visit, 2.73 inches (6.9 cm) of rain fell in the study area and caused considerable flooding, resulted in flooded fields and roadways, and water passed across the basin divide. The rainfall from this storm event is believed to be between a two and five percent annual recurrence interval event.

Table 7: Temperature Summary from 1971-2000 for the four stations near Little Killbuck Creek, Ohio (MRCC, 2011).

Mean Temperature in degrees F													
Station	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**	**ANN**
330058 Akron Canton WSO AP	25.2	28.3	37.7	48.1	58.8	67.5	71.8	70.3	63.0	51.6	41.1	30.7	49.5
330061 Akron	27.2	30.2	39.2	50.1	61.3	69.8	74.1	72.2	65.1	53.5	42.8	32.4	51.5
331541 Chippewa Lake	23.7	26.5	36.0	46.9	58.1	67.2	71.3	69.4	62.6	51.2	40.2	29.5	48.6
339312 Wooster Exp Station	24.9	28.0	37.7	48.4	59.1	67.7	71.5	69.6	62.6	50.9	40.6	30.3	49.3
Mean Temperature in degrees C													
330058 Akron Canton WSO AP	-3.8	-2.1	3.2	8.9	14.9	19.7	22.1	21.3	17.2	10.9	5.1	-0.7	9.7
330061 Akron	-2.7	-1.0	4.0	10.1	16.3	21.0	23.4	22.3	18.4	11.9	6.0	0.2	10.8
331541 Chippewa Lake	-4.6	-3.1	2.2	46.9	8.3	19.5	21.8	20.8	17.0	10.7	4.6	-1.4	9.2
339312 Wooster Exp Station	-3.9	-2.2	3.2	9.1	15.1	19.8	21.9	20.9	17.0	10.5	4.8	-0.9	9.6

Table 8: Precipitation Summary from 1971-2000 for the four stations near Little Killbuck Creek, Ohio (MRCC, 2011).

Mean Temperature in degrees F													
Station	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**	**ANN**
330058 Akron Canton WSO AP	2.49	2.28	3.15	3.39	3.96	3.55	4.02	3.65	3.43	2.53	3.04	2.98	38.47
330061 Akron	2.02	2.00	2.85	3.15	3.61	3.13	3.87	3.36	3.57	2.46	3.22	2.83	36.07
331541 Chip-pewa Lake	2.37	2.14	2.98	3.38	3.69	3.76	3.98	3.62	3.63	2.48	3.31	3.00	38.34
339312 Wooster Exp Station	2.26	1.97	2.78	3.43	3.92	4.02	3.96	4.03	3.42	2.58	3.00	2.67	38.04
Mean Temperature in degrees C													
330058 Akron Canton WSO AP	6.32	5.79	8.0	8.6	10.06	9.02	10.21	9.27	8.71	6.43	7.72	7.57	97.71
330061 Akron	5.13	5.08	7.24	8.00	9.17	7.95	9.83	8.53	9.07	6.25	8.18	7.19	91.62
331541 Chip-pewa Lake	6.02	5.44	7.57	8.59	9.37	9.55	10.11	9.19	9.22	6.30	8.41	7.62	97.38
339312 Wooster Exp Station	5.74	5.00	7.06	8.71	9.96	10.21	10.06	10.24	8.69	6.55	7.62	6.78	96.62

Figure 5. Climate data stations (Lodi is in northwest quadrant). Station 330058 Akron-Canton WSO AP, OH; Station 330061 Akron, OH; Station 331541 Chippewa Lake, OH; and Station 339312 Wooster Exp Station, OH. (MRCC, 2011). Background imagery courtesy of Bing Maps.

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 within the area that may influence the behavior of surface water. The location of the basin divide, the configuration of ditch network, and the flow directions of the ditches and streams in proximity to the Little Killbuck Creek aquatic pathway are shown in Figure 6. The arrow heads on this figure indicate the direction of flow within the ditches overlaid on the FEMA floodplain (USGS, 2011a). The lateral extent of the Little Killbuck Creek aquatic pathway at the one percent annual recurrence interval flood is also evident in Figure 6 through its illustration of the expansive floodplains and complex network of ditches in proximity to the basin divide.

The headwater streams leading away from the site on the Ohio River side of the basin divide are Little Killbuck Creek and Repp Run. On the right side of Figure 6, Little Killbuck Creek flows toward the southwest where it is then joined by two branches of Repp Run in the bottom center of the figure, where it then starts flowing due south. On the Lake Erie side of the basin divide there is an intricate network of agricultural ditches. These ditches are connected to the West Fork East Branch of the Black River via Clear Creek, which drains the site toward the west and is part of an approximately 34.6 square mile (90 km2) watershed. This network of agricultural, or irrigation ditches is also connected to an unnamed tributary to the east of the study area that carries runoff from an approximately four square mile (10 km^2) drainage area to the north. This network of ditches collects runoff and discharges to the north into the West Fork East Branch Black River. Typical dimensions of these ditches were approximately 15-20 feet (4.5-6 m) wide at the ground surface with a depth to channel bottom of about 8-10 feet (2-3 m) below grade.

The team next examined the topography of the area to see what barrier the slope of the land itself might offer to the spread of ANS between the basins. A shaded relief map showing elevations of the potential aquatic pathway and vicinity was created using ArcMap (Figure 7). Within the agricultural area at the basin divide, the topography is generally flat as shown by the green to light green colored areas in Figure 7. The site is a low lying area between surrounding hills and has been subjected to glaciations in the past. The watershed divide crosses east to west across this flat area. The ditches in the crop field were constructed to promote drainage to remove runoff from the fields or to provide irrigation to those fields when necessary. This berm was breached in many areas by floodwaters as observed during the site visit following the 2-5 year annual recurrence interval flood event.

Berms have been built along the north side of the Little Killbuck Creek and a small portion of Repp Run to prevent the normal stream flow from entering the crop fields. The top of the berm along Little Killbuck Creek is at approximately 910 feet and the ground elevation of the crop fields is approximately 905 feet. In the area west of Franchester Road, the ground elevations are slightly higher, about 906 feet (OIT, 2011). The FEMA Flood Insurance Rate Maps (FIRM) labels the flooded area as a Zone A, which is an area that floods with a one percent annual recurrence interval. Since detailed analyses were not performed for this area, no depths or base flood elevations are shown within this zone. However, by comparing the flooded area on the FIRM to the contours (the same vertical datum was used for the two maps), it was discovered that the one percent annual recurrence interval flood elevation is at approximately 913 feet. The FIRM shows that the berm, crop fields, Willow Road, Garden Isle Road, Franchester Road, and Swamp Road are underwater at the one percent flood event. The watershed divide, which runs through this area, is also underwater based on the FIRM (Figure 8 and Figure 9) (FEMA, 2011).

There are several wetlands in the area, most notably along Repp Run near Franchester Road and along Little Killbuck Creek near Interstate 75 and to the northeast (Figure 10). These are a mixture of freshwater emergent, forested, and scrub-shrub wetlands (Cowardin, et al., 1979). Based on area topography and land use (e.g., agricultural drainage ditches), it is highly likely that much if not all of the agricultural area currently being drained by the large network or drainage ditches north or Repp Run and Little Killbuck Creek would revert back to wetland area if active drainage were to cease.

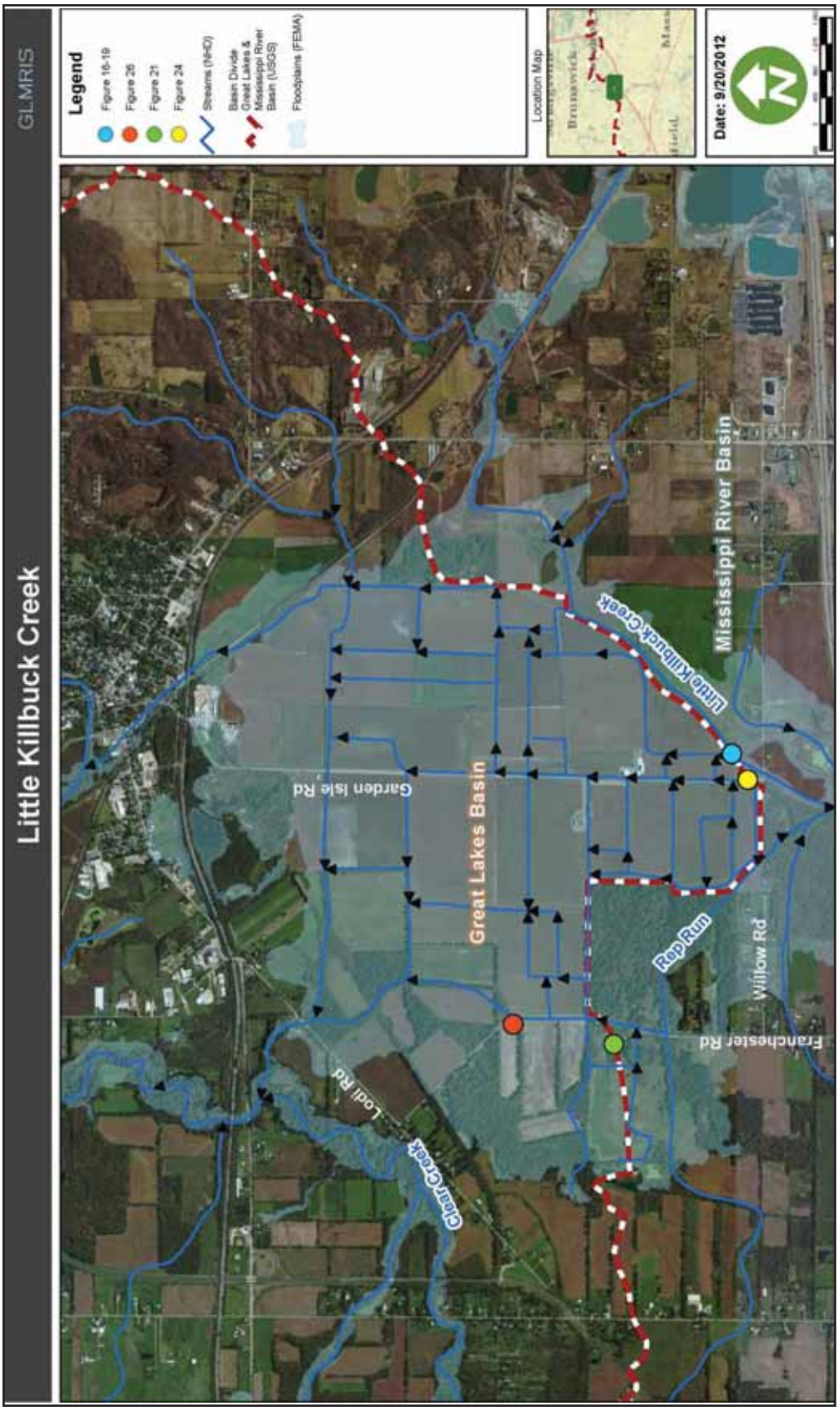


Figure 6. Streams and ditches at Little Killbuck Creek, Ohio, with predominant flow directions indicated by arrows (USGS, 2011a). Great Lakes and Mississippi River Basin divide shown by red-white line. Base imagery courtesy of Bing Maps.

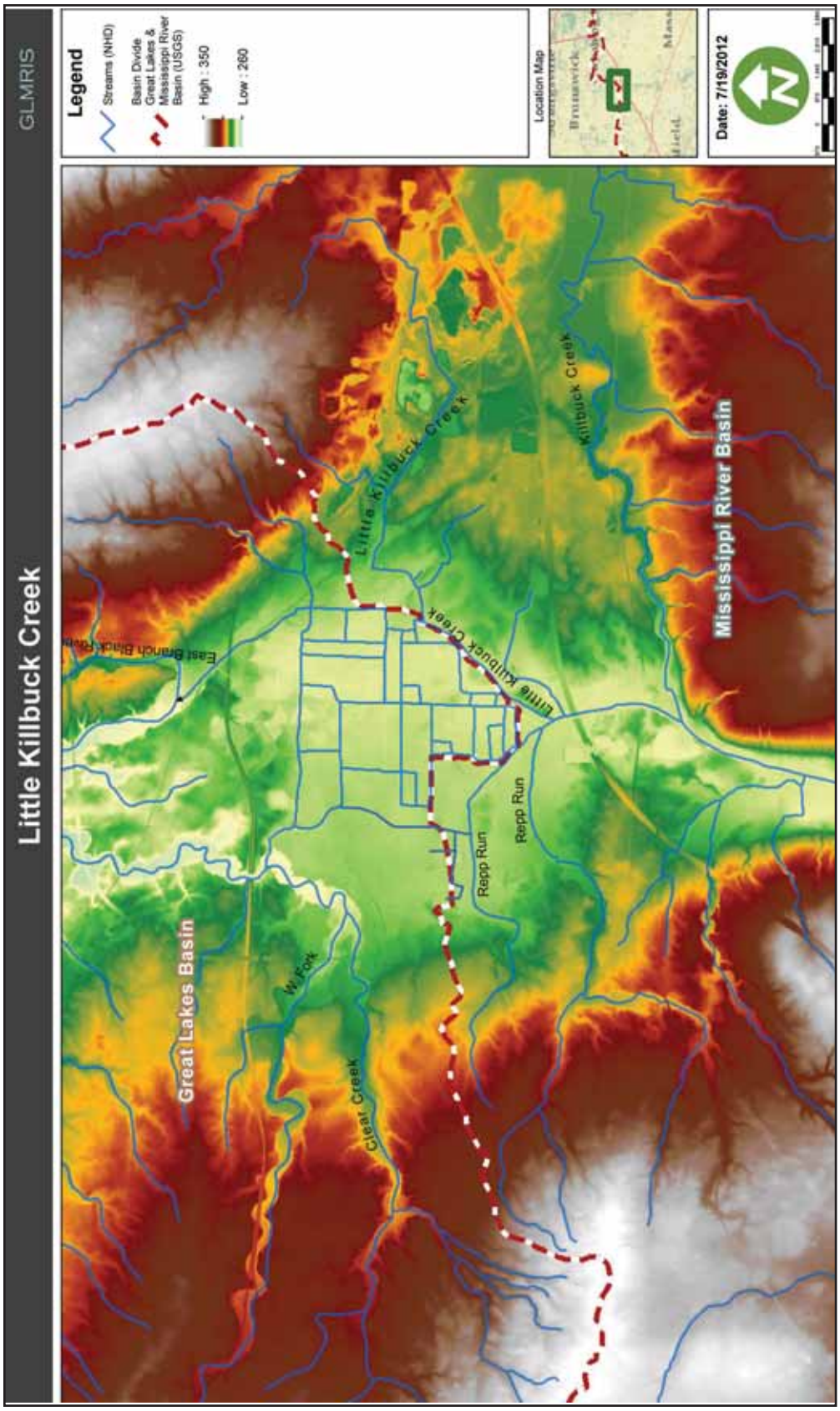


Figure 7. Colored relief map showing elevations at the potential pathway site and surrounding area. Basin divide shown by red-white line. Base imagery courtesy of Bing Maps.

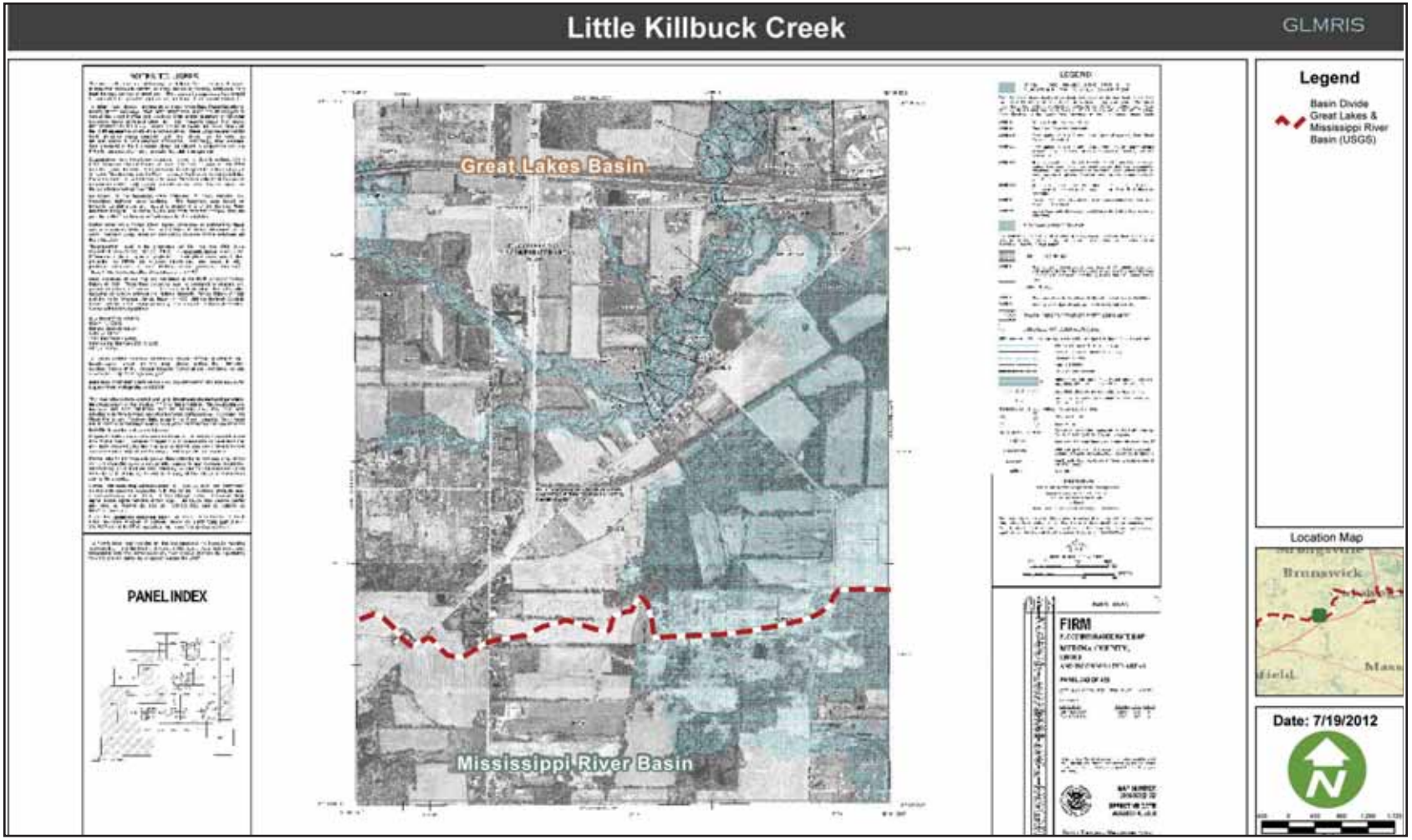


Figure 8.: FEMA FIRM Map 243D, west side of potential pathway showing Repp Run, Clear Creek, and West Fork East Branch Black River and Franchester Road area. (FEMA, 2011). Base imagery courtesy of Bing Maps.

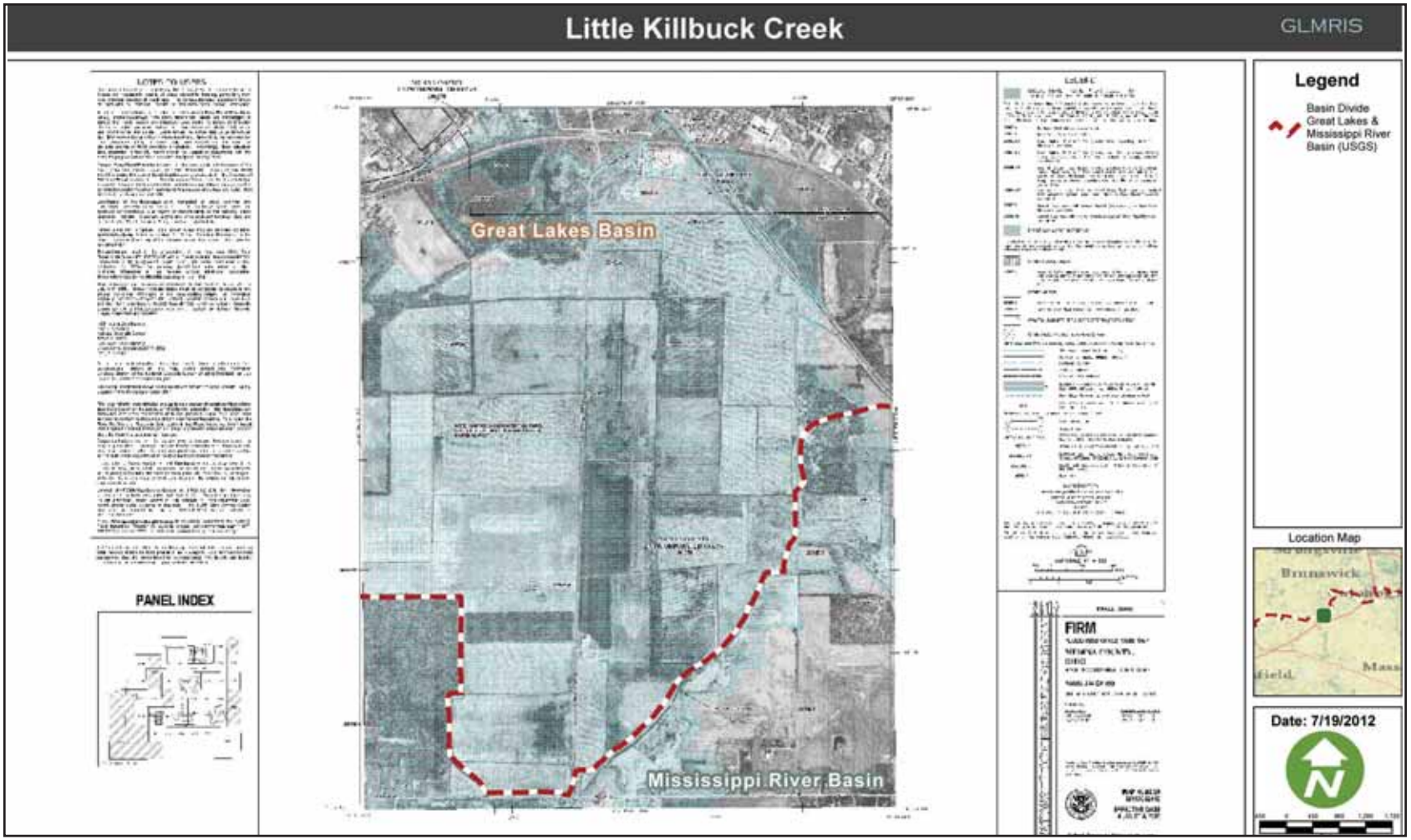


Figure 9. FEMA FIRM Map 244D, east side of potential pathway showing Little Killbuck Creek, Ditches, railroads, Willow Road, and Garden Isle Road. (USFWS, 2011). Base imagery courtesy of Bing Maps.

Figure 10. Mapped wetlands from USFWS National Wetland Inventory (USFWS, 2012). Base imagery courtesy of Bing Maps.

The USGS StreamStats program calculates stream flow statistics and characteristics for designated water basins based on data from existing data-collection stations or provides estimates on basins where no station data is available (USGS, 2010). The data taken directly from this website is good for developing preliminary hydraulic calculations and for basic statistics for hydraulic sections of reports. The accuracy would have to be verified before it could be used for design or detailed site hydrologic and hydraulic analyses. Using this resource, the watersheds for the potential pathway location were sub-divided into five sub-basins to assist in determining if there is a hydrologic connection between the watersheds, and to help determine the frequency of such connections. The three sub-basins within the Black River Watershed were the West Fork East Branch Black River, Clear Creek, and the area ditches. The two sub-basins within the Killbuck Creek Watershed were the Little Killbuck Creek and Repp Run Watersheds. The sub-basin sizes chosen for this report were set with the most downstream point being located near a confluence of streams within the project site or at a point near the boundary of the study area. The quantities of flows represent a relative magnitude of flow from the contributing watershed and will change based on the point chosen as the outlet. A summary of the flow statistics from these watershed sub-basins is presented in Tables 9-11.

FEMA has prepared a FIRM for Medina County, Ohio and incorporated areas. The original maps produced for that study, which include the Little Killbuck Creek potential pathway, are presented in Figure 8 and Figure 9 are are also represented by the flood outline earlier in Figure 6 (FEMA, 2011). The FEMA study that was completed on this specific site was not a detailed study and the maps do not provide one percent annual recurrence interval surface water elevations. However, a general outline of the flooded area for a one percent annual recurrence interval event is shown. Based on the imagery and the contours for the site, the one percent flood elevation is within the approximately 913-foot contour range. The top of the berm/dike along Little Killbuck Creek is at an elevation of approximately 910 feet. The FEMA study shows the berm/dike along Little Killbuck Creek covered by a one percent annual recurrence interval flood event and portions of the Great Lakes Basin and the Mississippi River Basin inundated on both sides of the dike.

Table 9: Mean Streamflow Statistics as calculated from USGS Streamstats (USGS, 2010). Flow data was collected for Little Killbuck Creek just upstream of its confluence with Repp Run, and flow data for the Black River Watershed was collected just upstream of the confluence of Clear Creek and West Fork Creek.

	Killbuck Creek Watershed		Black River Watershed		
Monthly Mean Flow	Little Killbuck Creek Subbasin (ft3/sec)	Repp Run Subbasin (ft3/sec)	Clear Creek Subbasin (ft3/sec)	West Fork East Branch Subbasin (ft3/sec)	Ditch Subbasin (ft3/sec)
January Mean Flow	6.3	8.55	8.44	38.2	8.12
February Mean Flow	6.94	9.44	10.7	43.8	9.24
March Mean Flow	7.94	10.9	12.4	52.3	10.6
April Mean Flow	7.22	9.83	11.1	45.6	9.62
May Mean Flow	4.37	6.04	6.91	29.3	5.87
June Mean Flow	2.91	4.02	4.51	19.7	3.91
July Mean Flow	1.64	2.3	2.9	12.3	2.3
August Mean Flow	1.1	1.51	1.68	7.18	1.46
September Mean Flow	0.71	0.98	1.14	4.89	0.94
October Mean Flow	0.83	1.16	1.31	5.97	1.12
November Mean Flow	1.94	2.69	3.02	13.7	2.64
December Mean Flow	4.06	5.59	6.4	27.3	5.46
Mean Annual	4.16	5.7	6.37	27.5	5.61

Table 10: Peak Flow Statistics indicating maximum instantaneous flow that occurs on avgerage once in x years) (USGS, 2010). Flow data was collected for Little Killbuck Creek just upstream of its confluence with Repp Run, and flow data for the Black River Watershed was collected just upstream of the confluence of Clear Creek and West Fork Creek.

