

EXECUTIVE SUMMARY

This document is the Water Year (WY) 1996 Annual Report of the Chicago District, U. S. Army Corps of Engineers activities in the monitoring and review of the accounting of Lake Michigan diversion flows through Chicago, Illinois as directed by 1980 amendment to the U. S. Supreme Court Decree. Additionally, this report serves to summarize the Corps' major accomplishment with respect to the mission as mandated by the Water Resources Development Act of 1986, PL99-662, Section 1142. This act gave the Corps complete responsibility for diversion accounting effective 1 October 1987. This report provides an overview and audit of flow measurements and accounting computed by the Corps of Engineers for WY 1995, 1 October 1994 through 30 September 1995.

The Lake Michigan Diversion Accounting Report for WY 1995 has been completed. The State of Illinois diverted 3,196.7 cfs during WY 1995. This diversion is 3.3 cfs less than the 3,200 cfs 40 year average diversion specified in the modified decree. The running average of the diversion for WY 1981 through WY 1995 is 3,439 cfs, or 239 cfs over the annual allocation. Also, the annual average diversion has exceeded the 3680 cfs annual limit three times, once more than the maximum number of times allowed in the decree. Additionally, the absolute annual maximum of 3840 cfs has been exceeded during the WY93 accounting period. The cumulative deviation is now - 3,586 cfs-years. The negative sign indicates a cumulative flow deficit. The maximum allowable cumulative flow deficit specified in the decree is 2,000 cfs-years.

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INTRODUCTION

The diversion of water from the Lake Michigan watershed is important to the Great Lake states and to the Canadian province of Ontario. The states and province that border the Great Lakes have concerns with diversions during periods of low lake levels and the long term effects of diversion. To insure these concerns are considered, the U.S. Army Corps of Engineers is responsible for the accounting of flow diverted from the Lake Michigan watershed.

The Water Year (WY) 1996 Annual Report on Lake Michigan Diversion Accounting presents activities by the Corps of Engineers in accounting for the diversion from Lake Michigan by the State of Illinois. The accounting of the diversion is performed according to the guidelines established in the 1980 modified U.S. Supreme Court Decree concerning the diversion.

Presented in this report is the history of the diversion and its accounting, the certification of WY 1995 diversion flows, a description of the sources of the diversion, a description of the accounting procedures, and a summary of all significant activities that occurred during WY 1996.

AUTHORITY FOR REPORT

Under the provisions of the U.S. Supreme Court Decree in the Wisconsin, et al v. Illinois et al, 388 U.S. 426, 87 S.Ct. 1774 (1967) as modified by 449 U.S. 48, 101 S. CT. 557 (1980), the Corps of Engineers monitors the measurement and computation Lake Michigan diversion by the State of Illinois. The terms of the modified decree require the Corps of Engineers to prepare an annual report on the accounting of the Lake Michigan water diverted by the State of Illinois and actions taken by the involved agencies.

HISTORY OF THE DIVERSION

Water has been diverted from Lake Michigan at Chicago into the Mississippi River Watershed since the completion of the Illinois and Michigan (I & M) Canal in 1848. At that time, the diversion averaged about 500 cubic feet per second (cfs). The I & M Canal was built primarily to serve transportation needs by providing a connecting watercourse between the Great Lakes and the Mississippi River system.

With the development of the Chicago metropolitan area, sewer and drainage improvements led to severe sanitation problems in the mid to late 1800's. The newly constructed sewers moved water and wastes into the Chicago River, which until 1900 drained to Lake Michigan. The water quality of Lake Michigan deteriorated and contaminated the city's primary water supply.

A second problem that occurred during this time period was an increase in the overbank flooding within the city. As more roads were built and buildings constructed, the sewer system was correspondingly expanded. The increase in impervious area from the newly constructed roads and buildings increased the rate and volume of stormwater runoff and resulted in increased flooding.

