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ANDERSON ECONOMIC GROUP

Aquatic Invasive Species in the Chicago Area Waterway System

Economic Impacts to the Chicago Region of Efforts to Mitigate Interbasin Transfer

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I.Executive Summary

The Chicago Area Waterway System (CAWS) is part of the only waterway connecting the Great Lakes and Mississippi River basins. The man-made connection has facilitated transportation between the two basins for over 150 years. Today, ships carrying aquatic life across the globe, and the accidental release of non-native species into the Mississippi River from the Great Lakes and vice versa, pose a serious threat to the ecological health of the nation's water bodies. Some non-native species deposited in these water bodies have not only survived, but thrived in the absence of natural predators, becoming aquatic invasive species (AIS).

There are over 250 AIS in the Mississippi River and Great Lakes basins, 13 of which scientists believe could cause significant harm if transferred between basins. The most salient AIS threat of recent years is Asian carp, which are present in the Mississippi River basin, but not Lake Michigan. Concerns are mounting over the potential impact that Asian carp could have on the Great Lakes if the fish traverse the CAWS and enter Lake Michigan.

Governments, businesses, and nonprofits have spent years working together to slow the spread of Asian carp and other AIS toward the Great Lakes. To date, Asian carp mitigation efforts have been largely successful, but the threat of interbasin transfer remains. For example, a Silver carp thought to have spawned in the Mississippi River basin below the CAWS electric fish barrier was found above the barrier in the Calumet River only nine miles from Lake Michigan in June 2017. To further reduce the risk of interbasin transfer, some stakeholders have proposed building new AIS-focused infrastructure in the CAWS.

Building this new infrastructure would have significant consequences for businesses, residents, and government in the Chicago region. The economic consequences alone potentially include:

- Avoiding the direct impacts of invasive species in the Great Lakes and the Mississippi River on industries that rely on the current ecosystem.
- Avoiding the nuisance costs of invasive species on a range of industries.
- Delaying or preventing the movement of goods between the Mississippi River and the Great Lakes.
- Altering the floodplain and the frequency of flooding around the CAWS.
- Altering the water quality and the speed of water flow, affecting which species can survive in the CAWS and suitability for commercial or recreational use.
- Imposing costs on federal, state, and/or local governments in order to fund the construction and operation of significant new infrastructure.
- Spending and hiring at local businesses during infrastructure construction.
- Increasing or decreasing costs to federal, state, and local government for non-structural AIS mitigation efforts.

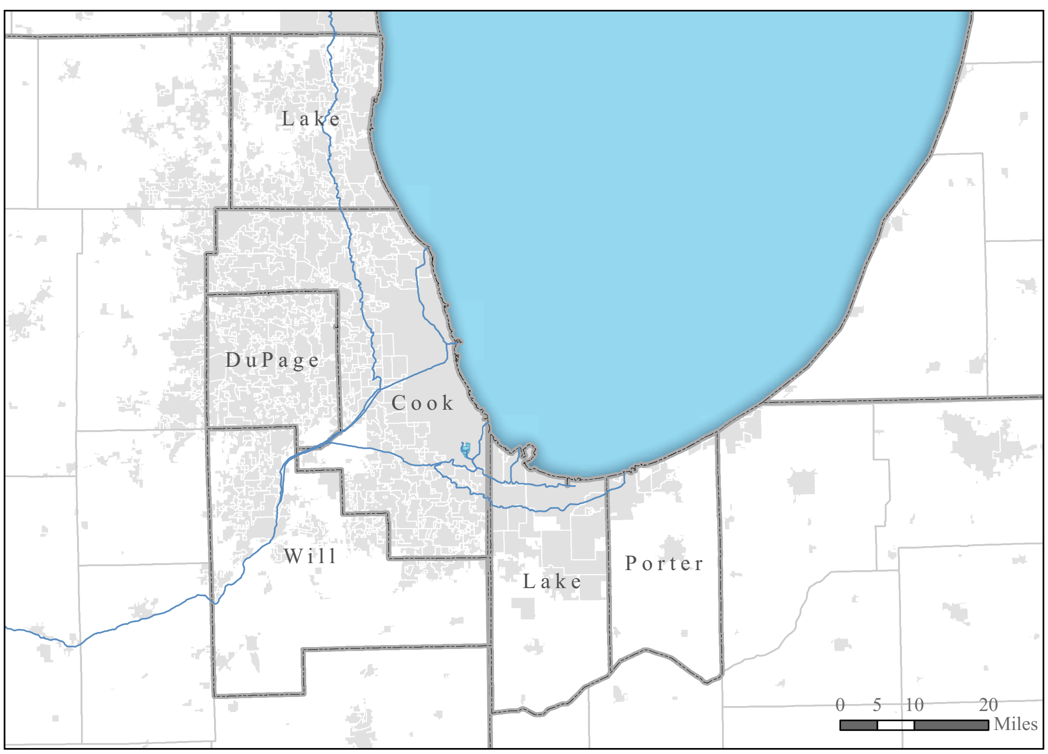
PURPOSE OF REPORT

Through a grant provided by the Joyce Foundation, the Metropolitan Planning Council (MPC) commissioned Anderson Economic Group (AEG) to examine a range of potential economic impacts of proposed efforts to prevent the interbasin transfer of AIS, including Asian carp, between the Great Lakes and Mississippi River basins via the CAWS. There are a number of potential economic consequences of these efforts. In this report, we focus on the following consequences:

- The net economic impact of infrastructure investments that minimize the risk of interbasin AIS transfer;
- The potential net costs or benefits to residents and businesses due to changes in flooding and water quality in the CAWS; and
- The extent to which businesses could be affected if Asian carp reach the Chicago River and Lake Michigan.

The spread of AIS between basins could have a wide geographic impact, potentially affecting all areas of the Mississippi River and Great Lakes basins, including Canada. In this report, we focus exclusively on the impact to the Chicago region, which we define as the counties of Cook, DuPage, Will, and Lake in Illinois, and Lake and Porter in Indiana.

FIGURE 1. Chicago Region Economic Impact Analysis Area



Source: Base data from Esri, Inc.

There are several important economic consequences—most notably the impact on water freight and transportation—that we do not examine in detail in this report. As a result, the effects that we quantify here represent only a portion of the overall impact of the proposed efforts to mitigate AIS in the CAWS.

OVERVIEW OF APPROACH

In order to inform our research and analysis, we interviewed consultants, engineers, ecologists, and representatives from government agencies and nonprofits. We also collected data and information from the Illinois and Indiana Departments of Natural Resources, the U.S. Army Corps of Engineers (USACE), HDR, and third-party reports on invasive species in the CAWS. We performed an extensive literature review on the economic impacts of flooding, urban waterway quality, and aquatic invasive species.

We identified three possible AIS mitigation infrastructure scenarios based on input from those we interviewed. See “Scenarios for Analysis” on page 7 for a description of those three scenarios.

We briefly discuss our approach in analyzing each effect below. For a more detailed discussion of our sources and methods, see “Appendix A. Methodology” on page A-1.

Net economic impact of infrastructure investment. We estimated the net impact of each infrastructure scenario on output, earnings, and employment using RIMS II multipliers from the Bureau of Economic Analysis and cost estimates from USACE, HDR, and the Metropolitan Water Reclamation District of Greater Chicago (MWRD). We define the net economic impact as the amount of economic activity that would result from construction of control points, excluding any activity that would have still occurred in the region if the control points were not built.

Our net economic impact estimates account for direct and indirect effects. Direct economic effects include direct spending to construct the control points, while the indirect effects represent increased spending, earnings, and employment in the Chicago region economy that is supported by the recirculation of direct project spending throughout the Chicago region.

See “Economic Impact Analysis” on page A-2 for a detailed description of our economic impact analysis methodology and assumptions.

Impact of infrastructure scenarios on flooding. Using extensive analysis by USACE, we estimate the increased acreage that would flood for all levels of storm events up to a 500-year storm. Using data from the American Community Survey, we determined the number of structures that would experience flooding, and the economic impact of these costs.

See "Flooding Impact" on page A-4 for a full description of our flood impact analysis methodology.

Impact of infrastructure scenarios on water quality. To measure the economic impact of changes to water quality, we reviewed existing water quality standards for the CAWS, and estimated the necessary upgrades to water quality in the CAWS under each control point scenario. We then researched the value of additional recreational uses for waterways, and estimated the increase in recreational users for sections of the CAWS that would see improved water quality.

See "Flooding Impact" on page A-4 for more details on our method for evaluating the impact of flooding and water quality.

Scale of Chicago-region industries affected by Asian carp. We reviewed existing research to identify potential industries that could be affected by Asian carp. We estimated the scale of these industries in the Chicago region—expressed in terms of employment and sales volume—using data from Esri Business Analyst. We then estimated the economic footprint of these industries in the Chicago region using data from several sources, including the Illinois Department of Natural Resources (DNR) and Indiana Department of Natural Resources, among others.

We define the economic footprint as the economic activity that is supported by spending in these industries. Our estimates account for direct and indirect effects. Direct effects include direct spending in these industries, while the indirect effects represent spending, earnings, and employment in the economy that is supported by the circulation of this spending throughout the Chicago region.

See "Regional Asian Carp Impact" on page A-6 for further discussion of our methodology.

SCENARIOS FOR ANALYSIS

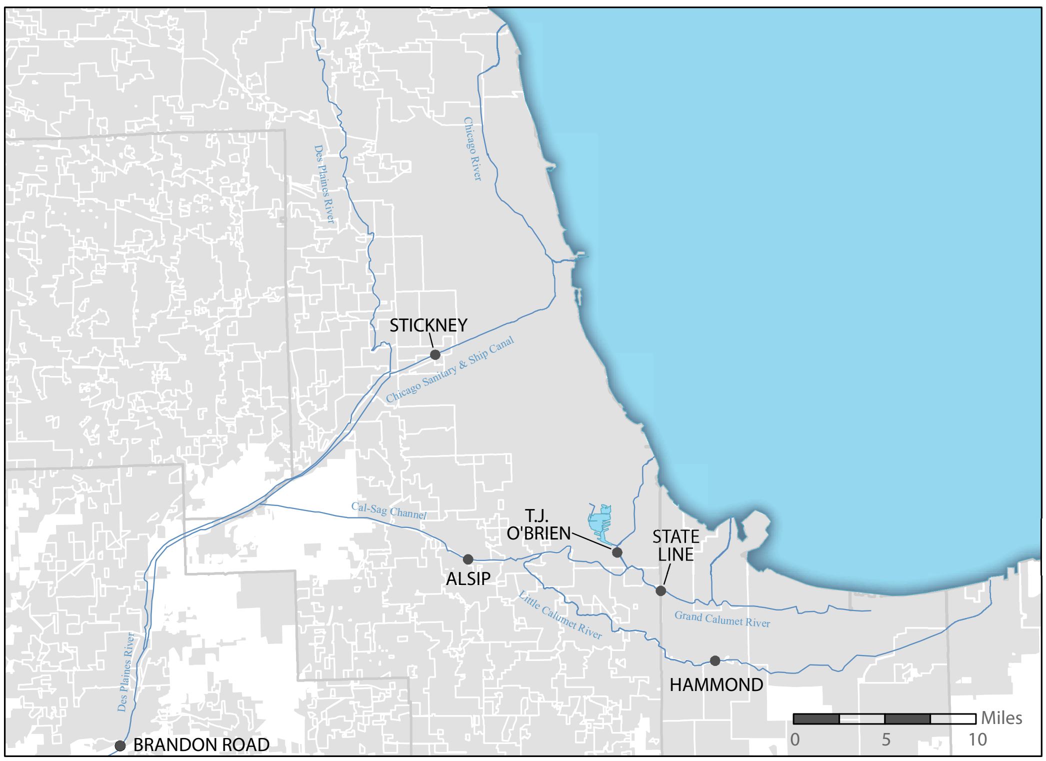
Based on input from those we interviewed and third party reports, we identified three scenarios for our analysis:

1. **Control measures at Brandon Road.** This scenario would involve reconfiguring the Brandon Road Lock and Dam near Joliet to prevent the upstream travel of some AIS, such as Asian carp. The control point would allow for upstream and downstream travel of vessels in the CAWS.
2. **Control measures at Brandon Road, Stickney, and Alsip.** In addition to the changes at Brandon Road mentioned above, which would prevent the upstream movement of AIS, this scenario would involve two additional locks near the villages of Stickney and Alsip that would prevent travel of invasive species downstream (from the Great Lakes to the Illinois River). All control points would allow for upstream and downstream travel of vessels in the CAWS.
3. **Control measures at Brandon Road, Stickney, T.J. O'Brien Lock and Dam, and on the Grand and Little Calumet Rivers.** This scenario would involve

control points at Brandon Road and Stickney, and T.J. O'Brien Lock and Dam in Chicago, along with physical barriers on the Grand Calumet River at the Illinois/Indiana state line, and on the Little Calumet River in Hammond. The control points at Brandon Road, Stickney, and T.J. O'Brien Lock and Dam would allow for upstream and downstream travel of vessels in the CAWS.

We show each of the control points described in these scenarios in Figure 2, and discuss each scenario in detail in "Infrastructure Scenarios" on page 22.

FIGURE 2. Potential AIS Control Point Locations



Source: AEG analysis of GLMRIS, HDR Summary of Technical Evaluations; base data from Esri, Inc.

FINDINGS

Our research and analysis resulted in the following findings:

1. *The most prominent aquatic invasive species in public discourse is Asian carp. Ecologists, however, are uncertain about the carp's ability to survive in and around the Great Lakes. In addition, Asian carp are only one of several AIS that could have an adverse impact by traversing the CAWS.*

Asian carp have no predators in U.S. rivers, consume large amounts of plankton, and out-compete native fish. It is difficult to gauge the extent of the impact that Asian carp would have on the Great Lakes ecosystem. Studies have shown that there may not be enough plankton in Lake Michigan for Asian carp to survive in the open waters of Lake Michigan; however, it is possible that the carp could change their diet in order to survive, and could become established in harbors or near-shore areas. Asian carp require rivers for spawning, and thus are more likely to establish themselves in Great Lakes tributaries than in other parts of the lakes.

See "Aquatic Invasive Species and the Chicago Area Waterway System" on page 17 for more information on Asian carp and other AIS in the Great Lakes and Mississippi River basins.

2. Infrastructure projects may not further reduce the risk of interbasin transfer until they are complete.

The infrastructure scenarios outlined in this report are expected to reduce the risk of AIS interbasin transfer. However, the full extent of two-way risk reduction will not be realized until the projects are complete. Based on forensic analysis of GLMRIS reports from the Army Corps of Engineers, we estimate that it will take five years to build a control point at Brandon Road, and 25 years to complete a project with multiple control points.

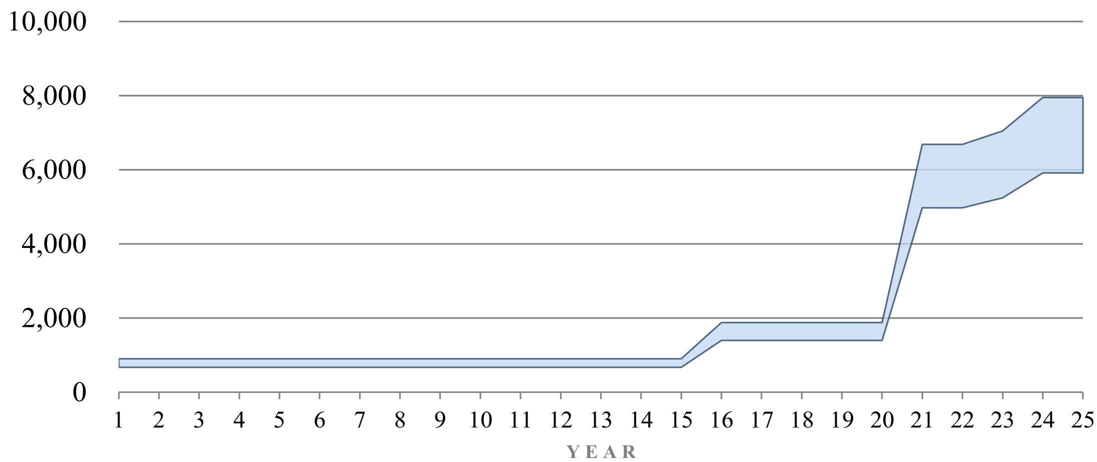
3. The net economic impacts of infrastructure investment for the Chicago region would range from a low of $387 million for a single control point at Brandon Road to $10.4 billion for projects that include multiple control points. Depending on the scenario, the projects would result in 450 to over 2,300 jobs annually and $115 million to $3.0 billion in total earnings for residents in the Chicago region.

Building AIS infrastructure in the CAWS would result in a measurable impact on the regional economy by adding to local output, earnings, and employment. Federal funding would likely comprise a large portion of the project, bringing in new money to the region's economy.

In the Brandon Road-only infrastructure scenario, we estimate that the output, earnings, and employment impact will be roughly constant over a period of five years.

In the case of the multiple-control-point scenarios, the economic impact would be smaller in early years, and would then increase significantly toward the end of each project's 25-year construction period, adding up to an average of 7,300 jobs annually during the last five years of the project's lifespan, as shown in Figure 3 on page 10. The extent of the economic impact will depend on the share of project funding from federal, state, and local governments, respectively.

FIGURE 3. Chicago Region Estimated Range of Increase in Annual Employment from Scenario 2 AIS Infrastructure Project



Source: AEG analysis of Army Corps of Engineers, HDR, MWDRD base data; U.S. Bureau of Economic Analysis RIMS II Multipliers.

For a full analysis of the economic impacts of each scenario, see "Economic Impact of Infrastructure Projects" on page 30.

4. Recreational boating and fishing and other supported industries are the primary Chicago region industries most likely to be affected by Asian carp in the CAWS and Great Lakes. Asian carp could have a negative impact on these industries, though the extent of this impact is very difficult to predict given available data and research.

Recreational fishing and boating and supported industries—such as accommodations, restaurants, and gas stations—are the primary industries in the Chicago region that would likely be affected by Asian carp in the CAWS and Great Lakes. Additional industries at risk include water-related tourism, such as boat tours along the Chicago River and Lake Michigan shoreline.

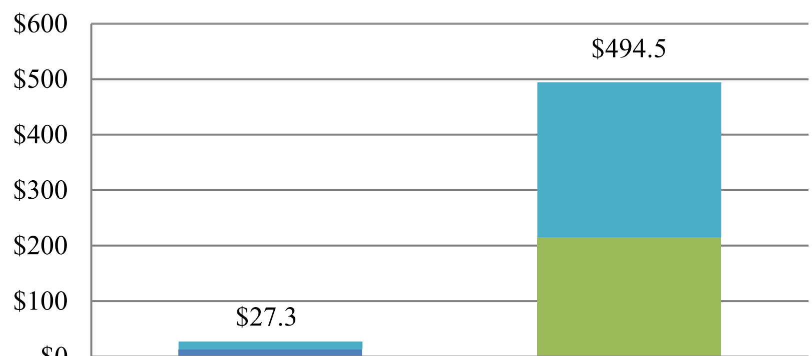
If Asian carp were to survive in the Great Lakes basin, the impact on these industries in the Chicago region is very difficult to predict because research that can provide an empirical basis for estimating this impact has not been conducted.

See "Potential Industries Affected by Asian Carp" on page 47 for further discussion.

5. Spending by recreational boaters supports over 3,700 employees and $130 million annually in earnings in the Chicago region, while spending on recreational fishing supports about 240 employees and nearly $8 million in earnings annually.

We estimate that boater spending supports nearly $500 million in output in the Chicago region annually, along with $130 million in earnings and over 3,700 jobs. In comparison, we estimate that angler spending supports about $27 million in output in the Chicago region annually, along with $8 million in earnings and 240 jobs. For both boater and angler spending, about half of these effects are associated with spending in supported industries, such as accommodations, restaurants, grocery stores, and gas stations.

FIGURE 4. Annual Output Effects of Recreational Fishing and Recreational Boating in the Chicago Region (millions)



	Angler Spending*	Boater Spending
Supported Industries	$14.5	$280.0
Recreational Boating	$0.0	$214.5
Recreational Fishing	$12.8	$0.0
Total	$27.3	$494.5

Source: AEG analysis using base data from Illinois Department of Natural Resources; Indiana Department of Natural Resources; U.S. Army Corps of Engineers; Ready, et al; U.S. Bureau of Labor Statistics; U.S. Bureau of Economic Analysis RIMS II Multipliers.

Angler spending reflects fishing activity in the Illinois portion of Lake Michigan, the Indiana portion of Lake Michigan, and Indiana inland waterways. It excludes fishing activity in Illinois inland waterways due to data availability.

For further discussion, see "Impact of Asian Carp on Industries in the Chicago Region" on page 47.

6. Scenario 1 would not have a significant impact on flooding. Under scenarios 2 and 3, we estimate that, within the Illinois portion of the

CAWS, in an average year, an additional 160 homes will be affected by flooding. This will result in approximately $700,000 in added costs to local households, annually.

The Tunnel and Reservoir Plan (TARP)—which is expected to be completed in 2029—along with the construction of additional reservoirs, pumps, and conveyance tunnels, will manage stormwater and eliminate a great deal of flood risk in the Chicago region if additional AIS infrastructure is built in the CAWS. The hydrological changes from the construction of control points and additional infrastructure under scenario 2 could potentially result in 162 additional flooded houses each year in the Illinois portion of the study area. This would result in costs to local households amounting to $692,000 per year in additional insurance or remediation costs after a flood. The impacts of flooding are similar in scenario 3.

Lake and Porter counties in Indiana are part of our region of analysis for this report; however, they are not included in our flood impact estimates because insufficient information is available on the extent to which flood risk in those counties would be affected by AIS infrastructure. Some stakeholders interviewed for this report noted that there could be a significant increase in flood risk in Northwest Indiana under scenario 3.[1]

For additional information, see "Potential Impact of Flooding" on page 36.

7. *Additional flood remediation costs from AIS infrastructure would negatively impact homeowners, but would be offset by an increase in spending at local businesses. As a result, the magnitude of the regional net economic impact of additional flooding would be very small.*

Additional flooding imposes costs on local households, leading homeowners to spend more on flood remediation services and replacement goods. New spending on home repairs and replacement of goods will result in a net economic impact of $274,000 under scenario 2, and $277,000 under scenario 3, as shown in Table 1. Although the net economic impact of flooding may actually be positive regionwide, it is important to note that this economic impact is a result of

1. The GLMRIS report analyzes flooding impacts in 10 communities along the Illinois portion of the CAWS, and does not examine flood impacts in Northwest Indiana. See Figure 15 on page 40 for a map of communities included in our flooding analysis.

new costs imposed on property owners, and represents a forced transfer from homeowners to businesses working in flood remediation in the region.

TABLE 1. Economic Impact of Flooding due to Installation of Control Points for Each Storm Event (dollar amounts in thousands)

Storm Event	Additional Flooded Homes	Additional Cost of Flooding to Households	Output	Earnings	Employment
Scenario 2					
25-Year	1,840	-$7,861	$3,100	$956	13
50-Year	3,777	-$16,135	$6,363	$1,961	26
100-Year	2,483	-$10,609	$4,184	$1,290	17
500-Year	-6,049	$25,843	-$10,192	-$3,141	-41
Average Annual Cost	**162**	**-$692**	**$274**	**$85**	**1**
Scenario 3					
25-Year	1,905	-$8,136	$3,209	$989	13
50-Year	3,859	-$16,486	$6,502	$2,004	26
100-Year	2,523	-$10,777	$4,250	$1,310	17
500-Year	-6,871	$29,354	-$11,577	-$3,568	-47
Average Annual Cost	**165**	**-$704**	**$277**	**$86**	**1**

Source: AEG analysis using base data from GLIMRIS, American Community Survey, Center for Neighborhood Technology, U.S. Bureau of Economic Analysis RIMS II Multipliers.