	Killbuck Creek Watershed		Black River Watershed		
Peak Flow	Little Killbuck Creek Subbasin (ft3/sec)	Repp Run Subbasin (ft3/sec)	Clear Creek Subbasin (ft3/sec)	West Fork East Branch Subbasin (ft3/sec)	Ditch Subbasin (ft3/sec)
Peak flow – 2 yr	233	332	446	1120	356
Peak flow – 5 yr	371	542	763	1780	596
Peak flow – 10 yr	467	693	997	2250	771
Peak flow – 25 yr	588	885	1300	2830	994
Peak flow – 50 yr	676	1030	1530	3270	1160
Peak flow – 100 yr	766	1170	1760	3720	1330
Peak flow – 500 yr	971	1510	2310	4740	1730

Table 11: Basin Characteristics as calculated by USGS Streamstats (USGS, 2010).

	Killbuck Creek Watershed		Black River Watershed		
Drainage Area	4.22 sq. mi.	5.81 sq. mi.	6.52 sq. mi.	28.1 sq. mi.	5.70 sq. mi.
Stream Slope	0.00422 ft/ft	0.00801 ft/ft	0.00650 ft/ft	0.00256 ft/ft	0.00972 ft/ft
% Storage	5.19	4.52	0.58	1.56	2.96
% Forested	21.6	21.6	32.2	25	20.2
Mean Annual Precipitation	36.3 in.	36.2 in.	36.1 in.	35.9	36.2
Peak flow – 500 yr	971	1510	2310	4740	1730

During the site visit on May 25-26, 2011 there was a significant thunderstorm. Over a 24 hour period, 2.73 inches (6.9 cm) of rain fell on the site (National Weather Service, 2011). Comparing the field observations with the contours at this location, the water elevation from the flooding was estimated to be at about 908 feet. Several agricultural fields along Franchester Road were underwater from this recent rainfall event and are illustrated in Figures 11-13. Flood water was also observed flowing across the basin divide from flooded fields and roadside ditches through a culvert underneath Franchester Road (Figures 14-15).

The ODNR Division of Soil and Water Resources recommends using the published updated precipitation frequency estimates for the Ohio River Basin and surrounding states for estimating average recurrence intervals (NOAA, 2011a). The values given for location N41.0261, W082.0399 are presented in Table 12. This data indicates that the observed 2.73 inches of rain over a 24-hour period is equivalent to between a two and five percent annual recurrence interval storm event.

The ditches within the Great Lakes Basin north of Little Killbuck Creek are connected at the north end of the site to an unnamed stream that flows from the east. The ditch system flows to the Great Lakes Basin, but there are also connections with the Mississippi River Basin particularly at the southern end of the study area near the intersection of Willow Road and Garden Isle Road, and just north of where Repp Run joins Little Killbuck Creek. These ditches are also used to hold water during dry time to irrigate the fields. It was noted by a local farmer that by opening control gates, water can pass from Little Killbuck Creek into these ditches. It was also observed during the field visit that the storm water was

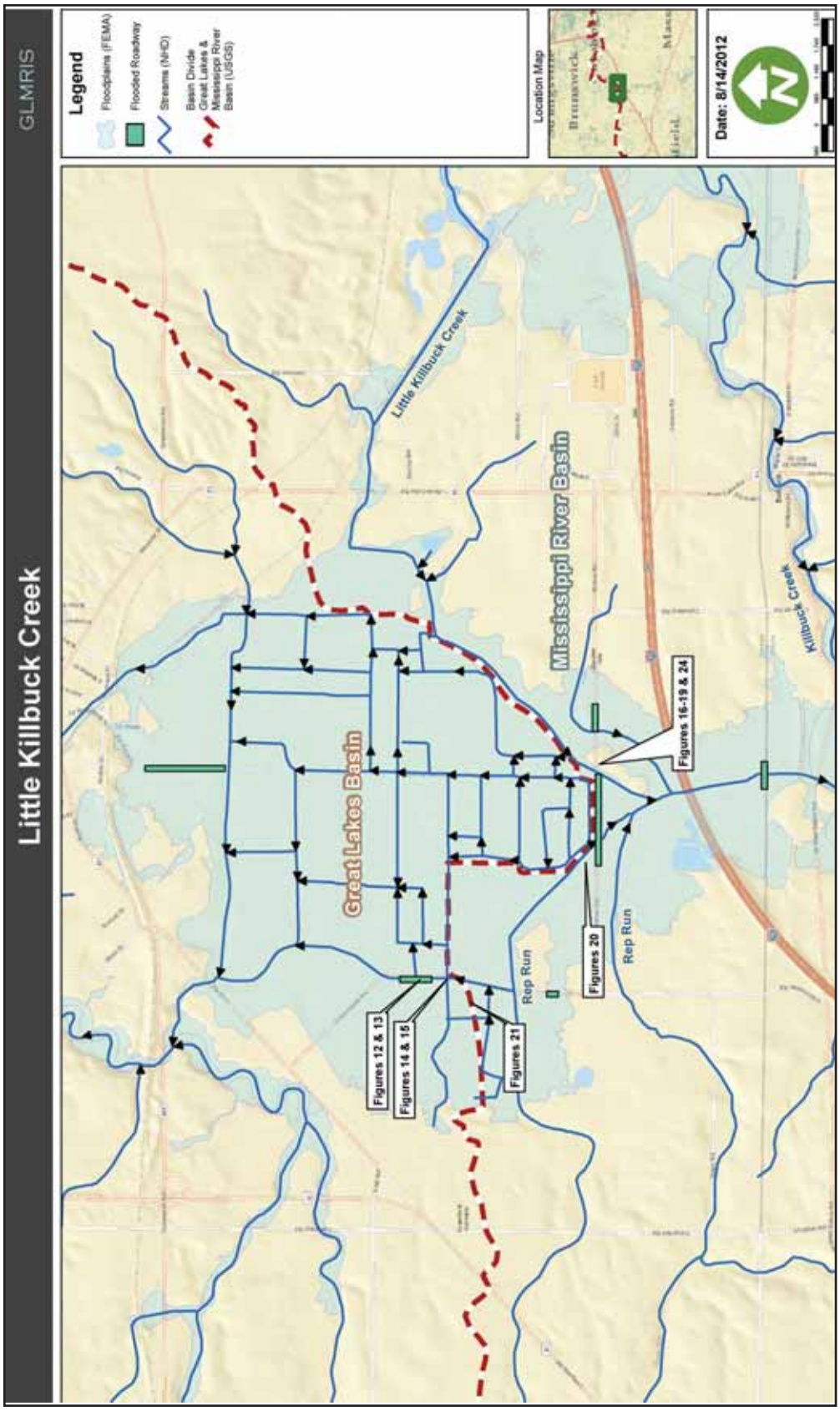


Figure 11. Photo reference locations and areas where roads were flooded after the storm event of May 26, 2011 shown in blue. Base imagery courtesy of Bing Maps.

Figure 12. Flooded field west of Franchester Road near basin divide. Photo by USACE looking southwest and taken from same position as the following figure.

Figure 13. Flooded field west of Franchester Road near basin divide. Photo by USACE looking west and taken from same position as previous figure.

Figure 14. Roadside ditch along Franchester Road. Photo by USACE.

Figure 15. Storm water in ditch along Franchester Road that cross the basin divide. Close-up view of roadside ditch shown in previous figure. Photo by USACE.

Table 12: Precipitation Frequency Estimates (NOAA, 2011a)			
Average Recurrence Interval (yrs)	**24 hour period** (in.)	**Upper bound 90% confidence** (in.)	**Lower bound 90% confidence** (in.)
1	2.08	2.25	1.93
2	2.49	2.7	2.32
5	3.09	3.35	2.87
10	3.59	3.89	3.32
25	4.32	4.67	3.97
50	4.93	5.33	4.5
100	5.59	6.05	5.05
200	6.29	6.82	5.64
500	7.32	7.96	6.47

being pumped from this network of ditches within the Great Lake Basin into Little Killbuck Creek within the Mississippi River Basin (Figures 16 - 19).

Repp Run (Mississippi River Basin) was channelized along the south side of the berm where Repp Run flows east-southeast between Franchester Road and Willow Road. This largely wetland area was flooded at the time of the site visit from Repp Run overflowing its banks during this 2-5 percent annual recurrence interval storm event resulting in the flooding of the low area north of Willow Road (Figure 20).

Along the paved roads, there are roadside ditches for collecting storm water. These ditches also drain into the streams such as Clear Creek, Repp Run, and Little Killbuck Creek. It was observed that along Franchester Road these roadside ditches cross the divide and connect the streams (i.e., Repp Run and Clear Creek) within the Great Lakes and the Mississippi River Basins. During the field visit, stormwater flow between the basins was observed throughout this roadside ditch connection and in flooded fields (Figures 11-15). West of Franchester Road, Repp Run flows through a wetland. In this area it was observed during the site visit that the fields were flooded and surface water was flowing over the basin divide to both the Great Lakes Basin and the Mississippi River Basin (Figure 21).

The agricultural fields and one percent FEMA floodplain dominating the area of the Little Killbuck Creek aquatic pathway are situated along a relatively low area along the profile of the Great Lakes and Mississippi River Basin Divide that extends for a distance of approximately 3.5 miles (5.6 km) (Figure 22). This area of the basin divide is at least 30-50 feet (9-15 m) lower in elevation than the basin divide to the east and west of the pathway. Although a potential surface water connection would appear possible along most of the 3.5 miles (5.6 km) at the one percent flood event, the drainage ditches and levees throughout this area prevent a simple interpretation of exactly where along this 3.5 miles (5.6 km) water actually crosses the basin divide. Several cross sections were taken through this low area perpendicular to the basin divide to look more closely at the ground elevations where it appeared that storm water might be able to find a flow path between the Great Lakes and the Mississippi River Basins. Five cross sections were evaluated for this potential pathway: two near Franchester Road and three near the intersection of Willow Road and Garden Isle Road (Figure 23 and Figure 24). The morning after the storm event of May 25-26, 2011, the floodwater in the fields and flowing across Franchester Road was at an elevation of approximately 909 feet (277 m). The cross sections in Figure 23 indicate high elevations of between 910.5 – 911 feet (277 m), but these were not in the ditches and did not follow the low areas in the fields. For this pathway, the elevations in Figure 23 and Figure 24 are based on the USGS 10m Digital Elevation Model (DEM) with a vertical accuracy of +/- 1 foot (30 cm). It should be pointed out that the absolute vertical accuracy (specific elevation) is not as important as the

Figure 16. Area of Little Killbuck Creek at intersection of Willow Road and Garden Isle Road, looking north. Garden Isle Road is located in background to the left. The main channel of Little Killbuck Creek is along right side of photo looking upstream to the northeast. The area of bare soil in the center of this photo is the top of the berm along the north side of the creek that is being actively overtopped. Photo by USACE.

Figure 17. Same area of Little Killbuck Creek flooding at intersection of Willow Road and Garden Isle Road, but looking directly upstream of the creek (northeast). Photo by USACE.

Figure 18. Same location as previous figures at intersection of Willow Road and Garden Isle Road, but after the water receded. Photo also showing irrigation/draining culverts. Photo by USACE.

Figure 19. Same location as previous figures at intersection of Willow Road and Garden Isle Road, but after the water receded. Little Killbuck Creek is the right channel extending upstream to the northeast and the left channel is a drainage/irrigation ditch. Photo by USACE.

Figure 20. Field flooded with water from Repp Run (north of Willow Road). Photo by USACE.

Figure 21: Flooded wetlands west of Franchester Road near basin divide. Photo by USACE.

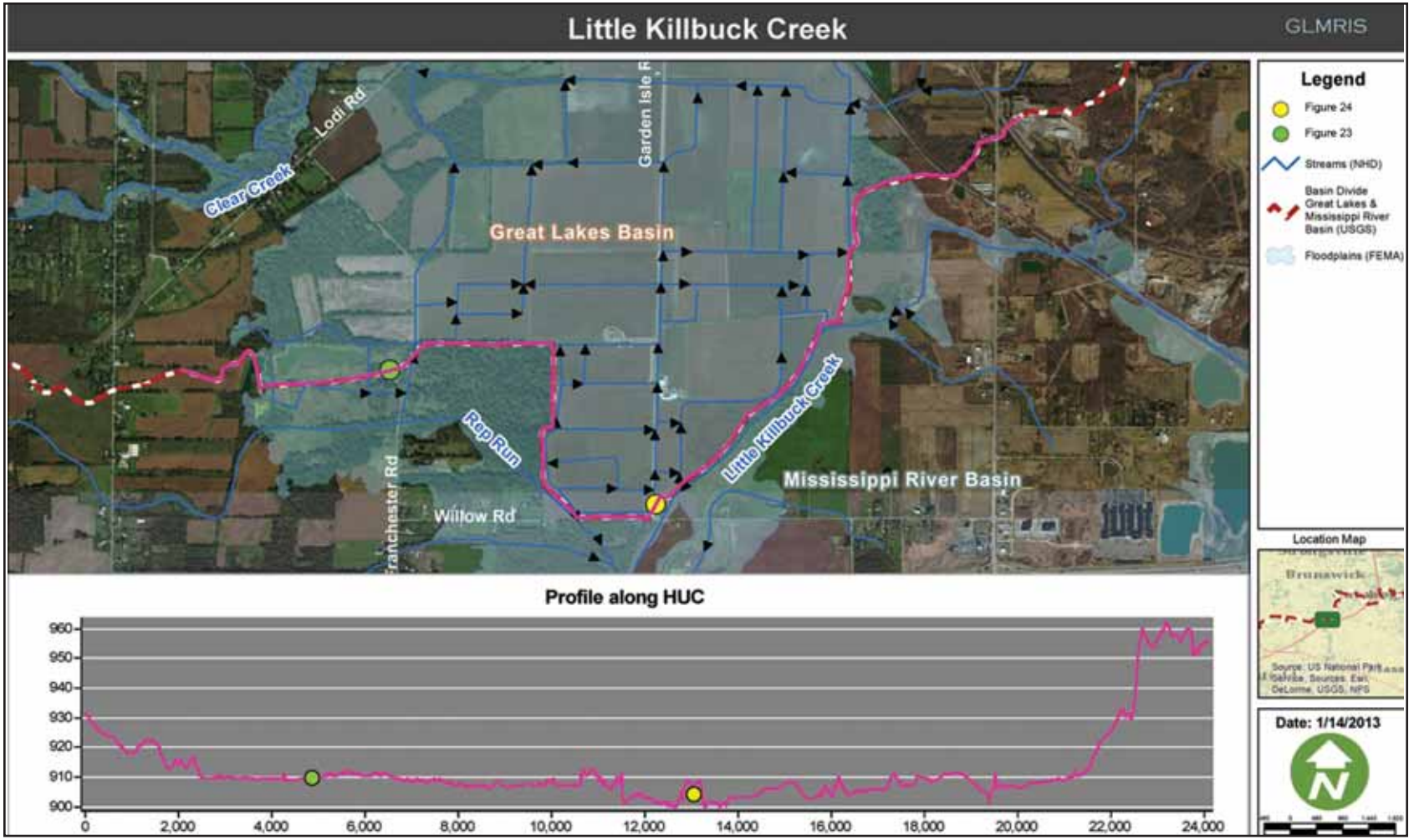


Figure 22: Plan view and surface elevation profile along the Great Lakes and Mississippi River Basin divide at Little Killbuck Creek. As seen by the 'Profile along HUC' at the bottom of the figure, the approximately 3.5 mile (5.6 km) agricultural area sits at a relative low point along the basin divide, anywhere from 30 to 50 feet (9-15 m) lower than the basin divide to the east and west of the aquatic pathway. Location of the cross sections through this divide are indicated by green and yellow dots. Background imagery courtesy of Bing Maps.

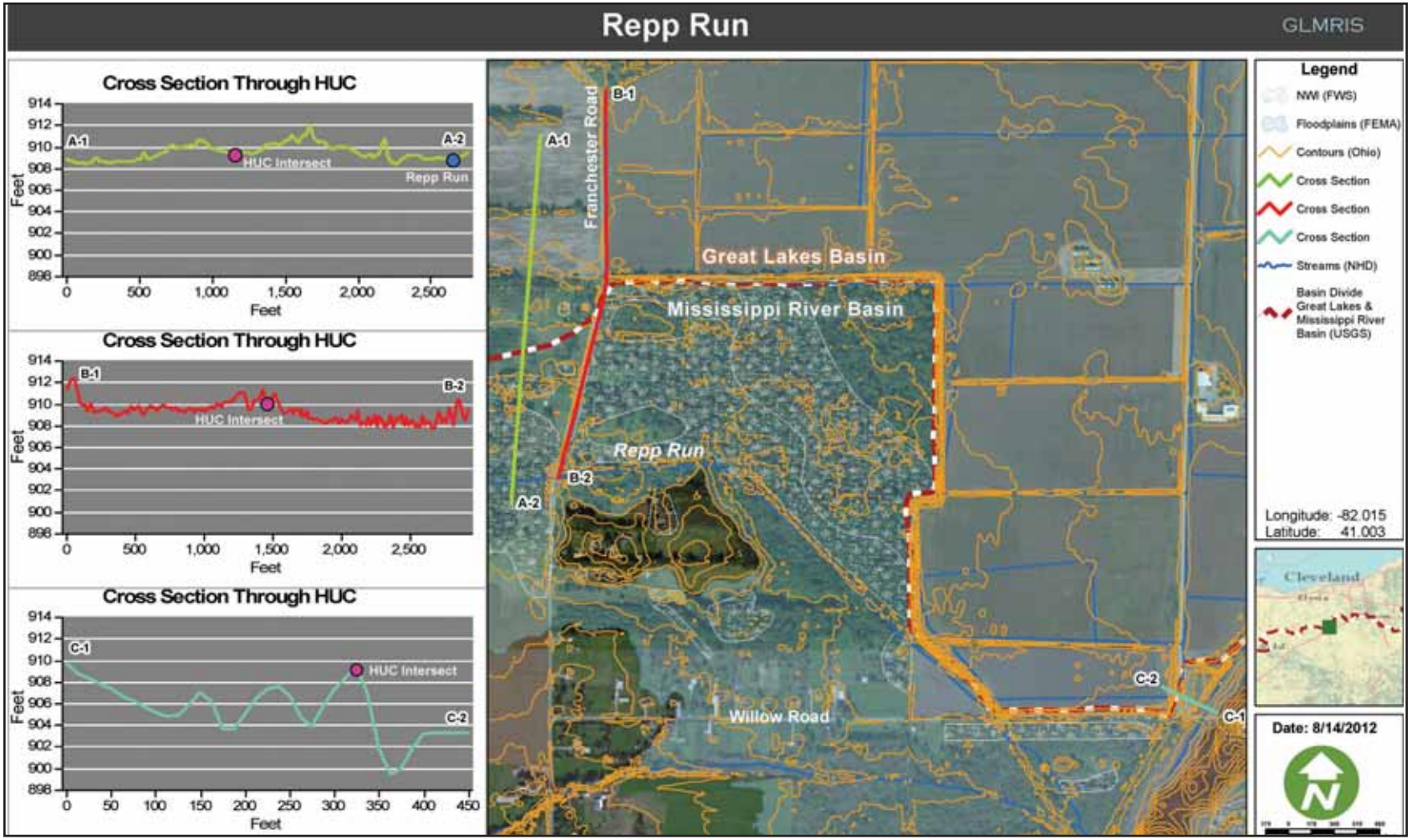


Figure 23: Plan view of area near Franchester Road (green dot on Figure 22) showing two foot (61 cm) contours with a vertical accuracy of +/- one foot (30 cm). The red-white line is the basin divide, with cross sections through this divide shown on inset figures to the left indicating flat topography with very little vertical relief, and mostly contiguous wetland area between the basin divide and Repp Run to the south. Background imagery courtesy of Bing Maps.

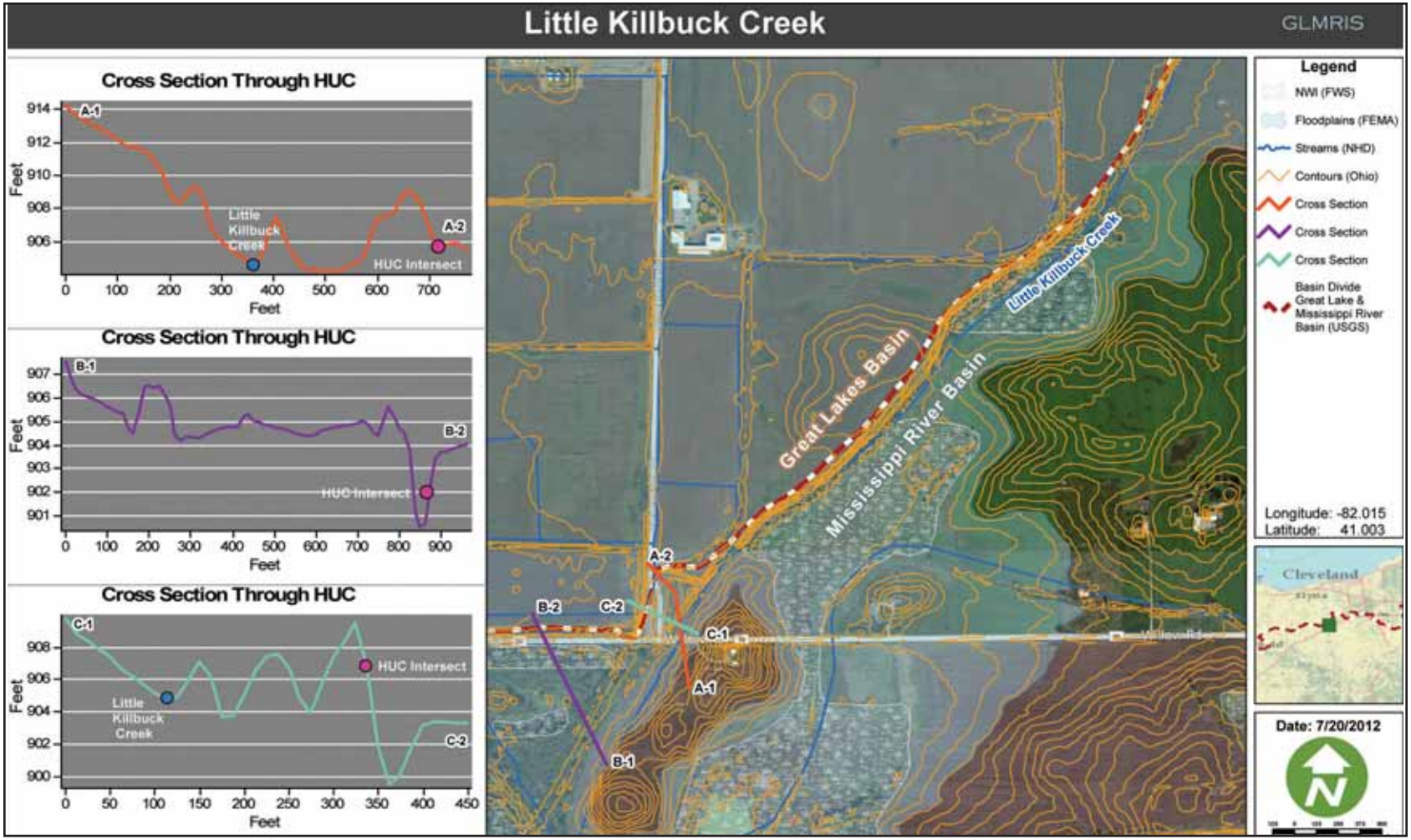


Figure 24: Plan view of area near intersection of Willow Road and Garden Isle Road (yellow dot on Figure 22) showing two foot (61 cm) contours with a vertical accuracy of +/- one foot (30 cm). The red-white line along the north side of Little Killbuck Creek is the basin divide, with cross sections through this divide shown on inset figures to the left indicating channel of the creek and the surrounding areas. Background imagery courtesy of Bing Maps.

relative, or point-to-point, vertical accuracy (terrain) when evaluating terrain at this pathway to try and predict hydrology. Point-to-point accuracy is much more important to understanding local surface water hydrology than the absolute elevation. Although the absolute elevation values may be slightly off from the true value (e.g., 600 feet above sea level), they tend to be off a comparable amount at adjacent points so that the terrain of the area is actually depicted with relative accuracy. The grid size used to create the DEM can also affect the accuracy of the DEM. The larger the grid cell size (10 m cells vs. 30 m cells), the less detailed the terrain appears and therefore the less accurately the DEM depicts the actual terrain. The largest grid size used at any of the pathway locations is 10 m cells with some areas having more detailed information. Even though the 10 m cell size does not depict every hummock or hollow in the terrain, it does provide sufficient detail regarding general terrain and relative elevations. At this site, the elevations are do not vary by much and the elevations of the area would not be likely prevent water from passing between the two basins.

The storm water at the intersection of Willow Road and Garden Isle Road was at an elevation of about 907 feet the day after the storm event. As can be seen by the elevations in the cross sections through the basin divide, an elevation of 907 feet comes close to and at some points over the elevation of the basin divide (Figure 24). At the time of the May 26, 2011 field assessment, the storm water had already started receding as can be seen by the wet line on the road in Figure 25. The cross sections indicate that the difference in elevation between the divide and flood elevations is shallow, but in some areas is in the range of 1.5-2.0 feet (30-61 cm).

3.4 Groundwater

Groundwater was taken into consideration as a part of determining the likelihood of a pathway existing due to the fact that groundwater can be a source of headwater to streams in upper portions of the basin divide or the source of baseflow in wetland areas. The state of Ohio has a network of observation wells for monitoring groundwater (ODNR, 2011). In 2011, there were four active wells in Medina County, four active wells in Wayne County, two active wells in Ashland County, and two active wells in Summit County. Wayne, Ashland,

Figure 25: Storm water at intersection of Willow Road and Garden Isle Road on May 26, 2011. Photo by USACE.

