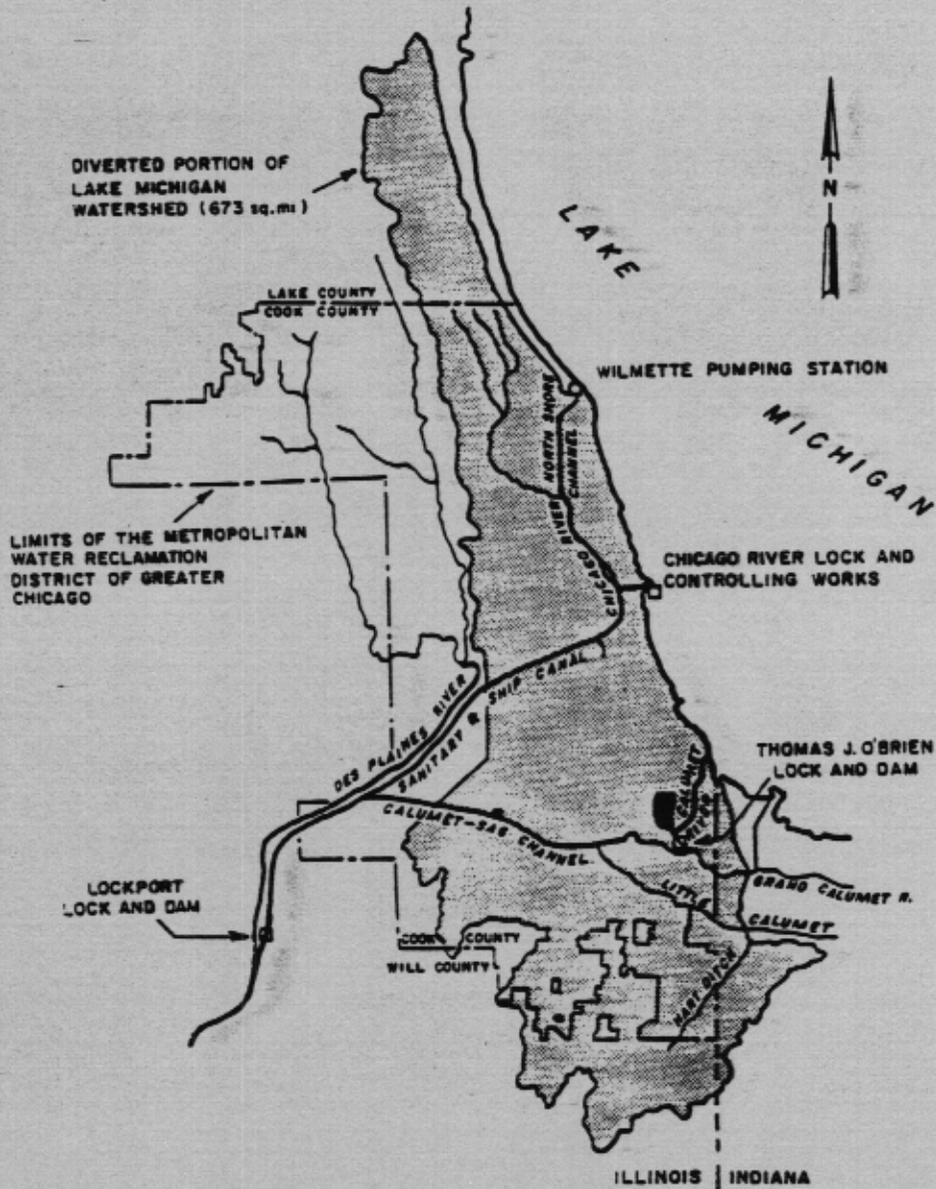




**US Army Corps  
of Engineers**  
Chicago District

# Lake Michigan Diversion Accounting 1989 Annual Report

Including WY84 & WY85 Accounting



## EXECUTIVE SUMMARY

This document is the 1989 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 accomplishments with respect to a new mission as mandated by the Water Resources Development Act of 1986, PL 99-662, 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 1988 through 30 September 1989.