As a solution to the sanitation and flooding problems, construction of the Chicago Sanitary and Ship Canal (CSSC) was undertaken. Construction of the CSSC allowed the flow direction of the Chicago River to be reversed (Figure 1). Construction of the Chicago Sanitary and Ship Canal was completed in 1900 by the MWRDGC. The CSSC followed the course of the older I & M Canal. The CSSC is much larger than the I & M canal and can handle the Chicago River flow, as well as increased shipping. In the 1930's, the Chicago River Controlling Works (CRCW) was constructed at the mouth of the Chicago River. The CRCW regulates the amount of Lake Michigan water allowed to pass into the river and restricts river flooding from entering Lake Michigan. The Lockport Lock and Dam controls the water level in the CSSC.

Between 1907 and 1910, the MWRDGC constructed a second canal called the North Shore Channel. It extended from Lake Michigan at Wilmette in a southerly direction 6.14 miles to the north branch of the Chicago River. The Wilmette Pumping Station, also known as the Wilmette Controlling Works, regulates the amount of Lake Michigan flow allowed down the channel through the use of one vertical lift gate.

Construction of a third canal, the Calumet Sag Channel, was completed in 1922. The canal connects Lake Michigan through the Grand Calumet River, to the CSSC. The Calumet Sag Channel was constructed to carry sewage from South Chicago, Illinois and East Chicago, Indiana. The Blue Island Lock and Dam controlled flow through the canal. The O'Brien Lock and Dam, which replaced the Blue Island Lock and Dam, was completed in 1967 and is located on the Calumet River. The O'Brien Lock and Dam regulates the flow of Lake Michigan waters down the Calumet Sag Channel. Figure 2 shows the affected watershed.