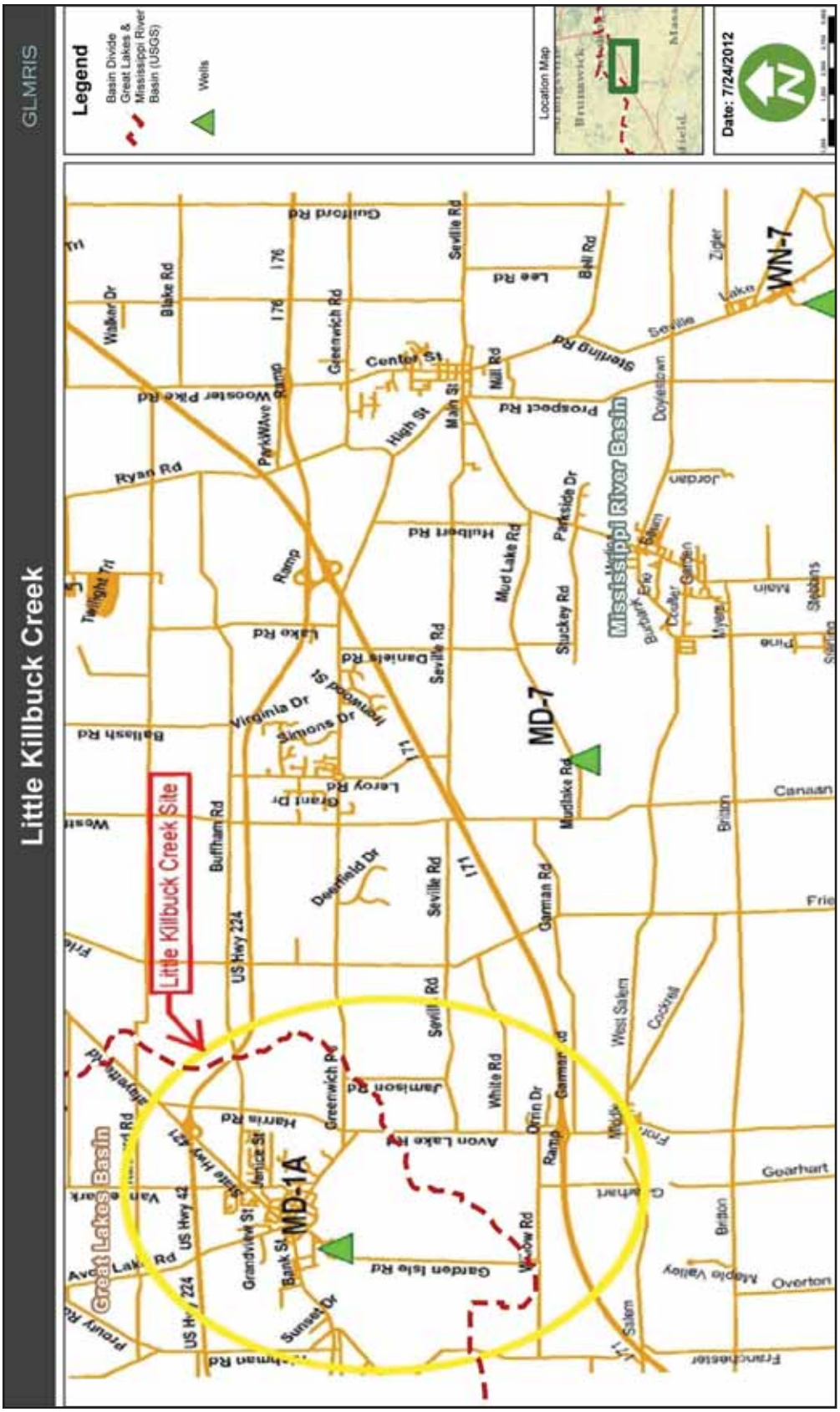


Figure 26. Nearest groundwater well locations in vicinity of Little Killbuck Creek potential pathway site. Base imagery courtesy of Bing Maps.

Table 13: List of Groundwater Monitoring Wells Near Little Killbuck Creek Pathway Location.

County	Well ID	Lat/Long	Period of Record
Medina:	MD-1A	N41.0283, W082.0158; 12/3/2002	Current
Medina:	MD-7	N40.9947, W081.9306; 5/8/2009	Current
Wayne:	WN-7	N40.9625, W081.8506; 11/24/1978	Current

and Summit Counties surround Medina County. The three wells closest to the potential aquatic pathway site are shown in Figure 26 and listed in Table 13.

Over the period of record (eight years), the water level in the Medina well MD-1A has fluctuated but remained relatively the same level at a depth between 20 and 30 feet (6-9 m) below the surface. The water level at Medina well MD-7 has shown a decline in the water level over the period of record (two years). It has dropped approximately three feet (0.9 m) to a depth of about 12 feet (3.7 m) . The water level at the Wayne County well (WN-7) has also fluctuated over the period of record (30 years) and has shown a general decline until it leveling off around 1992 where it has remained at a depth of around 25 feet (7.6 m). Ground water supply is likely helping to maintain baseflow in area streams throughout the year through springs and lateral subsurface flow.

3.5 Aquatic Pathway Temporal Characteristics

Characterizing the temporal variability of the pathway hydrology is an important aspect of understanding the likelihood of an ANS being able to traverse the basin divide at this location as flood events may coincide with species movement and reproduction patterns and abilities to survive and establish populations in various areas. The entire area of this potential aquatic pathway site (i.e., Little Killbuck Creek, Repp Run, Clear Creek, West Fork East Branch Black River) has been identified by FEMA to be an area that will be inundated with a one percent annual recurrence interval storm event. This information is based on an approximate study and not a detailed study. Since the topography is so flat and low, water will pond in the fields for days. This is evident by the wetlands and ponds in the immediate vicinity (Figure 10). These wetlands and ponds could provide stopping, foraging, and staging points for water dependent species as evidenced by fish observed in the field irrigation ditches during the site investigation.

Flow in the agricultural ditches is controlled and they are used to convey excess water away from the fields or to provide water to them for irrigation. One of these ditches at bank full from recent storm activity can be seen in Figure 27. There are several ponds in the area in both basins. Standing surface water appears to be common and fluctuates with the ground water and precipitation. Flooding in this area is frequent and several of the roads in the area have permanent signage indicating “HIGH WATER”. Road areas that were flooded at the time of the site visit in May 2011 are shown on Figure 10. A local farmer reported that the largest flooding event that he could remember was in 1969 when the rainfall was around 12 inches (30 cm). Records indicate that the event he is referring to occurred on July 5, 1969. The rainfall was recorded at the Wooster EXP Station to be 12.79”, which is in excess of a 0.2 percent annual recurrence interval storm. There is very little uncertainty that water crosses over the divide at this site during storms of between a two and five percent annual recurrence interval and greater intensity.

3.6 Probability Aquatic Pathway Exists

The rating discussed in this section is only for the likelihood of an aquatic connection existing at this

Figure 27: Drainage and irrigation ditch along crop fields. Photo by USACE.

potential pathway (P_0) at up to a one percent annual recurrence interval storm. A surface water connection does exist between the Great Lakes and Mississippi River Basins at the Little Killbuck Creek location, based on the following:

- During a recent storm event from between a two and five percent annual recurrence interval storm in May 2011, surface water was observed passing between the two basins. Fields were flooded, roads were flooded, and roadside ditches were flooded.

- The roadside ditches were continuous across the basin divide.

- There are wetlands in the area that are on or in close proximity to the basin divide. This was particularly evident along Franchester Road and west of Avon Lake Road. These areas were observed as being flooded during the May 25-26 storm event.

- There is a network of ditches that were constructed to manage storm water runoff in the crop fields north of Little Killbuck Creek and to provide a means for crop irrigation. Water is transferred between the basins via these ditches by natural flooding or by pumps as the circumstances require.

- Topography of the site is flat with very little relief, as evidenced by cross sections through the basin divide (12-digit HUC) showing elevation changes only in the range of 1-3 feet adjacent to the basin divide, or between the basin divide and the nearest stream. In some cases such as in adjacent wetlands, elevations away from the nearest streams were lower than the top of the stream bank.

- FEMA floodplain mapping indicates the majority of the aquatic pathway area to be inundated at the one percent annual recurrence interval flood event.

The interagency pathway assessment team determined that an aquatic connection exists between the two basins at Little Killbuck Creek since there are streams capable of maintaining a surface water connection with tributaries in either basin continuously for multiple

days from a ten percent annual recurrence interval flooding event. In addition, wetlands are also present that span parts of the basin divide and that are likely to become interconnected with streams on both sides of the basin divide from a ten percent annual recurrence interval flood event. Consequently, the probability of the existence of an aquatic pathway at Little Killbuck Creek is rated “medium” in either direction. .

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

- FEMA flood mapping indicates that a connection exists between the basins at the one percent annual recurrence interval flood event.
- Field observation of interbasin flooding on May 26-27, 2011, correlated to just between a two and five percent annual recurrence interval flooding event.
- Periodic agricultural pumping between the basins for the purpose of draining or irrigating fields.
- Expansive wetlands along both sides of the basin divide in some areas.

The team rating form for the probability of an aquatic pathway existing for Little Killbuck Creek aquatic pathway, along with associated definitions of the criteria that were used, can be found in Attachment A for this report.

3.7 Aquatic Pathway Habitat

3.7.1 Terrestrial and Riparian Land Use

Historically most of the area at the pathway was likely wetland based on observed elevations in the area and the large amount of agricultural drainage ditches that are in use. The majority of the Little Killbuck Creek site is underlain by hydric or partially hydric soils (Figure 28), 18 percent of which are histosols or organic muck soils. Agriculture is the dominant land use within the region. Due to the hydrology in the area, drainage ditches had to be excavated in order to convert this land from wetland for agricultural purposes (Figure 27). The altered drainage promotes the leaching of mobile organic compounds and carbonic acids into the drainage ditch system onsite. In addition to excess nitrate from increased decomposition, application of fertilizer contributes to free available nitrogen within this ecosystem. The end results are drainage ditches that are highly acidic, have seasonally elevated temperatures and eventually become eutrophic.

3.7.2 Aquatic Resources

While the majority of the pathway area is agricultural fields, a substantial portion also consists of a variety of wetland habitats (Figure 10 and Figure 21). This wetland ecosystem plays an important role in the life history of the many species that utilize its resources.

The Black River Watershed, just downstream of the potential pathway location within the Great Lakes Basin, drains an area of 470 square miles (1,217 km^2) in north-central Ohio. The area is highly susceptible to erosion with predominantly agricultural land use (44 % row crops) and a glacial history that has left piles of till material as end moraines, which can result in elevation changes that increase stream gradients and add velocity to the streams. Two of these moraines are the Spencer and Defiance Moraines near the Great Lakes and Ohio River Basin divide (OEPA, 2008). The Black River Watershed is located along the historic eastern fringes of the Great Black Swamp, which used to extend from about this location west toward Detroid, Michigan. Most of the watershed is part of an Area of Concern (AOC) under the Great Lakes Water Quality Agreement of 1978 and a Remedial Action Plan (RAP) was been developed with a list of several beneficial use impairments in the watershed, including degradation of fish and wildlife populations and benthos, eutrophication, and loss of fish and wildlife habitat (OEPA, 2008). Just downstream from the site within the Mississippi River Basin, the Killbuck Creek Watershed is a relatively linear, north-south oriented sub-basin of glacial origin. Killbuck Creek is a low gradient stream whose mainstem between the towns of Burbank and Killbuck drops only 2.11 feet per mile. Much of the

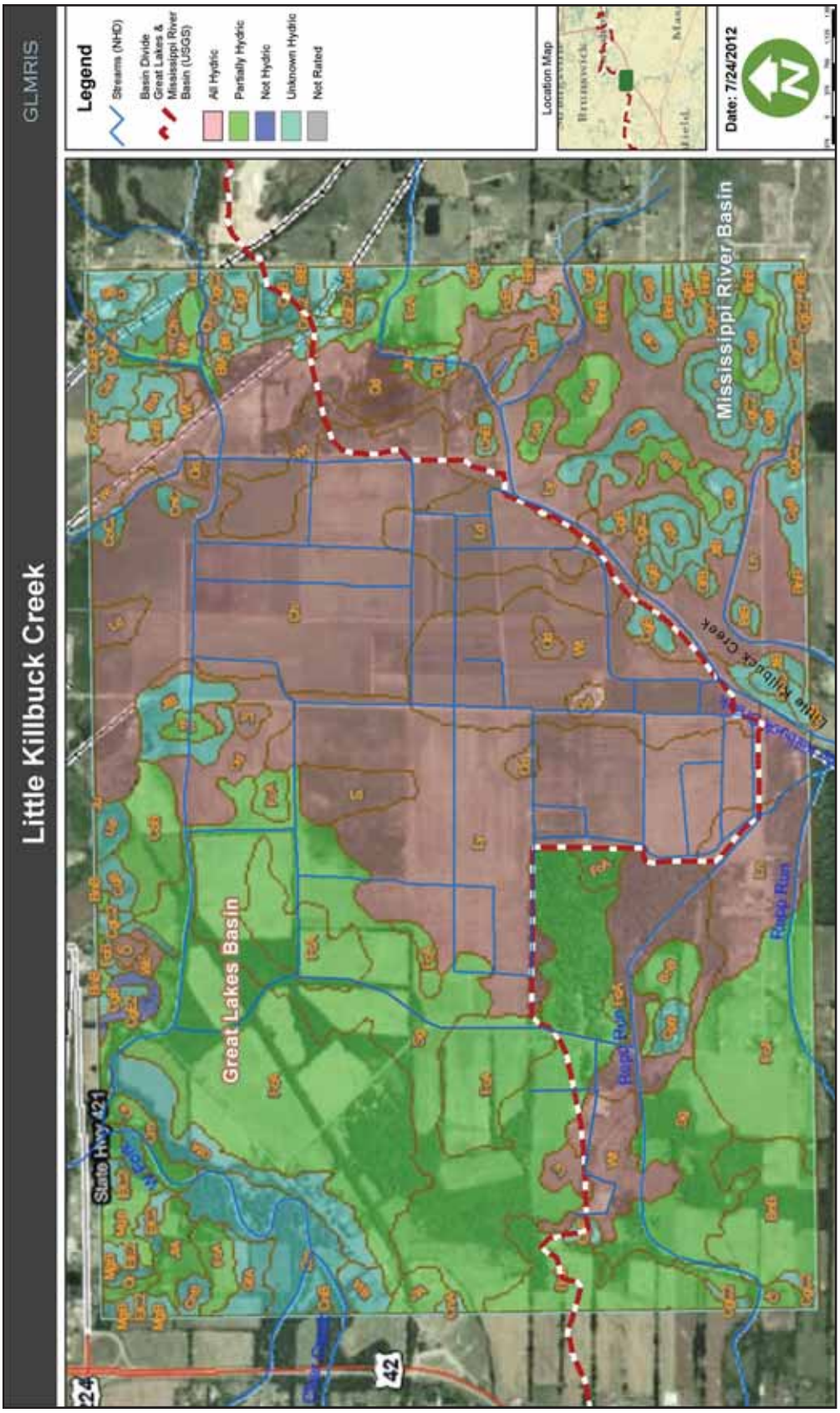


Figure 28. Hydric and non-hydric soils in the area of interest (USDA, 2012). Background imagery courtesy of Bing Maps.

Killbuck Creek Watershed consists of historically altered stream channel which are no longer maintained as trapezoidal ditches but have recovered many natural stream features (OEPA, 2011). There is also a general lack of bank erosion in the watershed with most of the banks being vegetated on both sides. The stream bed of the mainstem of Killbuck Creek is also comparatively free of silt and clay, indicating that sediments are likely being transported effectively through the watershed (OEPA, 2011). Further downstream in the Mississippi River Basin, the Muskingum River Watershed drains the largest watershed in Ohio at area of 8,051 square miles (20,852 km2). The river is used mainly for recreational boaters, with more than 5,800 boats using the river's 90 mile (145 km) navigation system of ten locks and dams annually (OEPA, 2007).

3.7.3 Water Quality

On the Great Lakes side of the basin divide, water from the agricultural ditch network is connected to Clear Creek, a small headwater stream in the Black River Watershed. In the agricultural upper watershed area, the modification of stream channels (for drainage improvement), failing home sewage treatment facilities, row crop and livestock production have resulted in habitat degradation, sedimentation, and high nutrient and pathogen loadings. Despite these impacts to the aquatic habitat, the East Fork East Branch and East Branch Black River are designated warm water habitat (WWH) as defined by Ohio Water Quality Standards: Designated Aquatic Life Uses. This designation represents the principle restoration target for the majority of water resource management efforts in Ohio and indicates that these water bodies provide good quality habitat for aquatic fish and macroinvertebrate communities (OEPA, 1999). This area of the watershed was delisted from the Black River AOC in 2005.

The Black River mainstem, including the cities of Elyria and Lorain, is urban and industrial in nature. In this reach of the watershed, major municipal and industrial discharges, combined sewer overflows, and urban runoff result in high nutrient and organic loads, poor habitat quality, siltation, and low dissolved oxygen concentrations (OEPA, 1999). Of the 14.1 miles (22.7 km) assessed in 1997, 2.9 miles (4.7 km) of this reach are fully attained, 5.7 miles (9.2 km) are partially attained, and 5.5 miles (8.8 km) did not attain the biological criteria for WWH. Low dissolved oxygen concentration derived from pollutant loadings is the primary cause of biological impairment in the reach of the Black River that is influenced by Lake Erie, with sediment contamination by heavy metals and polycyclic aromatic hydrocarbons (PAHs) a secondary cause.

Despite the deteriorating aquatic habitat conditions as one goes from the network of agricultural ditches at the basin divide down the Black River Watershed to Lake Erie, the aquatic pathway itself provides suitable temporary habitat. In some cases, permanent habitat for a diversity of aquatic life including the ANS species of concern that have been identified for this pathway.

On the Mississippi River Basin side of the pathway location, water from the agricultural ditch network can be connected during flood conditions to Little Killbuck Creek, a small headwater stream in the Killbuck Creek Watershed. The watershed is also home to the largest network of wetlands in the state outside of the Lake Erie drainage. In 2009, OEPA assessed the chemical, physical and biological integrity of the Killbuck Creek Watershed (OEPA, 2011). The biological communities in Little Killbuck Creek were found to fully attain WWH, Coldwater Habitat (CWH), or dual EWH/CWH. Further downstream, the biological communities sampled in the Killbuck Creek mainstem fully attained WWH (OEPA, 2011). The full length of the Muskingum River in the watershed just downstream from Killbuck Creek is fully attaining WWH aquatic life use designation, reflecting a high amount of biological integrity as well with chemical and organic parameters within reference levels at most locations (OEPA, 2007). The high water quality of Killbuck Creek could allow for support of various ANS spreading upstream through that area. The water quality within the network of ditches at the pathway location is likely characterized by eutrophication, low levels of dissolved oxygen, and low volumes of water during the majority of the year. Although during a flood event water quality could remain sufficiently high for the survival and transfer of ANS.

3.7.4 Aquatic Organisms

Despite the Black River being designated as a Great Lakes AOC due to water quality, it still provides drinking water for two communities and high-quality aquatic habitat for four state listed endangered, threatened or special concern aquatic animal species, including the recently sighted river otter and up to twelve state threatened and/or protected plant species (OEPA, 2008). Fish communities in the free flowing mainstem of the Black River improved in the 1990's, although fish consumption advisories are still in place in areas for brown bullhead, freshwater drum, and common carp. High turbidity and sedimentation continue to impair habitat quality and fish communities in the Black River (USEPA, 2001).

A 2011 OEPA study found three state listed fish species within Killbuck Creek including the river redhorse (*Moxostoma carinatum* – Species of Concern), the bluebreast darter (*Etheostoma camurum* - Threatened), and the eastern sand darter (*Ammocrypta pellucid* -Species of Concern). The state endangered caddisfly (*Brachycentrus numerosus*) was also found in Killbuck Creek. Nine state listed freshwater mussels were found in Killbuck Creek, including the state and Federally endangered purple catspaw (*Epioblasma obliquata obliquata*). The other state listed freshwater mussels were the elktoe (*Alasmidonta marginata* - Species of Concern), purple wartyback (*Cyclonaias tuberculata* - Species of Concern), snuffbox (*Epioblasma triquetra* - Proposed Endangered), sharp-ridged pocketbook (*Lampsilis ovate* - Endangered), creek heelsplitter (*Lasmigona compressa* - Species of Concern), black sandshell (*Ligumia recta* - Threatened), round pigtoe (*Pleurobema sintoxia* - Species of Concern), and kidneyshell (*Ptychobranchus fasciolaris* – Species of Concern) (OEPA, 2011). Fish communities in the mainstem of Killbuck Creek also met the expected parameters for WWH at most sites sampled in the watershed, with marked improvements in the fish communities as compared to earlier studies in 1983 and 1993 likely due to improved wastewater treatment and management of nonpoint sources (OEPA, 2011).

Further downstream, in the Muskingum River, high quantities of catfish, bullheads, common carp, suckers, bass, and white bass can be found (Isbell, 1988). Observed rare fish species include: northern madtom (*Notorus stigmosus*); mountain madtom (*Notorus eleutherus*); goldeye (*Hiodon alosoides*); pugnose minnow (*Opsopoeodus emiliae*); ohio lamprey (*Ichthyomyzon bdellium*), and several species of sensitive darters. Fish and macroinvertibrate surveys indicated healthy populations of several pollution sensitive species (OEPA, 2007). Historically, the Muskingum River has supported more than 63 unionid (freshwater mussel) species (Stansbery and King, 1983). Currently, two-thirds of these species are either extinct, extirpated, or in some way threatened (Gross, 2000). Among the endangered unionid species in the Lower Muskingum are the last remaining Ohio populations of the fanshell (*Cyprogenia stegaria*), monkeyface (*Quadrula metanevra*), clubshell (*Pleurobema clava*), Ohio pigtoe (*Pleurobema cordatum*), and butterfly mussels (*Ellipsaria lineolata*) (ILGARD, 2005).

If ANS are able of spread through the marginal to poor quality habitat of the agricultural ditches into the Mississippi River Basin, the aquatic pathway from this headwater area to the Mississippi River provides good quality temporary habitat, and in some cases, permanent habitat for a diversity of aquatic life including the ANS of concern that have been identified for this pathway.

3.8 Connecting Streams to Great Lakes and Mississippi or Ohio River

The surface water flow path from the study area at Little Killbuck Creek to both Lake Erie and the Ohio River is shown in Figure 29. Also illustrated in this figure is the location of each of the known potential obstructions to the upstream movement of ANS from their current known locations within either basin to the aquatic pathway site in Medina County, Ohio. There are multiple navigation locks and dams on the Ohio River. However, the presence of these dams on the Ohio River does not seem to provide a reliable obstacle to prevent the upstream passage of ANS based on the movement of Asian carp to date through the Mississippi and Illinois Rivers. A schematic drawing of the Ohio River Lock and Dam system is presented in Figure 30. While there are no known obstructions on

Killbuck Creek or the Walhonding River within the Ohio River Basin, there are a series of ten locks and dams on the Muskingum River. Each of these dams have an associated lock structure adjacent to them which could allow the movement of ANS in both directions.

The ten non-operational locks and dams along the Muskingum River may prevent the upstream movement of an ANS during most flow conditions. The dams range in hydraulic height from 11.6 to 20.1 feet (3.5-6.1 m) during normal flow conditions. Flood profiles were developed by the USACE for the Muskingum Watershed Conservancy District for the Muskingum River in 1936, which incorporates the proposed (now built) reservoirs in the basin (USACE, 1936). The study evaluated the effect of these non-operational navigation structures on water surface profiles given discrete flow frequencies. Given that the study was performed in 1936, it may not be consistent with current hydrologic and hydraulic conditions and/or computational procedures, but may offer good planning level insight to the relative frequency of submergence of these structures.

Based on the 1936 study, all of the locks and dams on the Muskingum River are overtopped by various amounts of floodwater on an annual basis (99 percent annual recurrence interval). The information presented in Table 14 compares the top (obstacle) elevation of each dam on the river against the approximate water elevation of different flow events. For example, at Lock and Dam No. 3 the one year storm would result in approximately 2.7 feet (82 cm) of flow over the top of the dam and the 100-year (one percent annual recurrence interval) event would result in approximately 20.6 feet (6.3 m) over the top of the dam. However, it is important to keep in mind that these are just estimates and not based on current hydrologic analysis and computational procedure. In addition, the amount of water flowing over the dam at a particular hydrologic event is not necessarily directly related to the ability of an ANS to pass through that flow. For example, at some undetermined flood event (which varies for each structure), there is likely to be enough flow over the dam such that there is not a large head difference between the upstream flow and the downstream tailwater, making it easier for a potential ANS to pass upstream of the structure.

The USACE Huntington District has identified great river fish passage as a project opportunity on the Muskingum River. Removal of dams and/or construction of fish passage ladders on the Muskingum River have been described as potential ecosystem restoration projects. These projects would allow for better movement and spawning opportunities for great river fish which have seen population declines since the lock and dam systems were constructed. Conversely, this may also aid the spread of ANS upstream towards the divide by decreasing the effectiveness of current obstacles in the river.

The National Inventory of Dams (NID) indicates that the East Bridge Street Dam in Lorain County, Ohio (Great Lakes Basin) has a maximum dam height of 12 feet (3.6 m), which is the dry height and not the height above the water level (NID, 2010; USACE, 2010). The FIS for Lorain County, Ohio and Incorporated Areas from 2008 indicates that the water level on the downstream side of the dam is approximately 1.5 feet (46 cm) below the top of the dam during the 10 percent annual recurrence interval flood, approximately three feet (1 m) above during the two percent annual recurrence interval flood, approximately five feet (1.5 m) above during the one percent annual recurrence interval flood, and approximately 11 feet (3.3 m) above for the 0.2 percent annual recurrence interval flood. For the other barriers, it shows the downstream water level above the top of the obstruction for the 10 percent, two percent, one percent, and 0.2 percent annual recurrence interval floods. Estimated water levels over the dams during modeled flood events from the FIS are presented in Figures 31 and 32.

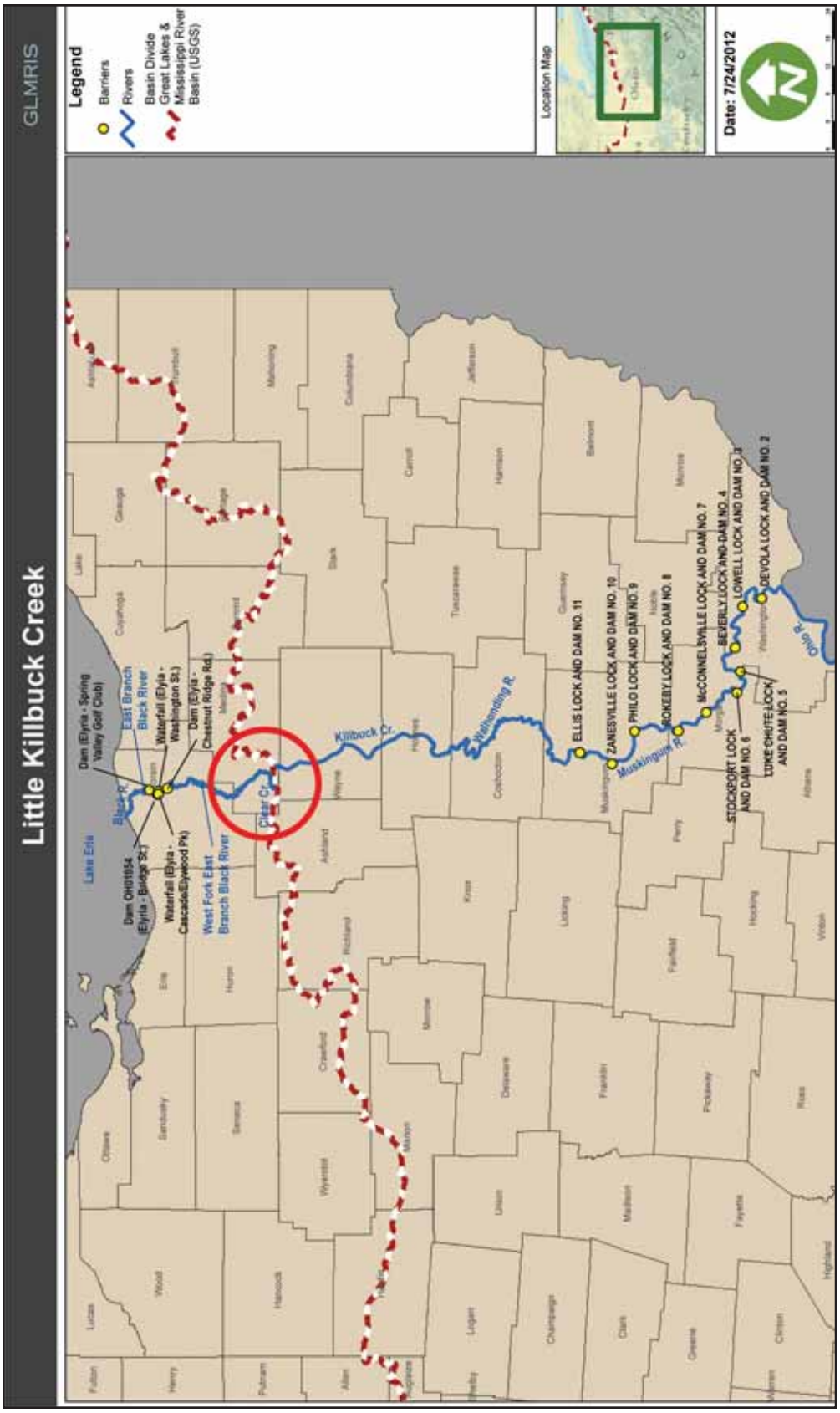


Figure 29. Surface water flow path from the aquatic pathway to both Lake Erie and the Ohio River, along with potential obstructions to the upstream movement of ANS toward the pathway (NID, 2010). Background imagery courtesy of Bing Maps.

