GLMRIS

Great Lakes and Mississippi River Interbasin Study

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

Aquatic Nuisance Species Controls Report

Wabash-Maumee Basin Connection

Fort Wayne, Indiana

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AQUATIC NUISANCE SPECIES CONTROLS REPORT
WABASH-MAUMEE BASIN CONNECTION STUDY
FORT WAYNE, INDIANA

EXECUTIVE SUMMARY

In 2010, the U.S. Army Corps of Engineers (USACE) Great Lakes and Mississippi River Interbasin Study (GLMRIS) Other Pathways Preliminary Risk Characterization (2) identified 18 potential aquatic pathways between the Great Lakes and Mississippi River basins, outside the Chicago Area Waterway System (CAWS), where a surface water connection may exist between headwater streams in either basin and that could be utilized for the interbasin transfer of aquatic nuisance species (ANS). Of these locations, Eagle Marsh in Fort Wayne, Indiana (Allen County), was determined to pose the greatest near-term potential for allowing interbasin transfer of ANS, specifically Asian carp. Therefore, the Indiana Department of Natural Resources (Indiana DNR) constructed a temporary fence across part of the marsh in late 2010 to prevent interbasin transfer of adult Asian carp into the Great Lakes Basin.

Through collaboration with multiple organizations at the Federal, state and local levels, the USACE followed up its initial study of this location in 2011-2012 by concurrently completing a more detailed aquatic pathway assessment and an ANS Controls Report for Eagle Marsh. The pathway assessment is the first of these reports (Appendix A) and characterizes the likelihood that a viable aquatic pathway exists at the Eagle Marsh Wetland Preserve southwest of Fort Wayne, Indiana, and could allow transfer of aquatic nuisance species (ANS) between the Great Lakes and Mississippi Rivers Basins. This ANS Controls Report, which is the second report, builds upon the findings of the pathway assessment and evaluates the available options and technologies that may be available at Eagle Marsh to prevent the transfer of ANS from occurring at this location. The objectives of this ANS Controls Report are to describe the existing environmental conditions of this pathway and to identify and evaluate the specific structural and non-structural measures, or controls, that are available to prevent ANS transfer from occurring between the Wabash and Maumee River basins at Eagle Marsh. However, it is not the objective of this report to recommend a particular course of action.

It is important to note that even if one or more of the alternatives identified in this Controls Report are implemented, there is substantial residual likelihood that ANS could transfer between the basins at this or other locations along the basin divide by using other vectors and pathways outside the scope of this study (e.g. bait buckets, terrestrial transport, commercial food fish, pet trade, recreational boating,). Table 1.1 provides descriptions and cost estimates for structural alternatives most likely to prevent ANS transfer at Eagle Marsh.

USACE took the need to minimize flooding and protect wetlands into consideration during the formulation of these various alternatives. In addition, the provisions of the Allen County stormwater management ordinance; sustainable and low-cost implementation and maintenance requirements; and removal of the existing chain-link fence were all considered during the study.

The study area for the Eagle Marsh pathway extends southwest from Fort Wayne along the Little River to Huntington, Indiana. Eagle Marsh itself is a restored wetland established in 2005 under the purview of the Little River Wetlands Project (LRWP), Natural Resources Conservation

Service (NRCS) and Indiana DNR. Since 2005, a variety of wetland habitats have been restored in an attempt to approximate pre-settlement conditions and enhance the ecology of the area. At 716 acres, Eagle Marsh is one of the largest wetland restorations ever completed in Indiana. It is also an urban natural area used primarily for conservation, education and recreation. The property is owned by Indiana DNR and LRWP, and is managed by the LRWP.

At this time, no single non-Federal sponsor has been identified, although several non-Federal organizations have expressed interest in assisting with implementation of a solution. Additionally, there is no specific authority from Congress that would allow USACE to implement any alternative evaluated in this report.

The Eagle Marsh ANS Controls Report was completed in November 2012, and a public meeting was held in December 2012 in Fort Wayne, Indiana. The public predominantly expressed support for Alternatives H and I; concerns were also voiced regarding the potential for induced flooding that could result from implementation of these alternatives. Following that public meeting, a meeting was conducted with the following organizational stakeholders: the Indiana DNR, U.S. Geological Survey, NRCS, U.S. Fish and Wildlife Service, Maumee River Basin Commission, The Nature Conservancy, LRWP, Allen County Drainage Board, White House Council on Environmental Quality and USACE. The organizational stakeholders also expressed support for Alternatives H & I. The outcome of this organizational stakeholder meeting, which was also held in December 2012, was a consensus that the quickest and most cost-effective means to implement a solution would be to pursue the project independent of GLMRIS, as part of the Great Lakes Restoration Initiative (GLRI) program, with a non-Federal stakeholder or Federal agency other than USACE as project lead.

Table 1.1 - Alternative Costs and Descriptions

Alternative	Location	Annual O&M[1]	Initial Construction Cost[2]
A. Construct an I-wall	Eagle Marsh (Basin Divide)	$11k	$14M
B. Construct a fence and reconstruct left descending Graham McCulloch Ditch berm	Eagle Marsh (Basin Divide)	$18k	$3.2M
C. Construct an earthen berm and pump station	Homestead Road	$600k	$25M
D. Construct a permeable berm with telemetered sluice gates	Amber Road	$22k	$7.8M
E. Construct a fence/earthen berm combination	Eagle Marsh (Basin Divide)	$44k	$4.2M
F. Construct bar screen barrier at existing weir	Huntington Dam	$96k	$2.7M
G. Construct vertical drop structure with telemetered sluice gate	Homestead Road	$26k	$4.8M
H. Reconstruct left descending Graham McCulloch Ditch berm	Eagle Marsh (Basin Divide)	$14k	$5.7M
I. Reconstruct left descending Graham McCulloch Ditch berm, Demolish right descending berm and construct multi-cell wetland area	Eagle Marsh (Basin Divide)	$17k	$7.2M

[1]Reference Section 9 of Appendix F for the Operation and Maintenance schedules.

[2]Reference Section 10 of Appendix F for the Cost Estimate.

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FORT WAYNE, INDIANA

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MAIN REPORT

1.0 INTRODUCTION

Aquatic Nuisance Species (ANS) are an increasing concern around the world and in the United States. The Aquatic Nuisance Species Task Force (ANSTF) is a group of Federal agencies led by the U.S. Fish and Wildlife Service (USFWS) and the National Oceanic and Atmospheric Association, and it indicates that the impacts of ANS are second only to habitat destruction as a cause of global biodiversity loss. The taskforce estimates the costs to control and eradicate invasive species in the U.S. alone amount to more than $137 billion annually. Preventing introductions of potentially harmful species is generally considered the most efficient way to reduce the threat of ANS and their potential to invade the Great Lakes.

The U.S. Geological Survey (USGS) Nonindigenous Aquatic Species (NAS) information resource defines NAS "…species that enters a body of water or aquatic ecosystem outside of its historic or native range." The ANSTF defines ANS 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." For GLMRIS and this study, ANS includes all nonindigenous aquatic species that are present in the Great Lakes but not known to be present in the Mississippi River Basin, as well as all nonindigenous aquatic species present in the Mississippi River or its tributaries but not known to be present in the Great Lakes Basin. Therefore, the term "ANS" is synonymous with "non-indigenous aquatic species" in this report.

Eagle Marsh is bisected by what is known as a "basin divide". A basin divide is a topographical rise that separates one drainage basin from another. In other words, precipitation that falls on one side or the other of this particular basin divide will ultimately either find its way northeast through the Maumee River to Lake Erie or west through the Wabash River (eventually) to the Mississippi River – but it *usually* does not mix. Eagle Marsh spans a low spot in the basin divide, where the surface waters between the Great Lakes and Mississippi River basins periodically connect during significant flood events. This presents a problem because Asian carp have been collected from the Wabash River approximately 20 miles downstream. Flooding occasionally opens a gateway between these basins and provides the opportunity for ANS from one basin to spread into the other, which can be harmful to their respective aquatic ecosystems.

This document is an interim report to the Great Lakes and Mississippi River Interbasin Study (GLMRIS) prepared by the Louisville District of the U.S. Army Corps of Engineers (USACE) with support from Indiana Department of Natural Resources and other governmental and non-governmental organizations that have a stake in preventing the spread of ANS. This study identifies an array of options and technologies to prevent any ANS from spreading between the Great Lakes and Mississippi River basins through Eagle Marsh.

1.1. Study Authority

GLMRIS was authorized in Section 3061(d) of the Water Resources Development Act of 2007 (WRDA 2007), which prescribes the following authority to the Secretary of the Army:

> (d) FEASIBILITY STUDY. - The Secretary, in consultation with appropriate Federal, State, local, and non-governmental 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.

USACE headquarters assigned the GLMRIS project management role to the Great Lakes and Ohio River Division (CELRD) and issued specific guidance to the Great Lakes and Ohio River Division commander for execution of the project, including the following general direction to:

> …provide a thorough and comprehensive analysis of the options and technologies that could be applied to prevent the interbasin transfer of aquatic nuisance species between the Great Lakes and Mississippi River through aquatic pathways.

Figure 1.1 illustrates the broad geographical area of GLMRIS. Hydrologically, GLMRIS encompasses the U.S. portion of the basin draining to the five Great Lakes (brown shaded area), and the Upper Mississippi River Basin (dark green shaded area), focusing on the approximately 1,500-mile subtle boundary between the two major drainage basins formed after recession of the Wisconsin period glacier 10,000 years ago. Ecologically, the GLMRIS area of consideration is even broader in scope because it considers all potential ANS from micro-organisms to large fish that may survive and thrive within the vast aquatic resources in the upper Mississippi and Ohio River basins as well as in the Great Lakes and their tributaries.

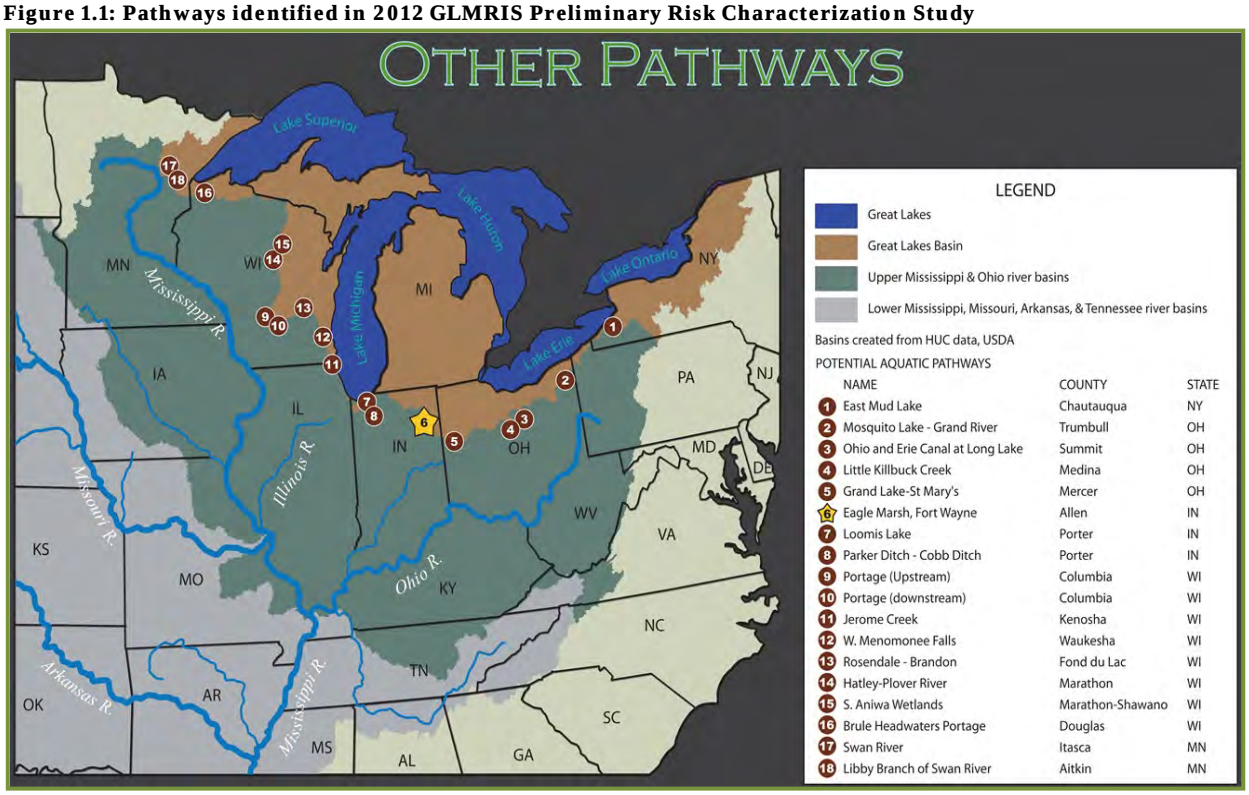
Locations 1 through 18 along the boundary between the basins are all of the potential aquatic pathways outside of the Chicago Area Waterway System (CAWS) that are being evaluated as part of GLMRIS. Location 6, designated by the star, is Eagle Marsh, which lies on the basin divide between the Maumee and Wabash River basins in southwest Fort Wayne, Indiana. A previous interim GLMRIS report identified Eagle Marsh as a significant near-term risk for interbasin transfer of ANS due to the nature of the intermittent aquatic pathway that forms between the basins (Section 1.3.2).

1.2. Study Area

Eagle Marsh is the green shaded area depicted in Figure 1.2 situated in a historic floodplain that lies between headwaters of the Wabash River and a small tributary of the St. Marys River known as Junk Ditch. The St. Marys River originates in west-central Ohio and flows northwest to Fort Wayne where it merges with the St. Joseph River, which flows southwest from its headwaters in Michigan to form the Maumee River. The Maumee River directs flow northeast into Lake Erie.

The paths of the St. Marys and St. Joseph rivers roughly parallel the Fort Wayne Moraine, which was formed during an episode in the sequential retreat of the Erie Lobe of the Laurentian Ice Sheet during the Wisconsin glacial period approximately 12,000 years ago. As temperatures warmed and the Erie Lobe continued to retreat, the Fort Wayne Moraine formed glacial Lake Maumee by preventing westward outflow while the retreating glacier blocked eastward outflow.

Figure 1.1: Pathways identified in 2012 GLMRIS Preliminary Risk Characterization Study



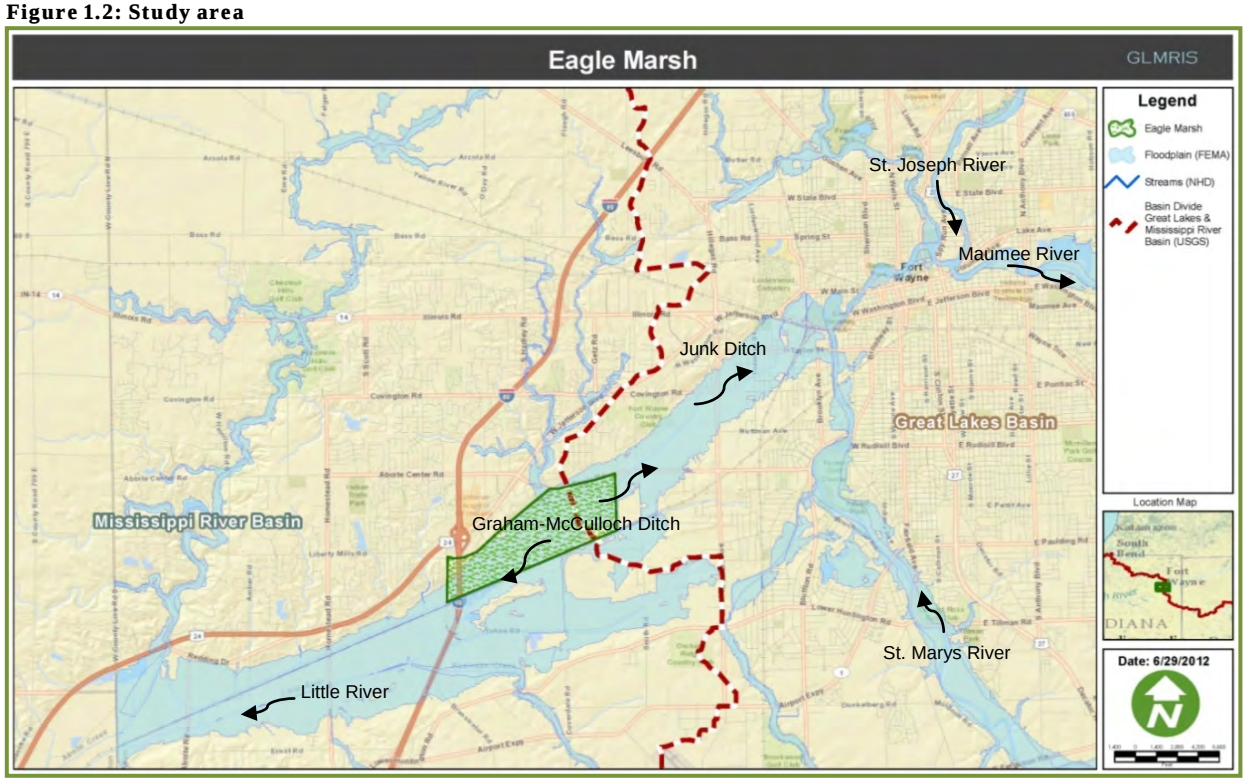
Glacial Lake Maumee rose until it overtopped a low spot in the moraine; and in an event known as the Maumee Torrent, rapidly eroded and carved out a mile-wide channel in the glacially deposited soils through Fort Wayne southeast to Huntington, Indiana, which rapidly drained glacial Lake Maumee into the Wabash River.

The red-white line in Figure 1.2 is the estimated alignment of the basin divide between runoff that drains into the Great Lakes and runoff that drains into the Mississippi River. The shaded areas depict the waterways' floodplains on both sides of the divide as well as the intermittent interbasin connection that forms across the divide through Eagle Marsh.

Eagle Marsh was established in 2005 as an urban natural area used primarily for conservation, education and recreation when the Natural Resources Conservation Service (NRCS) purchased an easement of about 660 acres. The property is now jointly owned by the State of Indiana and Little Rivers Wetland Project (LRWP), managed by LRWP. Additional land has been acquired since 2005, bringing the total to 716 acres, and a variety of wetland habitats were restored between 2005 and 2009 to approximate pre-settlement conditions. A 41-acre mature forested wetland is included in the preserve, one of the largest wetland restorations completed in Indiana.

The structures within Eagle Marsh are a barn used for equipment storage and office space and a picnic pavilion. Infrastructure within Eagle Marsh includes a parking area, several unpaved roads, a network of trails and a temporary chain-link fence to prevent the movement of adult Asian carp. The roads provide access into the interior and to the temporary chain-link fence constructed by Indiana DNR until a permanent solution is developed.

Figure 1.2: Study area



The area west of Eagle Marsh is agricultural land. Some structures associated with agriculture practices are present in this area, but substantial development is not present. This agricultural area extends from roughly Interstate-69 (I-69) downstream to Aboite Road. Even with the use of drain tiles and levees, crop production is problematic due to flooding from Graham-McCulloch Ditch. Flooding renders the area marginally suitable for agriculture. The area east of Eagle Marsh is comprised of a mix of flood-prone urban areas within Fort Wayne that include some residential and commercial structures within the floodplain.

1.3. Study Purpose

The purpose of this interim GLMRIS study is to identify a range of viable options and technologies to prevent the spread of ANS between the Mississippi River and Great Lakes basins through Eagle Marsh in Fort Wayne, Indiana. This study provides hydrologic, hydraulic, geomorphologic, biologic, cultural, engineering and construction details in the evaluation of possible controls to prevent interbasin transfer of ANS of specific concern at this location. This study is an incremental step intended to expedite implementation of one or more measures in a long-range plan to prevent interbasin spread of ANS through Eagle Marsh.

1.3.1. Relationship to GLMRIS Focus Area 1

The broad scope and technical complexity of GLMRIS led to a risk-based approach to most efficiently and effectively apply limited resources to address both the CSSC and other aquatic pathways that exist or may form across the basin divide. The CELRD commander split execution responsibilities for GLMRIS into two focus areas. Chicago District assumed project management responsibility for Focus Area 1, CSSC and the connected CAWS, which was deemed to be the greatest risk aquatic pathway for the spread of ANS between the Great Lakes and Mississippi

River basins. Buffalo District assumed the project management role for Focus Area 2, which consists of all other aquatic pathways that exist or may form along the basin divide. Louisville District was assigned to complete an expedited study to identify viable long-term options and technologies to prevent interbasin ANS transfer ANS through Eagle Marsh.

There are important similarities and differences between CSSC and the other potential aquatic pathways within GLMRIS Focus Area 2, including Eagle Marsh. Both GLMRIS focus areas must consider the risks of interbasin transfer of a wide array of potential ANS of concern based on evaluation of site specific circumstances and the array of available control technologies to determine the most viable ANS prevention options. Both require engagement and input from many organizational and public stakeholders to appropriately formulate and assess potential costs and benefits of individual prevention options and technologies as well as combinations of measures into alternative plans to prevent interbasin spread of ANS at any location. They must also comply with the principles and guidelines, engineer regulations and other guidance applicable to USACE planning studies and implementation of civil works projects.

There are two primary differences between the two focus areas. Within Focus Area 1, the CSSC is an active commercial navigation channel, through which an average of 3,500 cubic feet per second of water from Lake Michigan flows continuously into the Illinois River. On the other hand, within Focus Area 2 there is no aquatic pathway at most of the potential locations most of the time, and a large rare flood event is typically necessary to establish a temporary aquatic connection at any specific potential aquatic pathway location between the basins. At Eagle Marsh, a very shallow surface water connection between the basins begins to form from the largest storm event expected to occur during any given year. At the 1% annual frequency storm, the level of flood event that has only a 1 in 100 chance of being equaled or exceeded during any given year, the rate of interbasin flow through Eagle Marsh is estimated to peak at approximately 1,500 cubic feet per second, and interbasin flow is only expected to occur for a few days. The other key difference with Focus Area 1 is that none of the potential aquatic pathways within Focus Area 2, including Eagle Marsh, currently provide an avenue for commercial navigation.

Consequently, the nature of the risk associated with interbasin transfer of ANS through the potential aquatic pathways identified within Focus Area 2 is different and lower than in Focus Area 1. However, lower risk does not mean the risks associated with interbasin transfer of ANS through other aquatic pathways are inconsequential, especially for those ANS capable of causing large scale ecologic and economic consequences, such as Asian carp.

1.3.2. Relevant Prior Studies and Reports

The broad scope and technical complexity of GLMRIS have led to a risk-based approach to efficiently and effectively apply limited resources to address both the CSSC and other aquatic pathways that exist or may form across the basin divide. The following paragraphs are summaries of the relevant parts of three preceding interim GLMRIS reports that directly support this study to identify viable options to prevent interbasin spread of ANS through Eagle Marsh.

1.3.2.1. GLMRIS Other Pathways Preliminary Risk Characterization, (USACE 2010)

This interim GLMRIS report helped establish the scope of the other aquatic pathways portion of the Congressional authorization by identifying a preliminary list of 36 locations. Five of those

locations were later deemed to pose a very remote possibility as a potential pathway and were removed from further consideration. The remaining 31 pathways are located along the approximately 1,500 mile basin divide where an aquatic connection between the basins appeared feasible. This preliminary report was completed and approved for public release within five months of the day it began by engaging and receiving significant contributions from the U. S. Geological Survey (USGS); U. S. Fish and Wildlife Service (USFWS); National Oceanic and Atmospheric Administration (NOAA); U.S. Environmental Protection Agency (EPA); departments of natural resources of Minnesota, Wisconsin, Indiana and Ohio; New York Department of Environmental Conservation; and Great Lakes Fishery Commission.

Photo 1.1: Chain-link fence ties into the Graham-McCulloch Ditch left descending berm

At 13 of 31 locations, the interagency team determined there was a low likelihood of an interbasin connection ever forming and an even lower likelihood that any ANS would be capable of spreading between the basins and causing measurable impacts if an aquatic pathway ever formed at any of them. However, at 18 locations, the team could not find adequate information or an adequate basis to reach this same conclusion, and therefore recommended that each of these 18 locations be subjected to a more thorough collection of relevant data and a more rigorous evaluation of the risks of interbasin transfer of ANS (likelihood and consequences). One of the eighteen locations, Eagle Marsh, was singled out as a potentially significant near-term risk, and the interagency team determined that an interim risk reduction measure was warranted in advance of completing the evaluation of the other seventeen locations.

At an on-site meeting in July 2010, the interagency team and LRWP, identified a temporary barrier (a chain-link fence) to prevent the spread of adult Asian carp. Indiana DNR completed the fence with Federal funds in October 2010 (Photo 1.1). It was constructed in accordance with the Wetland Reserve Program Compatible Use Authorization (CUA) that expires 24 August 2014.

In response to the urgent situation at Eagle Marsh, the GLMRIS Other Pathways Preliminary Risk Characterization (2) recommended an expedited planning study performed in concert with stakeholder organizations sharing ANS responsibilities and an interest in Eagle Marsh to identify viable long-term risk reduction measures. Visit this site to view the preliminary risk characterization report: http://glmris.anl.gov/documents/docs/Other_Pathways_Risk.pdf.

1.3.2.2. Non-Native Species of Concern and Dispersal Risk for the Great Lakes and Mississippi River Interbasin Study

This study involved an extensive literature search to determine the number and types of ANS already present in the Unites States and Canada and determine those that are most likely to exist or be introduced into the Great Lakes or Mississippi River basins. Approximately 625 publications and reports were reviewed. A total of 254 non-native aquatic species were initially identified to occur in one or both basins with the threat of infiltrating the adjacent basin.

From the initial list of 254 potential invaders, 135 species were rejected because the species had already established in both basins and any dispersal control mechanism would be too late, the

species were not yet located in either basin, could bypass any aquatic control mechanism by terrestrial movement, or had no potential to cause adverse effects to the invaded ecosystem. This left 119 alien and native species to be assessed for the methods each ANS employs for dispersal to determine their likelihood of dispersing to the basin divide and the potential adverse effects to ecosystems each may cause. The final list was reduced to 39 high-risk ANS to potentially transfer between the Great Lakes and Mississippi River basins through the CSSC. Ten species were determined to be a high risk for potential spread into the Great Lakes Basin and 29 were determined to be a high risk for potential spread into the Mississippi River Basin.

This evaluation addressed one of the most complicated aspects of defining the scope of the GLMRIS authorization by establishing a comprehensive list of ANS with a potential for interbasin transfer, and it was a significant aid in defining the list of species of specific concern at the Eagle Marsh location, which is summarized in Section 3.3 of this report and presented in detail in Appendix A. The report is available at: http://glmris.anl.gov/documents/docs/Non-Native_Species.pdf.

1.3.2.3. Inventory of Available Controls for Aquatic Nuisance Species of Concern, Chicago Area Waterway System

This interim GLMRIS report took a broad look at the range of available options and technologies that may be applied to prevent ANS transfer via the CAWS portion of GLMRIS, also referred to as Focus Area 1. The results of the study concluded by identifying approximately 90 available controls that may be applied in the CAWS to prevent the transfer of organisms of concern between the Great Lakes and the Mississippi River basins via the aquatic pathway. The controls were grouped into 27 categories and described in individual fact sheets. The ANS controls identified in this report were considered in the development of the array of options and technologies that could be applied at Eagle Marsh. Both the summary report and the individual fact sheets may be viewed or downloaded from the GLMRIS website at: http://glmris.anl.gov/documents/docs/ANS_Control_Paper.pdf.

1.4. Report Contents

This interim report is formatted to be readily transformed into an integrated decision document that includes all documentation required for compliance with the National Environmental Policy Act (NEPA) and a feasibility study completed in accordance with USACE guidance and procedures for civil works planning documents. As such, Section 2.0 of this report presents a comprehensive synopsis of the existing environmental conditions that may be affected by implementation of a project to prevent interbasin spread of ANS between the Great Lakes and Mississippi River basins via Eagle Marsh.

Section 3.0 presents the results of application of the USACE plan formulation process, which starts with an explanation of the nature and extent of the ANS problem and identifies opportunities to prevent and mitigate those problems. It outlines the objectives and constraints to developing a Federal project and explains the most probable future conditions if a project is not implemented. The next subsection identifies the broad array of potential structural and non-structural measures initially considered and explains the criteria for how the measures were either screened out or developed into alternatives for more detailed consideration. Section 3.0 concludes with a comparison of the costs and overall effectiveness of each alternative.

Section 4.0 provides an assessment of potential environmental impacts of each of the alternatives relative to the environmental and socioeconomic conditions described in Section 2.0. Section 5.0 identifies mitigation of any potentially unacceptable impacts that could occur from implementing each of the nine alternatives, such as induced flooding. Section 6.0 explains requirements that must be met for Federal implementation of a project at Eagle Marsh and Section 7.0 explains the extent and results of public involvement on the project to date. Section 8.0 presents the conclusions and Section 9.0 lists the key sources of information used in developing this report.

Appendix A is an aquatic pathway assessment report, which was part of the completion of the evaluation of the likelihood of interbasin spread of ANS at 18 potential aquatic pathways within Focus Area 2 of GLMRIS. It provides the basis for the future without project condition summarized in Section 3.3 and the baseline for the formulation and comparison of prevention measures in Sections 3.5, 3.6 and 3.7. Appendix B provides a glossary of acronyms and Appendix C lists individuals who contributed to the report. Appendix D contains a Value Engineering report, which explains the preliminary identification and evaluation of structural and non-structural measures. Appendix E is the real estate plan and Appendix F presents the results of the hydraulic modeling and the engineering development and evaluation of structural alternatives. Appendix G contains the engineer drawings that depict the location and layout of facilities associated with each of the nine structural alternatives presented.

2.0 AFFECTED ENVIRONMENT - EXISTING CONDITIONS

2.1. Climate

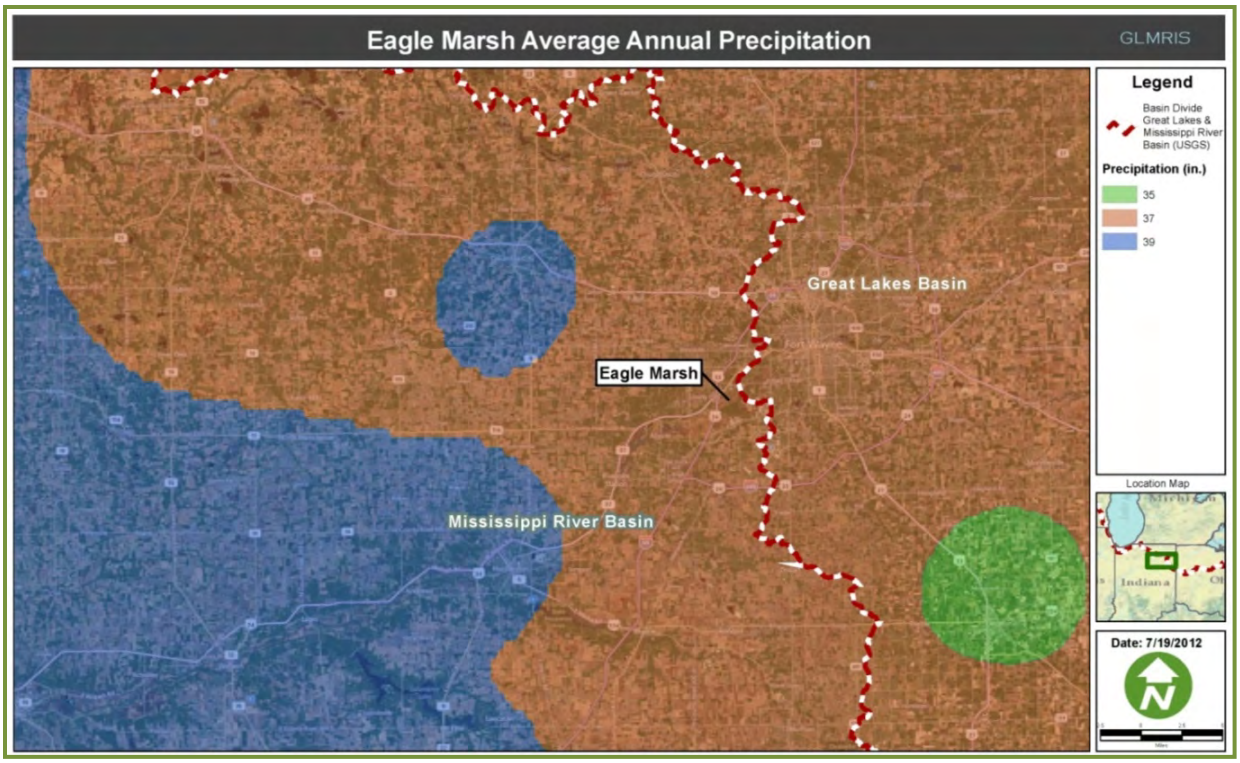
Allen County is located within the humid continental climate zone and experiences four distinct seasons per year. Weather patterns in Allen County are influenced by the Great Lakes. The seasonal range of temperature is a daily winter minimum of approximately 20 degrees Fahrenheit (ºF) to a daily summer maximum of approximately 85ºF. Snowfall is prevalent in the winter months, with average cumulative annual snowfall of approximately 33 inches. The average annual precipitation is approximately 36 inches, with annual evapotranspiration of approximately 27 inches. The vegetative growing season is approximately 156 days (22). The last freezing temperature in spring usually occurs around the seventh day in May, and the first freezing temperature in fall is usually about 10 October. The average annual extreme minimum temperature for the area is from -10ºF to -5ºF (23). Heavy precipitation and flooding is most likely to occur at Eagle Marsh during winter and spring. Remnants of hurricanes may also cause flooding in late summer. During winter flood events a significant portion of the water column may freeze leading to significant sheets of ice developing on top of flood waters. Dry conditions are most prevalent during summer and fall.

2.2. Soils and Geology

2.2.1. Geology and Physiography

The Wabash-Erie Channel is the geologic name given to the broad valley that extends southwestward for about 17 miles from the western apex of the Maumee Lake Plain through downtown Fort Wayne and southwest Allen County to just west of the City of Huntington where it joins the main stem of the Wabash River. Eagle Marsh is located at the upstream portion of the

Figure 2.1: Average annual precipitation in the study area



Wabash-Erie Channel near Fort Wayne. The channel was carved by glacial outwash from the Maumee Torrent during the last ice age and later filled with river sediments and organic peat and muck. The valley now generally consists of alluvial silts, sands and clays with areas of organic sediment overlying glacial till (Trafalgar formation). The Wabash-Erie Channel is naturally poorly drained and of low relief (25, 12). Elevations in Eagle Marsh and the surrounding area appear in Figure 2.2; low elevations are shown in white, and high elevations are shown in green and teal. Part of the Wabash-Erie Channel is visible as the band of low elevation that moves from the lower left corner to the upper right corner of Figure 2.2. The study area has some of the lowest elevations in Allen County (5).

The divide between the Great Lakes Basin and the Mississippi River Basin spans this area, and is illustrated in Figure 2.1 and Figure 2.2 by a red and white dashed line. Due to the low relief of this area the basin divide is poorly defined and during flood events mixing of the watersheds can occur. Historically, this area was a large marsh. It is likely that the basin divide was poorly defined before the area was modified by anthropogenic activities.

The Farmland Protection Policy Act, 7 U.S.C. §4201 et. seq., minimizes the unnecessary and irreversible conversion of farmland to non-agricultural uses. Locations outside of Eagle Marsh where structural measures could be constructed have the potential to contain prime or unique farmland. Generally, prime and unique farmlands are areas that are physically and chemically suited to producing a particular category of crops and are available for those uses.

2.2.2. Soil Associations

Eagle Marsh and the surrounding area of interest are composed largely of soils of the Carlisle-Willette Association. According to the Allen County Soil Survey, these soils are deep, poorly

drained mucky soils in upland depressions (5). Soils of the Morley-Blunt Association are also present within the study area in lesser quantities. This soil association is deep, moderately well drained to somewhat poorly drained (5).

