



South Branch of the Chicago River

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## Re-Envisioning the Chicago River: Adopting Comprehensive Regional Solutions to the Invasive Species Crisis

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In response to a public health emergency more than 100 years ago, engineers reversed the Chicago River and built the Chicago Sanitary and Ship Canal to carry wastewater away from Lake Michigan, the city's source of drinking water. The canal also provides a shipping link between the Mississippi River and the Great Lakes, opening navigation not only to recreational boats and commercial barges, but also to invasive species, and it diverts massive amounts of water from Lake Michigan. The unfolding Asian carp crisis reveals more than just the challenges faced by local, state, and federal agencies in stopping invasive species from entering the Great Lakes. It also exposes critical infrastructure deficiencies in the region's wastewater, stormwater, and transportation systems.

The Natural Resources Defense Council (NRDC) believes the crisis represents an unprecedented opportunity to rethink the way this infrastructure functions and develops comprehensive solutions to end invasive species traffic between the Great Lakes and the Mississippi River. Equally important is protecting and enhancing the water resources that more than 40 million people in the Great Lakes region rely on for drinking water, fishing, recreation, and commerce.



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## Asian Carp: The Face of the Current Crisis, but Not the Last

Federal and state officials call the migration of bighead and silver Asian carp from the Illinois and Des Plaines rivers “the most recent and likely most acute AIS [aquatic invasive species] threat facing the Great Lakes today.”<sup>1</sup> Since November 2009, environmental DNA (eDNA) evidence has indicated that invasive Asian carp have made their way past electric barriers in the Chicago Area Waterway System (CAWS) that are intended to prevent the big, hungry fish from colonizing Lake Michigan.<sup>2,3</sup> In June 2010, a live bighead Asian carp was captured in Lake Calumet, 6 miles from Lake Michigan, past all barriers between it and the Lake, including the Army Corps of Engineers’ electric barrier system intended to provide the primary defense against the carp’s advance.<sup>4</sup>

If Asian carp are allowed to establish themselves in the Great Lakes, it could have a devastating impact on Great Lakes fisheries and irrevocably change the ecosystem of the lakes and rivers throughout the watershed. Asian carp are voracious filter feeders that primarily consume plankton at the base of the food chain. Asian carp also breed multiple times each year, giving them a well-documented ability to outcompete native fish species and take over ecosystems. Once established, eradicating them is nearly impossible.

Worse, the silver and bighead carp are simply the latest invasive species threatening to move between the Mississippi River and the Great Lakes. More could follow, including blue catfish and Brazilian waterweed.<sup>5</sup> At least eight other species pose invasive threats in the opposite direction, from the Great Lakes to the Mississippi River, including water chestnut, bloody red shrimp and Eurasian ruffe, further exacerbating a problem that stresses our ecosystems and costs the American economy billions of dollars every year.<sup>6,7</sup> Until the underlying cause of invasive species movement between the Great Lakes and the Mississippi River is addressed, future invasions are inevitable, regardless of the outcome of the Asian carp crisis.

## Permanent Separation: One Solution to Many Problems

While debate continues about how to best respond to the Asian carp threat, there is a growing consensus within the Great Lakes community, in both the United States and Canada, that the invasive species problem needs a permanent, long-term solution: separation of Lake Michigan from the Mississippi River Basin.<sup>8</sup>

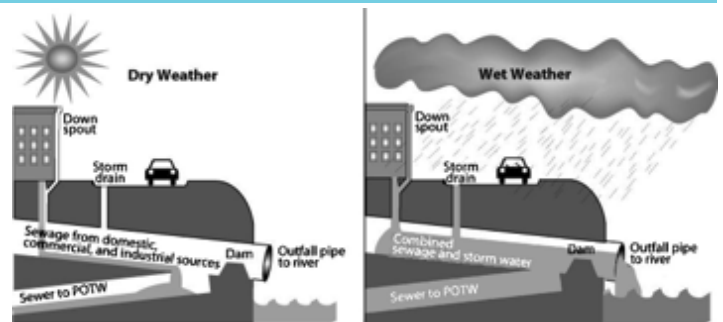
Hydrological or permanent separation does not mean arbitrarily closing the locks or the canal system. Under this alternative, barriers would be constructed strategically in the CAWS to minimize the disruption to existing navigation while eliminating any movement of water between the two ecosystems. Economic impacts on water-based commerce could even be turned into long-term benefits through the construction of new intermodal facilities and other support mechanisms.