8. *Required improvements in water quality that would accompany scenarios 2 and 3 would result in new potential uses (such as swimming) for parts of the Chicago and Calumet Rivers. The economic impacts of increased usability are uncertain, but likely small due to the difficulty of attracting additional recreational users in the short term.*

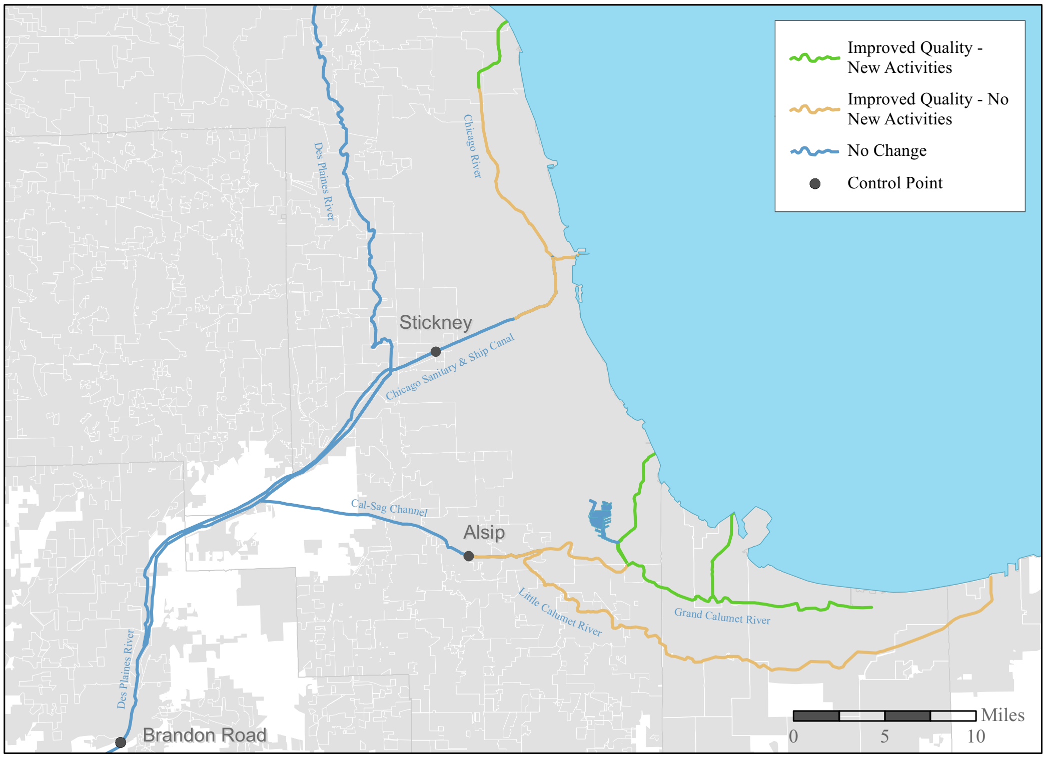
In scenarios 2 and 3, a portion of water in the CAWS would flow back towards Lake Michigan, which would necessitate significant improvements in water quality. These areas of the CAWS would support recreational activities such as boating and swimming, which represents a benefit to local residents.

Extensive efforts to clean up the Chicago River have resulted in some portions of the CAWS being designated for primary contact recreational uses, such as swimming, but these efforts have not necessarily changed the public's perception that the water is too dirty for such activities.[2] The inertia behind public perception of CAWS cleanliness may limit the recreational use of water for the

2. Dale Bowman, "Swimming the Chicago River: Coming much sooner rather than later," *Chicago Sun-Times*, March, 10, 2017.

foreseeable future, but improvements could lay the foundation for a variety of recreational uses of the CAWS.

FIGURE 5. Scenario 2 Water Quality Impacts



Source: Anderson Economic Group, based on Illinois statutes on water quality standards, base data from Esri, Inc.

See "Potential Impact on Water Quality" on page 42 for a full discussion of potential water quality impacts.

LIMITATIONS AND ASSUMPTIONS

In this report, we examine a specific subset of possible economic impacts of building AIS infrastructure and of Asian carp reaching the Great Lakes. Our analysis focuses on these impacts for the Chicago region only. We outline additional considerations and limitations for our analysis below.

Impacts to commercial navigation. Building AIS infrastructure in the CAWS could potentially slow or prohibit cargo movement on waterways, which would negatively impact the water freight industry and businesses that rely on waterborne shipping.

While we do not quantify these impacts in this report, GLMRIS, and the GLMRIS Brandon Road report, contain analyses of the impacts of various AIS infrastructure projects on commercial cargo navigation in the CAWS. Several other studies have examined the impacts of AIS infrastructure on navigation as well. See "Impacts to Navigation" on page B-3 for a list of these reports.

Lack of available data. We contacted a number of agencies to acquire data for this report. Not all agencies were able to provide the requested data. In some cases, a lack of data required us to make certain assumptions in our approach.

Our infrastructure cost estimates are based primarily on cost estimates made by USACE and HDR. The USACE cost estimates derived for this report from GLMRIS and the GLMRIS Brandon Road Tentatively Selected Plan are based on forensic analysis of publicly-available data from GLMRIS appendices. We contacted USACE and requested additional detail on these cost estimates, but USACE was unable to provide the requested data. The GLMRIS cost estimates we used are engineered to a 5% level of detail, and some itemized cost estimates have contingencies of nearly 100%. In order to be conservative in our economic impact analysis, we did not include cost contingencies in our economic impact estimates.

Our estimates on the cost of flooding were also limited by available data. USACE conducted a flooding impact study for some GLMRIS scenarios; however, the report only examined the impacts of flooding on a sample of communities, none of which were located in Northwest Indiana.

Strict water mitigation and retention plans. The flood management infrastructure used in GLMRIS is designed to accommodate a 500-year storm and capture and mitigate nearly every Combined Sewer Overflow in the region. This level of water mitigation and treatment capacity may not be viable or cost-effective in practice. Designs for a 100- or 200-year storm may be more appropriate, and could be much less costly than 500-year storm infrastructure.

The GLMRIS report does not consider any alternative solutions to water mitigation and treatment beyond building new infrastructure. It is possible that some of the negative flooding impacts of building AIS control points could be mitigated through public policies, such as increasing stormwater retention requirements for new development, or through eminent domain purchases of properties that are put at increased risk of flooding as a result of AIS infrastructure. These efforts could decrease the amount of stormwater storage capacity prescribed in GLMRIS, thus lowering project costs.

Where possible, we adjust itemized cost estimates downward to reflect a conservative approach to our economic impact analysis, since higher project cost estimates yield larger economic impacts. We also consulted with the Metropolitan Water Reclamation District of Greater Chicago in order to scale down cost estimates for some infrastructure items.

Scale of Chicago region industries affected by Asian carp. The primary limitation to our analysis regarding the impact of Asian carp on Chicago-area industries is the uncertainty of whether Asian carp would thrive in the Great Lakes, and how Asian carp would specifically affect the Great Lakes ecosystem and water-related businesses. At the very least, it appears that Asian carp could live in the mouths of rivers that flow into the Great Lakes, and possibly in areas near the lake shores. In our analysis, we determined which industries could be affected by Asian carp, and the scale of these industries. However, because of this uncertainty, we did not estimate the extent to which each industry would be affected.

We also faced limitations in data availability for recreational boating and fishing activity in the region of our analysis. We contacted a number of agencies to acquire data that reflect activity specifically in the Chicago region; however, not all agencies provided data at this level of detail. We often relied on data that reflected activity in the entire Great Lakes region to inform the assumptions we used to complete our analysis.

For a detailed description of our methodology, see “Appendix A. Methodology” on page A-1.

ABOUT ANDERSON ECONOMIC GROUP

Anderson Economic Group, LLC, is a boutique research and consulting firm, with offices in Chicago, Illinois; East Lansing, Michigan; New York, New York; and Istanbul, Turkey. The experts at AEG specialize in economics, public policy, business valuation, and industry analyses. They have conducted nationally-recognized economic and fiscal impact studies for private, public, and nonprofit clients across the United States.

The consultants at Anderson Economic Group have a deep understanding of advanced economic modeling techniques and extensive experience in a variety of fields, including economic impact analysis and environmental economics. Prior work in these areas include evaluating the costs of aquatic invasive species to the Great Lakes; assessing the economic impacts of carbon regulation; and quantifying the Great Lakes blue economy and contributions of water-related research. For more information, please see “Appendix D. About AEG” on page D-1 or visit www.AndersonEconomicGroup.com.

II.Aquatic Invasive Species and the Chicago Area Waterway System

Throughout its history, proximity to the Great Lakes and the Illinois River made Chicago an important transportation hub and a base for numerous global industries. In the nineteenth century, as the city quickly grew, waste dumping created public health problems for residents as the Chicago River carried waste into Lake Michigan and polluted the city's water supply.

By the early 1900s, workers constructed a canal that reversed the flow of the Chicago River such that sewage would no longer flow into Lake Michigan but into the Des Plaines River, which flows into the Illinois and Mississippi Rivers. Shortly thereafter the Calumet River was also connected to Des Plaines river via canal, creating the Chicago Area Waterway System and completing the first and only connection between the Great Lakes and Mississippi River basins.

The construction of the CAWS and reversal of the Chicago and Calumet Rivers provided substantial public health benefits for residents and provided new transportation routes. Today, however, concerns are mounting that the CAWS could serve as a pathway for the movement of aquatic invasive species between the Mississippi River and Great Lakes basins. There are over 250 AIS in both basins, 13 of which could cause significant harm if transferred between basins.[3] Ten of these species reside in the Great Lakes and pose a threat to the Mississippi River Basin, and three, including Silver and Bighead carp, pose a threat to the Great Lakes basin.

ASIAN CARP CHARACTERISTICS

The term "Asian carp" generally refers to four different species of carp—Bighead, Black, Grass, and Silver—that are native to Eastern Asia. Grass carp are the only Asian carp species present in the Great Lakes. Black carp are present in Illinois waterways, but at low concentrations. Bighead and Silver carp are firmly established in the Illinois River, and are the main AIS of concern.

Bighead and Silver carp were introduced into the United States in the 1970s for use in aquaculture. The fish are filter feeders and consume large amounts of plankton. Both species require rivers for spawning. Silver carp are known to jump out of water when disturbed by watercraft sounds, endangering boaters.

Plankton populations in the Great Lakes have been depleted significantly by invasive zebra mussels, and the introduction of Bighead or Silver carp into the Great Lakes could further decrease plankton levels in the Great Lakes and their tributaries, negatively impacting the native fish population.

3. U.S. Army Corps of Engineers, "Great Lakes and Mississippi River Interbasin Study," 2014.

INTERBASIN EXCHANGE OF ASIAN CARP

It is difficult to gauge the extent of the impact that Asian carp would have on the Great Lakes should they reach the basin because many fundamental questions about how Asian carp adapt to their environment remain unanswered. Researchers have modeled the spread of Asian carp using bioenergetic models that take into account a number of factors such as food availability, fish size, swimming speed, and water temperature. Some models suggest that there is not enough food available in Lake Michigan for Asian carp to establish themselves or have an adverse impact on other species.[4] Other studies suggest that Asian carp are very likely to establish themselves in Lake Michigan, but only in areas with tributaries and high concentrations of food.[5]

Bioenergetic models provide some guidance on the impact of Asian carp; however, ecosystems are complex, and these models cannot account for impacts such as changes to carp diets in cases of food scarcity or other unknown factors.

OTHER AQUATIC INVASIVE SPECIES

The GLMRIS report found that, in addition to Bighead and Silver carp, one species—scud—poses a medium risk to the Great Lakes should they traverse the CAWS from the Illinois River. Two AIS of concern that are present in the Great Lakes—the bloody red shrimp and fishhook waterflea—were identified as posing a high risk to the Mississippi River basin. Interbasin transfer prevention methods vary depending on the type of AIS and its method of movement. We describe these additional species of concern below.

Scud

Scud are crustaceans known to be located within 20 miles of the Brandon Road Lock and Dam. Scud could be transferred through passive drift or by attaching themselves to vessels traveling through the Brandon Road Lock and Dam. Scud have been known to outcompete native mussel species, and large swaths of the Great Lakes are thought to be suitable for their survival.[6]

4. Walter Hill and Mark Pegg, "Evaluating Asian Carp Colonization Potential and Impact in the Great Lakes," National Oceanic and Atmospheric Administration Illinois-Indiana Sea Grant, 2008.
5. Sandra Cooke and Walter Hill, "Can filter-feeding Asian carp invade the Laurentian Great Lakes? A bioenergetic modelling exercise," *Freshwater Biology* 55 no. 10 (2010): 2138-2152, and Karl Anderson, Duane Chapman, Timothy Wynne, and Craig Paukert, "Assessment of Phytoplankton Resources Suitable for Bigheaded Carps in Lake Michigan Derived From Remote Sensing and Bioenergetics," *Journal of Great Lakes Research*, forthcoming.
6. U.S. Army Corps of Engineers, "Great Lakes and Mississippi River Interbasin Study, Appendix C: Risk of Adverse Impacts from the Movement through the CAWS and Establishment of Aquatic Nuisance Species in the Great Lakes and Mississippi River Basins," 2014.

Bloody Red Shrimp

The bloody red shrimp is native to Asia and Eastern Europe and is well established in Lake Michigan. The shrimp are known to have spread across parts of Europe via river and canal systems, and the CAWS may prove enticing due to its slow water flow, which the shrimp prefer. If the shrimp reach the CAWS, they could be transported downstream as passive drifters or through bilge water. The shrimp could outcompete native species and consume large amounts of plankton, causing a drop in native fish populations and a subsequent decrease in commercial and sport fishing.[7]

Fishhook Waterflea

The fishhook waterflea is a planktonic insect native to Europe and Asia, and is known to be established in Lake Michigan. If the fleas enter into the CAWS, they could be transported downstream as passive drifters. The fleas are thought to present a threat to the native plankton population, and could outcompete native species for food. Furthermore, the fleas are thought to be a poor replacement food source for species that feed on plankton, because fish that feed on plankton may find them less palatable than other forms of plankton.[8]

Different methods are required to prevent the interbasin transfer of each species. Species that are active swimmers, such as Asian carp, may be deterred by electric or noise barriers as proposed in the GLMRIS Brandon Road report. These efforts, however, may be much less effective against species that affix themselves to boats or transport themselves with the natural flow of water. Flushing locks have shown to be effective against passive drifters, but not against species that affix themselves to boats or travel via bilge water.[9]

PAST AND PRESENT ASIAN CARP MITIGATION EFFORTS

Federal and state governments are undertaking a number of mitigation efforts aimed at stopping the upstream movement of Asian carp. We describe these efforts below.

Electric Fish Barrier

In 2002, USACE constructed an experimental electric dispersal barrier in the Des Plaines River near Romeoville in an attempt to prevent invasive fish species in the Mississippi River from swimming upstream into the CAWS. Today, USACE operates three adjacent electric barriers in Romeoville that provide redundancy in case of failure.

7. *Ibid.*
8. *Ibid.*
9. U.S. Army Corps of Engineers, "GLMRIS Brandon Road Draft Integrated Feasibility Study and Environmental Impact Statement—Will County, Illinois," 2017.

To a large extent, Asian carp have not challenged the barrier. The northernmost concentration of Asian carp is believed to be at Dresden Island pool—several miles downstream of the barrier. Nevertheless, the effectiveness of the barrier has been called into question. In June 2017, a live Silver Carp was found in the Little Calumet River. Biologists determined that the fish had hatched downstream of the electric barrier.[10] The barrier has also experienced outages on at least two occasions, and may not be effective in preventing the upstream movement of small Asian carp. In 2010 the barrier experienced a four minute weather-related outage, and, in May 2012, the barrier experienced a 13-minute outage in which the barrier's main and backup systems both failed.[11]

Research conducted by the U.S. Fish and Wildlife Service shows that the passage of tow boats across the barrier temporarily decreases the barrier's voltage, making it possible for small fish to swim across. Furthermore, tow boats moving downstream through the barrier may create an upstream current capable of propelling small fish across the barrier.[12]

Legal Action

A number of plaintiffs have filed lawsuits in federal court seeking injunctions to permanently close the CAWS and sever the connection between the Great Lakes and Mississippi River basins. In 2009, the State of Michigan unsuccessfully filed suit in the U.S. Supreme Court seeking an injunction to close the CAWS, arguing that the electric barrier alone is not effective in preventing Asian carp from reaching the Great Lakes. The State cited positive Asian carp environmental DNA tests above the barrier as evidence of the barrier's ineffectiveness.[13] [14] Since then, a coalition of five Great Lakes states has filed several additional requests for injunctions, all of which have been denied by appeals courts.[15]

10. John Flesher "Asian carp found in Little Calumet River had evaded three electric barriers," *Chicago Tribune*, Aug 18, 2017.
11. Associated Press, "Asian carp barrier near Chicago had power failure," *Milwaukee Journal Sentinel*, May 7, 2012.
12. U.S. Fish and Wildlife Service, "Effects of barge vessel transit on the efficacy of the Chicago Sanitary and Ship Canal Electric Dispersal Barrier: Preliminary Results from 2016 field trials."
13. Jaclyn Belczyk, "Michigan sues Illinois in Supreme Court over invasive fish species," *Jurist*, Dec. 23, 2009.
14. The presence of Asian carp eDNA in the CAWS does not necessarily mean that live Asian carp are present in the CAWS. Carp DNA can be transmitted across the electric barrier through a number of means, such as through transfer of bilge water or via bird movement around the barrier.
15. Peter Snyder, "Federal appeals court dismisses five-state Asian carp lawsuit," *Jurist*, July 16, 2014.

Commercial Fishing and Carp Deterrents

The Illinois DNR contracts with commercial fishers to harvest Asian carp from waterways. In 2016, commercial fishers harvested over 1 million pounds of Asian carp. To date, commercial fishing of Asian carp has been funded through the federal Great Lakes Restoration Initiative.

Asian Carp Research

Researchers are investigating new methods of mitigation, such as through the use of carbon dioxide, complex sounds, and toxins targeted specifically at Asian carp. Several of these technologies are included in the Brandon Road Tentatively Selected Plan report. Some of them could theoretically be implemented without additional construction of control points. The Great Lakes Regional Initiative has been a significant source of funding for carp research.

III.Infrastructure Scenarios

In this chapter, we provide an overview of three potential AIS interbasin transfer prevention scenarios. Since the release of GLMRIS, stakeholders have actively collaborated to identify the most feasible AIS transfer prevention scenarios. The scenarios we examine below reflect the direction of these discussions.

The scenarios are:

1. Control measures at Brandon Road;
2. Control measures at Brandon Road, Stickney, and Alsip; and
3. Control measures at Brandon Road, Stickney, T.J. O'Brien Lock and Dam, and physical barriers in the Grand and Little Calumet Rivers.

Figure 6 on page 23 shows the locations of each control point.

CONTROL POINT LOCATION CONSIDERATIONS

Constructing AIS control points in the CAWS could result in a number of impacts to industry and the environment. These impacts differ depending on the location of each control point. In addition to cost, the main considerations for control points scenarios are: flooding; water and environmental quality; and navigability.

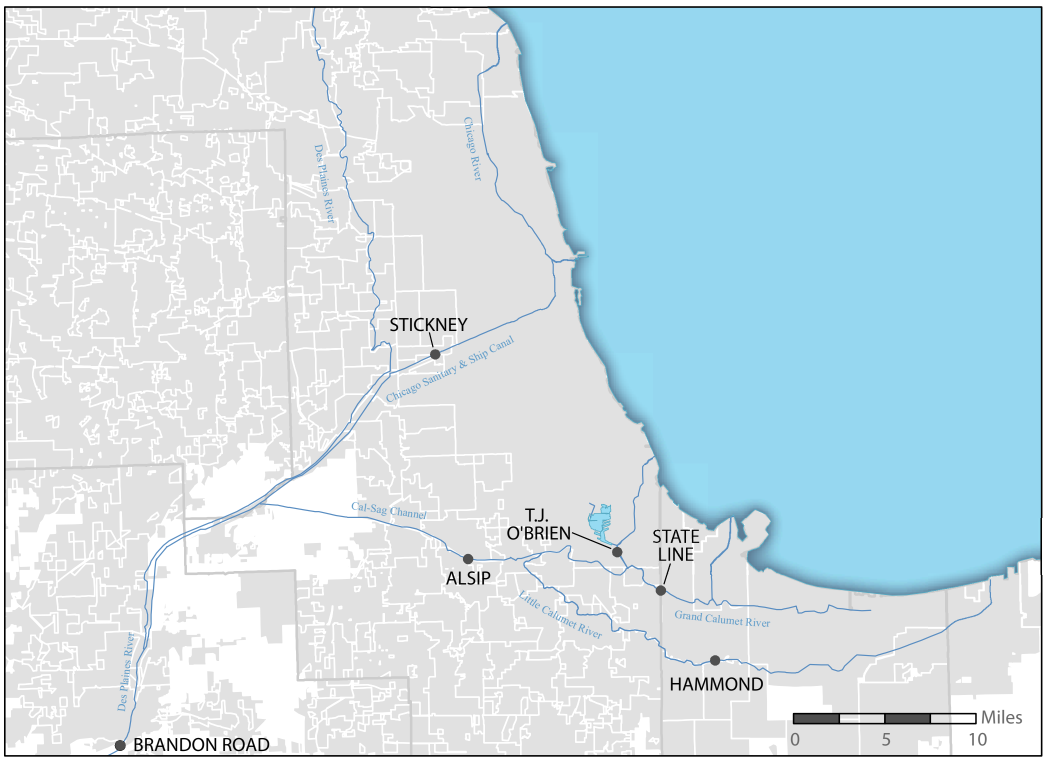
Flooding. Some control points would change the flow of the CAWS and lead to increased flood risk. Implementing control points along the region's natural drainage basin divide—at Stickney and Alsip—would restore the natural flow direction that existed prior to the construction of the CAWS, minimizing any increase in flood risk. Implementing control points in areas not along the natural drainage basin divide, without any additional mitigation measures, would increase the risk of flooding.

Water and environmental quality. AIS control points that change the flow of the CAWS could lead to stagnant water, which has a negative impact on water quality. Control points that change the flow direction of the CAWS could also expose Lake Michigan to polluted sediment that would otherwise remain undisturbed if the flow of the CAWS remained the same.

AIS control points that change the flow direction of the CAWS could also affect wastewater treatment plant (WWTP) discharge. Wastewater treatment standards for Lake Michigan are higher than those for the Mississippi River basin. WWTPs located on the Lake Michigan side of a control point that changes the flow of the CAWS would either have to upgrade their treatment processes to meet Lake Michigan standards or reroute their effluent through a conveyance tunnel to continue discharging effluent on the Mississippi River basin side of the control point.

Navigability. Implementing control points in the CAWS could affect the navigability of the waterway and negatively impact commercial and recreational boating. This report focuses on the economic impact of control point construction and operation, as well as the impacts of changes in water quality and flood risk. We do not analyze the impact of each scenario on navigation. For a list of reports that discuss navigation concerns, see "Impacts to Navigation" on page B-3.

FIGURE 6. Potential AIS Control Point Locations



Source: Anderson Economic Group analysis of GLMRIS, HDR Summary of Technical Evaluations; base data from Esri, Inc.

PROJECT COST ESTIMATES

In this report we rely on multiple sources for project cost estimates. The cost estimates we present here come primarily from the GLMRIS report. The infrastructure items included in the GLMRIS report and their respective costs have been a point of contention since the release of the report, with some stakeholders criticizing the report for including unnecessary stormwater retention and mitigation features and high estimated costs.

Although GLMRIS costs may be overstated, in many cases the estimates are the only cost estimates available. Where possible, we scale down project cost estimates, with the goal of being conservative in our economic impact projections presented in the next chapter. GLMRIS cost estimates include significant contingencies, and the cost estimates used in GLMRIS are consistently reported at the maximum contingency value. In cases where we use GLMRIS cost estimates, we use the base cost estimate with no contingency. We provide cost estimates including contingencies, where available, in “Appendix C: Detailed Exhibits” on page C-1.

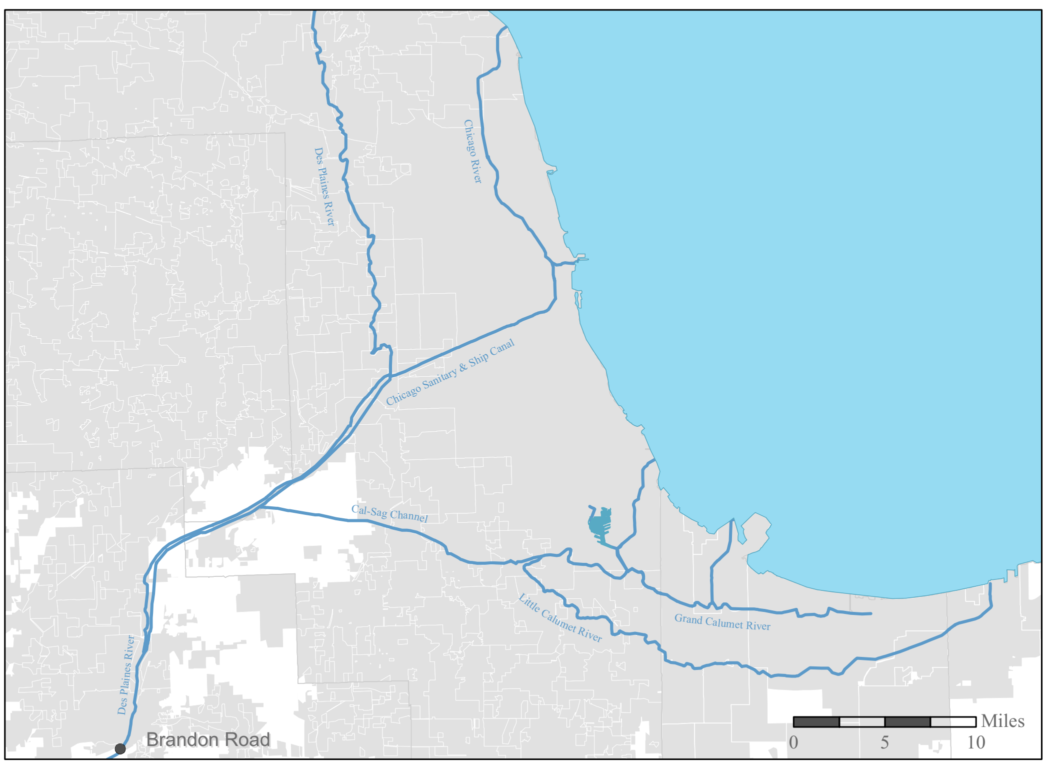
SCENARIO DESCRIPTIONS

In this section, we describe each AIS infrastructure scenario in detail.