2.2.3. Hydric Soils

Hydric soils are present in and around Eagle Marsh (Figure 2.3). The extent and type of hydric soils present will be determined once the location for implementation of a project to prevent the spread of ANS is selected. Hydric soils may indicate the presence of wetlands.

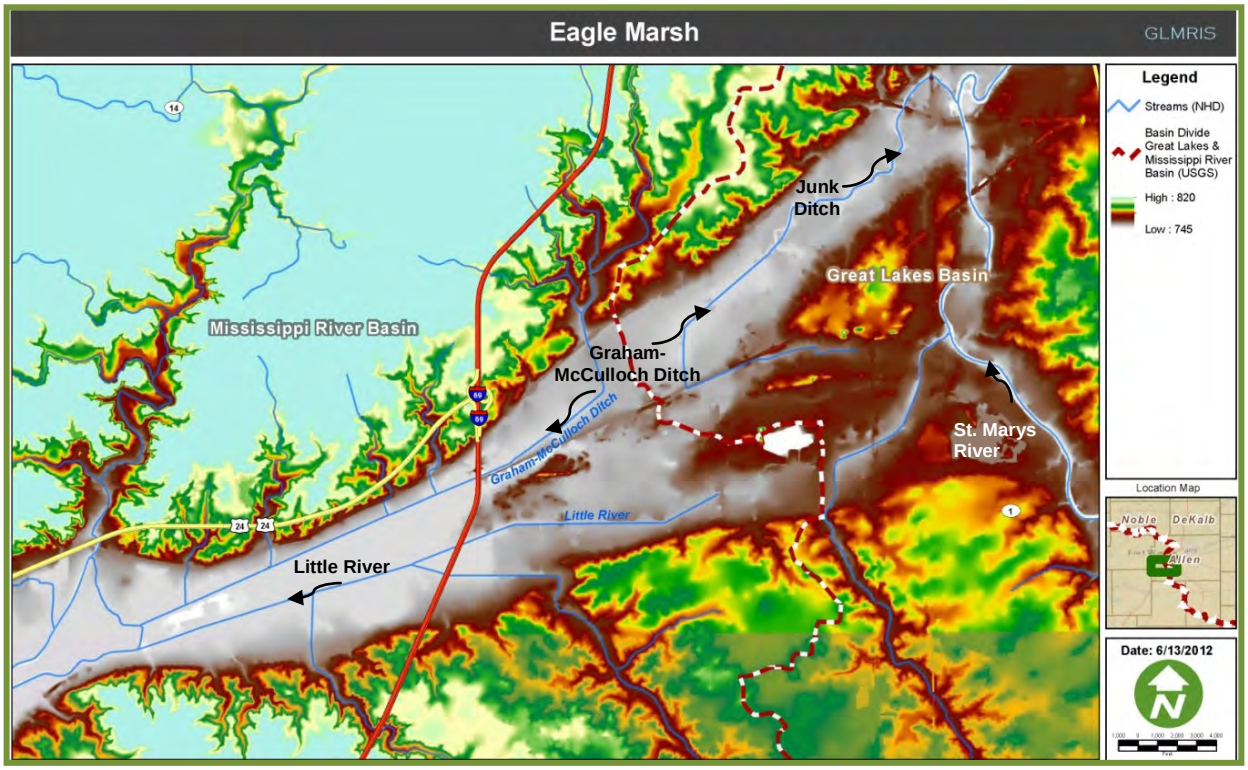
2.3. Surface Water and Other Aquatic Resources

2.3.1. Surface Water

Surface drainage in the study area is divided between the Wabash River and Maumee River basins. Rainwater that falls in the area normally either enters Graham-McCulloch Ditch, flows towards the Wabash River and ultimately into the Mississippi River or enters Junk Ditch, flows towards the Maumee River Basin and ultimately into the Great Lakes. Both Graham-McCulloch Ditch and Junk Ditch have been moved from their natural beds and straightened, with the profile of Junk Ditch modified from its natural direction to flow toward the St. Marys River.

Water quality in Junk and Graham-McCulloch ditches is poor (3) due to much of their watersheds occurring within the urbanized area of Fort Wayne and other developed areas. A wastewater treatment plant is located on Graham-McCulloch Ditch just upstream of Eagle Marsh. Several naturally occurring ponds (Photo 2.1) and a constructed irrigation pond (Photo 2.2) are present at Eagle Marsh.

Figure 2.2: Elevations in the study area



The naturally occurring ponds may dry up during prolonged dry periods. According to Indiana DNR, there are no state-designated wild and scenic rivers within the study area.

Photo 2.1: Naturally occurring pond, 16-Apr-10

2.3.2. Groundwater

Groundwater in and around Eagle Marsh is generally shallow or emergent. Operation of local quarries may cause an increase in the water table depth due to groundwater pumping.

Photo 2.2: Irrigation pond, 02-Nov-10

2.3.3. Floodplains

Federal Emergency Management Agency (FEMA) National Flood Insurance Program maps illustrate that the study area occurs within a special flood hazard area (SFHA). FEMA defines a floodplain as, "any area susceptible to inundation by water from any source" and a special flood hazard area as, "the land area covered by the floodwaters of the base flood". The SFHA is the area where the National Flood Insurance Program's floodplain management regulations must be enforced and the area where the mandatory purchase of flood insurance policies. Eagle Marsh and the other locations considered for construction of structural alternatives are located within the floodplain of the 1% annual chance flood event (Figure 2.4). Examples of flooding at Eagle Marsh can be seen in Photo 2.3 and Photo 2.4.

Figure 2.3: Hydric soils in the study area

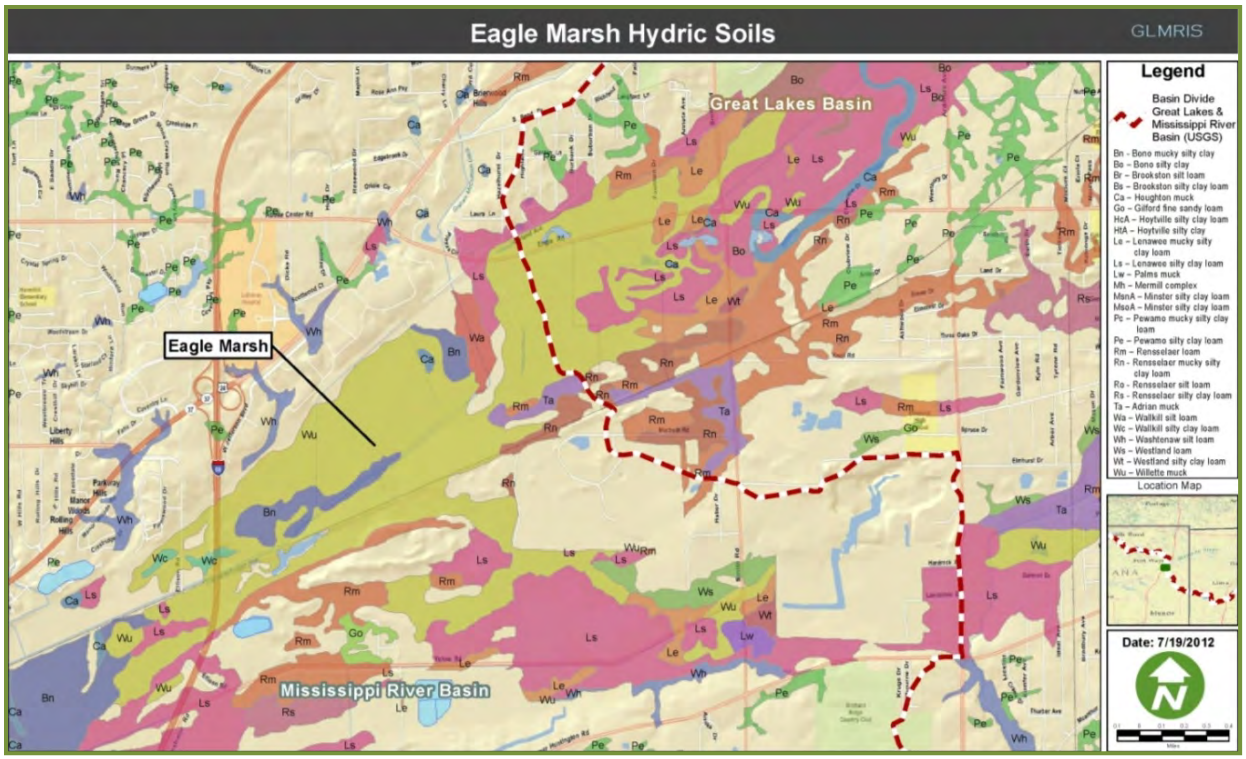


Photo 2.4: Flooding across the entrance road, 28-Apr-11

Photo 2.3: Flooding at the temporary ANS barrier, 28-Apr-11

In this study, frequency of storm and flood events will be described as a percent annual chance event, which is the chance of a storm or flood occurring or being exceeded in any given year. For example, a 1% annual chance event refers to a storm or flood event that statistically would be expected to occur one time in any given 100-year period. This has been referred to as a "100-year" event, which is misleading because the emphasis is on the time expected to occur between flood events of a given magnitude, and the chance of the event occurring is lost. It becomes expected that a "100-year storm" will only occur once every 100 years; the true meaning is that there is a 1 in 100 chance that this event could be equaled or exceeded in any given year. This term may refer to the amount of rainfall in a particular time period, but in this study it generally refers to the highest (peak) water surface elevation in streams resulting from such a storm event. For further explanation, see this website: http://ga.water.usgs.gov/edu/100yearflood.html.

Figure 2.4: Flooded areas during the 1% annual chance flood

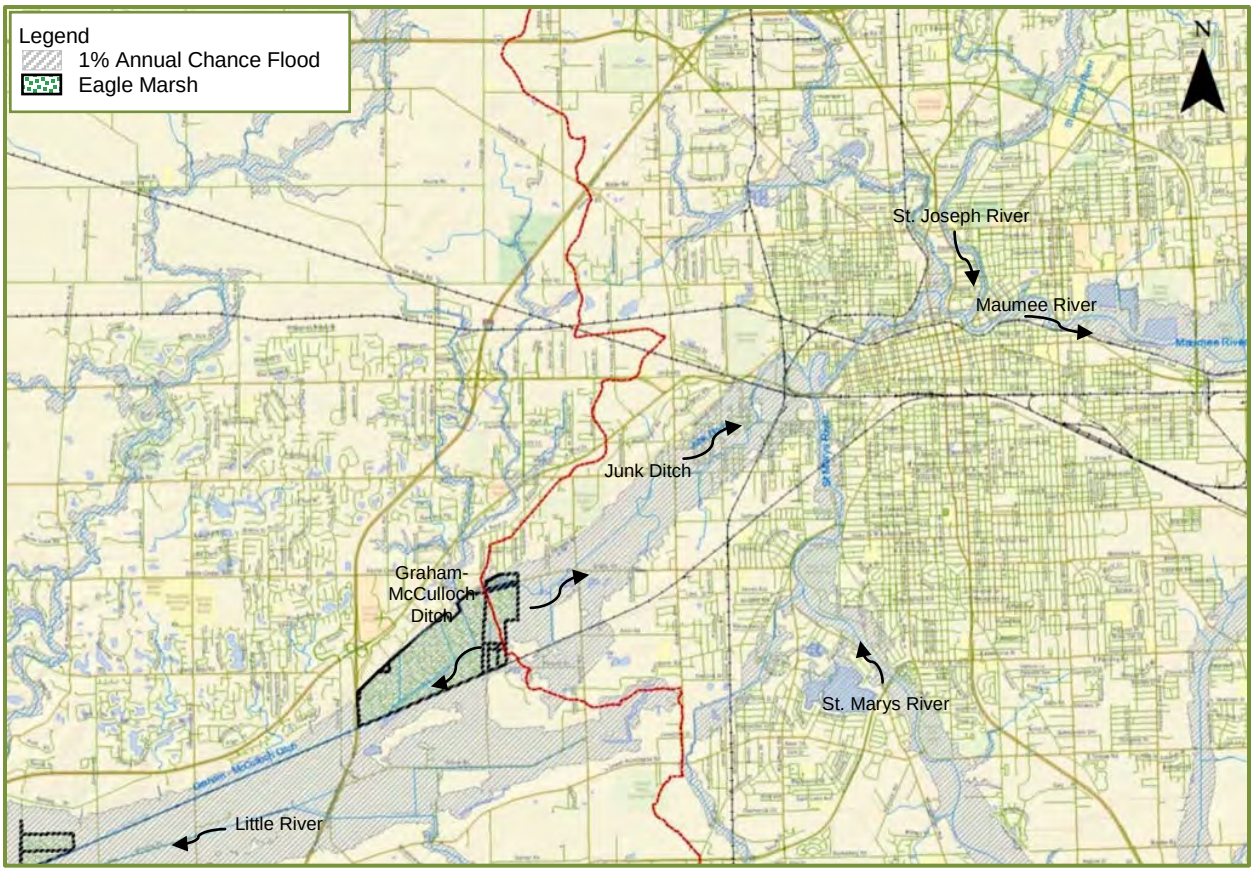


Figure 2.4 shows the approximate limits of a 1% annual chance floodplain as defined by the 2009 update of Flood Insurance Study (FIS) and Flood Insurance Rate Maps (FIRM) for the area. The models used to develop this 2009 inundation mapping for Junk Ditch and Graham-McCulloch Ditch were further refined to more accurately analyze the complex behavior of flow during high water events, when water is known to transfer between the St. Marys and Graham-McCulloch watersheds. This was done to more accurately evaluate impacts of structural alternatives under consideration in this study (see also Section 3.4.2.2). Statistics regarding the parcels and structures in the floodplain for a 1% annual chance event occurring on the St. Marys River and Graham-McCulloch Ditch watersheds are summarized in Tables 2.1 and 2.2 below. This data is for the area between the confluence of Junk Ditch at the St. Marys River to the confluence of Graham-McCulloch Ditch at the Little River. Parcels were included in the tally regardless of depth or location of inundation. Cumulative real property values were calculated using gross value data from the 2007-2008 property database from the Allen County Assessor's Office and the Allen County Department of Planning Services.

Table 2.1 Baseline Condition Floodplain Statistics[1] by Flooding Source

Number of Parcels Affected for 1% Event		Number of Structures Affected for 1% Event		Inundated Area for 1% Event (Ac)		Cumulative Real Property Values of Affected Parcels	
Graham-McCulloch Ditch	St. Marys River	Graham-McCulloch Ditch	St. Marys River	Graham-McCulloch Ditch	St. Marys River	Graham-McCulloch Ditch	St. Marys River
265	1203	13	1123	1471	2717	$6.8	$46.2

[1] Based upon revised modeling and 2007-2008 property information from the Allen County Assessor's Office and the Allen County Department of Planning Services

Table 2.2 - Inundated Area[1] Breakout by Land Use

Flooding Source	Residential	Commercial	Industrial	Agricultural	Public / Unclassified
Structures affected					
Graham-McCulloch Ditch	8	1	2	0	2
St. Marys River	840	134	49	9	91
Inundated Areas (acres)					
Graham-McCulloch Ditch	30	58	3	1086	294
St. Marys River	216	127	119	1556	699

[1] Based upon revised modeling and 2007-2008 property information from the Allen County Assessor's Office and the Allen County Department of Planning Services

2.3.4. Waters of the United States Including Wetlands

Section 404 of the Clean Water Act (CWA) of 1977, 33 U.S.C. §1344, authorizes the Secretary of the Army, acting through USACE, to issue permits for the discharge of dredged or fill material into waters of the United States, which includes many wetlands. Waters of the United States, as defined in 33 C.F.R. §328.3(a), include: (a) waters that currently are, were, or are susceptible to use in interstate or foreign commerce; (b) interstate waters, including interstate wetlands; (c) all other waters of which the use, degradation or destruction could affect interstate or foreign commerce; (d) all impoundments of waters of the United States; (e) tributaries of waters identified above; (f) the territorial seas; and (g) wetlands adjacent to waters identified above. Waters of the United States may include intrastate lakes, rivers, streams, mudflats, sand flats, wetlands, sloughs, prairie potholes, wet meadows, playa lakes, natural ponds, or impoundments of waters, tributaries of waters and territorial seas. Jurisdictional limits for non-tidal waters of the United States are established in 33 C.F.R. §328.4(c) as the ordinary high water

mark (OHWM) for non-wetland waters and as the limit of the wetland for wetlands. The OHWM is that line on the shore established by the fluctuations of water and indicated by physical characteristics such as clear, natural lines impressed on the bank, shelving, changes in the character of soil, destruction of terrestrial vegetation, the presence of litter and debris, or other appropriate means that consider the characteristics of the surrounding areas.

Wetlands are those areas inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions.

Historically, Eagle Marsh was part of an extensive system of wetlands known as the Great Marsh, which encompassed approximately 25,000 acres between Fort Wayne and Huntington along the Little River corridor. Before the arrival of European settlers, the Great Marsh spanned the length of the Wabash-Erie Channel. This area provided a route of overwater transportation from the Wabash River to within a few miles of the St. Marys River. During the late 1800s the area was largely drained by creation of a system of levees, ditches (including Junk Ditch and Graham-McCulloch Ditch) and other measures to promote drainage.

In 2005, LRWP purchased the area known as Eagle Marsh and began restoring the area to its historical state by restoring and creating wetlands on the property. LRWP is a nonprofit land trust founded in 1990 with the goal of restoring and preserving wetlands in the basin of the Little River, a headwater tributary of the Wabash River. The NRCS Wetlands Reserve Program (WRP) is also active in the area. This is a voluntary program that provides technical and financial assistance to private landowners and tribes to restore, protect and enhance wetlands in exchange for retiring eligible land from agriculture under a conservation easement.

The significance of these historic wetlands and the changes that have occurred to the natural waters of the U.S. in the vicinity since the 1850s is succinctly characterized in the introduction of the second edition of *Freshwater Mussels of the Maumee Drainage* (16). This publication also pointed out why this specific location is important to the purposes of GLMRIS in the following excerpt:

> Man-Made Pathways for Species Exchange Natural connections aside, man has also labored to improve the land for his own purposes. These artificial pathways have undoubtedly contributed to species exchange between topographically divided drainages. Two such examples are the Wabash-Erie Canal and the Miami-Erie Canal. The Wabash-Erie Canal, constructed from 1832-1853, was an attempt to provide transportation and stimulate trade in the Old Northwest Territory. While the construction took place in several stages, its final form provided a route from Evansville to Toledo, linking two large basins, the Ohio River and the Maumee River. The canal also utilized sub-basins of the formerly mentioned drainages, including the Wabash River and St. Joseph River.

Data from The National Wetland Inventory Map, site visits and personal communications with Indiana DNR and Eagle Marsh staff show wetlands are present within the marsh. LRWP has mapped various habitat types on the property (Figure 2.5). Jurisdictional wetlands occur in a small area just outside of Eagle Marsh on the west side of I-69. Junk Ditch and Graham-McCulloch Ditch are considered waters of the U. S. and subject to Federal jurisdiction.

2.3.5. Terrestrial and Aquatic Vegetation

Photo 2.5: Looking upstream at Graham-McCulloch Ditch, 02-Nov-10

Eagle Marsh is a 716-acre wetland preserve located on the southwest border of Fort Wayne. The preserve's varied habitats include shallow water wetland, sedge meadow, prairie, mature forest and young trees. Mature forested wetland occupies approximately 40 acres and provides habitat for many animals that require this habitat to complete their life cycles. Beginning in 2005, over 500 acres were seeded with native rushes, grasses and wildflowers, and approximately 45,000 native trees and shrubs were planted. The initial restoration was completed in 2009 (26). Higher quality riparian habitat along Graham-McCulloch Ditch within Eagle Marsh can be seen in Photo 2.5. An example of poor-quality riparian habitat along Graham-McCulloch Ditch outside Eagle Marsh can be seen in Photo 2.6.

The area southwest of Eagle Marsh and adjacent to Graham-McCulloch Ditch is used almost exclusively for agricultural purposes. Plant species diversity is much lower in this area than in Eagle Marsh due to habitat alteration. Predominant vegetation consists of crops such as corn or soybeans during the growing season and ground covers such as winter oats during the fall and winter months. Little aquatic vegetation is present within the channel.

2.3.6. Fauna

Over 200 species have been documented to inhabit Eagle Marsh, at least temporarily. The marsh offers habitat for many species not commonly encountered in the surrounding developed areas.

Figure 2.5: Eagle Marsh habitat types (26)

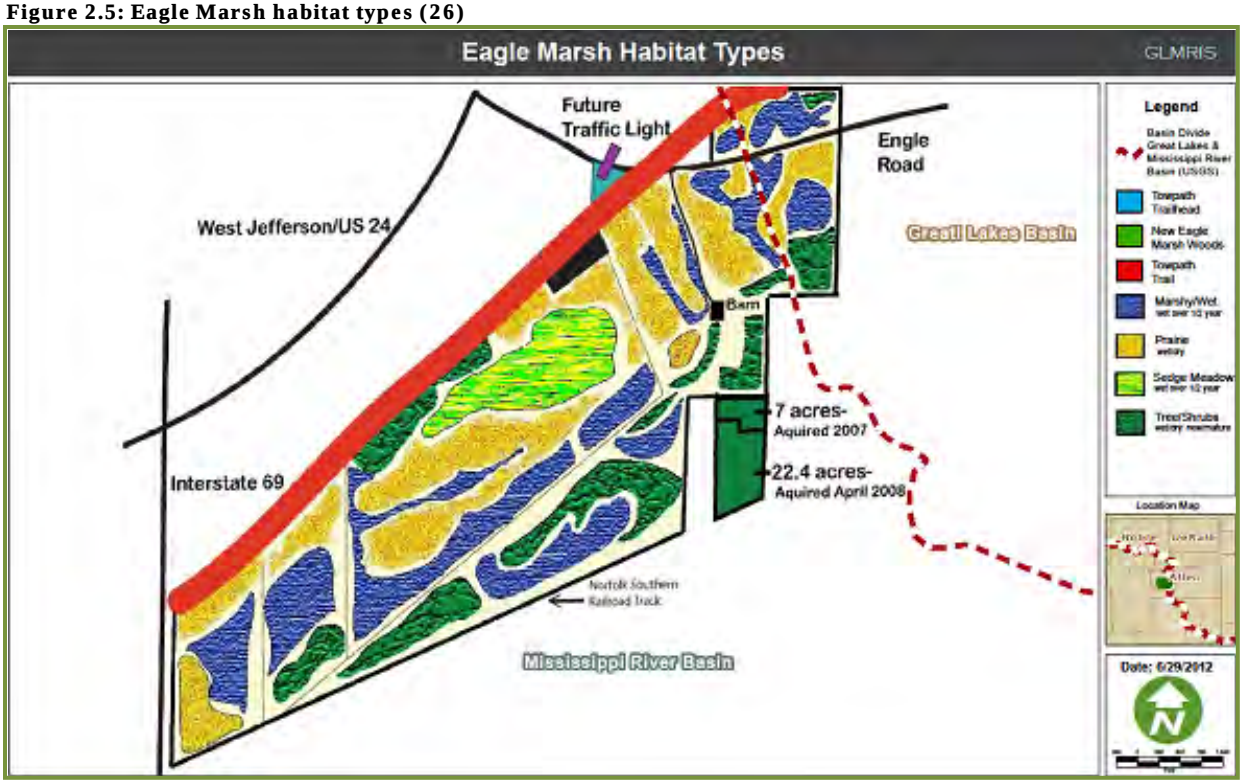


Photo 2.6: Graham-McCulloch Ditch, 16-Apr-11

Common native species known to occur or observed in the project area include: Jefferson salamander (*Ambystoma jeffersonianum*), eastern tiger salamander (*A. tigrinum*), red back salamander (*Plethodon cinereus*), American toad (*Bufo americanus*), northern spring peeper (*Pseudacris crucifer*), bullfrog (*Rana catesbeiana*), northern leopard frog (*R. pipiens*), common snapping turtle (*Chelydra serpentina*), painted turtle (*Chrysemys picta*), eastern milk snake (*Lampropeltis triangulum*), northern water snake (*Nerodia sipedon*), northern brown snake (*Storeria dekayi*), garter snake (*Thamnophis sirtalis*), eastern cottontail (*Sylvilagus floridanus*), eastern chipmunk (*Tamias striatus*), fox squirrel (*Sciurus niger*), raccoon (*Procyon lotor*), white-tailed deer (*Odocoileus virginianus*), muskrat (*Ondatra zibethicus*), mink (*Mustela vison*), opossum (*Didelphis virginiana*), coyote (*Canis latrans*), beaver (*Castor canadensis*) and red fox (*Vulpes vulpes*) (Little Rivers Wetland Project 2011a). Additional discussion of the fauna of Eagle Marsh and how they may interact with ANS is presented in Appendix A.

2.3.7. Existing Terrestrial and Aquatic Habitats

Eagle Marsh provides a variety of fish and wildlife habitat types in a predominantly urban and agricultural area. Aquatic habitat types present within Eagle Marsh include ditches, ponds and wetlands. Both Junk and Graham-McCulloch ditches are degraded due to historic straightening and from urban and agricultural runoff. Despite their degraded condition, they still provide habitat for aquatic and semi-aquatic organisms. In fact, during a high water event in 2011, common carp were observed on both sides of the temporary chain link fence across Eagle Marsh.

Naturally occurring ponds within Eagle Marsh are generally shallow. Most dry up in prolonged periods of dry weather; however, there is an irrigation pond that holds water year-round (Photo 2.2). Ponds and wetlands within Eagle Marsh provide important habitat to many species found in the marsh. During flood events, Eagle Marsh can become inundated by several feet of water (Photo 2.3 and Photo 2.4). As the flood waters recede, fish can become stranded in the ponds and wetlands. This process allows fish species to re-establish even after prolonged dry periods.

Eagle Marsh features four main habitats: wet/marshy areas, sedge meadows, forests and prairies. Eagle Marsh has approximately 154 acres of wet/marshy habitats including ponds and other areas that are wet more than half the year. Special plants thrive in wet/marshy areas. Indiana has lost many native rushes, grasses and sedges. Eagle Marsh has seeded several species such as Frank's sedge (*Carex frankii*), soft rush (*Juncus effusus*) and wool grass (*Scirpus cyperinus*) as well as flowering plants such as swamp milkweed (*Asclepias incarnata*), New England aster (*Symphyotrichum novae-angliae*), Joe Pye weed (*Eutrochium purpureum*), monkey flower (*Mimulus ringens*) and obedient plant (*Physostegia virginiana*) (Little Rivers Wetland Project 2011a). Several areas within Eagle Marsh have been replanted with native trees and shrubs to augment the existing forest (Little Rivers Wetland Project 2011a). These areas provide habitat and forage for many species that utilize the marsh.

The area southwest of Eagle Marsh and adjacent to Graham-McCulloch Ditch is used almost exclusively for agricultural purposes. Habitat diversity is much lower in this area than in Eagle

Marsh due to the removal of natural vegetation for agricultural production. In areas immediately adjacent to Graham-McCulloch Ditch, a narrow strip of riparian vegetation is typically present. Aquatic habitat within Graham-McCulloch Ditch is degraded due to channel straightening and runoff. Locations within this area that would naturally hold water have been drained for agricultural planting. Farm ponds are present within this area that were most likely constructed to provide water for livestock, recreation, aesthetic value or for a combination of these purposes. Additional discussion of the habitat found in and around Eagle Marsh is in Appendix A.

2.4. Endangered and Threatened Species

The Endangered Species Act (ESA) of 1973, 16 U.S.C. §1532 et. seq., was enacted to provide a program for preserving endangered and threatened species and to provide protection for the ecosystems upon which these species depend for their survival. All Federal agencies are required to implement protection programs for designated species and to use their authorities to further the purposes of the act. Responsibility for the identification of a threatened or endangered species and development of any potential recovery plans lies with the Secretary of the Interior and the Secretary of Commerce.

USFWS and the National Marine Fisheries Service are the primary agencies responsible for implementing the ESA. The USFWS is primarily responsible for birds, terrestrial and freshwater species, while the National Marine Fisheries Service is responsible for most non-bird marine species. USFWS's responsibilities under the ESA include:

- Identification of threatened and endangered species;
- Identification of critical habitat for listed species;
- Implementation of research on, and recovery efforts for, these species; and
- Consultation with other Federal agencies to avoid harm to listed species.

An endangered species is a species in danger of extinction throughout all or a significant portion of its range. A threatened species is a species likely to become endangered within the foreseeable future throughout all or a significant portion of its range. Proposed species have been formally submitted to Congress for official listing as threatened or endangered. Species may be considered endangered or threatened under the statute when any of these five criteria occur:

- Present or threatened destruction, modification, or curtailment of their habitat or range;
- Overuse of the species for commercial, recreational, scientific or educational purposes;
- Disease or predation;
- Inadequacy of existing regulatory mechanisms;
- Other natural or human-induced factors affect continued existence.

In addition, USFWS has identified species that are candidates for listing as a result of identified threats to their continued existence. The candidate designation includes those species for which USFWS has sufficient information on-hand to support proposals to list as endangered or threatened under the ESA, but whose proposed listing is precluded by other higher priority listing activities.

Along with protecting the individual species, the ESA also calls for conservation of critical habitat, i.e., areas of land, water and air space that an endangered species needs for survival.

Critical habitat also includes such things as feeding, watering and breeding sites; cover or shelter and sufficient habitat area to provide for normal population growth and behavior. One of the primary threats to many species is destruction or modification of critical habitat by uncontrolled land and water development. No Federally-listed endangered species are known to be present within the study area; additionally, no critical habitat has been designated within the project area.

Areas outside Eagle Marsh have a much lower probability of containing any of the species discussed in this section or critical habitat due to their degraded natural condition. Some alternatives considered in this study may create or improve habitat for these species by converting farmlands into wetlands.

2.4.1. Federal

USFWS lists the endangered Indiana bat (*Myotis sodalis*) as present in Allen County. This species has a broad range and is listed as occurring throughout the state. The Indiana bat forms small maternity colonies under loose tree bark on standing trees. The eastern massasauga rattlesnake (*Sistrurus c. catenatus*) is a candidate species and is recorded in Allen County. This species could potentially be present in the study area as its preferred habitats are wetlands and adjacent uplands. The rayed bean (*Villosa fabalis*), a species of freshwater mussel, is proposed for listing and has been recorded in Allen County; however, no areas within the study area provide suitable habitat for this species. The LRWP maintains records of species detected within Eagle Marsh. No Federally-endangered species have been observed within the preserve.

Along with protecting individual species, the ESA also calls for conservation of critical habitat, i.e., areas of land, water and air space that an endangered species needs for survival. Critical habitat also includes such things as feeding, watering and breeding sites; cover or shelter and sufficient habitat area to provide for normal population growth and behavior. One of the primary threats to many species is the destruction or modification of critical habitat by uncontrolled land and water development. No Federally-listed endangered species are known to be present within the study area; additionally, no critical habitat has been designated within the study area.

2.4.2. State

The State of Indiana has its own state Endangered Species Act at Ind. Code §14-22-34, and Indiana DNR maintains lists of threatened, endangered and rare species in Indiana. This list includes flora and fauna whose occurrence in Indiana is or may be in jeopardy, or with known or perceived threats or population declines. These species are not necessarily the same as those protected by the Federal government under the ESA.

Several species that occur within the study area are listed as threatened, endangered and rare species by the State of Indiana. Most of these species are bird species and use the area for a variety of purposes including foraging, breeding, as a temporary stop along a migration route or as a permanent home. These species include the short-eared owl (*Asio flammeus*), American bittern (*Botaurus lentiginosus*), northern harrier (*Circus cyaneus*), marsh wren (*Cistothorus palustris*), sedge wren (*C. platensis*), trumpeter swan (*Cygnus buccinators*), common moorhen (*Gallinula chloropus*), bald eagle (*Haliaeetus leucocephalus*), black-crowned night heron (*Nycticorax nycticorax*), osprey (*Pandion haliaetus*) and Virginia rail (*Rallus limicola*). A listing

of all bird species at Eagle Marsh and their conservation status can be found at http://www.lrwp.org/docs/2011%20EM%20Bird%20List.pdf.

Suitable habitat for several state listed species is present within Eagle Marsh. Some species that have been observed include least bittern (*Ixobrychus exilis*) and Blanding's turtle (*Emydoidea blandingii*) among others. The gray petaltail (*Tachopteryx thoreyi*) and upland sandpiper (*Bartramia longicauda*) have not been recorded. A complete listing of all state-listed species for Allen County is on the following site: http://www.in.gov/dnr/naturepreserve/files/np_allen.pdf.

2.5. Recreational, Scenic and Aesthetic Resources

2.5.1. Local Resources

Eagle Marsh also provides the local community and tourists with approximately 8 miles of multipurpose trials. This trail system is heavily used and provides visitors with numerous opportunities for wildlife observation, exercise and other forms of low impact outdoor recreation. The trail system also provides a connection to other trails in the area. The staff and volunteers at Eagle Marsh present educational programs to a variety of visitors to the property including school groups and community groups. The Boy Scouts of America have an office building adjacent to the marsh and heavily use the area.

2.5.2. Regional Resources

Since LRWP acquired Eagle Marsh in 2005, Eagle Marsh has become one of the largest wetland restoration efforts ever undertaken in the state of Indiana. The natural hydrology of the area has been restored as closely as possible and native plant species have been planted. Eagle Marsh is a scenic natural area that, in conjunction with Fox Island County Park and other privately owned natural properties, creates almost 2 square miles of habitat for a variety of plants and animals.

2.6. Cultural Resources

2.6.1. Cultural History

Northeastern Indiana has a cultural history that spans at least 12,000 years. Allen County has more than 2,100 recorded archaeological sites. These sites represent all cultural time periods from Paleoindian (12,000 - 9,500 years Before Present [B.P.]) to Historic (starting late 1600s/early 1700s with French exploration). The historic period includes Native American villages, French and American forts as well as Euroamerican residential settlements.

Based on a review of available records for the study area there are around 200 recorded archaeological sites representing a wide variety of site types. These range from prehistoric lithic scatters, camps and villages to historic Native American villages, French and American forts and historic scatters (representing former homesteads, schools etc.). The study area does contain a lot of marsh and wetland areas that through time would have provided a variety of food resources. It also includes the portage that links the Maumee and Wabash Rivers. This portage would have been utilized by both prehistoric and historic peoples. The portage was a vital link between the Great Lakes and the Mississippi River basins (1).

The portage was also the main corridor utilized by the Wabash and Erie Canal in the 1830s (30). The canal section between Fort Wayne and Huntington was opened in 1835 (19). Construction of the canal brought the further development of both communities through an influx of canal workers and once completed expanded opportunities for trade and an influx of new immigrants (18, 19). Introduction of the railroad to the area in the 1850s signaled the demise of the canal except for local usage and in many instances the railroads purchased canal right-of-way and placed rail lines on sections of canal towpath (18, 30). The railroads only further aided in the growth of both Fort Wayne and Huntington (18, 19).

Hunting and fishing camps and resource processing stations should be anticipated throughout the study area. Longer term habitation sites in the area would be located on higher points of land located in and around the marshes and wetlands. While the French and American forts seem to be more closely associated with the confluence of the St. Marys, Maumee and St. Joseph rivers, military outposts should be expected in the area as well, especially along the portage between the Maumee and Wabash rivers. Having the military presence in the area would have also spurred non-military settlement of the area. The portage corridor continued in importance as a transportation avenue first through the usage by the Wabash and Erie Canal and later by various railroads connecting Fort Wayne and Huntington to each other and to farther reaches of the state and country. Most of the commercial and residential development associated with these transportation modes center in the two communities; however, some settlement along the routes used between the communities would also be expected. Settlement of the region initially focused on the fur trade but soon turned to the shipment of goods from the area from agricultural and manufacturing pursuits.