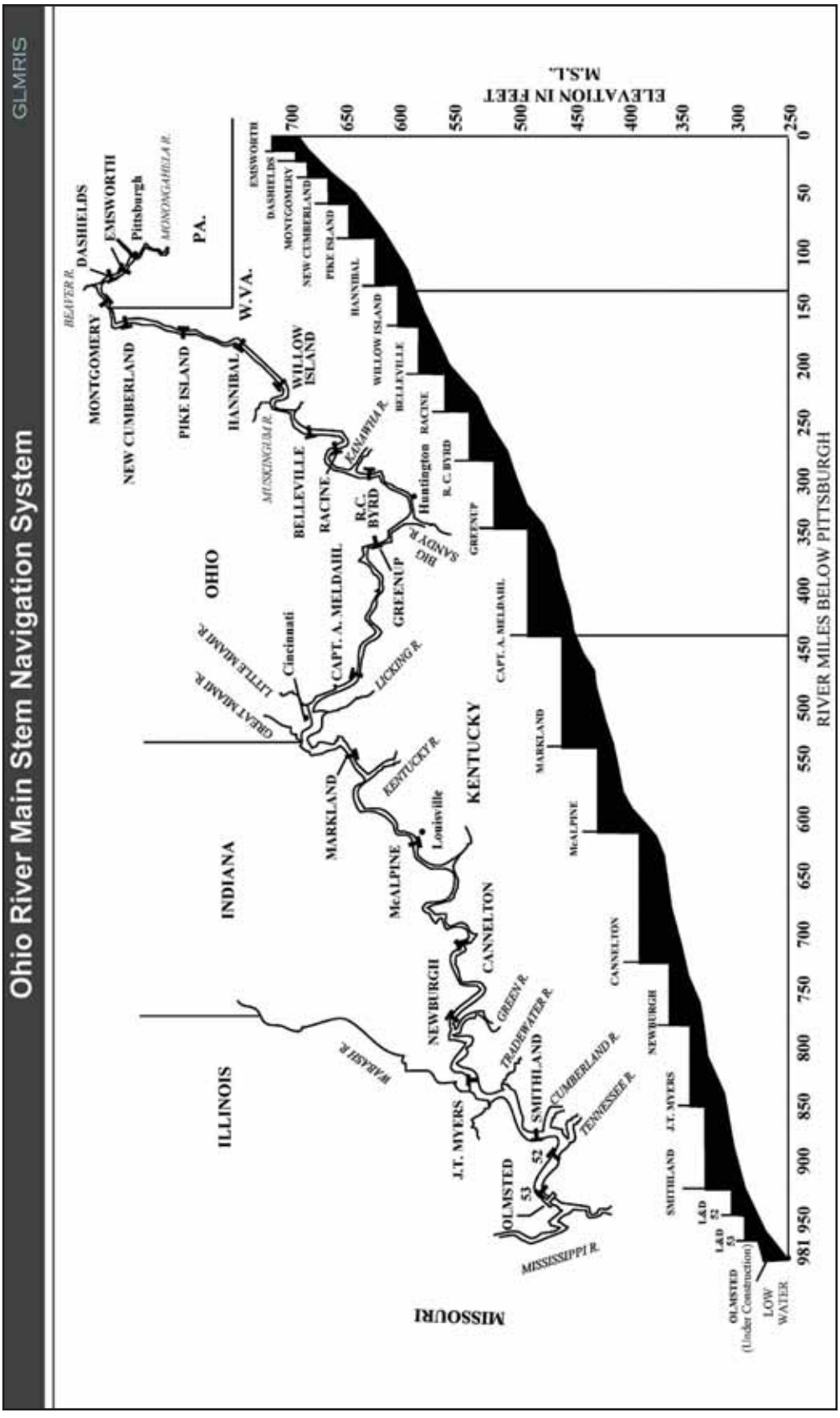


Figure 30. Ohio River Navigation System illustrating the relative distance and magnitude of the navigation structures and normal pools. Figure by USACE.

Table 14: Potential Obstacles for ANS Movement Through the Muskingum River (USACE, 1936; NID, 2010).

Name	RM	Obstacle Elev. (feet-NAVD88)	NIDHyd. Height(feet)	1 yr	2 yr	5yr	10yr	15yr	25yr	50yr	100yr
Lock and Dam No 2	5.7	593.5	17.5	603.1	606.7	611.9	614.5	616.8	619.5	623.5	627
Lock and Dam No 3	14	607.6	17.6	610.3	613.7	617.9	619	621.2	622.5	625.9	628.2
Lock and Dam No 4	25	617.0	17	623.9	626	629	630.8	632.4	634	637.1	640.1
Luke Chute lock and Dam (Dam No 5)	34	627.7	19.7	633.7	636	639.5	642	643.5	645.9	648.5	652.5
Stockport Lock and Dam (Dam No 6)	40	640.1	20	642	643	646	648.8	650.4	652.5	655.5	659.7
Malt Lock and Dam (Dam No 7)	49	650.2	15.2	656	658	661.1	663.8	665.8	667.7	670.5	674.5
Rokeby Lock and Dam (Dam No 8)	57	661.1	20.1	666	667	669.1	671.2	672.4	673.8	676.9	679.8
Lock and Dam No 9	68	672.1	18.5	679.8	680.5	682	684.2	685.9	687.2	690	692.2
Dam No 10	77	687.6	11.6	692	693.5	696.4	697.5	698	698.2	700.7	702
Lock and Dam No 11	85.5	699.3	15.3	704.8	705	705.9	706.8	707.7	709	710.2	714

4 Aquatic Pathway Viability for ANS of Concern

The following subsections present the results of the biological evaluation of the likelihood of ANS spreading between the Great Lakes and Mississippi River Basins via the Little Killbuck Creek aquatic pathway. The potential for species movement across the basin divide was assessed by the project team for the identified ANS of concern in accordance with the procedures outlined in the Methodology Section of this report. The potential for species transfer was characterized as high, medium or low for the following categories:

- Probability that Pathway Exists (Section 3)
- Probability of ANS being within Either Basin
- Probability of ANS Surviving Transit to Aquatic Pathway
- Probability of ANS Establishing in Proximity to the Aquatic Pathway
- Probability of ANS Spreading Across Aquatic Pathway into New Basin

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

- Very Certain (As certain as we will get with this effort)
- Reasonably Certain

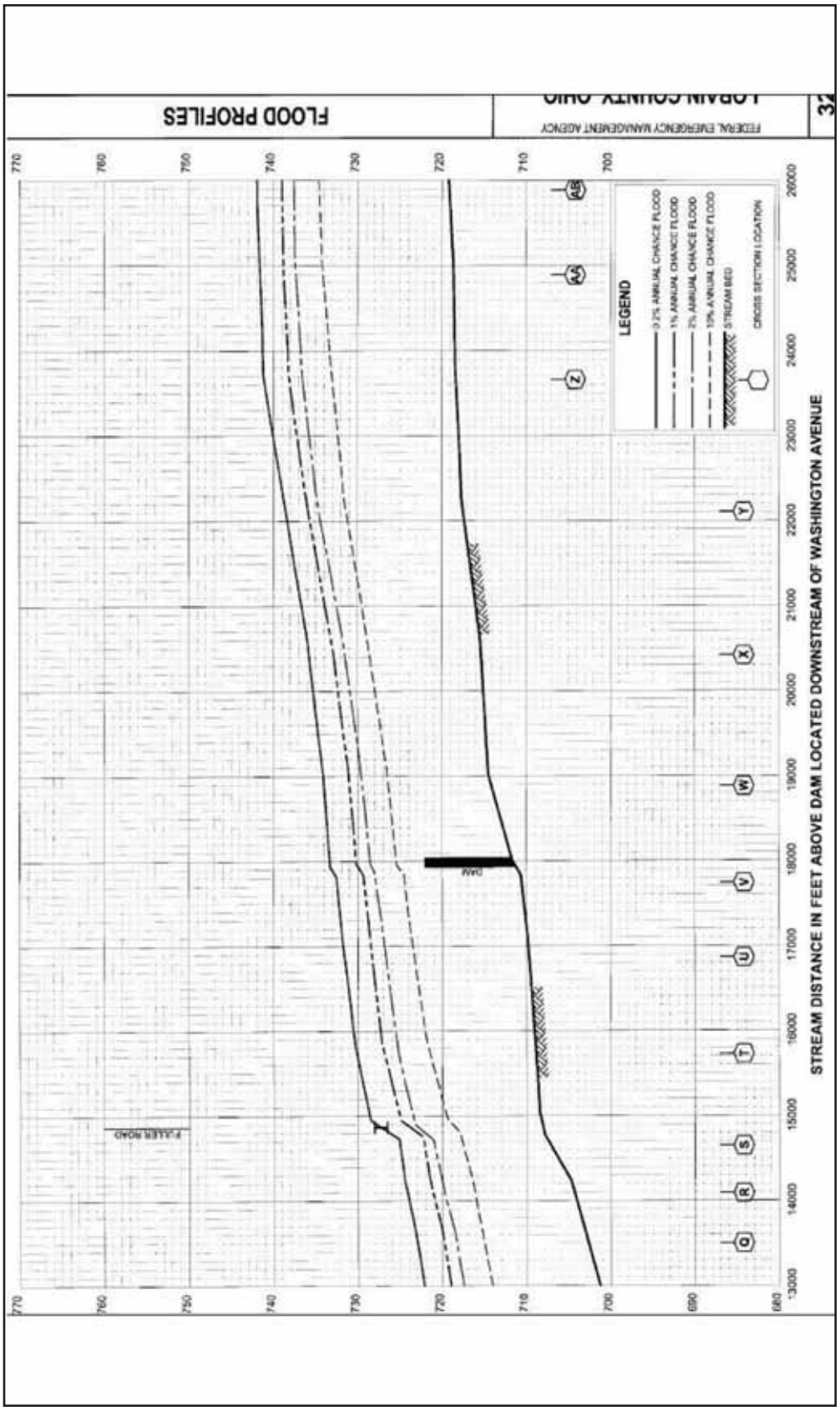


Figure 31. Amount of overtopping of dams between 2.5-4.9 miles (4-7.8 km) upstream of Washington Avenue, extracted from FEMA 2008 FIS for Lorain County and Incorporated Areas.

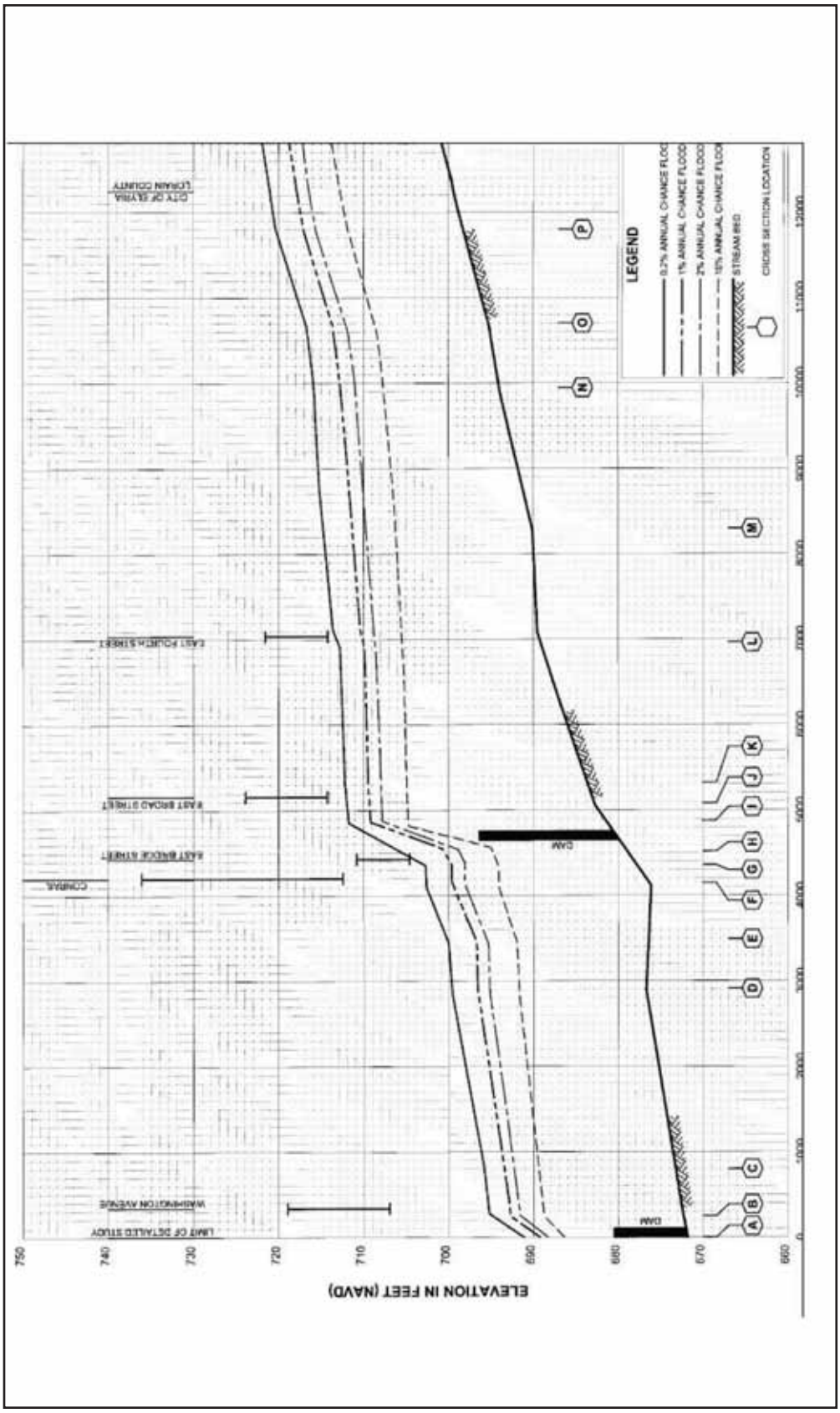


Figure 32. Amount of overtopping of dams 2.5 miles (4 km) upstream of Washington Avenue, extracted from FEMA 2008 FIS for Lorain County and Incorporated Areas.

- 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 in the middle and lower Mississippi River Basin. Successful breeding populations seem to stop near Louisville, Kentucky. Occurrences of the bighead carp have been noted in the Upper Ohio River Basin including Moundsville, West Virginia and the Mahoning River in Ohio. In 1995 and 2000, individuals of bighead carp were recorded from Lake Erie at Sandusky, Ohio although there is no evidence that these are from establish populations (Kolar, et al., 2005). Black carp may be established in portions of the lower Mississippi River Basin and they have also been reported in the Mississippi River upstream of the mouth of the Ohio River. The known distribution of black carp is not as extensive as that of the silver and bighead carp. Asian carp species are established in the Ohio River Basin.

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

Parasitic Copepod:

The parasitic copepod has a life cycle in which the female adopts a parasitic phase on several fish species, including members of the minnow family, sunfish family, catfish family, and potentially other fish species. The common carp (*Cyprinus carpio*) is a frequent host of the parasite (Hudson and Bowen, 2002). The females can detach and re-attach to host species. The invasive copepod has been established in Lake Huron since 1994, but has not yet been recorded in Lake Erie. It has also been found in Crane Creek basin, a tributary draining directly to Lake Erie. The common carp is established in Lake Erie and in the Black River. While other host fish species are known to exist in the pathway system, the common carp was selected as the most likely host species because of the life cycle capabilities of the common carp and the likelihood that the common carp would use and survive in the pathway habitats. The males are free living but do not have the capability of moving upstream. Due to its inhabitance of the Crane Creek Basin, it is probable that the parasitic copepod could move to the pathway within 20 years.

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

Viral Hemorrhagic Septicemia Virus (VHSv):

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 (WDNR, 2012). Variables such as host fish species and water temperature can impact the virulence of the virus. Seemingly healthy individuals that have been previously infected with VHSv can have chronic infections and be carriers of the disease (Skall, et al., 2005). This virus has been reported from throughout the Great Lakes Basin including Lake Erie (USGS, 2011c). Viral hemorrhagic septicemia virus has been found in many species of fish including common carp and is active at water temperatures less than 60º F (15.5º C) (WDNR, 2012). The common carp is established in Lake Erie, as well as the rivers and streams leading to the Little Killbuck pathway. While other host fish species are known to exist in the pathway system, the common carp was selected as the most likely host species because of the life cycle capabilities of the common carp and the likelihood the common carp would use and survive in the pathway habitats.

Team rating: **High**
Team certainty rating: Reasonably 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 in Texas and southeastern New Mexico; north from the Mississippi River and major tributaries (mainly Arkansas and Red Rivers) to southern Illinois and eastern Oklahoma (Page & Burr, 1991). It is a marine species that ascends rivers and prefers estuaries, lagoons, brackish seas, and rivers (Fishbase, 2011). The inland silverside has been collected in 2003 in Mt. Carmel, Indiana which is in southwestern Indiana (USGS, 2011c). The species has also been collected in Illinois from Lake Baldwin, Lake of Egypt, Rend Lake, Cache River, Wabash River, and the Mississippi, Ohio, and Kankakee Rivers (Laird & Page, 1996). It is believed that the presence of the species in the Mississippi River in southern Illinois and in the lower Ohio River in Illinois and Kentucky are a result of natural dispersal (Fuller & Nico, 2012). These locations are greater than 250 miles (402 km) from the Little Killbuck site.

Team rating: **Medium**
Team certainty rating: Relatively Certain

Northern Snakehead:

The northern snakehead was found in 2008 in Monroe, Arkansas (> 250 miles (402 km) from the Little Killbuck site, and further by stream mile), and has since established a reproducing population in that area. Although in a different basin, this species is also established in the Potomac River in Maryland and Virginia (USGS, 2011c).

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

Threespine Sticlkeback:

The threespine stickleback is found in each of the Great Lakes and has been collected in some inland river systems (USGS, 2011c). Literature indicates this species prefers to live in smaller streams but may occur in a variety of habitat including lakes and large rivers (USGS, 2011c). The threespine stickleback was first encountered in lower Green Bay and the Lower Fox River (below DePere Dam) about 25 years ago, but has never been seen upstream from this area. Great Lakes populations of this species tend to be potamodromous (truly migratory but within fresh water only) and only enter the lower reaches of streams briefly during spring spawning.

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

Ruffe/Tubenose Goby:

The ruffe and tubenose goby are located within the Great Lakes and associated with river mouths and estuaries of large river systems entering the Great Lakes. To date, the ruffe has not been identified within Lake Erie, but the fish has extended its range rapidly and modeling predicts it will find suitable habitat in all five Great Lakes. Literature reviews and actual fish survey data have not documented the collection of the ruffe in smaller upstream tributaries (USGS, 2011c). The ruffe is an aggressive species that possesses the ability to feed in darkness, cold temperatures, and turbid conditions. The tubenose goby's introduced range covers three Great Lakes including Lake Superior, Erie, and Huron (USGS, 2011c). It has been collected in the lower reaches of

larger Great Lakes rivers and estuaries. The tubenose goby is a benthic species that consumes a wide variety of invertebrates (USGS, 2011c). 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. 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.

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

European Fingernail Clam:

The European fingernail clam was first found in the Great Lakes Basin in Lake Ontario in 1924. It is considered to be established in Lakes Erie and Ontario and has been recorded in Lakes Michigan and Superior, Rice Lake (which is part of the Trent-Severn Canal system connecting Lake Huron and Lake Ontario), and Lake Huron, although it is very uncommon in Lake Huron (Herrington, 1962; Mackie et al., 1980; Mills et al., 1993; Mackie, 2000; Grigorovich et al., 2003, Kipp and Benson, 2011a). The European fingernail clam is found in freshwater lakes and slow-moving rivers and prefers eutrophic, vegetated shallow waters with high concentrations of magnesium, calcium, and bicarbonate (Kipp and Benson, 2011a). It generally lives in the sediment but can also be found among submerged vegetation instead of soft sediments (Watson and Ormerod, 2005). It often prefers more lentic habitats, but it cannot tolerate extremely high organic pollution nor does it tolerate desiccation well (Kipp and Benson, 2011a).

Team Rating: **Medium**
Team certainty rating: Very Certain

European Stream Valvata:

The European stream valvata was originally introduced to Lake Ontario at the mouth of the Genesee River in 1897. In forty years it dispersed to Lake Erie and subsequently expanded its range to the St. Lawrence River, the Hudson River, Lake Champlain, and Cayuga Lake. The valvata was recorded in the 1990s and the first decade of the 21st century in Superior Bay in Lake Superior (Minnesota), Lake Michigan (Wisconsin), and Oneida Lake in the Lake Ontario watershed (New York) (Grigorovich, et al., 2005; Kipp and Benson, 2011b). The European stream valvata is found in freshwater lakes and streams. In its native range of Europe, western Siberia, and central Asia, this species has been found to tolerate a wide range of habitats including oligotrophic nearshore zones (Grigorovich, et al., 2005), sparsely vegetated lakes or sites dominated by Chara spp. and Potamogeton spp. (Van den Berg, et al., 1995; Van den Berg, et al., 1997), littoral habitats with high siltation rates (Smith et al., 1994), and lentic and stagnant waters or slow streams (Frank, 1987). The valvata is found in habitats with fine substrates (mud, silt and sand) – especially during hibernation, and aquatic macrophytes – for laying its egg masses (Grigorovich et al., 2005; Kipp and Benson, 2011b).

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

Skipjack Herring:

The native range of skipjack herring includes the Mississippi River Basin from central Minnesota south to the Gulf of Mexico, and from southwestern Pennsylvania west to eastern South Dakota, Nebraska, Kansas, Oklahoma, and Texas (USGS, 2011c). Skipjack herring have been collected in Lake Michigan, but it has not yet been determined if the species is established in the basin. From the years 1989-1993, three separate collections were made by Wisconsin commercial fisherman. Since they are a migratory species, dams often impede their reproduction. Records suggest that this species was much more abundant in the Upper Mississippi River Basin before it was impounded. Current range distribution maps suggest that the species is established within the main stem of the Muskingum River approximately 50 - 100 miles (80-161 km) away from the aquatic pathway (NatureServe, 2012).

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

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 the 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

Spawning of silver and bighead carp is initiated by rising water levels following heavy rains (Jennings, 1988; Verigin, 1978). Both species are strong swimmers and silver carp are capable of jumping considerable distances out of the water (up to 12 feet (3.6 m)). There are no obstacles in Little Killbuck Creek or Killbuck Creek that would permanently prevent the upstream movement of silver carp or bighead carp to the pathway location. Habitat present within most of Little Killbuck Creek and Killbuck Creek is not ideal for silver and bighead carp, which are native to and thrive in larger river systems, but it is not known to what extent the smaller size of these creeks may prevent the upstream movement of Asian carp to the pathway. Bighead carp are zooplanktivorous, while silver carp consume smaller phytoplankton and fine particulate organic matter (Williamson and Garvey, 2005; Dong and Li, 1994). However, sufficient forage is believed to be available for both species throughout the river systems downstream of the pathway, including the Muskingum, Walhonding, and perhaps Killbuck Creek. Forage abundance and diversity likely decreases moving upstream towards the pathway as water quality and flow volume decreases.

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 (Nico and Jelks, 2005). It is believed that black carp should be able to colonize the same areas of the United States where the grass carp have established (USFWS, 2002).

Juvenile, sexually immature Asian carp have been observed in the upmost reaches of small tributaries to large rivers attempting to pass over barriers, such as dams, to continue their upstream movement (D. Chapman-USGS, personal communication, September 12, 2011 and N. Caswell-USFWS, personal communication September 12, 2011). The gradient needed to prevent juvenile fish from moving up streams is unknown. Thus it is unclear if the gradients of the Muskingum River or Killbuck Creek are sufficient to prevent potential future upstream movement of young carp. It is important to note that young Asian carp tend to move laterally away from the river in which they were spawned and not back upstream (D. Chapman-USGS, personal communication, September 12, 2011). It has also been observed that Asian carp, as small as advanced fingerlings, have traveled up to 37 miles (60 km) though tributaries of the lower Missouri River. These tributaries were located laterally to the Missouri river segment in which these fish hatched (D. Chapman-USGS, personal communication, September 12, 2011). Adult, sexually mature Asian carp have occasionally been found in very small streams, which appear scarcely large enough to support the fishes at low water (D. Chapman, personal communication, September 12, 2011). The age of these fish when they arrived at these locations is unknown.

The ability for Asian carp to survive transit upstream to Killbuck Creek is supported by the moderate levels of habitat and forage that would likely be provided by the Muskingum and Walhonding Rivers. Killbuck Creek could also likely support movement of juveniles and fry. However, it is believed that this group of fish has yet to establish any breeding populations above the McAlpine Pool on the Ohio River which is greater than 500 river miles (805 km) away. The nature of the Upper Ohio River is vastly different from the Lower Ohio River where successful populations have established. The lower river provides many backwater areas that Asian carp prefer for habitat. In general, the upper river is characterized by narrower valleys, smaller floodplains, and less backwater areas. This lack of preferred habitat on the Upper Ohio River may be the obstacle that cannot be overcome by Asian carp (D. Duane-USGS, J. Thomas-ORSANCO, and J. Stark-The Nature Conservancy, pers. Communication, June 2011). Asian carp have accordingly been assigned a medium rating for ability to survive transit to the pathway.

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

Parasitic Copepod

The parasitic copepod has been found on common carp. During spring run-off events in April and May, common carp move into the shallow waters of bays and river systems to spawn. Within the rivers, common carp move upstream to spawn in suitable habitat such as marshes and even drainage ditches with as little as or less than one foot (30 cm) depth of water. Common carp are strong swimmers and though they cannot jump like members of the salmon family, they can move upstream during moderate flow events. The common carp has been observed on both sides of the pathway and also within the agricultural drainage network (personal communication with land owner, May 26, 2011). The common carp has successfully moved to these points previously. Common carp are a very resilient species and are capable of surviving a wide range of water quality parameters. It is expected that the common carp will continue to move to this area successfully.

