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## EXECUTIVE SUMMARY

This document is the Water Year (WY) 1993 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 conducted by the Corps of Engineers from 1 October 1992 through 30 September 1993.

During WY 1993 the District has made some major changes to improve the accuracy and efficiency of the diversion accounting as listed below.

Modifications were made to the hydrologic runoff models and hydraulic sewer routing models in order to incorporate the 25-gage precipitation network into the WY 1990 diversion accounting procedures and computations. This included review and correction of map delineations for combined sewer special contributing areas, delineation of precipitation assigned areas for the 25-gage network, revisions and updates of land-use/land-cover delineations, and modifications to the hydraulic sewer routing models to reflect the revised precipitation network and land cover assignments.

Additionally, minor modifications were made to the hydrologic runoff model parameters to correct for past inconsistencies and improve parameter accuracy.

The Lake Michigan Diversion Accounting Report for WY 1990 has been completed. The State of Illinois diverted 3,531 cfs during WY 1990. This is 331 cfs greater 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 1990 is 3,452 cfs, or 252 cfs over the annual allocation. The cumulative deviation is now -2,520 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.

## 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) 1993 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 1990 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 1993.

## 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 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 was first diverted from Lake Michigan at Chicago into the Mississippi River Basin with the completion of the Illinois and Michigan (I & M) Canal in 1848. The Illinois and Michigan Canal was primarily for transportation and diverted up to 500 cubic feet per second (cfs).

Development of the Chicago sewer system led to severe sanitation problems in the Chicago River by 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 during this time was an increase in the overbank flooding within the city. The sewer system expanded as more roads and buildings were built. This construction increased the rate and volume of runoff and resulted in increased flooding.

As a solution to the sanitation and flooding problems, the Chicago Sanitary and Ship Canal (CSSC) was built. The construction reversed the flow direction of the Chicago River (figure 1). The Chicago Sanitary And Ship Canal was completed in 1900 by the Metropolitan Water Reclamation District of Greater Chicago (MWRDGC, formerly the Metropolitan Sanitary District of Greater Chicago, MSDGC). The Sanitary and Ship Canal followed the course of the older I & M Canal. This canal is much larger than the I & M Canal and can handle the Chicago River flow as well as increased shipping. The Chicago River Controlling Works were constructed at the mouth of the Chicago River in the 1930s. The lock and sluice gates regulate the amount of Lake Michigan water allowed to pass into the river and restricts river flooding entering Lake Michigan.

Between 1907 and 1910, the MWRDGC constructed a second sanitary canal called the North Shore Canal. This canal extends from Lake Michigan at Wilmette south 6.14 miles to the North Branch of the Chicago River. The Wilmette Controlling Works regulate the amount of Lake Michigan flow allowed down the channel.

Construction of a third canal, the Calumet Sag Canal, was completed in 1922. The canal connects Lake Michigan, through the Grand Calumet River, to the Sanitary and Ship Canal. This canal carried sewage from South Chicago, Illinois and East Chicago, Indiana. The O'Brien Lock and Dam located on the Calumet River, regulates the flow of Lake Michigan waters down the canal. Figure 2 shows the affected watershed.

Upon completion of the Chicago Sanitary and Ship Canal in 1901, the Secretary of War issued a permit authorizing a diversion of 4,167 cfs. In 1908 and 1913, the United States brought actions to enjoin the MWRDGC from diverting more than the 4,167 cfs previously authorized in 1901. The two actions were consolidated and the Supreme Court entered a decree on 5 January 1925 allowing the Secretary of War to issue diversion permits. In March 1925, the permit issued limited diversion 8,500 cfs, about the average then being used.

In 1922, 1925, and 1926, several Great Lakes States filed similar original actions in the U.S. Supreme Court seeking to restrict the diversion at Chicago. A Special Master, appointed by the U.S. Supreme Court to hear the combined three suits, found the 1925 permit to be valid and recommended dismissal of the action. The U.S. Supreme Court, however, reversed the Special Master's finding. Subsequently, the Court instructed the Special Master to determine the steps necessary for Illinois and MWRDGC to reduce the diversion. Consequently, a 1930 decree reduced the allowable diversion (which did not include domestic pumpage) in three steps: to 6,500 cfs after 1 July 1930; to 5,000 cfs after 30 December 1935; and to 1,500 cfs after 31 December 1938.