Given the number and types of archaeological sites known to be located in the study area, proposed alternative locations have the potential to contain archaeological sites. Any earthmoving activities and use of construction lay down areas associated with the proposed alternatives would potentially impact any such resources that might be present.

Consultation with the Indiana State Historic Preservation Officer (IN-SHPO) would be undertaken in accordance with Section 106 of the National Historic Preservation Act (NHPA), 16 U.S.C. § 470, as amended. As part of the consultation process under Section 106 of the NHPA, an Area of Potential Effect (APE) would be established. An APE is the geographic area or areas within which an undertaking may directly or indirectly cause alterations in the use or character of any prehistoric or historic district, site, building, structure or object listed or eligible for listing on the National Register of Historic Places (NRHP), if any such properties exist within it. If it were determined that any proposed undertaking resulting from this study would cause adverse effects to resources eligible for listing on the NRHP, appropriate measures would be developed to mitigate for the impacts to those resources.

2.6.2. Previous Investigations

According to research on the Indiana State Historic Architectural and Archaeological Research Database, of the approximate 200 recorded archeological sites in the area, at least six sites have been investigated. Four of these were road projects while two were related to development in wetland and marsh areas in or adjacent to Eagle Marsh.

Research on background information concerning these previous investigations for the study area continues. Any additional information gathered on the specific locations of these investigations will be included in the final study. The information will be further refined, if necessary, when an alternative is recommended.

2.7. Air Quality

The Clean Air Act (CAA), 42 U.S.C. §7401, et. seq., requires the United States Environmental Protection Agency (USEPA) to set National Ambient Air Quality Standards (NAAQS) for pollutants considered harmful to public health and the environment. The CAA established two types of national air quality standards: primary and secondary. Primary standards are limits to protect public health, including the health of sensitive populations such as asthmatics, children and the elderly. Secondary standards set limits to protect public welfare, including protection against decreased visibility damage to animals, crops, vegetation and buildings.

The USEPA Office of Air Quality Planning and Standards has established NAAQS for six principal pollutants that are called “criteria” pollutants. Those pollutants are carbon monoxide, lead, nitrogen dioxide, particulate matter (PM10 and PM2.5), ozone and sulfur oxides. Particulate matter is defined as the solid or liquid particles found in the air. The term PM10 refers to particles with a diameter of 10 micrometers or less and PM2.5 refers to particles with a diameter less than 2.5 micrometers. According to the USEPA, Fort Wayne is currently in attainment for all criteria pollutants (9).

2.8. Noise

Noise is generally described as unwanted sound, which can be based on either objective effects (hearing loss, damage to structures, etc.) or subjective judgments (community annoyance). Measurement and perception of sound involves two basic physical characteristics: amplitude and frequency. Amplitude is a measure of the strength of the sound and is directly measured in terms of the pressure of a sound wave. Because sound pressure varies in time, various types of pressure averages are usually used. Frequency, commonly perceived as pitch, is the number of times per second the sound causes air molecules to oscillate. Frequency is measured in cycles per second, or Hertz (Hz). Sound is usually represented on a logarithmic scale with a unit called the decibel (dB). Sound on the decibel scale is referred to as a sound level. The threshold of human hearing is approximately 0 dB and the threshold of discomfort or pain is around 120 dB. Noise levels are computed over a 24-hour period and adjusted for nighttime annoyances to produce the day-night average sound level (DNL). The DNL is the community noise metric recommended by the USEPA (8, 9) and has been adopted by most Federal agencies (10). A DNL of 65 dB is the level most commonly used for noise planning purposes and represents a compromise between community impact and the need for activities like construction, which do cause noise. Areas exposed to DNL above 65 dB are generally not considered suitable for residential use. A DNL of 55 dB is the level below which there is effectively no adverse impact (8, 9). A 75 dB DNL is the lowest level at which adverse health effects would be credible (8, 9). The very high annoyance levels make such areas unsuitable for residential land use. Noise levels at the project level are relatively low for an urban environment.

Although no measures of noise levels were conducted for this study, Eagle Marsh is surrounded by urban development, a landfill, pit mines and bordered by I-69. This may lead to a situation

where noise levels could exceed 55 dB in some areas of Eagle Marsh. The area south and southwest of Eagle Marsh is more rural and is expected to have lower levels of noise pollution.

2.9. Hazardous Material

No attempt has been made to determine the potential presence or absence of hazardous, toxic or radioactive substances within the study area at this time. Once an alternative is selected a Phase I Hazardous, Toxic and Radioactive Waste (HTRW) investigation will be completed.

2.10. Socioeconomic and Environmental Justice

2.10.1. Executive Order 12898 Environmental Justice

The concept of environmental justice is based on the premise that no segment of the population should bear a disproportionate share of adverse human health or environmental effects. To address these concerns, Executive Order (E.O.) 12898, Federal Actions to Address Environmental Justice in Minority and Low Income Populations was issued. It requires each Federal agency to "make the achievement of environmental justice part of its mission by identifying and addressing disproportionately high and adverse human health and environmental effects on minority and low-income populations." There are no indications that any of the alternatives that were considered would be contrary to the goals of E.O. 12898, or would create disproportionate, adverse human or environmental impacts on minority or low income populations of the surrounding community.

2.10.2. Executive Order 13045 Protection of Children

The concept of protecting children arises out of a growing body of scientific knowledge which demonstrates that children may suffer disproportionately from environmental health and safety risks. To address these concerns, E.O. 13045, Protection of Children from Environmental Health Risks and Safety Risks was issued. It requires each Federal agency to identify and assess environmental health and safety risks that may disproportionately affect children. It ensures that policies, programs, activities and standards address disproportionate risk to children resulting from environmental health or safety risks. None of the alternatives that were considered pose disproportionate environmental health or safety risks to children in the vicinity of the study area.

3.0 PLAN FORMULATION

3.1. Problems and Opportunities

3.1.1. Problem Identification

As described in Section 1.3.2.1, Eagle Marsh was determined to have an intermittent interbasin aquatic pathway, through which there is a significant near term risk for Asian carp to spread into the Maumee River Basin. The Aquatic Pathway Assessment of Eagle Marsh in Appendix A is a detailed evaluation intended to succinctly define the nature and extent of this problem. Below are the conclusions of that assessment.

- **Aquatic Pathway**. Eagle Marsh is a reconstructed wetland, through which significant volumes of water may cross the basin divide for days to weeks multiple times in a given year. There is uncertainty regarding the frequency, duration and depth of the water column when the aquatic pathway forms due to the presence of the agricultural berm placed many years ago along the left descending (looking downstream) bank of Graham-McCulloch Ditch.
    - There is a dearth of stream gages and data on water levels at and in proximity to the basin divide. This is a contributing factor to the level of uncertainty in the hydraulic model estimates for the frequency, duration and magnitude (width, depth and flow velocity) of the intermittent aquatic pathway spanning the divide at this location.
    - There are nearby locations where additional aquatic pathways could develop across the divide between the Maumee and Wabash River basins if new development causes changes in current topography and runoff patterns.
- **ANS of Concern**. Fish and parasites or diseases carried by fish are the only classes of ANS deemed to possess the ability to disperse solely through the aquatic pathway to reach Eagle Marsh from either the Maumee River Basin or the Wabash River Basin.
    - The primary ANS of concern for interbasin transfer from the Mississippi River Basin through Eagle Marsh into the Great Lakes Basin are Asian carp, inland silverside and northern snakehead (Appendix A). Asian carp (silver, bighead and to a lesser extent black) are prolific swimmers and are the most significant ANS of concern. The northern snakehead is not as prolific a swimmer, so it is not expected to be a near-term risk. However, its affinity for ditch and wetland types of habitats and its amphibious traits make it a species with a high likelihood of establishing a population and spreading across the basin divide if it reaches Eagle Marsh.
    - Asian carp (silver and bighead) have become well established in the Lower Wabash River and adult Asian carp (bighead) have been observed since 2004 below the J. Edward Roush Dam on the Wabash River approximately 20 miles downstream of Eagle Marsh. No Asian carp have been observed in Little River or Graham-McCulloch Ditch.
    - A recent USGS report (22) indicates that the Maumee River provides suitable habitat and conditions important to reproduction and establishment of an Asian carp population. Lake Erie is deemed to have a valuable fishery whose decline could negatively impact local and regional economies, the aquatic ecosystem, the sociopolitical climate and regional initiatives.
    - The primary ANS of concern for interbasin transfer from the Great Lakes Basin through Eagle Marsh into the Mississippi River Basin are: Viral Hemorrhagic Septicemia Virus (VHSv), three spine stickleback and parasitic copepod. VHSv was deemed the most likely ANS to be able to survive transit to Eagle Marsh and to pass through the intermittent aquatic pathway from either basin based on the assumption that common carp would be the most likely carrier of this disease affecting fish (Appendix A). However, the likelihood that VHSv would become established and spread through the Mississippi Basin is questionable due to its affinity for cool waters.
    - There was significant uncertainty associated with biological risk assessment due to a variety of unknowns and uncertainties regarding the location and distribution of the large array of ANS that have been introduced to the waters of the U.S., as well as the life

history requirements of each of these ANS, and the suitability of the habitat within the waterways between the current nearest locations of the ANS and Eagle Marsh.

- **Other Pathways**. There are other significant pathways that human beings could facilitate ANS bypassing Eagle Marsh and transferring between the basins, including but not limited to: collection of bait in one basin and release in the adjacent basin; ANS adhering to recreational boats in one basin and then being released when the vessel is placed in a water body in the adjacent basin; and inadvertent or deliberate release of ANS during transport or use of live species in the food and pet trade industries.

3.1.2. Eagle Marsh Opportunity Statements

While there have been several collections of live Asian carp from the Great Lakes and recent reports of the collection of Asian carp DNA from the basin, there is no evidence suggesting that Asian carp have already crossed through the Eagle Marsh pathway (or any of the Focus Area 2 pathways) or become established in the Great Lakes or its tributaries. Therefore, perhaps the most significant opportunity presented by the circumstances associated with Eagle Marsh is the opportunity to prevent dispersal of Asian carp into the Lake Erie Basin. Likewise, these circumstances offer the opportunity to develop a solution that may also prevent existing and future ANS from spreading across the basin divide at Eagle Marsh in both directions.

A dense, broad (up to 40 miles wide) wetland referred to as the Great Black Swamp once extended from the current location of Fort Wayne to Lake Erie roughly centered along the current alignment of the Maumee River. A glacial event known as the Maumee Torrent carved a channel up to a mile in width that extends southwest from Fort Wayne to Huntington that also once harbored a dense wetland known as the Great Marsh that ran the length of the channel's floodplain. LRWP is dedicated to restoring these former wetlands to the area, and implementation of a project to prevent ANS from spreading across the basin divide at this location may offer the opportunity to restore additional wetlands.

The circumstances at Eagle Marsh offer an opportunity to increase public awareness of the nature of problems associated with the spread of ANS and to develop a comprehensive plan that would include a combination of structural and nonstructural measures that address risks associated with ANS spreading through aquatic pathways as well as risks associated with other human-aided pathways. Such a comprehensive plan would likely have a Federal component as well as components that could be led by state or local government agencies. It would also afford the opportunity to engage non-governmental organizations and the public about actions that may be taken by private citizens and organizations to prevent ANS spreading.

3.2. Objectives and Constraints

3.2.1. Objectives

The primary objective of this study is to identify an array of viable long-term measures to prevent interbasin transfer of ANS through the aquatic pathway that forms across Eagle Marsh. Presently, a non-Federal sponsor has not been identified that is willing and capable of entering a partnership agreement with USACE to finalize and implement a recommended plan. Therefore, a related objective of this study is to identify measures which may readily be taken individually

and eventually combined into a comprehensive plan that reflects the collective interests, authorities, responsibilities and capabilities of USACE and other local, state and national stakeholder organizations to most efficiently and effectively prevent interbasin spread of ANS across Eagle Marsh.

3.2.2. Constraints

The broad geographical scope and technical complexity of GLMRIS combined with the urgency to complete the study for the CSSC and other aquatic pathways as quickly as possible poses a mix of resource challenges. The following subsections summarize the most significant legal and resource constraints that were considered in trying to advance completion of a study to address the periodic interbasin connection that occurs across Eagle Marsh. Each of the alternatives considered in detail in Section 3.5 were formulated within the bounds of these constraints.

3.2.2.1. Legal Constraints

Statutory authority currently does not exist for USACE to implement measures developed as a result of this study to mitigate the risks of interbasin spread of ANS. Furthermore, the congressional authority directing the GLMRIS also limits USACE to the development of options and technologies to those that will prevent the interbasin spread of ANS through aquatic pathways. No commercial or recreational navigation occurs across Eagle Marsh or in the Junk and Graham-McCulloch ditches in the vicinity, so ANS spread via ballast or bilge water release or attachment to boat hulls or submerged marine equipment does not appear to be an issue associated with Eagle Marsh. However, residual risk would remain for interbasin spread of ANS via pathways other than the intermittent aquatic pathway that periodically exists at Eagle Marsh. For example, collection of live bait from downstream in the Wabash River Basin and then use or release of the bait in a water body in the Maumee River Basin could lead to the establishment of Asian carp within the Great Lakes Basin. Likewise, other residual risks could come from ANS that adhere to surfaces of portable boats, nautical ropes and fishing and recreational marine gear that may be inadvertently transported from one basin into the other and then released. Transport and use of live animals as occurs in the food and exotic pet industries can result in both the intentional and unintentional spread of ANS between the basins. While this report is constrained from providing an estimate of the risk for the interbasin spread of ANS (likelihood and consequences) via these other potential pathways, implementation of a Federal project requires that such residual risks be identified and considered prior to selection of a recommended plan.

Indiana's Flood Control law (IC 14-28-1) may require a permit for certain construction measures considered under this study; additionally, such a permit could require mitigation in order to avoid an unreasonably detrimental effect upon the fish, wildlife or botanical resources located in the floodway. Additionally, certain measures considered under this study may need to be constructed in accordance with applicable portions of the Allen County Stormwater Management Ordinance, dated 25 April 2008, Ordinance Number 4-25-08-07. Further, wetland mitigation may need to be provided for measures constructed in wetlands in order to comply with the Clean Water Act and state law implemented by the Indiana Department of Environmental Management.

3.2.2.2. Resource Constraints

Simply stated, the USACE planning process requires a comprehensive estimate of the costs and benefits of implementation of a Federal project, and the benefits must be greater than the costs to support a recommendation of a plan for Federal implementation. On the cost side of this equation, there are traditional methods and a relatively high degree of experience and data from similar projects to develop reliable estimates of the range of costs to build and operate both structural and nonstructural water resource projects as well as to account for the costs to mitigate any unacceptable impacts that may result, such as induced flooding or loss of wetlands. However, the magnitude of the unknowns related to attempting to identify and evaluate the wide range of possible ANS and how each may be introduced, become established, disperse and cause ecological, economic and sociopolitical impacts in a new environment is daunting, especially for a project with the geographical scope of GLMRIS. These unknowns severely constrain the ability to develop an equally reliable quantitative estimate of the benefits of preventing interbasin transfer of ANS across Eagle Marsh.

Time is a significant resource constraint affecting GLMRIS and the challenging schedule requirements necessitated reliance on use of the best available data and development of the qualitative estimate of the likelihood or probability of interbasin spread of ANS through Eagle Marsh presented in Appendix A. No attempt was made to estimate the consequences of ANS surviving transit through the pathway. While the results of the Aquatic Pathway Assessment Report presented in Appendix A provide a basis for comparison of the array of viable options and technologies to prevent interbasin spread of ANS, development of a recommended alternative for Federal implementation will require an estimate of both the likelihood and consequences of the ANS of concern at Eagle Marsh to support a trade-off analysis of the relative costs and benefits of each viable alternative to support selection of a recommended plan.

A period of analysis of 50 years was established for estimating the future without project conditions and for the analysis and evaluation of alternatives. There was discussion among the interagency team as to whether a longer planning horizon was appropriate; however, the team concluded that the uncertainty and dearth of available data to estimate conditions over a longer time period would not result in the identification or development of a more effective or efficient array of options and technologies to prevent interbasin spread of ANS through Eagle Marsh.

3.3. Most Probable Future Without Project Conditions

The Eagle Marsh Aquatic Pathway Assessment (Appendix A) was a methodical evaluation and characterization of the likelihood of interbasin spread of ANS though Eagle Marsh. That characterization provided the baseline without project condition (WOPC) that was the basis for the formulation and evaluation of alternatives. Completion of the Aquatic Pathway Assessment accomplished the following objectives:

- Collected and organized relevant supplementary hydrological and biological data
- Narrowed array of potential ANS to a specific list of ANS of concern to Eagle Marsh
- Engaged a multi-agency team of ANS professionals in a collaborative evaluation; and
- Based on that evaluation, provided qualitative estimates of the likelihood of interbasin transfer of each species on the list of ANS of concern to Eagle Marsh during a typical 50-year planning horizon.

The Eagle Marsh aquatic pathway is the surface water connection that periodically occurs between Junk Ditch and Graham-McCullough Ditch. Flooding on these two ditches converges, creating the aquatic pathway. Drainage from this location to the Great Lakes is through Junk Ditch to the St. Marys and Maumee rivers and then Lake Erie. Drainage to the Mississippi River occurs through Graham-McCullough Ditch to the Little, Wabash and Ohio rivers.

An aquatic pathway forms across Eagle Marsh in most years (Photo 2.3 and Photo 2.4). Scale, duration and location (St. Marys or Little River side) of storm events will determine the depth, velocity, discharge and direction of flow. A surface water pathway between the basins occurs most frequently during late winter to early summer and sporadically during heavy rain events during other times of the year. The connection may last for several days, several times per year. The hydrologic connection between two watersheds can occur through the culverts in the agricultural berm on the southern bank of Graham McCulloch Ditch or by overtopping the crest. The former path may occur while the flap gate on the culvert is jammed or during drainage of the flood water in Eagle Marsh (back up from St. Marys River) to the Ditch. Based on modeling the latter path will occur during a hydrologic event of 10% chance of exceedance and 3% chance of exceedance on the Graham McCulloch Ditch and St. Marys River, respectively.

The feature controlling surface water connection between the basins is the low point in the left descending berm of the Graham-McCulloch Ditch. Tables 3.1 and 3.2 show that for events less than the 10% annual chance event the predicted depth of water over the Graham-McCulloch Ditch berm low point is between 1.74 feet and 0.58 feet.

As result of the preliminary pathway assessment conducted by the USACE in 2010, Indiana DNR installed a chain-link fence in Eagle Marsh (Photo 1.1) to prevent movement of adult silver and bighead carp through the marsh until a plan for a permanent measure could be formulated, designed and constructed. Construction of the fence was completed on October 2010. The fence is a temporary measure permitted to be operated in the floodplain as per the WRP Compatible Use Authorization (CUA) conferred from NRCS to Indiana DNR.

A factor that complicates the evaluation of the future without project conditions is the condition of the left descending berm of Graham-McCulloch Ditch. It is a non-engineered berm constructed in the early 1970s mostly of material trucked into the site (Sherman Liechty, NRCS, personal communication 2012). The berm was constructed with pipes passing through it at the base to facilitate movement of water into the ditch. Those pipes that have not collapsed or

Table 3.1 - Hydraulic Conditions for Little River Basin Storm Events

Percent Annual Chance Event	At Graham-McCulloch Low Point (755.15 feet MSL)			At Divide Low Point (750.98 feet MSL)		
	Maximum Depth (ft)	Velocity (ft/s)	Peak Discharge (ft^3/s)	Maximum Depth (ft)	Velocity (ft/s)	Peak Discharge (ft^3/s)
10%	≈0	0	0	0	0	0
2%	1.02	1.08	555	1.03	0.05	46
1%	1.29	3.04	755	1.64	0.05	167
0%	1.74	1.47	1020	1.75	0.09	600

Table 3.2 - Hydraulic Conditions for St. Marys River Basin Events

Percent Annual Chance Event	At Graham-McCulloch Low Point (755.15 feet MSL)			At Divide Low Point (750.98 feet MSL)		
	Maximum Depth (ft)	Velocity (ft/s)	Peak Discharge (ft^3/s)	Maximum Depth (ft)	Velocity (ft/s)	Peak Discharge (ft^3/s)
10%	0	0	0	2.74	0.03	190
2%	0.58	1	122	4.75	0	625
1%	1.14	1.4	978	5.31	0.07	1097
0%	1.17	1.43	1122	5.35	0.08	1243

otherwise been blocked remain open today. ANS could use these pipes to by-pass hydrologic separation provided by the berm. In the event of a collapse or erosion of a significant portion of the berm, this protection would be negated. Continued operation or maintenance of this berm is uncertain due to its current condition and lack of purpose. Multiple Indiana DNR and USACE engineers have confirmed that the left descending berm integrity is questionable; several slope failures, steep slopes, rodent burrows and other defects are visible; and there is no information regarding the level of design or construction methods. The berm therefore does not meet current geotechnical standards. As time progresses, additional failures or a breach are expected to occur.

The USACE white paper *Non-Native Species of Concern and Dispersal Risk for the Great Lakes and Mississippi River Interbasin Study* (2) listed 119 ANS that posed a potential risk of moving between basins. This list included microscopic viruses and bacteria, plants, invertebrates, crustaceans, amphibians and fish. The list of 119 species was reviewed by the aquatic pathway characterization team. In addition, the team reviewed information on the NOAA watch list (27) of species threatening the Great Lakes from international waters, and information on other species cited by the Agency Technical Review team as high risk potential invaders not yet in either basin. The original list was reduced to a list of 39 species of concern for transfer. This list was further evaluated based on the dispersal mechanisms and general mobility of the species within each group.

Since Eagle Marsh is positioned on the basin divide, well upstream of any known ANS listed here, any organism that moves solely through the aquatic pathway must possess either: 1) self-propelled mobility, or 2) the ability to "hitchhike" on other organisms to travel upstream. This eliminates organisms that rely on current for dispersal such as plants and algae. Based on the evaluation, ANS most likely to cross the divide in the near term are fish that can swim against a current and organisms that attach to fish. ANS lacking the ability to move independently or having a limited ability to move independently, such as plants, algae, zooplankton, snails, etc., are unlikely to arrive at Eagle Marsh through an aquatic pathway in the foreseeable future (Appendix A). Of all species considered, the Eagle Marsh aquatic pathway team determined five

Table 3.3 - Aquatic Nuisance Species of Concern

Taxa	Species	Common Name	Basin w/Known Populations	Dispersal Mechanism
fish	*Channa argus argus*	northern snakehead	Mississippi	swimmer
fish	*Hypophthalmichthys molitrix*	silver carp	Mississippi	swimmer
fish	*Hypophthalmichthys nobilis*	bighead carp	Mississippi	swimmer
fish	*Menidia beryllina*	inland silverside	Mississippi	swimmer
fish	*Mylopharyngodon piceus*	black carp	Mississippi	swimmer
fish	*Gasterosteus aculeatus*	threespine stickleback	Great Lakes	swimmer
fish	*Gymnocephalus cernua*	ruffe	Great Lakes	swimmer
fish	*Proterorhinus marmoratus*	tubenose goby	Great Lakes	swimmer
copepod	*Neoergasilus japonicas*	parasitic copepod	Great Lakes	on fish
virus	*Novirhabdovirus sp.*	Viral Hemorrhagic Septicemia Virus	Great Lakes	on fish

of these possible future invaders as potentially significant threats to the Great Lakes Basin and five of these ANS as potentially significant threats to the Mississippi River Basin (Table 3.3).

The interagency team then applied a systematic process and criteria to collaboratively estimate the likelihood each of these 10 ANS would spread across the basin divide at Eagle Marsh during

the next 50 years. This included assessment of the likelihood the ANS would; be in a connected waterway; survive transit to reach Eagle Marsh; become established in the proximity, and spread across the basin divide during the window in time and space that the aquatic pathway exists. The results of each of these individual elements were then combined into one estimate of the likelihood of interbasin spread of each ANS of concern.

Tables 3.4 and 3.5 summarize the results of the likelihood of interbasin spread for each species for both basins. The column labeled 4.1 lists the ratings for the likelihood the ANS exists in a connected waterway. A High rating indicates the judgment of the team that the ANS possesses the locomotive capabilities to reach the proximity of Eagle Marsh in less than 20 years. The columns labeled 4.2A and 4.2B address the likelihood the ANS can survive transit from its nearest observed location to reach the proximity of Eagle Marsh solely through the aquatic pathway, 4.2A, or by other means, 4.2B. A High rating indicates the ANS is likely to overcome any in-stream obstacles to reach the location within the next 20 years, while a Low rating indicates the ANS is not likely to reach the location in the next 50 years. The column labeled 4.3 provides an estimate of the likelihood that the ANS will establish a population in proximity to Eagle Marsh, from which it could launch an invasion across the basin divide when an aquatic pathway between the basins exists. A High rating indicates that aquatic habitat in proximity to Eagle Marsh is conducive to supporting all life stages of the ANS and that there are no predators or abiotic conditions that would significantly impede organism reproduction and growth. The column labeled 4.4 addresses the likelihood that once established in proximity to the divide, the ANS will successfully spread across Eagle Marsh when the aquatic pathway exists.

Table 3.4: Aquatic Pathway Assessment of ANS Transfer from Mississippi River Basin into Great Lakes Basin

Group	Common Name	Dispersal Mechanism	4.1	4.2		4.3	4.4	Aquatic Pathway Rating
				4.2A	4.2B			
fish	Asian Carp (silver, bighead and black carp)	swimmer	H	M/H	L	M	H	M
fish	inland silverside	swimmer	H	M	L	M	H	M
fish	northern snakehead	swimmer	M	M	L	H	H	M
Likelihood of ANS Transfer to Great Lakes Basin								**M**

Table 3.5: Aquatic Pathway Assessment of ANS Transfer from Great Lakes Basin into Mississippi River Basin

Group	Common Name	Dispersal Mechanism	4.1	4.2		4.3	4.4	Aquatic Pathway Rating
				4.2A	4.2B			
fish	three spine stickleback	swimmer	H	M	L	M	H	M
fish	Benthic fish (riffle, tubenose goby)	swimmer	H	L	L	M	H	L
copepod	parasitic copepod	parasite	M	M	L	H	H	M
virus	viral hemorrhagic septicemia	pathogen	H	H	L	H	H	H
Likelihood of ANS Transfer into Mississippi River Basin								**H**

Since common carp have dispersed throughout both basins and have been observed on both sides of the temporary barrier, it was chosen as the host species for spread of *N. japonicas* and VHSv. The team considered VHSv to be the most likely ANS to spread between the basins at this location and rated it “High” because it is possible that the virus could be passed to new host fish through water on the other side of the temporary fence during the time an aquatic pathway exists. No assessment of the likelihood of establishment and spread of VHSv through the Mississippi River Valley was attempted, nor were the consequences estimated; however, if any fish, ANS,

intentional introduction, or native species were to cross the divide carrying the VHSv and spread into the Mississippi River Basin, it could severely impact fish populations. VHSv has been responsible for several fish kills in the Great Lakes Basin. Clinically infected fish often exhibit hemorrhaging in the skin and congested organs with multiple hemorrhages in the liver, spleen and intestines. The swim bladders are also often extremely congested with hemorrhages. The ultimate cause of death is usually internal organ failure or the inability to osmoregulate, which is the control and balance of chemical elements in the body versus the water (31). VHSv becomes less virulent at water temperatures above 60ºF and may have less of an impact in the Mississippi River Basin due to warmer water temperatures (Appendix A).

Because the fish species of concern that could move from the Great Lakes to the Mississippi River basin prefer lake habitat to river habitat, movement of these species across the divide is highly unlikely.

Snakehead and inland silverside, though potentially serious threats to the Great Lakes, are unlikely to reach Eagle Marsh in the near term. The ANS of immediate concern are Asian carp. Asian carp are also the only ANS reported within a 25-mile radius of Eagle Marsh.

A forecast of how Asian carp in the Wabash River Basin would move to the Great Lakes if no alternative were implemented at Eagle Marsh requires an understanding of the hydraulic and habitat conditions through the aquatic pathway and the Asian carp's response to those conditions.

In addition, Asian carp move upstream for reasons not fully understood. Juvenile Asian carp (fish that have not reached sexual maturity) have been found to move upstream in some river systems for reasons that are currently unknown (Nate Caswell, USFWS, personal communication, 2011). Indiana DNR is funding Purdue University to monitor Asian carp movement within the Wabash River via implanted ultrasonic tags. In 2011, none of the tagged Asian carp moved into Little River. As more information is collected, this study will provide insight into fish movements in relation to river conditions.

In the Mississippi River Basin, Asian carp compete with several native fish and invertebrates for food and alter water quality by feeding on zooplankton and phytoplankton. Schuyler et al. (27) reported that the diets of bighead and silver carps in the Illinois River System have been found to have significant overlap with those of gizzard shad (*Dorosoma cepedianum*) and bigmouth buffalo (*Ictiobus cyprinellus*). This is cause for concern, as gizzard shad are a primary forage base for predacious fishes and important to the ecology of Midwestern rivers (23). Additionally, Silver carp are known to jump up to ten feet out of the water when threatened or startled. This behavior has resulted in injuries to boaters and may cause human fatalities.

Conditions in Eagle Marsh are vastly different from those Asian carp typically find conducive for spawning (23), thus the probability of Asian carp spawning there is extremely remote. Velocities and discharges within Eagle Marsh are small in relation to those where Asian carp are found (23). However, anecdotal observations have found Asian carp in places where they were not expected (Amy J. Benson, USGS, personal communication 2011). It is unknown whether these discharges would cause Asian carp to move upstream to Eagle Marsh.

The primary rationale for the Medium rating for the likelihood of silver and bighead carp spreading across the basin divide at Eagle Marsh was the lack of suitable habitat for Bighead or

Silver carp to become established in the channelized streams (Little River and Graham-McCulloch Ditch) that extend some 20 miles west of Eagle Marsh toward the confluence with the Wabash River in Huntington, IN. Minimal depth, low flow, low oxygen and high temperature conditions are prevalent in the Little River and Graham-McCulloch Ditch in mid to late summer. The aquatic pathway team concluded that a relatively large infrequent flood event was necessary to create a potentially viable aquatic pathway (a window in space and time) through which only adult silver and bighead carp, those capable of dispersing in excess of 25 miles in a given day, could spread across the basin divide when the aquatic pathway exists across Eagle Marsh.

While getting across Eagle Marsh would be difficult, a recent USGS report (22) identified the Maumee River as highly suitable for Asian carps to mature and spawn. That report presented evidence that suggests the largest western and central Lake Erie tributaries (including the Maumee River) are thermally and hydrologically suitable to support spawning of Asian carps. In order for spawning to occur on the Maumee side of the divide, a viable Asian carp population must be established. This may happen if adult fish cross the divide from the Little River or if a sufficient number of live fish are released contrary to established law (e.g., disposing of live bait by fishermen, escape from food fish haulers, or intentional release). In addition, Asian carp move upstream for reasons not fully understood. Juvenile Asian carp (fish that have not reached sexual maturity) have been found to move upstream in an aggressive and seemingly random manner in some river systems for reasons that are currently unknown (Nate Caswell, USFWS, personal communication, 2011).

Further, a recent binational risk assessment, led by the Canada Department of Fisheries and Oceans (4), concluded that once silver and bighead carp reach Lake Erie, they would be very likely to survive and become established. That risk assessment rated the ecological consequences to be “Moderate” within a 20-year period after establishment, meaning detectable changes in the structure or function of the ecosystem would likely occur. Over a 50-year period, the multinational risk assessment concluded the ecological consequence would be “High”, meaning changes in the abundance of native species and generation of a new food web resulting from establishment of bighead and silver carp.

3.4. Options to Prevent ANS Spreading Across Eagle Marsh

3.4.1. No Action

The no-action alternative is equivalent to the without-project conditions detailed in Section 3.3 above. If no action is taken, the without project conditions will persist. Observations of common carp attempting to migrate through the temporary barrier across Eagle Marsh illustrates that fish can reach this location from either basin, and left unimpeded, would spread between the basins. VHSv and Asian carp are potential near-term invaders, and continuing without control measures will increase the likelihood of interbasin spread of these and other ANS across Eagle Marsh.

Continuing without control measures will increase the likelihood of ANS spreading through Eagle Marsh and into the adjacent basin. It is difficult to predict how an ANS may impact an ecosystem in which it becomes established. Biologists must use species’ history of invasiveness along with knowledge of life history requirements to forecast consequences of a newly established ANS. Bighead and silver carp have exhibited extraordinary population growth in the Mississippi River Basin, which has provoked great concern about the likelihood and array of

potential ecologic, economic and sociopolitical consequences of Asian carp introductions into the Great Lakes. The consequences of interbasin spread of VHSv have not been estimated, but the severe impacts to host fish in the Great Lakes Basin indicate they could be significant.

The WRP Compatible Use Authorization (CUA) for the temporary fence expires on 24 August 2014. At that time, either the fence will need to be removed or the authorization extended. Additional funding for long-term operation and maintenance of the fence is uncertain. If the no-action alternative is adopted, a potential public safety concern, a fall hazard, could exist near the riprap tying the structure into the railroad ballast and the Graham-McCulloch Ditch.

3.4.2. Preliminary Structural and Non-Structural Measures

USACE civil works planning procedures specify evaluation of both structural and non-structural measures to mitigate problems and take advantage of opportunities for water resource projects to contribute to National Economic Development and/or National Ecosystem Restoration. These measures can be considered separately or in combination to develop alternatives which support a robust comprehensive plan to prevent the spread of ANS.

Specifically, structural measures are defined as construction activities that provide physical impediments to ANS and change hydraulic conditions in the floodplain. As an example, structural measures may include I-walls, earthen berms, pump stations, fences, detention basins, hydraulic structures or combinations of the above built within the 1% annual return frequency floodplain. Non-structural measures primarily alter biology, habitat, species behavior or human activity with a negligible impact to hydraulics within the floodplain. For instance, the application of piscicides, rotating drums and adjustments to land use ordinances are all considered non-structural measures. Likewise, barriers that employ electric current, bubbles, sound and/or light to control the behavior of a fish or any other ANS and prevent it from going into a specific area are considered non-structural measures even though they may require real estate acquisition; physical construction; and/or long-term operation and maintenance.

Early in the planning process a Value Engineering (VE) study was conducted in which numerous possible structural and non-structural measures were developed with attention to long-term prevention of ANS transfer at Eagle Marsh (Appendix D). VE is a structured facilitated process that identifies the key functions that must be provided to assure project success and to verify optimum project value. With this intention, a multi-disciplinary team (Appendix D) primarily composed of the PDT and personnel from Indiana DNR and NRCS attended a three day workshop in January of 2011. During this workshop numerous possible structural and non-structural measures were identified that warranted investigation toward the objective of finding the best solution to meet the project purpose and need. During this process many measures and alternatives were evaluated. Additionally, emphasis was placed on preserving the important ecological and aesthetic significance of Eagle Marsh and the Fort Wayne, Indiana area.

Based on feedback during the GLMRIS NEPA public scoping process and the preliminary evaluation of potential structural and non-structural measures, the team elected to focus on structural barriers to block interbasin spread of all ANS, but with an emphasis toward blocking dispersal of Asian carp into the Maumee River Basin. Over 100 measures were generated during the VE workshop regardless of feasibility. The VE team selected measures with the most merit for further development predicated on acceptability, effectiveness, efficiency and completeness

(Section 3.6 provides a detailed description of these screening criteria). Based on these criteria the team reduced the total to 12 measures and then evaluated these individual measures to form optimum combinations or stand-alone measures that are presented as alternatives. These 12 alternatives were further expanded in order to evaluate advantages and disadvantages and to develop cost comparisons. Of the 12 alternatives, the team eliminated five alternatives due to feasibility (see Section 1.6 of Appendix F for additional detail) and selected seven alternatives for additional consideration. Following the conclusion of the VE study, supplementary survey data were obtained and the team generated two additional alternatives.