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

Viral Hemorrhagic Septicemia Virus

Viral hemorrhagic septicemia virus has been found to infect common carp (USGS, 2011c). Within rivers, common carp move upstream to spawn in suitable habitat such as marshes and even drainage ditches. Common carp are strong swimmers that can reach sustained speeds of 1.3-3.9 feet per second (fps) [0.4-1.2 meters per second (mps)] and burst speed of 3.9-8.5 fps (1.2-2.6 mps). Though they cannot jump like members of the salmon family (maximum height six feet or 1.8 m), they can move upstream during moderate flow events. The common carp has been observed on both sides of the pathway and also within the agricultural drainage network (personal communication with land owner, May 26, 2011). It is expected that the common carp will continue to move to this area successfully. In order for successful movement through the pathway, at least a one percent flood event would need to occur.

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

Inland Silverside

The inland silverside moves in large schools that can number in the thousands and they can travel far up streams and rivers, especially in southern part of their range (NatureServe, 2012). 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, 2012). It is capable of producing 30,000 eggs per month (Stoeckel and Heidinger, 1988). As a relatively small fish (approximately five inches (13 cm) in total length at maturity), it is likely that this species would seek refuge from high water velocities during flood events, instead of attempting to move upstream. The available habitat data suggests the inland silverside will colonize within rivers and streams but are usually found in clear, quiet water over sand or gravel. Proximity to pathway is greater than 250 miles (402 km).

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

Northern Snakehead

The northern snakehead is an incredibly resilient species. The northern snakehead utilizes specialized structures (suprabranchial organ and a bifurcate ventral aorta) that permits aquatic and aerial respiration (Ishimatsu and Itazaw 1981, Graham 1997). This species thrives in stagnant, oxygen depleted back-waters and marshes (Courtenay, Jr. and Williams, 2004). The northern snakehead likely possesses the ability to move to the Little Killbuck site. However, its preferred habit is not flowing waters, which will likely slow its spread up the Mississippi River and its tributaries. Unlike the Asian carps, northern snakeheads do not make long upstream spawning runs and, as a result, are not likely to spread quickly through the Mississippi River Basin without the aid of anthropogenic means. Despite its preference for stagnant, oxygen-depleted back waters and marshes, the northern snakehead has been consistently caught by anglers in the Potomac River near Great Falls, Virginia during spring high flow events (J. Newhard-USFWS, personal communication, December 22, 2011). Based on data from external tags recaptured by anglers, in rare instances, northern snakehead have been found to move as far as 50 river miles (80 km) upstream at a rate of approximately one mile (1.6 km) per day. This extensive movement typically occurs in the spring with the fish returning back downstream to slower moving water in the summer (J. Newhard-USFWS, personal communication, December 22, 2011). The lack of backwater and marsh areas in the Upper Ohio, Muskingum, and Walhonding Rivers may impede the movement of the snakehead to the pathway.

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

Threespine Sticlkeback

The threespine stickleback has been found in the Great Lakes and in smaller river systems. Its close proximity in the Great Lakes and particularly Lake Erie indicate potential for access and transfer of this species to the Mississippi River Basin via the Little Killbuck Creek aquatic pathway. The dams and waterfalls in the Black River Watershed should be sufficient in impeding movement of the threespine stickleback at normal and low flows. However, as these obstacles become inundated during high flow events, the stickleback may then have ample opportunity to move upstream. However, it is likely that this species would seek refuge from higher velocities instead of expending energy attempting to move upstream. The fish could also potentially survive in emergent wetland and ditch areas during a storm runoff event as they are tolerant of low dissolved oxygen down to two parts per million (ppm) and temperatures up to 68°F (20°C) (Wootton, 1976). It is likely though that sufficient forage and habitat is available throughout the Black River and its tributaries for the threespine stickleback.

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

Ruffe/Tubenose Goby

The ruffe prefers deep waters of lakes and pools of rivers, usually over sand and gravels but has a tolerance for different habitats and environmental conditions (Gray and Best, 1989). The ruffe has a high reproductive rate and spawns in clean water. Females produce up to 200,000 eggs in the first batch, and up to 6,000 eggs per subsequent batch (Global invasive species database, 2012). Ballast water transport has been the key means for the spread of ruffe in the Great Lakes (USFWS, 1996). Natural rates of dispersion are not well known and ruffe have not spread beyond Green Bay in the nine years since its detection in that area, and populations have been trending down (Bowen and Goehle, 2011). The ruffe's ability to swim upstream during high flow events and move over dams is questionable, especially since it prefers still or slow moving water (Fishbase, 2011). 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 and move over dams is questionable but appears to be more capable of living in more varied types of riverine habitat than the ruffe. The dams and waterfalls in the Black River Watershed should be sufficient in impeding movement of both species at normal and low flows. However, as these obstacles become inundated during high flow events, both species may have opportunity to move upstream at those times. However, it is likely that this species will seek refuge from high velocities instead of expending energy attempting to move upstream.

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

European Fingernail Clam

The European fingernail clam has been found in the Great Lakes and in smaller river systems. Its close proximity in the Great Lakes and particularly Lake Erie, indicates that it is an ANS of concern for the Little Killbuck Creek aquatic pathway. The following are the obstacles to upstream movement within the Black River:

- Dam (Elyria – Chestnut Ridge Rd) N41.341, W082.090
- Dam OH01954 (Elyria – E. Bridge St.) N41.369, W082.098
- Waterfalls (Elyria – Washington St) N41.369, W082.107
- Waterfalls (Elyria – Cascade/Elywood Pk) N41.373, W082.109
- Dam (Elyria – Spring Valley Golf Club) N41.397, W082.096

These should be sufficient at impeding upstream movement of the European fingernail clam at normal and low flows. Even though these obstacles become inundated during high flow events, the limited ability of this species to move upstream unaided results in a low probability that this species will be able to make it from its current location to the pathway unaided. It is likely that sufficient habitat is available throughout the Black River and its tributaries for the European fingernail clam. However, these obstacles still make it highly unlikely that the European fingernail clam will be able to make it to the pathway unaided.

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

European Stream Valvata

The European stream valvata has been found in the Great Lakes and as mentioned previously can tolerate a wide range of habitats including lakes, ponds, rivers, small streams, canals, and ditches (Cleland, 1954; Grigorovich, et al., 2005; Kipp and Benson, 2011b). Its close proximity in the Great Lakes and particularly Lake Erie, indicates that it is an ANS of concern for the Little Killbuck Creek aquatic pathway. The same obstacles in the Black River listed for the European fingernail clam also apply for the European stream valvata.

These should be sufficient at impeding upstream movement of the European stream valvata at normal and low flows. Even though these obstacles become inundated during high flow events, the limited ability of this species to move upstream unaided results in a low probability that this species will be able to make it from its current location to the pathway unaided. This is reinforced by the fact that the dispersal of the valvata in the Great Lakes has been restricted and characterized by a slow rate of spread during the first 100 years of its colonization (Grigorovich, et al., 2005). It is likely that sufficient habitat is available throughout the Black River and its tributaries for the European stream valvata. However, these obstacles still make it highly unlikely that the European stream valvata will be able to make it to the pathway unaided.

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

Skipjack Herring

Skipjack herring are a migratory species found in larger rivers, often in areas of swift current. In Ohio this species is only found in the Ohio River and its larger tributaries, particularly the Scioto River and Muskigum River (USGS, 2011c). Skipjack herring are strongly migratory within rivers and prefer fast flowing water where they are renowned for leaping. They are found in clear to moderately turbid waters in large rivers and reservoirs usually within the current over sand or gravel (Page and Burr, 1991). Skipjack herring feed in large schools with adults feeding on other herring species such as the threadfin shad, the gizzard shad and young of the year herring species, while the juveniles feed on dipterans and other aquatic insects. Since skipjack herring tend to prefer large fast flowing rivers, it is unlikely that they would move upstream of their current range in the mainstem Muskingum River into the smaller, more turbid, tributaries leading the Little Killbuck pathway. Despite

the connectivity of the Walhonding River (and Killbuck Creek) to its native range further down the Ohio River Basin, the skipjack herring has never been recorded in that drainage. This is likely due to the affinity of the fish to large river habitat. The Walhonding River likely does not contain suitable habitat to allow for a successfully breeding population. As noted by Trautman (1981), "it is absurd to expect this deep- and swift-water inhabiting species to migrate across Ohio through the sluggish canals when it does not penetrate far inland in the largest unobstructed streams in the Ohio drainage."

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

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

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

General considerations for assigning probability ratings:

> **High** - ANS are established in relatively close proximity to the location and have ample opportunity, capability, and motivation to successfully navigate through a non-aquatic pathway to arrive at the subject pathway within 10 to 20 years.
>
> **Medium** - ANS are established at locations in close enough proximity to the location and have limited capability to survive movement through a non-aquatic pathway to arrive at the subject pathway within 20 to 50 years.
>
> **Low** - 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, Parasitic Copepod, VHSv, Inland Silverside, Northern Snakehead, Threespine Stickleback, Ruffe, Tubenose Goby, and Skipjack Herring:

Since the Little Killbuck site is an active farm consisting of interconnected drainage ditches, it is not likely that fishing or boating would occur at or relatively near this location as the area is in private ownership. Access by the general public is limited to vehicular traffic through and around the site. Many species of snakehead, including the northern snakehead, have been popular aquarium fish. However, in 2002 the import and interstate transport of northern snakehead was banned without a permit from the USFWS (www.anstaskforce.gov). However, if the northern snakehead were released in the immediate vicinity of the divide, on either side, it is likely the fish could survive and establish a viable population in the area. Considering these limitations, it is highly unlikely that these species will arrive at the divide by anthropogenic means, such as livewell, bait bucket, or aquarium releases.

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

European Fingernail Clam:

It is believed that transport by hard ballast has aided in the movement of the European fingernail clam in the past. Hard ballast is not commonly used anymore and the tributaries of the Black River are too small for commercial vessels. Thus the most likely form of transport today would be by recreational boating. However, the European fingernail clam does not tolerate desiccation well and the pathway is approximately 40 miles (64 km) from Lake Erie which greatly lowers the chance of any clams being alive if they were attached to a boat or on vegetation that was attached to a boat or trailer. In addition, fishing and boating are relatively uncommon in the vicinity of Clear Creek, thus it is highly unlikely that the species will arrive at the divide by anthropogenic means. It also has been shown that

the common toad (Bufo bufo) can aid in transporting the European fingernail clam to new waters in Europe (Kwet, 1995; Petkeviciutie, et al., 2004). The liklihood that the European fingernail clam could be transported by amphibians has not been demonstrated in the Great Lakes and would likely be relatively low. Thus, it is also highly unlikely that the clam will be transported to the pathway by other natural means. If the European fingernail clam were dumped into Little Killbuck Creek, it is likely they could then move downstream to suitable habitat.

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

European Stream Valvata:

It is believed that shipping and the use of marsh grasses in packing enabled the European stream valvata to be introduced to the Great Lakes in the past (Mills, et al., 1993). Subsequent range expansion may have occurred via natural dispersal, while more recent records of the 1990s and the first decade of the 21st century may have been aided by human-mediated dispersal in ships and via canals (Grigorovich, et al., 2005). The tributaries of the Black River are too small for commercial boats. Thus the most likely form of transport today would be by recreational boats and trailers. European steam valvata has been shown to be tolerant of desiccation. However, since fishing and boating are relatively uncommon in the vicinity of the Clear Creek, it is highly unlikely that the species will arrive at the divide by anthropogenic or other means. If European steam valvata were dumped into Little Killbuck Creek, it is likely they could move downstream to suitable habitat.

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

4.3 Probability of ANS Establishment in Proximity to the Aquatic Pathway

General Considerations for Assigning Probability Ratings:

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

Medium - Limited and disconnected areas and sources of food and habitat suitable to the ANS are available in proximity, abiotic conditions are within latitude limits of native range, but only a portion of the healthy individuals arriving at the 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 available habitat area suitable for ANS cover, sustainable food supply and reproduction; or native predators or competition with native species would likely prevent establishment of a sustainable population.

Asian Carp

Silver and bighead carp are fast growing species that are capable of surviving in a wide range of water temperatures and reproducing quickly, provided suitable habitat is available. Life history habitat requirements generally include diverse needs for current areas, backwater habitats, deep overwintering holes, and other habitat types needed for survival (Nico and Jelks, 2005). Successful spawning and recruitment is unlikely and would prevent establishment of actual populations at the divide, as all species of Asian carp require lowland rivers to complete their life cycles (Nico and Jelks, 2011). Bighead and silver carp need 35-40 miles (56-64 km) of open river to successfully spawn (Jennings, 1988; Verigin, 1978; Nico and Jelks, 2011). Furthermore, it is believed that silver and bighead carp require sufficient flow to keep fertilized eggs suspended for successful reproduction (Gorbach and Krykhtin, 1980). Neither of these habitat requisites for population establishment appear to be adequately met in the vicinity of the Little Killbuck Creek location. Although it is unlikely that adults would survive long periods of time within the

agricultural drainage network due to poor water quality and water volume, there is uncertainty about the ability of juvenile Asian carp to reach the pathway and survive since they have been observed in the uppermost reaches of small tributaries to large rivers attempting to pass over barriers, such as dams, to continue their upstream movement, and adult Asian carp have been found in very small streams with very low water (D. Chapman-USGS, personal communication, September 12, 2011;N. Caswell- USFWS, personal communication September 12, 2011). As a result, a rating of medium was assigned.

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

Parasitic Copepod

The parasitic copepod is very capable of persisting in eutrophic and polluted waters. The copepod demonstrates a rapid reproductive cycle and is capable of utilizing many different host species. It is highly likely that the copepod would be successful in establishing in and adjacent to the pathway at Little Killbuck Creek.

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

Viral Hemorrhagic Septicemia Virus

Survival and reproduction of common carp as a potential carrier of VHSv is considered high at this location during the spring. During spring runoff, the wetland divide and connecting ditches/streams would provide the necessary habitat for occupation of any VHSv carrier/host fish species, at least temporarily. The virus is capable of persisting outside of a host for several days when water temperatures are 37ºF - 54ºF (2.8ºC - 12.2ºC). It also demonstrates a rapid reproductive cycle and is capable of utilizing up to 28 known fish species in the Great Lakes Basin, including common carp (WDNR, 2012). However, the higher water temperatures that likely occur in the summer months at the Little Killbuck pathway site might prevent the establishment of VHSv during that time. It is highly likely that VHSv would be successful in establishing within fish populations already in and around the Little Killbuck pathway.

Team Rating: **High**
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 and drainage ditches at the divide (Elston and Bachen, 1976). 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). Food habits of the inland silverside include: planktivore; particulate feeder; size-selective picker, and the main food item is zooplankton (Saunders, 1959; Goldstein and Simon, 1999). Stomachs of adults in west Tennessee contained food items including midge larvae, mayfly larvae (Hexagenia), and fallen terrestrial insects, including Homoptera, Hymenoptera (Etnier and Starnes, 1993). Morris (1982) reported that inland silversides collected from Lake Conroe, Texas, fed mostly on zooplankton at all sizes, and major food organisms in the diet were from the following groups: Sididae, Chydoridae, Ceriodaphnia, Bosmina, Cyclopoida, nauplii, and Ostracoda. Species fed predominately upon cladocerans (60 percent of total number of food organisms, with largest category, Sididae, representing 32 percent). Bettoli et al. (1991) reported consumption of fish eggs, in Lake Conroe, Texas. Considering the dietary range of this species, it is reasonable to conclude that a population could be established in close proximity to the pathway.

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 34.7°F (1.5°C). Stoeckel and Heidinger (1988) demonstrated that inland silversides can be maintained over winter in aquaculture systems at temperatures above 59°F (15°C), when they were fed a prepared diet. They also demonstrated that inland silversides have a high mortality during extended periods of cold during the winter in unheated ponds and reservoirs. Overwintering mortality in the 80-90 percent range has been reported for the inland silverside in Rhode Island waters (Bengtson, 1982). The turbid water in the

agricultural ditches and connecting streams may severely limit the ability of this species to forage, but Little Killbuck Creek does lie within the latitudinal boundaries of the inland silversides' native range thereby potentially limiting any effect freezing temperatures might have to prevent them from overwintering.

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

Northern Snakehead

The northern snakehead's native range (latitude 24-53°N) and temperature tolerance 32–86º F (0-30°C) indicates a species that, if introduced, could establish populations throughout most of the contiguous United States (Courtenay, Jr. and Williams, 2004). Northern snakeheads are naturally aggressive predators that could easily acclimate to the conditions in and around the Little Killbuck site as long as there is an ample food supply, which appears to be the case. The snakehead's preference for shallow aquatic and wetland habitats, coupled with its ability to breathe air, make it more possible for this species to colonize the wetlands and ditches at the divide location. It still may succumb to winter freeze-out, but it does have the ability to survive under the ice. 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 (USGS, 2011c). This is similar to the aquatic habitat adjacent to Little Killbuck. Additionally, northern snakeheads aggressively defend their nest and young fry, reducing predation on young snakehead by other fish.

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

Threespine Sticlkeback

As a visual predator, the turbid waters of the network of agricultural ditches may be unsuitable for the threespine stickleback (Walker, 1997). Survival of a viable, reproducing population of the threespined stickleback within the agricultural ditch network may be unlikely due low water quality and high temperatures in summer months. However, Clear Creek may provide sufficient habitat for occupation of this species until a suitable storm event occurred and the fish could then pass into the ditch network and then be pumped directly into Little Killbuck Creek on the Mississippi River Basin side of the divide.

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

Ruffe/Tubenose Goby

The ruffe is an aggressive species that possesses the ability to feed in darkness, cold temperatures and turbid conditions. The tubenose goby is a benthic species that consume a wide variety of invertebrates (USGS, 2011c). They are often quite abundant in backwaters and lakes and seem to prefer dense vegetation. Clear Creek is unlikely to provide sufficient habitat for either species. Furthermore, survival of a viable, reproducing population of ruffe and tubenose goby within the agricultural ditch network may be unlikely due low water quality and high temperatures in summer months. However, the presence of active agricultural pumping and irrigation in these ditches between Clear Creek and Little Killbuck Creek makes a low rating for this element more uncertain, and so a medium rating was assigned.

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

European Fingernail Clam

The European fingernail clam often prefers somewhat eutrophied, more lentic habitat and has been sampled from water with temperatures ranging from 35 – 77° F (~2 – 25° C) (Berezina, et al., 2007; Kipp and Benson, 2011a). The European fingernail clam also has a high capacity for anaerobiosis and is able to survive anoxic conditions for around 400 days at 32° F (0°C) and for nine days at 68°F (20°C) (Heinonen, et al., 1997; Kipp and Benson, 2011a). The clam prefers hard waters with high magnesium, calcium, and bicarbonate concentrations and is found on fine sand, mud, silt, organic matter, and sometimes on gravel (Kipp and Benson, 2011a). The European fingernail clam is mainly a filter feeder feeding on diatoms and other types of phytoplankton, but can also feed on detritus from the substratum (Dussart, 1979; Kipp and Benson, 2011a). Survival of a viable, reproducing population of the European fingernail clam within the agricultural ditch network at the aquatic pathway may be unlikely due to

high organic concentrations from the adjacent farming operations, high temperatures, and low water levels in summer months. High levels of organics from hydric muck soils coupled with high seasonal water temperatures and potential for extended periods of drying would be detrimental to establishment of a viable population within the agricultural ditch network and wetlands adjacent to Clear Creek. However, Clear Creek may provide sufficient habitat for occupation of this species in close proximity.

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

European Stream Valvata

The European stream valvata is tolerant of a wide range of conditions in both lotic and lentic habitats and has been shown to be relatively insensitive to organic pollution (Mouthon, 1996). The European stream valvata has been found at sampling sites with temperatures ranging from 52-91°F (11-33°C) and in waters with mean temperature ranging from 42-62°F (5.5-16.5°C) (Gerard, 2001; Sereflisan et al., 2009). Densities of this species have been documented as increasing during a heat wave when water temperatures reached 85° F (29.5°C) and exceeded 77° F (25°C) for 75 days (Mouthon and Daufresne, 2006). The stream valvata is a generalist, grazing on epiphytic algae and detritus, and in more eutrophic environments is capable of filter feeding on suspended organic matter and algae (Grigorovich, et al., 2005). The European stream valvata can also rasp off pieces of aquatic vegetation (Fretter and Graham, 1978). Survival of a viable, reproducing population of the European stream valvata within the agricultural ditch network is possible given its tolerance to a wide range of habitat conditions and higher temperatures. In addition, Clear Creek may provide sufficient habitat for occupation of this species in close proximity.

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

Skipjack Herring

Survival of a viable, reproducing population of skipjack herring within the agricultural ditch network may be unlikely due this species being a visual predator, the turbid conditions of the agricultural ditches, low water quality, and high temperatures in summer months (USGS, 2011c; Smiley, et. al 2008).

Team Rating: **Low**
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

If Asian carp reach the basin divide and surface water connections permit, it is highly likely that they would be able to spread through the aquatic pathway into the Great Lakes Basin. Asian carp have demonstrated exceptional capabilities of spreading through large river systems, and will likely continue to do so.

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

Parasitic Copepod:

During the periodic surface water connections between the basins at Little Killbuck Creek, it is likely that a common carp hosting the parasitic copepod could

spread beyond the pathway to the Mississippi River Basin. The female copepod can detach and re-attach to another host fish. The time it takes and how often this happens is not certain. However, if common carp were at the pathway location, it is possible that a female copepod could detach, flow with the waters across/through the pathway, and re-attach to a new host fish across the divide. In addition, during a one percent annual recurrence interval flood event, the flooded drainage ditches would be pumped out and a free floating copepod could easily be moved via this pumped water.

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

Viral Hemorrhagic Septicemia Virus:

Given the characteristics at the divide it appears possible that a fish (e.g., common carp, trout) carrying VHSv would be able to move across the divide. Furthermore, given its wide range of potential hosts, that trout are naturally found in both sides of the divide, and VHSv can live for several days outside of its host depending on temperature, this rating is identified as high. During a one percent annual recurrence interval flood event, it is possible that an infected host could be carried into the agricultural drainage network where it could then be pumped out. It is reasonable to expect that a small infected fish or the virus itself could be pumped through the pathway to the Mississippi River Basin.

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

Inland Silverside:

The habitat at the pathway itself consists of a series of inter-connected, sparsely vegetated agricultural drainage ditches which link the Mississippi River Basin with the Great Lakes Basin. Establishing a sustainable population within or near the drainage ditches is not likely. However, it is possible that the inland silverside could survive in this system long enough to transfer across the basin divide under the proper conditions. A conversation with the farmer/landowner at the pathway in May, 2011 identified that he has seen common carp within the agricultural drainage ditches. During storm events water is pumped from these agricultural ditches into both basins. A storm event as minimal as a two to five percent annual recurrence interval storm results in significant portions of this site being inundated and FEMA maps display the entire site as inundated from a one percent annual recurrence interval storm event. Considering these factors, it would be possible for the inland silverside to transfer across the basin divide via the agricultural drainage ditches if the frequency between significant storm events was within a timeframe that would allow their survival within this system. In addition, roadside ditches along Franchester Road span the divide and connect both basins via Repp Run and Clear Creek. The results of the storm event witnessed during the site visit describe this area as being inundated with water flowing across the divide.

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

Northern Snakehead:

The habitat at the pathway itself consists of a series of inter-connected, sparsely vegetated agricultural drainage ditches which link the Mississippi River Basin with the Great Lakes Basin. It is likely that the northern snakehead could survive in this system and transfer across the basin divide under the proper flooding conditions. A conversation with the farmer/landowner in May, 2011 identified that he has seen common carp within the agricultural drainage ditches. During storm events, water is pumped from these agricultural ditches into both basins. A storm event as minimal as a two to five percent annual recurrence interval storm results in significant portions of this site being inundated and FEMA maps display the entire site as inundated from a one percent annual recurrence interval storm event. Considering these factors, it would be possible for the northern snakehead to transfer across the basin divide via the agricultural drainage ditches if the frequency between significant storm events was within a timeframe that would allow their survival within this system. In addition, roadside ditches along Franchester Road span the basin divide and connect both basins via Repp Run and Clear Creek. The results of the storm event witnessed during the site visit describe this area as being inundated and water flowing across the divide. As an air breather that has even been known to move

short distances over land, it is likely this species has the potential to move into and out of this environment.

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

Threespine Sticlkeback:

The threespine stickleback has been found in smaller river systems and downstream movement through the Little Killbuck Creek pathway site would be likely. If the threespine stickleback were able to reach the streams, ditchesv and wetlands at the divide, it is highly likely that the fish would survive and pass through the pathway into the Mississippi River Basin during a suitable flood event.

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

Ruffe/Tubenose Goby:

Ruffe and the tubenose goby have not been found in river systems similar to Clear Creek and Little Killbuck Creek, or the agricultural ditches at the basin divide. However, if the fish were introduced into the wetlands and ditch network at the basin divide, they would likely be successful in passing through the Little Killbuck Creek aquatic pathway into the Mississippi River Basin.

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

European Fingernail Clam and European Stream Valvata:

The European fingernail clam and stream valvata have been found in smaller rivers and canals, including ditches, and movement through the Little Killbuck Creek pathway would be likely, possibly aided by periodic agricultural pumping operations for drainage and irrigation.

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

Skipjack Herring:

It is possible that the skipjack herring could survive in the Little Killbuck aquatic pathway long enough to transfer across the basin divide under the proper flooding conditions. During certain storm events, water is pumped from these agricultural ditches into both basins. A storm event as minimal as atwo to five percent annual recurrence interval results in significant portions of this site being inundated and FEMA mapping displays the entire site as inundated from a one percent annual recurrence interval storm event. Considering these factors, it would be possible for the skipjack herring to transfer across the basin divide via the agricultural drainage ditches if the frequency between significant storm events was within a timeframe that would allow for their survival within this system. In addition, roadside ditches along Franchester Road span the divide and connect both basins via Repp Run and Clear Creek. The flooding event witnessed during the site visit in May, 2011 indicates that this area would be inundated with water across the basin divide from between a two and five percent annual recurrence interval event.

Team Rating: **Medium**
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 Little Killbuck Creek 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 15 and Table 16). 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 15. At the Little Killbuck Creek location, three of the four ANS were rated “medium” and one was rated “low”. Therefore, the overall pathway viability for transferring species from the Mississippi River Basin to the Great Lakes Basin is “medium”. The overall pathway viability for transferring species from the Great Lakes Basin is calculated the same way and is shown in Table 16. At the Little Killbuck Creek location, the overall pathway viability

for transferring species from the Great Lakes Basin to the Mississippi River Basin is “medium”. The last calculation is to determine the overall pathway viability for interbasin spread of ANS which is calculated by taking the highest of the overall ANS ratings for unidirectional transfer which were calculated in Table 15 and 16. Thus, the overall probability that a viable aquatic pathway exists at the Little Killbuck Creek Pathway is “medium”.