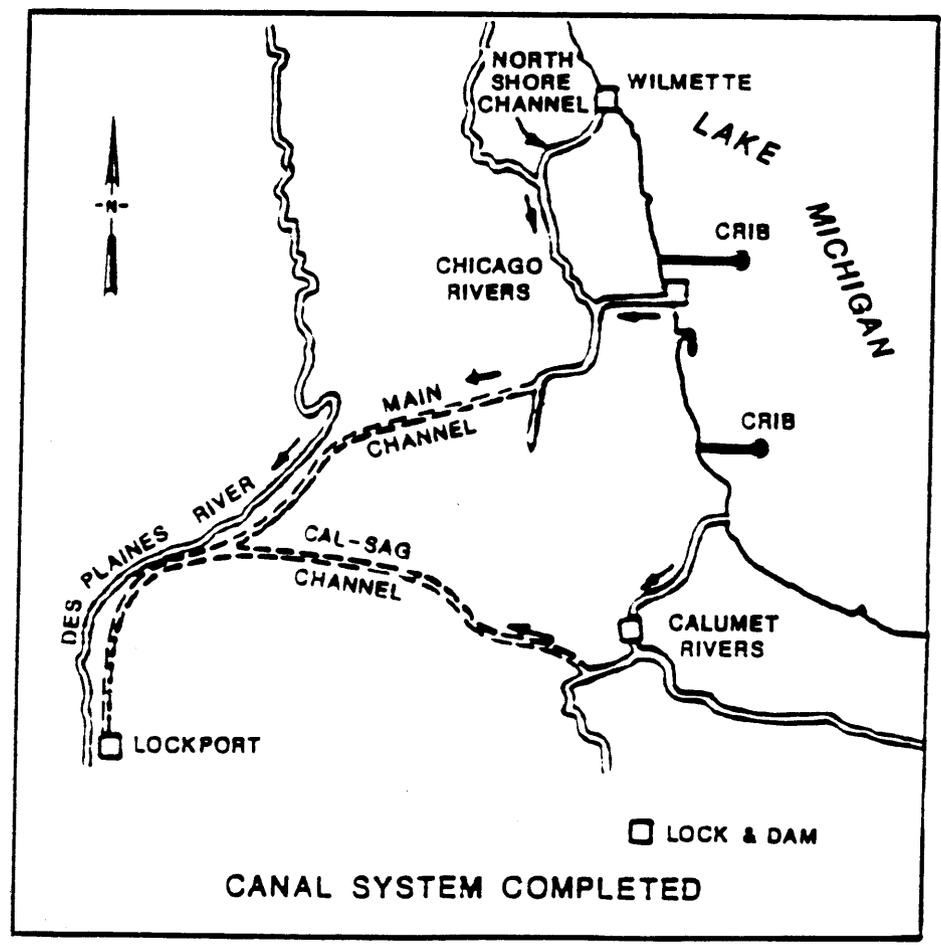
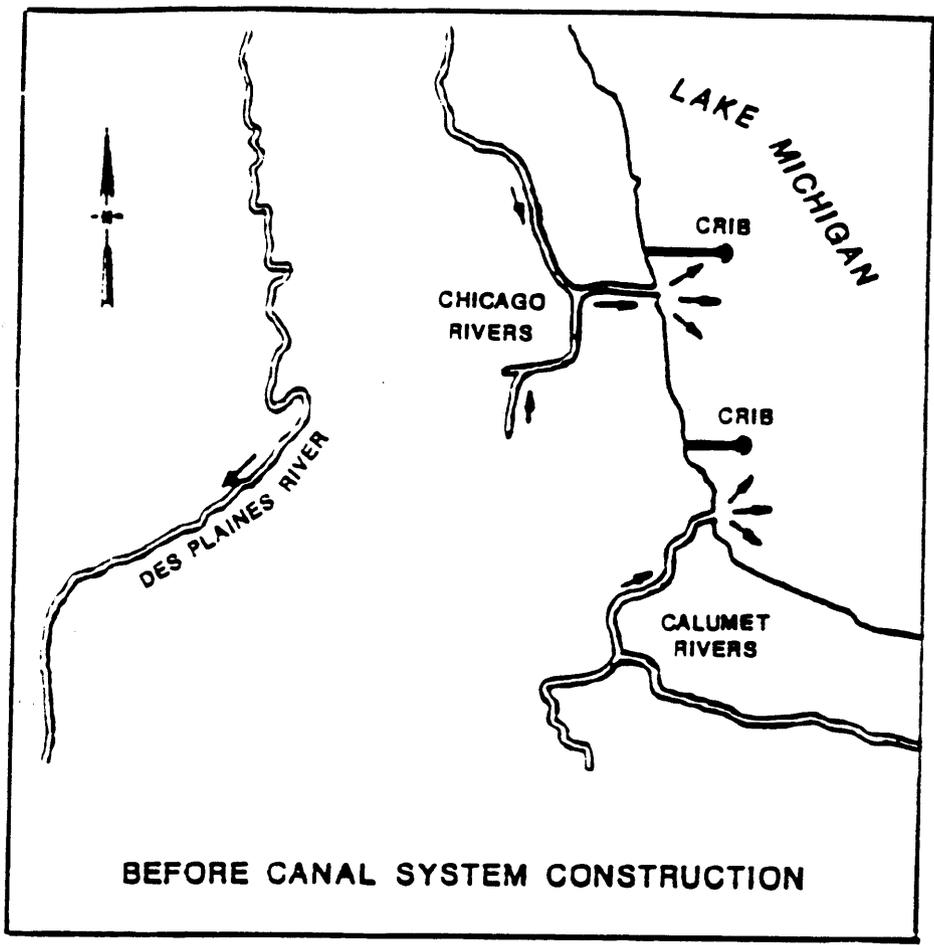
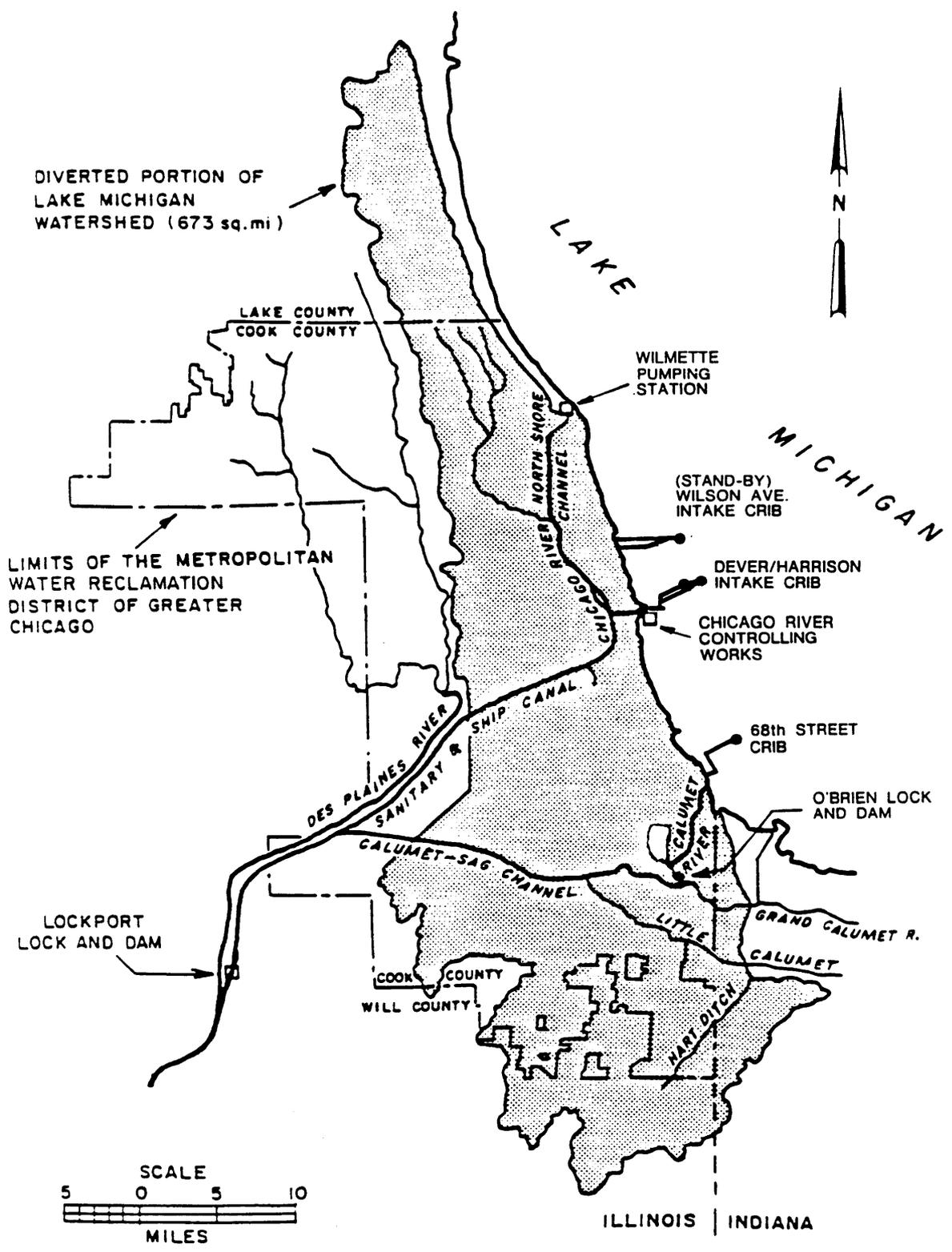