3.4.2.1. Non-Structural Measures

Non-structural measures can be considered independently or in combination with structural measures. Generally, non-structural measures do not explicitly prevent ANS from crossing the basin divide but rather reduce the numbers of ANS present in the source population or slow the spread of ANS. Most of the non-structural measures considered may be beyond the jurisdiction of USACE to implement, but could be implementable by other governmental and non-governmental organizations. Non-structural measures can be useful when structural means are not feasible. Multiple non-structural measures can be used in combination to reach a desired level of ANS control.

3.4.2.2. Structural Measures

Following the VE study and subsequent PDT meetings, a total of 12 structural measures were selected for further consideration. These measures included;

- Realign Graham-McCulloch Ditch and construct Berm parallel to I-69
- Create vertical drop structure(s) and construct berm
- Construct berm with underdrains/permeable barrier
- Keep/Enhance the Fence
- Construct a fence/berm combination
- Construct an I-Wall across basin divide
- Build structure and pump around
- Reroute Graham-McCulloch Ditch and build Floodwall
- Build barrier for longest economical crest for lowest depth
- Create Flood Storage in both basins
- Create a fence or barrier at Huntington Dam
- Electric Dispersal barrier

These measures were evaluated further by the PDT. Several of these measures were later eliminated utilizing the screening criteria discussed in the following section. The remaining measures were further analyzed hydraulically and have been developed into Structural Alternatives. Relatively all of the structural measures underwent some form of transformation or change from what was assumed in the VE Study to become the Structural Alternative as defined in the following sections.

Structural alternatives are construction activities that change the hydraulic conditions of an area. These construction activities may include I-walls, earthen berms, pump stations, fences, detention basins, hydraulic structures or a combination of the above.

For each structural alternative below, a conceptual design was developed and preliminary hydraulic modeling was performed to refine project features to the extent possible at this conceptual level of design. A preliminary modified 1% floodplain was determined in order to develop a comparison of indirect costs created by each alternative. In order to facilitate this comparison, the difference from the WOPC for total acreage, maximum depth of flooding, cumulative real property assessed value, and number and types of uses of properties will be preliminarily calculated and reported for each alternative. This was performed with the same data sets as identified in Section 3.3, Most Probable Future Without Project Conditions, above for the WOPC. Construction costs for each of the evaluated alternatives were also determined. This should provide the decision makers and public with a reasonable qualitative comparison of the possible induced impacts of the various alternative plans, in addition to their currently identified costs for project footprint implementation and operation & management (O&M).

The Real Estate summary, located in Appendix E, only applies to structural alternatives as the no-action and non-structural options would not require any real estate interests to support them. The structural alternatives will require the acquisition of private or state-owned real estate interests. Appendices F and G contain a more detailed explanation of each structural alternative and assumptions and methods used in determining the affects of the alternative. The proposed locations of the structural alternatives are shown in Figure 3.1 on page 49.

3.4.3. Screening Criteria

USACE policy for Civil Works Planning specify four criteria for use in an iterative process to formulate a recommended plan that address specific problems of Federal interest and the corresponding opportunities to contribute to National Economic Development or National Ecosystem Restoration by resolving them. The four criteria are effectiveness, efficiency, acceptability and completeness, and they are used first to assist in identifying individual measures that may address one or more identified problems and opportunities and to subsequently screen out measures unlikely to accomplish one or more of the planning objectives of a project. The same criteria are then used in an iterative process to more thoroughly analyze the most viable individual measures and then to formulate a limited number of alternative plans that may be composed of one or more individual measures. For an ecosystem restoration feasibility study such as GLMRIS, these criteria are then typically used to conduct a trade-off analysis of the relative costs and benefits of each of the alternative plans that will support a recommendation of a single plan that best contributes to National Ecosystem Restoration.

The site specific criteria below were used in the initial screening of measures discussed in Section 3.4.2 and in the more detailed analysis and comparison of structural alternatives presented in Sections 3.5 and 3.6, respectively. These criteria are also considered relevant and appropriate to guide formulation of alternative plans and potentially support development of a recommended plan for a Federal action at Eagle Marsh.

3.4.3.1. Acceptability

For the purposes of this study, acceptability was defined as the degree to which a measure is deemed feasible and the potential impacts are deemed acceptable to pertinent regulatory agencies, users and property owners in the affected floodplain, other stakeholder organizations and the public. Given the large number of variables that influence acceptability of any given measure, the qualitative criteria below were developed to provide a consistent basis for the study team to evaluate and assign a qualitative estimate of acceptability of individual measures. Those measures estimated to have a low degree of acceptability were excluded from further consideration in the initial screening process.

- High – acceptable to all or most stakeholders and compatible with interests, authority and capabilities of at least one potential non-Federal sponsor
- Medium - acceptable to most stakeholders and may be compatible with interests, authority and capabilities of at least one potential non-Federal sponsor
- Low - unacceptable to majority of stakeholders and/or no potential non-Federal sponsors

Factors affecting acceptability estimate:

- Ability to Implement
    - Primary factors
        - Compatibility of the measure with interests and capabilities of potential non-Federal sponsors (i.e. managers of the floodplain) – Indiana DNR & Allen County/Ft Wayne; Primary Eagle Marsh stakeholders – potential to expand wetlands NRCS, LRWP & Indiana DNR; and/or Regional and National stakeholders – protection, restoration and conservation of aquatic resources in Great Lakes and Mississippi River basins.
        - Measure is technically feasible and can be constructed, operated and maintained to perform as intended within legal, policy and resource constraints.
    - Secondary factors
        - Length of time to build and initiate operations.
        - Magnitude of costs to build.
        - Magnitude of costs to operate and maintain the facility and/or conduct requisite operations and monitoring.
        - Magnitude of potential mitigation requirements (induced flooding and/or impacts to wetlands, T&E species, cultural resources, etc.) and associated costs.
        - Level of complexity to operate and maintain.
- Satisfaction
    - Primary factors - Level of compatibility with current land use and interests of primary stakeholders at Eagle Marsh (Indiana DNR, LRWP and NRCS);

users/managers/occupants of the floodplain (Indiana DNR, Allen County/Fort Wayne officials and private landowners); and any other potential non-Federal sponsors.

- Secondary factors – level of confidence of regional and national stakeholders and public that measure will adequately mitigate risk from interbasin spread of ANS.

3.4.3.2. Effectiveness

For the purposes of this study, effectiveness was defined as the degree to which a measure will prevent interbasin spread of ANS across Eagle Marsh. Given the large number of variables that may influence effectiveness of any given measure, the qualitative criteria below were developed to provide a consistent basis for the study team to evaluate and assign a qualitative estimate of effectiveness of individual measures. Those measures estimated to have a Low degree of effectiveness were excluded from further consideration in the initial screening process.

- High – high degree of certainty that measure prevents spread of ANS across Eagle Marsh in both directions.
- Medium – measure reasonably certain to significantly reduce likelihood of interbasin spread of ANS across Eagle Marsh in both directions.
- Low – measure does not significantly reduce likelihood of interbasin spread of ANS across Eagle Marsh.

Factors affecting effectiveness estimate:

- Primary Factors
    - Degree of certainty measure will prevent spread of Asian carp across Eagle Marsh into Great Lakes Basin over 50-year planning horizon.
    - Degree of certainty measure will prevent interbasin spread of other ANS across Eagle Marsh into either basin over 50-year planning horizon.
- Secondary Factor: degree to which measure will reduce likelihood of interbasin spread of all ANS across Eagle Marsh in either direction over 50-year planning horizon.

3.4.3.3. Efficiency

For the purposes of this study, efficiency was defined as the magnitude of resource expenditures relative to the level of effectiveness of a measure to prevent interbasin spread of ANS across Eagle Marsh. The qualitative criteria below were developed to provide a consistent basis for the study team to evaluate and assign a qualitative estimate of the level of efficiency of individual measures. Those measures estimated to have a Low degree of efficiency were excluded from further consideration in the initial screening process.

- High – measure prevents spread of ANS of concern across Eagle Marsh at a reasonable or low total cost

- Medium – measure prevents interbasin spread of ANS at a high total cost, or uncertainty exists regarding level of effectiveness or reliability of measure but measure may be implemented at low or moderate cost.
- Low – measure costs excessively high relative to level of effectiveness.

Factors affecting efficiency estimate:

- Primary Factors
    - Magnitude of costs to construct, operate and maintain and mitigate impacts of measure implementation.
    - Level of reliability measure will prevent interbasin spread of Asian carp and other ANS across Eagle Marsh over 50-year planning horizon.
- Secondary Factors
    - Time to implement measure.
    - Level of resources needed to reliably maintain effectiveness of measure over 50-year planning horizon.

3.4.3.4. Completeness

For the purposes of this study, completeness was defined as the extent to which a measure accounts for all necessary investments and actions to achieve the planning objectives, including investments and actions by other Federal and non-Federal entities. The subjective criteria below were developed to provide a consistent basis for the study team to evaluate and assign a qualitative estimate of the level of completeness of each individual measure. A measure estimated to have a Low level of completeness were excluded from further evaluation in the initial screening process unless it was deemed to be an effective, efficient and acceptable means to address one or more of the specific problems or opportunities identified for the project.

- High – reasonably certain measure accurately accounts for all requisite actions and associated costs to USACE and others to achieve planning objectives.
- Medium – measure accounts for the most significant actions and associated costs to achieve planning objectives by the study team members, but there is uncertainty regarding the capabilities of others to take requisite actions to achieve planning objectives.
- Low – measure does not account for one or more significant actions by USACE or others needed to achieve planning objectives.

Factors affecting completeness estimate:

- Primary Factors
    - Extent measure accounts for all requisite actions by USACE and others to prevent spread of Asian carp across Eagle Marsh.
    - Extent measure accounts for all requisite actions by USACE and others to prevent interbasin spread of all ANS of concern across Eagle Marsh.

- Secondary Factor: number and magnitude of requisite actions beyond control of the study team to achieve planning objectives.

3.4.4. Excluded Measures

The VE study initially identified a wide array of available of options and technologies to prevent interbasin spread of ANS and applied a systematic approach to refine the list down to 12 structural measures the team deemed likely to be most effective. Through an iterative process looking at the inherent value and level of effectiveness, the team added several new alternatives and modified others before winnowing the array down to nine structural measures warranting detailed evaluation. Below is a list of seven alternatives that initially appeared promising followed by a brief explanation of the rationale they were excluded from further evaluation.

- Create Flood Storage in Both Basins
- Reroute Graham-McCulloch Ditch
- Keep Temporary Barrier Fence at Eagle Marsh
- Rotating Drums, Traveling Curtains, Floating Curtains
- Electric Dispersal Barrier
- Longest Economical Crest
- Store Floodwater in Local Quarry

Creating storage in both basins in theory would create massive detention areas within the two watersheds to reduce surface water elevations enough to avoid a hydraulic connection. This measure was eliminated early because a massive amount of real estate acquisition and excavation would be needed to alter the water levels.

Keeping the temporary barrier fence at Eagle Marsh is what it implies; permanently utilizing the previously constructed fence. This measure was eliminated due to the low level of confidence attributed to the berm that the fence ties into, the left descending berm of Graham-McCulloch Ditch. Structural Alternative B addresses this concern by rebuilding the left descending berm.

The Electric Dispersal Barrier measure consists of constructing an electrical field within the water pathway which would deter passage of some ANS, particularly fish. This measure was eliminated mostly due to long-term operation and maintenance costs.

Rotating drums, traveling curtains and floating curtains are all creative structural means of blocking passage of some ANS. These measures were eliminated for a variety of reasons including ice loads, large flow paths and damage from floating debris.

Utilizing a local quarry as a storage area for floodwaters from Junk Ditch was considered. In theory this would provide enough storage that no water would cross the divide into Graham-McCulloch Ditch or Little River. This measure was eliminated due to extensive costs associated with acquiring the quarry, constructing a drainage way to the quarry and unknown levels of storage available for successive events.

The team considered rerouting Graham-McCulloch Ditch to Junk Ditch. This would route the natural drainage into the Junk Ditch and St. Marys basin, and with it reduce the need for a barrier structure at Eagle Marsh to handle daily flows from Graham-McCulloch. This measure was abandoned due to elevation and slope restrictions.

The Longest Economical Crest alternative proposed creating a flow area wide enough to reduce the depth of water flowing across the divide to a minimal level, presumably 1 foot or less. This

alternative was abandoned due to the high flows of the 1% annual chance event and the low topographical relief, which rendered this concept unattainable. A detailed explanation of these eliminations is contained in Appendix F Section 1.6.

3.5. Analysis and Estimated Cost of Viable Structural Alternatives

Alternative A. Construct an I-Wall (Eagle Marsh Basin Divide)

Alternative A proposes construction of a permanent I-wall structure at the approximate location of the drainage divide in Eagle Marsh between the Maumee River Basin and Wabash River Basin. This concrete wall would create a hydrologic separation of the basins. In this alternative, the multi-disciplinary team considered two types of structures: an earthen levee and a sheetpile wall. The earthen levee would require a large amount of offsite material and higher maintenance costs, as well as reduce the aesthetic values of Eagle Marsh. For these reasons, the team considered a sheetpile wall with a concrete facade above ground (i.e., an I-wall) more feasible than the earthen levee. This option would provide hydraulic separation between basins; however, construction of this barrier would raise the floodwater crest elevation for Junk Ditch and would affect structures in the upper reaches of Junk Ditch. The I-wall average height is approximately 8 feet. The wall would stretch from tie-in to high ground north of Engle Road southeast through Eagle Marsh to the railroad as shown in Figure 3.2 on page 50 and Appendix G, Sheet CS101. A potential public safety concern, a fall hazard, could exist via pedestrians accessing the I-wall on each end. Mitigation of this hazard would be further developed if this alternative is selected.

The baseline construction cost estimate for Alternative A is $14.0 million. The mean annual operation and maintenance costs for Alternative A are estimated at $11,000. The increases in water surface elevation (WSEL) for the 1% annual chance event created by this alternative are anticipated to be approximately 1.5 feet on Junk Ditch for areas between the I-wall and Ardmore Avenue, and gradually decreasing to the east toward Taylor Street. Likewise, events on the Graham-McCulloch Basin would not be allowed to discharge excess flows into the St. Marys basin, resulting in WSEL increases on the Eagle Marsh south storage area (defined by the left bank berm of Graham-McCulloch Ditch, the railroad embankment and the natural drainage divide) and Fox Island County Park of approximately 0.6 feet and 0.4 feet respectively for the 1% annual chance event. These elevations are still significantly below the elevations for the 1% annual chance event on the St. Marys River under existing conditions.

Water surface profiles for the 1% annual chance Graham-McCulloch event are not expected to change. The increased water surface elevations would affect 69 parcels not previously affected by the St. Marys Basin 1% annual chance event, including 51 additional structures. Of these additional structures, 24 are residential, 6 are commercial, 16 are industrial, 2 are agricultural and 3 are publicly-owned or unclassified. The inundated area for the 1% event increases by approximately 220 acres, composed of 36 acres of residential land, 15 acres of commercial land, 8 acres of industrial land, 143 acres of agricultural land and 18 acres of publicly-owned, open space, or unclassified land. The

Photo 3.1: Graham-McCulloch Ditch left descending berm (center)

cumulative real property assessed values of the affected parcels increases by approximately $11.4 million for this reach between the mouth of Junk Ditch and the mouth of Graham-McCulloch Ditch.

Photo 3.2: Proposed site downstream of Homestead Road and Graham-McCulloch Ditch

Alternative A is considered highly effective as it would create a hydrologic separation between the Great Lakes and Mississippi River basins for storm events more frequent than the 1% annual chance event on either basin. Hydrologic separation would prevent ANS that reach the basin divide from crossing into the un-colonized basin. This alternative would provide a very high level of protection against the spread of all species of ANS.

Alternative B. Construct a Fence and Reconstruct Left Descending Graham-McCulloch Ditch Berm (Eagle Marsh Basin Divide)

Alternative B proposes construction of a permanent fence east of the location of the existing Indiana DNR fence and reconstruction of the left descending Graham-McCulloch ditch berm. The fence is intended to restrict movement of large ANS in either direction. The fence, approximately 8 feet tall, would be in a north-south orientation and would include tie-in rip rap abutments at the Graham-McCulloch Ditch berm and the Norfolk Southern Railroad embankment as shown in Appendix G Sheet CS102. A portion of the Graham-McCulloch Ditch berm would serve as part of the barrier. Because the existing left descending berm of Graham-McCulloch Ditch is unreliable for high water events, it should be demolished and reconstructed to an elevation above the 1% annual chance event. Moving the fence east would lessen the length of berm to be reconstructed and relied upon. A sacrificial drift and ice fence would be located on the east side of the primary fence to prevent or reduce possible damage or clogging. A borrow site may be needed to supplement acceptable material in the current berm to be demolished. A potential public safety concern, a fall hazard, could exist with all the riprap areas shown in Alternative B. Mitigation of this hazard would be further developed if this alternative is selected.

The baseline construction cost estimate for Alternative B is $3.2 million. The mean annual O&M costs for Alternative B are estimated at $18,000. As this alternative does not alter the hydraulics, this alternative would not affect water surface elevations during flood events.

Alternative B would not create hydrologic separation between the Great Lakes and Mississippi River basins and is considered moderately effective. Small species of ANS such as parasites, viruses, fish fry and small fish may be able to pass through the fence. Large ANS such as Asian carp and northern snakehead would not be able to pass through the fence. Juvenile Asian carp are small enough to pass through the fence. This alternative would provide a low level of protection against very small ANS and a high level of protection against large ANS.

Alternative C. Construct an Earthen Berm and Pump Station (Homestead Road)

Alternative C proposes construction of a pump station and earthen berm downstream of Homestead Road as shown in Figure 3.4 on page 52 and Appendix G Sheet CS104. This

alternative would restrict all flow of Graham-McCulloch Ditch and route it through the pump station, allowing only small ANS to pass from upstream to downstream.

Eleven electric pumps would control flow at the pump station. Three pumps would be 150-horsepower and would operate continually during normal low-flow conditions; the other eight would be 350-horsepower and would operate during high-flow conditions. The eight 350-horsepower pumps would each have 48-inch discharge pipes, while the three 150-horsepower pumps would have 30-inch discharge pipes. Each of the 11 discharge pipes would have a flap gate within the discharge well to route water through outlet pipes back into Graham-McCulloch Ditch downstream.

The berm would tie into the Norfolk Southern Railroad to the south and into Homestead Road to the north. Like Alternative B, Alternative C calls for construction of the berm to an elevation above the 1% annual chance event. An overflow spillway section can be constructed to account for extreme flood events and to prevent water from overtopping Homestead Road or the railroad, and to prevent damage to personal property. A potential public safety concern, a fall hazard, could exist with all the riprap shown in Alternative C. Mitigation of this hazard would be further developed if this alternative is selected.

The baseline construction cost estimate for Alternative C is $25.0 million. The mean annual operation and maintenance costs for Alternative C are estimated at $600,000. The resulting increase in water surface elevations on Junk Ditch is estimated to be 0.2 feet for the Graham-McCulloch 1% annual chance event and approximately 0.1 foot for the St. Marys 1% annual chance event. While the increase for the Graham-McCulloch 1% annual chance event is greater than the allowable increase per Indiana DNR floodplain management regulations of 0.15 feet, it is expected that this difference can be mitigated through further detailed modeling of the pump station features. For comparison, the increased WSEL for this alternative on Junk Ditch is more than 4 feet less than the St. Marys 1% annual chance event. For the St. Marys 1% annual chance event, 35 additional parcels and 1 additional structure are affected by this alternative as the floodplain increases by 125 acres, consisting of 101 acres of agricultural land, 3 acres of residential land, 6 acres of commercial land and 15 acres of publicly-owned, open space or unclassified lands.

The increase in the cumulative real property assessed value of the affected areas is approximately $3.6 million for this alternative during the St. Marys 1 % annual chance event. As modeled, the Graham-McCulloch 1% annual chance event would inundate areas immediately upstream of the pump station structure to a depth of approximately 1 foot and decrease up to a point just upstream of I-69 and inundate portions of 24 additional parcels. The inundated area for the 1% event increases by approximately 71 acres, composed of 40 acres of agricultural land, 2 acres of residential land, 2 acres of commercial land and 26 acres of publicly-owned or open space land. Because no new structures are affected for this Graham-McCulloch 1% annual chance event, the increase in the affected real property assessed values is not estimated.

Alternative C would create directional hydrologic separation between the Great Lakes and Mississippi River basins for storm events more frequent than the 1% annual chance event on either basin. The physical barrier created by the berm and pump station would prevent a hydraulic connection between the two basins. Flow from the Mississippi River Basin into the Great Lakes Basin would occur when the pumps engage.

This alternative is considered moderately effective at preventing spread of ANS. Small species of ANS such as parasites, viruses, fish fry and small fish would be able to pass through the pumps. Macroscopic ANS would most likely not be able to survive passing through the pumps. This alternative would provide a high level of protection from ANS spreading from the Mississippi River Basin into the Great Lakes Basin. This alterative would provide a medium level of protection against ANS spreading from the Great Lakes Basin into the Mississippi River Basin.

Alternative D. Construct a Permeable Berm with Telemetered Sluice Gates (Amber Road)

Alternative D proposes construction of a permeable berm made of open-graded riprap surrounding a perforated pipe system that captures the water as it passes through the stone. This allows flow though the embankment during high water to the downstream side. This oversized stone check dam alternative creates a barrier to large ANS traveling from either direction yet would allow the passage of small ANS from upstream to downstream. The berm would run north-northeast just upstream of and adjacent to Amber Road (Photo 3.4) and would tie into high ground approximately 200 yards east of Amber Road on the north end as shown in Figure 3.5 on page 53 or Appendix G Sheets CS105 and CS106. The southern end of the permeable berm would tie into the Norfolk Southern Railroad embankment. The system would drain south to Graham-McCulloch Ditch and the pipe system would empty into the existing channel downstream of the berm.

Since the permeable berm likely cannot pass enough water during large events, sluice gates are also included in the design. The sluice gates would have automated closure mechanisms programmed to close to a nominal opening height of 3-inches when flow conditions could allow for the transfer of ANS, forcing water to pond and infiltrate through the permeable berm. Large sluice gates constructed in the channel would remain open during normal low flow conditions to allow normal drainage of Graham-McCulloch Ditch.

When the sluice gates are closed, water levels would inundate a large area upstream of the berm and debris and sediment buildup is expected. Because debris and sediment buildup is of large concern for this alternative, a vegetated filter strip planted upstream would reduce debris and sediment buildup on and within the berm. Potential public safety concerns were noted in Alternative D. Opening and closing speeds of the sluice gates as well as accessibility to the sluice gates could be a potential hazard. In addition, a fall hazard could exist with all the riprap areas shown. Mitigation of these hazards would be further developed if this alternative is selected.

The baseline construction cost estimate for Alternative D is $7.8 million. Mean annual operation and maintenance costs for Alternative D are estimated at $22,000. Maximum water surface elevation increases on Junk Ditch for the 1% annual chance event on Graham-McCulloch is approximately 0.4 feet, but it is believed that further refinement of the gate operations could reduce this to meet Indiana floodplain limitations of 0.15 feet increase in the 1% annual chance. For reference, this increase is still less than the 1% annual chance elevation for the St. Marys River flood event. The St. Marys 1% annual chance event was not modeled for this alternative, as the Graham-McCulloch Ditch

Photo 3.3: Proposed Amber Road site (right)

1% annual chance event would control. As modeled, increased water surface elevations for the Graham-McCulloch 1% annual chance event would inundate portions of 19 additional parcels. Inundated areas immediately upstream of the permeable berm structure would increase approximately 2.3 feet and decrease to a point just upstream of I-69. The inundated area for the 1% event increases by approximately 118 acres, composed of 58 acres of agricultural land, 2 acres of residential land, 3 acres of commercial land and 55 acres of publicly-owned, open space, or unclassified land. Because no additional structures are affected for this Graham-McCulloch 1% annual chance event, the increase in affected cumulative real property assessed value is not estimated.

Alternative D would not create hydrologic separation between the Great Lakes and Mississippi River basins and is therefore considered moderately effective. During flood events when ANS could cross the basin divide, water would be forced to infiltrate through the permeable berm. During flood events, control of sluice gate openings would be designed to maintain high velocity flow through minimal gate openings of sluice gates to be an obstacle to swimmer species of ANS. This process would prevent ANS from crossing the basin divide. Even ANS that are microscopic or nearly so should have difficulty navigating and surviving this process. This alternative would provide a medium level of protection against small, and a high level of protection against large ANS moving from the Mississippi River Basin to the Great Lakes Basin.

Alternative E. Construct a Fence/Earthen Berm Combination (Eagle Marsh Basin Divide)

Alternative E proposes construction of a combination of an earthen berm to an elevation above a 4% annual chance event on Graham-McCulloch Ditch with a fence on the crown of the berm constructed to an elevation above a 1% annual chance event. This berm/fence combination would limit the number of hydrologic basin connections and prevent the spread of large ANS during flood events that overtop the berm with the fence. The berm would be approximately 3 to 4 feet tall, with a 6 to 7 feet tall fence along its crest. The south abutment of the berm and fence combination would tie into the Norfolk Southern Railroad embankment and run north, aligned approximately with the basin divide. Once at the Eagle Marsh access road, the berm and fence would separate and the access road would be located on the crown of the berm, while the fence continues on the west side of the berm as shown in Figure 3.6 on page 54 or Appendix G Sheet CS107. This alternative would require a borrow site for the berm construction. A potential public safety concern, a fall hazard, could exist with all the riprap areas shown in Alternative E. Mitigation of this hazard would be further developed if this alternative is selected.

The baseline construction cost estimate for Alternative E is $4.2 million. The mean annual operation and maintenance costs for Alternative E are estimated at $44,000. This alternative has no effect on the 1% annual chance event occurring on the St. Marys, and decreases the water surface elevations for the same chance exceedance event on Graham-McCulloch Ditch. Minor increases of up to 0.15 feet are created on Graham-McCulloch Ditch by this alternative for the 1% annual chance event on the Graham-McCulloch Ditch Basin. Increased water surface elevations for the Graham-McCulloch 1% annual chance event would inundate portions of 18 new parcels. The inundated area for the 1% event increases by approximately 33 acres, composed of 21 acres of agricultural land, 1 acre of residential land, 1 acre of commercial land and 10 acres of publicly-owned and open space, or unclassified land. Because no additional structures are affected for this Graham-McCulloch 1% annual chance event, the increase in the affected real property assessed value is not estimated.

Alternative E would create hydrologic separation between the Great Lakes Basin and the Mississippi River Basin during floods to an elevation to the 4% annual chance event on Graham-McCulloch Ditch. Due to the much larger magnitude of flows on the St. Marys River, this berm would only create separation for approximately a 99% annual chance exceedance (or nearly annual) event on that basin. During those conditions this alternative would provide a high level of protection against the spread of ANS. During floods to an elevation above the 4% annual chance event on Graham-McCulloch Ditch, or approximately a 99% annual chance event on the St. Marys River, hydrologic separation between the two basins would be lost. At this point, small species of ANS such as parasites, viruses, fish fry and small fish may be able to pass through the fence. For this reason this alternative is considered moderately effective. Large ANS such as Asian carp and northern snakehead would not be able to pass through the fence. During floods to an elevation above the 4% annual chance event on Graham-McCulloch Ditch this alternative would provide a low level of protection against very small ANS and a high level of protection against large ANS species.

Alternative F. Construct Bar Screen Barrier at Existing Weir (Huntington Dam)

Alternative F proposes construction of a bar screen at an existing fixed crest weir located on the Little River. This alternative would provide a screened barrier as well as a vertical drop to prevent ANS from traveling upstream to the Great Lakes Basin. This alternative is located approximately 20 miles downstream of the drainage divide in the town of Huntington, as shown in Figure 3.7 on page 55 or Appendix G Sheet CS108. Currently, the weir provides a 6-foot head differential at low water providing a vertical drop over the structure which would hinder the leaping ability of some ANS and prevent their movement upstream. Constructing a bar screen with the top of the screen elevation above the 1% annual chance event elevation would prevent the transfer of adult swimming ANS during high flow events. The bar screen would be slanted to counter the jumping ability of certain ANS, while allowing debris and ice to pass over, thus reducing the probability of damage to the screen.

Photo 3.4: Huntington Dam approximately 2.4 miles downstream of the basin divide

A floating boom incorporated upstream of the weir would deter debris and ice from collecting on or damaging the screen. The floating boom angled toward the right bank would divert floating debris to a collection point. A potential public safety concern, a fall hazard, could exist near the riprap at the debris boom tie-in on the northern side of Little River at Huntington in Alternative F. Further, the slanted bar screen spanning the river could be considered a nuisance. As such, fencing may be considered on both banks to prevent people from attempting to cross the river here. Mitigation of these hazards would be developed further if this alternative is selected.

The baseline construction cost estimate for Alternative F is $2.7 million. The mean annual operation and maintenance costs for Alternative F are estimated at $96,000.

Alternative F would not create hydrologic separation between the Great Lakes and Mississippi River basins at Eagle Marsh. Small ANS such as parasites, viruses, fish fry and small fish would be able to pass through the bar screen. Large ANS, such as adult Asian carp and northern snakehead, would not be able to pass through the screen. The size of juvenile Asian carp able to pass through the bar screen would depend on final bar spacing. This alternative offers a lower degree of protection against downstream movement of ANS towards the Mississippi River than it does against upstream movement of ANS towards the Great Lakes Basin. This alternative would provide a low level of protection against very small ANS and a medium level of protection against large ANS.

Alternative G. Construct Vertical Drop Structures with Telemetered Sluice Gate (Homestead Road)

Alternative G proposes construction of a berm upstream of Homestead Road with several large diameter intake structures to pass flow. This alternative provides a physical barrier for ANS with screened water intakes to deter large ANS. Normal low flow would pass through the sluice gates in the Graham-McCulloch Ditch channel. The gates would operate in a similar manner to those described in Alternative D, remaining open during normal low-flow conditions and closing when flows could allow ANS transfer. To pass additional flows during high-flow events, Alternative G requires construction of vertical-drop structures, similar to control structures commonly used in lakes, ponds or detention basins. Preliminarily, there would be ten drop structures with a 24-foot diameter. Each drop structure would drain through a 6-foot by 3-foot box culvert through the berm and exit downstream into Graham-McCulloch Ditch, as shown in Appendix G Sheets CS109 and CS110. Alternative G includes a fence to filter out trash and jumping fish around the top of the drop structure to prevent transfer of ANS from downstream to upstream. A potential public safety concern was noted in Alternative G. The drop structures could become a nuisance. The vertical drop structure area design should consider ways to minimize public access and fall hazards; mitigation of this hazard would be developed further if this alternative is selected.

The baseline construction cost estimate for Alternative G is $4.8 million. The mean annual operation and maintenance costs for Alternative G are estimated at $26,000. Despite the increase to WSEL elevation for a 1% annual chance event on the St. Marys River is less than 0.2 feet at the left bank berm, significant increases of approximately 1 foot or more are observed on Junk Ditch. The increased water surface elevations would affect 7 parcels not previously affected by the St. Marys Basin 1% annual chance event, including 7 additional residential structures and 1 additional industrial structure. The inundated area for the St. Marys River 1% annual chance event increases by approximately 106 acres, composed of 2 acres of residential land, 92 acres of agricultural land, 1 acre of commercial land, 1 acre of industrial land and 10 acres of publicly-owned or open space lands. The cumulative real property assessed value of the affected parcels increases by approximately $0.7 million for this reach between the mouths of Junk Ditch and Graham-McCulloch Ditch for the 1% annual chance event on the St. Marys River. For the same chance event on the Graham-McCulloch Ditch Basin, this alternative affects 27 additional parcels, including 2 additional residential structures. The inundated area for the 1% event on Graham-McCulloch Ditch increases by approximately 250 acres, composed of 6 acres of residential land, 133 acres of agricultural land, 10 acres of commercial land, 6 acres of industrial land and 95 acres of publicly-owned land or open space. The cumulative real property assessed value of the affected parcels increases by approximately $0.2 million for this reach.

Alternative G would not create hydrologic separation between the Great Lakes and Mississippi River basins. During flood events, when ANS could cross the basin divide, water would be forced through a vertical drop structure. This process would prevent ANS from crossing the basin divide by restricting the means of passage to the conduits and gates and the vertical water surface differential created for flow up to the 1% annual chance event.

Small species of ANS such as parasites, viruses, fish fry and small fish would be able to pass through the screen atop the vertical drop structures and survive the vertical drop. Large ANS, such as Asian carp and northern snakehead, would not be able to pass through the screen. Juvenile Asian carp may be small enough to pass through the screen yet are not likely to reach the intake structure through the turbulent flow of the outlet. This alternative would provide a low level of protection against very small ANS and a high level of protection against large ANS. This alternative is therefore considered moderately effective.

Alternative H. Reconstruct Left Descending Graham-McCulloch Ditch Berm (Eagle Marsh Basin Divide)

Alternative H proposes to separate waters from the Maumee and Wabash basins by reconstructing the left descending berm of the Graham-McCulloch ditch to a higher elevation, as shown in Figure 3.9 on page 57 or Appendix G Sheets CS111 and CS112. This berm, reconstructed to an elevation above the 1% annual chance event, would create a hydrologic separation between the two basins and prevent the spread of all ANS. This requires demolition of the left descending berm from the water treatment plant access road to the Norfolk Southern Railroad embankment, an estimated 8,700 feet. The new berm would be constructed in the same alignment as the previous berm and would have 3:1 (horizontal:vertical) slopes and a 10-foot crown for necessary operations and maintenance. Material from the existing berm may be available for reuse, if deemed suitable; however, additional material from a borrow source would be needed to raise the overall berm elevation.

A potential public safety concern, a fall hazard, could exist near the riprap tying the structure into the railroad ballast and Graham-McCulloch Ditch in Alternative H. Mitigation of this hazard would be further developed if this alternative is selected.

The baseline construction cost estimate for Alternative H is $5.7 million. Mean annual operation and maintenance cost for Alternative H are estimated at $14,000. Similar to Alternative A, a barrier completely blocking exchange of flow would impact water surface elevations in the area exceeding permissible increases by Indiana floodplain regulations. Increases to the Graham-McCulloch Ditch 1% annual chance event were approximately 0.5 feet near I-69, and 0.3 feet were observed on the Little River to the end of the model. Increases of up to 0.9 feet were noted on the western end of Junk Ditch, but no increases were computed east of Freeman Street. Increased water surface elevations would affect 66 parcels not previously affected by the St. Marys Basin 1% annual chance event, including 19 additional residential structures, 9 additional commercial structures, 3 additional industrial structures and 3 additional publicly-owned or unclassified structures. The inundated area for the 1% event increases by approximately 209 acres, composed of 28 acres of residential land, 133 acres of agricultural land, 9 acres of commercial land, 3 acres of industrial land and 36 acres of publicly-owned or open space lands. Cumulative real property assessed value of the affected parcels increases by approximately $7.2 million for this reach.

For a 1% annual chance event on Graham-McCulloch Ditch, increased water surface elevations would affect 5 parcels not previously affected by this storm event, including 1 additional structure. The inundated area for this event increases by 122 acres, including 2 acres of residential land, 103 acres of agricultural land, 3 acres of commercial land and 14 acres of publicly-owned or unclassified land. For this flood event, cumulative real property assessed value of affected parcels increases by approximately $0.1 million for this reach.

Alternative H would create a hydrologic separation between the Great Lakes and Mississippi River basins for storm events more frequent than the 1% annual chance event on either basin. Hydrologic separation would prevent ANS from crossing the basin divide into the un-colonized basin. This alternative would provide a very high level of protection against spread of all ANS species and is therefore considered highly effective.