Permanent separation could also enable the entire region to rethink its outdated systems for moving goods and managing wastewater and stormwater:

1. The region’s transportation network is inadequate to meet current demand and will fail to capitalize on forecasted future demand without significant reinvestment.<sup>9</sup> Goods are forced to sit idle as they slowly work their way through an archaic network of holding facilities as they move to their final destination. Restoring the natural divide between the Great Lakes and the Mississippi River system could stimulate construction of new intermodal facilities that would reroute commercial traffic from the CAWS, resulting in economic gain and a more efficient and sustainable regional transportation system.
2. The Chicago area’s basic means and theory of handling wastewater and stormwater have not evolved with the technological changes and improvements of the last decades, even as its traditional approach continues to escalate in cost. Canals and sewers are challenged by their inability to properly handle increasing runoff brought on by development, and the predicted increased intensity of

## Chicago’s Stormwater and Sewer System is Showing Its Age

The Chicago region has combined sewers, which means sanitary sewage and stormwater runoff are collected in a single pipe system. Under dry weather, or normal rain events, the system is able to process both types of water. However, during more substantial rains, the system can’t process the water rapidly enough, resulting in combined sewer overflows (CSOs), by which diluted sewage is released into the Chicago River, Lake Michigan, or peoples’ basements. CSOs are a serious threat to water quality. In 2009, there were 261 outfall locations in the CAWS; 2,036 discharge events occurred, resulting in flooded basements, closed beaches, and threats to drinking water quality.<sup>10</sup>



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storm events due to climate change will further strain these systems. A comprehensive plan to permanently separate the watersheds would create an opportunity to incentivize investments to substantially reduce the risk of flooding and fix long-standing water quality problems through deployment of Green Infrastructure and long-overdue upgrades in sewer systems and wastewater treatment in the CAWS.<sup>11</sup>

Designing and implementing permanent separation will require detailed analysis across a range of disciplines, including hydrology, transportation, and logistics. NRDC has begun to analyze these issues and retained an engineering firm, Shaw Environmental, to study the hydrologic impacts of permanent separation. This brief summarizes the initial findings of our (NRDC and Shaw) analysis, reflecting broad input from governmental, technical, stormwater and wastewater conveyance system experts, and civic stakeholders who commented on the ongoing analysis and presentations on the technical findings and assessments. In the coming months, NRDC will release additional materials in its effort to “Re-Envision the Chicago River,” including technical details on the analysis described in this issue brief.

### Understanding the Region’s Hydrology

As a result of the reversal of the Chicago River, Lake Michigan became a tributary to the Chicago, Des Plaines, Illinois, and Mississippi rivers, as well as the Gulf of Mexico. Law suits filed by other states resulted in a U.S. Supreme Court ruling that established the amount of water that the City of Chicago is allowed to divert from Lake Michigan on a daily basis to support navigation, provide drinking water, and help dilute wastewater discharged to the CAWS.<sup>12</sup>

We identified the hydrologic impacts of separating the Great Lakes from the Mississippi River within the CAWS by studying how water currently flows through the region under normal and storm conditions; how the expected effects of climate change might affect wastewater and stormwater systems; and how permanent separation could affect floodplain limits, stormwater management practices, combined sewer overflows, water quality, and basement flooding. We also explored how Green Infrastructure—the use of natural systems, such as wetlands, street trees, and other types of vegetation to infiltrate, store, and treat stormwater instead of the “hard infrastructure” that is traditionally used, including pipes, pumps, and storage tunnels—could mitigate some of those impacts and actually improve water management and quality of life within the watershed.

As part of this analysis, NRDC facilitated meetings with government and nongovernment experts on hydrology, the CAWS, and Green Infrastructure to critique findings and suggest additional areas of inquiry.

### Analyzing Rainfall and System Performance

Basement flooding is pervasive throughout the Chicago region. Using data from the National Oceanic Atmospheric Administration (NOAA), we characterized the rainfall events reported by the O’Hare Airport station between 1996 and 2010. Based on documents and consultations with City of Chicago personnel, we related rainfall to the performance of the wastewater and stormwater systems in the region:

- Though local flooding may occur, the current systems operate as designed for approximately 87 percent of all rain events each year, when rainfall is 0.67 inches or less in a 24-hour period.
- As rainfall exceeds 0.67 inches, which is approximately 13 percent of all rain events during a given year, water enters the system too quickly and some water must be diverted to the Metropolitan Water Reclamation District of Greater Chicago’s (MWRD) deep tunnel system for future treatment.
- Combined sewer overflows (CSOs) begin to occur when rainfall is between 0.67 to 1.5 inches (about 6 percent of rainfall events in a year). CSOs refer to rain events where sewage mixed with rainwater is released into area waterways and floods people’s basements. CSOs are a serious threat to water quality, human health, and quality of life.
- Seven percent of storms in a year typically average more than 1.5 inches of rain, resulting in CSOs and system flooding of basements and streets. They may also result in the untreated mix of stormwater and sanitary waste being discharged to Lake Michigan to prevent further flooding within the City of Chicago.