Figure 1



LOCATION PLAN-LAKE MICHIGAN DIVERSION AT CHICAGO

In 1967, an additional Supreme Court Decree limited the diversion of Lake Michigan water by the State of Illinois and its municipalities, including domestic pumpage, to a five year average of 3,200 cfs effective 1 March 1970. The 1967 Supreme Court Decree gave full responsibility to the State of Illinois for diversion measurements and computations. The role of the Corps of Engineers, as specified in the decree, was to be one of "general supervision and direction."

The 1967 decree was modified on 1 December 1980. This modified decree changed the beginning of the accounting year from 1 March to 1 October. The modified decree also extended the period for the running average diversion from five years to forty years beginning with WY 1981.

The amended decree contains three provisions that affected the role of the Corps of Engineers in the diversion accounting program. First, although the State of Illinois was primarily responsible for measurement and computation of diversion flows, the decree allowed the Corps of Engineers to participate in the function, subject to agreement and cost sharing with the State of Illinois. Negotiations were held on cost sharing the computation of the diversion. No agreement was reached due to lack of funding. The measurement and computation of the diversion continued to be done by the Illinois Department of Transportation (IDOT) through its consultants, the Northeastern Illinois Planning Commission (NIPC), MWRDGC, and the United States Geological Survey (USGS).

Second, the supervisory role for the Corps of Engineers increased so the Corps of Engineers was responsible for auditing the computations and measurements performed by the State of Illinois.

Third, the modified decree states that the Chief of Engineers shall appoint a Three Member Technical Committee to determine the best current engineering practice and scientific knowledge for measuring the diversion and to make recommendations as appropriate. The decree states that "...the members should be selected on the basis of recognized experience and technical expertise in flow measurement or hydrology." A technical committee is to be reconvened at least once every five years. The first Technical Committee convened in June 1981 and completed its work in April 1982. The second Technical Committee convened in July 1986, and completed their final report in November 1987. The third Technical Committee convened in February 1993.

The Water Resources Development Act of 1986 gave the Corps of Engineers responsibility for the computation of diversion flows as formerly done by the State of Illinois. The Corps of Engineers' new mission became effective 1 October 1987.

## SIGNIFICANT HYDROLOGIC EVENTS

On 7-10 June 1993, heavy thunderstorms flooded southern Cook County. The 25 gage precipitation network gages in the area measured 3.5 to 4.0 inches of rain. One gage registered 6.4 inches over 24 hours and 16.5 inches for the month of June. Above average rainfall tends to increase the diversion, especially when severe storms, such as in June, fall.

Monthly precipitation compared to 30 year averages are shown in Table 1.