Scenario 1—Brandon Road Control Measures

This scenario includes construction of a one-way flushing AIS control lock at Brandon Road Lock and Dam in Joliet as described by the U.S. Army Corps of Engineers’ Brandon Road Tentatively Selected Plan, released in July 2017. The upstream side of the Brandon Road Lock and Dam sits roughly 25 feet above the downstream side, making the dam an appealing site to prevent the upstream movement of Asian carp and other AIS.

FIGURE 7. Scenario 1 Control Point Locations



Source: Anderson Economic Group analysis of GLMRIS, HDR Summary of Technical Evaluations; base data from Esri, Inc.

In this scenario, the one-way lock would allow flood water to spill across the dam from the Lake Michigan side of the dam to the Mississippi basin side during rain events, alleviating upstream flooding risk and maintaining the existing flow pattern of the CAWS. The lock would prevent the upstream movement of AIS from the Mississippi River basin toward Lake Michigan, but would not prevent the downstream movement of AIS from Lake Michigan into the Mississippi River basin. This scenario would have no impact on flooding and water quality since it maintains the current flow direction of the CAWS.

The Army Corps estimates that this scenario would cost approximately $275 million, with construction taking approximately five years. Table 2 shows itemized cost estimates for this scenario.[16]

TABLE 2. Cost Estimates for Scenario 1: Control Measures at Brandon Road

	Item	Description	Estimated Cost		Source
1	Lock Improvement	Brandon Road Flusing Lock Conversion	$	247	Brandon Road TSP
2	Other	Land acquisition	$	1	AEG estimate based on analysis of GLMRIS Brandon Road Draft Plan
3	Other	Planning, engineering and design	$	27	AEG estimate based on analysis of GLMRIS Brandon Road Draft Plan
		Total Cost:	$	275	

Scenario 2—Control Measures at Brandon Road, Stickney, and Alsip

This scenario includes implementing a one-way AIS flushing lock at Brandon Road as described in Scenario 1, along with additional AIS flushing locks at Stickney and Alsip. Control points at Stickney and Alsip would prevent the downstream movement of Great Lakes AIS. The locks at Stickney and Alsip would also have electric barriers similar to the barriers at Brandon Road.

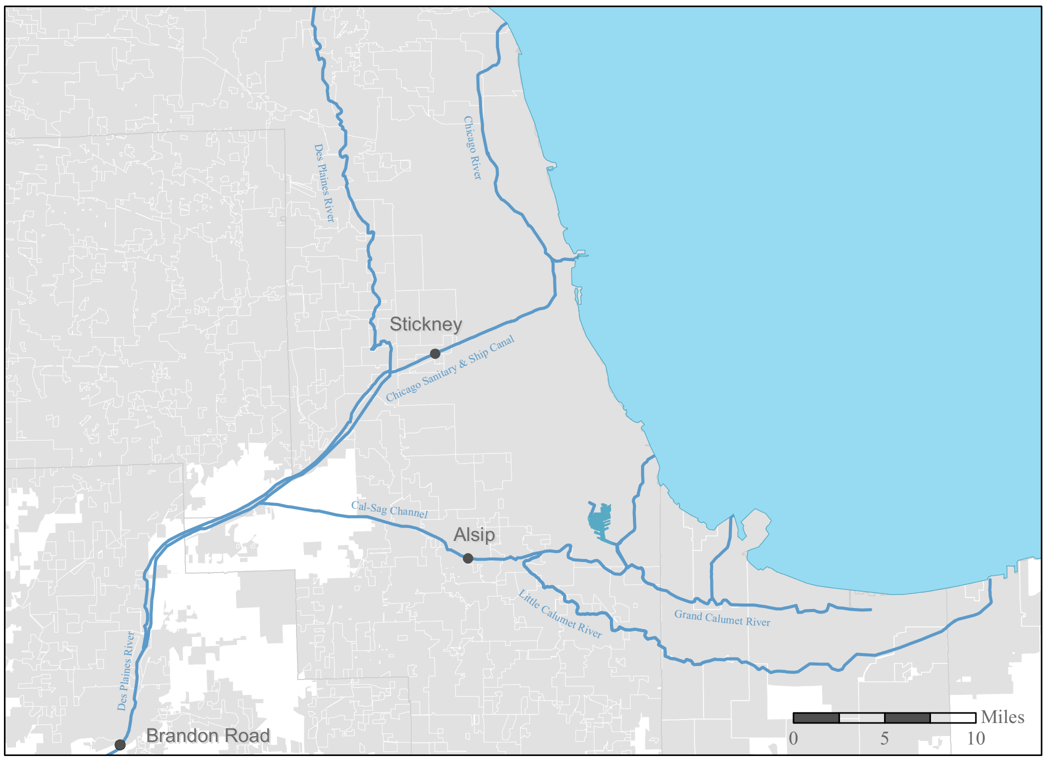
Control points at Stickney and Alsip would affect the flow of the CAWS. Under this scenario, portions of the CAWS on the west sides of Stickney and Alsip would continue to flow toward the Mississippi River basin while portions of the CAWS on the east side of Stickney and Alsip would flow toward Lake Michigan.

The O'Brien and Calumet WWTP effluent would be pumped via conveyance tunnel to discharge on the western sides of the Stickney and Alsip control points

16. At the time of this report, detailed cost estimates from the Brandon Road Tentatively Selected Plan (TSP) were not released, and it is not clear whether this total includes any contingencies. We contacted USACE and asked about cost contingencies in the Brandon Road TSP cost estimates, but did not receive a response.

respectively. A new Combined Sewer Overflow (CSO) tunnel would capture CSOs along the North Shore Channel and transfer them to the McCook reservoir where the overflows would be treated. Smaller WWTPs at Clavey Road, Deerfield, and Thorn Creek would be upgraded to meet Lake Michigan water quality standards.

FIGURE 8. Scenario 2 Control Point Locations



Source: Anderson Economic Group analysis of GLMRIS, HDR Summary of Technical Evaluations; base data from Esri, Inc.

This scenario would not significantly increase flood risk. Existing Tunnel and Reservoir Plan (TARP) plans could be modified to accommodate changes in flooding attributed to the new infrastructure.[17] This scenario would, however, lead to stagnant water flow in the CAWS, thus requiring the construction of flow augmentation systems. Sediment on the eastern side of the Alsip and Stickney control points would be remediated to prevent the flow of polluted sediment into Lake Michigan.

17. HDR, "Evaluation of Physical Separation Alternatives for the Great Lakes and Mississippi River Basins in the Chicago Area Waterway System: Technical Appendix Report to the Great Lakes Commission and the Great Lakes and St. Lawrence Cities Initiative," 2012.

We estimate this scenario would cost $5.4 billion and take 25 years to complete. Table 3 shows itemized cost estimates for this scenario.

TABLE 3. Cost Estimates for Scenario 2: Control Measures at Brandon Road, Stickney, and Alsip (millions)

	Item	Description	Estimated Cost		Source
1	Electric Barrier	Electric Barrier at Stickney	$	52	GLMRIS
2	Electric Barrier	Electric Barrier at Alsip	$	52	GLMRIS
3	Lock Improvement	Brandon Road Flusing Lock Conversion	$	247	Brandon Road TSP
4	Lock	Flushing Lock at Alsip	$	428	Brandon Road TSP
5	Lock	Flusing Lock at Stickney	$	428	GLMRIS
6	Sediment	Sediment Remediation lakeside of Stickney and Alsip control points	$	1,500	GLMRIS
7	Tunnel	WRP Outfall O'Brien - Stickney	$	956	Cost estimates provided by MWRD
8	Tunnel	WRP Outfall Calumet - Alsip	$	475	Cost estimates provided by MWRD
9	Tunnel	Conveyance Tunnel from North Shore to McCook	$	591	GLMRIS
10	WWTP Upgrade	Clavey Road WWTP upgrade	$	47	AEG professional judgment based on HDR estimates of Stickney and Alsip WWTP upgrade costs
11	WWTP Upgrade	Deerfield WWTP upgrade	$	9	AEG professional judgment based on HDR estimates of Stickney and Alsip WWTP upgrade costs
12	WWTP Upgrade	Thorn Creek WWTP upgrade	$	42	AEG professional judgment based on HDR estimates of Stickney and Alsip WWTP upgrade costs
13	Other	Flow Augmentation of South Branch of the Chicago River and Chicago Sanitary and Ship Canal	$	28	HDR Evaluation of Separation Alternatives Technical Appendix Report
14	Other	High-Speed CSO Treatment at McCook	$	-	No cost estimate not available
15	Other	Land acquisition	$	24	AEG professional judgment based on analysis of GLMRIS
16	Other	Planning, engineering and design	$	534	AEG professional judgment based on analysis of GLMRIS
		Total Cost:	$	5,413	

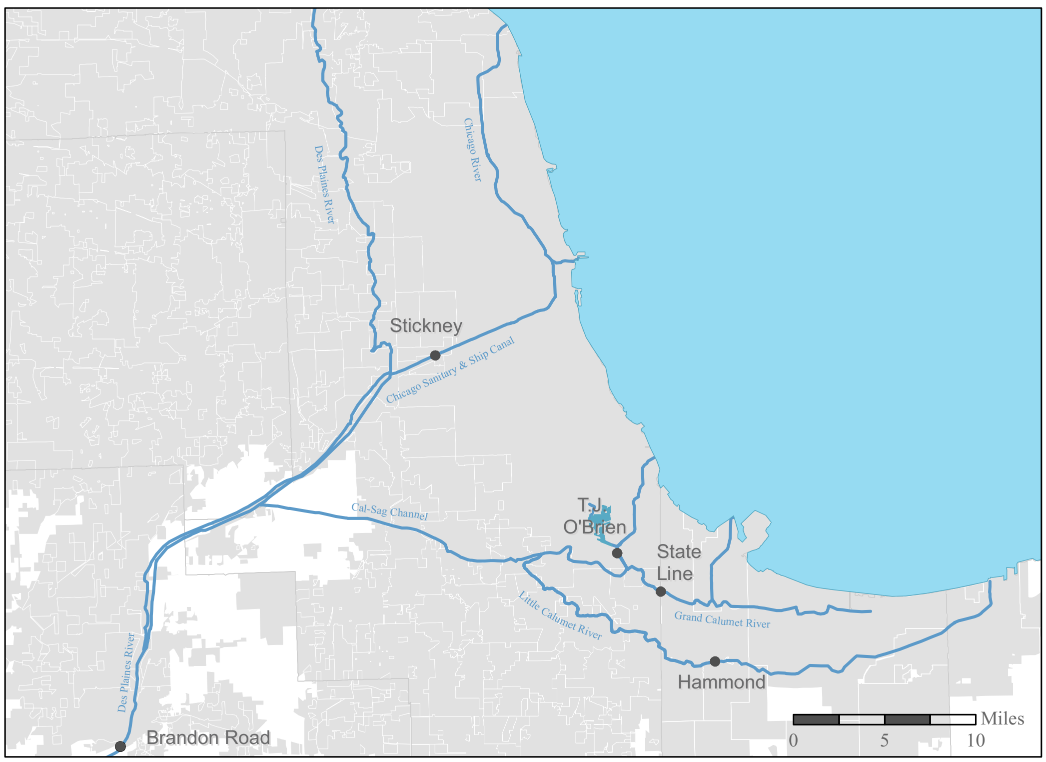
Scenario 3—Control measures at Brandon Road, Stickney, and T.J. O'Brien Lock and Dam

This scenario involves the construction of AIS flushing locks at Brandon Road and Stickney as previously outlined, along with an AIS flushing lock at T.J. O'Brien Lock and Dam in the Calumet River, and physical barriers in the Grand and Little Calumet Rivers at the Illinois/Indiana state line and in Hammond, Indiana, respectively.

This scenario would eliminate the need for an effluent conveyance tunnel for the Calumet WWTP, and would also eliminate the risk of spreading contaminated sediment into Lake Michigan via the Calumet River. The existing flow direction of the Calumet River would be maintained.

These control points would require construction of additional flood management infrastructure. A 300-million-gallon reservoir would be built at the Illinois/Indiana state line, and 4.4 billion gallons of storage capacity would be added at the Thornton reservoir. These reservoirs would be connected by tunnel. This scenario would have a minimal impact on water quality. Some flow augmentation would likely be required near Stickney, and in portions of the Grand and Little Calumet rivers. However, unlike scenario 2, in this scenario the southern portions of the CAWS would largely maintain their current water quality and flow.

FIGURE 9. Scenario 3 Control Point Locations



Source: Anderson Economic Group analysis of GLMRIS, HDR Summary of Technical Evaluations; base data from Esri, Inc.

We estimate that this scenario would cost $5.3 billion and take 25 years to complete. Table 4 on page 29 provides cost estimates for this scenario.

TABLE 4. Cost Estimates for Scenario 3: Control Measures at Brandon Road, Stickney, and T.J. O'Brien Lock and Dam, with Physical Barriers at State Line and Hammond (millions)

	Item	Description	Estimated Cost		Source
1	Electric Barrier	Electric Barrier at Stickney	$	52	GLMRIS
2	Electric Barrier	Electric Barrier at T.J. O'Brien	$	52	GLMRIS
3	Lock Improvement	Brandon Road Flusing Lock Conversion	$	247	Brandon Road TSP
4	Lock Improvement	T.J. O'Brien Flushing Lock Conversion	$	247	Brandon Road TSP
5	Lock Improvement	Sluice gate at T.J. O'Brien	$	25	GLMRIS
6	Lock	Flushing Lock at Stickney	$	428	GLMRIS
7	Barrier	Little Calumet River Physical Barrier	$	66	GLMRIS
8	Barrier	Hammond Physical Barrier	$	66	GLMRIS
9	Sediment	Sediment Remediation	$	743	GLMRIS
10	WWTP Upgrade	Clavey Road WWTP upgrade	$	47	AEG estimate based on HDR estimates of Stickney and Alsip WWTP upgrade costs
11	WWTP Upgrade	Deerfield WWTP upgrade	$	9	AEG estimate based on HDR estimates of Stickney and Alsip WWTP upgrade costs
12	Tunnel	WRP Outfall O'Brien - Stickney	$	956	Cost estimates provided by MWRD
13	Tunnel	North Shore-McCook Conveyance	$	591	GLMRIS
14	Tunnel	Conveyance Tunnel from Hammond to Thornton	$	187	GLMRIS
15	Reservoir	Thornton Reservoir	$	650	GLMRIS
16	Reservoir	State Line Reservoir	$	39	GLMRIS
17	Reservoir	Reservoir pump stations	$	287	GLMRIS
18	Other	Flow Augmentation of South Branch of the Chicago River and Chicago Sanitary and Ship Canal	$	28	HDR Evaluation of Separation Alternatives Technical Appendix Report
19	Other	Flow Augmentation of the Calumet and Little Calumet Rivers	$	62	HDR Evaluation of Separation Alternatives Technical Appendix Report
20	Other	High-Speed CSO Treatment at McCook	$	-	No cost estimate available
21	Other	Land acquisition	$	23	AEG estimate based on analysis of GLMRIS
22	Other	Planning, engineering and design	$	515	AEG estimate based on analysis of GLMRIS
		Total Cost:	$	5,320	

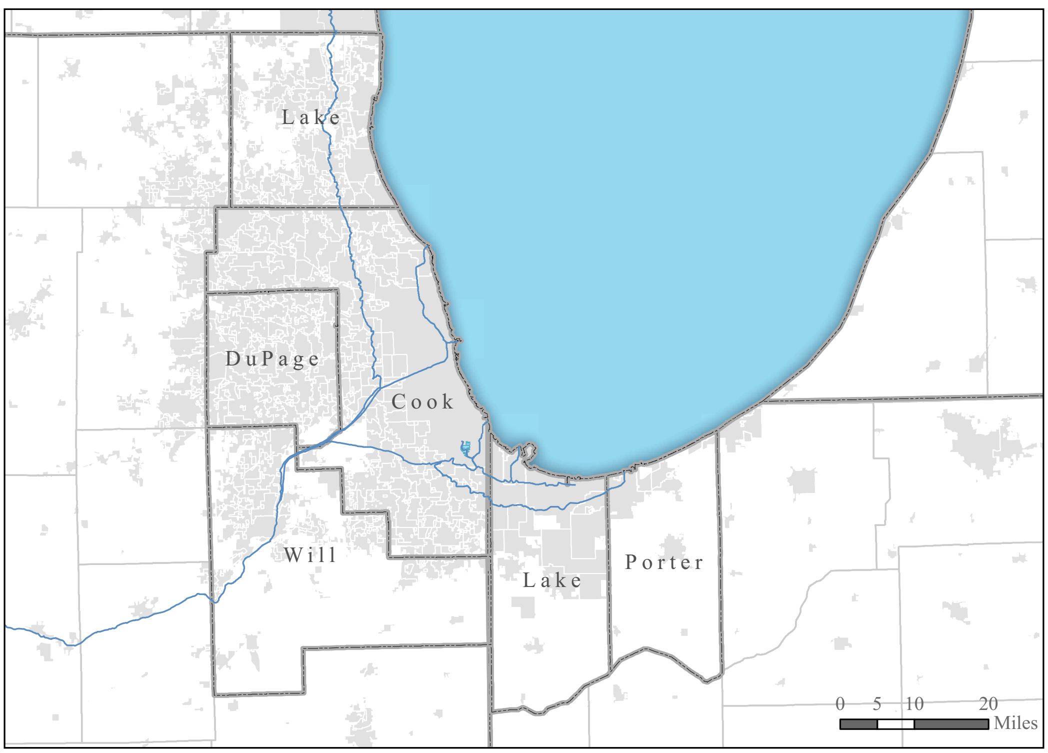
IV. Economic Impact of Infrastructure Projects

In this section, we discuss the regional economic impacts of constructing AIS infrastructure. Each scenario would make a measurable contribution to the region's economy, primarily due to an influx of federal funds in the region. We describe the various sources of economic impact and estimate their extent below.

LOCATION AND SOURCES OF ECONOMIC IMPACT

The net economic impact of each infrastructure scenario represents the total amount of economic activity that is caused directly and indirectly by construction activities in the Chicago region. We define the Chicago region as the counties of Lake, Cook, DuPage, and Will in Illinois, and Lake and Porter in Indiana, as shown in Figure 10.

FIGURE 10. Net Economic Impact Analysis Region



Source: Base data from Esri, Inc.

We measure the economic impact of these infrastructure projects in three ways: output, employment, and earnings. Output includes sales for local businesses.

Output and earnings are increased both directly and indirectly. Direct impacts include government spending on engineering, design, construction, and real estate. This spending will drive additional spending by each industry, creating an indirect economic impact. For example, after receiving payment for a project, a construction firm will spend a portion of this money on local goods and services needed to complete the project.

Employment is increased indirectly through hiring of project workers and workers in supporting industries. It is possible that these infrastructure scenarios would also have a direct impact on employment, with the government hiring employees to oversee the work; however, estimates for direct employment are not readily available, and we expect direct employment will be small relative to the overall impact of the project.

NET ECONOMIC IMPACT DEFINED

Our analysis accounts for the *net* economic impact of each scenario. A net economic impact analysis includes only the impact of spending and employment that would otherwise not occur in the region if AIS infrastructure were not built. In other words, our analysis does not include the impacts of AIS-related spending that will occur outside of the infrastructure projects, such as spending on continued commercial carp fishing or spending on previously planned upgrades to the Brandon Road electric fish barrier.

Our analysis also accounts for substitution. Substitution occurs if spending on an infrastructure project is offset by decreased spending elsewhere in the region, or if the spending in question would have occurred in the region without the project. For example, if the State of Illinois spends money on AIS infrastructure, it may choose to spend less on other infrastructure. Total spending in the region, less substitution, is referred to as “net new” spending.

The share of net new spending in the region varies depending on the source of project funding. It is possible, but, in our opinion, unlikely that federal spending on AIS infrastructure would lead to decreased federal spending elsewhere in the region; therefore, we count nearly all federal funding for AIS infrastructure as net new spending. If a portion of the project is funded by state or local governments, however, it is likely that state and local governments would decrease at least some of their spending on other projects in the region in order to pay for the new infrastructure. Furthermore, if a local government raises taxes in order to fund infrastructure, consumer spending may decrease, offsetting some economic impacts of local project spending.

We account for substitution in our model with “low” and “high” economic impact estimates in which varying amounts of project spending are counted as net new. In the low scenario, we assume that the federal government covers 65% of project costs, with 25% covered by state government, and 10% by local government. In the high scenario, we assume that 100% of project costs are covered by the federal government.

For a detailed description of how we arrived at our net new spending totals, see “Appendix A. Methodology” on page A-1.

ECONOMIC IMPACT RESULTS

The three infrastructure scenarios would take between 5 and 25 years to complete, with total project spending ranging from $275 million to $5.4 billion. Spending for scenario 1 is estimated to stay constant from the beginning of the project through completion, while spending on scenarios 2 and 3 would be low in early years and then increase considerably in later years.

Scenario 1—Brandon Road

The total project cost for scenario 1, which includes an AIS lock at Brandon Road, is estimated at $275 million. Under this scenario, project spending would remain constant at $55 million per year over five years, resulting in approximately the same impacts on output, employment, and earnings each year.

The project would have an annual impact between $77 and $105 million per year for five years and increase earnings between $23 and $31 million annually. The project would also create between 460 and 625 jobs annually through completion.

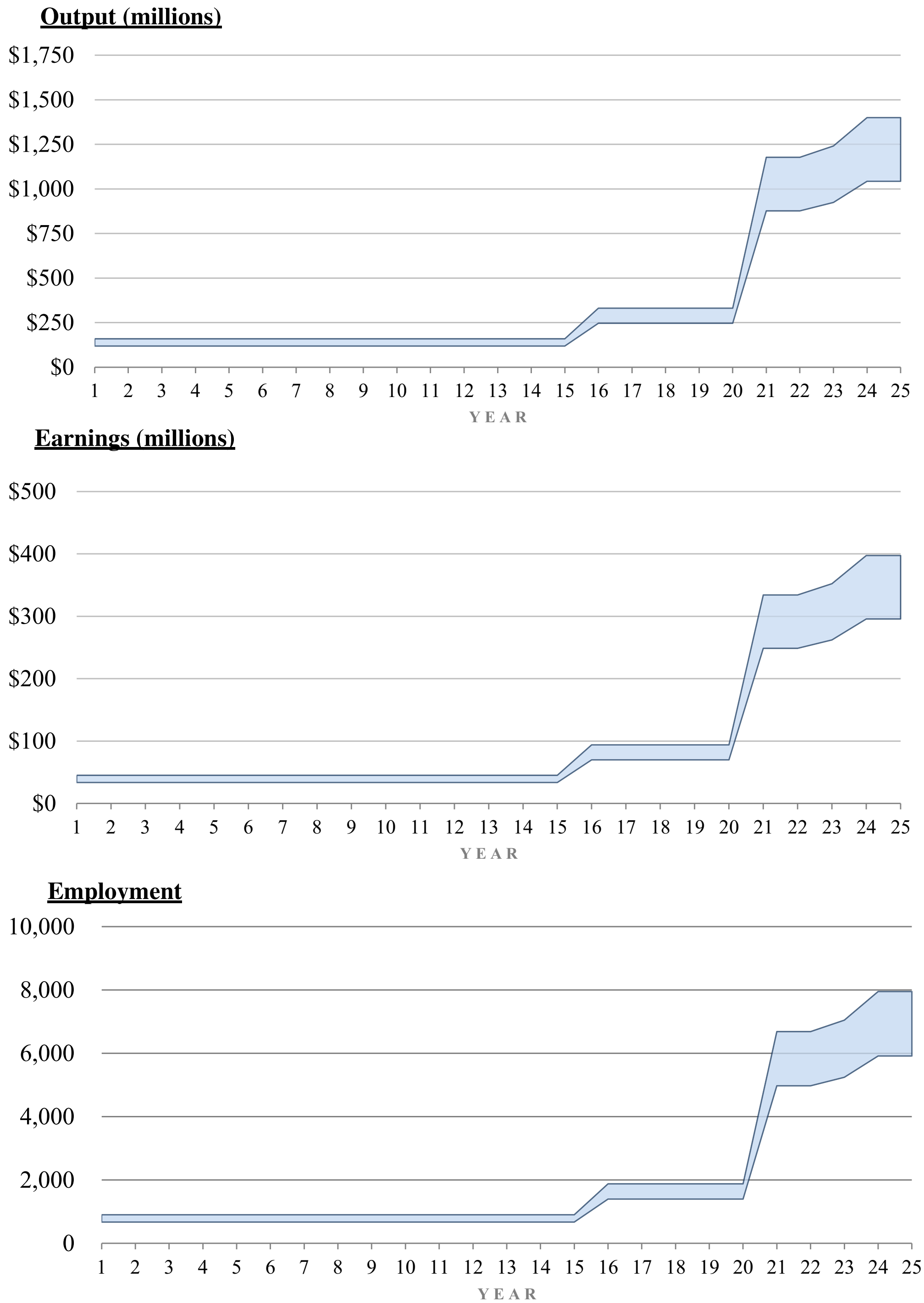
Scenario 2—Stickney and Alsip

Scenario 2 would be constructed over a 25-year time frame and have a total cost of $5.4 billion. Project spending would be relatively low for the first 15 years as conveyance and outfall tunnels would be constructed before other major elements. Project spending would then increase substantially during latter years as other components are built.