Alternative I. Reconstruct Left Descending Graham-McCulloch Ditch Berm, Demolish Right Descending Berm and Construct Multi-Cell Wetland Area (Eagle Marsh Basin Divide)

Similar to Alternative H, Alternative I proposes demolishing and reconstructing the left descending berm; however, this alternative also includes removing the right descending berm as shown in Figure 3.10 on page 59 and Appendix G Sheets CS113 and CS114. This alternative provides the same hydrologic separation as Alternative H, thereby preventing the spread of all ANS. This alternative is different from Alternative H in that it allows the creation of additional wetlands and reduces the volume of material needed from a borrow site. Demolition of the right descending berm would begin at the water treatment plant and conclude at the point where the ditch and berm become parallel with the Norfolk Southern Railroad, similar to the location of the left descending berm demolition. Material from both the right and left descending berms, if determined to be suitable, may be available for use in reconstructing the left descending berm thus reducing the need for borrow material as compared to Alternative H.

With removal of the right descending berm, stormwater flows from Graham-McCulloch would inundate the section of Eagle Marsh northwest of Graham-McCulloch Ditch with a higher frequency. This alternative calls for development of a multi-cell wetland area along the previous alignment of the right descending berm of Graham-McCulloch Ditch. The multi-cell wetland would begin at the wastewater treatment plant and run approximately 1,800 feet downstream until the ditch turns back to the west. The wetland area would pre-treat stormwater by slowing runoff and allowing sediment to settle and pollutants to be filtered by vegetation. A potential public safety concern, a fall hazard, could exist near the riprap tying the structure into the railroad ballast and Graham-McCulloch Ditch as in Alternative H. Mitigation of this hazard would be further developed if this alternative is selected.

The baseline construction cost estimate for Alternative I is $7.2 million. Mean annual operation and maintenance costs for Alternative I are estimated at $17,000. Removing the right bank berm, which functions as the controlling weir, causes the area to no longer function as a detention area. As a result, peak water surface elevations

Photo 3.5: Graham-McCulloch right descending berm as seen from the water treatment plant access road, 14-Mar-12.

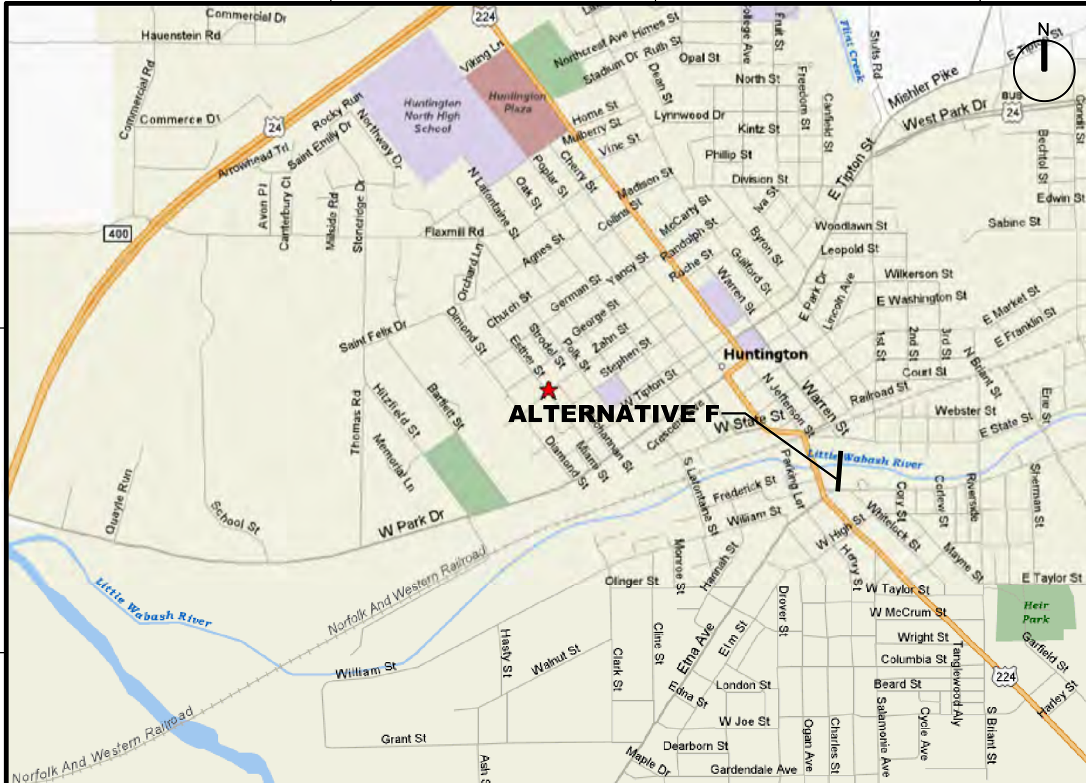
increase downstream of Eagle Marsh by up to 1.0 foot for the Graham-McCulloch Ditch 1% annual chance event. This is in addition to increases on the upstream end of Junk Ditch as discussed above for Alternative H.

Photo 3.6: Graham-McCulloch Ditch. Proposed multi-cell wetland area will be located behind the existing right descending berm (left)

Please refer to the discussion on page 46 for Alternative H regarding impacts to inundated areas and structures for the St. Marys Basin 1% annual chance event, as they would remain the same for Alternative I. For a 1% annual chance event on Graham-McCulloch Ditch, increased water surface elevations would affect 11 parcels not previously affected by this storm event, including 2 additional residential and 2 additional publicly-owned or unclassified structures. The inundated area for this event increases by 88 acres, including 4 acres of residential land, 55 acres of agricultural land, 7 acres of commercial land and 22 acres of publicly-owned or unclassified land. For this flood event, the cumulative real property assessed value of the affected parcels increases by approximately $0.5 million for this reach.

Alternative I would create hydrologic separation between the Great Lakes Basin and the Mississippi River Basin for storm events more frequent than the 1% annual chance event on either basin. Hydrologic separation would prevent ANS that reach the basin divide from crossing into the un-colonized basin. This alternative would provide a very high level of protection against the spread of all ANS species, and is therefore considered highly effective.

1 2 3 4 5 6 7 8 9

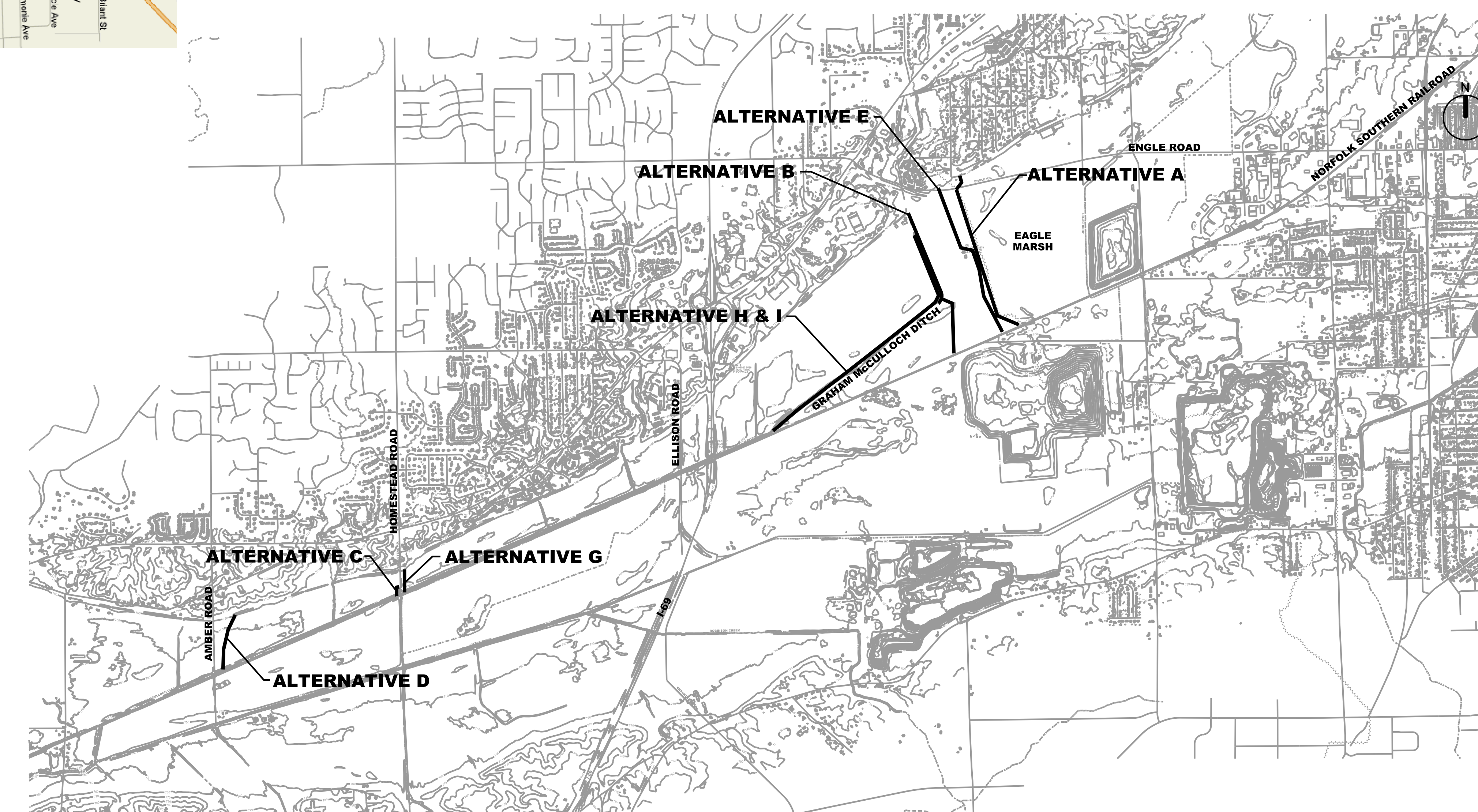


HUNTINGTON, INDIANA

NTS

ALTERNATIVES:

A: CONSTRUCT AN I-WALL, (EAGLE MARSH, BASIN DIVIDE)
B: CONSTRUCT A FENCE AND RECONSTRUCT LEFT DESCENDING GRAHAM MCCULLOCH DITCH BERM, (EAGLE MARSH, BASIN DIVIDE)
C: CONSTRUCT AN EARTHEN BERM AND PUMP STATION, (HOMESTEAD ROAD)
D: CONSTRUCT A PERMEABLE BERM WITH TELEMETERED SLUICE GATES, (AMBER ROAD)
E: CONSTRUCT A FENCE/EARTHEN BERM COMBINATION, (EAGLE MARSH, BASIN DIVIDE)
F: CONSTRUCT BAR SCREEN BARRIER AT EXISTING WEIR, (HUNTINGTON DAM)
G: CONSTRUCT VERTICAL DROP STRUCTURE WITH TELEMETERED SLUICE GATE,(HOMESTEAD ROAD)
H: RECONSTRUCT LEFT DESCENDING GRAHAM MCCULLOCH DITCH BERM, (EAGLE MARSH, BASIN DIVIDE)
I: RECONSTRUCT LEFT DESCENDING GRAHAM MCCULLOCH DITCH BERM, DEMOLISH RIGHT DESCENDING BERM, AND CONSTRUCT MULTI-CELL WETLAND AREA, (EAGLE MARSH, BASIN DIVIDE)



FORT WAYNE, INDIANA

0 2000' 4000'

US ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT

SYMBOL	REVISIONS DESCRIPTION	DATE	APPR.

DESIGNED BY: B. JENNINGS
DRAWN BY: C. ROBINSON
CHECKED BY: B. DORSCH
B. JENNINGS, P.E. PROJECT ENGINEER/ARCHITECT
DATE: FEBRUARY 2012
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DRAWING CODE: LR 5.6-12.1
DATE

AQAUTIC NUISANCE SPECIES CONTROL REPORT
WABASH-MAUMEE BASIN
FORT WAYNE, INDIANA

OVERALL MAP

SHEET REFERENCE NUMBER:
CS100
SHEET 3 OF 38

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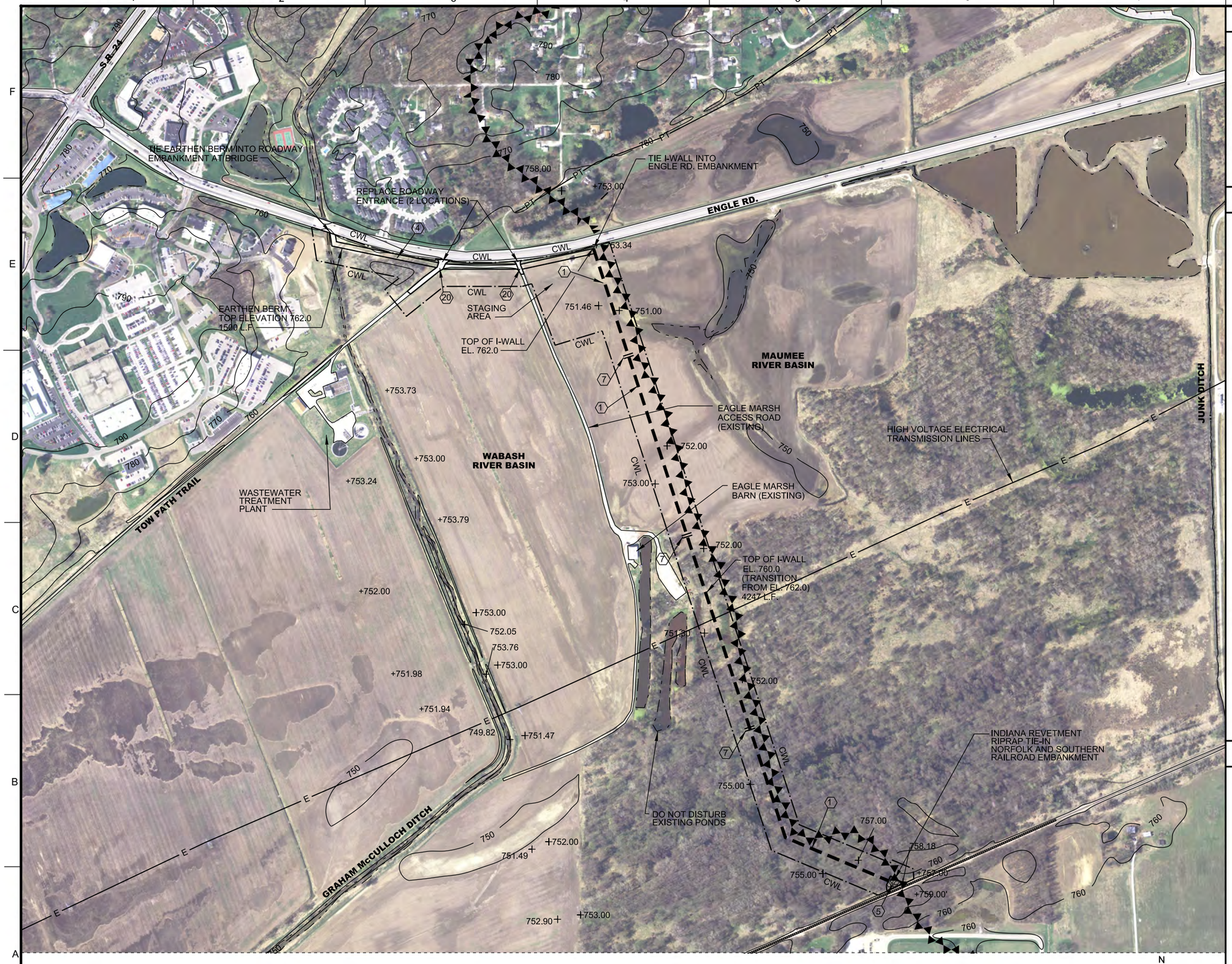

A1 ALTERNATIVE A CONSTRUCT I-WALL SITE PLAN

1"=300'

0 300' 600'

GENERAL SHEET NOTES

SHEET KEYNOTES

1 I-WALL, SEE DETAIL, SH. CZ001
2 FENCE , SEE DETAIL, SH. CZ002 & CZ003
3 DEMOLISH LEFT DESCENDING GRAHAM McCULLOCH DITCH BERM
4 EARTHEN BERM, SEE DETAIL, SH. CZ001
5 INDIANA REVETMENT RIPRAP
6 PUMP STATION (30' X 25'), SEE DETAILS, SH. CZ005
7 TERRESTRIAL ANIMAL CROSSING, SEE DETAIL SH. CZ001
8 GATEWELL/SLUICE GATE
9 PERMEABLE BERM, SEE DETAIL, SH. CZ001
10 DEBRIS FENCE, SEE DETAIL, SH. CZ003
11 FENCE / EARTHEN BERM, SEE DETAIL, SH. CZ001
12 METAL GATE, 15' WIDTH, SEE DETAIL, SH. CZ001
13 EQUIPMENT GATE STRUCTURE, SEE DETAIL SH. CZ002
14 FLAP GATE, SEE DETAIL, SH. CZ007
15 48" CMP
16 CONCRETE HEADWALL, SEE DETAIL, SH. CZ007
17 TRAPEZOIDAL DITCH, SEE DETAIL, SH. CZ001
18 TELEMETRY CONTROL STRUCTURE
19 HEAVY DUTY DEBRIS BOOM
20 ACCESS ROAD , SEE DETAIL, SH. CZ006
21 CONCRETE PIER AND BAR SCREEN BARRIER, SEE DETAIL, SH. CZ004
22 DEMOLISH RIGHT DESCENDING GRAHAM McCULLOCH DITCH BERM
23 MULTI-CELL WETLAND AREA (1800' x 100')
24 VERTICAL DROP STRUCTURE, SEE DETAIL SH. CZ006
25 VEGETATION FILTER STRIP (NATIVE TREES AND SHRUBS)
26 OUTLET PIPES, SEE DETAIL CZ006
27 RELOCATE EAGLE MARSH ACCESS ROAD, SEE DETAIL, SH. CZ006
28 DISCHARGE WELL (52' x 15')
29 PUMP STATION SUMP (101' x 47'), SEE DETAIL, SH. CZ005
30 SILT FENCE, SEE DETAIL, SH. CZ001

LEGEND

- I-WALL
- BASIN DIVIDE
- FENCE
- DEBRIS BOOM
- EARTHEN BERM
- FENCE/EARTHEN BERM
- INDIANA REVETMENT RIPRAP
- CWL — CONTRACTOR WORK LIMITS
- DEMOLISH STRUCTURE
- PT — POWER & TELEPHONE UTILITY LINES
- P — ELECTRIC UTILITY LINES

US ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT

REVISIONS

SYMBOL	DESCRIPTION	DATE	APPR.

DESIGNED BY: B. JENNINGS
DRAWN BY: C. ROBINSON
CHECKED BY: B. DORSCH
B. JENNINGS, P.E.
PROJECT ENGINEER/ARCHITECT
DATE: FEBRUARY 2012
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AQUATIC NUISANCE SPECIES CONTROL MEASURE WABASH-MAUMEE BASIN FORT WAYNE, INDIANA

ALTERNATIVE A SITE PLAN

SHEET REFERENCE NUMBER: CS101

SHEET 4 OF 38

FINAL SUBMITTAL

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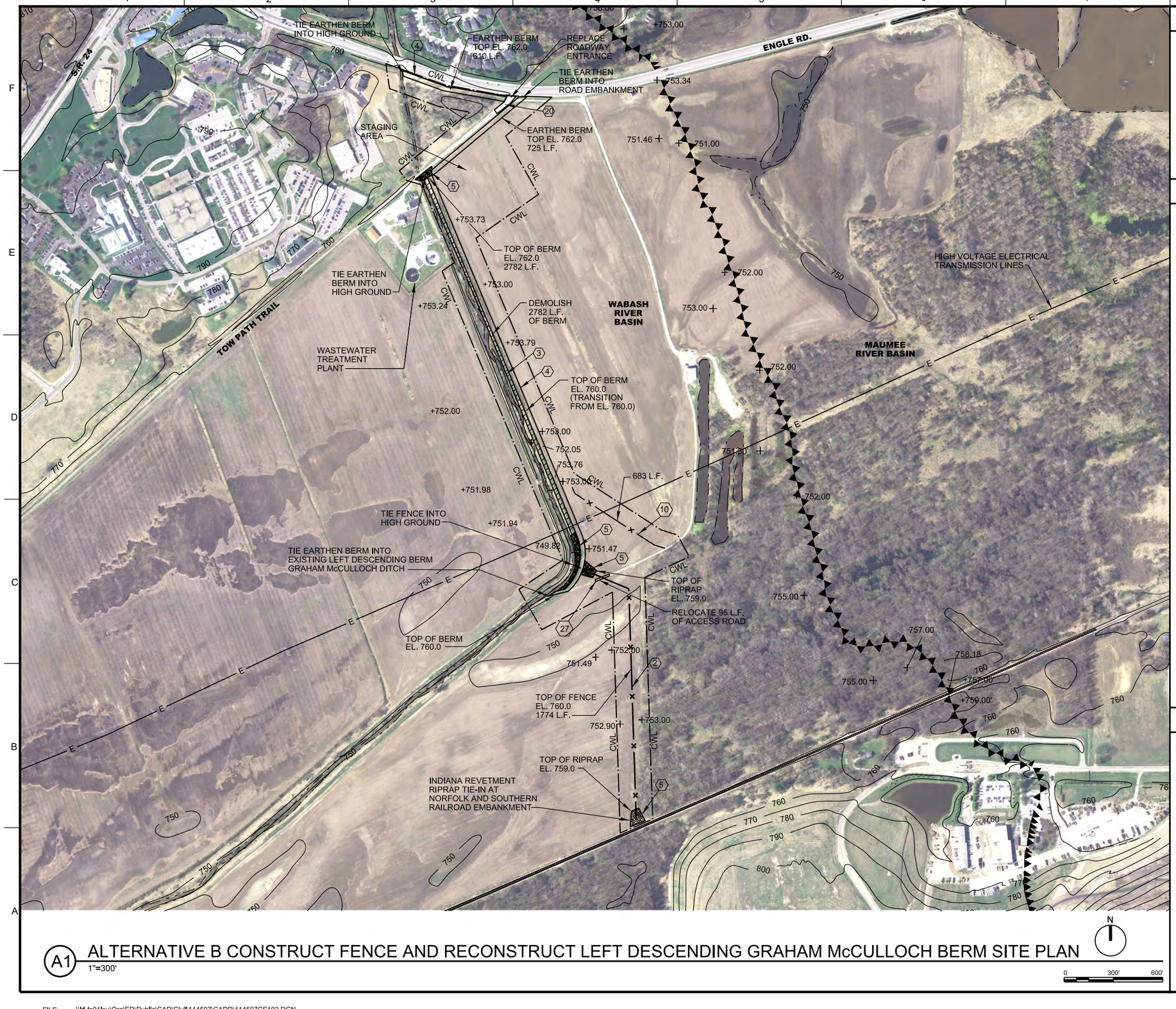

GENERAL SHEET NOTES

SHEET KEYNOTES

1 I-WALL, SEE DETAIL, SH. CZ001
2 FENCE , SEE DETAIL, SH. CZ002 & CZ003
3 DEMOLISH LEFT DESCENDING GRAHAM McCULLOCH DITCH BERM
4 EARTHEN BERM, SEE DETAIL, SH. CZ001
5 INDIANA REVETMENT RIPRAP
6 PUMP STATION (30' X 25'), SEE DETAILS, SH. CZ005
7 TERRESTRIAL ANIMAL CROSSING, SEE DETAIL SH. CZ001
8 GATEWELL/SLUICE GATE
9 PERMEABLE BERM, SEE DETAIL, SH. CZ001
10 DEBRIS FENCE, SEE DETAIL, SH. CZ003
11 FENCE / EARTHEN BERM, SEE DETAIL, SH. CZ001
12 METAL GATE, 15' WIDTH, SEE DETAIL, SH. CZ001
13 EQUIPMENT GATE STRUCTURE, SEE DETAIL SH. CZ002
14 FLAP GATE, SEE DETAIL, SH. CZ007
15 48" CMP
16 CONCRETE HEADWALL, SEE DETAIL, SH. CZ007
17 TRAPEZOIDAL DITCH, SEE DETAIL, SH. CZ001
18 TELEMETRY CONTROL STRUCTURE
19 HEAVY DUTY DEBRIS BOOM
20 ACCESS ROAD , SEE DETAIL, SH. CZ006
21 CONCRETE PIER AND BAR SCREEN BARRIER, SEE DETAIL, SH. CZ004
22 DEMOLISH RIGHT DESCENDING GRAHAM McCULLOCH DITCH BERM
23 MULTI-CELL WETLAND AREA (1800' x 100')
24 VERTICAL DROP STRUCTURE, SEE DETAIL SH. CZ006
25 VEGETATION FILTER STRIP (NATIVE TREES AND SHRUBS)
26 OUTLET PIPES, SEE DETAIL CZ006
27 RELOCATE EAGLE MARSH ACCESS ROAD, SEE DETAIL, SH. CZ006
28 DISCHARGE WELL (52' x 15')
29 PUMP STATION SUMP (101' x 47'), SEE DETAIL, SH. CZ005
30 SILT FENCE, SEE DETAIL, SH. CZ001

LEGEND

I-WALL
BASIN DIVIDE
FENCE
DEBRIS BOOM
EARTHEN BERM
FENCE/EARTHEN BERM
INDIANA REVETMENT RIPRAP
CWL — CONTRACTOR WORK LIMITS
DEMOLISH STRUCTURE
PT — POWER & TELEPHONE UTILITY LINES
P — ELECTRIC UTILITY LINES

A1 ALTERNATIVE B CONSTRUCT FENCE AND RECONSTRUCT LEFT DESCENDING GRAHAM McCULLOCH BERM SITE PLAN
1"=300'

N
0 300' 600'

US ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT

REVISIONS	DESCRIPTION	DATE	APPR.
SYMBOL			

DESIGNED BY: B. JENNINGS
DRAWN BY: C. ROBINSON
CHECKED BY: B. DORSCH
B. JENNINGS, P.E.
PROJECT ENGINEER/ARCHITECT
DATE: FEBRUARY 2012
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DATE

AQUATIC NUISANCE SPECIES CONTROL FEASIBILITY WABASH-MAUMEE BASIN FORT WAYNE, INDIANA

ALTERNATIVE B SITE PLAN

SHEET REFERENCE NUMBER: CS102
SHEET 5 OF 38

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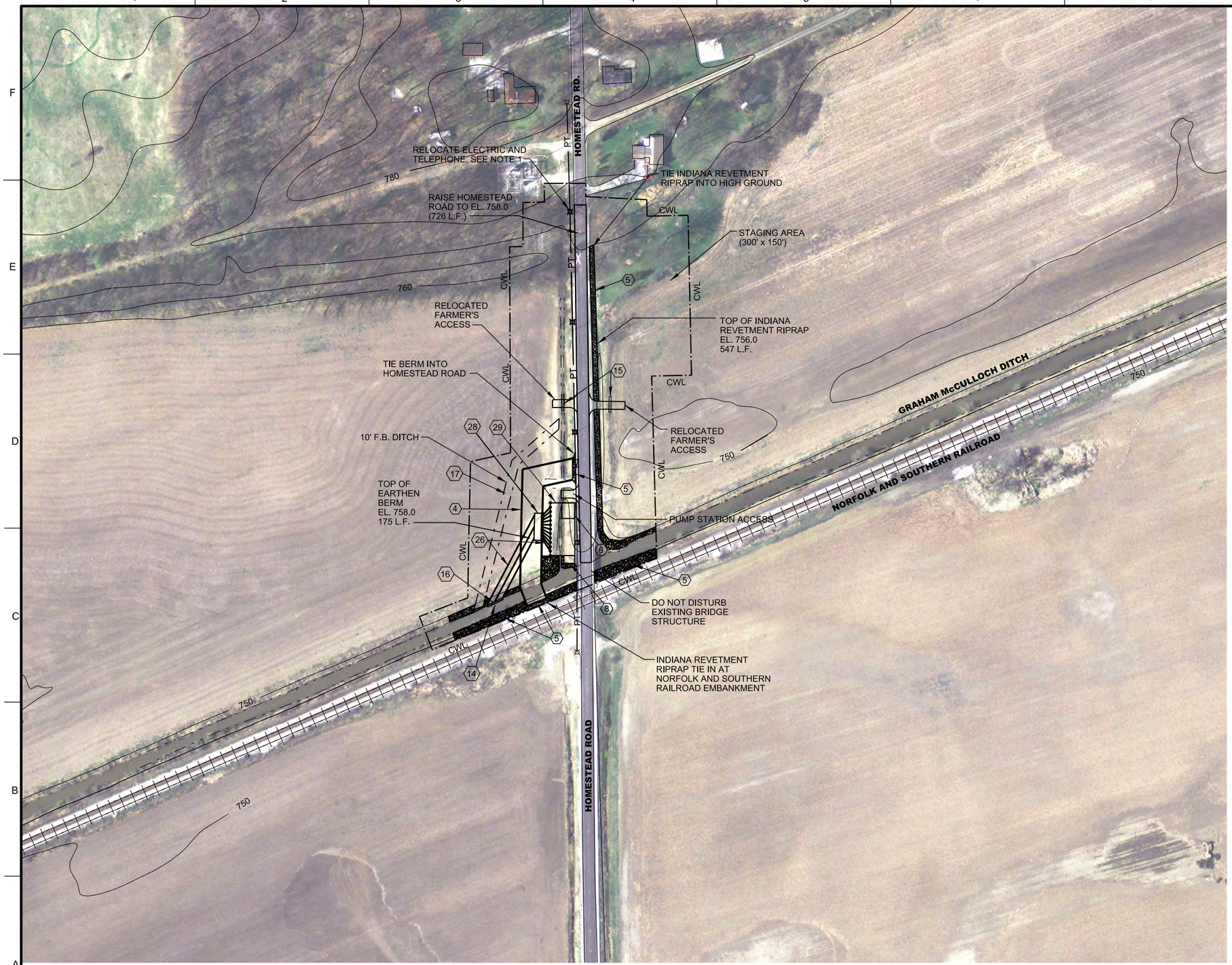

A1 ALTERNATIVE C CONSTRUCT EARTHEN BERM AND PUMP STATION ENLARGED SITE PLAN

1"=100'

N

0 100' 200'

GENERAL SHEET NOTES

1. RELOCATE APPROXIMATELY 1055 L.F. OF POWER AND TELEPHONE AND 4 JOINT-USE UTILITY POLES.
2. BURIED FIBER OPTIC CABLE NOT TO BE DISTURBED.
3. REMOVE EXISTING 18" CMP UNDER FARMER'S ACCESS.
4. PUMP STATION STRUCTURE TO BE 30' x 25'.
5. PUMP DISCHARGE PIPES WILL BE 48" (8) ANFD 30" (3) IN DIAMETER. EACH WILL HAVE FLAP GATE (11 TOTAL).

SHEET KEYNOTES

1 I-WALL, SEE DETAIL, SH. CZ001
2 FENCE , SEE DETAIL, SH. CZ002 & CZ003
3 DEMOLISH LEFT DESCENDING GRAHAM McCULLOCH DITCH BERM
4 EARTHEN BERM, SEE DETAIL, SH. CZ001
5 INDIANA REVETMENT RIPRAP
6 PUMP STATION (30' X 25'), SEE DETAILS, SH. CZ005
7 TERRESTRIAL ANIMAL CROSSING, SEE DETAIL SH. CZ001
8 GATEWELL/SLUICE GATE
9 PERMEABLE BERM, SEE DETAIL, SH. CZ001
10 DEBRIS FENCE, SEE DETAIL, SH. CZ003
11 FENCE / EARTHEN BERM, SEE DETAIL, SH. CZ001
12 METAL GATE, 15' WIDTH, SEE DETAIL, SH. CZ001
13 EQUIPMENT GATE STRUCTURE, SEE DETAIL SH. CZ002
14 FLAP GATE, SEE DETAIL, SH. CZ007
15 48" CMP
16 CONCRETE HEADWALL, SEE DETAIL, SH. CZ007
17 TRAPEZOIDAL DITCH, SEE DETAIL, SH. CZ001
18 TELEMETRY CONTROL STRUCTURE
19 HEAVY DUTY DEBRIS BOOM
20 ACCESS ROAD , SEE DETAIL, SH. CZ006
21 CONCRETE PIER AND BAR SCREEN BARRIER, SEE DETAIL, SH. CZ004
22 DEMOLISH RIGHT DESCENDING GRAHAM McCULLOCH DITCH BERM
23 MULTI-CELL WETLAND AREA (1800' x 100')
24 VERTICAL DROP STRUCTURE, SEE DETAIL SH. CZ006
25 VEGETATION FILTER STRIP (NATIVE TREES AND SHRUBS)
26 OUTLET PIPES, SEE DETAIL CZ006
27 RELOCATE EAGLE MARSH ACCESS ROAD, SEE DETAIL, SH. CZ006
28 DISCHARGE WELL (52' x 15')
29 PUMP STATION SUMP (101' x 47'), SEE DETAIL, SH. CZ005
30 SILT FENCE, SEE DETAIL, SH. CZ001

LEGEND

- I-WALL
- BASIN DIVIDE
- FENCE
- DEBRIS BOOM
- EARTHEN BERM
- FENCE/EARTHEN BERM
- INDIANA REVETMENT RIPRAP
- CWL — CONTRACTOR WORK LIMITS
- DEMOLISH STRUCTURE
- PT — POWER & TELEPHONE UTILITY LINES
- P — ELECTRIC UTILITY LINES

US ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT

REVISIONS DESCRIPTION	DATE	APPR.
SYMBOL		

DESIGNED BY: B. JENNINGS
DRAWN BY: C. ROBINSON
CHECKED BY: B. DORSCH
B. JENNINGS, P.E. PROJECT ENGINEER/ARCHITECT

DATE: FEBRUARY 2012
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AQUATIC NUISANCE SPECIES CONTROL PROJECT
WABASH-MAUMEE BASIN
FORT WAYNE, INDIANA

ALTERNATIVE C
ENLARGED SITE PLAN

SHEET REFERENCE NUMBER:
CS104
SHEET 7 OF 38

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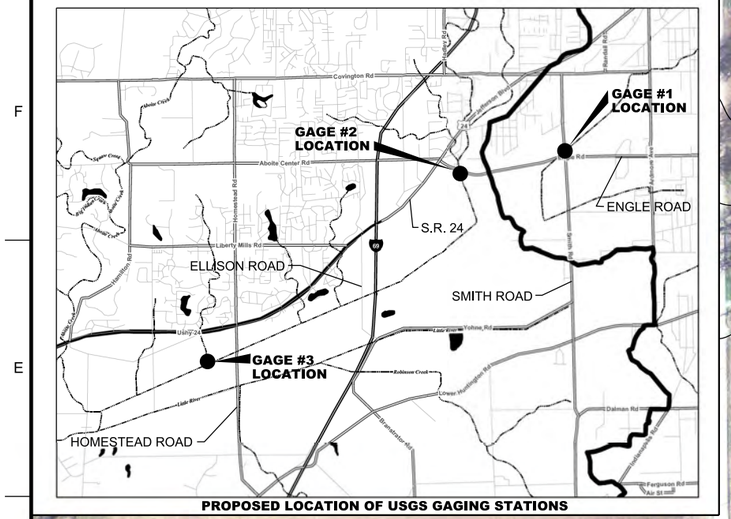

PROPOSED LOCATION OF USGS GAGING STATIONS

GENERAL SHEET NOTES

1. THE PROPOSED SLUICE GATE ON GRAHAM-MULLOCH DITCH WILL OPEN/CLOSE BASED ON THE USGS STREAM GAGES AS SHOWN ON THE MAP INSERT AT THE TOP OF THE PAGE.
2. BURIED FIBER OPTIC CABLE NOT TO BE DISTURBED.