TABLE 1  
WY 1993 Monthly And Annual Precipitation (Inches)  
National Weather Service O'Hare Weather Station

<u>MONTH</u>	<u>PRECIPITATION</u>	1951-80 AVG. <u>PRECIPITATION</u>	<u>DEVIATION</u>	<u>% DEVIATION</u>
10/92	1.79	2.28	- 0.49	- 21
11/92	5.41	2.06	+ 3.35	+163
12/92	0.39	2.10	- 1.71	- 81
01/93	3.83	1.60	+ 2.23	+139
02/93	0.82	1.31	- 0.49	- 37
03/93	4.52	2.59	+ 1.93	+ 75
04/93	4.57	3.66	+ 0.91	+ 25
05/93	1.83	3.15	- 1.32	- 42
06/93	9.96	4.08	+ 5.88	+144
07/93	4.45	3.63	+ 0.82	+ 23
08/93	5.74	3.53	+ 2.21	+ 63
09/93	4.47	3.35	+ 1.12	+ 33
ANNUAL	47.78	33.34	+14.44	+ 43

## OTHER SIGNIFICANT EVENTS

Three major non-hydrologic events occurred during WY 1993. The first major event was the convening of the third Technical Committee during February 1993. The committee's mission is to review the diversion accounting procedures and assure that the "best current engineering practice and scientific knowledge" is being applied by the Corps of Engineers in computing the diversion. The second major event was the USGS flow measurements at the three lakefront structures from April through October 1993. The USGS used a highly accurate Acoustic Doppler Current Profiler (ADCP) to measure leakage and sluice gate flows at the Chicago River Controlling Works, O'Brien Lock and Dam, and the Wilmette Controlling Works. The third major event was the modifications to the hydrologic runoff and hydraulic sewer routing models for the purpose of incorporating the 25-gage precipitation network into the diversion accounting procedures. A large portion of this work was accomplished by Rust Environment and Infrastructure

under contract to the Corps of Engineers. The three major events listed above are documented within individual reports that are included as appendices to this WY 1993 Annual Report. A separate, detailed chronology of significant non-hydrologic events is included in appendix A.

### 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 1989. The WY 1990 Lake Michigan Diversion Accounting Report is certified and included as appendix B of this Water Year 1993 Annual Report. The State of Illinois diverted 3,531 cfs during WY 1990. This is 331 cfs greater 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.

Table 2 Status of the State of Illinois' Diversion  
Under the 1980 Modified U.S. Supreme Court Decree

Accounting Year	Certified Flow (cfs)	Running Average (cfs)	Cumulative Deviation (cfs)
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

The running average diversion for the period WY 1981 through WY 1990 is 3,452 cfs, 252 cfs greater than the 3,200 cfs 40 year average diversion specified by the modified decree. Also, the annual average diversion has twice exceeded the 3680 cfs annual limit, the maximum number of times allowed in the decree. None of the years have exceeded the absolute annual maximum of 3840 cfs. The cumulative deviation, the sum of the differences between the annual average flows and 3,200 cfs, is -2,520 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 for the WY 1991 and WY 1992 accounting reports will be performed by the Corps. Christopher B. Burke Engineering, under contract to the Corps of Engineers, will compute the diversion and prepare the accounting reports for WY 1991 and WY 1992 with assistance provided by the Corps of Engineers. Data collection and preparation for these reports began in Fiscal Year (FY) 1993. Certification of the WY 1991 and WY 1992 accounting is scheduled for FY 1995.

### 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.

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.

Domestic pumpage from Lake Michigan is used for water supply and its effluent is discharged to 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 discharge 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 to ultimately drain into the Illinois River and the Mississippi River. The drainage area of the diverted Lake Michigan watershed is approximately 673 square miles.

## 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 of 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.

During WY 1990, the flow measured at Romeoville was approximately 106% of the annual diversion. Approximately 97% of the diversion was measured by the AVM.

Deductions from the Romeoville 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 1 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 3% of the diversion. 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 the 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 are discussed in more detail later in the WY 1990 accounting report in appendix B.

## PROCEDURAL CHANGES AND UPGRADES

This section will highlight the changes and upgrades in the accounting procedure and their impacts on the computation of Lake Michigan diversion. The accounting of the diversion consists of measuring the water that flows past Lockport, subtracting the deductions and adding back the by-pass flows.

- a. The installation of the AVM has produced the single largest impact of any change in the accounting procedures. The AVM flow measurements, plus the use of the regression equations (that translate Lockport flows into AVM flows) for filling in missing records, have significantly increased the flow records, and therefore the flows accountable to the State of Illinois. The average difference between the Lockport flows and the AVM record is equal to 192 cfs for WY 1990. The average difference was 313 cfs from WY 1986 through WY1989.
- b. The new 25-gage precipitation network was introduced into the WY 1990 diversion accounting procedures during FY 1993. A report by the ISWS describing the installation and operation of this 25-gage precipitation network constitutes appendix C of this WY 1993 Annual Report. Subsequent modifications were made to the hydrologic runoff models and hydraulic sewer routing models in order to incorporate the 25-gage precipitation network into the diversion accounting modeling. Additionally, improvements and updates were made for land-use/land-cover delineations used in the models. Input parameters used in the hydrologic runoff models were slightly revised as well. All of these modifications have resulted in improved water balances at the primary calibration points, the three major MWRDGC water reclamation plants and the Upper Des Plaines pump station. Consequently, the deductible Des Plaines River watershed runoff is simulated with increased accuracy.

## ACCOMPLISHMENTS DURING FY 1993

In each accounting year, various changes to the diversion procedures and other activities help to improve the accuracy and efficiency of the diversion accounting.

### REVISION OF COMPUTER MODELS

As previously discussed, modifications were made to the hydrologic runoff models and hydraulic sewer routing models in order to incorporate the new WY 1990 25-gage precipitation network into the WY 1990 diversion accounting. The procedures for the model modifications are outlined in a report by Rust Environment and Infrastructure that constitutes appendix D of this report. Additional improvements and updates were made for land-use/land-cover delineations and hydrologic runoff input parameters. These revisions have resulted in improved water balances at the MWRDGC water reclamation plants and the Upper Des Plaines pumping station. Consequently, the Des Plaines River watershed runoff deduction is simulated with increased accuracy.