Approximately $82 million would be spent annually for the first 15 years of the project. This spending would have an annual economic impact between $118 and $160 million, with an annual increase in earnings between $34 and $45 million. During this period, the project would result in 670 to 900 jobs annually.

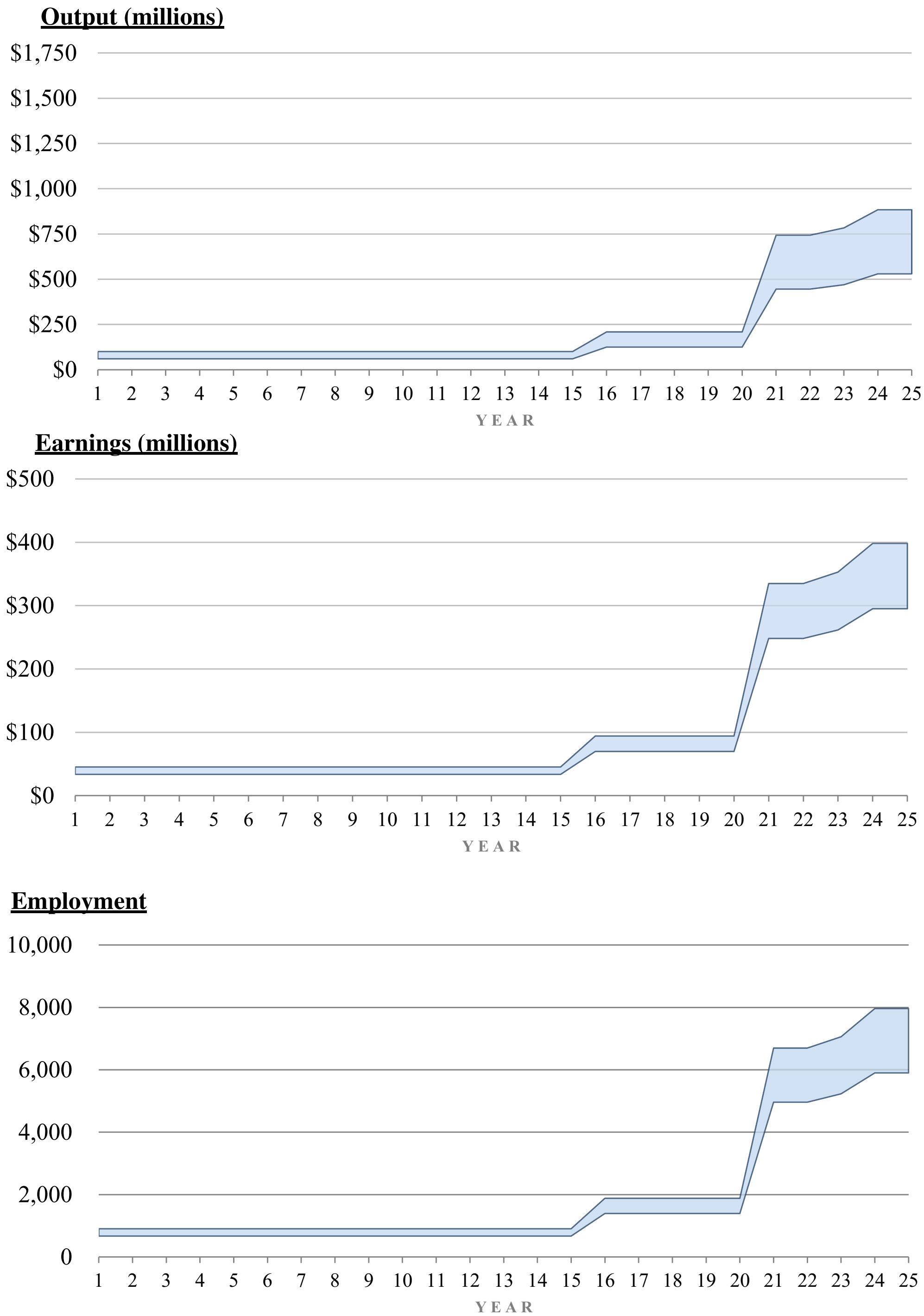
After 15 years, spending would increase significantly, and the economic impact would reach its peak in year 25, with an increase in regional output of $1.0 billion to $1.4 billion, and increased earnings of $300 to $400 million. By year 25, the project would support between 5,900 and 8,000 jobs in the region. Figure 11 on page 33 shows these impacts.

FIGURE 11. Chicago Region Increase in Annual Output, Earnings, and Employment from Scenario 2 AIS Infrastructure Projects



Source: Anderson Economic Group analysis of Army Corps of Engineers, HDR base data; U.S. Bureau of Economic Analysis RIMS II Multipliers.

FIGURE 12. Chicago Region Increase in Annual Output, Earnings, and Employment from Scenario 3 AIS Infrastructure Projects



Source: Anderson Economic Group analysis of Army Corps of Engineers, HDR base data; U.S. Bureau of Economic Analysis RIMS II Multipliers.

Scenario 3—Stickney and T.J. O'Brien

Scenario 3 would have a total cost of $5.3 billion—nearly the same as the cost for scenario 2. The project would be built over a 25-year period. Spending would be relatively low for the first 15 years as effluent and reservoir tunnels would be built first, followed by substantial increases in spending during latter years as other project components are built.

Approximately $81 million would be spent annually for the first 15 years of the project, resulting in an annual economic impact of $118 to $155 million. Earnings would increase by $34 to $45 million annually. Spending during the first 15 years would result in 670 to 900 jobs annually in the region.

The economic impacts of the project would reach their peak in year 25, with an increase in regional output of $1.0 billion to $1.4 billion, and increased earnings of $295 to $400 million. By year 25, the project would support between 13,000 and 17,000 jobs in the region. Figure 12 on page 34 shows these impacts.

Impacts from Ongoing Operations

The AIS infrastructure in each scenario would require ongoing operations and maintenance spending, which would have an economic impact on the region. We do not quantify these impacts in this report due to the uncertainty surrounding these costs, the number of employees required to operate and maintain the infrastructure, and how these costs would be shared among federal, state, and local governments. The GLMRIS report estimates that operations and maintenance costs for each GMLRIS scenario would range between $67 and $146 million per year.[18]

Building AIS infrastructure could also impact the cost of current mitigation efforts. In the short term, spending on monitoring and fishing could be increased during project construction to minimize the risk of interbasin transfer. After construction, the type of ongoing mitigation efforts could change, with spending on contract fishing or carp monitoring potentially decreasing

18. U.S. Army Corps of Engineers, "The GLMRIS Report: Great Lakes and Mississippi River Interbasin Study, Appendix K, Cost Engineering," 2014.

V.Flooding and Water Quality Impacts

Control points to separate the Great Lakes and Mississippi River basins, either at midsystem or at the lakefront, will drastically reshape the hydrological condition of the region. If implemented, sections of rivers in the CAWS will have altered flows, which could impact the flood risk of the surrounding areas and the quality of water in the system.

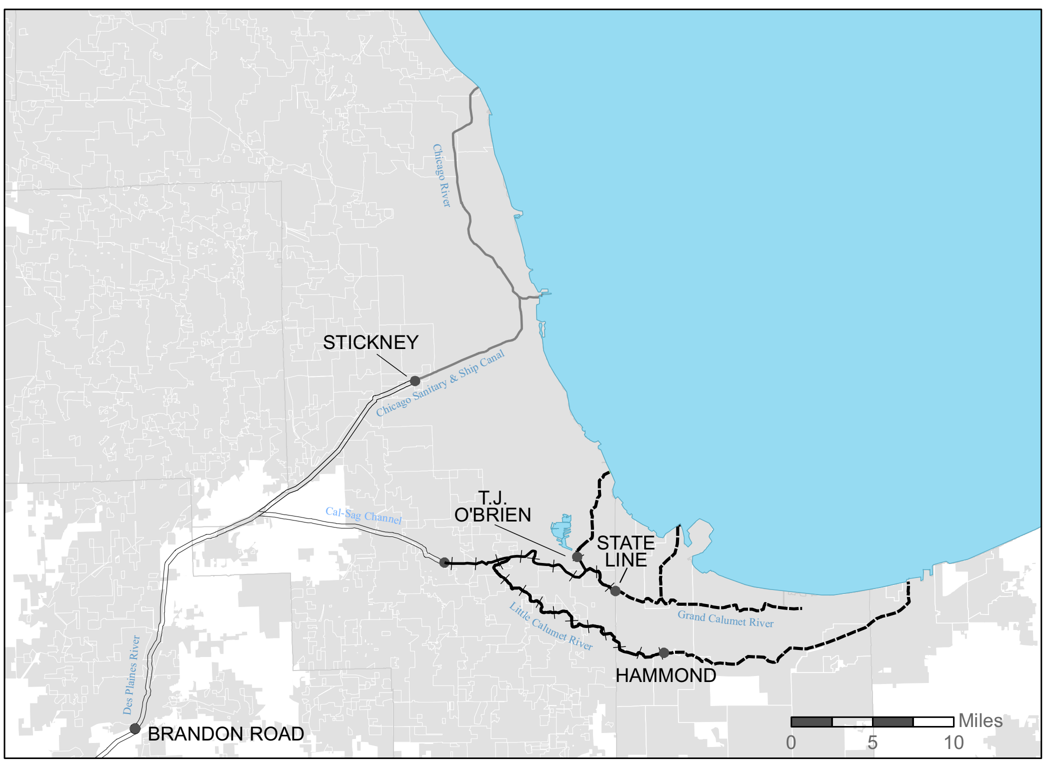
POTENTIAL IMPACT OF FLOODING

In this section we discuss the potential areas of concern for flooding, and the cost of flooding in the CAWS region.

Hydrological Changes

As discussed in “Control Point Location Considerations” on page 22, there are several different control scenarios, each with a different effect on the hydrological condition of the CAWS. Figure 13 below shows potential control point locations.

FIGURE 13. Proposed Control Points



Source: Anderson Economic Group analysis of GLMRIS, base data from Esri, Inc.

In scenario 1, the flow in all sections of the CAWS is unaffected. It is possible that the dam at Brandon Road might affect the rate at which water could flow from upstream waters. Based on our conversations with engineers, the lock would be designed in a way to open, if needed, to prevent flooding.

In scenario 2 the hashed, solid grey, and solid black sections of the CAWS in Figure 13 on page 36 would reverse direction. The hydrological changes resulting from the installation of control points is unlikely to result in flooding. However, the sections of the CAWS marked with a double line in the figure would experience a decreased flow of water, which could result in these sections of the waterway becoming stagnant.

In scenario 3 only the sections of water marked solid grey and black would reverse direction. This reversal would put the hashed and solid black marked sections of the CAWS at risk for increased flooding. In the case of the hashed sections, severe storms cause the rivers to reverse flow and discharge into the lake under current conditions. However, once the barriers are put in place, this water would no longer be allowed to flow back into Lake Michigan, and this could result in flooding in the surrounding area. In the case of the solid black sections in Figure 13, the barriers will prevent water in the Grand Calumet and Little Calumet Rivers from flowing towards the Mississippi River, and could result in overbank flooding in Northwest Indiana under certain circumstances.

Cost of Flooding in the CAWS

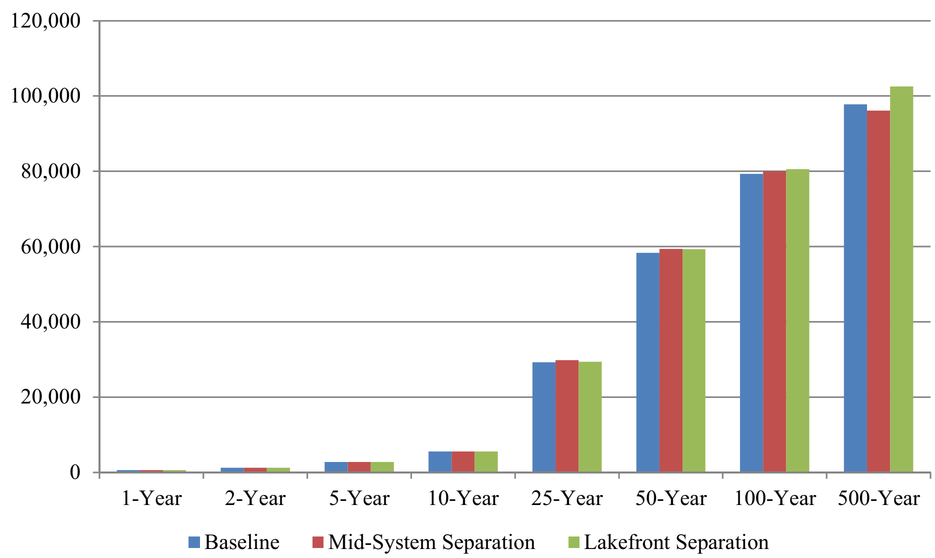
Flooding can cause damage in two ways: by rivers overrunning their banks (over bank floods) or by overloading sewer systems causing backups (sewer backups). Below we discuss how each of the three control point scenarios would affect flood risk and the potential damage resulting from the two sources of flooding. Using prior research on the cost of a flood per acre and USACE estimates of the increase in area that will flood under these control scenarios, we estimate the impact of additional flooding caused by the control scenarios.

Change in the Amount of Area at Risk of Flooding. Scenario 1 is unlikely to result in changes to the hydrological condition of the CAWS in a way that would alter the flood risk of nearby communities. Scenarios 2 and 3 include extensive improvements to the waste and stormwater sewer systems to mitigate the increased risk of over bank floods and sewer backups. The USACE and HDR reports suggest specific improvements necessary to prevent mass flooding. Below we detail the risk of these events in several communities surrounding the CAWS—Blue Island, Burnham, Calumet City, Chicago, Dolton, Evanston, Forest View, Harvey, Palos Hills, and South Holland.[19]

19. The USACE measures the increase in area that is at risk of flooding for several levels of rain events rather than the risk to specific buildings. The risk to each building would require extensive data for each structure.

If the TARP is completed to its full specification, neither scenario 2 or 3 separation will increase the amount of area at flood risk by more than 5% for any level of storm event. For all but 500-year storm events, the resulting increase would be less than 2%. Note that, for scenario 3, this result includes significant investments in reservoir expansion, conveyance tunnels, and pumps. For community level data on the amount of area at flood risk, see “Acreage at Risk for Flooding by Community Under Mid-System and Lakefront Separation” on page C-9.

FIGURE 14. Acres at Risk of Flooding in CAWS Areas Under Scenario 2 and 3 Separation Scenarios



Source: U.S. Army Corps of Engineers GLMRIS Report, Appendix D.

As this figure shows, the number of acres that will flood for a given storm event is unchanged for rain events with a greater-than-10% chance of occurring in any given year. For a 100-year storm, which indicates a level of rainfall that has a 1% chance of occurring each year, 79,000 acres are expected to flood under current conditions, while 80,000 acres would flood if scenario 2 separation is implemented and 80,600 acres would flood if scenario 3 separation is implemented.

Cost of a Flood in the CAWS. The Center for Neighborhood Technology (CNT) issued a report in 2014 on urban flooding, using Cook County as a case study. CNT found that 181,000 flood insurance claims were made by Cook County residents between 2007 and 2011. These claims were made across 97% of zip codes in the county. The zip codes with the highest concentration of payouts had no land area within federally designated floodplains, suggesting basement backups are a more common source of flood damage in Cook County. The claims totaled $773 million, with an average payout of $4,272.

The National Weather Service keeps data on significant flooding events. Table 5 below details the significant floods in the area since 1992.

TABLE 5. Significant Illinois Floods, designated by the National Weather Service

Flood Name	Location Impacted	No. of Fatalities	No. of Injuries	Value of Damage
Summer 1993 Flood	Upper Midwest, across 9 states	50	Unknown	$20 billion
July 1996 Flash Flood	Northeast Illinois	2	Unknown	--
June 2008 Flood	Upper Midwest, across 5 states	Unknown	Unknown	Unknown
Spring 2011 Middle & Lower Mississippi River Valley Floods	Most of southern Illinois	0	Unknown	$8 million
April 2013 Record Des Plaines and Illinois River Flood	Areas along the Des Plaines and Illinois Rivers	1	Unknown	$375 million

Source: National Weather Service: Flooding In Illinois, http://www.floodsafety.noaa.gov/states/il-flood.shtml, last accessed 4/5/2017.

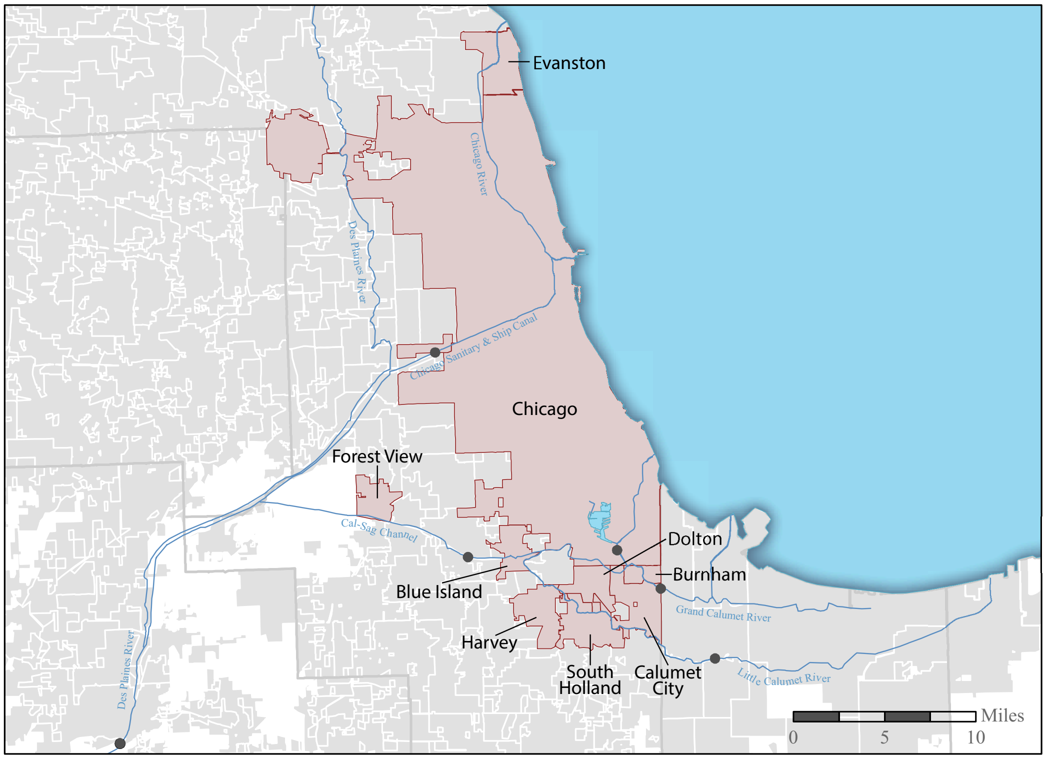
In addition to homeowner property damage, these storms shut down numerous roads and bridges, resulting in additional unknown economic costs due to a variety of factors.

Economic Impact of Increased Flooding in the CAWS

Property damage from flooding results in higher costs for households in the area. Due to limitations in available estimates for flood risk, we were only able to estimate the impact of flooding in Cook County, Dupage, Lake, and Will Counties. Flooding in DuPage, Lake, and Will Counties in Illinois is not expected to increase because no rivers in those counties will reverse flow under any of the proposed control point scenarios.

Based on expected hydrological changes, Lake and Porter Counties in Indiana may experience additional flooding under scenarios 2 and 3. However, because we did not have any data on the extent of area that would be impacted we were unable to estimate the economic impact of any potential flooding. Figure 15 on page 40 shows the study area.

FIGURE 15. Flooding Impact Study Area



Source: U.S. Army Corps of Engineers GLMRIS Report, Appendix E, base data from Esri, Inc.

If all planned infrastructure is completed, we estimate that scenario 2 would cost residents $692,000 annually, while scenario 3 will cost residents $704,000 annually. These costs will take the form of additional insurance premiums, insurance deductibles, and other spending after a flood that may not be covered by insurance.[20] For our methodology, see "Flooding Impact" on page A-4.

The additional costs of increased flooding will have a negative impact on residents, who may be forced to make purchases they otherwise would not have if there was no increase in flooding. We estimate that much of the spending on flood remediation will occur in the region, with residents purchasing local services, such as cleaning and construction. If residents spend more of their money in the region because of a flood event, the flooding would actually result in a positive economic impact on the regional economy due to an increase in local spending. It is important to note that, although the economic impact may be pos-

20. Property owners that do not have insurance may see costs beyond $4,272 per incident. We were unable to find cost estimates for flood remediation for units without flood insurance, therefore we use the $4,272 number as a baseline for our estimates.

itive, much of the impact constitutes a wealth transfer between residents and businesses in the region, with businesses benefitting from resident losses. Although the impact is positive, increased flooding should not be considered beneficial to the economy.

The positive economic impact of flooding highlights the differences between a cost-benefit analysis and an economic impact analysis. In this circumstance, additional compulsory costs to residents of the region result in more local spending, and therefore have a positive net economic impact. Table 6 shows the economic impact to the region for a single flooded home.

TABLE 6. Economic Impact of a Flooded Home

Category	Dollar Amount
Average Cost of a Flood per Household	*$4,272*
Economic Impact on Output Due to Flood Remediation Spending	$7,263
Economic Impact on Output Due to Lower Household Spending on Other Goods and Services	-$5,578
Net Economic Impact of a Flooded Home	$1,685

Source: AEG Analysis using base data from the American Community Survey, Center for Neighborhood Technology, U.S. Bureau of Economic Analysis RIMS II Multipliers.

Because the control points will increase flooding for larger rain events, we estimate that the additional flooding will have an annual economic impact between $274,000 and $277,000 due to increased spending on post-flood purchases. This estimate accounts for spending that households cannot make on other goods and services due to the increased costs of flooding

As indicated in Table 7 on page 42, a 100-year storm event—which has a 1% chance of occurring in a given year—will increase the number of homes in Cook County that will flood by 2,483 structures if scenario 2 is implemented. An additional 2,523 structures will flood if scenario 3 is implemented. This will result in households incurring $10.6 million and $10.8 million, respectively, in additional costs to recover from flooding. However, this cost to households is also the amount spent on goods and services after a flood, resulting in a positive economic impact of $4.2 million to $4.3 million, and the creation of 17 new jobs.