Table 15: Summary of individual probability elements and overall pathway viability rating (Mississippi River Basin to Great Lakes Basin). Certainty ratings for each element are in parentheses.

			Form 1	Form 2	Form 3a	Form 4	Form 5	
Group	Common Name	Mode of Dispersal	Pathway Exists? (Sect. 3.6)	ANS Occurring Within Either Basin? (Sect. 4.1)	ANS Surviving Transit to Pathway? (Sect. 4.2.1)	ANS Establishing in Proximity to Pathway? (Sect. 4.3)	ANS Spreading Across Aquatic Pathway into New Basin? (Sect. 4.4)	Aquatic Pathway Viability Rating
fish	*Asian carp, silver carp, bighead carp, black carp*	swimmer	M (VC)	H (RC)	M (RC)	M (RC)	H (VC)	M
fish	*inland silverside*	swimmer		M (RC)	M (MC)	M (RC)	H (RC)	M
fish	*northern snakehead*	swimmer		M (RC)	M (RC)	H (RC)	H (RC)	M
fish	*skipjack herring*	swimmer		H (VC)	L (MC)	L (MC)	M (RC)	L
Overall Pathway Viability for Spread of ANS from Mississippi River Basin to Great Lakes Basin:								**M**

Table 16: Summary of individual probability elements and overall pathway viability rating (Great Lakes Basin to Mississippi River Basin). Certainty ratings for each element are in parentheses.

			Form 1	Form 2	Form 3a	Form 4	Form 5	
Group	Common Name	Mode of Dispersal	Pathway Exists? (Sect. 3.6)	ANS Occurring Within Either Basin? (Sect. 4.1)	ANS Surviving Transit to Pathway? (Sect. 4.2.1)	ANS Establishing in Proximity to Pathway? (Sect. 4.3)	ANS Spreading Across Aquatic Pathway into New Basin? (Sect. 4.4)	Aquatic Pathway Viability Rating
fish	*threespine stickleback*	swimmer	M (VC)	H (VC)	M (RC)	M (MC)	H (RC)	M
fish	*ruffe and tubenose goby*	swimmer		H (MC)	M (RC)	M (MC)	H (RC)	M
crustacean	*parasitic copepod*	parasite		H (MC)	M (RC)	H (RC)	H (RC)	M
virus	*VHSv*	fish pathogen / water colmumn		H (RC)	M (RC)	H (MC)	H (RC)	M
mollusk	*European fingernail clam*	floater		M (MC)	L (RC)	M (MC)	H (RC)	L
mollusk	*European stream valvata*	floater		H (RC)	L (MC)	H (MC)	H (RC)	L
Overall Pathway Viability for Spread of ANS from Great Lakes Basin to Mississippi River Basin:								**M**

6 Conclusions

The hydrologic assessment determined that an aquatic pathway exists across the basin divide at the Little Killbuck Creek site during storm events between a two and five percent annual recurrence interval storm. There is a possibility that multiple ANS could utilize this aquatic pathway to transfer in either direction between the Mississippi River and Great Lakes Basins. A rating of medium in this case means that while multiple ANS could transfer between the basins at this location, they are not likely to reach the pathway from their current known locations in the Mississippi River Basin within the next 20 years. Water quality and the physical nature of the streams and ditches at and leading to the pathway will likely allow for the support of multiple ANS under the proper flooding conditions, which only exist on an intermittent basis. Although introduction of ANS to the pathway location is possible by anthropogenic means, it was determined to be highly unlikely due to existing land use and private ownership, and was not a consideration in the overall rating of the Little Killbuck Creek pathway location.

7 Problems and Opportunities

This section uses the results of the pathway assessment to develop a list of statements that define and frame the nature and extent of the problems associated with the potential interbasin transfer of ANS at this site. Following these problem statements is a list of corresponding opportunity statements that were developed in the course of the pathway assessment to help initiate and guide any further study of this location.

7.1 Little Killbuck Creek Problem Statements

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

- The interagency team evaluating the hydrology of the Little Killbuck Creek site rated it as a location where there is a medium probability of an aquatic pathway existing between the basins, and determined that such a connection results from between a two and five percent annual recurrence interval storm.

- Based on the species assessments in Section 4.2.1 of this report, it has been estimated that it is unlikely that any ANS of concern could arrive at the Little Killbuck Creek pathway on their own within the next 20 years. This may provide an important period of time to allow stakeholders and resource agencies to develop potential ANS transfer prevention measures for this location.

- An existing agricultural ditch system at an active farm spans the divide and connects both basins during certain storm events. Pumps within this system are utilized to pump water from the fields into either basin for drainage while check valves create the ability to bring water from either basin into the ditch system for irrigation.

- Roadside ditches along Franchester Road, which span the divide, allow wetland systems to become hydrologically connected during certain storm events and creates potential for inter-basin transfer.

- Any measures at the pathway location to prevent potential transfer of ANS will likely impact the existing use of the surrounding land, but the full effects of such potential actions are unclear and will require further investigation.

- There was significant uncertainty associated with the biological ratings, including:

    - The current location and distribution of the large array of ANS that have been introduced to the waters of the U.S.

    - The life history requirements of each of these ANS.

- The suitability of the habitat between the current nearest locations of the ANS and the pathway.

- Lack of site specific hydraulic and hydrologic modeling to better understand the frequency, duration, and magnitude (width, depth, and flow velocity) of the aquatic pathway.

- Scarcity of stream gages and real data on water levels at, and in proximity to, the aquatic pathway.

- Detailed survey information on the exact elevations at this location was not available.

7.2 Little Killbuck Creek Opportunity Statements

While it is not the purpose of this assessment to produce and evaluate an exhaustive list of potential actions to prevent ANS transfer at this location, some opportunities were still identified that, if implemented, could prevent or reduce the probability of ANS spread between the basins at the Little Killbuck Creek aquatic pathway. 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:

- Land use alteration:

    - The conversion of the agricultural lands to wetlands could allow a land use that does not require basin to basin pumping.

    - There are multiple Federal programs that assist landowners develop wetlands, such as the NRCS Wetlands Reserve Program (WRP), a voluntary program offering landowners the opportunity to protect, restore, and enhance wetlands on their property.

    - Such land use alteration would likely also require some structural measure(s) at some location(s) at the pathway site.

- Evaluate structural alternatives for preventing transfer of ANS at Little Killbuck:

    - Berm supplementation (e.g., improvement and raising) along Little Killbuck Creek and/or Repp Run to prevent interbasin surface water flows up to a certain flood event.

    - New berm construction along Little Killbuck Creek, Repp Run, and/or along Franchester Road to prevent interbasin surface water flows up to a certain flood event.

    - Drainage ditch reconfiguration and/or modification of irrigation practices to minimize or eliminate interbasin flows.

    - Weir structure or some sort of in stream blockage that allows for normal flows and site drainage, but prevents upstream movement of ANS. A potentially suitable location for this option would be within the ditch network that forms the headwaters of Clear Creek on the northern part of the existing farm.

- Evaluate non-structural alternatives for deterring transfer of ANS at Little Killbuck:

    - Discontinue drainage ditch pumping.

    - Chemical control measures and deterrents within the drainage system and or within the pathway ditch network.

    - Biological monitoring and physical removal of fish in the drainage system.

- New or modified regulations or ordinances prohibiting the establishment of drainage ways that connect the Mississippi River tributaries with Great Lakes tributaries.

- Collection of addition data to better understand the frequency, duration, and magnitude (width,

depth, and flow velocity) of the aquatic pathway at different flood events. Also, collection of site-specific survey data to verify or better understand relative ground elevations at the aquatic pathway.

- Stream restoration efforts, such as for fish passage of native species, should take into consideration any potential effect they might have on the factors that contributed to this rating. For example, a proposal to remove or modify an existing dam that is relied upon in this assessment for blockage of ANS might alter the rating for one or more species of ANS.

- Explore measures to reduce the potential source populations of ANS:
    - Increase commercial and recreational harvest, specifically bighead and silver carp
    - Implement measures to interfere with successful reproduction of ANS
    - Introduce biological controls such as species-specific diseases specific to particular ANS

- Public education to:
    - Prevent anthropogenic (e.g., bait bucket) transfer
    - Prevent transfer due to cultural reasons
    - Identify and report the observation and collection of ANS to the ODNR and the USGS-NAS
    - Support research on the biology of ANS so that risk of ANS transfer can be better understood.
    - Habitat requirements and tolerances
    - History of invasiveness

- Improve and increase field sampling and monitoring in connecting streams 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 utilizing eDNA and conventional biological sampling techniques
    - Target, encourage, and train recreational fishermen, boaters, and other direct users of the surface waters of the state of Ohio to identify, report, collect, and deliver ANS to the ODNR and report to the state and USGS-NAS

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

None of the opportunities identified above are exclusive of the others. In fact, any single structural measure to prevent ANS transfer through the Little Killbuck Creek pathway would likely benefit from corresponding development and implementation of one or more of the other types of opportunities identified. The results of this assessment may also aid in the implementation of, and future updates to, the Ohio Aquatic Nuisance Species Management Plan.

8 References:

ANSTF. (1996). *Generic Nonindigineous Aquatic Organisms Risk Analysis Review Process for Estimating Risk Associated with the Introduction of Nonindigineous Aquatic Organisms and How to Manage for that Risk. Report to the Aquatic Nuisance Species Task Force*. Risk Assessment and Management Committee, Aquatic Nuissance Species Task Force (October 21, 1996).

Bengtson, D.A. (1982). Resource partitioning by *Menidia menidia* (L.) and *Menidia beryllina* (Cope) in two Rhode Island estuaries. Ph. D. dissertation. University of Rhode Island, Kingston, RI.

Berezina, N.A., I.G. Tsiplenkina, E.S. Pankova and J.I. Gubelit. (2007). Dynamics of Invertebrate Communities on the Stony Littoral of the Neva Estuary (Baltic Sea) Under Macroalgal Blooms and Bioinvasions. Transitional Waters Bulletin 1: 65-76.

Bettoli, P.W., J.E. Morris, and R.L. Noble. (1991). Changes in the abundance of two atherinid species after aquatic vegetation removal. Trans. Amer. Fish. Soc. 120:90-97.

Bowen, A.K. and M.A. Goehle, (2011). Surveillance for ruffe in the Great Lakes, 2011. http://www.fws.gov/midwest/alpena/documents/2011-GL-Ruffe-Report.pdf

Cleland, D.M. (1954). A Study of the Habits of *Valvata Piscinalis* (Muller) and the Structure and Function of the Alimentary Canal and Reproductive System. Journal of Molluscan Studies 30(6):167-203.

Courtenay, Jr., W.R. and J.D. Williams. (2004). Snakeheads (Pisces, Channidae) - A Biological Synopsis and Risk Assessment. USGS Circular 1251.

Cowardin, L. M., V. Carter, F.C. Golet and E.T. LaRoe. (1979). Classification of Wetlands and Deepwater Habitats of the United States. U.S. Department of the Interior, Fish and Wildlife Service. Washington D.C. 131pp.

Dong, S., and D. Li. (1994). Comparative studies of the feeding selectivity of silver carp, *Hypophthalmichthys molitrix*, and bighead carp, *Aristichthys nobilis*. Journal of Fish Biology 44:621-626.

Dussart, G.B.J. (1979). *Sphaerium Corneum* (L.) and *Pisidium* Spp. Pfeiffer – The Ecology of Freshwater Bivalve Molluscs in Relation to Water Chemistry. Journal of Molluscan Studies 45:19-34.

Elston, R. and B. Bachen (1976). Diel feeding cycle and some effects of light on feeding intensity of the Mississippi silverside (*Menidia audens*) in Clear Lake, California. Transactions of the American Fisheries Society 105:84-88.

Etnier, D.A. and W.C. Starnes. (1993). *The Fishes of Tennessee*. The University of Tennessee, Knoxville. 681 pp.

FEMA. (2011). *Flood Insurance Rate Maps* [Data files]. Federal Emergency Management Agency. Maps 903820243D, 3903780243D, 39103C0243D and 39103C0244D. Retrieved from http://www.fema.gov/hazard/map/firm.shtm

Fishbase. (2011). Froese, R. and D. Pauly. Editors. World Wide Web electronic publication: www.fishbase.org.

Frank, C. (1987). A contribution to the knowledge of Hungarian Mollusca part III. Berichte des Naturwissenschaftlich-Medizinischen Vereins in Innsbruck 74:113-124.

Fretter, V. and A. Graham. (1978). The prosobranch mollusks of Britain and Denmark; Part 3: *Neritacea, Viviparacea*, *Valvatacea*, terrestrial and fresh water *Littorinacea* and *Rissoacea*. Journal of Molluscan Studies Supplement 5:101-150.

Fuller, P. and L. Nico. (2012). *Menidia beryllina*. USGS Nonindigenous Aquatic Species Database, Gainesville, FL: http://nas.er.usgs.gov/queries/factsheet.aspx?SpeciesID=321

Gerard, C. (2001). Consequences of a Drought on Freshwater Gastropod and Trematode Communities. Hydrobiologia 459: 9-18.

Global Invasive Species Database. Accessed May 24, 2012: http://www.issg.org/database/species/ecology.asp?si=544&fr=1&sts=sss&lang=EN.

Goldstein, R.M. and T.P.Simon. (1999). Toward a united definition of guild structure for feeding ecology of North American freshwater fishes. pp. 123-202 in T.P. Simon, editor. Assessing the Sustainability and Biological Integrity of Water Resources using Fish Communities. CRC Press, Boca Raton, Florida.

Gorbach, E.I. and M.L. Krykhtin. (1980). Maturation rate of the white amur (*Ctenopharyngodon idella*) and silver carp (*Hypophthalmichthys molitrix*) in the Amur River. Journal of Ichthyology, 21(4): 835–843.

Graham, J. B. (1997). Air-breathing fishes: evolution, diversity, and adaptation. Academic Press. San Diego, California. xi +. 299 pp.

Gray, J.A.B. and A.C.G. Best. (1989). Patterns of excitation of the lateral line of the ruffe. Journal of the Marine Biological Association of the United Kingdom 69:289-306.

Great Lakes Commission. (2011). Website accessed February 21, 2012: http://www.great-lakes.net/envt/flora-fauna/invasive/pdf/vhs_glc_factsheet_2011.pdf

Grigorovich, I.A., A.V. Korniushin, D.K. Gray, I.C. Duggan, R.I. Colautti , and H.J. MacIsaac. (2003). Lake Superior: an invasion coldspot? Hydrobiologia 499:191-210.

Grigorovich, I.A., Mills, E.L., Richards, C.B., Breneman, D. and Ciborowski, J.J.H. (2005). European Valve Snail Valvata piscinalis (Muller) in the Laurentian Great Lakes Basin. Journal of Great Lakes Research 31:135-143.

Gross, W.H. (2000). Ohio's Freshwater Mussels - A Treasure Squandered.<http://www.ohiodnr.com/wildlife/publications/wildohio/summer00/summer00.pdf> [May 2003]

Heinonen, J., J. Kukkonen, O.P. Penttinen, and I.J. Holopainen. (1997). Effects of Hypoxia on Valve-Closure Time and Bioaccumulation of 2,4,5-Trichlorophenol by the Freshwater Clam Sphaerium corneum [L.]. Ecotoxicology and Environmental Safety 36: 49-56.

Herrington, H.B. (1962). A revision of the Sphaeriidae of North America (Mollusca: Pelecypoda). Museum of Zoology, University of Michigan, Miscellaneous Publications 118. 74 pp 7 plates.

Hildebrand, S.F. (1922). Notes on habits and development of eggs and larvae ofthe silversides *Menidia menidia* and *Menidia beryllina*. Bulletin of the U.S. Bureau of Fisheries, vol.38, pp.113-120.

Hubbs, C., H.B. Sharp, and J.F. Schneider. (1971). Developmental rates of *Menidia audens* with notes on salt tolerance. Transactions of the American Fisheries Society, 100:603-610.

Hudson, P.L. and C.A. Bowen II. (2002). First record of *Neoergasilus japonicus* (Poecilostomatoida: Ergasilidae), a parasitic copepod new to the Laurentian Great Lakes. Journal of Parasitology 88(4):657-663.

ILGARD. (2005). Institute for Local Government Administration and Rural Development (ILGARD) Ohio University. Lower Muskingum River Watershed Management Plan: Meigs Creek Subwatershed. pp. 286.

Isbell, G. (1988). Ohio sport fisheries catch statistics. Ohio Department of Natural Resources, Division of Wildlife, Columbus, Ohio.

Ishimatsu, A. and Y. Itazaw. 1981. Ventilation of the air-breathing organ in the snakehead *Channa argus*. Japanese Journal of Ichthyology 28(3): 276–282.

Jennings, D.P. (1988). Bighead carp (Hypophthalmichthys nobilis): a biological synopsis. U.S. Fish and Wildlife Service, Washington, DC. U.S. Fish and Wildlife Service Biological Report 88(29):1-47.

Kipp R.M. and A. Benson. (2011a). *Sphaerium corneum*. USGS Nonindigenous Aquatic Species Database, Gainesville, FL. Retrieved from: http://nas.er.usgs.gov/queries/FactSheet.aspx?speciesID=131 RevisionDate: 3/23/2007.

Kipp, R.M. and A. Benson. (2011b). *Valvata piscinalis*. USGS Nonindigenous Aquatic Species Database, Gainesville, FL.http://nas.er.usgs.gov/queries/FactSheet.aspx?SpeciesID=1043 RevisionDate: 2/25/2007

Kolar, C.S., D.C. Chapman, W.R. Courteney, C.M. Jr., Housel, J.D. Williams, and D.P. Jennings. (2005). Asian carp of the Genus *Hypophthalmichthys* (Pisces, Cyprinidae) - A biological synopsis and environmental risk assessment. Report to the U.S. Fish and Wildlife Service, 183pp.

Kwet, A. (1995). The common toad (*Bufo bufo*) as a vector host of the bivalve Sphaerium corneum. Salamandra 31(1):61-64.

Laird, C.S. and L.M. Page. (1996). Non-native fishes inhabiting the streams and lakes of Illinois. Illinois Natural History Survey Bulletin, vol.35(1), pp.1-51.

Mackie, G.L., D.S. White, and T.W. Zdeba. (1980). A guide to freshwater mollusks of the Laurentian Great Lakes with special emphasis on the genus *Pisidium*. Environmental Research Laboratory, Office of Research and Development, U. S. Environmental Protection Agency, Duluth, Minnesota 55804. 144 pp.

Mackie, G.L. (2000). Ballast water introductions of Mollusca. Pp. 219-254 in R. Claudi and J.H. Leach, eds. Nonindigenous Freshwater Organisms: Vectors, Biology and Impacts. CRC Press LLC, Boca Raton, Florida. 464 pp.

MRCC. (2011). Climate Summaries [Data file]. Midwest Regional Climate Center. Retrieved from http://mcc.sws.uiuc.edu/climate_midwest/mwclimate_data_summaries.html#

Mills, E. L., J.H. Leach, J.T. Carlton, and C.L. Secor. (1993). Exotic Species in the Great Lakes: A History of Biotic Crises and Anthropogenic Introductions. Journal of Great Lakes Research 19(1):1-54.

Morris, J.E. (1982). Distribution and food habits of the inland silverside, *Menidia beryllina*, and the northern brook silverside, (*Labidesthes sicculus*), in Lake Conroe, Texas. Texas A & M University, 1982.

Mouthon, J. (1996). Molluscs and biodegradable pollution in rivers: proposal for a scale of sensitivity of species. Hydrobiologia 317:221-229.

Mouthon, J. and M. Daufresne. (2006). Effects of the 2003 Heatwave and Climatic Warming on Mollusc Communities of the Saone: A Large Lowland River and of its Two Main Tributaries (France). Global Change Biology 12: 441-449.

National Weather Service. (2011). National Oceanic and Atmospheric Administration Website: http://www.nws.noaa.gov/climate/index.php?wfo=cle. Location Akron/Canton, Ohio for May 2011.

NatureServe. (2012). NatureServe: A Network Connecting Science with Conservation. Website accessed June 19, 2012: http://www.natureserve.org/

Nico, L.G., J.D. Williams, and H.L. Jelks. (2005). Black Carp: biological synopsis and risk assessment of an introduced fish. American Fisheries Society, Special Publication 32, Bethesda, Maryland.

Nico, L.G. and Jelks, H.L. (2011). The Black Carp in North America: An Update. American Fisheries Society Symposium 74: 89-104. Bethesda, Maryland.

NID. (2010). National Inventory of Dams [Data files]. U.S. Army Corps of Engineers. Retrieved from http://geo.usace.army.mil/pgis/f?p=397:758033484717107

NOAA. (2011a). National Oceanic and Atmospheric Administration - National Weather Service. Hydrometeorological Design Studies Center [Data files]. Retrieved from http://www.nws.noaa.gov/oh/hdsc/

ODNR. (2011). Ohio Department of Natural Resources - Division of Soil and Water Resources. *Ohio Observation Well Network* [Data file]. Retrieved from: http://www.dnr.stste.oh.us/water/waterobs/

OEPA. (1999). Total maximum daily loads for the Black River watershed. Ohio Environmental Protection Agency.

OEPA. (2007). 2006 Biological and Water Quality Study of the Muskingum River. Ohio Environmental Protection Agency. (March 30, 2007).

OEPA. (2008). Biological and water quality study of the Black River Basin. Ohio Environmental Protection Agency. (May 30, 2008).

OEPA. (2011). Biological and water quality study of the Killbuck Creek Watershed. Ohio Environmental Protection Agency. (June 20, 2011).

OIT. (2011). Ohio Office of Information Technology. Ohio Geographically Referenced Information Program [Data file]. Retrieved from http://ogrip.oit.ohio.gov/

Page, L. M. and B. M. Burr (1991). A Field Guide to Freshwater Fishes of North America North of Mexico. The Peterson Field Guide Series, Houghton-Mifflin Co., Boston, MA.

Petkeviciutie, R., V. Stunzenas, and G. Stanevicte. (2004). Cytogenetic and sequence comparison of adult Phyllodistomum (Digenea: Gargoderidae) from the three-spined stickleback with larvae from two bivalves. Parasitology 129(6):771-778.

Richards, K. R. (1977). Evaluation of the Mississippi silversides as a forage fish in Colorado.Master's thesis. Colorado State University, Fort Collins.

Saunders, R.P. (1959). A study of the food of the Mississippi silverside, *Menidia audens* Hay, in Lake Texoma. M.S. Thesis, Univ. Oklahoma, Norman.

Sereflisan, H., M.Z. Yildirim, and M. Sereflisan. (2009). The Gastropod Fauna and Their Abundance, and Some Physicochemical Parameters of Lake Golbasi (Hatay, Turkey). Turkish Journal of Zoology 33(3): 287-296.

Skall, H.F., N. J. Olesen, and S. Mellergaard. (2005). Viral haemorrhagic septicaemia virus in marine fish and its implications for fish farming – a review. Journal of Fish Diseases. 28: 509–529.

Smiley, P.C., R.B. Gillespie, K.W. King, and C. Huang. (2008). Contribution of habitat and water quality to the integrity of fish communities in agricultural drainage ditches. Journal of Soil and Water Conservation 63(6):218A-219A

Smith, H., J.A. Van den Velden, and A. Klinik. (1994). Macrozoobenthic assemblages in littoral sediments in the enclosed Rhine-Meuse delta. Netherlands Journal of Aquatic Ecology 28(2):199-212.

Stansbery, D.H. and C.C. King. (1983). Management of Muskingum River Mussel Populations. Final Report to the Ohio Division of Wildlife. (Columbus, Ohio). 60 pp.

Stoeckel, J. N. and R. C. Heidinger. (1988). Overwintering of the Inland Silverside in Southern Illinois. North American Journal of Fisheries Management, 8(1), 127-131

Trautman, M.B. (1981). The fishes of Ohio. Ohio State University Press, 1981.

USACE. (1936). Modified Frequency Profiles, Muskingum River. State of Ohio Muskingum Watershed Conservancy District.

USACE. (2010). Great Lakes and Mississippi River Interbasin Study Other Pathways Preliminary Risk Characterization. U.S. Army Corps of Engineers, Great Lakes and Ohio River Division.

USACE. (2011a). Great Lakes and Mississippi River Inter-basin Study Focus Area 2 Risk Characterization Plan. U.S. Army Corps of Engineers (USACE),

USACE. (2011b). Non-Native Species of Concern and Dispersal Risk for the Great Lakes and Mississippi River Interbasin Study. U.S. Army Corps of Engineers.

USDA. (2012). U.S. Department of Agriculture, Natural Resources Conservation Service. Web Soil Survey, Medina County, Ohio. Website accessed July 24, 2012: http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm

USEPA. (2001). Black River Area of Concern. U.S. Environmental Protection Agency. Website compiled by John Hummer on July 9, 2001: http://www.glc.org/demo/aoc/blackriver.html

USFWS. (1996). Ruffe control plan. Submitted to the Aquatic Nuisance Species Task Force by the Ruffe Control Committee. Available at: http://www.fws.gov/midwest/ashland/ruf_cont.html

USFWS. (2002). Black Carp Invasive Species Program Fact sheet. Accessed March 23, 2012: http://www.fws.gov/southeast/hotissues/Black_Carp_FS.pdf

USFWS. (2012). National Wetland Inventory. U.S. Fish and Wildlife Service on-line mapper: http://www.fws.gov/wetlands/Data/Mapper.html

USGS. (2010). StreamStats [Data files]. United States Geological Survey (USGS). Retrieved from: http://warter.usgs.gov/osw/streamstats/ohio.html

USGS. (2011a). National Hydrography Dataset [Data file]. United States Geological Survey (USGS). Retrieved from: http://nhd.usgs.gov/data.html

USGS. (2011b). United States Geological Survey (USGS). Website, accessed February 21, 2012: Retrieved from http://nas.er.usgs.gov/queries/FactSheet.aspx?SpeciesID=2656

USGS. (2011c). Nonindigenous Aquatic Species (NAS) website. United States Geological Survey (USGS). Retrieved from http://nas.er.usgs.gov.

Van den Berg, M. S., H. Coops, R. Noordhuis, J. Van Schie, and J. Simons. (1995). Macroinvertebrate communities in relation to submerged vegetations in two Chara-dominated lakes. Hydrobiologia 342-343:143-150.

Van den Berg, M. S., R. Doef, F. Zant, and H. Coops. (1997). Charophytes: clear water and macroinvertebrates in the lakes Veluwemeer and Wolderwijd. Levende Natuur. 98(1):14-19.

Verigin, B.V., A.P. Makeyeva, and M.I. Zaki Mokhamed. (1978). Natural spawning of the silver carp (*Hypophthalmichthys nobilis*), the bighead carp (*Aristichthys nobilis*), and the grass carp (*Ctenopharyngodon idella*) in the Syr-Dar'ya River. Journal of Ichthyology 18(1):143-146.