### AVM GAGE REGRESSION EQUATIONS

New regression equations were developed for the Romeoville AVM gage for calculating flows when the AVM is not functioning. The USGS has reviewed the AVM flows for WY 1986 through WY 1992. The USGS revised the regression equations and the updated flows have been included in the Accounting Reports for WY 1986 through WY 1990. The USGS report included as appendix E of this report provides a complete description of the review process and the development of the revised regression equations. An additional update of the regression equations is underway to include the AVM's installed by MWRDGC in the Lockport Powerhouse during WY 1992.

### LAKEFRONT FLOW MEASUREMENTS

The accuracy of the canal balance budget, used to check the diversion modeling, depends on the accuracy of the reported lakefront flows. While errors in the lakefront flows do not change the diversion accounting flows, errors reduce the accuracy and usefulness of the budget to indicate modeling errors. To quantify errors in the reported flows through and around the lakefront structures a series of measurements have been taken at all three lakefront structures, the Chicago Lock, the O'Brien Lock and Dam and the Wilmette Controlling Works.

The first series of measurements were taken in WY 1990. The report by the Corps of Engineers documenting the measurements is included in the WY 1990-92 Annual Report. Flow velocities were measured downstream of each of the three structures between 23 July and 27 July. Five flow measurements were taken at each site while the nearby structures maintained constant gate openings with all locks closed. Measured flows were compared to flows calculated using the MWRDGC methods. The measured flows were about twice the calculated flows.

Given the limited nature of the study, in time and equipment, the results are only a guide to the possible errors in the present lakefront flow calculations.

In WY 1993 a far more extensive series of measurements were undertaken from April through October 1993. The USGS conducted a detailed program utilizing an Acoustic Doppler Current Profiler (ADCP) and dye tests. The measurements focused on leakage and sluice gate flows. Detailed results of the leakage measurements can be found in the USGS report contained in appendix F. The report detailing USGS results on sluice gate measurements will be available during the summer of 1994. A brief letter report on the sluice gate measurements is included in this report as appendix G. A brief discussion of the leakage measurements is summarized below.

Chicago River Controlling Works: During a majority of the measurements the lock gates were in a state of disrepair which resulted in increased leakage. The lake gates began experiencing closing difficulties sometime during WY 1990. The river gates began experiencing closing difficulties sometime between the winter of 1992 and the winter of 1993. During September and October 1993 both lock gates were rehabilitated. This involved roller maintenance and side seal replacement. The effect of this maintenance was that the lake gates now fully close and the leakage through the side seals of both sets of gates has been reduced. Additional lock rehabilitation is currently under design. This future rehabilitation will include replacement of the bottom and front seals of both pairs of gates. This should further reduce the leakage passing through the lock chamber.

The river gates are of greater importance to diversion accounting since these gates act as the control gates. This is because the river gates are closed for the majority of the time during normal operations. The only time these gates are open during normal operations is shortly before an upstream lockage or immediately after a downstream lockage.

Over the period of measurement, the most significant leakage occurred through the lake gates while the river gates were open. Although there is considerable leakage during this gate configuration the annual effect is minimal since this gate setting occurs only for a short time prior to an upstream lockage or immediately after a downstream lockage. A better estimate of the normal leakage through the lock is obtained with the river gates closed. With the river gates closed the measured leakage passing through the lock chamber was approximately six times less than the measured leakage under the former gate configuration. The total leakage, including leakage through the sluice gates and harbor walls, was also measured. The measurements indicated that leakage through the river gates accounted for well over half the total leakage.

O'Brien Lock and Dam: Leakage passing through the lock chamber with both gates closed was very minimal. Velocities were near the minimal threshold velocities which the ADCP can accurately measure. The leakage measured through the lock chamber was reasonable for this structure. Attempts to measure total leakage which includes leakage through the sluice gates were unsuccessful due to extremely low velocities. This indicates that the leakage through the sluice gates is minimal.

Wilmette Controlling Works: Total leakage, leakage through the old abandoned lock and pump bays, was measured before and after MWRDGC sealed the old pump bays. The total measured leakage prior to the sealing of the pump bays was significantly greater than the reported leakage. After the pump bays were sealed, the total measured leakage dropped by a factor of approximately four.

The leakage and sluice gate measurements have accounted for a significant portion of the imbalance of flows determined in the canal system balance budget. Refer to appendix B for a detailed discussion of the canal system balance budget. Additional measurements and evaluations have been recommended by the third Three Member Technical Committee for the purpose of additional verification and to obtain measurements over a wide range of lake elevations and sluice gate settings. Further, since these measurements were made in WY 1993, they may not represent the level of leakage occurring during previous years. Without further review of how the lakefront structures have changed over time, it would be inappropriate to generalize these results.

### THIRD TECHNICAL COMMITTEE

The third Three Member Technical Committee was convened during February 1993. The committee's mission is to review and assess the diversion accounting procedures and to assure that the "best current engineering practice and scientific knowledge" is applied by the Corps of Engineers in computing the diversion. Their work culminated in a report that constitutes appendix H of this WY 1993 Annual Report. The primary recommendations of the third Technical Committee are summarized below.

- a. Release diversion accounting and annual reports in a more timely fashion.
- b. Consider revising the WY81 through WY83 accounting to reflect AVM based flows through the use of regression equations.
- c. A detailed manual of procedures for diversion accounting should be developed.
- d. Update the diversion accounting and AVM quality assurance plans.
- e. Improve the accuracy and reliability of measured flows at the Upper Des Plaines pumping station.