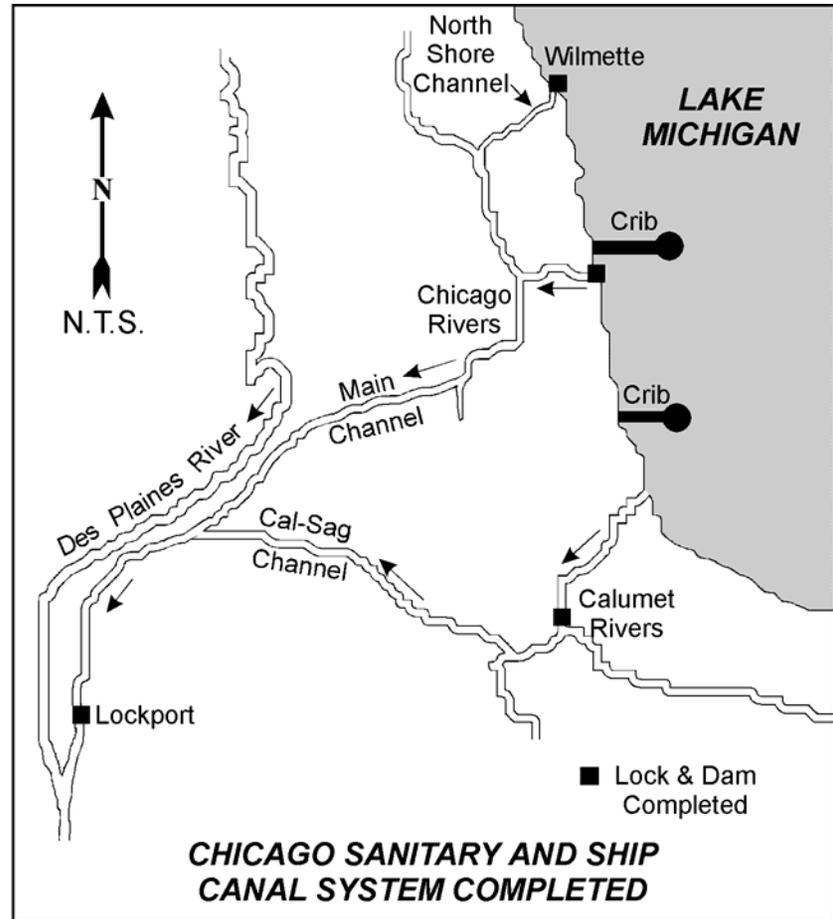
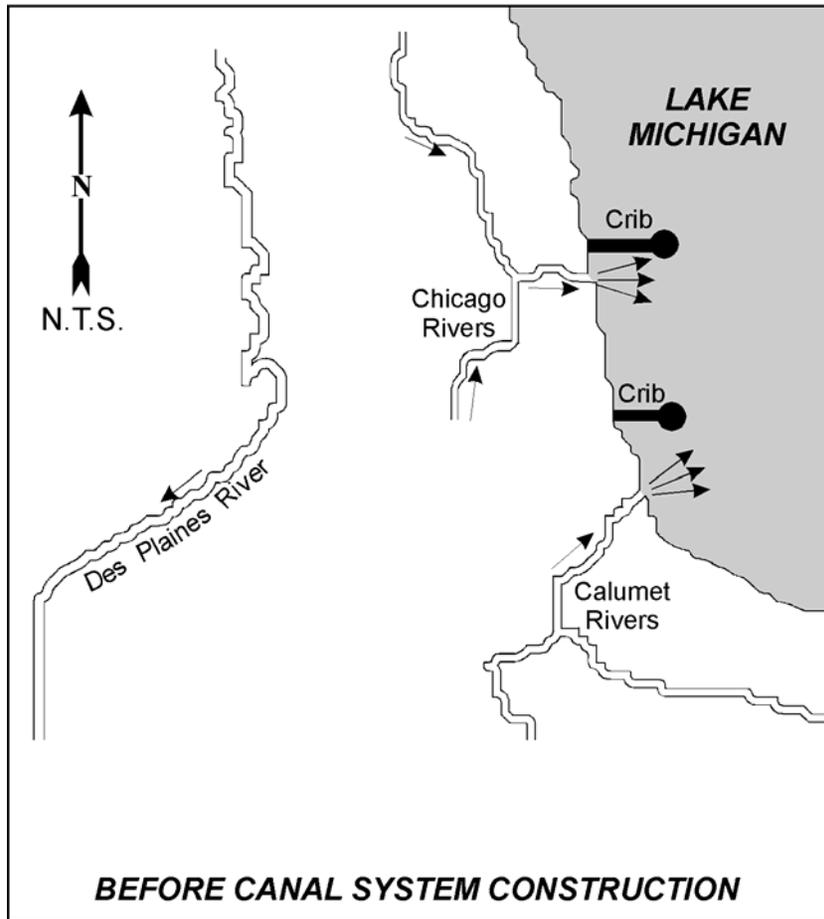