Walker, J. (1997). Ecological morphology of lacustrine threespine stickleback *Gasterosteus aculeatus* L. Biological Journal of the Limnean Society, 61: 3-50.

WDNR. (2012). VHS 101 Fact Sheet. Wisconsin Department of Natural Resources. Website accessed April 10, 2012: http://dnr.wi.gov/fish/vhs/vhsfacts.html#3a

WRDA. (2007). Water Resources Development Act of 2007 [Section 3061(d): P.L. 110-114; amends Section 345: P.L. 108-335; 118 Stat. 1352].

Watson, A.M. and S.J. Ormerod. (2005). The Distribution and Conservation of Threatened Sphaeriidae on British Grazing Marshland. Biodiversity and Conservation. 14:2207□2220.

Weinstein, M.P. (1986). Habitat suitability index models: inland silverside. U.S. Fish and Wildlife Service Biol. Rep. 82(10.120). 25 pp.

Williamson, C. J. and J. E. Garvey. (2005). Growth, fecundity, and diets of newly established silver carp in the middle Mississippi River. Transactions of the American Fisheries Society, 134: 1423–1430.

Wootton, R.J. (1976). The Biology of the Stickleback. Academic Press. London.

Appendix A

Evaluation Forms for each ANS of Concern Selected for the Little Killbuck Pathway

Little Killbuck Creek, Medina County, OH - 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 LRB-H&H Hydraulic Engineer	Medium	VC	Medium	VC
	USACE LRH - Wildlife Biologist	Medium	RC	Medium	RC
	ODNR - Fisheries Biologist	Medium	VC	Medium	VC
	USACE LRB - Soil Scientist	Medium	VC	Medium	VC
	USACE LRB - Biologist	Medium	VC	Medium	VC
	Team Ratings	**Medium**	**VC**	**Medium**	**VC**

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

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

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

Remarks: During the Little Killbuck Creek site field visit on May 25 and 26, 2011 there was a storm that produced 2.73 inches of rain over a 24 hour period. As a result of this storm, roads in the area of concern were flooded and there was a visible waterway connection between the divide from the Great Lakes Basin and the Mississippi River Basin. It is estimated that the storm was less than a 5 year storm event.

Little Killbuck Creek, Medina County, OH - Asian Carp

2. Probability of ANS occurring within either basin

Aquatic Pathway Team	Expertise Position title or team role	Rating	Certainty		
	USACE LRH - Wildlife Biologist	High	RC		
	USACE LRB - Soil Scientist	High	RC		
	USACE LRB - Biologist	High	RC		
	USACE LRB - Biologist	High	RC		
	Division of Wildlife, D3 Fish Mgmt. Sup.	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: Silver and bighead carp are established throughout the Lower Ohio River basin. Successful breeding populations seem to stop near Louisville, KY. Occurences of the bighead carp have been noted in the Upper Ohio River basin including Moundsville, WV and the Mahoning River in Ohio. It is reasonable to expect that bighead carp and silver carp, later, could migrate up Killbuck Creek. The reproductive success of those individuals is questionable.

Little Killbuck Creek, Medina County, OH - 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 LRH - Wildlife Biologist	Medium	RC	Low	RC
	USACE LRB - Soil Scientist	Medium	RC	Low	RC
	USACE LRB - Biologist	Medium	RC	Low	RC
	USACE LRB - Biologist	Medium	RC	Low	RC
	Division of Wildlife, D3 Fish Mgmt. Sup.	Medium	RC	Low	RC
	Team Ratings	**Medium**	**RC**	**Low**	**RC**

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

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

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

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

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

Spawning initiated by rising water levels following the heavy rains. Both species are strong swimmers and silver carp are capable of jumping considerable distances out of the water (up to 12 feet). There are no obstacles in Little Killbuck Creek or Killbuck Creek that would permanently prevent upstream migration of silver carp or bighead carp. Habitat present within most of Little Killbuck Creek and Killbuck Creek is not ideal habitat for silver and bighead carp, which are native to and thrive in large rivers, but it is not known to what extent this may prevent migration or passage. Bighead carp are zooplanktivorous, while silver carp consume smaller phytoplankton and fine particulate organic matter. Sufficient forage is available for both species throughout the larger rivers downstream of the including the Muskingum, Walhonding, and perhaps Killbuck Creek. Forage abundance and diversity decreases moving upstream towards the pathway as water quality and volume decrease. Adult black carp are primarily molluscivores. However, they will opportunistically consume a wide variety of food items. Juvenile black carp have a diet more similar to silver and bighead carp, consisting primarily of zooplankton. 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. It is believed that black carp should be able to colonize the same areas of the United States where the grass carp have established.

Juvenile, sexually immature Asian carp have been observed in the upmost reaches of small tributaries to large rivers attempting to pass over barriers, such as dams, to continue their upstream movement (Chapman, Duane. USGS, personal communication, September 12, 2011 and Caswell, Nate. USFWS, personal communication September 12, 2011 with Eagle Marsh team). It is important to note that young Asian carp tend to move laterally away from the river in which they were spawned and not back upstream (Chapman, Duane. USGS, personal communication, September 12, 2011 with Eagle Marsh team). Newly hatched fry are not known to move significant distances upstream; however, they may move long distances up small tributaries and side channels in the vicinities of where they hatch. It has also been noted that 12-18 inch Asian carp have been known to travel long distances, throughout river systems, for no apparent reason (Chapman, Duane. USGS, personal communication, September 12, 2011 with Eagle Marsh team). Adult, sexually mature Asian carp have also been found in very small streams, which appear scarcely large enough to support the fishes at low water (Chapman, Duane. USGS, personal communication, September 12, 2011 with Eagle Marsh team). The age these fishes arrived at these locations is unknown.

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

There are poor recreation opportunities at the Little Killbuck site. Therefore, it is highly unlikely that Asian carp could be spread through other anthropogenic means.

Little Killbuck Creek, Medina County, OH - Asian Carp

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

Aquatic Pathway Team	Expertise Position title or team role	Rating	Certainty		
	USACE LRH - Wildlife Biologist	Medium	RC		
	USACE LRB - Soil Scientist	Medium	RC		
	USACE LRB - Biologist	Medium	RC		
	USACE LRB - Biologist	Medium	RC		
	Division of Wildlife, D3 Fish Mgmt. Sup.	Medium	RC		
	Team Ratings	**Medium**	**RC**		

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

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

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

Remarks: 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. It's believed that silver and bighead carp require sufficient flow to keep fertilized eggs suspended for successful reproduction. It is unlikely that spawning would occur within Little Killbuck or the agricultural drainage network at the pathway. If Asian carp reach the pathway during a flooding event they may survive long enough to be pumped into the Great Lakes basin. Although it is unlikely that adults would survive long periods of time within the agricultural drainage network due to poor water quality and water volume.

Little Killbuck Creek, Medina County, OH - 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 LRH - Wildlife Biologist	High	VC		
	USACE LRB - Soil Scientist	High	VC		
	USACE LRB - Biologist	High	VC		
	USACE LRB - Biologist	High	VC		
	Division of Wildlife, D3 Fish Mgmt. Sup.	High	VC		
	Team Ratings	**High**	**VC**		

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

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

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

Remarks: Asian carp have demonstrated exceptional capabilities of spreading through large river systems, and will likely continue to do so. It is still uncertain whether they will colonize the Upper Ohio River and its tributaries. But if these species reach the basin divide and surface water connections permit, it is highly likely that they would spread beyond the aquatic pathway into the Great Lakes Basin.

Little Killbuck Creek, Medina County, OH - Parasitic Copepod (*Neoergasilus japonicus*)

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 LRB-H&H Hydraulic Engineer	Medium	VC	Medium	VC
	USACE LRH - Wildlife Biologist	Medium	RC	Medium	RC
	ODNR - Fisheries Biologist	Medium	VC	Medium	VC
	USACE LRB - Soil Scientist	Medium	VC	Medium	VC
	USACE LRB - Biologist	Medium	VC	Medium	VC
	Team Ratings	**Medium**	**VC**	**Medium**	**VC**

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

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

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

Remarks: During the Little Killbuck Creek site field visit on May 25 and 26, 2011 there was a storm that produced 2.73 inches of rain over a 24 hour period. As a result of this storm, roads in the area of concern were flooded and there was a visible waterway connection between the divide from the Great Lakes Basin and the Mississippi River Basin. It is estimated that the storm was less than a 5 year storm event.

Little Killbuck Creek, Medina County, OH - Parasitic Copepod (*Neoergasilus japonicus*)

2. Probability of ANS occurring within either basin

Aquatic Pathway Team	Expertise Position title or team role	Rating	Certainty		
	USACE LRH - Wildlife Biologist	High	MC		
	USACE LRB - Soil Scientist	High	MC		
	USACE LRB - Biologist	High	MC		
	USACE LRB - Biologist	High	MC		
	Division of Wildlife, D3, Fish Mgmt. Sup.	High	MC		
	Team Rating	**High**	**MC**		

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

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

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

Remarks: The copepod has a life cycle in which the female adopts a parasitic phase on several fish species, including members of the minnow family, sunfish family, catfish family, and potentially other fish species. The common carp is a frequent host of the parasite. The females can detach and re-attach to host species. The invasive copepod has been established in Lake Huron since 1994, but has not yet been recorded in Lake Erie. It has also been found in Crane Creek basin, a direct draining tributary to Lake Erie. The common carp is established in Lake Erie. While other host fish species are known to exist in the pathway system, the common carp was selected as the most likely host species because of the life cycle capabilities of the common carp and the likelihood the common carp would use and survive in the pathway habitats. The males are free living but do not have the capability of migration upstream. The literature indicates N. japonicus is small and relatively easy to miss in field surveys, even by trained biologists. Therefore, the parasitic copepod may be much more prevalent than the distribution maps depict. Due to its inhabitance of the Crane Creek basin, it is highly likely that the parasitic copepod could migrate to the pathway within 20 years.

Little Killbuck Creek, Medina County, OH - Parasitic Copepod (*Neoergasilus japonicus*)

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 LRH - Wildlife Biologist	Medium	RC	Low	RC
	USACE LRB - Soil Scientist	Medium	RC	Low	RC
	USACE LRB - Biologist	Medium	RC	Low	RC
	USACE LRB - Biologist	Medium	RC	Low	RC
	Division of Wildlife, D3, Fish Mgmt. Sup.	Medium	RC	Low	VC
	Team Ratings	**Medium**	**RC**	**Low**	**RC**

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

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

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

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

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

The common carp has been observed on both sides of the pathway and also within the agricultural drainage network (verified with the land owner). The common carp has successfully migrated to these points previously. It is reasonable to expect that the common carp will continue to migrate to this area successfully. In order for successful migration through the pathway, at least a 5% flood event would need to occur.

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

There is poor recreational opportunity near the pathway. Therefore, there is a very low chance for other anthropogenic or other natural means of transfer.

Little Killbuck Creek, Medina County, OH - Parasitic Copepod (*Neoergasilus japonicus*)

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

Aquatic Pathway Team	Expertise Position title or team role	Rating	Certainty		
	USACE LRH - Wildlife Biologist	High	RC		
	USACE LRB - Soil Scientist	High	RC		
	USACE LRB - Biologist	High	RC		
	USACE LRB - Biologist	High	RC		
	Division of Wildlife, D3, Fish Mgmt. Sup.	High	RC		
	Team Ratings	**High**	**RC**		

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

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

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

Remarks: The copepod is very capable of persisting in eutrophic and polluted waters. The copepod demonstrates a rapid reproductive cycle and is capable of utilizing many different host species. It is highly likely that the copepod would be successful in establishing in and adjacent to the pathway at Little Killbuck Creek.

Little Killbuck Creek, Medina County, OH - Parasitic Copepod (*Neoergasilus japonicus*)

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

Aquatic Pathway Team	Expertise Position title or team role	Rating	Certainty		
	USACE LRH - Wildlife Biologist	High	RC		
	USACE LRB - Soil Scientist	High	RC		
	USACE LRB - Biologist	High	RC		
	USACE LRB - Biologist	High	RC		
	Division of Wildlife, D3, Fish Mgmt. Sup.	High	RC		
	Team Ratings	**High**	**RC**		

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

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

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

Remarks: During a 5% flood event, it is possible that an infected carp could be carried into the agricultural drainage network. After a flood event the drainage network would be pumped out. It is reasonable to expect that a small infected carp or a free floating copepod could be pumped through to the Mississippi basin.

Little Killbuck Creek, Medina County, OH - Viral Hemorrhagic Septicemia (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 LRB-H&H Hydraulic Engineer	Medium	VC	Medium	VC
	USACE LRH - Wildlife Biologist	Medium	RC	Medium	RC
	ODNR - Fisheries Biologist	Medium	VC	Medium	VC
	USACE LRB - Soil Scientist	Medium	VC	Medium	VC
	USACE LRB - Biologist	Medium	VC	Medium	VC
	Team Ratings	**Medium**	**VC**	**Medium**	**VC**

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

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

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

Remarks: During the Little Killbuck Creek site field visit on May 25 and 26, 2011 there was a storm that produced 2.73 inches of rain over a 24 hour period. As a result of this storm, roads in the area of concern were flooded and there was a visible waterway connection between the divide from the Great Lakes Basin and the Mississippi River Basin. It is estimated that the storm was less than a 5 year storm event.

Little Killbuck Creek, Medina County, OH - Viral Hemorrhagic Septicemia (VHSv)

2. Probability of ANS occurring within either basin

Aquatic Pathway Team	Expertise Position title or team role	Rating	Certainty		
	USACE LRH - Wildlife Biologist	High	RC		
	USACE LRB - Soil Scientist	High	RC		
	USACE LRB - Biologist	High	RC		
	USACE LRB - Biologist	High	RC		
	Division of Wildlife, D3, Fish Mgmt. Sup.	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: 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. This virus has been reported from throughout the Great Lakes Basin including Lake Erie. VHSv has been found in many species of fish including common carp. The common carp is established in Lake Erie, as well as the rivers and streams leading to the Little Killbuck pathway. While other host fish species are known to exist in the pathway system, the common carp was selected as the most likely host species because of the life cycle capabilities of the common carp and the likelihood the common carp would use and survive in the pathway habitats.

Little Killbuck Creek, Medina County, OH - Viral Hemorrhagic Septicemia (VHSv)

3. Probability of ANS surviving transit to aquatic pathway

Aquatic Pathway Team	Expertise Position title or team role	3A Rating	Certainty	3B Rating	Certainty
	USACE LRH - Wildlife Biologist	Medium	RC	Low	RC
	USACE LRB - Soil Scientist	Medium	RC	Low	RC
	USACE LRB - Biologist	Medium	RC	Low	RC
	USACE LRB - Biologist	High	RC	Low	RC
	Division of Wildlife, D3, Fish Mgmt. Sup.	Medium	RC	Low	VC
	Team Ratings	**Medium**	**RC**	**Low**	**RC**

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

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

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

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

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

The common carp has been observed on both sides of the pathway and also within the agricultural drainage network (verified with landowner). The common carp has been successful migrating to these points previously. It is reasonable to expect that the common carp will continue to migrate to this area successfully. In order for successful migration through the pathway, at least a 5% flood event would need to occur.

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

There is poor recreational opportunity near the pathway. Therefore, there is a very low chance for other anthropogenic or natural means of transfer.

Little Killbuck Creek, Medina County, OH - Viral Hemorrhagic Septicemia (VHSv)

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

Aquatic Pathway Team	Expertise Position title or team role	Rating	Certainty		
	USACE LRH - Wildlife Biologist	High	MC		
	USACE LRB - Soil Scientist	High	MC		
	USACE LRB - Biologist	High	MC		
	USACE LRB - Biologist	High	MC		
	Division of Wildlife, D3, Fish Mgmt. Sup.	High	VC		
	Team Ratings	**High**	**MC**		

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

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

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

Remarks: 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. It is highly likely that VHSv would be successful in establishing in fish populations already in and around the Little Killbuck pathway.

Little Killbuck Creek, Medina County, OH - Viral Hemorrhagic Septicemia (VHSv)

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

Aquatic Pathway Team	Expertise Position title or team role	Rating	Certainty		
	USACE LRH - Wildlife Biologist	High	RC		
	USACE LRB - Soil Scientist	High	RC		
	USACE LRB - Biologist	High	RC		
	USACE LRB - Biologist	High	RC		
	Division of Wildlife, D3, Fish Mgmt. Sup.	High	RC		
	Team Ratings	**High**	**RC**		

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

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

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

Remarks: During a 5% flood event, it is possible that an infected carp could be carried into the agricultural drainage network. After a flood event drainage network would be pumped out. It is reasonable to expect that a small infected fish or the virus itself could be pumped through to the Mississippi basin.

Little Killbuck Creek, Medina County, OH - 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 LRB-H&H Hydraulic Engineer	Medium	VC	Medium	VC
	USACE LRH - Wildlife Biologist	Medium	RC	Medium	RC
	ODNR - Fisheries Biologist	Medium	VC	Medium	VC
	USACE LRB - Soil Scientist	Medium	VC	Medium	VC
	USACE LRB - Biologist	Medium	VC	Medium	VC
	Team Ratings	**Medium**	**VC**	**Medium**	**VC**

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

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

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

Remarks: During the Little Killbuck Creek site field visit on May 25 and 26, 2011 there was a storm that produced 2.73 inches of rain over a 24 hour period. As a result of this storm, roads in the area of concern were flooded and there was a visible waterway connection between the divide from the Great Lakes Basin and the Mississippi River Basin. It is estimated that the storm was less than a 5 year storm event.

Little Killbuck Creek, Medina County, OH - Inland Silverside (*Menidia beryllina*)

2. Probability of ANS occurring within either basin

Aquatic Pathway Team	Expertise Position title or team role	Rating	Certainty		
	USACE LRB - Soil Scientist	Medium	RC		
	USACE LRH - Wildlife Biologist	Medium	RC		
	USACE LRB - Biologist	Medium	RC		
	USACE LRB - Biologist	Medium	RC		
	Division of Wildlife, D3, Fish Mgmt Sup.	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 inland silverside has been collected in 2003 in Mt. Carmel, Indiana which is in southwestern Indiana; stocked in the Wabash River in 1996; and established in the White river near the confluence with the Arkansas and Mississippi Rivers. These locations are greater than 250 miles from the Little Killbuck site.

Little Killbuck Creek, Medina County, OH - 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 LRB - Soil Scientist	Medium	MC	Low	RC
	USACE LRH - Wildlife Biologist	Medium	RC	Low	VC
	USACE LRB - Biologist	Medium	MC	Low	RC
	USACE LRB - Biologist	Medium	MC	Low	RC
	Division of Wildlife, D3, Fish Mgmt Sup.	Medium	MC	Low	MC
	Team Ratings	**Medium**	**MC**	**Low**	**RC**

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

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

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

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

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

As a relatively small fish (approximately five inches in total lenght at maturity), it is likely that this species would seek refuge from high water velocities during flood events, instead of attempting to migrate upstream. The habitat data suggests the inland silverside will colonize within rivers and streams but are usually found in clear, quiet water over sand or gravel. Proximity to pathway is greater than 250 miles.

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

Since the Little Killbuck site is an active farm consisting of connected drainage ditches, it is not likely that fishing or boating would occur at or relatively near this location. Access by the general public is limited to vehicular traffic through and around the site. Any other means of access would be considered trespassing. Considering these limitations it is highly unlikely that the inland silverside will arrive at the divide by anthropogenic means, such as livewell or aquarium releases.

Little Killbuck Creek, Medina County, OH - Inland Silverside (*Menidia beryllina*)

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

Aquatic Pathway Team	Expertise Position title or team role	Rating	Certainty		
	USACE LRB - Soil Scientist	Medium	RC		
	USACE LRH - Wildlife Biologist	Medium	RC		
	USACE LRB - Biologist	Medium	RC		
	USACE LRB - Biologist	Medium	MC		
	Division of Wildlife, D3, Fish Mgmt Sup.	Medium	MC		
	Team Ratings	**Medium**	**RC**		

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

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

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

Remarks: Food habits of the Inland Silverside include: Planktivore; particulate feeder; size-selective picker; main food item zooplankton. Stomachs of adults in west Tennessee contained food items including midge larvae, mayfly larvae (Hexagenia), and fallen terrestrial insects (including Homoptera, Hymenoptera. Major food organisms in the diet were from the following groups: Sididae, Chydoridae, Ceriodaphnia, Bosmina, Cyclopoida, nauplii, and Ostracoda. Species fed predominately upon cladocerans (60% of total number of food organisms, with largest category, Sididae, representing 32%). Considering the dietary range of this species, it is reasonable to conclude that a population could be established in close proximity to the pathway.

Little Killbuck Creek, Medina County, OH - 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 LRB - Soil Scientist	High	RC
	USACE LRH - Wildlife Biologist	High	RC
	USACE LRB - Biologist	High	RC
	USACE LRB - Biologist	High	RC
	Division of Wildlife, D3, Fish Mgmt Sup.	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: The habitat at the pathway itself consists of a series of connected sparsely vegetated agricultural drainage ditches which create a pathway from one basin to another. It is possible that the inland silverside could survive in this ditch system long enough to transfer across the basin under the proper conditions. A conversation with the farmer/landowner informed us that he has seen common carp within the agricultural drainage ditches. During storm events water is pumped from these agricultural ditches into both basins. A storm event as minimal as a 5% annual return storm results in significant portions of this site being inundated. FEMA maps display the entire site inundated from a 100% annual return storm event. Considering these factors, it would be possible for the inland silverside to transfer across basins via the agricultural drainage ditches if the frequency between significant storm events was within a timeframe that would allow their survival within this system. In addition, roadside ditches along Franchester Road span the divide and connect both basins via Repp Run and Clear Creek. The results of the storm event witnessed during the site visit describe this area as being inundated and water flowing across the divide.

Little Killbuck Creek, Medina County, OH - 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 LRB-H&H Hydraulic Engineer	Medium	VC	Medium	VC
	USACE LRH - Wildlife Biologist	Medium	RC	Medium	RC
	ODNR - Fisheries Biologist	Medium	VC	Medium	VC
	USACE LRB - Soil Scientist	Medium	VC	Medium	VC
	USACE LRB - Biologist	Medium	VC	Medium	VC
	Team Ratings	**Medium**	**VC**	**Medium**	**VC**

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

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

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

Remarks: During the Little Killbuck Creek site field visit on May 25 and 26, 2011 there was a storm that produced 2.73 inches of rain over a 24 hour period. As a result of this storm, roads in the area of concern were flooded and there was a visible waterway connection between the divide from the Great Lakes Basin and the Mississippi River Basin. It is estimated that the storm was less than a 5 year storm event.

Little Killbuck Creek, Medina County, OH - Northern Snakehead (*Channa argus*)

2. Probability of ANS occurring within either basin

Aquatic Pathway Team	Expertise Position title or team role	Rating	Certainty		
	USACE LRB - Soil Scientist	Medium	RC		
	USACE LRH - Wildlife Biologist	Medium	RC		
	USACE LRB - Biologist	Medium	RC		
	USACE LRB - Biologist	Medium	RC		
	Division of Wildlife, D3, Fish Mgmt Sup.	Medium	MC		
	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 northern snakehead was found in 2008 in Monroe, Arkansas (> 250 miles from the Little Killbuck site), and has since established a reproducing population in the area. Although in a different basin, this species is also established in the Potomac River in Maryland and Virginia.

Little Killbuck Creek, Medina County, OH - 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 LRB - Soil Scientist	Medium	RC	Low	RC
	USACE LRH - Wildlife Biologist	Medium	RC	Low	RC
	USACE LRB - Biologist	Medium	RC	Low	RC
	USACE LRB - Biologist	Medium	RC	Low	RC
	Division of Wildlife, D3, Fish Mgmt Sup.	Low	RC	Medium	RC
	Team Ratings	**Medium**	**RC**	**Low**	**RC**

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

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

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

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

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

The northern snakehead is an incredibly resilient species. As obligate air breathers, northern snakeheads obtain required oxygen directly from the atmosphere. This species thrives in stagnant, oxygen depleted back-waters and marshes. The northern snakehead likely possesses the ability to migrate through the aquatic pathway to the Little Killbuck site, however, its preferred habit is not flowing waters, which will likely slow its spread up the Mississippi River and it tributaries. Unlike the Asian carps, northern snakeheads do not make long upstream spawning runs and, as a result, are not likely to spread quickly through the Mississippi River Basin without the aid of anthropogenic means. Andy J. - The lack of backwater and marsh areas in the Upper Ohio River, Muskingum, and Walhonding Rivers may impede the migration of the snakehead to the pathway.

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

Many species of snakehead, including the northern snakehead, have been popular aquarium fish. However, in 2002 the import and interstate transport of northern snakehead was banned without a permit from the U.S. Fish and Wildlife service (www.anstaskforce.gov). Since the Little Killbuck site is an active farm consisting of connected drainage ditches, it is not likely that fishing or boating would occur at or relatively near this location. Access by the general public is limited to vehicular traffic through and around the site. Considering these limitations it is highly unlikely that the northern snakehead will arrive at the divide by anthropogenic means, such as livewell or aquarium releases.

Little Killbuck Creek, Medina County, OH - Northern Snakehead (*Channa argus*)

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

Aquatic Pathway Team	Expertise Position title or team role	Rating	Certainty		
	USACE LRB - Soil Scientist	High	RC		
	USACE LRH - Wildlife Biologist	Medium	MC		
	USACE LRB - Biologist	High	RC		
	USACE LRB - Biologist	High	MC		
	Division of Wildlife, D3, Fish Mgmt Sup.	High	RC		
	Team Ratings	**High**	**RC**		

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

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

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

Remarks: The northern snakehead's native range (lat 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. Northern snakeheads are naturally aggressive predators that could easily acclimate to the conditions in and around the Little Killbuck site 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 aquatic habitat adjacent to Little Killbuck. Additionally, northern snakeheads aggressively defend their nest and young fry, reducing predation on young snakehead by other fish. Andy J. - There are some connected wetlands in the area, but I do not believe they are expansive enough to support a sustainable population.

Little Killbuck Creek, Medina County, OH - 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 LRB - Soil Scientist	High	RC		
	USACE LRH - Wildlife Biologist	High	RC		
	USACE LRB - Biologist	High	RC		
	USACE LRB - Biologist	High	RC		
	Division of Wildlife, D3, Fish Mgmt Sup.	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: The habitat at the pathway itself consists of a series of connected sparsely vegetated agricultural drainage ditches which create a pathway from one basin to another. It is possible that the northern snakehead could survive in this system long enough to transfer across the basin under the proper conditions. A conversation with the farmer/landowner informed us that he has seen common carp within the agricultural drainage ditches. During storm events water is pumped from these agricultural ditches into both basins. A storm event as minimal as a 5% annual return storm results in significant portions of this site being inundated and FEMA maps display the entire site inundated from a 100% annual return storm event. Considering these factors, it would be possible for the northern snakehead to transfer across basins via the agricultural drainage ditches if the frequency between significant storm events was within a timeframe that would allow their survival within this system. In addition, roadside ditches along Franchester Road span the divide and connect both basins via Repp Run and Clear Creek. The results of the storm event witnessed during the site visit discussed earlier in this report describe this area as being inundated and water flowing across the divide. As an air breather that has even been known to move short distances over land, it is likely this species has the potential to move into and out of this environment.