## ACTIVITIES FOR FY 1994 AND 1995

### ACCOUNTING REPORTS

The Accounting Report for WY 1990 was completed in FY 1994 and the Accounting Reports for WY 1991 and WY 1992 will be completed in FY 1995. The Accounting Reports for WY 1993 and WY 1994 will be completed in FY 1996. 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.

### THIRD TECHNICAL COMMITTEE

The Third Technical Committee was under contract at the close of FY 1992. The Committee began its work in February 1993 which culminated in a report included as appendix H of this report.

### FLOW MEASUREMENTS

Due to significant measurement problems that exist at the Upper Des Plaines pumping station, flow measurements will be conducted during WY 1995 to assess the accuracy of existing pump measurements. Based on the measurements, either the existing pumps will be recalibrated or additional measurement devices will be permanently installed to provide a consistently accurate and reliable means of measuring the flows. Accurate measurements are necessary so that the full advantage of this facility as a calibration point for the diversion models may be realized.

### DIVERSION ACCOUNTING MANUAL

A manual will be written during FY 1995 to describe in detail the steps in the diversion accounting procedure. The manual will include any updates and modifications up to and including the WY 1992 Accounting Report.

### SOFTWARE IMPROVEMENT

The conversion of the Hydrologic Simulation Program - FORTRAN (HSPF) from the TSS (Time Series Storage) database to a DSS (Data Storage System) database was completed in January 1994 by Aqua Terra Consultants, under contract to the Corps of Engineers through the USGS. HSPF uses hydrologic and meteorological data to calculate runoff. The result of this conversion will be an increase in computational efficiency which should reduce the time required to compute the diversion for future water years.

Beginning with the WY 1991 accounting, the DSS database will be used as the sole database for all modeling and computations. This will require numerous conversions of HSPF and SCALP model input decks as well as conversions of all mathematical computational input decks since all of the input decks, excluding TNET, used through the WY 1990 accounting read from and write to a TSS database.

## SUMMARY AND CONCLUSIONS

### SUMMARY

The Lake Michigan Diversion Accounting procedure continues to evolve and improve. Further improvements will occur during the WY 1991 and WY1992 diversion accounting. Among the changes is the inclusion of the more efficient DSS database as the sole database for all modeling and computations. A comprehensive manual will also be written to include all the improvements.

### CONCLUSIONS

The Lake Michigan Diversion Accounting Report for WY 1990 has been completed as required by the Supreme Court Decree.

The State of Illinois diverted 3,531 cfs during WY 1990. This is 331 cfs greater than the 3,200 cfs limit specified in the decree. The running average of the diversion for WY 1981 through WY 1990 is 3,452 cfs, or 252 cfs over the annual allocation. The cumulative deviation is now -2,520 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**  
**SIGNIFICANT EVENTS (NON HYDROLOGIC)**



07 October 1992 Memorandum from CENCD-ED-WH to CENCC-ED-H.  
Subject: Status of Reservoir Regulation Manuals.

15 October 1992 Memorandum from CENCD-ED-WH to CENCC-ED-H.  
Subject: Update of the procedures to transfer real Time Hydrologic Data to CENCD.

26 October 1992 Letter to Tom Fogarty from USGS (Kevin Oberg).  
Steve Melching and Kevin Oberg prepared brief Statement of Work and a cost estimate for the Romeoville AVM record analysis.

26 October 1992 Letter to Tom Fogarty from USGS (Kevin Oberg)  
Completion of estimate of the cost to do work at Romeoville.

26 October 1992 Letter to Tom Fogarty from USGS (Kevin Oberg).  
Analysis of Romeoville AVM Discharge Record for inconsistencies.

26 October 1992 Letter to Tom Fogarty from USGS (Kevin Oberg)  
Preliminary Investigation of Romeoville Record consistency

26 October 1992 Letter to Tom Fogarty from USGS (Stephen Blanchard)  
Funding needed for gaging station in Kishwaukee River near Perryville. USGS wanted to know if ACE was interested in funding the gage station..

28 October 1992 Memorandum from CENCC-ED-HW to CENCD-PE-ED-WH.  
Subject: Comments on draft WCDS Field Guidance and ER1110-2-249.

29 October 1992 Memorandum from CENCD-PE-ED-WH to CENCC-ED-HW.  
Subject: Lake Michigan diversion Accounting Concerns.

02 November 1992 Memorandum from CENCC-ED-HW to CENCC-ED.  
Subject: Status of Reservoir Regulation Manual

03 November 1992 Memorandum from CENCD-PE-ED-WH to CENCC-ED-H.  
Subject: Problems with Cooperative Stream Gaging Program, Gage, FY93.

03 November 1992 Memorandum from CENCD-PE-ED-WH to CENCC-ED-H.  
Subject: Update on procedures to transfer Real Time Data to the NCD PC Server using TCP-IP protocol.

09 November 1992 Letter from David Kiel CENCC-ED-HW sent to: R.H. Gabey (AMG Resources Corp.), Russell Harrison ( Cal Flexicore Corp.), Ron Santelik (CITGO Petroleum Co.), J.N. Orban (E.I. Dupont), Hon. Robert Pastrick (E. Chicago Mncipal WWYP), Thomas Gordon (Gary WWTP), Nicholas Menninga (Hammond Municipal STP), S.L. Hocker (Indresco), Mark Knight (9nth Ave Dump Superfund Site), Landy Herndon Jr. (Roll Center Inc.), Pat Murphy (USX Corp): Subject: Request for locations and volumes of discharge to the river for the development of the flow model for Grand Cal Riv. including Indiana Harbor/Lake George Canals.