TABLE 7. Economic Impact of Flooding due to Installation of Control Points for Each Storm Event (dollar amounts in thousands)

Storm Event	Additional Flooded Homes	Additional Cost of Flooding to Households	Output	Earnings	Employment
Scenario 2					
25-Year	1,840	-$7,861	$3,100	$956	13
50-Year	3,777	-$16,135	$6,363	$1,961	26
100-Year	2,483	-$10,609	$4,184	$1,290	17
500-Year	-6,049	$25,843	-$10,192	-$3,141	-41
Average Annual Cost	**163**	**-$692**	**$274**	**$85**	**1**
Scenario 3					
25-Year	1,905	-$8,136	$3,209	$989	13
50-Year	3,859	-$16,486	$6,502	$2,004	26
100-Year	2,523	-$10,777	$4,250	$1,310	17
500-Year	-6,049	$29,354	-$11,577	-$3,568	-47
Average Annual Cost	**165**	**-$704**	**$277**	**$86**	**1**

Source: AEG analysis using GLIMRIS Report, American Community Survey, Center for Neighborhood Technology, U.S. Bureau of Economic Analysis RIMS II Multipliers.

POTENTIAL IMPACT ON WATER QUALITY

If control points are established in the CAWS, some sections of the waterways will reverse direction and flow into Lake Michigan. Substantial infrastructure investments will need to be made in order to raise the water quality of these waterways such that they can meet the quality standards of Lake Michigan. The cleaner water will provide additional recreational and aesthetic benefits for local residents that would in turn have an economic effect.

Impacted Waterways & Quality Standards

Scenario 1, in which a control point is established at Brandon Road, does not alter the flow of water in the CAWS to a degree that will impact water quality.

Between the remaining two scenarios, scenario 2 would require more extensive water quality treatment infrastructure to prevent water quality degradation in Lake Michigan. Scenario 3 would present a lower adverse impact on water quality, requiring less treatment.

The waterways are governed by multiple environmental standards, split by particular points in the water. The installation of control points would result in further divides and change the standards for some portions of the CAWS.

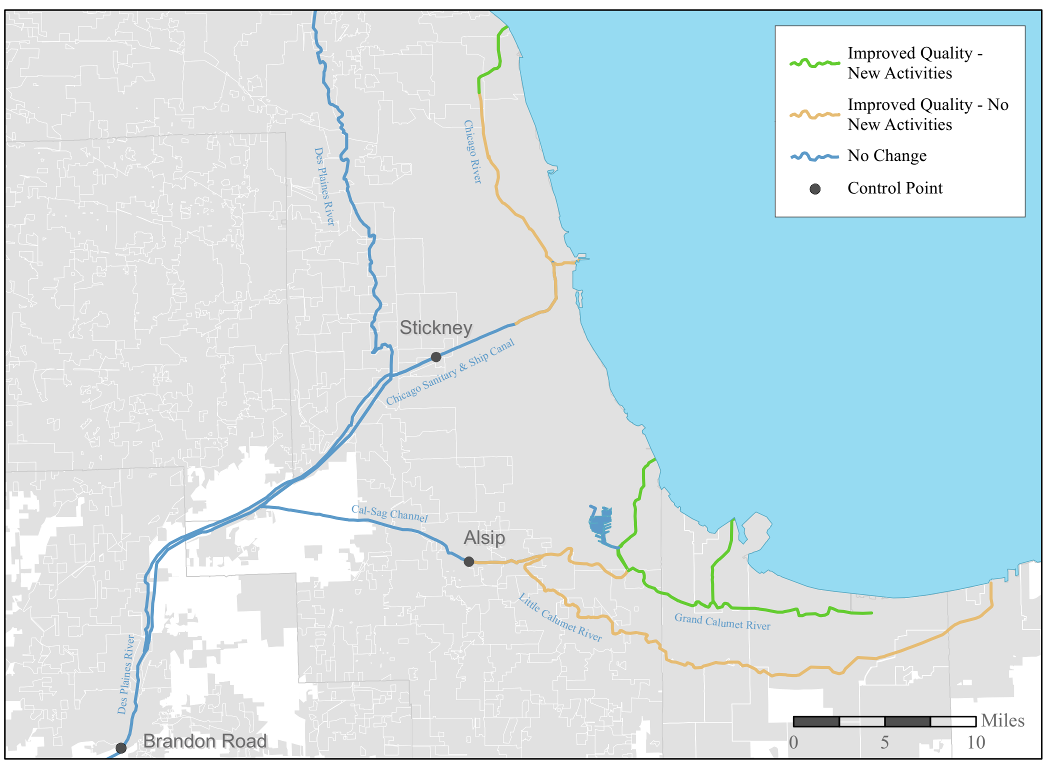
Figure 16 below presents the definitions for waters with an “upper” and “lower” division.The standards for life use, contact, and water quality are governed by the General Assembly’s Illinois Administrative Code, Title 35, Subtitle C, Chapter I, Part 302.

FIGURE 16. Definitions of Waterways in the CAWS

Body of Water	Upper Region	Lower Region
North Shore Channel	Lake Michigan to O'Brien Water Treatment Plant	O'Brien Water Treatment Plant to Chicago River
Des Plaines River	Sanitary and Ship Canal to Brandon Road Lock	Brandon Road Lock to I-55 Bridge
Sanitary and Ship Canal	Chicago River to Cal-Sag Channel	Cal-Sag Channel to Des Plaines River
Cal-Sag Channel*	Sanitary and Ship Canal to proposed Alsip Lock	Proposed Alsip Lock to Little Calumet River
Grand Calumet River**	Cal-Sag Channel to proposed IL-IN State Line Lock	East of proposed IL-IN State Line Lock
Little Calumet River**	Cal-Sag Channel to proposed IL-IN State Line Lock	East of proposed Hammond Lock

*Division only applicable to scenario 3
**Division only applicable to scenario 4

FIGURE 17. Scenario 2 Water Quality Impacts

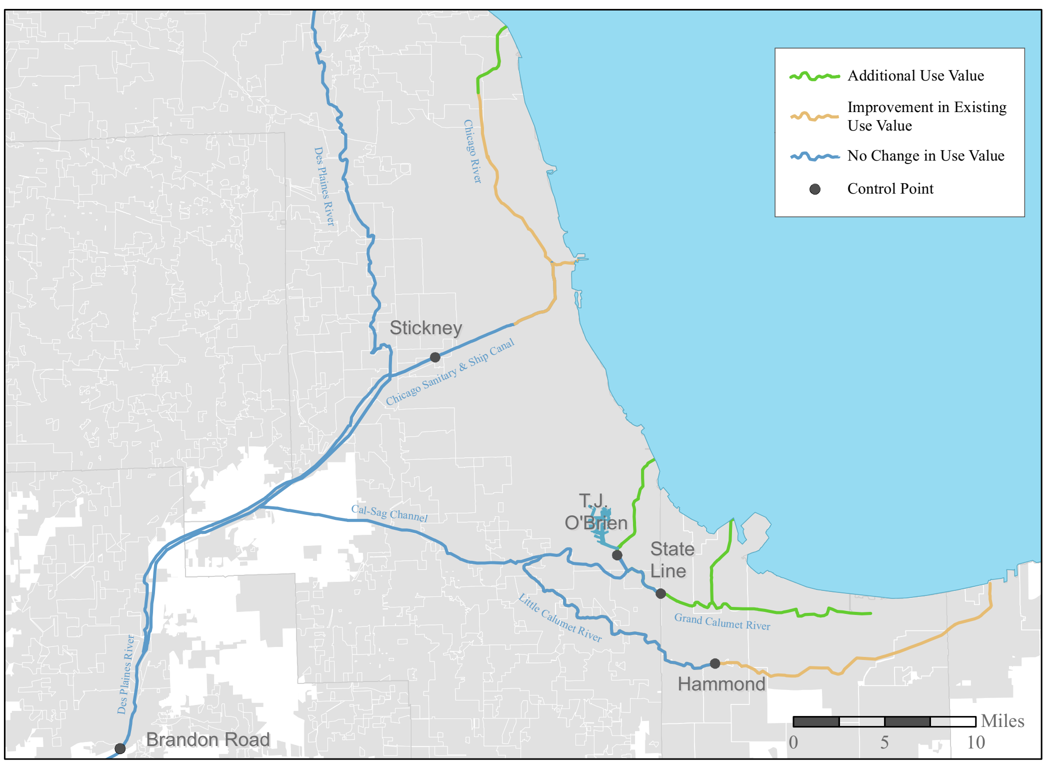


Source: Anderson Economic Group, based on Illinois statute on water quality standards, base data from Esri, Inc.

To measure the economic impact of water quality, we compare the standards that are currently applied to each section of the CAWS, and the new standard that would be applied after some sections are reversed. We determine if application of the new standard would result in new recreational opportunities or reduction in illness. In Figure 17 on page 43 and Figure 18 below, we show changes in how residents would be able to use these local waters.

As Figure 17 shows, the Chicago River, the North Shore Channel below the O'Brien water treatment plant, the Cal-Sag Channel below the proposed Alsip lock, the Calumet River, the Grand Calumet River, and the Little Calumet River below the proposed Hammond lock would be governed by a higher water quality standard in Scenario 2. This means that residents would be able to swim, in addition to boat, on the upper North Shore Channel, the Calumet River, and the Grand Calumet River. In addition, residents who currently use the Chicago River and Little Calumet River will incur fewer illnesses due to the cleaner water (those waterways are already required to meet standards for swimming).

FIGURE 18. Scenario 3 Water Quality Impacts



Source: Anderson Economic Group, based on Illinois statute on water quality standards, base data from Esri, Inc.

If the two watersheds are separated using the separation described in scenario 3, the Chicago River, the North Shore Channel below the O'Brien treatment plant, and the Little Calumet River below the proposed Hammond lock would see water quality improvements that might enhance their value to current users. People who boat or swim on these waters are less likely to get sick from their recreation on the water. The Bubbly Creek section of the Chicago River, the North Shore Channel above the O'Brien treatment plant, the Calumet River, and the Grand Calumet River below the lock located at the Illinois/Indiana state line would see water quality improvements enough so that residents would be able use the water for new recreational opportunities, such as swimming.

Economic Impact of Water Quality Improvements

These changes in water quality would result in two potential benefits. First, residents can use the waterways for additional activities or use them with less risk of illness. Second, improved quality of life if the water looks or smells better, producing additional value for nearby residents, businesses, and users. The existing research on the benefits of recreational use of water is not substantial enough to allow us to quantify the precise economic impact of the water quality improvement due to the control measures implemented.

A study on the changes in water quality of the Monongahela River in Pittsburgh showed that users who were boating on the river valued the additional capacity to swim on the river between $27 and $133 per user.[21] This suggests that there is some latent demand for swimming activities on CAWS waters that are currently designated only for incidental contact. However, we are unable to estimate how many users there might be, and therefore unable to quantify the total benefit of these changes in water quality.

Health benefits of improved water quality. In addition to the benefits gained by users who can now swim in new areas of the CAWS, people who already use the water are less likely to get sick from their usage. The MWRD and University of Illinois at Chicago (UIC) studied the cost of illness from use of the Chicago River and Lake Michigan. They found that the cost of gastrointestinal illness was $1,220 per 1,000 users.[22] Nearly all of the cost of illness is due to a loss in productivity. The Illinois Economic Policy Institute and the University of Illinois issued a report claiming that a $1 billion investment in clean water infra-

21. William Desvousges, Kerry Smith, and Matthew McGivney, "A Comparison of Alternative Approaches for Estimating Recreation and Related Benefits of Water Quality Improvements," *EPA Reference No. W.83.6, Washington, DC: Office of Policy Analysis*, 1983.

22. Stephanie DeFlorio-Barker, Timmothy Wade, Rachael Jones, Lee Friedman, Coady Wing, and Samuel Dorevitch, "Estimated Costs of Sporadic Gastrointestinal Illness Associated with Surface Water Recreation: A Combined Analysis of Data from NEEAR and CHEERS studies," *Environmental Health Perspectives*, 125, no. 2 (2017): 215-222.

structure in the Chicago area would result in $184 per capita in improved health.[23]

However, these per-user costs are only realized by users of waters already designated for primary contact (swimming). The MWRD/UIC study also found that waters designated for incidental contact (boating) had the same rate of gastrointestinal illness as waters designated for primary contact because users of primary contact waters received much higher exposure to the water.[24] As a result, net reductions in illness will only occur as those portions of the waterway already designated for primary contact become cleaner. Changing from an incidental contact standard to a primary contact standard does not result in a net reduction in illness.

Perceptions of water quality. Furthermore, any benefits are likely to be small as perception of the water may take some time to change and people remain unlikely to use the water for certain types of recreation in the short term. For example, the Chicago River has been designated for primary contact since at least 2014 and recreational use beyond incidental contact recreation remains nearly non-existent.[25] Therefore, the near term benefits from improved use and aesthetic value would be very small in relation to the other costs and benefits considered in this report, but these improvements could lay the groundwork for a fundamental change in the way that residents use the river in the distant future.

23. Frank Manzo IV and Robert Bruno, "A Flowing Economy," 2015.

24. Samuel Dorevitch, Preethi Pratap, Meredith Wroblewski, and Peter Scheff, "Health Risks of Limited-Contact Water Recreation," *Environmental Health Perspectives*, 120, no. 2 (2012) 192-197.

25. Dale Bowman, "Swimming the Chicago River: Coming much sooner rather than later," *Chicago Sun-Times*, March 10, 2017.

VI.Impact of Asian Carp on Industries in the Chicago Region

In this section, we describe potential Chicago-region industries that could be affected by the establishment of Asian carp in the Great Lakes. We then estimate the scale and economic footprint of these industries in the region. We measure the total size of these industries, but due to uncertainty about carp impacts, we do not quantify the extent to which they could be impacted by Asian carp.

POTENTIAL INDUSTRIES AFFECTED BY ASIAN CARP

Informed by a review of existing research, we have identified that the following activities could be negatively affected by the establishment of Asian carp in the Great Lakes:

- Recreational fishing;
- Commercial fishing;
- Recreational boating;
- Water-related tourism; and
- Supported industries.

We describe these industries further below. See “Potential Industries Affected by Asian Carp” on page A-6 for a discussion of our review of the research.

Recreational Fishing

Certain species of Asian carp, such as silver carp and bighead carp, could potentially outcompete recreationally significant fish species in the Great Lakes basin and the Chicago River. Businesses in the recreational fishing industry include:

- Fishing equipment supplies establishments, such as bait and tackle shops;
- Recreational fishing watercraft rental establishments;
- Boat dealers for recreational fishing; and
- Providers of charter and guided fishing trips.

Commercial Fishing

Certain species of Asian carp, such as silver carp and bighead carp, could potentially outcompete commercially significant fish species in the Great Lakes basin, such as trout, sturgeon, and whitefish. If so, these Asian carp species would not replace the value of the species they outcompete because Asian carp has little commercial value. The commercial fishing industry consists of commercial fisheries that catch fish in the Great Lakes.

Recreational Boating

Silver carp, unlike other species such as black carp and bighead carp, jump from the water, particularly in response to boat motors. There have been numerous reports of injuries to boaters due to leaping silver carp, including cuts from fins, black eyes, broken bones, neck and back injuries, and concussions.[26] The risk of injury could discourage recreational boating in the Great Lakes, Chicago River, and connected waterways. Businesses in the recreational boating industry include:

- Boat dealers and rentals for recreational fishing;
- Boat clubs; and
- Marinas and yacht clubs.

Water-related Tourism

The risk of injury due to silver carp could also discourage water-related tourism in the Chicago region, such as boat tours along the Chicago River and Lake Michigan shoreline.

Supported Industries

Several businesses are supported by activity in the potentially-affected industries listed above. During fishing and boating trips, anglers and boaters, respectively, go out to eat, stay in local lodging, and fuel their vehicles and boats. Local establishments that rely on this business could be affected if there are declines in recreational fishing and boating activity. These establishments are in industries such as:

- Accommodations, such as campgrounds, RV parks, and motels;
- Grocery stores;
- Restaurants;
- Gas stations;
- Recreation and entertainment;
- Other retail stores;
- Producers of retail goods;
- Wholesale distributors; and
- Transportation of wholesale goods.

26. *Hypophthalmichthys molitrix* USGS Nonindigenous Aquatic Species Database, Gainesville, FL, and NOAA Great Lakes Aquatic Nonindigenous Species Information System, Ann Arbor, MI, December 12, 2012, https://nas.er.usgs.gov/queries/greatlakes/FactSheet.aspx?SpeciesID=7&Potential=Y&Type=2&HUCNumber=

POTENTIAL IMPACT OF ASIAN CARP ON CHICAGO REGION INDUSTRIES

As we discussed in “Interbasin Exchange of Asian Carp” on page 18, existing research is inconclusive on the extent of the impact of Asian carp should they reach the Great Lakes basin. Based on the information available at this time, it is impossible to predict the impact of Asian carp on the Chicago region.

The recently-published Brandon Road Tentatively Selected Plan report by the USACE evaluated the potential impact of Asian carp in Lake Erie based on several possible scenarios.[27] The study found that Asian carp would have a positive impact on commercial and recreational fishing under all scenarios except for those in which Asian carp feed on fish larvae.

These results highlight the uncertainty surrounding the economic impact of Asian carp. Further, the study excluded from the scope evaluating the impact of Asian carp on other Great Lakes due to limited ecological modeling data. The study’s findings may not necessarily translate to the potential impacts on Lake Michigan, which are most applicable to the Chicago region. Lake Erie is unique, since it is further south and the shallowest and warmest of the Great Lakes.

SCALE OF AFFECTED INDUSTRIES IN THE CHICAGO REGION

We have estimated the employment and sales volume of a select set of potential establishments that could be affected by Asian carp:

- Bait and tackle shops;
- Charter fishing;
- Boat dealers;
- Boating clubs;
- Marinas and yacht clubs;
- Tour operators; and
- RV parks and campgrounds.

Our estimates for the scale of the industries that could be affected by Asian carp are conservative, as they do not represent all of the types of establishments identified in “Potential Industries Affected by Asian Carp” on page 47.[28] Data sources we relied on did not indicate the presence of commercial fishing establishments in the Chicago region.

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27. U.S. Army Corps of Engineers, “The Great Lakes and Mississippi River Interbasin Study—Brandon Road Draft Integrated Feasibility Study and Environmental Impact Statement, Will County, Illinois,” U.S. Army Corps of Engineers, August 2017; and

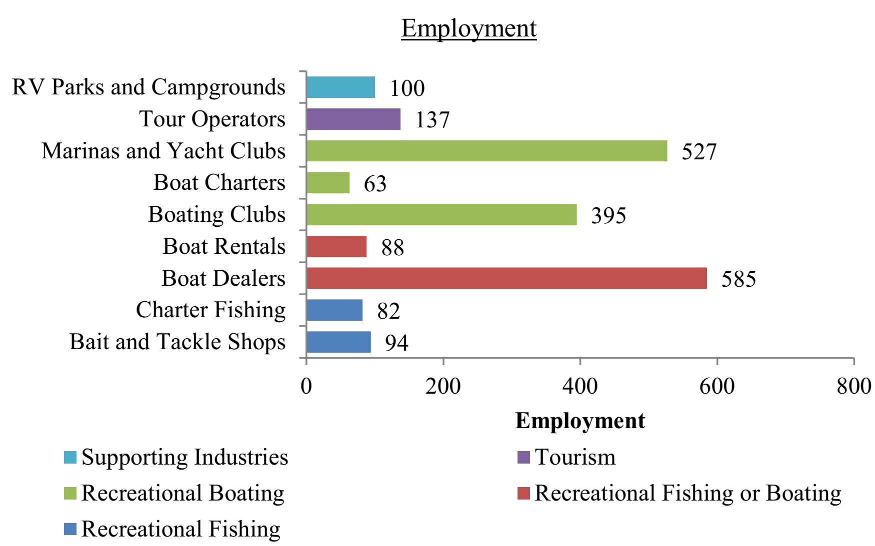
    U.S. Army Corps of Engineers, “GLMRIS—Brandon Road: Appendix D-Economic Analyses,” U.S. Army Corps of Engineers, August 2017.

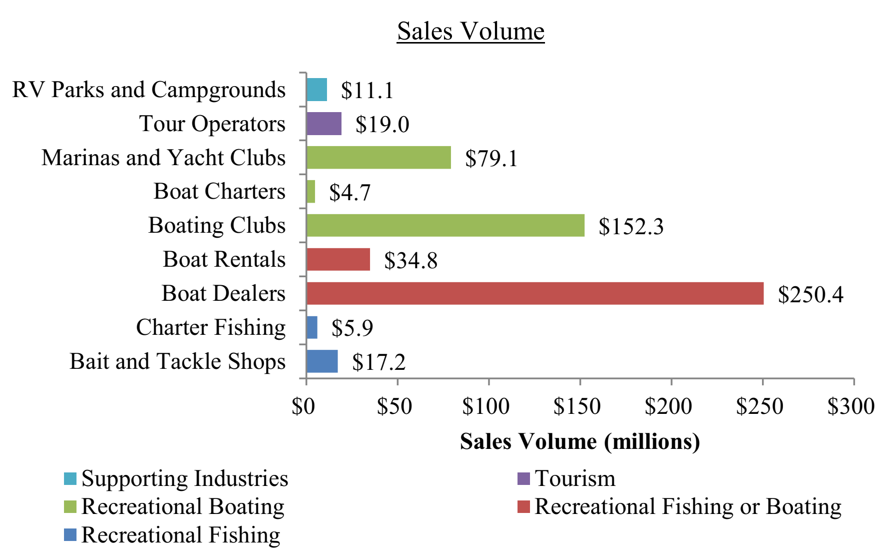
    See “Potential Industries Affected by Asian Carp” on page A-6.

28. We excluded several supported industries such as grocery stores, restaurants, and gas stations since the majority of the business for these establishments in the Chicago area are not supported by recreational fishing and boating.

As shown in Figure 19 below, we estimate that employment in these industries in the Chicago region totals nearly 2,100 jobs, with 89% of employment in recreational fishing and boating. In particular, boat dealers support the highest number of jobs. The sales volume of establishments in these industries is over $574 million, with 95% of those sales in recreational fishing and boating. Boat dealers also garner the highest volume of sales out of these industries. See "Potential Industries Affected by Asian Carp" on page A-6 for our methodology.

FIGURE 19. Potential Chicago-Region Industries Affected by Asian Carp





Source: AEG analysis using base data from Esri, Inc.

ECONOMIC FOOTPRINT OF AFFECTED INDUSTRIES IN THE CHICAGO REGION

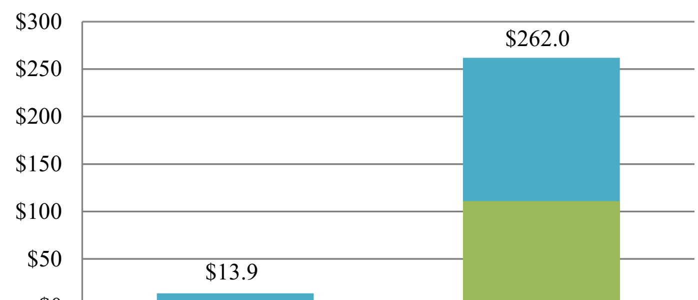
In this section, we show the economic footprint in the Chicago region of recreational fishing and recreational boating, as well as the industries supported by these activities. The economic footprint accounts for both direct and indirect effects. Direct effects account for the direct spending by anglers and boaters who support these industries. Indirect effects account for the output, earnings and employment supported by the circulation of spending throughout the Chicago region.

Note that "economic footprint" differs from "net economic impact" in that we analyze the influence of an entire industry rather than the impact of a marginal change in spending. See "Economic Footprint in the Chicago Region" on page A-9 for a discussion of our methodology.

Angler and Boater Spending

To estimate the economic footprint of these industries, we estimated the amount of angler and boater spending that remained in the Chicago region. We account for the fact that some spending occurs outside of the region. For example, a significant portion of the purchase cost of boats supports boat manufacturers—which are likely located outside of the region—rather than boat dealers located in Chicago region. These producer costs, as well as any other costs that support businesses outside of the region, are excluded from our spending estimates.

FIGURE 20. **Annual Spending for Recreational Fishing and Recreational Boating in the Chicago Region (millions)**



	Angler Spending*	Boater Spending
Supported Industries	$7.8	$151.1
Recreational Boating	$0.0	$110.9
Recreational Fishing	$6.1	$0.0
Total	$13.9	$262.0

Source: AEG analysis using base data from the Illinois Department of Natural Resources; Indiana Department of Natural Resources; U.S. Army Corps of Engineers; Ready, et al; and U.S. Bureau of Labor Statistics.