SHEET KEYNOTES

1 I-WALL, SEE DETAIL, SH. CZ001
2 FENCE , SEE DETAIL, SH. CZ002 & CZ003
3 DEMOLISH LEFT DESCENDING GRAHAM McCULLOCH DITCH BERM
4 EARTHEN BERM, SEE DETAIL, SH. CZ001
5 INDIANA REVETMENT RIPRAP
6 PUMP STATION (30' X 25'), SEE DETAILS, SH. CZ005
7 TERRESTRIAL ANIMAL CROSSING, SEE DETAIL SH. CZ001
8 GATEWELL/SLUICE GATE
9 PERMEABLE BERM, SEE DETAIL, SH. CZ001
10 DEBRIS FENCE, SEE DETAIL, SH. CZ003
11 FENCE / EARTHEN BERM, SEE DETAIL, SH. CZ001
12 METAL GATE, 15' WIDTH, SEE DETAIL, SH. CZ001
13 EQUIPMENT GATE STRUCTURE, SEE DETAIL SH. CZ002
14 FLAP GATE, SEE DETAIL, SH. CZ007
15 48" CMP
16 CONCRETE HEADWALL, SEE DETAIL, SH. CZ007
17 TRAPEZOIDAL DITCH, SEE DETAIL, SH. CZ001
18 TELEMETRY CONTROL STRUCTURE
19 HEAVY DUTY DEBRIS BOOM
20 ACCESS ROAD , SEE DETAIL, SH. CZ006
21 CONCRETE PIER AND BAR SCREEN BARRIER, SEE DETAIL, SH. CZ004
22 DEMOLISH RIGHT DESCENDING GRAHAM McCULLOCH DITCH BERM
23 MULTI-CELL WETLAND AREA (1800' x 100')
24 VERTICAL DROP STRUCTURE, SEE DETAIL SH. CZ006
25 VEGETATION FILTER STRIP (NATIVE TREES AND SHRUBS)
26 OUTLET PIPES, SEE DETAIL CZ006
27 RELOCATE EAGLE MARSH ACCESS ROAD, SEE DETAIL, SH. CZ006
28 DISCHARGE WELL (52' x 15')
29 PUMP STATION SUMP (101' x 47'), SEE DETAIL, SH. CZ005
30 SILT FENCE, SEE DETAIL, SH. CZ001

LEGEND

- I-WALL
- BASIN DIVIDE
- FENCE
- DEBRIS BOOM
- EARTHEN BERM
- FENCE/EARTHEN BERM
- INDIANA REVETMENT RIPRAP
- CWL — CONTRACTOR WORK LIMITS
- DEMOLISH STRUCTURE
- PT — POWER & TELEPHONE UTILITY LINES
- P — ELECTRIC UTILITY LINES

A1 ALTERNATIVE D CONSTRUCT PERMEABLE BERM WITH TELEMETERED SLUICE GATES ENLARGED SITE PLAN
1"=100'

US ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT

REVISIONS DESCRIPTION	DATE	APPR.
SYMBOL		

DESIGNED BY: B. JENNINGS
DRAWN BY: C. ROBINSON
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B. JENNINGS P.E.
PROJECT ENGINEER/ARCHITECT

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DATE

AQUATIC NUISANCE SPECIES CONTROL AT THE CONFLUENCE WABASH-MAUMEE BASIN FORT WAYNE, INDIANA

ALTERNATIVE D ENLARGED SITE PLAN

SHEET REFERENCE NUMBER: CS106
SHEET 9 OF 38

FINAL SUBMITTAL

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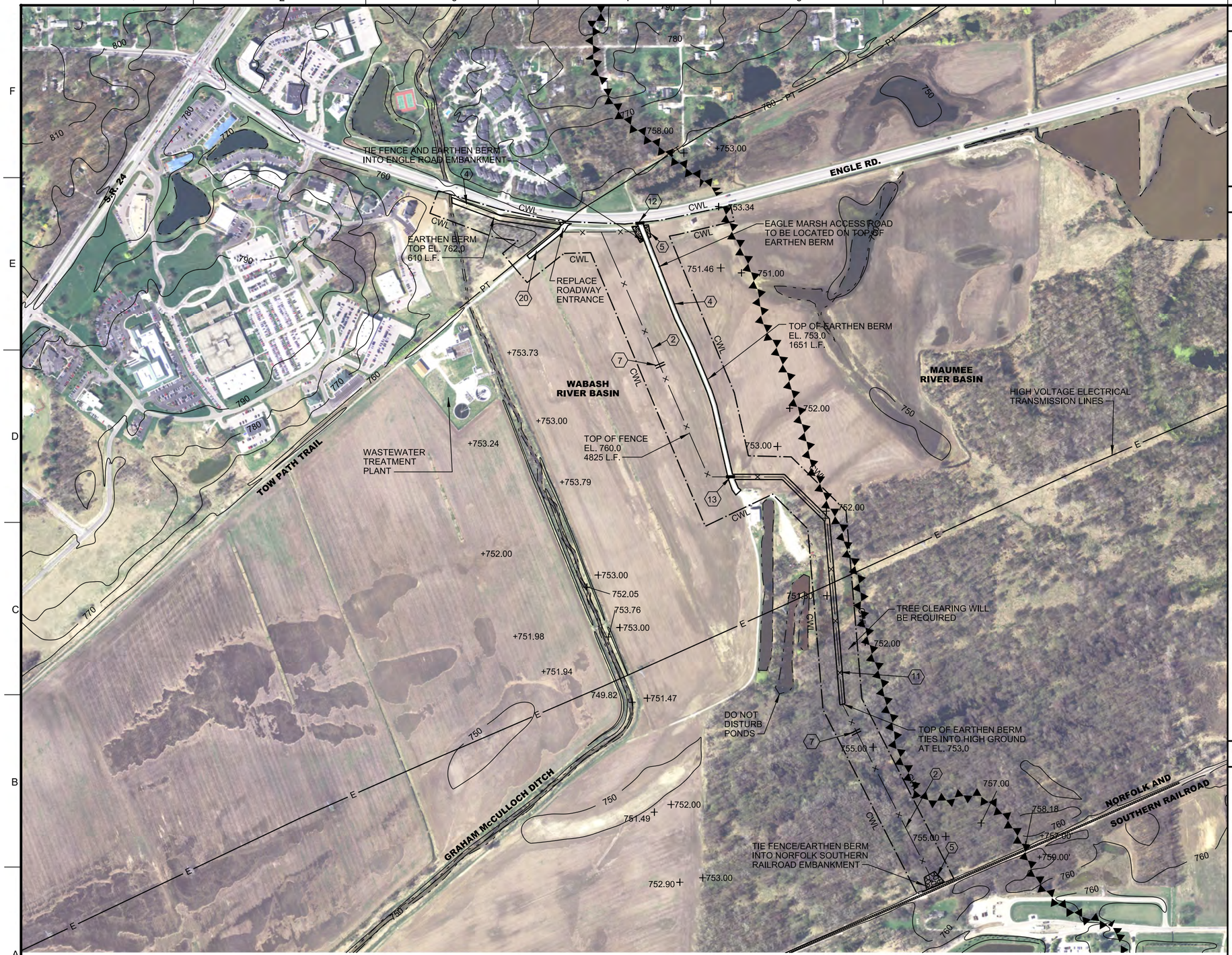


GENERAL SHEET NOTES

SHEET KEYNOTES

1 I-WALL, SEE DETAIL, SH. CZ001
2 FENCE , SEE DETAIL, SH. CZ002 & CZ003
3 DEMOLISH LEFT DESCENDING GRAHAM McCULLOCH DITCH BERM
4 EARTHEN BERM, SEE DETAIL, SH. CZ001
5 INDIANA REVETMENT RIPRAP
6 PUMP STATION (30' X 25'), SEE DETAILS, SH. CZ005
7 TERRESTRIAL ANIMAL CROSSING, SEE DETAIL SH. CZ001
8 GATEWELL/SLUICE GATE
9 PERMEABLE BERM, SEE DETAIL, SH. CZ001
10 DEBRIS FENCE, SEE DETAIL, SH. CZ003
11 FENCE / EARTHEN BERM, SEE DETAIL, SH. CZ001
12 METAL GATE, 15' WIDTH, SEE DETAIL, SH. CZ001
13 EQUIPMENT GATE STRUCTURE, SEE DETAIL SH. CZ002
14 FLAP GATE, SEE DETAIL, SH. CZ007
15 48" CMP
16 CONCRETE HEADWALL, SEE DETAIL, SH. CZ007
17 TRAPEZOIDAL DITCH, SEE DETAIL, SH. CZ001
18 TELEMETRY CONTROL STRUCTURE
19 HEAVY DUTY DEBRIS BOOM
20 ACCESS ROAD , SEE DETAIL, SH. CZ006
21 CONCRETE PIER AND BAR SCREEN BARRIER, SEE DETAIL, SH. CZ004
22 DEMOLISH RIGHT DESCENDING GRAHAM McCULLOCH DITCH BERM
23 MULTI-CELL WETLAND AREA (1800' x 100')
24 VERTICAL DROP STRUCTURE, SEE DETAIL SH. CZ006
25 VEGETATION FILTER STRIP (NATIVE TREES AND SHRUBS)
26 OUTLET PIPES, SEE DETAIL CZ006
27 RELOCATE EAGLE MARSH ACCESS ROAD, SEE DETAIL, SH. CZ006
28 DISCHARGE WELL (52' x 15')
29 PUMP STATION SUMP (101' x 47'), SEE DETAIL, SH. CZ005
30 SILT FENCE, SEE DETAIL, SH. CZ001

LEGEND

I-WALL
BASIN DIVIDE
FENCE
DEBRIS BOOM
EARTHEN BERM
FENCE/EARTHEN BERM
INDIANA REVETMENT RIPRAP
CWL — CONTRACTOR WORK LIMITS
DEMOLISH STRUCTURE
PT — POWER & TELEPHONE UTILITY LINES
P — ELECTRIC UTILITY LINES

A1 ALTERNATIVE E CONSTRUCT FENCE / EARTHEN BERM COMBINATION SITE PLAN
1"=300'

N
0 300' 600'

US ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT

REVISIONS
SYMBOL | DESCRIPTION | DATE | APPR.

DESIGNED BY: B. JENNINGS
DRAWN BY: C. ROBINSON
CHECKED BY: B. DORSCH
B. JENNINGS, P.E. PROJECT ENGINEER/ARCHITECT
DATE: FEBRUARY 2012
SCALE: AS SHOWN
DRAWING CODE: LR 5,6-12,1
DATE

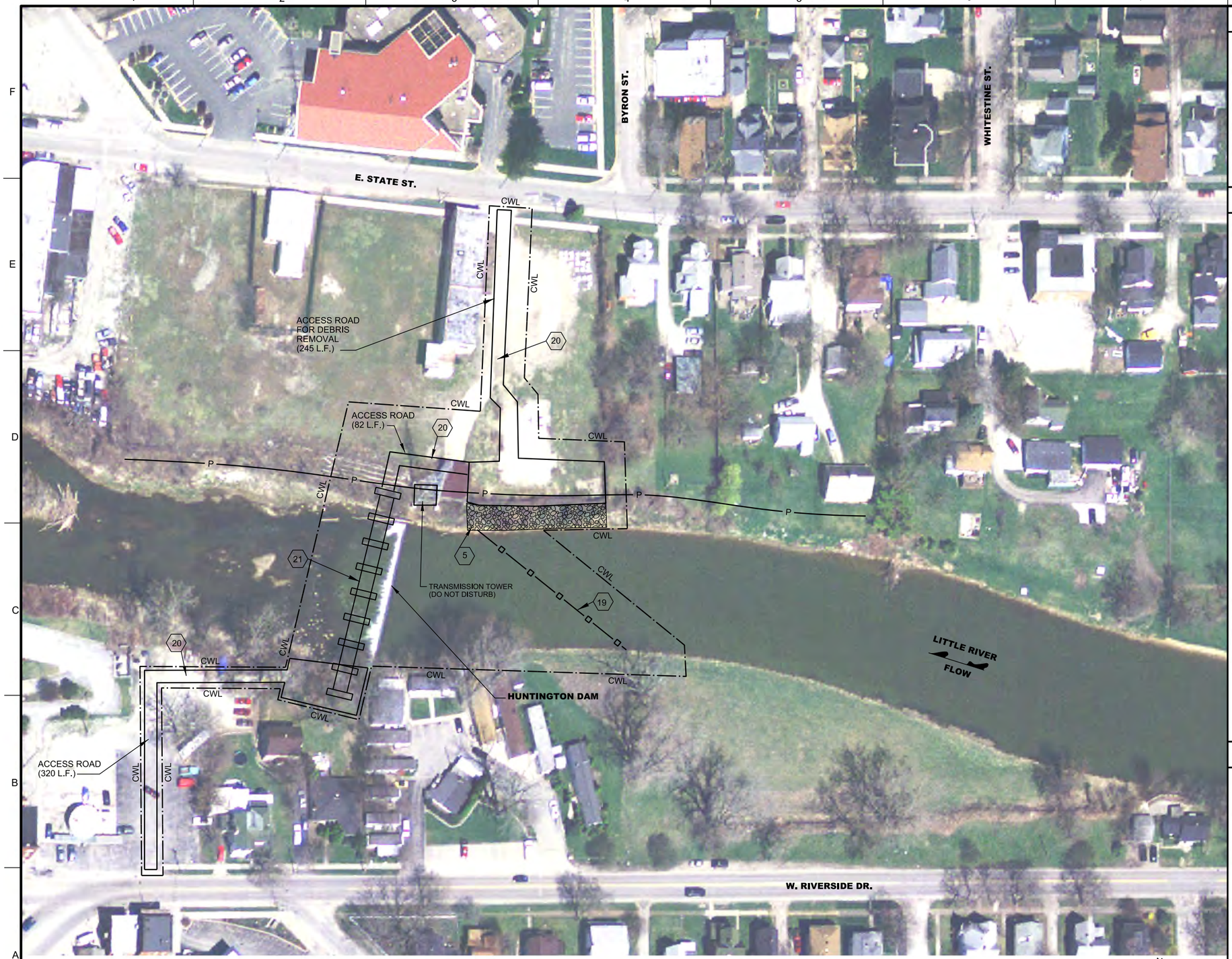
AQUATIC NUISANCE SPECIES CONTROL FEASIBILITY WABASH-MAUMEE BASIN FORT WAYNE, INDIANA

ALTERNATIVE E SITE PLAN

SHEET REFERENCE NUMBER: CS107
SHEET 10 OF 38

FINAL SUBMITTAL

FILE: \\lrl-fs01lou\Org\ED\Public\CAD\Civil\114597\CADD\114597CS107.DGN
DATE: 30-MAY-2012 11:55



GENERAL SHEET NOTES

1. HUNTINGTON DAM IS A FIXED CREST WEIR WHICH PROVIDES A VERTICAL DROP OF APPROXIMATELY 6'.

SHEET KEYNOTES

1 I-WALL, SEE DETAIL, SH. CZ001
2 FENCE , SEE DETAIL, SH. CZ002 & CZ003
3 DEMOLISH LEFT DESCENDING GRAHAM McCULLOCH DITCH BERM
4 EARTHEN BERM, SEE DETAIL, SH. CZ001
5 INDIANA REVETMENT RIPRAP
6 PUMP STATION (30' X 25'), SEE DETAILS, SH. CZ005
7 TERRESTRIAL ANIMAL CROSSING, SEE DETAIL SH. CZ001
8 GATEWELL/SLUICE GATE
9 PERMEABLE BERM, SEE DETAIL, SH. CZ001
10 DEBRIS FENCE, SEE DETAIL, SH. CZ003
11 FENCE / EARTHEN BERM, SEE DETAIL, SH. CZ001
12 METAL GATE, 15' WIDTH, SEE DETAIL, SH. CZ001
13 EQUIPMENT GATE STRUCTURE, SEE DETAIL SH. CZ002
14 FLAP GATE, SEE DETAIL, SH. CZ007
15 48" CMP
16 CONCRETE HEADWALL, SEE DETAIL, SH. CZ007
17 TRAPEZOIDAL DITCH, SEE DETAIL, SH. CZ001
18 TELEMETRY CONTROL STRUCTURE
19 HEAVY DUTY DEBRIS BOOM
20 ACCESS ROAD , SEE DETAIL, SH. CZ006
21 CONCRETE PIER AND BAR SCREEN BARRIER, SEE DETAIL, SH. CZ004
22 DEMOLISH RIGHT DESCENDING GRAHAM McCULLOCH DITCH BERM
23 MULTI-CELL WETLAND AREA (1800' x 100')
24 VERTICAL DROP STRUCTURE, SEE DETAIL SH. CZ006
25 VEGETATION FILTER STRIP (NATIVE TREES AND SHRUBS)
26 OUTLET PIPES, SEE DETAIL CZ006
27 RELOCATE EAGLE MARSH ACCESS ROAD, SEE DETAIL, SH. CZ006
28 DISCHARGE WELL (52' x 15')
29 PUMP STATION SUMP (101' x 47'), SEE DETAIL, SH. CZ005
30 SILT FENCE, SEE DETAIL, SH. CZ001

LEGEND

I-WALL
BASIN DIVIDE
FENCE
DEBRIS BOOM
EARTHEN BERM
FENCE/EARTHEN BERM
INDIANA REVETMENT RIPRAP
CONTRACTOR WORK LIMITS
DEMOLISH STRUCTURE
PT POWER & TELEPHONE UTILITY LINES
P ELECTRIC UTILITY LINES

N

0 50' 100'

A1 ALTERNATIVE F CONSTRUCT BAR SCREEN BARRIER AT EXISTING WEIR
1"=50'

US ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT

REVISIONS

SYMBOL	DESCRIPTION	DATE	APPR.

DESIGNED BY: B. JENNINGS
DRAWN BY: C. ROBINSON
CHECKED BY: B. DORSCH
B. JENNINGS, P.E. PROJECT ENGINEER/ARCHITECT
DATE: FEBRUARY 2012
SCALE: 1"=50'
DRAWING CODE: LR 5,6-12,1
DATE

AQUATIC NUISANCE SPECIES CONTROL PROJECT
WABASH-MAUMEE BASIN
FORT WAYNE, INDIANA

ALTERNATIVE F
SITE PLAN

SHEET REFERENCE NUMBER:
CS108
SHEET 11 OF 38

FINAL SUBMITTAL

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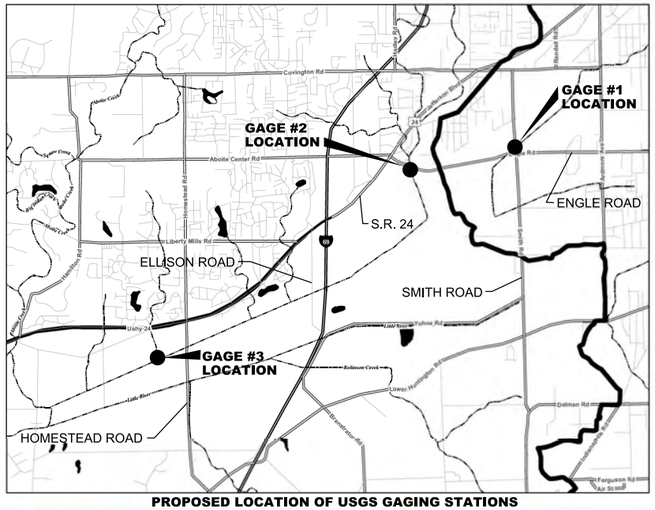

PROPOSED LOCATION OF USGS GAGING STATIONS

HOMESTEAD RD.

TIE BERM INTO HIGH GROUND EL. 758.0

TOP OF PERMEABLE BERM EL. 758.0 750 L.F.

24' DIA. CIRCULAR WEIR INLET (10 TOTAL)

6' x 3' CONCRETE BOX

20' F.B. DITCH

30' F.B. DITCH

GRAHAM McCULLOCH DITCH

NORFOLK AND SOUTHERN RAILROAD

TIE BERM INTO NORFOLK AND SOUTHERN RAILROAD EMBANKMENT

CWL

PT

760

780

790

770

750

N

0 100' 200'

A1 ALTERNATIVE G CONSTRUCT VERTICAL DROP STRUCTURES W/ TELEMETERED SLUICE GATE - ENLARGED SITE PLAN

1"=100'

GENERAL SHEET NOTES

1. THE PROPOSED SLUICE GATE ON GRAHAM-MULLOCH DITCH WILL OPEN/CLOSE BASED ON THE USGS STREAM GAGES AS SHOWN ON THE MAP INSERT AT THE TOP OF THE PAGE.
2. BURIED FIBER OPTIC CABLE NOT TO BE DISTURBED.

SHEET KEYNOTES

1 I-WALL, SEE DETAIL, SH. CZ001
2 FENCE , SEE DETAIL, SH. CZ002 & CZ003
3 DEMOLISH LEFT DESCENDING GRAHAM McCULLOCH DITCH BERM
4 EARTHEN BERM, SEE DETAIL, SH. CZ001
5 INDIANA REVETMENT RIPRAP
6 PUMP STATION (30' X 25'), SEE DETAILS, SH. CZ005
7 TERRESTRIAL ANIMAL CROSSING, SEE DETAIL SH. CZ001
8 GATEWELL/SLUICE GATE
9 PERMEABLE BERM, SEE DETAIL, SH. CZ001
10 DEBRIS FENCE, SEE DETAIL, SH. CZ003
11 FENCE / EARTHEN BERM, SEE DETAIL, SH. CZ001
12 METAL GATE, 15' WIDTH, SEE DETAIL, SH. CZ001
13 EQUIPMENT GATE STRUCTURE, SEE DETAIL SH. CZ002
14 FLAP GATE, SEE DETAIL, SH. CZ007
15 48" CMP
16 CONCRETE HEADWALL, SEE DETAIL, SH. CZ007
17 TRAPEZOIDAL DITCH, SEE DETAIL, SH. CZ001
18 TELEMETRY CONTROL STRUCTURE
19 HEAVY DUTY DEBRIS BOOM
20 ACCESS ROAD , SEE DETAIL, SH. CZ006
21 CONCRETE PIER AND BAR SCREEN BARRIER, SEE DETAIL, SH. CZ004
22 DEMOLISH RIGHT DESCENDING GRAHAM McCULLOCH DITCH BERM
23 MULTI-CELL WETLAND AREA (1800' x 100')
24 VERTICAL DROP STRUCTURE, SEE DETAIL SH. CZ006
25 VEGETATION FILTER STRIP (NATIVE TREES AND SHRUBS)
26 OUTLET PIPES, SEE DETAIL CZ006
27 RELOCATE EAGLE MARSH ACCESS ROAD, SEE DETAIL, SH. CZ006
28 DISCHARGE WELL (52' x 15')
29 PUMP STATION SUMP (101' x 47'), SEE DETAIL, SH. CZ005
30 SILT FENCE, SEE DETAIL, SH. CZ001

LEGEND

- I-WALL
- BASIN DIVIDE
- FENCE
- DEBRIS BOOM
- EARTHEN BERM
- FENCE/EARTHEN BERM
- INDIANA REVETMENT RIPRAP
- CONTRACTOR WORK LIMITS (CWL)
- DEMOLISH STRUCTURE
- PT POWER & TELEPHONE UTILITY LINES
- P ELECTRIC UTILITY LINES

US ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT

REVISIONS

SYMBOL	DESCRIPTION	DATE	APPR.

DESIGNED BY: B. JENNINGS
DRAWN BY: C. ROBINSON
CHECKED BY: B. DORSCH
B. JENNINGS, P.E. PROJECT ENGINEER/ARCHITECT

DATE: FEBRUARY 2012
SCALE: AS SHOWN
DRAWING CODE: LR 5,6-12,1
DATE

AQUATIC NUISANCE SPECIES CONTROL PROJECT
WABASH-MAUMEE BASIN
FORT WAYNE, INDIANA

ALTERNATIVE G
ENLARGED SITE PLAN

SHEET REFERENCE NUMBER:
CS110
SHEET 13 OF 38

FINAL SUBMITTAL

FILE: \\lrl-fs01lou\Org\ED\Public\CAD\Civil\114597\CADD\114597CS110.DGN
DATE: 30-MAY-2012 11:57

GENERAL SHEET NOTES

1. THE PROPOSED GRAHAM McCULLOCH BERM IS TO BE LOCATED APPROX. ON ITS EXISTING ALIGNMENT AS SHOWN ON THE PLANS.
2. THE GRAHAM McCULLOCH DITCH TOP OF BERM HEIGHT DECREASES FROM EL. 761.0 (UPSTREAM) TO EL. 759.0 (DOWNSTREAM).

SHEET KEYNOTES

1 I-WALL, SEE DETAIL, SH. CZ001
2 FENCE , SEE DETAIL, SH. CZ002 & CZ003
3 DEMOLISH LEFT DESCENDING GRAHAM McCULLOCH DITCH BERM
4 EARTHEN BERM, SEE DETAIL, SH. CZ001
5 INDIANA REVETMENT RIPRAP
6 PUMP STATION (30' X 25'), SEE DETAILS, SH. CZ005
7 TERRESTRIAL ANIMAL CROSSING, SEE DETAIL SH. CZ001
8 GATEWELL/SLUICE GATE
9 PERMEABLE BERM, SEE DETAIL, SH. CZ001
10 DEBRIS FENCE, SEE DETAIL, SH. CZ003
11 FENCE / EARTHEN BERM, SEE DETAIL, SH. CZ001
12 METAL GATE, 15' WIDTH, SEE DETAIL, SH. CZ001
13 EQUIPMENT GATE STRUCTURE, SEE DETAIL SH. CZ002
14 FLAP GATE, SEE DETAIL, SH. CZ007
15 48" CMP
16 CONCRETE HEADWALL, SEE DETAIL, SH. CZ007
17 TRAPEZOIDAL DITCH, SEE DETAIL, SH. CZ001
18 TELEMETRY CONTROL STRUCTURE
19 HEAVY DUTY DEBRIS BOOM
20 ACCESS ROAD , SEE DETAIL, SH. CZ006
21 CONCRETE PIER AND BAR SCREEN BARRIER, SEE DETAIL, SH. CZ004
22 DEMOLISH RIGHT DESCENDING GRAHAM McCULLOCH DITCH BERM
23 MULTI-CELL WETLAND AREA (1800' x 100')
24 VERTICAL DROP STRUCTURE, SEE DETAIL SH. CZ006
25 VEGETATION FILTER STRIP (NATIVE TREES AND SHRUBS)
26 OUTLET PIPES, SEE DETAIL CZ006
27 RELOCATE EAGLE MARSH ACCESS ROAD, SEE DETAIL, SH. CZ006
28 DISCHARGE WELL (52' x 15')
29 PUMP STATION SUMP (101' x 47'), SEE DETAIL, SH. CZ005
30 SILT FENCE, SEE DETAIL, SH. CZ001

LEGEND

- I-WALL
- BASIN DIVIDE
- FENCE
- DEBRIS BOOM
- EARTHEN BERM
- FENCE/EARTHEN BERM
- INDIANA REVETMENT RIPRAP
- CWL — CONTRACTOR WORK LIMITS
- DEMOLISH STRUCTURE
- PT — POWER & TELEPHONE UTILITY LINES
- P — ELECTRIC UTILITY LINES

N

0 300' 600'

A1 ALTERNATIVE H RECONSTRUCT LEFT DESCENDING GRAHAM McCULLOCH DITCH BERM - SITE PLAN
1"=300'

US ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT

REVISIONS DESCRIPTION	DATE	APPR.

DESIGNED BY: B. JENNINGS
DRAWN BY: C. ROBINSON
CHECKED BY: B. DORSCH
B. JENNINGS, P.E. PROJECT ENGINEER/ARCHITECT
DATE: FEBRUARY 2012
SCALE: AS SHOWN
DRAWING CODE: LR 5.6-12.1
DATE

AQUATIC NUISANCE SPECIES CONTROL PROJECT
WABASH-MAUMEE BASIN
FORT WAYNE, INDIANA

ALTERNATIVE H SITE PLAN (SH. 1 OF 2)

SHEET REFERENCE NUMBER: CS111
SHEET 14 OF 38

FINAL SUBMITTAL

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GENERAL SHEET NOTES

1. THE PROPOSED GRAHAM McCULLOCH BERM IS TO BE LOCATED APPROX. ON ITS EXISTING ALIGNMENT AS SHOWN ON THE PLANS.
2. THE GRAHAM McCULLOCH DITCH TOP OF BERM HEIGHT DECREASES FROM EL. 761.0 (UPSTREAM) TO EL. 759.0 (DOWNSTREAM).

SHEET KEYNOTES

1 I-WALL, SEE DETAIL, SH. CZ001
2 FENCE , SEE DETAIL, SH. CZ002 & CZ003
3 DEMOLISH LEFT DESCENDING GRAHAM McCULLOCH DITCH BERM
4 EARTHEN BERM, SEE DETAIL, SH. CZ001
5 INDIANA REVETMENT RIPRAP
6 PUMP STATION (30' X 25'), SEE DETAILS, SH. CZ005
7 TERRESTRIAL ANIMAL CROSSING, SEE DETAIL SH. CZ001
8 GATEWELL/SLUICE GATE
9 PERMEABLE BERM, SEE DETAIL, SH. CZ001
10 DEBRIS FENCE, SEE DETAIL, SH. CZ003
11 FENCE / EARTHEN BERM, SEE DETAIL, SH. CZ001
12 METAL GATE, 15' WIDTH, SEE DETAIL, SH. CZ001
13 EQUIPMENT GATE STRUCTURE, SEE DETAIL SH. CZ002
14 FLAP GATE, SEE DETAIL, SH. CZ007
15 48" CMP
16 CONCRETE HEADWALL, SEE DETAIL, SH. CZ007
17 TRAPEZOIDAL DITCH, SEE DETAIL, SH. CZ001
18 TELEMETRY CONTROL STRUCTURE
19 HEAVY DUTY DEBRIS BOOM
20 ACCESS ROAD , SEE DETAIL, SH. CZ006
21 CONCRETE PIER AND BAR SCREEN BARRIER, SEE DETAIL, SH. CZ004
22 DEMOLISH RIGHT DESCENDING GRAHAM McCULLOCH DITCH BERM
23 MULTI-CELL WETLAND AREA (1800' x 100')
24 VERTICAL DROP STRUCTURE, SEE DETAIL SH. CZ006
25 VEGETATION FILTER STRIP (NATIVE TREES AND SHRUBS)
26 OUTLET PIPES, SEE DETAIL CZ006
27 RELOCATE EAGLE MARSH ACCESS ROAD, SEE DETAIL, SH. CZ006
28 DISCHARGE WELL (52' x 15')
29 PUMP STATION SUMP (101' x 47'), SEE DETAIL, SH. CZ005
30 SILT FENCE, SEE DETAIL, SH. CZ001

LEGEND

- I-WALL
- BASIN DIVIDE
- FENCE
- DEBRIS BOOM
- EARTHEN BERM
- FENCE/EARTHEN BERM
- INDIANA REVETMENT RIPRAP
- CONTRACTOR WORK LIMITS
- DEMOLISH STRUCTURE
- PT — POWER & TELEPHONE UTILITY LINES
- P — ELECTRIC UTILITY LINES

A1 ALTERNATIVE H RECONSTRUCT LEFT DESCENDING GRAHAM McCULLOCH DITCH BERM - SITE PLAN

1"=300'

US ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT

REVISIONS			
SYMBOL	DESCRIPTION	DATE	APPR.

DESIGNED BY: B. JENNINGS
DRAWN BY: C. ROBINSON
CHECKED BY: B. DORSCH
B. JENNINGS, P.E.
PROJECT ENGINEER/ARCHITECT
DATE: FEBRUARY 2012
SCALE: AS SHOWN
DRAWING CODE: LR 5,6-12,1
DATE

AQUATIC NUISANCE SPECIES CONTROL MEASURES
WABASH-MAUMEE BASIN
FORT WAYNE, INDIANA

ALTERNATIVE H
SITE PLAN
(SH. 2 OF 2)

SHEET REFERENCE NUMBER:
CS112
SHEET 15 OF 38

FINAL SUBMITTAL

FILE: \\lrl-fs01lou\Org\ED\Public\CAD\Civil\114597\CADD\114597CS112.DGN
DATE: 30-MAY-2012 11:58

*** SAFETY PAYS ***

MATCH LINE SH. CS114

ALTERNATIVE I RECONSTRUCT LEFT DESCENDING GRAHAM McCULLOCH DITCH BERM,
DEMOLISH RIGHT DESCENDING BERM AND CONSTRUCT MULTI-CELL WETLAND AREA - SITE PLAN

A1

1"=300'

N

0 300' 600'

GENERAL SHEET NOTES

1. THE PROPOSED GRAHAM McCULLOCH BERM IS TO BE LOCATED APPROX. ON ITS EXISTING ALIGNMENT AS SHOWN ON THE PLANS.
2. THE GRAHAM McCULLOCH DITCH TOP OF BERM HEIGHT DECREASES FROM EL. 761.0 (UPSTREAM) TO EL. 759.0 (DOWNSTREAM).

SHEET KEYNOTES

1 I-WALL, SEE DETAIL, SH. CZ001
2 FENCE , SEE DETAIL, SH. CZ002 & CZ003
3 DEMOLISH LEFT DESCENDING GRAHAM McCULLOCH DITCH BERM
4 EARTHEN BERM, SEE DETAIL, SH. CZ001
5 INDIANA REVETMENT RIPRAP
6 PUMP STATION (30' X 25'), SEE DETAILS, SH. CZ005
7 TERRESTRIAL ANIMAL CROSSING, SEE DETAIL SH. CZ001
8 GATEWELL/SLUICE GATE
9 PERMEABLE BERM, SEE DETAIL, SH. CZ001
10 DEBRIS FENCE, SEE DETAIL, SH. CZ003
11 FENCE / EARTHEN BERM, SEE DETAIL, SH. CZ001
12 METAL GATE, 15' WIDTH, SEE DETAIL, SH. CZ001
13 EQUIPMENT GATE STRUCTURE, SEE DETAIL SH. CZ002
14 FLAP GATE, SEE DETAIL, SH. CZ007
15 48" CMP
16 CONCRETE HEADWALL, SEE DETAIL, SH. CZ007
17 TRAPEZOIDAL DITCH, SEE DETAIL, SH. CZ001
18 TELEMETRY CONTROL STRUCTURE
19 HEAVY DUTY DEBRIS BOOM
20 ACCESS ROAD , SEE DETAIL, SH. CZ006
21 CONCRETE PIER AND BAR SCREEN BARRIER, SEE DETAIL, SH. CZ004
22 DEMOLISH RIGHT DESCENDING GRAHAM McCULLOCH DITCH BERM
23 MULTI-CELL WETLAND AREA (1800' x 100')
24 VERTICAL DROP STRUCTURE, SEE DETAIL SH. CZ006
25 VEGETATION FILTER STRIP (NATIVE TREES AND SHRUBS)
26 OUTLET PIPES, SEE DETAIL CZ006
27 RELOCATE EAGLE MARSH ACCESS ROAD, SEE DETAIL, SH. CZ006
28 DISCHARGE WELL (52' x 15')
29 PUMP STATION SUMP (101' x 47'), SEE DETAIL, SH. CZ005
30 SILT FENCE, SEE DETAIL, SH. CZ001

LEGEND

I-WALL
BASIN DIVIDE
FENCE
DEBRIS BOOM
EARTHEN BERM
FENCE/EARTHEN BERM
INDIANA REVETMENT RIPRAP
CWL — CONTRACTOR WORK LIMITS
DEMOLISH STRUCTURE
PT — POWER & TELEPHONE UTILITY LINES
P — ELECTRIC UTILITY LINES

US ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT

REVISIONS			
SYMBOL	DESCRIPTION	DATE	APPR.