16 November 1992 Letter to Gerald Kauffman (Sec Donohue) from Dave Kiel . Forwarded Final Scope of Work dated 16 Nov 92 for work under contract # DACW23-91-D-0001. Work consist of Hydrologic Modeling of Grand Cal River Basin.

17 November 1992 Memorandum from CENCC-ED-HW to CENCC-ED.  
Subject: Reservoir Regulation Manual for CUP O'Hare.

18 November 1992 Memorandum from CENCD-PE-ED-WH to CENCC-ED-HW.  
Subject: Update on {procedures to transfer Real; Time Data to the NCD PC Server using TCP-IP Protocol.

20 November 1992 Memorandum for Record  
Subject: Technical and Cost Price Analysis of SEC Donohue's proposal for Hydrologic Modeling of Grand Calumet River Basin - Contract DACW-23-91-D-0001.

24 November 1992 Letter to LTC David Reed from Illinois Department of Transportation (Donald Vonnahme). IDOT received written confirmation from NCD Commander that water diverted into canal system during freight tunnel flooding is not to be included as part of Illinois Diversion. Discusses WY87 Annual Report and has remarks.

01 December 1992 Contract Acknowledgment to Gerald Kauffman ( SEC Donohue) from Dave Moughton. Letter of Notice to proceed with Contract DACW-23-91-D-0001, Work order #0003.

04 December 1992 Contract Acknowledgment to Gerald Kauffman (SEC Donohue) from Dave Moughton. Letter of Notice to proceed with contract DACW23-91-D-0001, Work order # 0004.

04 December 1992 Fax to Tom Fogarty from Lynette Moughton CENCD  
Subject: Conference Call, Location of Water Control Function in Reorganization.

07 December 1992 Conference call with District on Water Control for Tom Fogarty and Dave Moughton.

08 December 1992 Memorandum from CENCC-ED-HW to CENCD.  
Subject: Lake Michigan Diversion Accounting Concerns.

18 December 1992 Letter to Donald R. Vonnahme (IDOT) from CENCC-ED-HW.  
NCC and NCD reviewing the issues raised in letter of 24 November, 1992.

23 December 1992 Memorandum from CENCC-ED-HW for CENCD-PE-ED-WH.  
Subject: Annual Report of Water Control Management Activities.

28 December 1992 Fax to Tom Fogarty from CECW-EH.  
Subject: Principles and procedures for carrying out water control management functions.

05 January 1993 Fax to Dan Injerd from J. Jacobazzi.  
Subject: Water Control Management Meeting Agenda & Presentation Notes.

12 January 1993 Memorandum from CENCC-ED-H to CENCR-CT-C.  
Subject: Price changes in Contract DACW23-93-M-0214.

19 January 1993 Memorandum from CENCC-ED-P to ED Branch.  
Subject: FY 93 O & M Cost Codes

22 January 1993 Fax to Tom Fogarty from John Vento (NCD).  
Subject: District Water Control Cell Operations Division.

03 February 1993 Fax to Tom Fogarty from Lynette Moughton.  
Subject: Corps User Exchange (CUE) 1993 Annual Meeting.

05 February 1993 Memorandum from Don Leonard NCD to Tom Fogarty.  
Subject: Forwarded the latest proposal for the water control organization. Comments Requested.

08 February 1993 Debriefing Package for BG Fuhrman on water management reorganization meeting in Cincinnati on 3-4 February 1993.

08 February 1993 Memorandum from CENCD-PE-ED-WH to CENCC-ED-HW.  
Subject: Lake Michigan Diversion Accounting Concerns.

08 February 1993 Fax to Tom Fogarty from Lynette Moughton.  
Subject: Rock Island Comments on Draft Procedures for Water Management and Control Centers.

10 February 1993 to Tom Fogarty from Lynette Moughton.  
Subject: Request for comments on staffing and activities for cells.

17 February 1993 Memorandum from CENCC-ED-HW to CENCD-ED  
Subject: Lake Michigan Diversion Accounting Draft Report for Water Years 1986 thru 1989.

25 February 1993 Letter to Stephen Blanchard (USGS) from CENCC-ED-HW.  
Comments on the draft report titled "Discharge and Regression Analysis For Acoustical Velocity Meter Data for the Chicago Sanitary and Ship Canal at Romeoville, IL".

08 March 1993 Letter to CENCC-ED-HW from USGS (Stephen Blanchard).  
Forwarded one signed copy of agreement # A5212B-93004-001. Agreement request the USGS to analyze and update flows measured by the Romeoville AVM for WY 84 - WY 92 for period of Oct 1, 92 - Jul 31, 92.

11 March 1993 Letter to Gerry Wolkowicz from CENCC-ED-HW.  
Request for construction drawings for the Crawford Ave. Main Drain from 146th Ave. to Cal Sag Channel.

12 March 1993 Letter to Stephen Blanchard (USGS) from CENCC-ED-HW.  
Response to request concerning report on discharge comparison and analysis for AVM at Romeoville, IL.

12 March 1993 Letter to Donald Vonnahme (IDOT) from CENCC-ED-HW.  
Response to letter of 24 Nov 1992, explaining that a modification of the Supreme Court Decree would be necessary in order to subtract excessive leakage from LMD.

16 March 1993 Letter to David Moughton from James A. Stewart (USGS).  
Forwarded primary information for USGS Stations. Grand Cal River at Hammond and Gary, IN, and Indiana Harbor Canal at E. Chicago, IN.

17 March 1993 Memorandum from CENCD-PE-ED-WH to CENCC-ED-HW.  
Subject: NCD H & H Personnel Meeting.

19 March 1993 Letter to Tom Fogarty from Kevin Oberg (USGS).  
The report "Comparison, analysis and estimation of discharge data from two acoustic velocity meters on the Chicago Sanitary and Ship Canal at Romeoville, IL" by C.S. Melching and Kevin Oberg approved for publication.