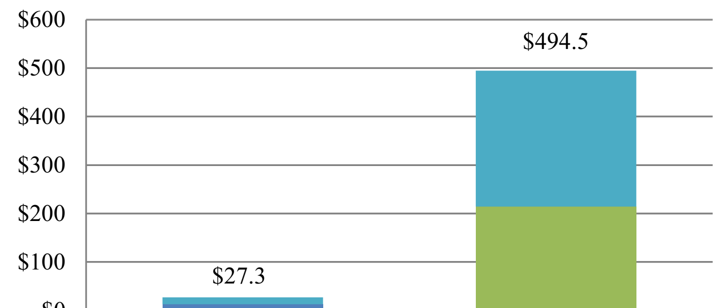
**Angler spending reflects fishing activity in the Illinois portion of Lake Michigan and in the Indiana portion of Lake Michigan and Indiana inland waterways. It excludes fishing activity in Illinois inland waterways due to data availability.*

Figure 20 on page 51 presents a breakdown of this spending for recreational fishing, recreational boating, and supported industries. We estimate that $262 million of angler spending remains in the Chicago region annually and that $14 million of boater spending remains in the region. For both anglers and boaters, spending in supported industries—such as accommodations, restaurants, and gas stations—make up over half of the total spending.

Output Effects

As we show in Figure 21 below, anglers and boaters support nearly $30 million and $500 million, respectively, in output in the Chicago region annually. These estimates account for both direct and indirect effects. For both angler and boater spending, we estimate that over half of the output effects are associated with spending in the supported industries.

FIGURE 21. Annual Output Effects of Recreational Fishing and Recreational Boating in the Chicago Region (millions)



	Angler Spending*	Boater Spending
Supported Industries	$14.5	$280.0
Recreational Boating	$0.0	$214.5
Recreational Fishing	$12.8	$0.0
Total	$27.3	$494.5

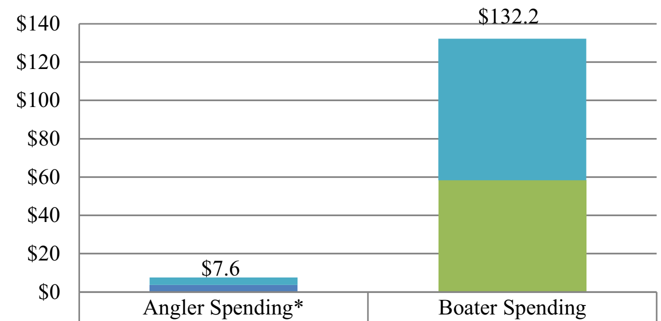
Source: AEG analysis using base data from the Illinois Department of Natural Resources; Indiana Department of Natural Resources; U.S. Army Corps of Engineers; Ready, et al; U.S. Bureau of Labor Statistics; and U.S. Bureau of Economic Analysis, RIMS II Multipliers.

**Angler spending reflects fishing activity in the Illinois portion of Lake Michigan and in the Indiana portion of Lake Michigan and Indiana inland waterways. It excludes fishing activity in Illinois inland waterways due to data availability.*

Earnings Effects

Anglers and boaters support over $7 million and $130 million, respectively, in earnings for residents in the Chicago region annually, as shown in Figure 22 on page 53. For both angler and boater spending, we estimate that over half of the earnings effects are associated with spending in the supported industries.

FIGURE 22. Annual Earnings Effects of Recreational Fishing and Recreational Boating in the Chicago Region (millions)

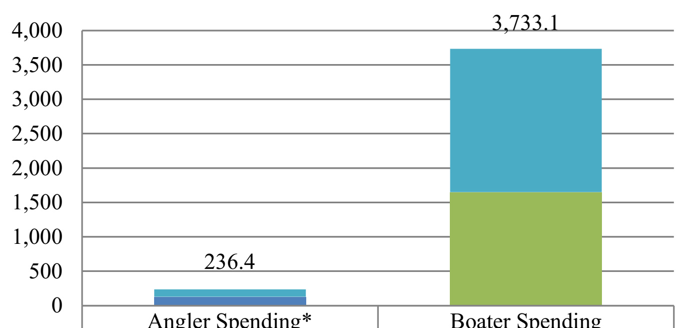


	Angler Spending*	Boater Spending
Supported Industries	$3.9	$73.9
Recreational Boating	$0.0	$58.3
Recreational Fishing	$3.7	$0.0
Total	$7.6	$132.2

Source: AEG analysis using base data from the Illinois Department of Natural Resources; Indiana Department of Natural Resources; U.S. Army Corps of Engineers; Ready, et al; U.S. Bureau of Labor Statistics; and U.S. Bureau of Economic Analysis, RIMS II Multipliers.

**Angler spending reflects fishing activity in the Illinois portion of Lake Michigan and in the Indiana portion of Lake Michigan and Indiana inland waterways. It excludes fishing activity in Illinois inland waterways due to data availability.*

FIGURE 23. Annual Employment Effects of Recreational Fishing and Recreational Boating in the Chicago Region



	Angler Spending*	Boater Spending
Supported Industries	108.0	2,082.2
Recreational Boating	0.0	1,650.9
Recreational Fishing	128.4	0.0
Total	236.4	3,733.1

Source: AEG analysis using base data from the Illinois Department of Natural Resources; Indiana Department of Natural Resources; U.S. Army Corps of Engineers; Ready, et al; U.S. Bureau of Labor Statistics; and U.S. Bureau of Economic Analysis, RIMS II Multipliers.

**Angler spending reflects fishing activity in the Illinois portion of Lake Michigan and in the Indiana portion of Lake Michigan and Indiana inland waterways. It excludes fishing activity in Illinois inland waterways due to data availability.*

Employment Effects

As we show in Figure 23 on page 53, anglers and boaters support over 230 jobs and 3,700 jobs, respectively, in the Chicago region. For both angler and boater spending, we estimate that roughly half of the employment effects are associated with spending in the supported industries.

ADDITIONAL CONSIDERATIONS

Not included in our economic footprint estimates are businesses along the Chicago Riverwalk and water-related tourism businesses. Should Asian carp—in particular, silver carp—proliferate in the Chicago River, the area may become less pleasant for patrons of these businesses. Plans for further development of the riverwalk could be negatively affected. The scale of economic activity that is at stake is difficult to estimate since these plans have not yet unfolded. Based on data from Esri Business Analyst, businesses along the riverwalk, including the riverboat tour companies, generated over $5 million in sales and employed nearly 70 people in 2016.

Appendix A. Methodology

In this section we provide a detailed description of how we arrived at our infrastructure cost estimates and economic impact totals. We also discuss our methodology for quantifying the sizes of industries impacted by Asian carp.

PROJECT COST ESTIMATES

We estimated the cost of each AIS infrastructure scenario by taking the following steps:

1. Estimated project costs and timeline.
   We used cost estimates from GLMRIS, the GLMRIS Brandon Road Tentatively Selected Plan report, HDR, and MWRD in order to estimate the total cost of each infrastructure scenario. We first determined what infrastructure elements would be required for each scenario, and then consulted each source for cost estimates.

   The majority of our cost estimates are based on forensic analysis of GLMRIS cost estimates. GLMRIS provides cost estimates for a number of infrastructure components, with limited detail. We contacted USACE and requested detailed cost data, but did not receive a substantive response.

   GLMRIS estimated the cost of infrastructure components based on a 500-year storm level. This level of stormwater retention and remediation may not be necessary in practical application. In order to be conservative in our net economic impact analysis, we scaled down some cost estimates.

   When we used GLMRIS cost estimates in this report, we used the point estimate for each infrastructure item, rather than using cost estimates at the highest point of contingency, as GLMRIS does.

   We were unable to estimate a cost for one item—high speed CSO treatment at McCook reservoir. Rapid treatment technologies were recommended by HDR in lieu of adding additional storage capacity along the northwestern side of the CAWS. We left this cost out of our scenario cost estimates in order to be conservative, but included it as a line item in project cost tables for scenarios 2 and 3 to be transparent.

   We were also unable to calculate cost contingencies for some items, including costs for Brandon Road infrastructure, as well as costs to upgrade the Clavey Road, Deerfield, and Thorn Creek WWTPs. The Brandon Road Tentatively Selected Plan provides cost estimates, however the report's cost engineering appendix has not yet been made public since the report is in draft form. Additional planning and engineering would be required to estimate contingencies for upgrading the aforementioned WWTPs.

   Additional calculations were also required to estimate costs for the following items:

   - Land and Planning, Engineering, and Design
     We estimated that land costs for each scenario would be equal to 0.5% of the total project cost. We also estimated that planning, engineering, and design costs would be equal to 9.9% of the total project costs. Both of these estimates are based on the average land and planning, engineering, and design costs for all GLMRIS scenarios.

- Clavey Road, Deerfield, and Thorn Creek WWTP upgrades

  We estimated the cost of upgrading the Clavey Road, Deerfield, and Thorn Creek WWTPs based on HDR cost estimates for upgrading the North Side, Calumet, and Stickney WWTPs to meet current and projected future effluent treatment requirements for Lake Michigan. These costs were estimated by HDR as a cost per million gallons per day of effluent. We applied these costs to the daily average flow of each treatment plant to estimate the total upgrade cost.

2. Estimated construction timelines.
   We estimated each scenario's construction timeline based on forensic analysis of GLMRIS. For scenario 1, we estimated that construction would take five years based on the GLMRIS Brandon Road Tentatively Selected Plan report. For scenarios 2 and 3, we estimated that construction would take 25 years, based on GLMRIS alternative 7, which was the most similar GLMRIS alternative to both of these scenarios.

ECONOMIC IMPACT ANALYSIS

We constructed an input-output model that translates project spending into regional economic impacts. Our model incorporates RIMS II multipliers from the U.S. Bureau of Economic Analysis.

We define net economic impact as the amount of activity that occurs in a well-defined region exclusively due to a project. We compare the project scenario to one in which no new AIS infrastructure is built, and express the economic impact in terms of output, employment, and earnings.

We took the following steps to estimate the economic impact of each scenario:

1. Estimated the amount of spending in the region by year and source

   We first estimated the proportion of spending that would occur in the region for each project item. We defined the study region as the counties of Lake, Cook, DuPage, and Will in Illinois, and Lake and Porter in Indiana. Purchases of goods and services from areas outside of the study region do not directly contribute to the local economy, and are thus excluded from our analysis. We estimated that, for nearly all project costs, between 95% and 100% of spending would occur in the region. The one exception to this is spending on engineering and design services. If any of the scenarios are built, it is possible that the engineering and design firm would be located outside of the Chicago region. Therefore, we estimated that 50% of spending on engineering and design would actually occur in the study region. Table 8 shows our estimates for in-region spending by project item.

TABLE 8. Estimated In-Region Spending by Industry

Industry	Percent In-Region	
	Low	High
Construction	95%	98%
Professional, Scientific, and Technical Services	50%	50%
Real Estate	100%	100%
Waste Remediation	100%	100%

Source: AEG professional judgment.

2. Estimated substitution

The amount of substitution that would occur as a result of the project varies depending on the source of funding. We estimated that the substitution rate for federal spending on the project would be very low (2%), since the amount of federal spending on other projects in the region would likely not be lower because AIS infrastructure is built.

We estimated that the substitution rate for State government would be higher, since covering even a portion of AIS infrastructure costs would be very costly, and could result in some decreased spending on other infrastructure projects in the region. We assumed the substitution rate for State spending would be moderate (41%), based on the proportion of the state's population that lives in the study region.

We also estimated that substitution would be very high (95%) if local governments funded a portion of the project, since local governments would likely raise taxes on businesses and individuals in the region in order to fund the infrastructure. Thus, any locally-funded increase in infrastructure spending would be accompanied by a decrease in consumer and business expenditures on other goods and services.

TABLE 9. Estimated Substitution Rate by Project Funding Source

Funding Source	Substitution Rate (Percent)
Federal	2%
State	41%
Local	95%

Source: AEG professional judgment.

Due to uncertainty about funding sources, and the large differences in substitution rates, we estimated the economic impacts of each infrastructure project under two scenarios. In our low-impact scenario, 65% of funding would be from the federal government, while 25% would come from the State, and 10% would come from local government. In our high-impact scenario we assumed that 100% of funding would be from the federal government.

3. Estimated the direct and indirect output and earnings impacts.

   The direct impact to output is simply the total amount of net new spending occurring in the region. In order to determine the indirect impact to output, we multiplied project spending, categorized by industry, by Bureau of Economic Analysis RIMS II final demand multipliers generated specifically for the study region. We used multipliers for the Construction; Professional, Scientific, and Technical Services; Real Estate; and Waste Remediation industries. We used a similar methodology to determine the increase in earnings, multiplying project spending by direct and indirect effect RIMS II multipliers.

4. Estimated indirect employment impact.

   We did not estimate a direct impact for employment for the AIS scenarios. It is possible that the funding agencies may hire someone to oversee the project work; however, the number of people directly hired by project funders would likely be minimal, and substantially smaller than the number of people hired by industries such as engineering and construction. We multiplied project spending by a RIMS II final demand multiplier to determine the number of jobs created each year.

FLOODING IMPACT

In this section, we describe our methodology for estimating the impact the installation of control points would have on flooding in the region.

Estimated Increase in Flooding

To estimate the impact of flooding, we relied on estimates of flooded area produced in the GLIMRIS report issued by the USACE. Using community level data in this report, we were able to determine how many acres in Cook County would flood due to the proposed installation of control points described in scenarios 2 and 3 in “Scenario Descriptions” on page 24.

The USACE mid-system separation matched closely with our definition of scenario 2, so we relied on those estimates for our economic impact modeling. The lakefront scenario modeled in the GLIMRIS report relied on similar control points near the Illinois-Indiana border as our scenario 3, but used different control points along the Chicago River. Therefore, we combined community-level estimates for the two scenarios to produce an estimate for the increase in flooding that would result in scenario 3. We determined which USACE estimate to use based on the body of water which would impact the community. Table 10 on page A-5 below shows the USACE scenario we used for each community.

The change in flooding is the number of acres expected to flood under the separation plan less the number of acres expected to flood under current conditions.

TABLE 10. USACE Separation Scenario Definitions Used to Define Scenario 3 Flood Impact

Community	Separation Scenario
Blue Island	Lakefront
Burnham	Lakefront
Calumet City	Lakefront
Chicago	Mid-System
Dolton	Lakefront
Evanston	Mid-System
Forest View	Mid-System
Harvey	Lakefront
Palos Hills	Mid-System
South Holland	Lakefront

Source: AEG analysis based on U.S. Army Corps. of Engineers, GLIMRIS Report - Appendix E

Estimated Cost of Flooding

After estimating how many additional acres would flood, we used that estimate to determine the estimated cost to households as a result of flooding, and the economic impact as a result of the reduction in household disposable income. To produce these estimates, we took the following steps.

1. The U.S. Census Bureau indicates that Cook County is 604,800 acres and has 2,161,077 household structures.[29] This figure counts each multi-unit structure as a single building.
2. The Center for Neighborhood Technology estimates that the average amount in damages paid out for a flooded home in Cook County is $4,272.
3. We divided the number of housing structures in Cook County by the area of Cook County, and multiplied the result by the change in flooded acreage.
4. We then multiplied this estimate by the average value of a claim to determine the total amount lost by households due to flooding.
5. We then multiplied these household losses by the household multiplier for the defined CAWS region.

This method produces results for the impact of a storm event, but does not tell us how much households can expect to lose in a given year. To determine the average annual losses, we made the following adjustments to the steps above.

29. American Community Survey - 2011-2015 Estimates

1. After multiplying the average value of a claim by the number of affected structures, we divided the total amount by the probability that a storm event would occur. This probability is one over the year storm event. For example a 25- year storm event would occur with a probability 1/25, or 4%.
2. After completing step 5, we totaled up the losses for each level storm event. We totalled up the expected losses by households, as well as the economic impacts on output, earnings, and employment.

This produced our estimate for the lost economic impact due to reduced household earnings. To determine the economic impact of additional spending on flood remediation we used the following steps:

1. Using Center for Neighborhood Technology data on flooding damages by household, we determined the share of spending by industry for all flood remediation spending, including home repairs, furniture, electronics, clothing, and other flood remediation services.
2. We multiplied the share of spending by industry by the amount of damages paid out for each flooded household.
3. We then multiplied the amount from step two by the appropriate industry multiplier and summed up the result for each industry to produce the net economic impact of flood remediation spending for each flooded home.
4. We then multiplied this amount by the estimated number of additionally flooded homes for each storm event.
5. To estimate the final impact, we subtracted our estimated loss of economic impact due to reduced household earnings.

REGIONAL ASIAN CARP IMPACT

In this section, we describe our methodology for identifying potential industries that could be affected by Asian carp and estimating the scale and economic footprint of these industries in the Chicago region. We summarized the results of our research and analysis in "Impact of Asian Carp on Industries in the Chicago Region" on page 47.

Potential Industries Affected by Asian Carp

Review of research. In order to estimate the effect of Asian carp in the Great Lakes on the Chicago region economy, we first performed a review of existing research on the types of industries that would be affected by Asian carp. We found several reports that either identified or quantified the scale of these potential industries.[30] These studies had the following industries in common:

- Recreational fishing;
- Commercial fishing;
- Recreational boating; and
- Supported industries, such as restaurants, accommodations, gas stations, etc.

We also reviewed research evaluating the potential impact of Asian carp on these activities and industries. We found that, generally, existing research on economic activity associated with these industries stopped short of estimating the impact of Asian carp due to uncertainty regarding whether Asian carp would survive in the Great Lakes and the extent to which they would affect the ecosystem if they did.

However, we did find a handful of studies that have attempted to estimate the impacts of Asian carp. Most recently, the USACE evaluated the impact of Asian carp on Lake Erie.[31] They considered under several scenarios that vary on factors such as:

- Whether plankton are vulnerable to consumption by Asian carp,
- Turnover of the Asian carp population;[32]
- Whether salmonid predation on Asian carp takes place; and
- Whether Asian carp feed on fish larvae.

The authors excluded the impact of Asian carp on other Great Lakes from the study's scope due to limited ecological modeling data. The study found that, under most scenarios, Asian carp would have a positive economic impact on commercial and recreational fishing in Lake Erie. The modeling results indicate that the presence of Asian carp would increase viable biomass for commercial and recreational fishing. The exceptions included scenarios in which Asian carp feed on fish larvae.

Another study provided a range of the potential impacts of Asian carp on consumer surplus, or the difference between what a consumer is willing to pay for a

30. See Invasive Species Centre, "Socio-economic Impact: The Threat of Aquatic Invasive Species to the Great Lakes," Asian Carp Canada, n.d., http://asiancarp.ca/WHAT-IS-AT-RISK/Socio-economic-Impact, accessed August 2017.

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    U.S. Army Corps of Engineers, "The GLMRIS Report: Great Lakes and Mississippi River Interbasin Study, Appendix D," U.S. Army Corps of Engineers, October 2013.

31. U.S. Army Corps of Engineers, "The Great Lakes and Mississippi River Interbasin Study—Brandon Road Draft Integrated Feasibility Study and Environmental Impact Statement, Will County, Illinois," and

    U.S. Army Corps of Engineers, "GLMRIS—Brandon Road: Appendix D-Economic Analyses."

32. The study refers to this as the ratio of Asian carp production to biomass.

good or service and what the consumer actually pays.[33] The magnitude of the impacts varied based on projected losses of fish species. We also found research that suggests that Asian carp might have had a negative impact on swimming and boating in the Illinois River, though further research is required to estimate the magnitude of this effect.[34]

Scale of industries. To estimate the scale of the industries we identified, we relied on business listing data from Esri Business Analyst, which provides data gathered by Infogroup. We took the following steps:

1. Gathered and identified appropriate businesses.

   We identified a series of North American Industry Classification System (NAICS) codes that correspond to establishments that would be potentially be affected by Asian carp in the Great Lakes. We excluded many of the supported industries, such as restaurants and grocery stores, since a small share of their activity in the Chicago region is attributable to industries that could be affected by Asian carp.

   We then collected information on Chicago-region businesses with these NAICS codes.[35] We reviewed the list of businesses and filtered out any businesses that would not be significantly affected by Asian carp, as several NAICS codes represent a broad set of establishments (e.g., “sporting goods stores” includes businesses that sell a variety of sporting equipment beyond fishing equipment).

2. Estimated employment and sales volume.

   After identifying the appropriate businesses, we estimated the amount of employment and sales volume in each category.

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33. Richard C. Ready, et al., “Impacts of Aquatic Invasive Species on Sport Fish and Recreational Fishing in the Great Lakes: Possible Future Scenarios,” Cornell University, March 2016.

34. See Molly M. Spacapan, Jordan F. Besek, and Greg G. Sass, “Perceived Influence and Response of River Users to Invasive Bighead and Silver Carp in the Illinois River,” May 5, 2016; and

    Molly M. Spacapan, Craig Miller, and Greg G. Sass, “Has river use in the Mississippi River basin changed following the invasion of Asian carp?,” Paper presented at the 2012 Northeastern Recreation Research Symposium, April 1, 2012.

35. In addition to Esri Business Analyst, several sources indicate that there are no commercial fishing establishments in the Chicago region.

    See U.S. Bureau of Labor Statistics, Quarterly Census of Employment and Wages, https://www.bls.gov/cew/;

    U.S. National Oceanic and Atmospheric Administration, Great Lakes Commercial Fishery Landings, http://www.st.nmfs.noaa.gov/commercial-fisheries/commercial-landings/other-specialized-programs/great-lakes-landings/; and

    U.S. National Oceanic and Atmospheric Administration, Annual Commercial Landings Statistics, https://www.st.nmfs.noaa.gov/commercial-fisheries/commercial-landings/annual-landings/index

Table A-1 presents the list of NAICS codes we identified.

TABLE A-1. Potential Industries

Category	NAICS Code	NAICS Definition
Commercial fishing	114100	Fishing
Boat dealers	441222	Boat dealers
Bait and tackle shops	451110	Sporting goods stores
Charter fishing	487210	Scenic sightseeing transportation, water
Boat rentals	532284	Recreational goods rental
Campgrounds	721211	RV parks and campgrounds
Marinas and yacht clubs	713930	Marinas
Boating clubs	713990	All other amusement and recreation industries

Source: AEG compilation of data sourced from North American Industry Classification System (2012)

Economic Footprint in the Chicago Region

The extent to which Asian carp in the Great Lakes and connected waterways would affect these industries is unknown, so we limited our analysis to estimating the economic footprint, a baseline of the economic activity that could be affected. We relied on a similar approach and data that was used by the USACE to estimate the impact of Asian carp on the Great Lakes.[36]

Angler spending. We took the following steps to estimate the angler spending in the recreational fishing and supported industries:

1. Estimated angler-trips.

   For the Illinois portion of the Chicago region, we relied on published angler trip data from the Illinois DNR non-creel charter survey and creel surveys to estimate the number of angler-trips.[37] We define an angler-trip as the number of anglers that fish for one day. These surveys only capture recreational fishing activity in Lake Michigan and exclude activity in connected inland waterways.

   For the Indiana portion of the Chicago region, we relied on angler-trip data from the Indiana DNR, as well as GIS analysis to estimate the number of angler-trips. The creel survey conducted by the Indiana DNR captures recreational fishing in

36. See U.S. Army Corps of Engineers, "GLMRIS—Brandon Road: Appendix D-Economic Analyses," and

    U.S. Army Corps of Engineers, "The GLMRIS Report: Great Lakes and Mississippi River Interbasin Study, Appendix D."

37. See Charles R. Roswell and Sergiusz J. Czesny, "A Survey of Sport Fishing in the Illinois Portion of Lake Michigan: March through September 2015," Illinois Natural History Survey Prairie Research Institute, November 30, 2016; and

    Steven R. Robillard, "Charter Boat Fishing in Lake Michigan: 2015 Illinois Reported Harvest," Illinois Department of Natural Resources, February 4, 2016.

both Lake Michigan and connected inland waterways in Lake, Porter, and LaPorte Counties. The survey segments this activity by boat fishing, shore fishing, and stream fishing. We estimated the share of trips that took place in the Lake and Porter Counties, as follows:

- *Boat fishing:* we estimated that about 56% of these trips took place in Lake and Porter Counties based on the share of employment in marinas and the share of river mileage in these counties out of the three counties.
- *Shore fishing:* we estimated that about 59% of these trips took place in Lake and Porter Counties based on the share of inland lake and Lake Michigan shoreline in these counties out of the three counties.
- *Stream fishing:* we estimated that about 66% of these trips took place in Lake and Porter Counties based on the share of creek mileage in these counties out of the three counties.

2. Estimated angler spending.

   We relied on boat and fishing gear spending data from the Illinois DNR creel survey to estimate spending per angler-trip for both the Illinois and Indiana non-charter fishing activity.

   We relied on spending data for fishing in the Great Lakes from a different angler survey to estimate spending in other categories.[38] Since this angler survey was conducted in 2012, we adjusted the angler-trip spending for inflation.

   We then multiplied our estimates for angler-trip spending by the number of angler-trips to estimate the total angler spending.

See Exhibit C-9 on page C-12 for further details on our angler spending estimates.