Year 1989 marked the first year in which the Chicago District, Corps of Engineers embarked on compiling the diversion accounting data and calculating diversion flows. The District's activities for FY89 are discussed in this report. It is anticipated that coordination and transitional activities will continue throughout the 1990 accounting year.

The second Three-Member Technical Committee completed its report in the beginning of 1988. The committee reviewed the hydrologic and hydraulic computer models used in calculation of the Lake Michigan diversion and agreed that the approach was consistent with what was required by the decree (Espey et al, 1987). However, the committee felt that some of the parameters used in the models were out of date and in need of revision. To address the committee's concerns, the Corps hired a consultant to review and update the modeling parameters. The review and update was completed during 1989.

An Acoustic Velocity Meter (AVM) is used to calculate flows in the Sanitary and Ship Canal. The AVM replaces Lockport as the central measurement point for the Lake Michigan diversion and the meter is located at Romeoville, approximately five miles upstream of Lockport. A backup system for the AVM was completed during 1989. The backup system uses the flows measured at Lockport and a set of three regression equations to calculate flows in the Sanitary and Ship Canal when the AVM malfunctions.

The 1984 and 1985 diversion accounting reports were previously developed by the Northeastern Illinois Planning Commission (NIPC) for the State of Illinois. The Corps reviewed the reports, updated the modeling parameters questioned by the Second Technical Committee, converted the 1984 Lockport flows to AVM flows, and recalculated the 1984 and 1985 diversion flows. The final calculated diversions for 1984 and 1985 are 3432 cubic feet per second (cfs) and 3473 cfs, respectively. The average diversion for 1981 through 1985 is 3442 cfs, 242 cfs greater than the 3200 cfs, 40 year average specified by Supreme Court Decree.

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## INTRODUCTION

### 1.1 INTRODUCTION

The Fiscal Year 1989 (FY89) Annual Report on Lake Michigan Diversion gives a brief history of the diversion and its accounting, certifies the WY84 and WY85 Lake Michigan Diversion flows, describes the sources of the diversion, presents the diversion accounting procedure, and includes a summary of all the major activities occurring during fiscal year 1989 (1 October 1988 - 30 September 1989). Scheduled activities for FY90 and FY91 are also presented. The Water Year (WY) covers the same period as the fiscal year, 1 October - 20 September.

The major activities covered in this report include installation of a new AVM at Romeoville, revision of the diversion accounting modeling parameters questioned by the Second Three Member Technical Committee, development of a backup system for the Acoustic Velocity Meter (AVM) at Romeoville, and installation of a precipitation gage network.

### 1.2 BACKGROUND

The City of Chicago, as well as some of its suburbs, have drawn on Lake Michigan as the source of their municipal water supply for almost their entire history. When the flow of the Chicago River was reversed and the Chicago Sanitary and Ship Canal was completed (in 1900), this flow of water was diverted from the Lake Michigan (St. Lawrence and Atlantic Ocean) watershed to the Illinois River (Mississippi and Gulf of Mexico) watershed. This diversion procedure is still in effect today and is closely controlled by the State of Illinois. As directed by the modified Supreme Court Decree, the U. S. Army Corps of Engineers is responsible for supervising the activities of the State of Illinois. Additionally, the Corps was given total responsibility for diversion accounting effective 1 October 1987. Thus, a dual role for the Corps was created with respect to management of the accounting program. This report is the sixth in a continuing series of Annual Reports prepared by the Corps beginning with the FY83 report. The reports are distributed to the Great Lakes states and the Department of Justice as well as other involved concerns.

### 1.3 AUTHORITY FOR REPORT

Under the provisions of the U.S. Supreme Court Decree in 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 is responsible for monitoring the measurement and computation of Lake Michigan water by the State of Illinois. Under the terms of the modified decree, the Corps is required to prepare an annual report covering the diversion accounting activities as well as actions taken by the involved agencies.

