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A Unique Solution to Chicago's Water Pollution: Tunnels and Reservoirs

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ABSTRACT

For more than 125 years Chicago has been diverting water from Lake Michigan to serve its domestic/industrial water needs, to dilute the city's polluted waters, and to enable navigation to Chicago from the Illinois River system. These diversions created a series of controversies with other lake states and seven of these controversies have gone to the U.S. Supreme Court. The city of Chicago has faced serious water pollution problems since the 1870s and made adjustments to use lake waters to move its polluted waters down the Illinois River. Heavy rains brought in-city flooding and to relieve the flooding, polluted waters were often released into Lake Michigan, an undesirable act since the lake is the city's source of water. In the 1960s the city proposed a costly solution, construction of 110 miles of large water storage tunnels under the city. This unique tunnel and reservoir project (TARP) has been built largely with federal funding, and has been found to handle most rainstorms except for infrequent storms having multi-hour rainfall amounts in the 100-year category. In summary, TARP has been found to be a very valuable system for reducing urban flooding and the spread of pollution into the lake or down the Illinois River. It addresses the hydrology and water quality of a large region. Now the Asian Carp is causing a new controversy affecting the diversion and water treatment.

INTRODUCTION: HISTORY OF THE DIVERSION

Chicago developed alongside Lake Michigan in the 19th Century and was built in the basin of a small river, later named the Chicago River, that flowed into the lake. All wastes were dumped into the river for decades, an act that polluted the lake and often the city's source of drinking water. A major epidemic resulted in 1885 and 90,000 residents died. The first action of the city was to move its water intakes 2 miles out in the lake (with tunnels back to the city) to try to escape the polluted waters (Neil and Dalton, 1980).

The city sought other solutions for drainage of its polluted river waters. One chosen was 1) to use the Illinois & Michigan Canal (I & M) from the Chicago River's southern headwaters to drain city waters into the headwaters of the Illinois River, located 45 miles away, and 2) to build a dam where the river exited into the lake (Fig. 1). The I&M Canal was deepened in 1865 to facilitate drainage, and the lake water could be diverted and pumped downstream. Lake waters came at the site where the river ran into the lake. St.

Louis and other cities downstream along the Illinois and Mississippi Rivers, fought this solution but the Supreme Court allowed Illinois continue the diversion into the Illinois River (Changnon et al., 1994).

After the epidemic of 1885, Chicago leaders acted to dilute the polluted water and reduce down river worries. Chicago began diverting large amounts of water from the lake at the river's mouth, typically 10,000 cfs. By 1900, to facilitate movement of this large volume of diverted water, and to facilitate barge movements on the canal-river system, the city built a much larger canal, the Sanitary and Ship Canal, from the south branch of the Chicago River to the Des Plaines River at Lockport where locks and a dam were built (Fig. 1). The Des Plaines River flowed into the Illinois River. The large flow of water through the Sanitary and Ship Canal, and ultimately into the Illinois River, also allowed passage of a large amount of shipping between downstream locales and Chicago.

The city also built a connection from the lake to the north branch of the river in1907 with a pumping station at Wilmette (Fig.1) to move the polluted water on the city's north side downstream. In 1910 the city built another canal (Calumet-Sag Channel)) that used the Calumet River to connect to the south end of the lake, and it served to move polluted water from the city's south side to the Sanitary Canal. Thus, there were three locations to access lake water so as to dilute the city's waste waters that ultimately flowed down the Illinois River (Fig. 1).

The large diversion of lake waters for water supply, for dilution of polluted waters, and for navigation raised concerns in other states around the Great Lakes, particularly as lake levels dropped during the dry 1920 and 1930s. The industries that used lake water and relied on shipping of large amounts of iron ore and coal on the Great Lakes were also deeply concerned. The lake states legally challenged Chicago's diversion through Congress. The disagreements ultimately went to the Supreme Court seven times during the 1930-1980 period (Changnon and Changnon, 1996). The Court's final resolution between Illinois and lake states in 1964 set the level for diversion at 3,200 cfs. This amount was for three uses: 1) domestic (Chicago and suburban) water supply (62%), 2) sewage dilution (22%), and 3) navigation (16%). The 3200 cfs, as measured in the Sanitary and Ship Canal, was to include diverted lake water and the runoff of the rain water that fell over the city.

Experience showed that when rains were 2 inches or more in one day, the river-canal drainage system could not handle the volume. Flooding then resulted and so the city quickly released the polluted stormwater into the lake. Rainwater became severely polluted because, at the time Chicago was built, the city took the least expensive option and installed a single set of drain pipes instead of a set for rain and a set for sewage. Vast amounts of polluted stormwater frequently existed and these were often released into Lake Michigan when heavy rains fell. These releases into the lake created major problems for the city's water supply.

A UNIQUE SOLUTION TO POLLUTION

Chicago faced continuing pressures during and after the 1940s to stop polluting Lake Michigan with its stormwater releases. These endangered Chicago's water supplies taken

locally from the lake and in summer also led to beach closings. Then in the 1960s, the nation had a new theme—environmental protection emerged. This put additional pressure on any acts that polluted the Great Lakes, and so a new issue faced Chicago and its release of polluted stormwaters into Lake Michigan. Illinois also wanted all stormwaters to go down the Illinois River since this water was a part of the annual accounting of the total diversion amount. Thus, if Illinois released stormwater into the lake it could not count this water as part of the diversion and had to divert more lake water against its limit of 3,200 cfs.