Boater spending. We took the following steps to estimate angler spending in the recreational fishing and supported industries:

1. Estimated boat-days.

   We relied on the Illinois DNR and Indiana DNR for information on watercraft registrations in the Chicago region. We then estimated the number of boat-days per registered boat in each state using data from a USACE report on Great Lakes recreational boating.[39] We multiplied these estimates by the respective number of registered watercrafts in each state to estimate the total number of boat-days.

2. Estimated boater spending.

   We relied on boat-day and craft spending data from the USACE report on Great Lakes recreational boating to estimate the amount of spending by category. We estimated that the marina and yacht club spending in the Chicago region was about 40% higher than elsewhere in the Great Lakes region. Since this survey

38. Richard C. Ready, et al., "Net Benefits of Recreational Fishing in the Great Lakes, Upper Mississippi River, and Ohio River Basins," Cornell University, December 2012.

39. U.S. Army Corps of Engineers, "Great Lakes Recreational Boating," December 2008.

was conducted in 2004, we adjusted the boat-day and craft spending for inflation.

We then multiplied the boat-day spending by the number of boat-days and the craft spending by the number of registered watercrafts to estimate the total boater spending.

See Exhibit C-13 on page C-15 and Exhibit C-14 on page C-16 for further details on our boater spending estimates.

Economic footprint analysis. We took the following steps to estimate the economic footprint of each type of spending:

1. Estimated spending in the Chicago region.

   For angler spending, we relied on data from the angler survey, which segmented spending data by whether the spending took place in the county in which the fishing trip took place. This information provided a lower bound for the share of spending in the Chicago region since it would not include spending that is outside of the county where fishing takes place, but in the Chicago region.

   For categories of spending that support retailers (e.g., fishing equipment, groceries, fuel, etc.), we estimated the share of spending that is attributed to producers, transportation, and wholesale margin using data from the U.S. Bureau of Economic Analysis. These categories often comprise a significant share of the purchase price of goods. Producers, transportation firms, and wholesale merchants are often likely to be located outside of the region of analysis. To estimate the share of producer, transportation, and wholesale portion of the purchase cost remained in the Chicago region, we relied on our professional judgment, as well as estimates of the share of employment in the producer industries in the Chicago region.

   See Exhibit C-9 on page C-12, Exhibit C-13 on page C-15, and Exhibit C-14 on page C-16 for further details on our angler and boater spending estimates.

2. Estimated direct and indirect effects.

   Similar to our economic impact analyses, we multiplied the spending estimates by the appropriate RIMS II multiplier to estimate the indirect effects for output, earnings, and employment.

   See Exhibit C-12 on page C-14 and Exhibit C-15 on page C-17 for further details on our economic footprint estimates.

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U.S. Fish and Wildlife Service, "Aquatic Invasive Species Interbasin Exchange," 2002.

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U.S. Army Corps of Engineers, "The GLMRIS Report: Great Lakes and Mississippi River Interbasin Study, Appendix K—Cost Engineering," U.S. Army Corps of Engineers, 2014.

U.S. Bureau of Economic Analysis RIMS II Multipliers.

Appendix C. Detailed Exhibits

LIST OF EXHIBITS

This appendix contains the following:

EXHIBIT C-1. Net New Spending, Output, Earnings, and Employment in Chicago Region for AIS Scenario 1

65% Federal

	Net New Spending			Economic Impact		
Year	**Construction**	**Prof., Scientific, & Tech. Svcs.**	**Real Estate**	**Output**	**Earnings**	**Employment**
1	$ 34.9	$ 2.0	$ 0.2	$ 77.5	$ 23.1	461
2	$ 34.9	$ 2.0	$ 0.2	$ 77.5	$ 23.1	461
3	$ 34.9	$ 2.0	$ 0.2	$ 77.5	$ 23.1	461
4	$ 34.9	$ 2.0	$ 0.2	$ 77.5	$ 23.1	461
5	$ 34.9	$ 2.0	$ 0.2	$ 77.5	$ 23.1	461

Industry Assumptions

Industry	% In Region	% Net New
Construction	95.0%	74.5%
Professional, Scientific, and Technical Services	50.0%	74.5%
Real Estate	100.0%	74.5%

100% Federal

	Net New Spending			Economic Impact		
Year	**Construction**	**Prof., Scientific, & Tech. Svcs.**	**Real Estate**	**Output**	**Earnings**	**Employment**
1	$ 47.4	$ 2.7	$ 0.2	$ 105.0	$ 31.3	625
2	$ 47.4	$ 2.7	$ 0.2	$ 105.0	$ 31.3	625
3	$ 47.4	$ 2.7	$ 0.2	$ 105.0	$ 31.3	625
4	$ 47.4	$ 2.7	$ 0.2	$ 105.0	$ 31.3	625
5	$ 47.4	$ 2.7	$ 0.2	$ 105.0	$ 31.3	625

Industry Assumptions

Industry	% In Region	% Net New
Construction	98.0%	98.0%
Professional, Scientific, and Technical Services	50.0%	98.0%
Real Estate	100.0%	98.0%

Source: Anderson Economic Group analysis of base data from GLMRIS, HDR, MWRD; Bureau of Economic Analysis RIMS II Multipliers.

EXHIBIT C-2. Net New Spending, Output, Earnings, and Employment in Chicago Region for AIS Scenario 2 With 65% Federal Funding

	Net New Spending				*Economic Impact*		
Year	Construction	Prof., Scientific, & Tech. Svcs	Real Estate	Waste Remediation	Output	Earnings	Employment
1	$ 36.2	$ 3.0	$ 0.3	$ 17.0	$ 118.5	$ 33.6	672
2	$ 36.2	$ 3.0	$ 0.3	$ 17.0	$ 118.5	$ 33.6	672
3	$ 36.2	$ 3.0	$ 0.3	$ 17.0	$ 118.5	$ 33.6	672
4	$ 36.2	$ 3.0	$ 0.3	$ 17.0	$ 118.5	$ 33.6	672
5	$ 36.2	$ 3.0	$ 0.3	$ 17.0	$ 118.5	$ 33.6	672
6	$ 36.2	$ 3.0	$ 0.3	$ 17.0	$ 118.5	$ 33.6	672
7	$ 36.2	$ 3.0	$ 0.3	$ 17.0	$ 118.5	$ 33.6	672
8	$ 36.2	$ 3.0	$ 0.3	$ 17.0	$ 118.5	$ 33.6	672
9	$ 36.2	$ 3.0	$ 0.3	$ 17.0	$ 118.5	$ 33.6	672
10	$ 36.2	$ 3.0	$ 0.3	$ 17.0	$ 118.5	$ 33.6	672
11	$ 36.2	$ 3.0	$ 0.3	$ 17.0	$ 118.5	$ 33.6	672
12	$ 36.2	$ 3.0	$ 0.3	$ 17.0	$ 118.5	$ 33.6	672
13	$ 36.2	$ 3.0	$ 0.3	$ 17.0	$ 118.5	$ 33.6	672
14	$ 36.2	$ 3.0	$ 0.3	$ 17.0	$ 118.5	$ 33.6	672
15	$ 36.2	$ 3.0	$ 0.3	$ 17.0	$ 118.5	$ 33.6	672
16	$ 75.2	$ 6.3	$ 0.6	$ 35.4	$ 246.4	$ 69.9	1,399
17	$ 75.2	$ 6.3	$ 0.6	$ 35.4	$ 246.4	$ 69.9	1,399
18	$ 75.2	$ 6.3	$ 0.6	$ 35.4	$ 246.4	$ 69.9	1,399
19	$ 75.2	$ 6.3	$ 0.6	$ 35.4	$ 246.4	$ 69.9	1,399
20	$ 75.2	$ 6.3	$ 0.6	$ 35.4	$ 246.4	$ 69.9	1,399
21	$ 267.6	$ 22.4	$ 2.0	$ 126.0	$ 876.8	$ 248.7	4,976
22	$ 267.6	$ 22.4	$ 2.0	$ 126.0	$ 876.8	$ 248.7	4,976
23	$ 282.1	$ 23.6	$ 2.1	$ 132.8	$ 924.1	$ 262.1	5,245
24	$ 318.3	$ 26.7	$ 2.4	$ 149.8	$ 1,042.6	$ 295.7	5,917
25	$ 318.3	$ 26.7	$ 2.4	$ 149.8	$ 1,042.6	$ 295.7	5,917

Industry Assumptions

Industry	% In Region	% Net New
Construction	95.0%	74.5%
Professional, Scientific, and Technical Services	50.0%	74.5%
Real Estate	100.0%	74.5%
Waste Remediation	100.0%	74.5%

Source: Anderson Economic Group analysis of base data from GLMRIS, HDR, MWRD; U.S. Bureau of Economic Analysis RIMS II Multipliers.

EXHIBIT C-3. Net New Spending, Output, Earnings, and Employment in Chicago Region for AIS Scenario 2 With 100% Federal Funding

	Net New Spending				*Economic Impact*		
Year	Construction	Prof., Scientific, & Tech. Svcs	Real Estate	Waste Remediation	Output	Earnings	Employment
1	$ 49.1	$ 4.0	$ 0.4	$ 22.4	$ 159.1	$ 45.2	904
2	$ 49.1	$ 4.0	$ 0.4	$ 22.4	$ 159.1	$ 45.2	904
3	$ 49.1	$ 4.0	$ 0.4	$ 22.4	$ 159.1	$ 45.2	904
4	$ 49.1	$ 4.0	$ 0.4	$ 22.4	$ 159.1	$ 45.2	904
5	$ 49.1	$ 4.0	$ 0.4	$ 22.4	$ 159.1	$ 45.2	904
6	$ 49.1	$ 4.0	$ 0.4	$ 22.4	$ 159.1	$ 45.2	904
7	$ 49.1	$ 4.0	$ 0.4	$ 22.4	$ 159.1	$ 45.2	904
8	$ 49.1	$ 4.0	$ 0.4	$ 22.4	$ 159.1	$ 45.2	904
9	$ 49.1	$ 4.0	$ 0.4	$ 22.4	$ 159.1	$ 45.2	904
10	$ 49.1	$ 4.0	$ 0.4	$ 22.4	$ 159.1	$ 45.2	904
11	$ 49.1	$ 4.0	$ 0.4	$ 22.4	$ 159.1	$ 45.2	904
12	$ 49.1	$ 4.0	$ 0.4	$ 22.4	$ 159.1	$ 45.2	904
13	$ 49.1	$ 4.0	$ 0.4	$ 22.4	$ 159.1	$ 45.2	904
14	$ 49.1	$ 4.0	$ 0.4	$ 22.4	$ 159.1	$ 45.2	904
15	$ 49.1	$ 4.0	$ 0.4	$ 22.4	$ 159.1	$ 45.2	904
16	$ 102.2	$ 8.3	$ 0.8	$ 46.6	$ 330.9	$ 93.9	1,880
17	$ 102.2	$ 8.3	$ 0.8	$ 46.6	$ 330.9	$ 93.9	1,880
18	$ 102.2	$ 8.3	$ 0.8	$ 46.6	$ 330.9	$ 93.9	1,880
19	$ 102.2	$ 8.3	$ 0.8	$ 46.6	$ 330.9	$ 93.9	1,880
20	$ 102.2	$ 8.3	$ 0.8	$ 46.6	$ 330.9	$ 93.9	1,880
21	$ 363.4	$ 29.5	$ 2.7	$ 165.8	$ 1,177.3	$ 334.2	6,687
22	$ 363.4	$ 29.5	$ 2.7	$ 165.8	$ 1,177.3	$ 334.2	6,687
23	$ 383.1	$ 31.1	$ 2.8	$ 174.8	$ 1,240.9	$ 352.2	7,049
24	$ 432.2	$ 35.1	$ 3.2	$ 197.2	$ 1,400.0	$ 397.4	7,952
25	$ 432.2	$ 35.1	$ 3.2	$ 197.2	$ 1,400.0	$ 397.4	7,952

Industry Assumptions

Industry	% In Region	% Net New
Construction	98.0%	98.0%
Professional, Scientific, and Technical Services	50.0%	98.0%
Real Estate	100.0%	98.0%
Waste Remediation	100.0%	98.0%

Source: Anderson Economic Group analysis of base data from GLMRIS, HDR, MWRD; U.S. Bureau of Economic Analysis RIMS II Multipliers.

EXHIBIT C-4. Net New Spending, Output, Earnings, and Employment in Chicago Region for AIS Scenario 3 With 65% Federal Funding

	Net New Spending				*Economic Impact*		
Year	Construction	Prof., Scientific, & Tech. Svcs	Real Estate	Waste Remediation	Output	Earnings	Employment
1	$ 43.5	$ 2.9	$ 0.3	$ 8.4	$ 115.4	$ 33.5	671
2	$ 43.5	$ 2.9	$ 0.3	$ 8.4	$ 115.4	$ 33.5	671
3	$ 43.5	$ 2.9	$ 0.3	$ 8.4	$ 115.4	$ 33.5	671
4	$ 43.5	$ 2.9	$ 0.3	$ 8.4	$ 115.4	$ 33.5	671
5	$ 43.5	$ 2.9	$ 0.3	$ 8.4	$ 115.4	$ 33.5	671
6	$ 43.5	$ 2.9	$ 0.3	$ 8.4	$ 115.4	$ 33.5	671
7	$ 43.5	$ 2.9	$ 0.3	$ 8.4	$ 115.4	$ 33.5	671
8	$ 43.5	$ 2.9	$ 0.3	$ 8.4	$ 115.4	$ 33.5	671
9	$ 43.5	$ 2.9	$ 0.3	$ 8.4	$ 115.4	$ 33.5	671
10	$ 43.5	$ 2.9	$ 0.3	$ 8.4	$ 115.4	$ 33.5	671
11	$ 43.5	$ 2.9	$ 0.3	$ 8.4	$ 115.4	$ 33.5	671
12	$ 43.5	$ 2.9	$ 0.3	$ 8.4	$ 115.4	$ 33.5	671
13	$ 43.5	$ 2.9	$ 0.3	$ 8.4	$ 115.4	$ 33.5	671
14	$ 43.5	$ 2.9	$ 0.3	$ 8.4	$ 115.4	$ 33.5	671
15	$ 43.5	$ 2.9	$ 0.3	$ 8.4	$ 115.4	$ 33.5	671
16	$ 90.6	$ 6.1	$ 0.6	$ 17.5	$ 240.0	$ 69.7	1,395
17	$ 90.6	$ 6.1	$ 0.6	$ 17.5	$ 240.0	$ 69.7	1,395
18	$ 90.6	$ 6.1	$ 0.6	$ 17.5	$ 240.0	$ 69.7	1,395
19	$ 90.6	$ 6.1	$ 0.6	$ 17.5	$ 240.0	$ 69.7	1,395
20	$ 90.6	$ 6.1	$ 0.6	$ 17.5	$ 240.0	$ 69.7	1,395
21	$ 322.2	$ 21.6	$ 2.0	$ 62.4	$ 853.7	$ 248.1	4,962
22	$ 322.2	$ 21.6	$ 2.0	$ 62.4	$ 853.7	$ 248.1	4,962
23	$ 339.7	$ 22.8	$ 2.1	$ 65.8	$ 899.8	$ 261.5	5,230
24	$ 383.2	$ 25.7	$ 2.3	$ 74.2	$ 1,015.2	$ 295.1	5,901
25	$ 383.2	$ 25.7	$ 2.3	$ 74.2	$ 1,015.2	$ 295.1	5,901

Industry Assumptions

Industry	% In Region	% Net New
Construction	95.0%	74.5%
Professional, Scientific, and Technical Services	50.0%	74.5%
Real Estate	100.0%	74.5%
Waste Remediation	100.0%	74.5%

Source: Anderson Economic Group analysis of base data from GLMRIS, HDR, MWRD; U.S. Bureau of Economic Analysis RIMS II Multipliers.

EXHIBIT C-5. Net New Spending, Output, Earnings, and Employment in Chicago Region for AIS Scenario 3 With 100% Federal Funding

	Net New Spending				*Economic Impact*		
Year	Construction	Prof., Scientific, & Tech. Svcs	Real Estate	Waste Remediation	Output	Earnings	Employment
1	$ 59.1	$ 3.8	$ 0.3	$ 11.1	$ 155.6	$ 45.3	905
2	$ 59.1	$ 3.8	$ 0.3	$ 11.1	$ 155.6	$ 45.3	905
3	$ 59.1	$ 3.8	$ 0.3	$ 11.1	$ 155.6	$ 45.3	905
4	$ 59.1	$ 3.8	$ 0.3	$ 11.1	$ 155.6	$ 45.3	905
5	$ 59.1	$ 3.8	$ 0.3	$ 11.1	$ 155.6	$ 45.3	905
6	$ 59.1	$ 3.8	$ 0.3	$ 11.1	$ 155.6	$ 45.3	905
7	$ 59.1	$ 3.8	$ 0.3	$ 11.1	$ 155.6	$ 45.3	905
8	$ 59.1	$ 3.8	$ 0.3	$ 11.1	$ 155.6	$ 45.3	905
9	$ 59.1	$ 3.8	$ 0.3	$ 11.1	$ 155.6	$ 45.3	905
10	$ 59.1	$ 3.8	$ 0.3	$ 11.1	$ 155.6	$ 45.3	905
11	$ 59.1	$ 3.8	$ 0.3	$ 11.1	$ 155.6	$ 45.3	905
12	$ 59.1	$ 3.8	$ 0.3	$ 11.1	$ 155.6	$ 45.3	905
13	$ 59.1	$ 3.8	$ 0.3	$ 11.1	$ 155.6	$ 45.3	905
14	$ 59.1	$ 3.8	$ 0.3	$ 11.1	$ 155.6	$ 45.3	905
15	$ 59.1	$ 3.8	$ 0.3	$ 11.1	$ 155.6	$ 45.3	905
16	$ 123.0	$ 8.0	$ 0.7	$ 23.1	$ 323.7	$ 94.1	1,882
17	$ 123.0	$ 8.0	$ 0.7	$ 23.1	$ 323.7	$ 94.1	1,882
18	$ 123.0	$ 8.0	$ 0.7	$ 23.1	$ 323.7	$ 94.1	1,882
19	$ 123.0	$ 8.0	$ 0.7	$ 23.1	$ 323.7	$ 94.1	1,882
20	$ 123.0	$ 8.0	$ 0.7	$ 23.1	$ 323.7	$ 94.1	1,882
21	$ 437.6	$ 28.4	$ 2.6	$ 82.1	$ 1,151.6	$ 334.9	6,697
22	$ 437.6	$ 28.4	$ 2.6	$ 82.1	$ 1,151.6	$ 334.9	6,697
23	$ 461.2	$ 30.0	$ 2.7	$ 86.6	$ 1,213.8	$ 353.0	7,059
24	$ 520.3	$ 33.8	$ 3.1	$ 97.7	$ 1,369.5	$ 398.2	7,964
25	$ 520.3	$ 33.8	$ 3.1	$ 97.7	$ 1,369.5	$ 398.2	7,964

Industry Assumptions

Industry	% In Region	% Net New
Construction	98.0%	98.0%
Professional, Scientific, and Technical Services	50.0%	98.0%
Real Estate	100.0%	98.0%
Waste Remediation	100.0%	98.0%

Source: Anderson Economic Group analysis of base data from GLMRIS, HDR, MWRD; U.S. Bureau of Economic Analysis RIMS II Multipliers.

EXHIBIT C-6. Scenario 2 Detailed Project Cost Estimate With Contingencies

	Item	Description	Estimated Cost	Contingency	Total Cost With Contingency	Source
1	Electric Barrier	Electric Barrier at Stickney	$ 52	64%	$ 85	GLMRIS
2	Electric Barrier	Electric Barrier at Alsip	$ 52	64%	$ 85	GLMRIS
3	Lock Improvement	Brandon Road Flushing Lock Conversion	$ 247	(a)	$ 247	Brandon Road TSP
4	Lock	Flushing Lock at Alsip	$ 428	99%	$ 852	Brandon Road TSP
5	Lock	Flushing Lock at Stickney	$ 428	99%	$ 852	GLMRIS
6	Sediment	Sediment Remediation lakeside of Stickney and Alsip control points	$ 1,500	61%	$ 2,415	GLMRIS
7	Tunnel	WRP Outfall O'Brien - Stickney	$ 956	100%	$ 1,912	Cost estimates provided by MWRD
8	Tunnel	WRP Outfall Calumet - Alsip	$ 475	100%	$ 950	Cost estimates provided by MWRD
9	Tunnel	Conveyance Tunnel from North Shore to McCook	$ 591	74%	$ 1,028	GLMRIS
10	WWTP Upgrade	Clavey Road WWTP upgrade	$ 47	(b)	$ 47	AEG estimate based on HDR estimates of Stickney and Alsip WWTP upgrade costs
11	WWTP Upgrade	Deerfield WWTP upgrade	$ 9	(b)	$ 9	AEG estimate based on HDR estimates of Stickney and Alsip WWTP upgrade costs
12	WWTP Upgrade	Thorn Creek WWTP upgrade	$ 42	(b)	$ 42	AEG estimate based on HDR estimates of Stickney and Alsip WWTP upgrade costs
13	Other	Flow Augmentation of South Branch of the Chicago River and Chicago Sanitary and Ship Canal	$ 28	(b)	$ 28	HDR Evaluation of Separation Alternatives Technical Appendix Report
14	Other	High-Speed CSO Treatment at McCook	(c)	(c)	$ -	
15	Other	Land acquisition	$ 24	100%	$ 49	AEG estimate based on analysis of GLMRIS
16	Other	Planning, engineering and design	$ 534	45%	$ 774	AEG estimate based on analysis of GLMRIS
			$ 5,413	73%	$ 9,375	

(a) Contingencies not reported for draft of Brandon Road Tentatively Selected Plan

(b) No contingency estimate reported in base data.

(c) No cost estimate established.

EXHIBIT C-7. Scenario 3 Detailed Project Cost Estimate With Contingencies

	Item	Description	Estimated Cost	Contingency	Total Cost With Contingency	Source
1	Electric Barrier	Electric Barrier at Stickney	$ 52	64%	$ 85	GLMRIS
2	Electric Barrier	Electric Barrier at T.J. O'Brien	$ 52	64%	$ 85	GLMRIS
3	Lock Improvement	Brandon Road Flushing Lock Conversion	$ 247	(a)	$ 247	Brandon Road TSP
4	Lock Improvement	T.J. O'Brien Flushing Lock Conversion	$ 247	(a)	$ 247	Brandon Road TSP
5	Lock Improvement	Sluice gate at T.J. O'Brien	$ 25	143%	$ 61	GLMRIS
6	Lock	Flushing Lock at Stickney	$ 428	99%	$ 852	GLMRIS
7	Barrier	Little Calumet River Physical Barrier	$ 66	69%	$ 112	GLMRIS
8	Barrier	Hammond Physical Barrier	$ 66	69%	$ 112	GLMRIS
9	Sediment	Sediment Remediation	$ 743	61%	$ 1,196	GLMRIS
10	WWTP Upgrade	Clavey Road WWTP upgrade	$ 47	(b)	$ 47	AEG estimate based on HDR estimates of Stickney and Alsip WWTP upgrade costs
11	WWTP Upgrade	Deerfield WWTP upgrade	$ 9	(b)	$ 9	AEG estimate based on HDR estimates of Stickney and Alsip WWTP upgrade costs
12	Tunnel	WRP Outfall O'Brien - Stickney	$ 956	100%	$ 1,912	Cost estimates provided by MWRD
13	Tunnel	North Shore-McCook Conveyance	$ 591	74%	$ 1,028	GLMRIS
14	Tunnel	Conveyance Tunnel from Hammond to Thornton	$ 187	71%	$ 320	GLMRIS
15	Reservoir	Thornton Reservoir	$ 650	47%	$ 956	GLMRIS
16	Reservoir	State Line Reservoir	$ 39	47%	$ 57	GLMRIS
17	Reservoir	Reservoir pump stations	$ 287	74%	$ 499	GLMRIS
18	Other	Flow Augmentation of South Branch of the Chicago River and Chicago Sanitary and Ship Canal	$ 28	(b)	$ 28	
19	Other	Flow Augmentation of the Calumet and Little Calumet Rivers	$ 62	(b)	$ 62	HDR Evaluation of Separation Alternatives Technical Appendix Report
20	Other	High-Speed CSO Treatment at McCook	(c)	(c)	$ -	
21	Other	Land acquisition	$ 23	100%	$ 47	AEG estimate based on analysis of GLMRIS
22	Other	Planning, engineering and design	$ 515	45%	$ 746	AEG estimate based on analysis of GLMRIS
			$ 5,320	64%	$ 8,707	

(a) Contingencies not reported for draft of Brandon Road Tentatively Selected Plan.
(b) No contingency estimate reported in base data.
(c) No cost estimate established.