FIGURE 1 DEVELOPMENT OF THE CHICAGO SANITARY AND SHIP CANAL SYSTEM

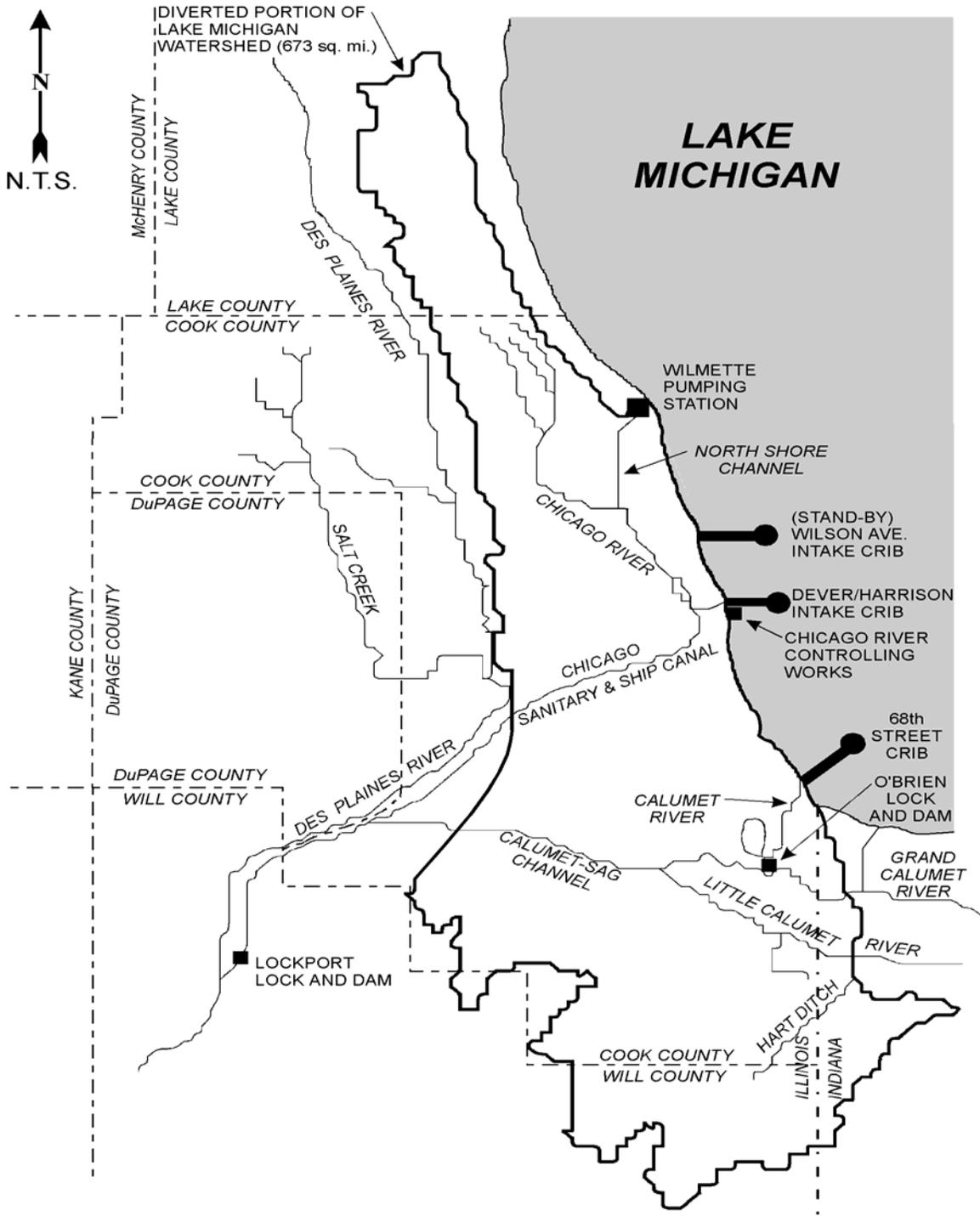


FIGURE 2 LOCATION PLAN - LAKE MICHIGAN DIVERSION AT CHICAGO

SIGNIFICANT HYDROLOGIC EVENTS

During WY 1996, a total of 30.33 inches of precipitation fell at the National Weather Service (NWS) O'Hare Weather Station. This recorded precipitation for 1996 is 15% less than the long term (1951-1990) average of 35.82 inches. The recorded monthly rainfall data during WY 1996, and the deviation from long term annual and monthly average precipitation, are tabulated in Table 1.