In 1967 the Metropolitan Sanitary District (MSD) of Chicago proposed a unique solution: construction of a reservoir-tunnel system to store stormwaters underground in Chicago until the waters could be pumped up, treated, and then released into the canal-river system. The city also proposed upgrades of the water treatment plants and construction of new interceptor sewers (Neil and Dalton, 1980). This plan labeled the tunnel and reservoir project (TARP), would curb local flooding and prevent water pollution in the lake or river drainage system. It was really the only way Illinois could meet the 3,200 cfs diversion limit and its share of polluted waters that needed dilution. The TARP plan called for 131 miles of tunnels of 35-foot diameter to be built 150 to 300 feet below existing riverways and in Silurian dolomite rock, plus construction of three large surface reservoirs. These tunnels and reservoirs were intended to hold the polluted stormwater when heavy rains occurred over Chicago. After surface flood waters had receded, the stormwater in the tunnels was to be pumped up, treated at the sewage plants along the rivers and canal, and then released into the Des Plaines River. The city also developed a “Rain Blocker System”, which cost $75 million. These devices were installed at street drains and were designed to slow the inflow from the sewer system during rains.

In 1977 the MSD got federal funds from EPA (furnished 75% of the total Phase 1 funding needed) and construction began. Actions to reduce pollution of the Great Lakes helped justify multi-billion dollars of federal funding. Phase 1 of the plan was aimed at pollution reduction and was to consist of 110 miles of tunnels to be done by 1979. Phase 2, which included 21 more miles of tunnels and 3 surface reservoirs, was primarily for flood relief and was scheduled to be done by 1982.

The deep tunnel project got its first funding in 1977, and in 1978 MSD was pressing the federal government for more funds to meet the projected costs of $3.7 billion (Injerd, 1993). In 1980 the MSD claimed the backflows to Lake Michigan would be eliminated by TARP. By 1987 some of Phase 1, 47 miles of tunnels, was completed. Phase 1 was nearing completion in the early 1990s, but the MSD predicted that Phase 1 would not be done until 1996, 17 years after the planned completion date. Phase 2 was then scheduled to be done by 1995, but was still not done in 2009. The city was still working to develop two large reservoirs.

During the 1970-1996 period the city had been experiencing 1 to 3 rain events each year that led to releases of stormwater into Lake Michigan to eliminate flooding. After completion of the Phase 1 tunnels in 1996, only four heavy rain events during 1997-2009 caused flooding in the city and led to releases of polluted stormwater into Lake Michigan. Two storms came in 2001, one of the wettest years on record (Changnon and Westcott, 2002). A record setting rainstorm in 2006 led to a lake release (Changnon, 2010), and a

fourth comparable heavy rainstorm in 2009 required a release into Lake Michigan to halt in-city flooding. Each of these four storms had 6- to 12-hour rain amounts that matched the once in 100-year return interval. They also occurred when the tunnels were already partially full of water from prior rains. Thus, only four storms had backflows in 13 years compared to an annual average of 2 per year prior to 1997.

A NEW PROBLEM

A new problem facing the diversion, TARP, and the handling of heavy rains to reduce flooding and water pollution, surfaced in 2000. The appearance of an invasive species of fish, the large Asian Carp, occurred south of the Sanitary and Ship Canal as the carp had migrated northward up the Mississippi and Illinois Rivers. The voracious Asian Carp eats existing native fish species. Illinois and the other lake states feared the carp's entry into the Great Lakes, an act that could seriously damage the native fish population which is a source of income for fisheries around the lakes. Thus, the carp challenged the survival of many native species, as protected by the Endangered Species Act.

To stop the northward migration of the Asian Carp, Illinois installed during 2002-2004 two underwater electric fences across the Sanitary and Ship Canal. Regardless, certain lake states have called for closing the canal gates at Lockport and those three connecting to Lake Michigan (Fig. 1) to stop the northward movement of the carp into Lake Michigan. Chicago claimed that closing the locks at Lockport would halt valuable shipping along the canal and also result in frequent in-city flooding. Furthermore, with no releases into the river, high waters would flow over the lake locks allowing the carp to move into the lake (Chicago Tribune, February 2010).

The debate over what other actions to take has gone to the Congress and the President. Congress refused to support a proposal by the state of Michigan to disconnect the waterways between Lake Michigan and the Illinois River. Michigan sued Illinois during December 2009 in the Supreme Court to close the locks, but the court rejected the case. President Obama pledged $78.5 million to Great Lakes states to prevent the carp from spreading into the lakes (Farm Week, February 15, 2010). Monitoring over the past 3 years reveals no Asian Carp have been found in Lake Michigan or the Chicago River.

CONCLUSIONS

The expensive tunnel and reservoir system has been found to handle most rainstorms except for those having multi-hour rainfall amounts in the 100-year category. One reason for this problem is that most extremely heavy rain events in the Chicago climate occur during wet periods (Changnon, 1980). This causes the tunnel storage to be partly if not totally filled before most extreme rain events occur.

For more than 100 years Chicago has been diverting water from Lake Michigan to serve domestic/industrial water needs, the dilution of polluted waters, and navigation. There have been series of controversies surrounding Chicago's diversion of Great Lakes water. These led to several political-forced physical adjustments to the drainage of waters from Chicago (Changnon and Glantz, 1996). TARP was one of the major adjustments, a unique approach to stop releases of polluted waters into the lake and down the Illinois

River. In summary, TARP has been found to be a very valuable system for reducing flooding and the spread of pollution into the lake or down the Illinois River. Now the Asian Carp is causing a new controversy affecting the diversion and water treatment.

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Figure 1. The primary rivers, canals, and water-controlling works in the Chicago area.