EXHIBIT C-8. Acreage at Risk for Flooding by Community Under Mid-System and Lakefront Separation

Storm Event Level	No Separation (Current TARP)	Mid-System Separation (Current TARP)	Lakefront Separation (Current TARP)	No Separation (Completed TARP)	Mid-System Separation (Completed TARP)	Lakefront Separation (Completed TARP)
Blue Island						
1-Year	63	63	63	63	63	63
2-Year	63	63	63	63	63	63
5-Year	63	63	63	63	63	63
10-Year	112	112	112	112	112	112
25-Year	167	167	167	167	167	167
50-Year	167	167	167	167	167	167
100-Year	171	167	230	167	167	171
500-Year	232	192	295	232	192	295
Burnham						
1-Year	-	-	-	-	-	-
2-Year	-	-	-	-	-	-
5-Year	-	-	-	-	-	-
10-Year	56	56	56	56	56	56
25-Year	129	129	129	129	129	129
50-Year	231	212	212	212	212	212
100-Year	231	212	212	223	212	212
500-Year	219	212	212	231	212	212
Calumet City						
1-Year	-	-	-	-	-	-
2-Year	-	-	-	-	-	-
5-Year	529	529	529	529	529	529
10-Year	1,026	1,026	1,026	1,026	1,026	1,026
25-Year	2,188	2,188	2,188	2,188	2,188	2,188
50-Year	2,870	2,809	2,870	2,870	2,870	2,870
100-Year	2,870	2,837	2,870	2,870	2,870	2,870
500-Year	2,900	2,856	2,880	2,900	2,900	2,880
Chicago						
1-Year	213	213	460	213	213	213
2-Year	643	643	643	643	643	643
5-Year	1,056	1,056	1,065	1,056	1,056	1,056
10-Year	1,916	1,797	2,403	1,724	1,724	1,724
25-Year	33,267	33,619	34,497	24,539	25,072	24,631

Source: Army Corps. of Engineers, GLIMRIS Report - Appendix E

Storm Event Level	No Separation (Current TARP)	Mid-System Separation (Current TARP)	Lakefront Separation (Current TARP)	No Separation (Completed TARP)	Mid-System Separation (Completed TARP)	Lakefront Separation (Completed TARP)
50-Year	65,153	67,770	78,421	54,236	55,329	55,055
100-Year	82,960	86,345	95,176	75,128	75,869	76,683
500-Year	99,138	101,293	108,609	93,764	91,962	98,651
Dolton						
1-Year	439	439	439	439	439	439
2-Year	1,017	1,017	1,017	1,017	1,017	1,017
5-Year	1,986	1,986	1,986	1,986	1,986	1,986
10-Year	2,763	2,763	2,763	2,763	2,763	2,763
25-Year	2,854	2,819	2,854	2,854	2,854	2,854
50-Year	3,071	2,953	3,071	3,071	3,071	3,071
100-Year	3,071	3,022	3,071	3,071	3,071	3,071
500-Year	3,176	3,115	3,176	3,176	3,176	3,176
Evanston						
1-Year	-	-	-	-	-	-
2-Year	-	-	-	-	-	-
5-Year	-	-	-	-	-	-
10-Year	-	-	18	-	-	-
25-Year	-	-	18	18	-	18
50-Year	360	360	427	360	360	607
100-Year	509	564	856	478	478	694
500-Year	839	870	1,154	779	779	1,041
Forest View						
1-Year	-	-	-	-	-	-
2-Year	-	-	-	-	-	-
5-Year	-	-	-	-	-	-
10-Year	-	-	-	-	-	-
25-Year	-	-	-	-	-	-
50-Year	37	30	57	30	30	30
100-Year	57	48	57	48	48	48
500-Year	57	57	70	57	57	57
Harvey						
1-Year	-	-	-	-	-	-
2-Year	43	43	43	43	43	43
5-Year	442	442	442	44	442	442
10-Year	469	469	469	469	469	469

Source: Army Corps. of Engineers, GLIMRIS Report - Appendix E

Storm Event Level	No Separation (Current TARP)	Mid-System Separation (Current TARP)	Lakefront Separation (Current TARP)	No Separation (Completed TARP)	Mid-System Separation (Completed TARP)	Lakefront Separation (Completed TARP)
25-Year	2,395	2,395	2,395	2,395	2,395	2,395
50-Year	2,730	2,669	2,688	2,688	2,688	2,688
100-Year	3,192	2,974	2,997	2,997	2,997	2,997
500-Year	3,604	3,289	3,478	3,456	3,456	3,456
Palos Hills						
1-Year	31	31	31	31	31	31
2-Year	31	31	31	31	31	31
5-Year	55	52	55	55	55	55
10-Year	1,158	69	1,158	1,158	1,158	1,158
25-Year	1,225	1,184	1,225	1,225	1,225	1,225
50-Year	1,285	1,266	1,285	1,285	1,285	1,285
100-Year	2,173	2,119	2,173	2,173	2,173	2,173
500-Year	2,389	2,178	2,547	2,389	2,388	2,394
South Holland						
1-Year	-	-	-	-	-	-
2-Year	45	-	45	45	45	45
5-Year	45	45	45	45	45	45
10-Year	130	130	130	130	130	130
25-Year	449	449	449	449	449	449
50-Year	1,106	1,079	1,106	1,106	1,106	1,106
100-Year	1,622	1,539	1,587	1,622	1,622	1,587
500-Year	2,207	1,792	2,093	2,207	2,207	2,207

Source: Army Corps. of Engineers, GLIMRIS Report - Appendix E

EXHIBIT C-9. Angler Spending for Recreational Fishing in the Chicago Region

	Category	Spending per angler-trip		Number of angler-trips *(i)*		Total angler spending	*Less to: Producers (c), (d), (e), (f)*	*Less to: Transportation (g)*	*Less to: Wholesale Trade (h)*	Total angler spending		Share in the Chicago region		Total spending in the Chicago region
(a)	Boat and motor	$49.36	x	97,486	=	$4,812,410	*68%*	*1%*	*2%*	$1,391,514	x	80%	=	$1,113,211
(a)	Bait, tackle, and gear	$13.09	x	97,486	=	$1,275,989	*41%*	*8%*	*14%*	$475,949	x	99%	=	$471,190
(b)	Marinas or yacht clubs	$12.12	x	115,979	=	$1,405,614	*0%*	*0%*	*0%*	$1,405,614	x	100%	=	$1,405,614
(b)	Fishing charters or guides	$26.74	x	115,979	=	$3,101,769	*0%*	*0%*	*0%*	$3,101,769	x	100%	=	$3,101,769
(b)	Restaurants and bars	$17.39	x	115,979	=	$2,017,028	*0%*	*0%*	*0%*	$2,017,028	x	100%	=	$2,017,028
(b)	Grocery stores	$14.31	x	115,979	=	$1,660,237	*60%*	*3%*	*9%*	$473,184	x	95%	=	$449,525
(b)	Lodging	$15.98	x	115,979	=	$1,853,399	*0%*	*0%*	*0%*	$1,853,399	x	99%	=	$1,834,865
(b)	Gas stations	$30.90	x	115,979	=	$3,583,876	*63%*	*2%*	*19%*	$598,862	x	95%	=	$568,919
(c)	Boat and motor producers									$3,286,037	x	0%	=	$0
(d)	Bait, tackle, and gear producers									$521,893	x	3%	=	$15,657
(e)	Food and beverage producers									$990,260	x	0%	=	$0
(f)	Fuel producers									$2,252,439	x	80%	=	$1,801,951
(g)	Transportation of wholesale goods									$246,510	x	30%	=	$73,953
(h)	Wholesale trade									$1,095,864	x	95%	=	$1,041,071
	Total Spending					***$ 19,710,321***				***$ 19,710,321***				***$ 13,894,751***
	Memo:													
	Non-charter fishing	*$179.91*				*$17,538,333*				*$17,538,333*				*$11,981,527*
	Charter fishing	*$117.45*				*$2,171,988*				*$2,171,988*				*$1,913,225*

Source: AEG analysis using base data from the Illinois Department of Natural Resources; Ready, et al; U.S. Bureau of Labor Statistics.

(a) Spending amounts are based on data from the 2015 Illinois Department of Natural Resources creel survey.

(b) Spending amounts are based on data for Great Lakes fishing from the 2012 survey by Ready, et al.

(c) This industry represents producers that benefit from boat and motor retail sales. We assume that 0% of the producer's value is spent in the Chicago region.

(d) This industry represents producers that benefit from bait, tackle, and gear retail sales. We assume that 3% of the producer's value is spent in the Chicago region based on U.S. Bureau of Labor Statistics employment data.

(e) This industry represents producers that benefit from grocery store retail sales. We assume that 0% of the producer's value is spent in the Chicago regiom.

(f) This industry represents producers that benefit from fuel sales. We assume that 80% of the producer's value is spent in the Chicago region.

(g) This industry represents the transportation industry that benefits from the transportation of retail goods. We assume that 30% of the transportation costs is spent in the Chicago region.

(h) This industry represents wholesale trade industry that benefit from the sales of retail goods. We assume that 95% of the wholesale costs is spent in the Chicago region.

(i) "Boat and motor" and "bait, tackle, and gear" categories only include non-charter fishing trips (68,412), while all other categories include both charter (3,626) and non-charter fishing trips. These estimates reflect fishing activity in the Illinois portion of Lake Michigan and in the Indiana portion of Lake Michigan and Indiana inland waterways.It excludes fishing activity in Illinois inland waterways due to data availability.

EXHIBIT C-10. Economic Footprint of Angler Spending for Recreational Fishing in the Chicago Region

Category	Total angler spending in the Chicago region		Final Demand Multipliers: Output	Final Demand Multipliers: Earnings	Final Demand Multipliers: Employment *(a)*		Economic Footprint: Output	Economic Footprint: Earnings	Economic Footprint: Employment
Boat and motor	$1,113,211	x	1.8826	0.6304	13.9264	=	$2,095,732	$701,768	15.5
Bait, tackle, and gear	$471,190	x	2.0428	0.5878	19.8728	=	$962,546	$276,965	9.4
Marinas or yacht clubs	$1,405,614	x	2.1665	0.6064	22.9756	=	$3,045,262	$852,364	32.3
Fishing charters or guides	$3,101,769	x	2.1665	0.6064	22.9756	=	$6,719,982	$1,880,913	71.3
Restaurants and bars	$2,017,028	x	2.1277	0.6170	22.6681	=	$4,291,630	$1,244,506	45.7
Grocery stores	$449,525	x	2.0113	0.6169	19.6249	=	$904,129	$277,312	8.8
Lodging	$1,834,865	x	1.9423	0.5365	14.3419	=	$3,563,858	$984,405	26.3
Gas stations	$568,919	x	2.0534	0.5991	18.5478	=	$1,168,218	$340,839	10.6
Boat and motor producers	$0	x				=	$0	$0	0.0
Bait, tackle, and gear producers	$15,657	x	2.1227	0.4761	9.7797	=	$33,235	$7,454	0.2
Food and beverage producers	$0	x				=	$0	$0	0.0
Fuel producers	$1,801,951	x	1.3083	0.2173	2.8338		$2,357,492	$391,564	5.1
Transportation of wholesale goods	$73,953	x	2.2532	0.5982	12.3072	=	$166,631	$44,239	0.9
Wholesale trade	$1,041,071	x	1.9532	0.5551	9.9823	=	$2,033,420	$577,898	10.4
					Direct Effects:		*$13,894,751*	*$0*	*0.0*
					Indirect Effects:		*$13,447,383*	*$7,580,228*	*236.4*
Total Economic Footprint							***$27,342,135***	***$7,580,228***	***236.4***
Memo:									
Non-charter fishing							*$23,569,630*	*$6,555,295*	*203.2*
Charter fishing							*$3,772,505*	*$1,024,933*	*33.2*

Source: AEG analysis using base data from the Illinois Department of Natural Resources; Ready, et al; U.S. Bureau of Labor Statistics; U.S. Bureau of Economic Analysis, RIMS II Multipliers.

Employment multiplier is the number of jobs due to a $1 million increase in final demand.

EXHIBIT C-11. Boater Trip Spending for Recreational Boating in the Chicago Region

	Category	Spending per boat-day		Number of boat-days *(h)*		Total boater spending	*Less to: Producers (b), (c), (d), (e)*	*Less to: Transportation (f)*	*Less to: Wholesale Trade (g)*	Total boater spending		Share in the Chicago region		Total spending in the Chicago region
(a)	Marine supplies	$6.92	x	2,149,119	=	$14,881,992	*41%*	*8%*	*14%*	$5,551,046	x	100%	=	$5,551,046
(a)	Marina services	$3.28	x	2,149,119	=	$7,043,386	*0%*	*0%*	*0%*	$7,043,386	x	100%	=	$7,043,386
(a)	Repairs and maintenance	$10.43	x	2,149,119	=	$22,425,231	*0%*	*0%*	*0%*	$22,425,231	x	100%	=	$22,425,231
(a)	Restaurants and bars	$17.75	x	2,149,119	=	$38,147,886	*0%*	*0%*	*0%*	$38,147,886	x	100%	=	$38,147,886
(a)	Grocery stores	$14.72	x	2,149,119	=	$31,627,074	*60%*	*3%*	*9%*	$9,014,033	x	100%	=	$9,014,033
(a)	Lodging	$10.90	x	2,149,119	=	$23,424,938	*0%*	*0%*	*0%*	$23,424,938	x	100%	=	$23,424,938
(a)	Gas stations	$35.50	x	2,149,119	=	$76,295,772	*63%*	*2%*	*19%*	$12,748,940	x	100%	=	$12,748,940
(a)	Recreation and entertainment	$2.94	x	2,149,119	=	$6,316,327	*0%*	*0%*	*0%*	$6,316,327	x	100%	=	$6,316,327
(a)	Shopping	$2.18	x	2,149,119	=	$4,680,443	*40%*	*10%*	*15%*	$1,638,155	x	100%	=	$1,638,155
(b)	Marine supplies producers									$6,086,892	x	3%	=	$182,607
(c)	Food and beverage producers									$18,864,191	x	0%	=	$0
(d)	Fuel producers									$47,951,306	x	80%	=	$38,361,045
(e)	General merchandise producers									$1,872,177	x	0%	=	$0
(f)	Transportation of wholesale goods									$3,577,519	x	30%	=	$1,073,256
(g)	Wholesale trade									$20,181,021	x	95%	=	$19,171,969
	Total Spending	***$104.62***				***$ 224,843,048***				***$ 224,843,048***				***$ 185,098,818***

Source: AEG analysis using base data from the Illinois Department of Natural Resources; Indiana Department of Natural Resources; U.S. Army Corps of Engineers; U.S. Bureau of Labor Statistics.

(a) *Spending amounts are based on data from the 2008 Great Lakes Recreational Boating report.*

(b) *This industry represents producers that benefit from marina supplies retail sales. We assume that 3% of the producer's value is spent in the Chicago region based on U.S. Bureau of Labor Statistics employment data.*

(c) *This industry represents producers that benefit from grocery store retail sales. We assume that 0% of the producer's value is spent in the Chicago regiom.*

(d) *This industry represents producers that benefit from fuel sales. We assume that 80% of the producer's value is spent in the Chicago region.*

(e) *This industry represents producers that benefit from general retail sales. We assume that 80% of the producer's value is spent in the Chicago region.*

(f) *This industry represents the transportation industry that benefits from the transportation of retail goods. We assume that 30% of the transportation costs is spent in the Chicago region.*

(g) *This industry represents wholesale trade industry that benefit from the sales of retail goods. We assume that 95% of the wholesale costs is spent in the Chicago region.*

(h) *Boat-days are based on data from the 2008 Great Lakes Recreational Boating report and watercraft registrations in 2016 in the Chicago region from the Illinois Department of Natural Resources and the Indiana Department of Natural Resources.*

EXHIBIT C-12. Boater Craft Spending for Recreational Boating in the Chicago Region

	Category	Annual spending per boat		Number of boats *(e)*		Total boater spending	*Less to: Producers (b)*	*Less to: Transportation (c)*	*Less to: Wholesale Trade*	Total boater spending		Share in the Chicago region		Total spending in the Chicago region
(a)	Marinas or yacht clubs	$155.30	x	94,613	=	$14,693,684	*0%*	*0%*	*0%*	$14,693,684	x	100%	=	$14,693,684
(a)	Off-season storage	$40.01	x	94,613	=	$3,785,630	*0%*	*0%*	*0%*	$3,785,630	x	100%	=	$3,785,630
(a)	Put-in and haul-out	$51.75	x	94,613	=	$4,896,383	*0%*	*0%*	*0%*	$4,896,383	x	100%	=	$4,896,383
(a)	Equipment	$535.72	x	94,613	=	$50,686,635	*78%*	*1%*	*1%*	$10,041,914	x	100%	=	$10,041,914
(a)	Repairs and maintenance	$401.55	x	94,613	=	$37,992,308	*0%*	*0%*	*0%*	$37,992,308	x	100%	=	$37,992,308
(a)	Insurance	$188.56	x	94,613	=	$17,840,063	*72%*	*1%*	*1%*	$4,449,151	x	100%	=	$4,449,151
(b)	Equipment producers									$12,931,873	x	0%	=	$0
(c)	Transportation of wholesale goods									$761,882	x	30%	=	$228,565
(d)	Wholesale trade									$851,535	x	95%	=	$808,959
	Total	***$1,372.90***				***$ 129,894,704***				***$ 90,404,361***				***$ 76,896,594***

Source: AEG analysis using base data from the Illinois Department of Natural Resources; Indiana Department of Natural Resources; U.S. Army Corps of Engineers; U.S. Bureau of Labor Statistics.

(a) *Spending amounts are based on data from the 2008 Great Lakes Recreational Boating report.*

(b) *This industry represents producers that benefit from equipment retail sales. We assume that 0% of the producer's value is spent in the Chicago region based on U.S. Bureau of Labor Statistics employment data.*

(c) *This industry represents the transportation industry that benefits from the transportation of retail goods. We assume that 30% of the transportation costs is spent in the Chicago region.*

(d) *This industry represents wholesale trade industry that benefit from the sales of retail goods. We assume that 95% of the wholesale costs is spent in the Chicago region.*

(e) *Boat amounts are based on data from the 2008 Great Lakes Recreational Boating report and watercraft registrations in 2016 in the Chicago region from the Illinois Department of Natural Resources and the Indiana Department of Natural Resources.*

EXHIBIT C-13. Economic Footprint of Boater Spending in the Chicago Region

	Category	Spending in the Chicago region		Final Demand Multipliers: Output	Final Demand Multipliers: Earnings	Final Demand Multipliers: Employment *(c)*		Economic Footprint: Output	Economic Footprint: Earnings	Economic Footprint: Employment
	Marine supplies	$5,551,046	*x*	2.0428	0.5878	19.8728	=	$11,339,677	$3,262,905	110.3
(a)	Marinas or yacht clubs	$21,737,070	*x*	2.1665	0.6064	22.9756	=	$47,093,361	$13,181,359	499.4
(b)	Repairs and maintenance	$60,417,539	*x*	1.8454	0.4830	12.372	=	$111,494,527	$29,181,671	747.5
	Off-season storage	$3,785,630	*x*	1.7042	0.3387	10.1709	=	$6,451,470	$1,282,193	38.5
	Put-in and haul-out	$4,896,383	*x*	2.2532	0.5982	12.3072	=	$11,032,531	$2,929,017	60.3
	Equipment	$10,041,914	*x*	1.8826	0.6304	13.9264	=	$18,904,908	$6,330,423	139.8
	Insurance	$4,449,151	*x*	1.8454	0.483	12.372	=	$8,210,463	$2,148,940	55.0
	Restaurants and bars	$38,147,886	*x*	2.1277	0.617	22.6681	=	$81,167,257	$23,537,246	864.7
	Grocery stores	$9,014,033	*x*	2.0113	0.6169	19.6249	=	$18,129,926	$5,560,757	176.9
	Lodging	$23,424,938	*x*	1.9423	0.5365	14.3419	=	$45,498,256	$12,567,479	336.0
	Gas stations	$12,748,940	*x*	2.0534	0.5991	18.5478	=	$26,178,672	$7,637,890	236.5
	Recreation and entertainment	$6,316,327	*x*	2.0787	0.5285	17.3557	=	$13,129,748	$3,338,179	109.6
	Shopping	$1,638,155	*x*	2.0428	0.5878	19.8728	=	$3,346,423	$962,908	32.6
	Marine supplies producers	$182,607	*x*	2.1227	0.4761	9.7797	=	$387,619	$86,939	1.8
	Food and beverage producers	$0	*x*				=	$0	$0	0.0
	Fuel producers	$38,361,045	*x*	1.3083	0.2173	2.8338	=	$50,187,755	$8,335,855	108.7
	General merchandise producers	$0	*x*				=	$0	$0	0.0
	Equipment producers	$0	*x*				=	$0	$0	0.0
	Transportation of wholesale goods	$1,301,821	*x*	2.2532	0.5982	12.3072	=	$2,933,262	$778,749	16.0
	Wholesale trade	$19,980,928	*x*	1.9532	0.5551	9.9823	=	$39,026,749	$11,091,413	199.5
						Direct Effects:		*$261,995,412*	*$0*	*0.0*
						Indirect Effects:		*$136,635,384*	*$110,958,057*	*3374.6*
	Total Economic Footprint							***$398,630,796***	***$110,958,057***	***3,374.6***

Source: AEG analysis using base data from the Illinois Department of Natural Resources; Indiana Department of Natural Resources; U.S. Army Corps of Engineers; U.S. Bureau of Labor Statistics; U.S. Bureau of Economic Analysis, RIMS II Multipliers.

(a) *This is the sum of the "marinas or yacht clubs" under trip spending and "marinas services" under craft spending.*

(b) *This is the sum of "repairs and maintenance" under trip spending and craft spending.*

(c) *Employment multiplier is the number of jobs due to a $1 million increase in final demand.*

Appendix D. About AEG

Anderson Economic Group, LLC, is a boutique consulting firm founded in 1996, with offices in East Lansing, Chicago, New York, and Istanbul. Our team has a deep understanding of advanced economic modeling techniques and extensive experience in the impacts of policy and economic changes in multiple states and countries. We are experts across a variety of fields in tax policy, strategy and business valuation, public policy and economic analysis, and market and industry analysis.

Anderson Economic Group has performed work on a number of environmental economics issues. Relevant publications from our firm include:

- "The Costs of Aquatic Invasive Species to Great Lakes States," updated published in 2017.
- "Innovating for the Blue Economy," published in 2014.
- "Financing the Battle Against Invasive Species," published in 2010.
- "Four Plausible Scenarios that Could Emerge from Court Ruling on the EPA's Clean Power Plan," published in 2016.
- "Analysis of Michigan's Options Under the EPA's Clean Power Plan," published in 2016.

Past clients of Anderson Economic Group include:

- *Governments:* The government of Canada; the states of Michigan, North Carolina, and Wisconsin; the cities of Detroit, Cincinnati, and Sandusky; counties such as Oakland County, and Collier County; and authorities such as the Detroit-Wayne County Port Authority.
- *Corporations:* Ford Motor Company, First Merit Bank, Lithia Motors, Spartan Stores, Nestle, and InBev USA; automobile dealers and dealership groups representing Toyota, Honda, Chrysler, Mercedes-Benz, General Motors, Kia, and other brands.
- *Nonprofit organizations:* The Nature Conservancy of Michigan, Convention and visitor bureaus of Lansing, Ann Arbor, Traverse City, and Detroit, and Experience Grand Rapids; higher education institutions including the University of Chicago and University of Michigan; trade associations such as the National Association of Realtors, Service Employees International Union, the Chicago Loop Alliance, Automation Alley, and the Michigan Chamber of Commerce.

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Mr. Horwitz has advised governments, trade organizations, and corporations across the country on economic issues and the impacts of policy. His work also includes economic impact studies on universities, hospitals, museums, retailers, and large-scale events. His work has been featured in Bloomberg Businessweek, NPR Marketplace, Chicago Sun-Times, Detroit News, Crain's Chicago Business, and on WBEZ Radio.

Prior to joining AEG, Mr. Horwitz was the Coordinator of Distribution for the Community Center of St. Bernard near New Orleans, where he oversaw the distribution of donated food, clothes, and household supplies to low-income residents of St. Bernard Parish and New Orleans' Lower Ninth Ward.

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At AEG, Mr. Peterson has performed research and analysis for a number of clients, including advocacy groups, businesses, and local governments. His recent work includes fiscal impact analyses of Illinois and Michigan pension systems; property tax analyses for new real estate developments in Illinois and Michigan; and analysis of business tax burdens among all 50 states.

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