#### 1.4 HISTORY

Water has been diverted from Lake Michigan at Chicago into the Mississippi River Basin since the completion of the Illinois and Michigan Canal in 1848. The diversion, at that time, averaged approximately 500 cubic feet per second (cfs). Upon completion of the Chicago Sanitary and Ship Canal in 1900, the flow direction of the Chicago River was reversed (away from Lake Michigan) and a permit was issued by the Secretary of War for the diversion of 4,167 cfs. In 1908 and again in 1913, the United States brought actions to enjoin the Metropolitan Water Reclamation District of Greater Chicago (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, a permit was issued to divert 8,500 cfs which was about the average then being used. Figure 1-1 is a schematic of the flow reversal and Figure 1-2 shows the affected watershed.

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 Court to hear the combined three suits, found the 1925 permit to be valid and recommended dismissal of the action. The 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.

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 an average of 3,200 cfs over a five-year period 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 rate from five years to forty years and the forty year period begins with Water Year 1981 (WY81). A water year refers to the period 1 October through 30 September and the water year coincides with the Corps of Engineers fiscal year.

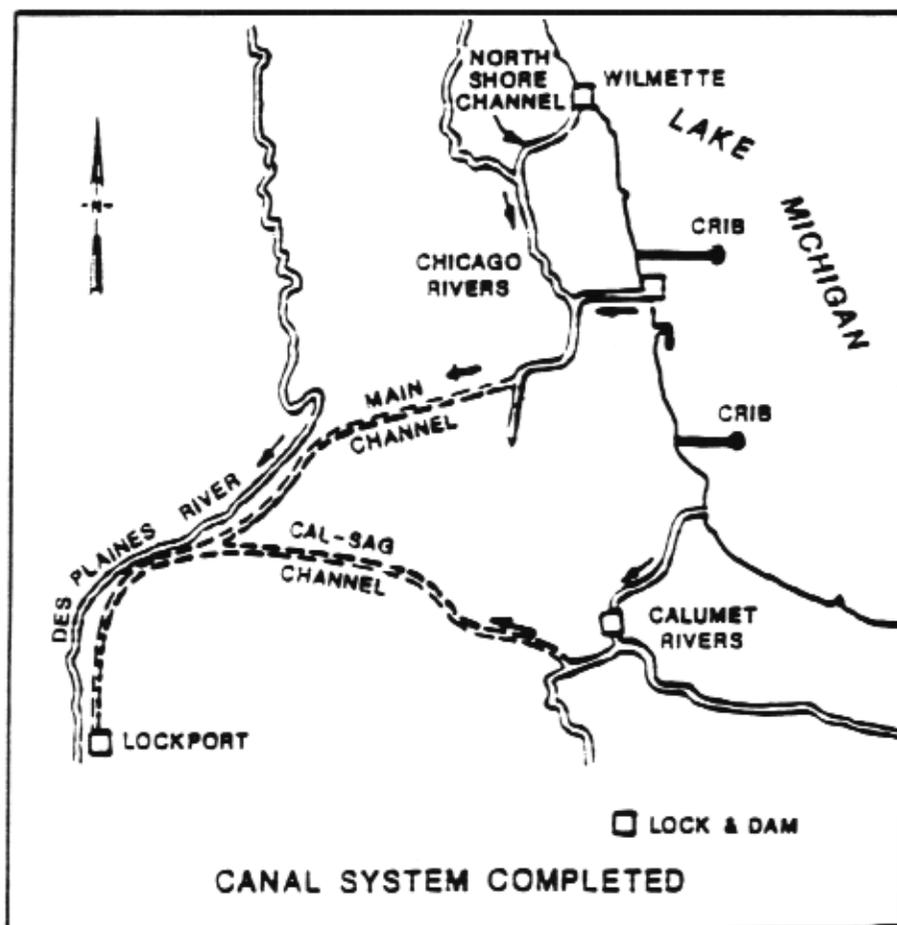
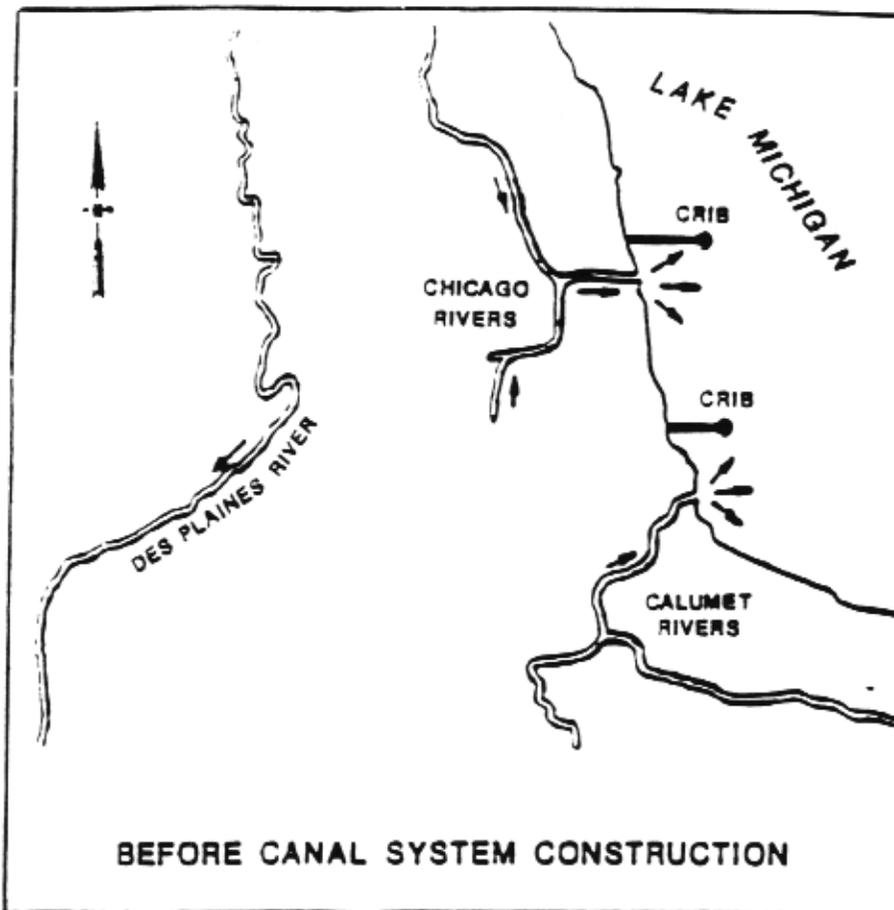
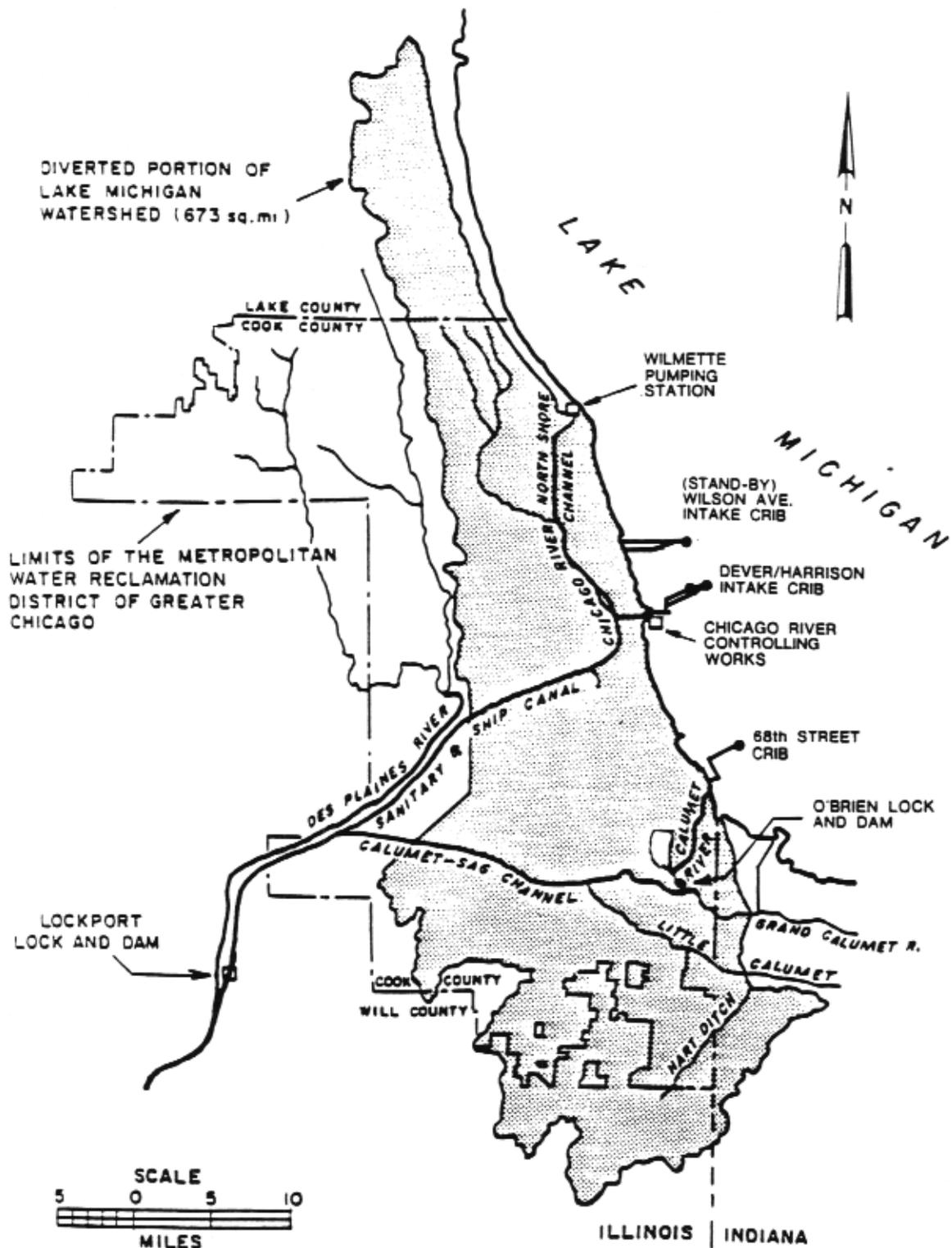