DESIGNED BY: B. JENNINGS — DATE: FEBRUARY 2012
DRAWN BY: C. ROBINSON — SCALE: AS SHOWN
CHECKED BY: B. DORSCH — DRAWING CODE: LR 5,6-12,1
B. JENNINGS, P.E. PROJECT ENGINEER/ARCHITECT — DATE

AQUATIC NUISANCE SPECIES CONTROL PROJECT
WABASH-MAUMEE BASIN
FORT WAYNE, INDIANA

ALTERNATIVE I
SITE PLAN
(SH. 1 OF 2)

SHEET REFERENCE NUMBER:
CS113
SHEET 16 OF 38

FINAL SUBMITTAL

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DATE: 30-MAY-2012 11:59

*** SUPPORT VALUE ENGINEERING - IT PAYS ***

ALTERNATIVE I RECONSTRUCT LEFT DESCENDING GRAHAM McCULLOCH DITCH BERM, DEMOLISH RIGHT DESCENDING BERM AND CONSTRUCT VEGETATION FILTER STRIP - SITE PLAN

A1

1"=300'

N

0 300' 600'

GENERAL SHEET NOTES

1. THE PROPOSED GRAHAM McCULLOCH BERM IS TO BE LOCATED APPROX. ON ITS EXISTING ALIGNMENT AS SHOWN ON THE PLANS.
2. THE GRAHAM McCULLOCH DITCH TOP OF BERM HEIGHT DECREASES FROM 761.0 EL. (UPSTREAM) TO EL. 759.0 (DOWNSTREAM).

SHEET KEYNOTES

1 I-WALL, SEE DETAIL, SH. CZ001
2 FENCE , SEE DETAIL, SH. CZ002 & CZ003
3 DEMOLISH LEFT DESCENDING GRAHAM McCULLOCH DITCH BERM
4 EARTHEN BERM, SEE DETAIL, SH. CZ001
5 INDIANA REVETMENT RIPRAP
6 PUMP STATION (30' X 25'), SEE DETAILS, SH. CZ005
7 TERRESTRIAL ANIMAL CROSSING, SEE DETAIL SH. CZ001
8 GATEWELL/SLUICE GATE
9 PERMEABLE BERM, SEE DETAIL, SH. CZ001
10 DEBRIS FENCE, SEE DETAIL, SH. CZ003
11 FENCE / EARTHEN BERM, SEE DETAIL, SH. CZ001
12 METAL GATE, 15' WIDTH, SEE DETAIL, SH. CZ001
13 EQUIPMENT GATE STRUCTURE, SEE DETAIL SH. CZ002
14 FLAP GATE, SEE DETAIL, SH. CZ007
15 48" CMP
16 CONCRETE HEADWALL, SEE DETAIL, SH. CZ007
17 TRAPEZOIDAL DITCH, SEE DETAIL, SH. CZ001
18 TELEMETRY CONTROL STRUCTURE
19 HEAVY DUTY DEBRIS BOOM
20 ACCESS ROAD , SEE DETAIL, SH. CZ006
21 CONCRETE PIER AND BAR SCREEN BARRIER, SEE DETAIL, SH. CZ004
22 DEMOLISH RIGHT DESCENDING GRAHAM McCULLOCH DITCH BERM
23 MULTI-CELL WETLAND AREA (1800' x 100')
24 VERTICAL DROP STRUCTURE, SEE DETAIL SH. CZ006
25 VEGETATION FILTER STRIP (NATIVE TREES AND SHRUBS)
26 OUTLET PIPES, SEE DETAIL CZ006
27 RELOCATE EAGLE MARSH ACCESS ROAD, SEE DETAIL, SH. CZ006
28 DISCHARGE WELL (52' x 15')
29 PUMP STATION SUMP (101' x 47'), SEE DETAIL, SH. CZ005
30 SILT FENCE, SEE DETAIL, SH. CZ001

LEGEND

I-WALL
BASIN DIVIDE
FENCE
DEBRIS BOOM
EARTHEN BERM
FENCE/EARTHEN BERM
INDIANA REVETMENT RIPRAP
CWL — CONTRACTOR WORK LIMITS
DEMOLISH STRUCTURE
PT — POWER & TELEPHONE UTILITY LINES
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US ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT

REVISIONS			
SYMBOL	DESCRIPTION	DATE	APPR.

DESIGNED BY: B. JENNINGS
DRAWN BY: C. ROBINSON
CHECKED BY: B. DORSCH
B. JENNINGS, P.E.
PROJECT ENGINEER/ARCHITECT

DATE: FEBRUARY 2012
SCALE: AS SHOWN
DRAWING CODE: LR 5,6-12,1
DATE

AQUATIC NUISANCE SPECIES CONTROL RESEARCH
WABASH-MAUMEE BASIN
FORT WAYNE, INDIANA

ALTERNATIVE I
SITE PLAN
(SH. 2 OF 2)

SHEET REFERENCE NUMBER:
CS114
SHEET 17 OF 38

FINAL SUBMITTAL

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3.6. Analysis of Viable Non-Structural Measures

Following the VE study and subsequent PDT meetings, several non-structural measures were selected for further consideration. These measures included:

- physical removal of ANS at their current locations
- chemical deterrents to establish non-habitable environment at or within connecting streams
- biological control measures that prevent ANS reproduction or prevent the ability of ANS to establish a sustainable population
- regulations or ordinances prohibiting the establishment of drainage ways that connect the Mississippi River tributaries with tributaries of Lake Michigan and Lake Erie
- explore and support measures to reduce the potential source populations of ANS
    - increase commercial and recreational harvest, specifically bighead and silver carp
    - implement measures to interfere with successful reproduction of ANS
    - introduce biological controls such as diseases specific to particular ANS
- educate the public to
    - prevent bait bucket transfers of ANS
    - prevent transfer via boating and recreational equipment
    - prevent transfer due to religious or cultural ceremonies
    - identify and report the observation and collection of ANS to the appropriate authorities
- support research on the biology of ANS so risk of transfer can be better understood.
    - life history
    - habit requirements
    - history of invasiveness
- improve and increase field sampling and monitoring for the presence of ANS to support better informed water resource management decisions within the state and region
    - develop integrated ANS sampling and analysis plan utilizing eDNA and conventional biological sampling events at times when ANS would be expected to be present in the area, such as during flood events
    - target, encourage, and train recreational fishermen, boaters and other direct users of the surface waters of the state of Indiana to identify, report, collect and deliver ANS to the appropriate agencies
- prevent introductions of additional ANS
    - improve regulations for bilge releases
    - improve regulations on the pet industry
    - impose regulations on the live bait industry
    - improve regulations on the aquaculture industry

Hoff et al. (20) showed that the most effective way to reduce the number of small bighead carp from entering the population was to reduce the number of spawning adults. Although this seems obvious, wild fish populations often compensate for a low number of spawning adults by

increasing the number of eggs produced by the spawning adults present. A reduction in spawning adults may also reduce the number of young silver carp since the reproductive biology of the silver carp is similar to the bighead carp. Suppressing the number of spawning adults, and thus, the number of young, may over time keep these species within acceptable limits. Though the research cited above was specific to bighead carp, it was assumed that a reduction in the number of spawning adults would help to reduce the number of most species of ANS. Methods to reduce the number of spawning adults include: increased commercial and recreational harvest, specifically of bighead and silver carp, biological control measures that prevent ANS reproduction or prevent the ability of ANS to establish a sustainable population in the vicinity, physical removal of ANS at their current locations, and the introduction of genetically modified sterile ANS. Hoff et al. (20) also indicated that varying the water level affects the number of young. Modifying the discharge, timing and volume at J. Edward Roush Dam may serve to reduce the number of Asian carp on the Wabash River.

Alternatively, research by Garvey et al. (13) suggests that fishing and other control efforts targeting only a single size class of fish (only small or only large) will not control Asian carp populations in the Illinois River. Rather, all sizes of Asian carp must be harvested. This can be achieved with a fish meal market as well as a value-added market where both large and small fish can be converted to a saleable product. A market based on selling only large fish, like the exportation of whole fish to China, will not control the populations. Garvey et al. (13) suggests that to control Asian carp and keep them from continually challenging the Great Lakes watershed, source populations will need to be suppressed indefinitely by a long-term commitment. Some recommended methods for accomplishing this include further developing the existing fish meal and organic fertilizer markets, contracting fishermen to harvest carp over time, and providing an incentive program for fishermen to remove Asian carp from the Illinois River.

Another means of control considered was enhanced regulation or legislation that would prohibit or restrict ANS movement by more rigorously controlling possession and transport of ANS. Examples of enhanced regulation or legislation include: improved or new regulations for bilge releases, improved or new regulations on the pet industry, improved or new regulations on the live bait industry, and improved or new regulations on the aquaculture industry.

Educating the public on the importance of preventing introductions of invasive species was also considered as a control measure. This would entail providing the public with information that reduces the chance of unintentionally introducing new species into either basin through anthropogenic means (bait bucket, portable vessels and trailers, aquaculture and domestic aquatic pet releases) and improve identification and reporting of ANS to the appropriate authorities.

Regulations and ordnances that are more stringent could regulate development and construction near the basin divide to prevent new ditches, sewers or other surface water conduits from creating new hydraulic connections between the watersheds. The responsibility of creating, modifying and enforcing these regulations and ordnances would fall primarily to state and local government agencies. Support for research on the biology of ANS so transfer potential can be better understood may also be an effective non-structural measure. Examples of this include: research regarding the life history of ANS, research regarding the habitat requirements and tolerances to ANS and research regarding the history of invasiveness of ANS.

An important non-structural measure in use is improved monitoring and a rapid response plan designed to provide early detection of the presence of Asian carp. Indiana DNR is monitoring Asian carp in the Wabash River. The agency reported an Asian carp spawn in late May, 2011. Very few eggs were found in Peru, Indiana, which is approximately 40 miles downstream of the J. Edward Roush Dam, located near Huntington, Indiana. Peru, Indiana is located approximately 55 miles downstream of Eagle Marsh. The eggs were also very young (few embryonic cell divisions had taken place). Substantial numbers of eggs were found in Logansport and Lafayette, Indiana (Doug Keller, Indiana DNR, personal communication, 16 August 2011). Indiana DNR has also funded Purdue University to conduct a two year ultrasonic telemetry study on Asian carp movement. One hundred silver carp were collected, tagged and rereleased in the Wabash River. Attempts were made to collect fish for tagging as far upstream as possible. Only a few individuals were collected in or above Peru, Indiana, due to low densities. Monitoring stations are in place along the Wabash River and Little River to monitor the movements of the carp. To date, no tagged fish have been detected in the Little River. One tagged fish has been detected in the Wabash River near the mouth of Little River (Doug Keller, Indiana DNR, personal communication, 16 August 2011).

These measures were evaluated further by the PDT. None of the measures identified above were found to be independently effective at preventing the spread of ANS. However, any single structural measure to prevent ANS transfer through the Eagle Marsh would benefit from corresponding development and implementation of one or more of these non-structural measures.

3.7. Comparison of Alternatives

The nine structural alternatives described in Section 3.5 were further evaluated based on four screening criteria: effectiveness, efficiency, acceptability and completeness (Section 3.4.3). For each alternative, the PDT assigned a qualitative value of High, Medium or Low as it related to addressing the identified problems and achieving the corresponding opportunities (Section 3.1). The evaluation began by establishing the level of effectiveness of each alternative at preventing interbasin transfer of ANS through the aquatic pathway. Developing consensus around the level of effectiveness of each alternative provided the framework for assigning ratings for the subsequent screening criteria. For example, an alternative with a low level of effectiveness would not be considered acceptable to any stakeholder organizations and the public. Additionally, the alternative could not be considered efficient or complete since the investment would not achieve the project objective. While the three remaining screening criteria are significant in optimizing a recommended plan, effectiveness is the linchpin that determines if an alternative should receive further consideration. Table 3.6 provides an overview of the level of prevention provided by each alternative. The following paragraphs explain key data and information that was used to inform each rating for the nine structural alternatives.

Effectiveness

Alternatives A, H and I all received a rating of “High.” All three of these alternatives provide hydrologic separation of the two basins and consequently prevent interbasin spread of all ANS through Eagle Marsh. Alternative A was the most effective measure considered of the nine and is anticipated to require minimal maintenance over the course of its 50 year design life.

The PDT assigned a "Medium" rating to Alternatives B, C, D, E and G. All of these alternatives prevent spread of adult Asian carp; however, their effectiveness is dependent on the size of the ANS and direction of movement. Of this group, Alternative E is the only one that provides some level of hydrologic separation. Still, separation only occurs below a 4% annual chance event. Events above this level allow the spread of small ANS, but prevent spread of adult Asian carp. Alternatives C and G prevent transfer of ANS primarily in one direction. For example, these two alternatives would prevent ANS from spreading into the Great Lakes Basin from the Mississippi River Basin, but do not prevent small ANS from spreading into the Great Lakes Basin through the pump station or sluice gates. The final two Alternatives, B and D allow small ANS to spread in both directions, as they were primarily formulated to prevent the spread of adult Asian carp.

Alternative F received the only "Low" rating. While it prevents adult Asian carp, it allows small ANS to spread in both directions. The screen barrier is situated in closer proximity to a known Asian carp population, which increases the possibility of ANS spread.

Efficiency

The PDT rated Alternatives H and I "High" for efficiency. This rating is based their low initial cost; low operation and management (O&M); and ability to prevent ANS from spreading.

The Alternatives that were rated as "Medium" all had trade-offs between initial cost, O&M and level of prevention. For instance, Alternative A is highly effective at preventing ANS spread and has a low O&M cost, but has a comparatively high initial cost. Conversely, Alternative E has a low initial cost, but is only effective at preventing interbasin spread of ANS up to a 4% annual event. Alternative B also has a low initial cost, but allows interbasin spread of small ANS. Both Alternatives D and G have moderate initial costs and prevent the spread of adult Asian carp, but D allows interbasin spread of small ANS and G is ineffective at preventing ANS spreading from the Great Lakes Basin to the Mississippi River Basin.

While Alternative F has a relatively low initial cost, it received a "Low" rating because it is not considered to be very effective at preventing interbasin spread. Alternative C also received a

Table 3.6 - Level of Prevention Provided by Structural Alternatives Against ANS

Alternative	Reduces probability of ANS occurring within either basin	Reduces probability of ANS surviving transit through aquatic pathway	Reduces probability of ANS establishing in aquatic pathway	Reduces probability of ANS spreading across aquatic pathway into new basin
A. Construct an I-wall	No	No	No	High
B. Construct a fence and reconstruct left descending Graham McCulloch Ditch berm	No	No	No	Low Small ANS, Medium Large ANS
C. Construct an earthen berm and pump station	No	No	No	High ANS from MRB into GLB. Medium ANS from GLB to MRB.
D. Construct a permeable berm with telemetered sluice gates	No	No	No	Medium Small ANS, High Large ANS
E. Construct a fence/earthen berm combination	No	No	No	High: floods <4% annual event; Low: floods >4% annual event; Small ANS, Medium-Large ANS
F. Construct bar screen barrier at existing weir	No	Low: Small ANS; Med: Large ANS	No	No
G. Construct vertical drop structure with telemetered sluice gate	No	No	No	Low Small ANS, Medium Large ANS
H. Reconstruct left descending Graham McCulloch Ditch berm	No	No	No	High
I. Reconstruct left descending Graham McCulloch Ditch berm, Demolish right descending berm and construct multi-cell wetland area	No	No	No	High

"Low" rating as it has a high initial cost, high O&M and allows ANS to spread from the Great Lakes Basin to the Mississippi River Basin.

Acceptability

Similar to efficiency, Alternatives H and I received high ratings for acceptability. The primary drivers for this rating are that they provide hydrologic separation and are generally acceptable to most local and national stakeholders. While both alternatives provide the opportunity to create wetlands, only Alternative I incorporates wetlands as a specific measure in the alternative.

Alternatives A, B, D, E and G were all assigned a "Medium" rating and have varied appeal to stakeholders. Alternative A was considered acceptable to most national stakeholders, but may not be satisfactory to local organizations such as LRWP. Primary reasons for potential opposition include induced flooding, terrestrial animal movement and aesthetic impacts. Alternative A may become more acceptable to potential sponsors if mitigation funding were available for impacted properties. The fences proposed in Alternatives B and E also negatively impose on the viewshed and movement of terrestrial native species. Alternatives D and G both have moderate initial and O&M costs and have potential support from local and national stakeholders. A noted benefit of Alternative D is the possibility of wetland creation and minimal amount of induced damages.

Frequent, expensive and extensive O&M heavily influences "Low" ratings for Alternatives C and F. Two additional factors for the low rating is the high initial cost given the level of effectiveness of Alternative C and the concern for public safety at the weir in Alternative F.

Completeness

Alternatives H and I were rated as "Medium" by the PDT. Both alternatives create hydrologic separation of the two basins. This is achieved without additional measures at a moderate initial cost and with minimal O&M required from a local sponsor. The primary drawback to both Alternatives H and I is the high level of induced damages that would result from implementation. One enhancement is the creation of wetlands as a component of Alternative I.

Alternatives A, B, D, E and G all were also rated as "Medium" for completeness. Alternative A stops all ANS without additional measures such as monitoring, but the level of induced damages is high and the number of mitigation actions is unknown. The initial cost of this alternative is high, but similar to I and H the O&M cost is low. Alternative D also has a low O&M cost, however the cleaning the screen and siltation of the permeable berm could be challenging for a local sponsor. In contrast to A, H and I, Alternative D does not induce flooding in the area, but would allow the spread of ANS from GLB to the MRB. Likewise, Alternative E does not induce damages, but would allow the interbasin spread of small ANS when water levels reach the 4% annual chance event. Alternative G also allows the spread of ANS from the GLB to the MRB during much smaller events than Alternative E, but does have a potential sponsor despite the high level of O&M that would be required. Alternatives B has a moderate initial cost, O&M , and induced damages, but still allows interbasin spread of ANS.

For Alternatives C and F, the extensive and costly O&M steered the rating to "Low" for both of these variables. In addition, these two alternatives do not prevent the interbasin spread of small ANS from the Great Lakes Basin to the Mississippi River Basin. Two additional components to the "Low" rating for Alternative F is the requirement for extensive monitoring coupled with the questionable stability of the existing weir structure.

Table 3.7 - Comparison of Alternatives

Alternative	Acceptability	Effectiveness	Efficiency	Completeness	Induced Damages	Baseline Cost Est. (M)	O&M Cost Est. (k)	Years to Implement
A. Construct an I-Wall (see F1.5.1)	M	H	M	M	H	$14.0	$11	>4
B. Construct a fence & reconstruct left descending Graham-McCulloch ditch berm (see F1.5.2)	M	M	M	M	L	$3.2	$18	2 - 3
C. Construct earthen berm & pump station (see F1.5.3)	L	M	L	L	L	$25.0	$600	>4
D. Construct permeable berm with telemetered sluice gate (see F1.5.4)	M	M	M	M	L	$7.8	$22	2 - 3
E. Construct fence/earthen berm combination (see F1.5.5)	M	M	H	M	L	$4.2	$44	<2
F. Construct bar screen barrier at existing weir (see F1.5.6)	L	L	L	L	L	$2.7	$96	2 - 3
G. Construct vertical drop structures with telemetered sluice gate (see F1.5.7)	M	M	M	M	M	$4.8	$26	2 - 3
H. Reconstruct left descending Graham-McCulloch ditch berm (see F1.5.8)	H	H	H	M	H	$5.7	$14	2 - 3
I. Reconstruct left descending Graham-McCulloch ditch, demolish right descending berm & construct multi-cell wetland area (see F1.5.9)	H	H	H	M	H	$7.2	$17	2 - 3

M=Medium H=High L=Low

Induced Damages

As discussed previously, a consideration in the ranking given to the acceptability, effectiveness, efficiency and completeness factors is the relative damages that would result from an increase in water surface elevations caused by an alternative. Please also see Section 5.0 for further discussion. The description of each alternative in Section 3.5 includes a discussion of the increases in water surface elevations and the structures and properties potentially affected by this increase (also summarized in Table 5.1).

A qualitative comparison of these effects is given in Table 3.7 under the column titled "Induced Damages". The ranking given each alternative was based upon the number of newly affected structures and acreage newly inundated by the 1% annual chance exceedance event:

A "High" ranking indicates that the induced flooding appears to affect numerous structures not previously in the 1% annual chance exceedance floodplain. The number of residential, commercial, and public structures newly impacted would likely mean high mitigation costs and/or time to implement the mitigation. Alternatives A, H, and I were given a "High" ranking because of the number of structures that would be affected in the upper Junk Ditch area, particularly relative to the other alternatives.

A "Medium" ranking was selected if the number of potential structures affected is small but there are significant areas that are newly inundated by an increase in the 1% annual chance event (when compared to the baseline conditions). Alternative G was ranked "Medium" for this reason.

A "Low" ranking was chosen if the alternative does not significantly affect water surface elevations (near to or below the 0.15 foot acceptable limit), and/or no structures are affected. Alternatives B, C, D, E, and F were given a "Low" rating because of the expected or modeled affects on water surface profiles in the area.

4.0 ENVIRONMENTAL EFFECTS

A preliminary evaluation of environmental effects is presented below. A detailed evaluation of environmental effects would be conducted when an appropriate authority and funding mechanism is identified and a final alternative is recommended. Table 4.1, at the conclusion of Section 4.11, provides a preliminary assessment of environmental impacts of structural alternatives.

4.1. Soil

No significant impacts to soils are expected from the construction of any structural alternative.

4.2. Surface Waters and Other Aquatic Resources

All alternatives are expected to provide varying degrees of protection against ANS spreading (Section 3.4). Preventing ANS from spreading is the primary positive impact associated with all the alternatives. Any reduction of the likelihood and magnitude of ecological impacts to aquatic resources in both basins realized by preventing interbasin spread of ANS would have considerable positive benefits to aquatic resources. Effects of sea-level rise on the project or as a result of the project were considered during development of alternatives. Because the study location is at approximately 750 feet MSL and 150 feet above the surface elevation of Lake Erie, no effects are anticipated.

Alternative A (Construct an I-Wall)

Alternative A is expected to detrimentally alter the wetlands and aquatic habitat within and around Eagle Marsh. The I-wall would further fragment the wetlands into largely unconnected parcels, inhibiting the flow of water and movement of aquatic organisms throughout the local wetland area.

Alternative B (Construct a Fence and Reconstruct Left Descending Graham-McCulloch Ditch Berm)

Alternatives B is not expected to have significant impacts to surface water and other aquatic resources.

Alternative C (Construct an Earthen Berm and Pump Station)

Alternative C would have detrimental impacts to the limited fish community of Graham-McCulloch Ditch by impeding their movement through the stream, and thereby limiting available habitat. Additionally, any fish forced through the pumps would likely not survive.

Alternative D (Construct a Permeable Berm with Telemetered Sluice Gates)

Alternative D is not expected to have significant impacts to surface water and other aquatic resources.

Alternative E (Construct a Fence/Earthen Berm Combination)

Alternative E is not expected to have significant impacts to surface water and other aquatic resources.

Alternative F (Construct Bar Screen Barrier at Existing Weir)

Alternative F is not expected to have significant impacts to surface water and other aquatic resources.

Alternative G (Construct Vertical Drop Structures with Telemetered Sluice Gate)

Alternative G is not expected to have significant impacts to surface water and other aquatic resources.

Alternative H (Reconstruct Left Descending Graham-McCulloch Ditch Berm)

Alternative H is not expected to have significant impacts to surface water and other aquatic resources.

Alternative I (Reconstruct Left Descending Graham-McCulloch Ditch Berm, Demolish Right Descending Berm and Construct Multi-Cell Wetland Area)

Alternative I would have a positive impact to aquatic resources. This alternative calls for creation of additional wetlands. Creating wetlands positively impacts surface water quality and provides seasonal aquatic habitat for many organisms. This alternative would augment restoration efforts currently underway at Eagle Marsh.

4.3. Wildlife Habitat

Alternative A (Construct an I-Wall)

Construction of alternative A is expected to have negative impacts to wildlife habitat. Alternatives A would require construction of an I-wall. This structure would prevent movement of many types of wildlife with Eagle Marsh.

Alternative B (Construct a Fence and Reconstruct Left Descending Graham-McCulloch Ditch Berm)

Construction of Alternative B would have negative impacts to wildlife habitat. Alternative B would require construction of a fence. This structure would prevent movement of many types of wildlife within Eagle Marsh.

Alternative C (Construct an Earthen Berm and Pump Station)

Construction of Alternative C is expected to have negative impacts to wildlife habitat. Alternative C would require construction of a berm and pump stations. This alternative would require pumps to run at all times, producing noise that may repel some species of wildlife. Additionally, the berm may impede movement of some species of wildlife.

Alternative D (Construct a Permeable Berm with Telemetered Sluice Gates)

Alternative D is expected to have positive impacts to wildlife habitat. Alternative D would result in the creation of a vegetated buffer area that would also provide additional wildlife habitat.

Alternative E (Construct a Fence/Earthen Berm Combination)

Construction of Alternative E is expected to have negative impacts to wildlife habitat. Alternative E would require construction of a fence, which would prevent many types of wildlife from moving throughout the marsh.

Alternative F (Construct Bar Screen Barrier at Existing Weir)

Alternative F is not expected to have significant impacts to wildlife habitat.

Alternative G (Construct Vertical Drop Structures with Telemetered Sluice Gate)

Construction of Alternative G is expected to have negative impacts to wildlife habitat. Alternative G would impede movement of some species of wildlife throughout the upper reach of Graham-McCulloch Ditch.

Alternative H (Reconstruct Left Descending Graham-McCulloch Ditch Berm)

Alternative H is not expected to have significant impacts to wildlife habitats.

Alternative I (Reconstruct Left Descending Graham-McCulloch Ditch Berm, Demolish Right Descending Berm and Construct Multi-Cell Wetland Area)

Alternative I is expected to have positive impacts to wildlife habitat. Alternative I would create additional wetlands that would provide seasonal habitat for many species of wildlife.

4.4. Endangered and Threatened Species

No Federally listed threatened or endangered species are known in the proposed construction locations of any of the alternatives. Therefore, no impacts to Federally-listed threatened or endangered species are expected from construction and operation of any alternative. Upon selection of a preferred alternative, coordination and consultation with USFWS would commence.

4.5. Recreational, Scenic and Aesthetic Resources

Alternative A (Construct an I-Wall)

Alternative A would have negative impacts to recreational, scenic and aesthetic resources. Constructing an I-wall across Eagle Marsh would reduce the scenic and aesthetic resources by detracting from its natural beauty; however, placing an aesthetically pleasing facade on the I-wall would reduce these impacts. The I-wall would restrict movement within the marsh thereby reducing recreational opportunities.

Alternative B (Construct a Fence and Reconstruct Left Descending Graham-McCulloch Ditch Berm)

Construction of Alternative B would have negative impacts to recreational, scenic and aesthetic resources. Construction of a fence across the marsh would reduce the scenic and aesthetic resources of Eagle Marsh by detracting from the natural beauty of the area. Construction of the fence would also reduce recreational opportunities by restricting movement within the marsh. Reconstruction of the berm may have some recreational benefit by providing safer elevated access to the center of the Eagle Marsh for wildlife viewing.

Alternative C (Construct an Earthen Berm and Pump Station)

Construction and operation of Alternative C would have negative impacts to recreational, scenic and aesthetic resources. Alternative C would require the continual operation of three 150-horspower pumps and up to eight additional 350-horspower pumps during flood events. The noise produced by the operation of the pumps would reduce the recreational value of several activates, such as wildlife viewing, by disturbing wildlife and creating additional noise pollution.

Alternative D (Construct a Permeable Berm with Telemetered Sluice Gates)

Construction of Alternative D is expected to have negative impacts to recreational, scenic and aesthetic resources. This alternative would result in construction of a large berm and telemetered sluice gates, which would detract from the scenic and aesthetic resources of the area.

Alternative E (Construct a Fence/Earthen Berm Combination)

Construction of Alternative E would have negative impacts to recreational, scenic and aesthetic resources. A fence across the marsh would reduce the scenic and aesthetic resources of Eagle Marsh by detracting from the natural beauty. The fence would also reduce recreational opportunities by restricting movement within Eagle Marsh. The berm may have an operational benefit to LRWP by providing better access to maintenance facilities during flooding periods.

Alternative F (Construct Bar Screen Barrier at Existing Weir)

Construction of Alternative F is expected to have negative impacts to recreational, scenic and aesthetic resources. Placement of the bar screen would reduce the scenic and aesthetic resources of Little River by detracting from the natural beauty of the area. The bar screen would likely trap debris, including trash, further diminishing the aesthetic quality of the river.

Recreational opportunities may also be reduced, as the bar screen could potentially create a fall hazard near the riprap at the debris boom tie-in on the northern side of Little River at Huntington. Further, the slanted bar screen spanning the river could be considered a nuisance. As such, fencing may be considered on both banks to prevent people from attempting to cross the river here. Mitigation of these hazards would be developed if this alternative is selected.

Alternative G (Construct Vertical Drop Structures with Telemetered Sluice Gate)

Construction of Alternative G (Construct Vertical Drop Structures with Telemetered Sluice Gate) is expected to have negative impacts to recreational, scenic and aesthetic resources. This alternative would result in construction of a large vertical drop structure and telemetered sluice gates which would detract from the scenic and aesthetic resources of the area.

Alternative H (Reconstruct Left Descending Graham-McCulloch Ditch Berm)

Alternative H is not expected to have significant impacts to recreational, scenic and aesthetic resources. The reconstructed berm may provide improved elevated access to the center of Eagle Marsh, improving wildlife viewing and providing better maintenance access for LRWP.

Alternative I (Reconstruct Left Descending Graham-McCulloch Ditch Berm, Demolish Right Descending Berm and Construct Multi-Cell Wetland Area)

Alternative I is expected to have a positive impact to recreational, scenic and aesthetic resources. This alternative includes the creating additional wetlands, which increases the scenic and aesthetic value and creates or improves recreational opportunities such as wildlife viewing.

4.6. Cultural Resources

Impacts to cultural resources are unknown at this time. As stated in Section 2.6, the structural alternatives under consideration have the potential to impact cultural resources. Determination of the presence of cultural resources requires a detailed investigation involving excavation. Once a preferred alternative is selected a cultural resources investigation would be implemented.

4.7. Air Quality

No significant impacts to air quality are expected from construction and operation of any structural alternative except Alternative C (Construct an Earthen Berm and Pump Station). Alternative C would require the continual operation of three 150-horsepower pumps and the operation of up to eight additional 350-horspower pumps during flood events.

4.8. Noise

No significant impacts to noise levels are expected from construction and operation of any structural alternative except alternative C (Construct an Earthen Berm and Pump Station), which would require continual operation of three 150-horspower pumps and the operation of up to eight additional 350-horspower pumps during flood events. Construction noise for all alternatives is expected to be of short duration.

4.9. Hazardous Materials

Based on site reconnaissance and land use history of the floodplain between Eagle Marsh and the town of Huntington none of the locations for the nine structural alternatives are likely to be contaminated with hazardous or toxic substances. However, a formal assessment was not conducted for this phase of the project. Should the project proceed to recommending a plan for Federal implementation, a formal assessment would be done of the real estate needed to build and operate the project to assure that contaminated property is not acquired.

4.10. Socioeconomics and Environmental Justice

Alternatives A (Construct an I-Wall), C (Construct an Earthen Berm and Pump Station), D (Construct a Permeable Berm with Telemetered Sluice Gates) and G (Construct Vertical Drop Structures with Telemetered Sluice Gate) would lead to varying levels of increase in the flood elevation of the 1% annual chance event. Specific increases to the 1% annual chance event for each alternative are given in Section 3.4.3 of this study. Increases in flood elevations could cause economic impacts to the local populous; therefore, mitigation may be required in accordance with Indiana law to avoid socioeconomic impacts to Fort Wayne residents.

No significant impacts are expected to socioeconomic conditions or to environmental justice from construction and operation of any structural alternative.

4.11. Cumulative Effects

Cumulative effects must be determined before construction of any alternative. Each alternative is expected to have a unique set of cumulative impacts. Due to the complexity of the analysis of cumulative impacts it is not practical to present cumulative impacts evaluations for each alternative at this stage of the evaluation process. Evaluation of cumulative impacts will be postponed until appropriate authority and funding are in place and an alternative is recommended.

All ratings are preliminary and require further investigation and evaluation if a preferred alternative is selected. Alternatives with positive ratings are expected to have a positive impact on the resource. Alternatives with negative ratings are expected to have a negative impact on the resource. Negative ratings do not include mitigation. ‘No effect’ ratings are assigned to alternatives that are not expected to have significant positive or negative impact on the resource.

Table 4.1 - Preliminary Assessment of Impacts

Alternative	Soils	Wetlands	Aquatic Habitat	Wildlife Habitat	Recreational Use	Scenery & Aesthetics	Air Quality	Noise	Hazardous Materials	Socioeconomics	Environmental Justice
A. Construct an I-wall	NE	(-)	(-)	(-)	(-)	(-)	NE	NE	NE	NE	NE
B. Construct a fence and reconstruct left descending Graham-McCulloch Ditch berm	NE	NE	NE	(-)	(-)	(-)	NE	NE	NE	NE	NE
C. Construct an earthen berm and pump station	NE	NE	(-)	(-)	(-)	(-)	(-)	(-)	NE	NE	NE
D. Construct a permeable berm with telemetered sluice gates	NE	(+)	NE	(+)	(-)	(-)	NE	NE	NE	NE	NE
E. Construct a fence/earthen berm combination	NE	NE	NE	(-)	(-)	(-)	NE	NE	NE	NE	NE
F. Construct bar screen barrier at existing weir	NE	NE	NE	NE	NE	(-)	NE	NE	NE	NE	NE
G. Construct vertical drop structure with telemetered sluice gate	NE	NE	NE	(-)	(-)	(-)	NE	NE	NE	NE	NE
H. Reconstruct left descending Graham-McCulloch Ditch berm	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
I. Reconstruct left descending Graham-McCulloch Ditch berm; demolish right descending berm; construct multi-cell wetland area	NE	(+)	(+)	(+)	(+)	(+)	NE	NE	NE	NE	NE
	NE = No Effect			(+) = Positive Effect			(-) = Negative Effect				

5.0 POSSIBLE MITIGATION

Mitigation and any necessary monitoring and adaptive management plans will be determined in greater detail later in the study process when a recommended alternative is developed. It is likely that any structural alternative constructed within Eagle Marsh would require mitigation for impacts to wetlands and wildlife habitat, and potentially induced water surface elevations. Any alternative that causes a loss of flood storage capacity may require mitigation to replace the lost capacity in accordance with Allen County stormwater management requirements.

5.1. Mitigation of Induced Water Surface Elevations

Indiana's Flood Control Act, Indiana Code (IC) 14-28-1, requires that prior to undertaking work in a floodway a person must obtain a permit from the Department of Natural Resources. Section 22 of the Act states that to obtain a permit the applicant must clearly prove the project will not:

(1) Adversely affect the efficiency of or unduly restrict the capacity of the floodway.
(2) Constitute an unreasonable hazard to the safety of life or property.
(3) Result in unreasonably detrimental effects upon fish, wildlife, or botanical resources.

The administrative regulations associated with the Act are contained in the Flood Plain Management Rules, 312 Indiana Administrative Code (IAC) 10. The regulations define "adversely affect the efficiency of or unduly restrict the capacity of the floodway" as:

> "an increase in the elevation of the regulatory flood of at least fifteen-hundredths (0.15) of a foot as determined by comparing the regulatory flood elevation under the project condition to that under the base condition. This definition does not, however, apply to any of the following:
>
> (1) A dam regulated under IC 14-27-7 and IC 14-28-1.
> (2) A flood control project authorized under IC 14-28-1-29.
> (3) An area for which a flood easement is secured and recorded with the county recorder."

As described in the discussion of each alternative in Section 3.5, increases in water surface elevations are a common effect of any structure forming a barrier to flow, and thus a barrier to ANS. This is due to the important role this valley plays in conveying flood flows for the St. Marys and Graham-McCulloch Ditch watersheds. Refer to Appendix F, Section 2.10, for a thorough discussion of the impacts of each alternative on water surface elevations, and particularly to Appendix F Tables 2.5a, 2.5b as well as Appendix F Figures 2.17 through 2.23. Effects of these induced water surface elevations on real property discussed previously are summarized in Table 5.1. Please note that at this preliminary level of investigation, the assumptions used in identifying quantities for this table are conservative. Where only portions of parcels are newly affected by higher water surface elevations, the real property value of affected parcels does not assign a value to the affected portion, but includes the entire value of the parcel (per 2008 records) in its summation of cumulative real property values of affected parcels. Gathering additional hydrologic and survey data will facilitate refinement of the hydrologic and hydraulic models, which may reduce the extent of the impacts.