Research conducted by the University of Illinois and Texas Tech University for the Chicago Climate Action Plan suggests that precipitation could increase by as much as 20 percent by the end of the century.<sup>13</sup> However, the frequency of extreme storm events, when more than 2.5 inches of rain fall within a 24-hour period of time, could increase 50 percent by 2039 and 80-160 percent by the end of the century.<sup>14</sup> These events would be seen mostly in the spring and winter. If this were to happen, there would be fewer storm events in the 0.0 to 0.67 inches per year range, where the system can manage the resulting volume of runoff, and more storms with greater amounts of rain that result in CSOs and bypass treatment provided by the water reclamation plants.

## Water Facts

### Exploring Options for Permanent Separation

We reviewed six possible sites for a separation barrier, using a report issued by the Great Lakes Fishery Commission and authored by the Alliance for the Great Lakes as a starting point. We evaluated these possible sites based on their potential to adversely impact wastewater and stormwater management, navigation and recreational impacts, and maximize potential community and system benefit.

- The four existing control structures—Wilmette, O'Brien, Chicago, and Calumet—would be the easiest to implement in the shortest amount of time because their permanent closure could be the separation structure. However, these locations were rejected because they could increase the risk of flooding and seriously disrupt navigation and recreational traffic.
- A structure at or between the confluence of the Chicago Sanitary and Ship Canal, the Cal-Sag Channel, and the Lockport Lock and Powerhouse had the benefit of protecting two watersheds with a single structure, but was also rejected because this could cause the greatest disruption to current barge traffic.
- Ultimately, we chose to model permanent separation at two locations on the city's Southside: between the Racine Pump Station and Lake Michigan and in between the Calumet Wastewater Treatment Facility and Lake Michigan. Our analysis showed that these locations:
  - Minimize impacts of higher discharge from MWRD facilities during storm events
  - Focus the investment in water quality improvements in a few key wastewater treatment facilities whose capacities could be further expanded with the use of green infrastructure, including street trees, bioswales (gently sloping areas filled with vegetation and/or compost), and permeable pavement, throughout the neighborhoods
  - Leave recreation traffic largely unaffected
  - Provide greatest potential for flood protection

Separation at these sites has one significant challenge: it could cut off barge and boat traffic passing through to Lake Michigan and downtown. Further analysis is needed on current and future goods movement and opportunities to create new intermodal facilities that could accommodate and perhaps complement this traffic.

It is also critical to understand that if a hydrological barrier was installed, existing water levels in the Chicago River, the North Branch, and any other waterways upstream of the barriers would have to be maintained to prevent flooding. In the short run, large volumes of water would have to be pumped from the Chicago River into the Sanitary and Ship Canal in a manner that ensures invasive species are not transferred from one waterbody to another.

### Chicago Waterways and Possible Locations for Permanent Separation Barriers



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If the water were pumped into Lake Michigan, rather than *from* it, additional water quality concerns also come into play. Currently, the MWRD does not have to meet much stricter Lake Michigan Water Quality Standards for the water it treats and pumps into the Chicago Sanitary and Ship Canal. Of particular concern would be potential levels of bacteria, phosphorous, and possibly ammonia and mercury. The technology exists to treat Chicago's waste to the same level as other cities do before discharging into Lake Michigan. But it would require a substantial new investment in existing wastewater treatment facilities.

### Addressing Neighborhood Impacts of Storms and Floods



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Severe storms and heavy rainfall in the summers of 2007 and 2008 resulted in tens of thousands of flooded basements and scores of flooded streets. Climate change suggests these types of rain events will occur more frequently in the future. The use of Green Infrastructure could mitigate some of those impacts. Street trees and bioswales help absorb water and slow its descent into sewer pipes; native plants have deep, fibrous roots that can also absorb rainwater more effectively than non-native plants.



### Impacts of Green Infrastructure

The conveyance ability of traditional gray infrastructure (pipes, pumps and treatment plants) can be expanded by detaining/retaining stormwater runoff before it reaches the sewer system. We illustrated this management approach using a study area on the northwest side of Chicago, which is fairly typical of neighborhoods found throughout the metropolitan area. The study area has approximately 1,880,000 square feet of impervious area from a mixture of single-family homes as well as a number of multifamily homes and commercial areas.