TABLE 1 WY 1996 MONTHLY AND ANNUAL PRECIPITATION (INCHES)
National Weather Service, O'Hare Weather Station

<u>Month</u>	1951 - 1990 Average			<u>Percent of Average</u>
	<u>Precipitation</u>	<u>Precipitation</u>	<u>Deviation</u>	
Oct-95	4.20	2.41	1.79	174%
Nov-95	3.68	2.92	0.76	126%
Dec-95	0.59	2.47	-1.88	24%
Jan-96	1.58	1.53	0.05	103%
Feb-96	0.71	1.36	-0.65	52%
Mar-96	0.62	2.69	-2.07	23%
Apr-96	2.59	3.64	-1.05	71%
May-96	4.70	3.32	1.38	142%
Jun-96	3.56	3.78	-0.22	94%
Jul-96	3.89	3.66	0.23	106%
Aug-96	1.48	4.22	-2.74	35%
Sep-96	2.73	3.82	-1.09	71%
Annual	30.33	35.82	-5.49	85%

STATUS OF ACCOUNTING REPORTS

Lake Michigan diversion flow data is summarized in accounting reports prepared on an annual basis as flows are certified. Since implementation of the modified Supreme Court Decree of 1 December 1980 and before this report, the Corps of Engineers has certified diversion flows for WY 1981 through WY 1994. The WY 1995 Lake Michigan Diversion Accounting Report is certified and included as appendix A of this Water Year 1996 Annual Report. The State of Illinois diverted 3,196.7 cfs during WY 1995. This diversion is 3.3 cfs less than the 3,200 cfs 40 year average diversion specified in the 1980 modified decree. Table 2 shows the accounting year, the certified flows, the running average flows, and the cumulative deviation from the allowable diversion of 3,200 cfs.

The running average diversion for the period WY 1981 through WY 1995 is 3,439 cfs, 239 cfs greater than the 3,200 cfs 40 year average diversion specified by the

modified decree. Also, the annual average diversion has exceeded the 3680 cfs annual limit three times, once more than the maximum number of times allowed in the decree. Additionally, the absolute annual maximum of 3840 cfs has been exceeded during the WY93 accounting period. The cumulative deviation, the sum of the differences between the annual average flows and 3,200 cfs, is -3,586 cfs-years. The negative cumulative deviation indicates a cumulative flow deficit. The decree specifies a maximum allowable deficit of 2,000 cfs- years over the first 39 years of the 40 year averaging period.

Data collection and preparation, diversion computation, and report writing for the WY 1995 accounting report was performed by the Corps. Data collection and preparation for this report began in Fiscal Year (FY) 1996. Certification of the WY 1996 accounting report is scheduled for FY 1999.

TABLE 2 STATUS OF THE STATE OF ILLINOIS DIVERSION
Under the 1980 modified U.S. Supreme Court decree

<u>Accounting Year</u>	<u>Certified Flow (cfs)</u>	<u>Running Average (cfs)</u>	<u>Cumulative Deviation (cfs)</u>
1981	3,106	3,106	94
1982	3,087	3,097	207
1983	3,613	3,269	-206
1984	3,432	3,310	-438
1985	3,472	3,342	-710
1986	3,751	3,410	-1,261
1987	3,774	3,462	-1,835
1988	3,376	3,451	-2,011
1989	3,378	3,443	-2,189
1990	3,531	3,452	-2,520
1991	3,555	3,461	-2,875
1992	3,409	3,457	-3,084
1993	3,841	3,487	-3,725
1994	3,064	3,456	-3,589
1995	3,197	3,439	-3,586

SOURCES OF DIVERSION

The Lake Michigan diversion consists of three primary components. These components are domestic pumpage from Lake Michigan used for water supply and not returned to Lake Michigan, stormwater runoff from the diverted Lake Michigan watershed, and direct diversions through the three lakefront control structures.

Domestic pumpage from Lake Michigan is used for water supply and its effluent is discharged to the canals by various Water Reclamation Plants (WRP's). Currently, the WRP's that divert domestic pumpage from the lake either discharge to the canal system or to the Des Plaines River and its tributaries. In the future as more communities

convert to Lake Michigan water supply, water supply effluent may also be discharged to the Fox River. The Fox River is approximately 35 miles west of downtown Chicago.