Figure 1-1



LOCATION PLAN-LAKE MICHIGAN DIVERSION AT CHICAGO

The amended decree contains three provisions that affected the role of the Corps with regard to the diversion accounting program. First, although the State of Illinois was to be primarily responsible for measurement and computation of diversion flows, the decree allowed the Corps to take over this function subject to a cost sharing agreement. Although negotiations were held with the objective of reaching this goal, no agreement was reached due to lack of funding. Therefore, 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), the Metropolitan Water Reclamation District of Greater Chicago (MWRDGC), and the United States Geological Survey (USGS). As discussed above, responsibility for diversion accounting was finally given to the Corps effective 1 October 1987 as a result of the passage of the Water Resources Development Act of 1986.

Second, the supervisory role for the Corps was increased, in that the Corps was now 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 was convened in June 1981 and completed its work in April 1982. The second Technical Committee was convened in July 1986, and completed their final report in November 1987. The third Technical Committee is scheduled to be convened in mid 1991.

## SIGNIFICANT EVENTS

### 2.1 HYDROLOGIC EVENTS

There were two large rainfall runoff events that occurred in FY89. During the period of 29 May through 4 June, there were severe storms in the Little Calumet and the Kankakee river basins. The worst flooding occurred in Munster, Indiana, along the Little Calumet River and Hart Ditch, where the storm intensity was recorded as a 50-year event. Also, on 4 August, there was a very intense rainfall between 2:00 and 5:30 AM, which caused backflows through the Wilmette controlling works averaging approximately 552 cfs during a 3.5 hour period (5:00 - 8:30 am). This rainfall was estimated to be at least a 50 year event for the short duration.