We quantified the reduction in the volume of stormwater runoff (and its corresponding pollutant reduction in CSOs) that could be taken up by specific Green Infrastructure practices applied to a demonstration area including, rain barrels and associated hanging gardens, street trees, urban bioswales, and conversion of alleys and parking lanes to permeable pavement. Our analysis found that the use of Green Infrastructure could have a significant impact. By installing street trees, bioswales, raingardens, and porous pavement on 50 percent of the available impervious area within the study site, it was estimated that there would be a:

- 30 percent reduction in the volume of water entering the sewer system, reducing the number of CSOs and corresponding pollutants discharged to the river by 30 percent
- 30 percent reduction in pollutants entering the sewer system, potentially reducing treatment needs farther down

Green Infrastructure has other benefits as well—it improves the aesthetics of a street and neighborhood. Consider the pictures above. The commercial strip on the left is devoid of vegetation and unappealing. The commercial strip on the right is a much more inviting place to live and work. The addition of street trees, bioswales, and a strip of permeable paving not only augments existing stormwater infrastructure by cleaning and slowing water entry into a sewer system, but also provides a more aesthetically pleasing, functional environment.

### Moving Toward a Comprehensive Solution to Regional Challenges

NRDC has just begun its investigation into the feasibility of permanently separating the Great Lakes from the Mississippi River. This paper reflects our analysis of the challenges already facing our aging wastewater and stormwater systems. We suggest solutions to the invasive species issue that could create neighborhood benefit, improve water quality, and bring key parts of Chicago's infrastructure into the 21st century. These issues must be addressed if the region is to grow and prosper. If we take advantage of the opportunities, the benefits will range far beyond northeastern Illinois. The Great Lakes provide drinking water to more than 40 million people. Tens of thousands of people depend on the Great Lakes multibillion dollar fishing and tourism industries. More than a third of all the freight in this country moves through Chicago, and if Chicago's ports and railways can be modernized to move more goods, the economic benefit would be multiplied across the country. Many cities in this country face the same challenges of updating centuries-old wastewater and stormwater systems. Chicago can lead the way in determining how to maximize the use of new technology, such as Green Infrastructure, to make its infrastructure more resilient and extend its useful life.

There is much more work to do. While the analysis is far from complete, it does suggest that a different future could await the region. NRDC will continue to refine this analysis to better understand how additional neighborhoods and treatment systems could be affected and improved by permanent separation; how the region can rethink goods movement to increase economic activity; and how to engage affected stakeholders in this process.