Stormwater runoff that previously drained to Lake Michigan through the Chicago River and the Calumet River now drains to the Chicago Sanitary and Ship Canal (CSSC) and the Calumet Sag Channel, respectively. The Calumet Sag Channel drains to the CSSC, and the CSSC ultimately drains into the Illinois River and the Mississippi River. The drainage area of the diverted Lake Michigan watershed is approximately 673 square miles.

Direct diversion locations are at the Chicago River Controlling Works (CRCW), the O'Brien Lock and Dam, and the Wilmette Controlling Works. These controlling structures are located downtown, at the south end, and at the north end of the Chicago area, respectively.

The direct diversion consists of four components; lockage, discretionary flow, navigation makeup flow, and leakage. The lockage component is the flow used in locking vessels to and from the lake. The purpose of the discretionary diversion is to dilute effluent from sewage discharges. When large storms are forecast, the canal is drawn down before the storm to prevent flooding. If the runoff is not enough to refill the canal, navigation makeup water is passed. The leakage component is water estimated to pass, in an uncontrolled way, through or around the lakefront structures.

ACCOUNTING PROCEDURES

Diversion accounting uses both measured and estimated flows. A series of hydrologic and hydraulic computer models use various meteorological data to simulate flows not measured. These simulated flows as well as measured flows are used to compute the diversion. Along with the diversion calculation, a number of water budgets verify simulated flows and estimate the reliability of the computed diversion.

DIVERSION COMPUTATION

An acoustic velocity meter (AVM) was installed and has been operating at Romeoville (five miles upstream of the Lockport Powerhouse and three miles upstream of the Lockport Controlling Works) since 12 June 1984. The AVM directly measures total flow through the canal above both the Powerhouse and the Controlling Works. The overwhelming majority of the Lake Michigan diversion and some non-Lake Michigan flows pass through the AVM. The diversion accounting procedure uses the flow measured at Romeoville and deducts flows not accountable in the diversion. Diversion flows which bypass Lockport are added to yield the net computed diversion of water from Lake Michigan. This procedure represents the accounting technique as required by the modified Supreme Court Decree.

The flow measured at Romeoville was approximately 101% of the annual diversion during WY 1995. Approximately 92% of the diverted water was measured by the AVM during WY 1995. This portion of the diversion measured at the AVM is being

reduced due to the influx of western suburbs using Lake Michigan water as their primary domestic water supply source. Most of these new users of Lake Michigan water do not discharge their sewage effluent to the canal system. As more communities are added, more water will be discharged outside the canal system, further lowering the percentage measured by the AVM.

Deductions from the Romeoville AVM flow include runoff from 217 square miles of the Des Plaines River watershed discharged to the canal, groundwater supply effluent and groundwater seepage into the Tunnel and Reservoir Plan (TARP) tunnels discharged to the canal, and Indiana water supply discharged to the canal through the Calumet River system and the Calumet Sag Channel (see figure 2 for locations). The computer models of the Des Plaines watershed area estimate the runoff deduction. The groundwater pumpage deductions are obtained directly from pumping records. The Indiana water supply is computed from pumping records and a calculation to determine the portion of the water supply draining west to the Calumet Sag Channel.

The additions for diversion flow that do not flow through Romeoville are primarily Lake Michigan water supply pumpage effluent treated and released to the Des Plaines River or its tributaries. This flow is obtained directly through pumping records of the communities involved and accounts for approximately 8% of the diversion in WY 1995. As more communities convert to Lake Michigan water supply, the percentage will increase.

DIVERSION BUDGET CHECKS

Water budgets verify those flows not measured. Most of the budgets compare simulated flows to recorded flows and these comparisons indicate the accuracy of the diversion accounting. The four primary budgets are the budgets for the three major Water Reclamation Plants (WRP's) that serve the area involved in diversion accounting and the canal balance budget for the CSSC. The Upper Des Plaines pump station budget will also become a significant budget after measurement problems are resolved. The remaining budgets estimate runoff from stream gaged areas in the Lake Michigan watershed or are budgets of non-simulated flows such as water supply pumpage. The budgets were discussed in detail in the WY 1995 accounting report.