## 2.2 NON-HYDROLOGIC EVENTS

During WY89, there were a number of significant non-hydrologic events that transpired. The three most significant events were as follows: (a) installation of a new AVM at Romeoville, (b) transmittal of proposed legislation to the Council of Great Lakes Governors to give the Corps authority to make temporary minor deviations in the diversion for navigation emergencies and to make essential repairs, and (c) installation of a 25 gage precipitation measurement network by the Illinois State Water Survey (ISWS), under contract with the Chicago District. A separate, detailed chronological listing of the significant non-hydrologic events is included as Appendix A.

## DIVERSION ACCOUNTING

### 3.1 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 prior to this report, the Corps has certified diversion flows for the 1981, 1982, and 1983 water years. The WY84 and WY85 Accounting reports are certified with this annual report. A table showing the accounting year, the certified flows, the running average flows, and the cumulative deviation from the allowable diversion (3,200 cfs) is shown below:

TABLE 3-1

#### LAKE MICHIGAN DIVERSION FLOWS

ACCOUNTING YEAR	CERTIFIED FLOW	RUNNING AVERAGE	CUMULATIVE DEVIATION
1981	3,106 cfs	3,106 cfs	+94 cfs-years
1982	3,087 cfs	3,097 cfs	+207 cfs-years
1983	3,613 cfs	3,269 cfs	-206 cfs-years
1984	3,432 cfs	3,309 cfs	-438 cfs-years
1985	3,472 cfs	3,342 cfs	-710 cfs-years

The running average diversion for the period WY81 through WY85 is 3,342 cfs, 242 cfs greater than the 3,200 cfs, 40-year average diversion specified by the modified decree. The cumulative deviation, which is the sum of the annual differences between 3,200 cfs and the certified flow, is -710 cfs-years. The negative cumulative deviation indicates a flow debt and the maximum allowable debt during the first 39 years covered by the modified decree is 2,000 cfs-years.

The WY84 and WY85 accounting flows developed by NIPC were recalculated based on revised modeling parameters and based on AVM flows rather than Lockport flows for WY84. The revised WY84 and WY85 accounting flows are presented in a joint accounting report included as Appendix B. Section 3.4 of this report discusses the results of the WY84 and WY85 accounting.

A work order for WY86 diversion accounting was awarded to NIPC by the Chicago District in August 1989 and work has begun. The report is scheduled for completion in July 1990 and will be certified with the FY90 Annual Report.

Data collection and preparation for the WY87 accounting report was nearly completed in FY89. However, precipitation data will not be available until July 1990. The WY87 accounting report is scheduled to be developed during the latter part of FY90 and the early part of FY91. This report will be certified with the FY91 annual report.

Data collection and preparation for the WY88 and WY89 accounting reports will be performed by the Corps. The Chicago District will complete these accounting reports in house. Data collection and preparation for these reports will begin in FY90. Certification is scheduled for FY91.

### 3.2 SOURCES OF DIVERSION

The Lake Michigan diversion is composed of three primary components. These components are direct diversion through the three lake front structures, domestic pumpage from Lake Michigan which is used for water supply and not returned to Lake Michigan, and stormwater runoff from the Lake Michigan watershed which is diverted from the lake.

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 that is passed as part of locking vessels to and from the lake.

The original purpose of the diversion was for diluting effluent from sewage treatment plants. Occasionally, flow must still be diverted for this purpose and to flush the canal. This component of the direct diversion is known as discretionary diversion.

Periodically when large storm events are predicted, the canal is drawn down prior to the event to prevent flooding. If the event fails to materialize, the canal level must be restored. The direct diversion flow used during the drawdown of the canal and to restore the canal level when no event occurs is referred to as navigation makeup.

The leakage component of the direct diversion is through the locks and the controlling structures at the lake.