## ENDNOTES

- <sup>1</sup> Asian Carp Workgroup, "Draft Asian Carp Control Strategy Framework," February 2010, 1.
- <sup>2</sup> The University of Notre Dame developed eDNA testing to improve monitoring for invasive species. Fish DNA is released into the water in several ways, including the shedding of mucus, feces and urine. eDNA testing takes water samples and filters it for fragments of DNA, which can be left suspended in water for days. While the eDNA methodology is considered cutting edge, federal agencies, including the USEPA and the ACOE, consider it "sufficiently reliable and robust in reporting a pattern of detection that should be considered actionable in a management context."
- <sup>3</sup> According to the Illinois Environmental Protection Agency, "the Chicago Area Waterways System, or CAWS, consists of 78 miles of canals and modified streams located within Cook and surrounding counties. The CAWS consists of the Chicago River, its two main branches (North Branch and South Branch), as well as the Cal-Sag Channel, the Chicago Sanitary and Ship Canal, and the tributaries in an area extending from the metropolitan Chicago area to the Lockport vicinity. It also includes Lake Calumet." <http://www.epa.state.il.us/mailman/listinfo/chicago-area-waterways>.
- <sup>4</sup> "Carp creeps into Lake Calumet," Joel Hood, *Chicago Tribune*, 23 June 2010, <http://www.chicagotribune.com/news/local/ct-met-0624-asian-carp-found-20100623,0,3511274.story>
- <sup>5</sup> Christopher L. Jerde et al, "Aquatic Invasive Species Risk Assessment for the Chicago Sanitary and Ship Canal," Center for Aquatic Conservation, University of Notre Dame, 2010, 24-25.
- <sup>6</sup> Jerde et al, 26.
- <sup>7</sup> David Pimentel, Rodolfo Zuniga and Doug Morrison, "Update on the Environmental and Economic Costs Associated with Alien-Invasive Species in the United States," *Ecological Economics* 52 (2005): 273.
- <sup>8</sup> Numerous state and local governments, nonprofit organizations and editorial boards have called for permanent, i.e. ecological or hydrological, separation. See: The Great Lakes Commission, chaired by Illinois Governor Pat Quinn ("Actions to Address the Threat to the Great Lakes from Asian Carp," *Great Lakes Commission / Commission Des Grands Lacs*, <http://www.glc.org/about/resolutions/10/asiancarp.html>); Great Lakes United ("Battling Back the Asian Carp | Great Lakes United / Union Saint-Laurent Grands Lacs," <http://www.glu.org/asiancarp>), National Wildlife Federation; the governors of Ohio ("Governor, Lt. Governor Call for Vigilance, Collaborative Action to Protect Lake Erie from Invasive Species Asian Carp," Ohio.gov., State of Ohio, 8 Feb. 2010, <http://www.governor.ohio.gov/Default.aspx?tabid=1511>); Wisconsin ("Testimony by Matt Frank, Secretary of the Wisconsin Department of Natural Resources Before the U.S. House Transportation and Infrastructure Subcommittee on Water Resources and Environment," 2010); and Michigan ("Granholm, Cherry Urge Attorney General Cox to Pursue Every Legal Means to Keep Asian Carp Out of Great Lakes," *SOM - State of Michigan*, 2 December 2009, <http://michigan.gov/gov/0,1607,7-168-23442-227176--,00.html>); the Metropolitan Milwaukee Sewerage District ("Supporting Measures for Protecting Lake Michigan from Asian carp," Milwaukee Metropolitan Sewerage District, Certified Resolution No. 10-057-4, 26 April 2010, [http://v3.mmsd.com/proceedings\\_resolutions.aspx](http://v3.mmsd.com/proceedings_resolutions.aspx)). *The Cleveland Plain-Dealer* ("Shelve the Politicking and Do What's Necessary to Preserve the Great Lakes from a Devastating Asian Carp Infestation: Editorial," *Cleveland Plain-Dealer* 22 February 2010), the *Milwaukee Journal-Sentinel* ("A Futile Search," *Milwaukee Journal-Sentinel* 19 Mar. 2010, <http://www.jsonline.com/news/opinion/88691417.html>) and the *Kalamazoo Gazette* ("Time for Action to Halt Spread of Asian Carp," Editorial, *Kalamazoo Gazette* 6 December 2009, Mlive.com, 6 December 2009, [http://www.mlive.com/opinion/kalamazoo/index.ssf/2009/12/editorial\\_time\\_for\\_action\\_to\\_h.html](http://www.mlive.com/opinion/kalamazoo/index.ssf/2009/12/editorial_time_for_action_to_h.html)) have all editorialized on the need for a permanent separation. In 2003, a local, state, and federal interagency group hosted the Chicago Aquatic Invasive Species Summit, where more than 70 experts agreed that stopping water movement between the Great Lakes and Mississippi River was the only way to eliminate the movement of invasive species ("Proceedings of Closing the Revolving Door: Summary of the Aquatic Invasive Summit Proceedings," Chicago, 2003, <http://www.cityofchicago.org/.../InvasiveSpecies/AquaticInvasiveSpeciesSummitSummary2003.pdf>). A 2008 report released by the Great Lakes Fishery Commission and authored by the Alliance for the Great Lakes also recommended separation (Joel Brammeier, Irwin Polls, Scudder Mackey, "Preliminary Feasibility of Ecological Separation of the Mississippi River and the Great Lakes to Prevent the Transfer of Aquatic Invasive Species," Great Lakes Fishery Commission, 2008).
- <sup>9</sup> Chicago Metropolis 2020, "The Metropolis Freight Plan: Delivering the Goods," December, 2004, 3.
- <sup>10</sup> Metropolitan Water Reclamation District, "CSO Event Synopsis Report." <http://www.mwrd.org/irj/portal/anonymous?NavigationTarget=navurl://a5611bcef89c3cc2abca008c0ea969df>
- <sup>11</sup> Green Infrastructure is the use of natural systems, such as wetlands, street trees, and other types of vegetation to store and treat stormwater instead of the "hard infrastructure" that is traditionally used, such as pipes, pumps, and storage tunnels. Increased use of Green Infrastructure could provide additional storage capacity to wastewater and stormwater treatment facilities, potentially forestalling additional hard infrastructure investment.
- <sup>12</sup> *Wisconsin v. Illinois*, 388 U.S. 426 (1967).
- <sup>13</sup> Katharine Hayhoe and Donald Wuebbles, *Climate Change and Chicago: Projections and Potential Impacts*, Chapter Three: Water, 11 November 2007, 3, 8.
- <sup>14</sup> Katharine Hayhoe and Donald Wuebbles, 8.