ACTIVITIES FOR FY 1997 AND FY 1998

The activities for FY 1996 centered on completing WY 1993 and WY 1994 accounting reports, thereby enabling the diversion accounting program to be on schedule. Additionally, the Corps supported the Great Lakes Mediation Committee (as discussed in the next paragraph). The efforts in FY 1997 will be to complete the WY 1995 accounting report, to address the recommendations of the Third Technical Committee and to initiate the contracting for the Fourth Technical Committee.

In response to a dispute over the alleged violation by the State of Illinois of the diversion limits set forth in the 1967 and 1980 Supreme Court Consent Decree in *Wisconsin v. Illinois*, 388 U.S. 426 (1967), as modified, 449 U.S. 48 (1980) ("Decree"),

voluntary negotiations were carried out among the State of Illinois, the other seven Great Lakes states, the Metropolitan Water Reclamation District of Greater Chicago and the United States during a mediation (The Great Lakes Mediation) that began in December 1995. Representatives from Canada and the Province of Ontario observed the negotiations and participated in the discussions. The negotiators involved in the Great Lakes Mediation agreed to principles set forth in a Memorandum of Understanding ("MOU"), dated July 29, 1996. The final acceptance of these terms was ratified by principals not present at the mediation. In support of the mediation process the Corps provided technical support, including long-term runoff and consumptive use studies. These studies provide the technical basis of an agreement between the states to potentially move the accounting process to the lakefront.

RUNOFF STUDY

In support of negotiations for changing the Decree, Chicago District conducted a model study for estimating runoff from the Lake Michigan watershed for 44 years (1951 through 1994). The model was based on the hydrologic models used in the accounting procedures. The report for this study will be included in the WY 1997 Annual Report.

CONSUMPTIVE USE STUDY

In support of negotiations for changing the Decree, Chicago District briefly studied and modeled the water supply for metropolitan Chicago. The results of the study give a range of consumptive use of Chicago's water supply. The report for this study will be included in the WY 1997 Annual Report.

ACCOUNTING REPORTS

The Accounting Reports for WY 1993 and WY 1994 were completed in FY 1996 and the Accounting Reports for WY 1995 was completed in FY 1998. The Accounting Reports for WY 1996 and WY 1997 will be completed in FY 1999. Thereafter, additional accounting reports are expected to be completed in the second fiscal year following the end of the water year for which the diversion is computed.

SUMMARY AND CONCLUSIONS

SUMMARY

The Lake Michigan Diversion Accounting procedure continues to evolve and improve. Further improvements are being implemented. A comprehensive manual is being completed during FY 1998 to include all the improvements. This manual will be included in the WY 1997 Annual Report.

CONCLUSIONS

The Lake Michigan Diversion Accounting Report for WY 1995 has been completed as required by the Supreme Court Decree.

The State of Illinois diverted 3,196.7 cfs during WY 1995. These flows are 3.3 cfs less than the 3,200 cfs limit specified in the decree. The running average of the diversion for WY 1981 through WY 1995 is 3,439 cfs, or 239 cfs over the annual allocation. Also, the annual average diversion has exceeded the 3680 cfs annual limit three times, once more than the maximum number of times allowed in the decree. Additionally, the absolute annual maximum of 3840 cfs has been exceeded during the WY93 accounting period. The cumulative deviation is now -3,586 cfs-years. The negative sign indicates a cumulative flow deficit. The maximum allowable cumulative flow deficit specified in the decree is 2,000 cfs-years.

APPENDIX A
LAKE MICHIGAN DIVERSION ACCOUNTING
WATER YEAR 1995 REPORT