29 March 1993 Memorandum from CECW-EH-W to CENCC-ED-HW  
Subject: Corps gaging cost for FY 93.

30 March 1993 Memorandum from CENCC-ED-H to CENCC-OC  
Subject: Chicago Flood Records.

30 March 1993 Memorandum from CENCC-ED-HW to CENCD-PE-ED-WH.  
Subject: Lake Michigan Diversion Accounting Annual Report for FY 90-92.

31 March 1993 Letter to Tom Fogarty from Kevin Oberg (USGS).  
Questions relating to February 24, 1993 presentation to the LMDA Review Committee.

01 April 1993 Engineer Technical Letter from CECW-EP.  
Engineering and design requirements and procedures for referencing coastal navigation projects to Mean Lower Low Water Datum.

01 April 1993 Memorandum from CENCC-ED-HW to CENCD.  
Subject: Lake Michigan Diversion Accounting of Maintenance Diversions.

02 April 1993 Memorandum from CENCD-PE-ED-WH to CENCC-ED-HW.  
Subject: Lake Michigan Diversion Accounting Annual Report for FY 90-92.

04 April 1993. Fax from USGS to Dave Moughton Provided rating tables for Grand Cal at Hohman Ave at Hammond, IN.

05 April 1993 Letter to J. Jacobazzi from W. Espey.  
Third Tech Committee reviewed material from first Lake Michigan Diversion Accounting Meeting and found material to be reasonable and consistent.

08 April 1993 Memorandum from CENCC-ED-HW to CENCD-PE-ED-WH.  
Subject: Lake Michigan Diversion Accounting Annual Report for FY 90-92.

08 April 1993 Letter to Brigadier general Russell Fuhrman to CENCC-ED-HW from Donald Vonnahme (Illinois Department of Transportation). Lakefront Leakage through Corps Installations.

08 April 1993 Letter to Honorable William C. Bryson from CENCC-ED-HW.  
Transmitting the Joint Annual Report for WY 90-92.

09 April 1993 CC Mail message from DD to Dave Moughton.  
Subject: Refrain from issuing the diversion report.

15 April 1993 Memorandum from CENCD-PE-ED-WH to CENCC-ED-H.  
Subject: Collection of funds for operation of hydraulic programs.

18 April 1993 Memorandum from CENCD to CENCC-ED-HW.  
Subject: Lake Michigan Diversion Accounting of Maintenance Diversions.

20 April 1993 Letter to James Flannery (LTV Steel) from CENCC-ED-HW.  
Requesting data for the period of Oct 91 to Oct 92 for development of flow model for Grand Cal River/Indiana Harbor.

20 April 1993 Letter to Robert Johnston (Inland Steel) from CENCC-ED-HW.  
Requesting data for the period Oct 91 to Oct 92 for development of flow model for Grand Cal River/Indiana Harbor.

05 May 1993 Memorandum from CENCD to CENCC-ED-H  
Subject: Submittal of Annual Report for Water Control Data Systems.

12 May 1993 Memorandum from CENCD-PE-ED-WH to CENCC-ED-H.  
Subject: Corps of Engineers NEXRAD Data Acquisition Plan Update.

12 May 1993 Letter to Thomas O'Connor from CENCC-ED-HW.  
Asking for MWRDGC cooperation in taking measurements at Lockport Powerhouse Turbine Flow Meter with dataloggers and verify measurements at Upper Des Plaines pump station with 2 different options.

14 May 1993 Memorandum from CENCC-ED-HW to CENCD-PE-ED-WH.  
Subject: NEXRAD data acquisition.

14 May 1993 Memorandum from CENCC-ED-HW to CENCD-PE-ED-WH.  
Subject: Water control Data System Annual Report.

18 May 1993 Letter to Lynn Pruitt (Stanley Consultants) from CENCC-ED-HW.  
Forwarding two copies of the Lake Michigan Diversion Report per request.

27 May 1993 Memorandum from CENCC-ED-HW to CENCD-RM-FA.  
Subject: Collection of project funds for operation of hydrologic programs.

30 June 1993 Memorandum from CENCC-ED-H to CENCC-IM.  
Subject: Ordering of PC parts for water control section.

13 July 1993 Letter to Thomas O'Connor (MWRDGC) from CENCC-ED-HW.  
Announcing series of flow measurements at CRCW. Requesting that all sluice gates be closed during measurements which were scheduled for 13 to 16 July from 2AM to 6AM.

09 August 1993 Memorandum from CENCC-ED-HW to CENCC-CO.  
Subject: Request by Metropolitan Water Reclamation District of Greater Chicago concerning Lockage Data.

20 August 1993 Memorandum from CENCC-ED-HW to CENCD-PE.  
Subject: Updated flows for Lake Michigan Diversion Accounting.

27 August 1993 Memorandum from CENCCED-HW TO CENCD.  
Subject: Cooperative stream gaging costs for FY 94.

30 August 1993 Letter to Tom Fogarty from RUST Environmental & Infrastructure.  
HSPF Hydrologic Modeling Grand Cal Basin Contract # DACW23-91-D-0001.

31 August 1993 Letter to Tom O'Connor (MWRDGC) from CENCC-ED-HW.  
Requesting measured data from the turbine AVM's for the period Aug 92 thru present.

31 August 1993 Letter to Robert Buchman from CENCC-ED-HW.  
Response to letter of Aug 20 93 about Lake Michigan Water Levels.

22 September 1993 Letter to Melcy Curth Pons (RUST Environmental & Infrastructure  
Inc.) Response to request of Aug 30 93 letter for additional funding of HSPF Model of  
Grand Cal River.