Little Killbuck Creek, Medina County, OH - 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 LRB-H&H Hydraulic Engineer	Medium	VC	Medium	VC
	USACE LRH - Wildlife Biologist	Medium	RC	Medium	RC
	ODNR - Fisheries Biologist	Medium	VC	Medium	VC
	USACE LRB - Soil Scientist	Medium	VC	Medium	VC
	USACE LRB - Biologist	Medium	VC	Medium	VC
	Team Ratings	**Medium**	**VC**	**Medium**	**VC**

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

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

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

Remarks: During the Little Killbuck Creek site field visit on May 25 and 26, 2011 there was a storm that produced 2.73 inches of rain over a 24 hour period. As a result of this storm, roads in the area of concern were flooded and there was a visible waterway connection between the divide from the Great Lakes Basin and the Mississippi River Basin. It is estimated that the storm was less than a 5 year storm event.

Little Killbuck Creek, Medina County, OH - Threespine Stickleback (*Gasterosteus aculeatus*)

2. Probability of ANS occurring within either basin

Aquatic Pathway Team	Expertise Position title or team role	Rating	Certainty		
	USACE LRB - Biologist	High	VC		
	USACE LRH - Biologist	High	VC		
	USACE LRB - Soil Scientist	High	VC		
	USACE LRB - Biologist	High	VC		
	Division of Wildlife, D3, Fish Mgmt Sup.	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 is found in each of the Great Lakes and has been collected in some inland river systems. Literature indicates this species prefers to live in smaller streams but may occur in a variety of habitat including lakes and large rivers.

Little Killbuck Creek, Medina County, OH - Threespine Stickleback (*Gasterosteus aculeatus*)

3. Probability of ANS surviving transit to aquatic pathway

Aquatic Pathway Team	Expertise Position title or team role	3A Rating	Certainty	3B Rating	Certainty
	USACE LRB - Biologist	Medium	RC	Low	RC
	USACE LRH - Biologist	Medium	RC	Low	RC
	USACE LRB - Soil Scientist	Medium	RC	Low	RC
	USACE LRB - Biologist	Medium	RC	Low	RC
	Division of Wildlife, D3, Fish Mgmt Sup.	Medium	RC	Low	RC
	Team Ratings	**Medium**	**RC**	**Low**	**RC**

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

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

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

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

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

The threespine stickleback has been found in the Great Lakes and in smaller river systems. Obstacles in the Black River should be sufficient in impeding migration of the threespine stickleback at normal and low flows. As these obstacles become inundated during high flow events, the stickleback may have ample opportunity to move upstream. However, it is likely that this species will seek refuge from high velocities instead of expending energy attempting to move upstream. It is likely that sufficient forage and habitat is available throughout the Black River and it's tributaries for the threespine stickleback.

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

It is believed that bait-bucket transport has aided in the movement of the threespine stickleback in the past. However, since fishing and boating are realtively uncommon in the vicinity of the Clear Creek, it is highly unlikely that the species will arrive at the divide by anthropogenic means.

Little Killbuck Creek, Medina County, OH - Threespine Stickleback (*Gasterosteus aculeatus*)

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

Aquatic Pathway Team	Expertise Position title or team role	Rating	Certainty		
	USACE LRB - Biologist	Medium	MC		
	USACE LRH - Biologist	High	MC		
	USACE LRB - Soil Scientist	High	MC		
	USACE LRB - Biologist	Medium	MC		
	Division of Wildlife, D3, Fish Mgmt Sup.	Medium	MC		
	Team Ratings	**Medium**	**MC**		

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

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

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

Remarks: As a visual predator, the turbid waters of network of agricultural ditiches may be unsuitable for the threespine stickleback. Survival of a viable, reproducing population of the threespined stickleback within the agricultural ditch network may be unlikely due low water quality and high temperatures in summer months. However, Clear Creek may provide sufficient habitat for occupation of this species until a suitable storm event occurred and the fish could pass into the ditch network.

Little Killbuck Creek, Medina County, OH - Threespine Stickleback (*Gasterosteus aculeatus*)

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

Aquatic Pathway Team	Expertise Position title or team role	Rating	Certainty		
	USACE LRB - Biologist	High	RC		
	USACE LRH - Biologist	High	RC		
	USACE LRB - Soil Scientist	High	RC		
	USACE LRB - Biologist	High	RC		
	Division of Wildlife, D3, Fish Mgmt Sup.	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: The threespine stickleback has been found in smaller river systems and downstream migration through the Little Killbuck Creek would be likely.

Little Killbuck Creek, Medina County, OH - Ruffe (*Gymnochephalus cernuus*) / Tubenose Goby (*Proterorhinus semilunaris*)

1. Probability of aquatic pathway existence

Aquatic Pathway Team	Expertise Position title or team role	Rating Flow into GLB	Certainty	Rating Flow into MRB	Certainty
	USACE LRB-H&H Hydraulic Engineer	Medium	VC	Medium	VC
	USACE LRH - Wildlife Biologist	Medium	RC	Medium	RC
	ODNR - Fisheries Biologist	Medium	VC	Medium	VC
	USACE LRB - Soil Scientist	Medium	VC	Medium	VC
	USACE LRB - Biologist	Medium	VC	Medium	VC
	Team Ratings	**Medium**	**VC**	**Medium**	**VC**

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

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

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

Remarks: During the Little Killbuck Creek site field visit on May 25 and 26, 2011 there was a storm that produced 2.73 inches of rain over a 24 hour period. As a result of this storm, roads in the area of concern were flooded and there was a visible waterway connection between the divide from the Great Lakes Basin and the Mississippi River Basin. It is estimated that the storm was less than a 5 year storm event.

Little Killbuck Creek, Medina County, OH - Ruffe (*Gymnochephalus cernuus*) / Tubenose Goby (*Proterorhinus semilunaris*)

2. Probability of ANS occurring within either basin

Aquatic Pathway Team	Expertise Position title or team role	Rating	Certainty		
	USACE LRB - Biologist	High	MC		
	USACE LRH - Biologist	High	MC		
	USACE LRB - Soil Scientist	High	MC		
	USACE LRB - Biologist	High	MC		
	Division of Wildlife, D3, Fish Mgmt Sup.	High	MC		
	Team Rating	**High**	**MC**		

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

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

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

Remarks: The ruffe and tubenose goby are located within the Great Lakes and associated with river mouths and estuaries of large river systems entering the Great Lakes. To date, the ruffe has not been identified within Lake Erie but the fish has extended its range rapidly and modeling predicts it will find suitable habitat in all five Great Lakes. Literature reviews and actual fish survey data have not documented the collection of the ruffe in smaller upstream tributaries. The tubenose goby's introduced range covers three Great Lakes including Lake Superior, Erie and Huron. It has been collected in the lower reaches of larger Great Lakes rivers and estuaries.

Little Killbuck Creek, Medina County, OH - Ruffe (*Gymnochephalus cernuus*) / Tubenose Goby (*Proterorhinus semilunaris*)

3. Probability of ANS surviving transit to aquatic pathway

Aquatic Pathway Team	Expertise Position title or team role	3A Rating	Certainty	3B Rating	Certainty
	USACE LRB - Biologist	Medium	RC	Low	RC
	USACE LRH - Biologist	Medium	RC	Low	RC
	USACE LRB - Soil Scientist	Medium	RC	Low	RC
	USACE LRB - Biologist	Medium	RC	Low	RC
	Division of Wildlife, D3, Fish Mgmt Sup.	Low	RC	Low	RC
	Team Ratings	**Medium**	**RC**	**Low**	**RC**

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

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

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

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

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

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. 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 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 and migrate over dams is questionable but appears to be more capable of living in more varied types of riverine habitat than the ruffe. Obstacles in the Black River should be sufficient in impeding migration of both species at normal and low flows. As these obstacles become inundated during high flow events, both species may have opportunity to move upstream. However, it is likely that this species will seek refuge from high velocities instead of expending energy attempting to move upstream.

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

It is believed that bait-bucket transport has aided in the movement of the ruffe and goby in the past. However, since fishing and boating are realtively uncommon in the vicinity of the Clear Creek, it is highly unlikely that the species will arrive at the divide by anthropogenic means.

Little Killbuck Creek, Medina County, OH - Ruffe (*Gymnochephalus cernuus*) / Tubenose Goby (*Proterorhinus semilunaris*)

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

Aquatic Pathway Team	Expertise Position title or team role	Rating	Certainty		
	USACE LRB - Biologist	Medium	MC		
	USACE LRH - Biologist	Medium	MC		
	USACE LRB - Soil Scientist	Medium	MC		
	USACE LRB - Biologist	Medium	MC		
	Division of Wildlife, D3, Fish Mgmt Sup.	Medium	MC		
	Team Ratings	**Medium**	**MC**		

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

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

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

Remarks: The ruffe is an aggressive species that possesses the ability to feed in darkness, cold temperatures and turbid conditions. The tubenose goby is a benthic species that consume a wide variety of invertebrates. They are often quite abundant in backwaters and lakes and seem to prefer dense vegetation. Clear Creek is unlikely to provide sufficient habitat for either species. Furthermore, survival of a viable, reproducing population of ruffe and tubenose goby within the agricultural ditch network may be unlikely due low water quality and high temperatures in summer months.

Little Killbuck Creek, Medina County, OH - Ruffe (*Gymnochephalus cernuus*) / Tubenose Goby (*Proterorhinus semilunaris*)

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

Aquatic Pathway Team	Expertise Position title or team role	Rating	Certainty		
	USACE LRB - Biologist	High	RC		
	USACE LRH - Biologist	High	RC		
	USACE LRB - Soil Scientist	High	RC		
	USACE LRB - Biologist	High	RC		
	Division of Wildlife, D3, Fish Mgmt Sup.	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: Ruffe and the tubenose goby have not been found in stream systems similar to the Clear Creek and Little Killbuck Creek, but could likely still pass through the pathway given the active pumping/irrigation.

Little Killbuck Creek, Medina County, OH - European fingernail clam (*Sphaerium corneum*)

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 LRB-H&H Hydraulic Engineer	Medium	VC	Medium	VC
	USACE LRH - Wildlife Biologist	Medium	RC	Medium	RC
	ODNR - Fisheries Biologist	Medium	VC	Medium	VC
	USACE LRB - Soil Scientist	Medium	VC	Medium	VC
	USACE LRB - Biologist	Medium	VC	Medium	VC
	Team Ratings	**Medium**	**VC**	**Medium**	**VC**

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

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

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

Remarks: During the Little Killbuck Creek site field visit on May 25 and 26, 2011 there was a storm that produced 2.73 inches of rain over a 24 hour period. As a result of this storm, roads in the area of concern were flooded and there was a visible waterway connection between the divide from the Great Lakes Basin and the Mississippi River Basin. It is estimated that the storm was less than a 5 year storm event.

Little Killbuck Creek, Medina County, OH - European fingernail clam (*Sphaerium corneum*)

2. Probability of ANS occurring within either basin

Aquatic Pathway Team	Expertise Position title or team role	Rating	Certainty		
	USACE LRB - Biologist	Medium	RC		
	USACE LRH - Biologist	Medium	RC		
	USACE LRB - Soil Scientist	Medium	VC		
	USACE LRB - Biologist	Medium	VC		
	Division of Wildlife, D3 Fish Mgt. Sup.	Medium	VC		
	Team Rating	**Medium**	**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 clam was first found in the Great Lakes basin in Lake Ontario in 1924. It is considered to be established in Lakes Erie and Ontario and has been recorded in Lakes Michigan and Superior, Rice Lake (which is part of the Trent-Severn Canal system connecting Lake Huron and Lake Ontario), and Lake Huron, although it is very uncommon in Lake Huron. It is found in freshwater lakes and slow-moving rivers.

Little Killbuck Creek, Medina County, OH - European fingernail clam (*Sphaerium corneum*)

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 LRB - Biologist	Low	RC	Low	RC
	USACE LRH - Biologist	Low	RC	Low	RC
	USACE LRB - Soil Scientist	Low	RC	Low	RC
	USACE LRB - Biologist	Low	RC	Low	RC
	Division of Wildlife, D3 Fish Mgt. Sup.	Low	RC	Low	RC
	Team Ratings	**Low**	**RC**	**Low**	**RC**

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

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

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

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

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

It is believed that transport by hard ballast has aided in the movement of the European fingernail clam in the past. Hard ballast is not commonly used anymore and the tributaries of the Black River are too small for commercial boats. Thus the most likely form of transport today would be by recreational boating. However, the clam does not tolerate dessication well and the pathway is approximately 40 miles from Lake Erie which greatly lowers the chance of any clams being alive if they were attached to the boat or on vegetation that was attached to the boat or trailer. In addition, fishing and boating are realtively uncommon in the vicinity of the Clear Creek, thus it is highly unlikely that the species will arrive at the divide by anthropogenic means. It also has been shown that the common toad can aid in transporting S. corneum to new waters in Europe. The potential that the clam could be transported by amphibians has not been demonstrated in the Great Lakes and would be relatively low.

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

There is poor recreational opportunity near the pathway. Therefore, there is a very low chance for other anthropogenic or natural means of transfer.

Little Killbuck Creek, Medina County, OH - European fingernail clam (*Sphaerium corneum*)

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

Aquatic Pathway Team	Expertise Position title or team role	Rating	Certainty		
	USACE LRB - Biologist	Medium	MC		
	USACE LRH - Biologist	Medium	MC		
	USACE LRB - Soil Scientist	Low	MC		
	USACE LRB - Biologist	Medium	MC		
	Division of Wildlife, D3 Fish Mgt. Sup.	Medium	RC		
	Team Ratings	**Medium**	**MC**		

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

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

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

Remarks: The clam often prefers somewhat eutrophied, more lentic habitat and has been sampled from water with temperatures ranging from ~2 – 25 °C. It also has a high capacity for anaerobiosis and is able to survive anoxic conditions for around 400 days at 0oC and for 9 days at 20oC. The clam prefers hard waters with high magnesium, calcium, and bicarbonate concentrations and is found on fine sand, mud, silt, organic matter, and sometimes on gravel. It is mainly a filter feeder feeding mainly on diatoms and other types of phytoplankton but can also deposit feed on detritus from the substratum. Survival of a viable, reproducing population of the European fingernail clam within the agricultural ditch network at the pathway may be unlikely due to high organic concentrations from the adjacent farming operations, high temperatures, and low water levels in summer months. However, Clear Creek may provide sufficient habitat for occupation of this species in close proximity. Currie: High levels of organics from muck soils coupled with high seasonal water temperatures and potential for extended periods of drying would be detrimental to establishment of a viable population within the agricultural ditch network and wetlands adjacent to Clear Creek.

Little Killbuck Creek, Medina County, OH - European fingernail clam (*Sphaerium corneum*)

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

Aquatic Pathway Team	Expertise Position title or team role	Rating	Certainty
	USACE LRB - Biologist	High	RC
	USACE LRH - Biologist	High	MC
	USACE LRB - Soil Scientist	High	RC
	USACE LRB - Biologist	High	RC
	Division of Wildlife, D3 Fish Mgt. Sup.	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: The European fingernail clam has been found in smaller rivers and canals including ditches and movement through the Little Killbuck Creek would be likely. It is possible that life history requirements of European fingernail clam could be met in Little Killbuck.

Little Killbuck Creek, Medina County, OH - European stream valvata (*Valvata piscinalis*)

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 LRB-H&H Hydraulic Engineer	Medium	VC	Medium	VC
	USACE LRH - Wildlife Biologist	Medium	RC	Medium	RC
	ODNR - Fisheries Biologist	Medium	VC	Medium	VC
	USACE LRB - Soil Scientist	Medium	VC	Medium	VC
	USACE LRB - Biologist	Medium	VC	Medium	VC
	Team Ratings	**Medium**	**VC**	**Medium**	**VC**

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

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

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

Remarks: During the Little Killbuck Creek site field visit on May 25 and 26, 2011 there was a storm that produced 2.73 inches of rain over a 24 hour period. As a result of this storm, roads in the area of concern were flooded and there was a visible waterway connection between the divide from the Great Lakes Basin and the Mississippi River Basin. It is estimated that the storm was less than a 5 year storm event.

Little Killbuck Creek, Medina County, OH - European stream valvata (*Valvata piscinalis*)

2. Probability of ANS occurring within either basin

Aquatic Pathway Team	Expertise Position title or team role	Rating	Certainty		
	USACE LRB - Biologist	High	RC		
	USACE LRH - Biologist	High	MC		
	USACE LRB - Soil Scientist	High	RC		
	USACE LRB - Biologist	High	RC		
	Division of Wildlife, D3 Fish Mgt. Sup.	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: The European stream valvata was originally introduced to Lake Ontario at the mouth of the Genesee River in 1897. In forty years it dispersed to Lake Erie and subsequently it expanded its range to the St. Lawrence River, the Hudson River, Lake Champlain and Cayuga Lake. The valvata was recorded in the 1990s and the first decade of the 21st century in Superior Bay in Lake Superior (Minnesota), Lake Michigan (Wisconsin) and Oneida Lake in the Lake Ontario watershed (New York). It is found in freshwater lakes and streams. In its native range of Europe, western Siberia, and central Asia, this species has been found to tolerate a wide range of habitats including oligotrophic nearshore zones, sparsely vegetated lakes or sites dominated by Chara spp. and Potamogeton spp., littoral habitats with high siltation rates, lentic and stagnant waters or slow streams The valvata is found in habitats with fine substrates (mud, silt and sand) – especially during hibernation, and aquatic macrophytes – for laying its egg masses.

Little Killbuck Creek, Medina County, OH - European stream valvata (*Valvata piscinalis*)

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 LRB - Biologist	Low	MC	Low	RC
	USACE LRH - Biologist	Low	MC	Low	RC
	USACE LRB - Soil Scientist	Low	MC	Low	RC
	USACE LRB - Biologist	Low	MC	Low	RC
	Division of Wildlife, D3 Fish Mgt. Sup.	Low	RC	Low	RC
	Team Ratings	**Low**	**MC**	**Low**	**RC**

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

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

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

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

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

The European stream valvata has been found in the Great Lakes and can tolerate a wide range of habitats including lakes, ponds, rivers, small streams, canals, and ditches. Its close proximity in the Great Lakes and particularly Lake Erie, indicate a potential for access and transfer to the Mississippi River Basin via the Little Killbuck Creek aquatic pathway. Obstacles to upstream migration within the Black River include:

- Dam (Elyria – Chestnut Ridge Rd)
- Dam OH01954 (Elyria – E. Bridge St.)
- Waterfalls (Elyria – Washington St)
- Waterfalls (Elyria – Cascade/Elywood Pk)
- Dam (Elyria – Spring Valley Golf Club)

These should be sufficient in impeding migration of the European stream valvata at normal and low flows. Even though these obstacles become inundated during high flow events, the limited ability of this species to move upstream unaided results in a low probability that this species will be able to make it from its current location to the pathway unaided. This is reinforced by the fact that the dispersal of the valvata in the Great Lakes has been restricted and characterized by a slow rate of spread during the first 100 years of its colonization. It is likely that sufficient habitat is available throughout the Black River and it's tributaries for the European stream valvata, however, these obstacles still make it highly unlikely that the European stream valvata will be able to make it to the pathway unaided.

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

Shipping and the use of marsh grasses in packing enabled the European fingernail clam in the past to be introduced to the Great Lakes. Subsequent range expansion may have occurred via natural dispersal, while more recent records of the 1990s and the first decade of the 21st century may have been aided by human-mediated dispersal in ships and via canals. The tributaries of the Black River are too small for commercial boats. Thus the most likely form of transport today would be by recreational boats and trailers. The valvata has been shown to be tolerant of dessication, however, since fishing and boating are relatively uncommon in the vicinity of the Clear Creek, it is highly unlikely that the species will arrive at the divide by anthropogenic or other means.

Little Killbuck Creek, Medina County, OH - European stream valvata (*Valvata piscinalis*)

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

Aquatic Pathway Team	Expertise Position title or team role	Rating	Certainty		
	USACE LRB - Biologist	High	MC		
	USACE LRH - Biologist	High	MC		
	USACE LRB - Soil Scientist	High	MC		
	USACE LRB - Biologist	High	MC		
	Division of Wildlife, D3 Fish Mgt. Sup.	High	RC		
	Team Ratings	**High**	**MC**		

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

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

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

Remarks: The valvata is tolerant of a wide range of conditions in both lotic and lentic habitats and has been shown to be relatively insensitive to organic pollution. It has been found at sampling sites with temperatures ranging from 11-33 oC and in waters with mean temperature ranging from 5.5-16.5 oC. Densities of this species have been documented as increasing during a heat wave when water temperatures reached 29.5 oC and exceeded 25oC for 75 days. The European stream valvata is a generalist, grazing on epiphytic algae and detritus, and in more eutrophic environments is capable of filter feeding on suspended organic matter and algae. It can also rasp off pieces of aquatic vegetation. Survival of a viable, reproducing population of the valvata within the agricultural ditch network is possible given its tolerance to a wide range of habitat conditions. In addition, Clear Creek may provide sufficient habitat for occupation of this species in close proximity.

Little Killbuck Creek, Medina County, OH - European stream valvata (*Valvata piscinalis*)

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

Aquatic Pathway Team	Expertise Position title or team role	Rating	Certainty		
	USACE LRB - Biologist	High	RC		
	USACE LRH - Biologist	High	RC		
	USACE LRB - Soil Scientist	High	RC		
	USACE LRB - Biologist	High	RC		
	Division of Wildlife, D3 Fish Mgt. Sup.	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: The European stream valvata has been found in smaller rivers and canals including ditches and downstream migration through the Little Killbuck Creek pathway would be likely.

Little Killbuck Creek, Medina County, OH - Skipjack herring (*Alosa chrysochloris*)

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 LRB-H&H Hydraulic Engineer	Medium	VC	Medium	VC
	USACE LRH - Wildlife Biologist	Medium	RC	Medium	RC
	ODNR - Fisheries Biologist	Medium	VC	Medium	VC
	USACE LRB - Soil Scientist	Medium	VC	Medium	VC
	USACE LRB - Biologist	Medium	VC	Medium	VC
	Team Ratings	**Medium**	**VC**	**Medium**	**VC**

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

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

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

Remarks: During the Little Killbuck Creek site field visit on May 25 and 26, 2011 there was a storm that produced 2.73 inches of rain over a 24 hour period. As a result of this storm, roads in the area of concern were flooded and there was a visible waterway connection between the divide from the Great Lakes Basin and the Mississippi River Basin. It is estimated that the storm was less than a 5 year storm event.

Little Killbuck Creek, Medina County, OH - Skipjack herring (*Alosa chrysochloris*)

2. Probability of ANS occurring within either basin

Aquatic Pathway Team	Expertise Position title or team role	Rating	Certainty		
	USACE LRB - Biologist	High	VC		
	Div. of Wildlife-District 3 Fish Mgt. Sup.	High	VC		
	USACE LRH - Biologist	High	VC		
	USACE LRB - Soil Scientist	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 northern snakehead was found in 2008 in Monroe, Arkansas (> 250 miles from the Little Killbuck site), and has since established a reproducing population in the area. Although in a different basin, this species is also established in the Potomac River in Maryland and Virginia.

Little Killbuck Creek, Medina County, OH - Skipjack herring (*Alosa chrysochloris*)

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 LRB - Biologist	Low	RC	Low	RC
	Div. of Wildlife-District 3 Fish Mgt. Sup.	Medium	RC	Low	RC
	USACE LRH - Biologist	Low	MC	Low	RC
	USACE LRB - Soil Scientist	Low	MC	Low	RC
	Team Ratings	**Low**	**MC**	**Low**	**RC**

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

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

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

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

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

Skipjack herring are a migratory species found in larger rivers often in areas of swift current. In Ohio this species is only found in the Ohio River and its larger tributaries, particularly the Scioto River and Muskigum River. Skipjack herring are strongly migratory within rivers and prefer fast flowing water where they are renowned for leaping. They are found in clear to moderately turbid waters in large rivers and reservoirs usually within the current over sand or gravel. Skipjack herring feed in large schools with adults feeding on other herring species such as the threadfin shad, the gizzard shad and young of the year herring species, while the juveniles feed on dipterans and other aquatic insects. Because skipjack herring tend to prefer large fast flowing rivers, is unlikely that they would migrate upstream of their current range in the mainstem Muskingum River into the smaller, more turbid, tributaries leading the Little Killbuck pathway. Despite the connectivity of the Walhonding River (and Killbuck Creek) to its native range, the skipjack herring has never been recorded in that drainage. This is likely due to the affinity of the fish to large river habitat. The Walhonding likely does not contain suitable habitat to allow for a successfully breeding population.

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

Since the Little Killbuck site is an active farm consisting of connected drainage ditches, it is not likely that fishing or boating would occur at or relatively near this location. Access by the general public is limited to vehicular traffic through and around the site. Considering these limitations it is highly unlikely that the skipjack herring will arrive at the divide by anthropogenic means, such as livewell or aquarium releases.

Little Killbuck Creek, Medina County, OH - Skipjack herring (*Alosa chrysochloris*)

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

Aquatic Pathway Team	Expertise Position title or team role	Rating	Certainty		
	USACE LRB - Biologist	Low	MC		
	Div. of Wildlife-District 3 Fish Mgt. Sup.	Low	RC		
	USACE LRH - Biologist	Low	RC		
	USACE LRB - Soil Scientist	Low	MC		
	Team Ratings	**Low**	**MC**		

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

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

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

Remarks: As a visual predator, the turbid waters of the agricultural ditches may be unsuitable for the skipjack herring. Survival of a viable, reproducing population of skipjack herring within the agricultural ditch network may be unlikely due low water quality and high temperatures in summer months.

Little Killbuck Creek, Medina County, OH - Skipjack herring (*Alosa chrysochloris*)

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

Aquatic Pathway Team	Expertise Position title or team role	Rating	Certainty		
	USACE LRB - Biologist	Medium	RC		
	Division of Wildlife-District 3 Fish Mgt. Sup.	Low	RC		
	USACE LRH - Biologist	Medium	RC		
	USACE LRB - Soil Scientist	Medium	MC		
	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: The habitat at the pathway consists of a series of connected sparsely vegetated agricultural drainage ditches which create a pathway from one basin to another. It is possible that the skipjack herring could survive in this system long enough to transfer across the basin under the proper conditions. During storm events water is pumped from these agricultural ditches into both basins. A storm event as minimal as a 5% annual return storm results in significant portions of this site being inundated and FEMA maps display the entire site inundated from a 100% annual return storm event. Considering these factors, it would be possible for the skipjack herring to transfer across basins via the agricultural drainage ditches if the frequency between significant storm events was within a timeframe that would allow their survival within this system. In addition, roadside ditches along Franchester Road span the divide and connect both basins via Repp Run and Clear Creek. The results of the storm event witnessed during the site visit describe this area as being inundated and water flowing across the divide.