As the analysis shows, Alternative A creates the highest impact of the nine structural alternatives because it significantly reduces the area available for storage. The resulting increases in water surface elevations occur in Junk Ditch, an area with the most residential and commercial development. Alternatives H & I are similar, but the location of the barrier further west allows the floodplain to expand into other storage areas, reducing the impact to properties along Junk Ditch. Alternatives C, D, and G include barriers along Graham-McCulloch Ditch and involve intentional ponding of water upstream of the berm in order to create separation. These areas would likely require purchase of flowage easements or complete purchase in fee of the affected properties. A formal determination would be made based upon the frequency of inundation and other factors, and as it is a detailed process, would be determined upon the selection of a final alternative. Alternative E may also require similar flowage easements for properties that are affected upon a more frequent basis than the 1% annual chance exceedance event. Alternatives B and F are expected to not increase water surface elevations as they do not significantly affect the hydraulics of the area. Alternative F requires further design of the bar screens for this determination, should this alternative be selected.

Mitigation of the induced water surface elevations may take several forms, and would highly depend on the ANS structural alternative, the correlating damages, and the location of properties affected. Purchase of affected properties and relocation of residents or businesses may be

required. Where structures are not impacted, flood easements may be appropriate. In accordance with Indiana code, if a project increases the 1% chance flood elevation by more than 0.15 feet, flood easements may be acquired provided the requirements of 312 IAC 10-4-4 are met:

" … the applicant must demonstrate to the satisfaction of the department the project:
(1) will not constitute an unreasonable hazard to the safety of life or property;
(2) is not unreasonably detrimental to fish, wildlife, or botanical resources; and
(3) is either:
(A) a dam;
(B) a flood control project under IC 14-28-1-29; or
(C) a public works project."

In such instances flood easements must be secured for land which would be added to the 1% chance floodplain and land within the existing 1% chance floodplain which would experience increased inundation as a result of a surcharge in excess of 0.15 feet.

Due to the flat topography, isolated properties or structures may be feasible to protect through construction of small levees. The drawback to this method of mitigation is that some volume of flood storage is also removed from the floodplain, which in turn may increase water surface elevations in other areas. This may or may not be acceptable, depending upon what new damages are created. Non-structural flood risk management measures, such as elevating the first floor elevations of residences, installation of flashboards on buildings or construction of ring levees for example, may also be a consideration. Determination of the most economical means of mitigation is a detailed process, therefore infeasible to perform until a final alternative is selected.

5.2. Mitigation of Wildlife Habitat Impacts

The majority of the proposed alternatives creates a physical barrier to aquatic species during flood events, but also creates a barrier to terrestrial species when flows are normal. The separation caused by these barriers may adversely affect biological diversity by fragmenting and reducing available habitat necessary to support an existing species population, or by blocking migration routes. This was a consideration in the development of the alternatives, and where feasible, the barriers consist of berms instead of abrupt features like fences or walls, as it is assumed that berms are traversable by terrestrial species. Where fences or walls were a necessary feature of the alternative, such as Alternatives A and E, terrestrial animal crossings were included. Animal crossings are essentially berms of a specified width that are formed overtop a barrier at designated intervals.

Table 5.1 - Comparison of Induced Damages								
	Additional Parcels Affected for 1% Event		Additional Structures Affected for 1% Event		Additional Inundated Area for 1% Event (ac)		Cumulative Real Property Values of Affected Parcels (M)	
Alternative	Graham-McCulloch	St. Marys/ Junk Ditch	Graham-McCulloch	St. Marys/ Junk Ditch	Graham-McCulloch	St. Marys/ Junk Ditch	Graham-McCulloch	St. Marys/ Junk Ditch
A. Construct an I-Wall (see F1.5.1)	0	69	0	51	0	143	$0	$11.4
B. Construct a fence & reconstruct left descending Graham-McCulloch ditch berm (see F1.5.2) (1)								
C. Construct an earthen berm & pump station (see F1.5.3)	24	35	0	1	71	125		$3.6
D. Construct permeable berm with telemetered sluice gates (see F1.5.4) (2)	19		0		118			
E. Construct fence/earthen berm combination (see F1.5.5)	18	0	0	0	33	0	$0	
F. Construct bar screen barrier at existing weir (see F1.5.6) (3)								
G. Construct vertical drop structures with telemetered sluice gate (see F1.5.7)	27	7	2	8	250	106	$0.2	$0.7
H. Reconstruct left descending Graham-McCulloch ditch berm (see F1.5.8)	5	66	1	34	122	209	$0.1	$7.2
I. Reconstruct left descending Graham-McCulloch ditch, demolish right descending berm & construct multi-cell wetland area (see F1.5.9)	11	66	4	34	88	209	$0.5	$7.2

(1) Alternative B was not specifically modeled, as the hydraulic conditions will remain essentially the same the the current (baseline) conditions.
(2) Alternative D was not specifically modeled for this flow condition, as the Graham-McCulloch Ditch 1% annual chance event flows will control.
(3) Alternative F was not specifically modeled, as it was assumed that the constraints of minimizing impacts to upstream water surface elevations upstream to at or near Indiana maximum allowable levels of 0.14 feet increases for 1% chance event will dominate the bar screen design

6.0 IMPLEMENTATION REQUIREMENTS

6.1. Identify Implementation Authority

Congress did not provide authority to USACE to implement a recommended plan in the GLMRIS authorization. However, there are two ways USACE could complete design and construction of a project at Eagle Marsh to prevent interbasin spread of ANS. One method is through a new specific authority that Congress might choose to include in a future WRDA and in a corresponding appropriation act to provide the requisite Federal share of the costs. The other method is through application of a standing authority. USACE has three standing authorities through which implementation could possibly be achieved: Section (§) 206 of the Continuing Authority Program (CAP); §506 of the Great Lakes Fishery and Ecosystem Restoration initiative; and §105 of the Energy and Water Development and Related Agencies Appropriations Act, 2012. Significant provisions in these three authorities are discussed below.

Section 206 of WRDA 1996 (PL 104-303), as amended, allows USACE to participate in projects for aquatic ecosystem restoration and protection. However, there is a per project Federal expenditure limit of $5 million and a non-Federal sponsor must agree to: provide all lands, easements, rights of way relocations and disposal areas for the project; operate and maintain the project into perpetuity after construction is complete and contribute a total of 35% of the project implementation costs, which includes the full value of the required real property interests up to the 35% cost share requirement. The law also provides for the non-Federal sponsor of projects to include non-governmental organizations. Annual Federal appropriations for this program are limited to $25 million and typically there is significant nationwide competition among other §206 projects for access to this allotment.

Section 506, WRDA 2000 (PL 106-541) provides programmatic authority to USACE for planning, design, construction and evaluation of projects to restore the fishery, ecosystem and beneficial uses of the Great Lakes in cooperation with other Federal, state and local agencies and the Great Lakes Fishery Commission. Costs for planning, design, construction and evaluation of restoration projects are to be shared 65% Federal and 35% non-Federal. Non-Federal interests may contribute up to 50% of their share of the support plan and projects in the form of services, materials, supplies, or other in-kind contributions. Non-Federal interests receive credit for the value of lands, easements, rights-of-ways, relocations and earth material disposal areas needed for project construction. Non-Federal interests are responsible for operation, maintenance, repair, rehabilitation and replacement of projects. The law also provides for non-governmental organizations to serve as the non-Federal sponsor.

Section 105 of the Energy and Water Development Appropriations Act of 2012 provides authority for the Secretary of the Army, during the fiscal year covered by the Act, to "implement measures recommended in the efficacy study authorized under §3061 of the Water Resources Development Act of 2007 (121 Stat. 1121) or in interim reports, with such modifications or emergency measures as the Secretary of the Army determines to be appropriate, to prevent aquatic nuisance species from dispersing into the Great Lakes by way of any hydrologic connection between the Great Lakes and Mississippi River basins." Section 105 extended and revised a prior authority to include specific language to make clear that the geographic reach of the authority is beyond the Chicago Area Waterways System and allows Federal action to prevent dispersal of ANS across Eagle Marsh into the Great Lakes Basin. However, the joint

explanatory report to the legislation states that the "conferees do not consider hydrologic separation of the Great Lakes Basin from the Mississippi River Basin to be an emergency measure authorized by this Act." Lastly, all requisite design, real estate acquisition and construction must be completed during the fiscal year covered by the Act, which expired on 30 September 2012. Congress may again extend or revise this authority, but it does not exist in current law.

6.2. Identify a Viable Sponsor and Execute a Project Partnership Agreement

The 1986 WRDA established cost sharing rules for all studies and projects conducted by USACE, which were intended to place greater financial responsibilities on non-Federal sponsors. Consequently, current USACE policy and regulations governing water resources studies and projects developed are predicated on this and other laws and administrative provisions specifying use of Federal and non-Federal partnerships to resolve problems and take advantage of opportunities to support national economic development and national ecosystem restoration.

To date, a non-Federal sponsor has not been identified. Section 7.2 reflects the level of collaboration and discussions among other governmental and non-governmental organizations in formulating alternatives to prevent interbasin spread of ANS and to identify a potential non-Federal sponsor. Costs for acquisition of real estate interests and long-term operation and maintenance of a Federal project are typically most efficiently accomplished by a local organization, and in many water resource projects, the benefits are also realized by the community served by that organization. In the case of a project to prevent interbasin spread of ANS across Eagle Marsh, the vast majority of the benefits would not be realized at a local level.

6.3. Finalize NEPA Compliance and Federal Decision Document

In the event that USACE were to be the lead Federal agency for implementation of an alternative at Eagle Marsh and the lead Federal agency for purposes of NEPA, USACE would likely select two or three alternative plans (or combination thereof) with the most promising measures and subject them to a more detailed assessment of potential impacts to support selection of the recommended plan. The NEPA documentation and plan formulation culminating in the recommended plan would be presented in an integrated Federal decision document. The integrated decision document would be coordinated with the appropriate regulatory agencies and posted for public comment. Upon receipt and due consideration of all agency and public comments, the Federal decision document would then be submitted the Great Lakes and Ohio River Division Commander for approval. If the decision document is formulated in compliance with an existing implementation authority, the Great Lakes and Ohio River Division Commander has the authority for final approval. If the study recommends a specific authorization by Congress for USACE to implement the project, then the Great Lakes and Ohio River Division Commander would submit the decision document to USACE Headquarters with a recommendation that Secretary of the Army approve the decision document and submit it to Congress for consideration.

6.4. Submit to Congress

The Secretary of the Army will present the results of the GLMRIS Feasibility Study to Congress. This could occur in one comprehensive study that addresses the CSSC and all other aquatic

pathways between the basins, or depending on level of risk and public concern, could occur in a series of submissions that address single or multiple aquatic pathways. Submission of a recommended plan for any specific aquatic pathway such as Eagle Marsh would address the full range of potential impacts and provide estimates of the project benefits and life-cycle project implementation costs, including any possible mitigation for induced flood damages.

7.0 PUBLIC INVOLVEMENT

7.1. Public Views and Comments

This interim GLMRIS study is the result of extensive communication and collaboration with a variety of interested stakeholders at the national, state and local levels. Additionally, relevant public input was also received during a series of NEPA public scoping meetings held in twelve cities across the region from December 2011 through April 2012. This report was made available for 60 days for public review and comment. Additionally, a public meeting was widely advertized and held approximately midway through the comment period on December 4, 2012 in Fort Wayne, Indiana. Remote public access to the public meeting was also provided via web-meeting to facilitate ample opportunity for public input. All public comments received and the transcript of the webinar has been incorporated into the record of public involvement for the project. This report reflects significant public involvement, and the results were derived through a collaborative process throughout its development with an array of stakeholder organizations.

7.1.1. NEPA Public Scoping

A total of 24 public meetings were held in 12 cities around the Great Lakes and along the Mississippi and Ohio Rivers between December 2010 through April 2011 to introduce the GLMRIS Project Management Plan and initiate the NEPA public scoping process. The meetings were coordinated in advance with a variety of Federal, state and local government agencies and non-governmental stakeholder organizations to solicit input from a broad array of water resource user perspectives. USACE also used various traditional news outlets and social media venues to reach out for public input on the scope and objectives of GLMRIS. The complete transcripts for each of the sessions are available at the GLMRIS Website: http://glmris.anl.gov/.

Each public session included a presentation by USACE to explain the Congressional authority directing GLMRIS, the study plan to implement it and the study progress relative to the CSSC and other aquatic pathways, including Eagle Marsh, to that point. Each session also included the Council on Environmental Quality's (CEQ) appointed leader of the Asian Carp Regional Coordinating Committee to explain the on-going and planned efforts directed to prevent introduction of Asian carp into the Great Lakes through the CSSC and other pathways, aquatic and anthropogenic. Following the presentations, public comments and questions were received verbally and in written form.

While attendance at the 24 sessions ranged from less than a handful of people at a couple sessions to as many as 300, the sessions clearly illustrated widespread passionate opinion from individuals and an array of non-governmental organizations about the state of the Great Lakes and the need to restore this invaluable natural resource and prevent Asian carp from reaching the Great Lakes. Most of the public interest was focused on the CSSC, and there were two general themes to the majority of the public comments. The first was that the threat posed by Asian carp

to the Great Lakes is dire, and that the schedule for GLMRIS was not acceptable due to the urgent need for a permanent means to prevent Asian carp and other ANS from transferring between the Great Lakes and Mississippi River basins. The other theme was that hydrologic separation was the only acceptable long-term solution to prevent Asian carp from navigating through the CSSC to access Lake Michigan.

In general, there was consensus that the sooner the study can be completed, the better. On the second point however, navigation industry stakeholders and other users of the waterways cautioned that the subject waters have served multiple human purposes for many decades and indicated that a rush to select a solution before the likelihood and consequence of interbasin transfer of ANS are known and the potential impacts of hydrologic separation are reliably estimated is not wise and could lead to many unintended and unacceptable consequences.

There were comments and questions specific to Eagle Marsh at nearly all of the sessions. Most acknowledged satisfaction with the prompt interagency efforts led by Indiana DNR and supported by Federal funds to very quickly construct an interim risk reduction measure. Some questioned the effectiveness of the temporary barrier to prevent small fish from swimming across the basin divide when the aquatic pathway forms across Eagle Marsh. Some questioned the timeline for implementation of a permanent solution at Eagle Marsh, and at the meetings in Buffalo and Cleveland as well as other several other locations, there were significant comments about the significant value and improved health of the Lake Erie fishery and concern that Lake Erie would likely be the most suitable habitat of all the Great Lakes to the Asian carp. The discussion of other pathways also generated questions and comments about other ways Asian carp and other ANS may be introduced into either basin, such as through:

- Exchange of bilge and ballast water from ocean-going vessels;
- Collection of bait fish from a stream infested with Asian carp or other ANS and that bait and water later being released in another water body;
- Transport of live ANS in combination with accidental or intentional release as may occur in the exotic pets trade and food industries; and
- ANS attached to portable marine equipment that may be transported over land from one water body to another.

7.1.2. Eagle Marsh Public Meeting and Comments

A public meeting was held in the Allen County Library in Fort Wayne, Indiana on December 4, 2012. The purpose of the meeting was to present the nine structural alternatives contained in the Eagle Marsh Controls Report midway through the 60-day public comment period (November 16, 2012 to January 14, 2013). The meeting was also live on the internet via web-meeting. There were approximately 50 members of the public in attendance.

The Louisville District Commander opened the meeting and introduced the Chairman of the Asian Carp Regional Coordinating Council (ACRCC) who facilitated the meeting. The GLMRIS Program Manager provided an overview of GLMRIS, Focus Area I (CAWS) and Focus Area II (Other Pathways) and the Louisville District project team described the Eagle Marsh pathway, the ANS of concern, and a brief synopsis of each of the nine alternatives.

Following the presentation, the ACRCC Chairman moderated a question and answer session. Questions generally focused on alternatives contained in the Eagle Marsh ANS Controls Report and the larger GLMRIS study. The overall sentiment was favorable for preventing interbasin transfer at the Eagle Marsh pathway, so long as any selected alternative maintained the aesthetic and ecological function of the location. Specifically, there was positive feedback on Alternatives H and I, which entail reconstructing and reinforcing existing berms in order to separate the two basins for floods up to the 1% annual chance event. The public also expressed concerns about induced flooding that could result from implementation of these alternatives.

Public comments submitted during the 60-day public review period echoed the December 2012 public meeting in requesting that any solution implemented at Eagle Marsh maintain or enhance the marsh's current condition while properly addressing any induced flooding. Three letters were received from The Nature Conservancy, Lake Erie Waterkeeper Inc. /Upper Maumee River Save Maumee Program and the National Wildlife Federation (NWF). The letter from NWF represented the views of 23 conservation organizations with members across the Great Lakes and Mississippi River basins and nationwide. Public comments were also received from the Hoosier Environmental Council and three individual citizens. Overall, the public comments supported an expeditious solution to construct a permanent barrier to stop invasive species transfer at Eagle Marsh.

7.2. Agency Coordination

The initial decision to prepare this study occurred at a multi-agency onsite meeting held in July 2010. Jointly arranged by USACE and Indiana DNR, an array of stakeholder agencies were invited to attend and sent information compiled by Indiana DNR and USGS Water Science Center in Indiana on flooding and the relative frequency and magnitude of interbasin flow across Eagle Marsh along with information on the advancing Asian carp front up the Wabash River. The organizations in attendance were Indiana DNR, USACE, USGS, USEPA, NRCS and LRWP and an informal ad hoc steering committee of members of these organizations was formed to collaborate on the actions that could be taken to prevent interbasin spread of ANS across Eagle Marsh. City of Fort Wayne officials were unable to attend, but were included in initial and follow on correspondence and information sharing.

The information presented indicated that a flood approximately equal to a flood that has a one in ten chance of being equaled or exceeded during any given year had occurred at Eagle Marsh four times in about the past ten years and a 2009 Flood Insurance Study indicated a storm of that size would result in a maximum depth of water of approximately 4.5 feet across the basin divide at Eagle Marsh during a flood event of that magnitude. After a briefing and discussion, the group toured Eagle Marsh and convened a brainstorming session, first to assess the apparent risk of Asian carp spreading, and then to discuss options to prevent that from happening.

All the agency technical experts agreed that a significant hydraulic connection between the basins occurs at Eagle Marsh, but there was significant uncertainty about the likelihood of Asian carp being within close enough proximity and suitably motivated to spread across the basin divide during the brief periods in time when the hydraulic connection exists. After considerable discussion, the group concluded the potential consequences of Asian carp reaching the Great Lakes Basin through this aquatic pathway were unacceptable and that prompt action was warranted to prevent it from happening.

A number of temporary and permanent structural and non-structural measures ranging from increased monitoring to hydrologic separation of the basins were discussed along with the range of capabilities and authorities each agency had that may best be utilized to quickly implement measures to prevent interbasin transfer of Asian carp. USACE indicated that the GLMRIS authorization would allow expedited completion of a feasibility study of the options to prevent Asian carp and all other ANS from crossing the basin divide through Eagle Marsh at Federal expense; nevertheless, another authority would be required to allow USACE to implement any preventive measures. USACE identified two other standing authorities through which USACE might be able to take preventative actions within a two- to three-year time period, and explained they have constraints such as the need for a non-Federal sponsor to acquire any needed real estate, assume any requisite operation and maintenance responsibilities and contribute a percentage of the costs to design and build any facilities.

These discussions led the group to determine that a permeable barrier such as the interim risk reduction measure that USACE employed between the CSSC and Des Plaines River in Illinois was a measure that could likely be very quickly designed and constructed across Eagle Marsh to prevent Asian carp from spreading across the basin divide. Indiana DNR stepped forward and indicated they had authority and ability to quickly implement such an action if funding could be provided to cover major costs. USEPA identified Federal funds that could be used to implement the temporary barrier. The interagency team concluded this was an appropriate action to pursue immediately and recommended that USACE use the GLMRIS authority to complete a feasibility study of options for a long-term solution. Through a collaborative effort and infusion of Federal funds, Indiana DNR completed design, secured the requisite permits and completed construction of the temporary barrier in early October 2010.

In 2010, the USGS installed and continues to operate and maintain two water level gages at the Eagle Marsh temporary barrier fence. Water levels are monitored to identify conditions when a potential for hydrologic connection exists between the Wabash and Maumee watersheds, so that field crews can mobilize to investigate the existence of ANS here during these conditions, and to assure debris buildup does not obstruct flow at the fence. In 2012, two additional gages were installed, one in Junk Ditch to the east of the watershed boundary and one on the Graham-McCulloch Ditch to the west. These gages will gather hydrologic, hydraulic and water quality gages at the site. These gages will substantially improve the understanding of the complex hydrologic conditions in the area, particularly during flood events on either watershed. The USGS has obtained and committed funding for the operation and maintenance of these gages through September 2014, at which point additional sponsorship of these gages is envisioned.

Indiana DNR, NRCS, USFWS, USGS, LRWP and City of Fort Wayne actively contributed to collecting relevant information and evaluating alternatives for a long-term solution presented in this interim GLMRIS study. Additionally, the Allen County Soil and Water Conservation District and County Surveyors Office, CEQ, Maumee River Basin Commission (MRBC) and The Nature Conservancy (TNC) participated in project meetings. Table 7.1 provides a summary account of some significant interagency meetings held in the course of developing this study.

The MRBC provided technical support for quantifying the impacts of induced damages through the data they developed for the 2008 Flood Mitigation Master Plan Update. MRBC and the City of Fort Wayne identified the Junk Ditch Special Flood Hazard Area (SFHA) as a “High Priority” area for Flood Mitigation Acquisition Projects. Maumee River Basin Commission and the City

of Fort Wayne have purchased numerous homes and removed them from the Junk Ditch SFHA and currently are implementing a FEMA Flood Acquisition Project to remove an additional 52 homes. Currently, MRBC is collaborating with USACE and stakeholders to identify compatible authorities within their existing program that may mutually benefit both the Flood Mitigation Plan and any mitigation associated with implementing an ANS controls alternative.

Indiana DNR, NRCS, USFWS, USGS and LRWP also directly contributed to collection of data and analyses presented in the Aquatic Pathway Assessment of Eagle Marsh presented in Appendix A. Additionally, Eagle Marsh is a topic of discussion at quarterly meetings of the CEQ-led Asian Carp Regional Coordinating Committee, which includes representatives from each state bordering the Great Lakes and the Federal agencies that directly contributed to this study, the National Oceanic and Atmospheric Agency and the Great Lakes Fishery Commission.

This study was most closely coordinated with the technical experts of Indiana DNR and its leadership. The technical expertise lent to the study by Indiana DNR greatly increased the quality of the analyses, and the Indiana DNR leadership raised the following general observations and concerns with the GLMRIS and USACE cost sharing requirements, which were excerpted from notes from the January 2011 meeting:

> …While the conditions found to exist in Focus Area 2 are real and require some level of attention, the areas are generally much less problematic due to their intermittent and short-term nature than represented by Focus Area 1 which is a perennial deep water connection.
>
> …The general concept that construction of a barrier to the interbasin transfer of ANS as a public works project would be sponsored by a local public unit seems problematic at best. Local sponsor cost share funding, long-term ownership and maintenance of a structure that provides very limited and poorly defined local benefit is highly unlikely. Asian carp migration is really responsible for instigating the GLMRIS study as a national issue. This spread was not brought on by the Midwestern states that are now attempting to curtail the movement of Asian carp into the Great Lakes Basin. This again begs that any solution should be through full Federal funding and not through local cost-share…
>
> …The human transport factor is a primary transportation mechanism that seems understated. For many ANS a rating of possible to favorable would exist for this mechanism. A public education effort will be required to lower the transportation risk associated with human activities such as bait buckets and catch and release. This public education would be most effective if sponsored at as local a level as possible...

Likewise, NRCS has strong vested interests in any action that may occur at Eagle Marsh or in the floodplain connecting the basins and contributed significant information related to formulation of alternatives. NRCS is currently seeking applicants within the study area to participate in their Wetlands Reserve Program (WRP). USACE has participated in discussions with Indiana NRCS staff to ensure that any project at Eagle Marsh would be compatible with WRP efforts underway in the area, and for alternatives that alter hydrology to look at how the altered hydrology may also contribute to potential future wetland restoration efforts. NRCS currently holds a Warranty Easement Deed which restricts activities within the Eagle Marsh WRP boundary.

The Indiana DNR, TNC, CEQ, LRWP, MRBC and USACE met as the primary organizational stakeholders on December 5, 2012 and also voice support for Alternatives H and I. The stakeholders agreed that the quickest and most cost-effective means to implement a solution

would be to pursue a project independent of GLMRIS, as part of the Great Lakes Restoration Initiative (GLRI) program. The stakeholders discussed the possibility of TNC taking the lead for designing and constructing the berm, though this evolved in subsequent conversations to NRCS taking the lead on berm design and construction with USACE providing technical support.

The organizational stakeholders are currently considering implementing the project (a variation of Alternatives H and I), in two phases to accommodate necessary mitigation of induced flooding that could result from hydrological separation of the two basins. Phase One would consist of reconstructing the existing berm with a spillway elevation low enough that there would be no offsite impacts, but high enough to maximize separation of the watersheds without inducing stages. Phase Two would elevate the spillway to the 1% annual chance event after offsite induced stages are properly mitigated. Appropriate real estate interests would need to be acquired prior to Phase Two construction. The Maumee Basin Commission is exploring whether it may be able to serve as the lead agency for implementation of the Phase Two real estate acquisition, provided funding is available for land acquisition. Issues related to compliance with NEPA, the Clean Water Act, and other environmental and historic preservation laws will also need to be evaluated.

Table 7.1: Coordination Meetings	
9-Jul-10	Attendees: USACE, NRCS, USEPA, USGS, USFWS, LRWP, IN DNR, Allen Co Soil & Water Conservation District, Maumee River Basin Commission (MRBC)
First site visit by stakeholders to discuss potential surface water connection between the Great Lakes and Mississippi River at Eagle Marsh and associated risks for ANS transfer. (Tetra Tech EM, Inc. 2010).	
4-5-Jan-11	Attendees: USACE, IN DNR, CEQ
Describe the study plan to complete characterization of the Loomis Lake, Parker-Cobb Ditch and Eagle Marsh locations and the feasibility study of long-term measures to prevent interbasin spread of ANS in Eagle Marsh.	
2-3-Nov-11	Attendees: USACE, NRCS, LRWP, IN DNR
Site visit to Eagle Marsh by USACE PDT to further evaluate conditions on the ground and obtain input from the owners and operators of Eagle Marsh.	
17-Mar-11	Attendees: USACE, NRCS, LRWP, USGS, IN DNR, Allen Co. Surveyor's Office
First stakeholder meeting. Held in Fort Wayne. Discussed authority, purpose, scope, methodology and results to date. Stakeholder views of alternatives and other approaches to the project were received.	
22-Aug-11	Attendees: USACE, NRCS, LRWP, USGS, IN DNR, Allen Co. Surveyor's Office, TNC
Second stakeholder meeting. Held at The Nature Conservancy (TNC) in Indianapolis. Progress on the project was presented.	
2-Nov-11	Attendees: USACE, CEQ, NRCS, LRWP, IN DNR, Allen Co. Surveyor's Office
First brief to Allen County Surveyor's Office. • Council on Environmental Quality (CEQ) representative discussed overall GLMRIS authorities, interagency coordination, his role and funding outlook through FY13. • USACE PDT representative gave brief overview of the iterative USACE planning process and ANS Controls Report, including authorizing legislation, constraints, status of Agency Technical Review (ATR) and schedule. He emphasized that a preferred alternative will not be identified in report.	
15-Mar-12	Attendees: USACE, GLMRIS Program Mgr, CEQ, LRWP, IN DNR, Allen Co. Surveyor's Office
Second brief to Allen County Surveyor's Office. • Discussed the nine structural alternatives including major construction features; construction costs; O&M costs and responsibilities; and levels of protection. • Allen County Surveyor's Office will explore the possibility of being the NFS for O&M for Alternatives A, H, or I. • CEQ will explore developing a NFS for construction with the MRBC, Maumee River Basin Partnership of Local Governments (MRBPLG) and others.	
27-Mar-12	Attendees: USACE PDT, GLMRIS Program Mgr, CEQ, IN DNR
Telephone conference call. Discussed the nine structural alternatives including major construction features, Construction costs, O&M costs and responsibilities and levels of protection. Essentially the same brief given to the Allen County Surveyor's Office on 15-Mar-12.	
30-Aug-12	Attendees: USACE, NRCS, USGS, LRWP, IN DNR, MRBC, CEQ, GLMRIS Program Mgr, TNC
Stakeholder meeting in Fort Wayne to summarize the final report contents and discuss that a recommended plan would not be presented in the report until a non-Federal sponsor is identified.	
4-Dec-12	Attendees: Public Informational Meeting
A public meeting for Eagle Marsh Controls Report was held at the Allen County Public Library in Ft Wayne, IN. This was part of the 60-day public comment period for the draft report. Over 50 members of the public attended the meeting which was moderated by John Goss, Asian Carp Director for the White House Council for Environmental Quality. USACE technical experts highlighted the nine structural alternatives that are detailed in the Controls Report. Public sentiment was very supportive of options that have the least impact on the wildlife and habitat of the Eagle Marsh Preserve. The meeting was also live on the internet via web-meeting.	
5-Dec-12	Attendees: USACE, NRCS, USGS, LRWP, IN DNR, MRBC, CEQ, GLMRIS Program Mgr, TNC
The meeting focused in on Alternative H and Alternative I , which entail reconstructing and reinforcing existing berms in order to separate the two basins for floods up to the 1% annual chance event. This group reached a consensus that the quickest and most cost-effective means to implement a solution would be to pursue the project independently, as part of the Great Lakes Restoration Initiative (GLRI) program, with a non-Federal stakeholder or other Federal agency as project lead.	
30-Jan-13	Attendees: USACE, NRCS, USGS, LRWP, IN DNR, MRBC, CEQ, GLMRIS Program Mgr, TNC
Stakeholder meeting in Indianapolis to outline next steps towards a non-federal project implementation at Eagle Marsh.	
22-Apr-13	Attendees: USACE, NRCS, USGS, LRWP, IN DNR, MRBC, CEQ, GLMRIS Program Mgr, TNC
Telephone conference call. Discussed NRCS status of berm design, Wetland Reserve Program (WRP) concerns, permitting and future O&M Considerations.	

7.3. Regulatory Requirements

A number of laws and regulations must be considered in developing a recommended plan for Federal implementation, some of which trigger specific regulatory requirements that must be followed during construction and operation of a Federally-developed project. The following paragraphs summarize regulatory requirements most likely to apply to the completion of a feasibility study recommending Federal action at Eagle Marsh.

NEPA is an overarching Federal statute focused on informed decision-making and an opportunity for public involvement; NEPA requires potential impacts to be considered by Federal agencies prior to making decisions where the actions proposed may significantly affect the human environment. Section 4.0 of this study outlines the potential environmental, social and economic impacts of the nine alternatives developed and presented in this interim study. If USACE were to be the lead Federal agency for purposes of implementing an alternative and complying with NEPA, then a more detailed analysis would be conducted and description provided of the potential environmental, social and economic impacts to comply with NEPA requirements.

Applicable provisions of the Clean Water Act (CWA), state law, and state and federal regulations will be considered in the evaluation of the nine structural alternatives considered in this study. USACE is the Federal agency authorized to regulate the discharge of dredged or fill material into waters of the U.S. under §404 of the CWA; the Indiana Department of Environmental Management (IDEM) is the state agency responsible for issuing water quality certifications under §401 of the CWA for such dredge or fill activities. These provisions may require mitigation for any impacts to waters that occur. IDEM also is responsible for issuing National Pollutant Discharge Elimination System (NPDES) permits in the state of Indiana, including permits for storm water discharges from construction activities involving one acre or more; it is likely that such a permit will need to be obtained prior to the construction of any of the measures under consideration in this study. Further, a construction in the floodway permit from the Indiana DNR pursuant to IC 14-28-1 may also be necessary; Indiana DNR may choose to require mitigation or other measures as a condition of issuing such a permit where it determines such a provision is necessary to avoid resulting in unreasonably detrimental effects upon the fish, wildlife, or botanical resources, or adversely affect the efficiency of the affected floodway. The Allen County Stormwater Management Ordinance, dated 25 April 2008, Ordinance Number 4-25-08-07, will also need to be considered prior to selecting any of the alternatives under consideration.

8.0 CONCLUSIONS

The likelihood of interbasin spread of ANS through the intermittent aquatic pathway that forms across Eagle Marsh warrants preventive action, and this report provides an assessment of viable structural and non-structural options and technologies that could be taken. Nine structural alternatives are compared relative to effectiveness, efficiency, completeness, acceptability, cost of construction, annual O & M cost, time to complete and potential for induced flood damages that would require mitigation. At least three structural measures were rated as having a “high” likelihood of preventing interbasin spread of ANS by way of the Eagle Marsh aquatic pathway. An array of non-structural alternatives are also described that could complement and/or augment

a structural solution. Non-structural measures are also discussed relative to residual risks for interbasin spread of ANS, which for the GLMRIS are defined as means of interbasin spread of ANS that may occur other than direct transit through a connected surface water body.

Eagle Marsh is one of several aquatic pathways identified by the GLMRIS through which ANS may spread from one basin into the other. Consequently, the benefits of preventing interbasin spread of ANS across the intermittent aquatic pathway that forms at Eagle Marsh are partly dependent upon the nature of the risks and the related actions to be taken at other aquatic pathway locations. The identification of viable control measures at Eagle Marsh is an important step, and the results of this and other GLMRIS interim reports are being evaluated individually and collectively relative to prevention of interbasin spread of ANS between the Great Lakes and Mississippi River basins through aquatic pathways.

The report also reflects significant interest and input from an array of stakeholder agencies and the public that possess related authorities, responsibilities and capabilities to manage and reduce the risks posed by the spread of ANS. Local involvement is critical to efficient implementation of any controls, and USACE civil works policy and regulations pursuant to WRDA 1986 stipulate identification and development of an agreement with a non-federal cost sharing partner as a fundamental prerequisite for USACE water resource project implementation.

The Eagle Marsh ANS Controls Report was completed in November 2012, and a public meeting was held in December 2012 in Fort Wayne, Indiana. The public predominantly expressed support for Alternatives H and I. The Indiana DNR, TNC, CEQ, LRWP, MRBC and USACE also met as the primary organizational stakeholders in December, 2012 and also voice support for Alternatives H and I. The stakeholders agreed that the quickest and most cost-effective means to implement a solution would be to pursue a project independent of GLMRIS, as part of the Great Lakes Restoration Initiative (GLRI) program. The stakeholders discussed the possibility of TNC taking the lead for designing and constructing the berm, though this evolved in subsequent conversations to NRCS taking the lead on berm design and construction with USACE providing technical support.

The organizational stakeholders are currently considering implementing the project (a variation of Alternatives H and I), in two phases to accommodate necessary mitigation of induced flooding that could result from hydrological separation of the two basins. Phase One would consist of reconstructing the existing berm with a spillway elevation low enough that there would be no offsite impacts, but high enough to maximize separation of the watersheds without inducing stages. Phase Two would elevate the spillway to the 1% annual chance event after offsite induced stages are properly mitigated. Appropriate real estate interests would need to be acquired prior to Phase Two construction. The Maumee Basin Commission is exploring whether it may be able to serve as the lead agency for implementation of the Phase Two real estate acquisition, provided funding is available for land acquisition. Issues related to compliance with NEPA, the Clean Water Act, and other environmental and historic preservation laws will also need to be evaluated.

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