Domestic pumpage from Lake Michigan is used for water supply and its effluent is discharged to various Water Reclamation Plants (WRPs). Currently, the WRPs 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 via the Chicago River and the Calumet River now drain to the Sanitary and Ship Canal and the Calumet Sag Channel, respectively. The Calumet Sag Channel drains to the Sanitary and Ship Canal which ultimately drains to the Illinois River and the Mississippi River. The drainage area of the diverted Lake Michigan watershed is approximately 673 square miles.

### 3.3 ACCOUNTING PROCEDURE

Diversion accounting is performed through the use of both measured and estimated flows. Beginning with the WY83 accounting report, a new system was developed by NIPC to perform the accounting and the procedure is described in detail in the Lake Michigan Diversion Accounting Manual of Procedures, (NIPC,1985). The system uses various meteorologic data to simulate flows that cannot be measured and simulated as well as measured flows are used to compute the diversion. In addition to the diversion calculation, a number of water budgets are developed to check the computed diversion and to give an estimate of the reliability of the computed diversion.

#### 3.3.1 DIVERSION COMPUTATION

An acoustic velocity meter (AVM) was installed and is operating at Romeoville (five miles upstream of Lockport Powerhouse and three miles upstream of Lockport Controlling Works) since 12 June 1984 for direct measurement of Lockport flows. The majority of the diverted Lake Michigan flows and some non-Lake Michigan flows drain through the Lockport facilities. The diversion accounting procedure uses the flow measured at Lockport and deducts flows not attributable to the diversion. Diversion flows which bypass Lockport are added to the resultant,

yielding the net computed diversion of water from Lake Michigan. This procedure represents the accounting technique as required by the modified Supreme Court Decree. This method of accounting is used as opposed to computing the sum of the individual components of the diversion described in section 3.2.

During WY84 and WY85 the flow measured at Lockport was roughly 110% of the average annual diversion and roughly 99% of the diversion passed through Lockport. Thus both deductions from, and additions to, the Lockport record were made to calculate the Lake Michigan diversion accountable to the State of Illinois. The calculation of the diversion is described briefly below and in more detail in the accounting report in Appendix B.

Deductions to the Lockport record include runoff from 217 square miles of the Des Plaines River watershed which is discharged to the canal, groundwater supply whose effluent is discharged to the canal, and Indiana water supply which discharges to the canal via the Calumet River system and the Calumet Sag Channel (see figure 1-2 for locations). The NIPC computer models of the Des Plaines watershed area are used to ascertain the best estimate of the runoff deduction. The groundwater pumpage deductions are obtained directly from pumping records. The Indiana water supply deduction is computed from pumping records and a calculation which determines the portion of the water supply draining west to the Calumet Sag Channel.

The additions for diversion flow which does not pass through Lockport is primarily composed of Lake Michigan water supply pumpage whose effluent is treated and released to the Des Plaines River or one of its tributaries. This flow is obtained directly through pumping records of the communities involved. This flow accounts for approximately 1% of the diversion. However, as more communities convert to Lake Michigan Water, this percentage will increase.

### 3.3.2 DIVERSION BUDGET CHECKS

A series of water budgets are developed to verify those flows that cannot be measured. Most of the budgets compare simulated flows to recorded flows and these comparisons give an indication of the accuracy of the diversion accounting. The four primary budgets are the budgets for the three major Water Reclamation Plants (WRP) that service the area involved in diversion accounting and the budget for the Sanitary and Ship Canal. The remaining budgets either represent balances for relatively small flows or are budgets of non-simulated flows such as water supply pumpage.

### 3.4 WY84 AND WY85 DIVERSION ACCOUNTING

The WY84 and WY85 accounting was performed by NIPC for the State of Illinois using the original modeling parameters and Lockport flows for WY84. The Corps updated the modeling parameters and calculated AVM flows for WY84 using the Lockport flows and the regression equation AVM backup system. In developing the WY85 report, NIPC used flows from the AVM at Romeoville. The Corps recalculated the diversion for both WY84 and WY85 using the updated modeling parameters and Romeoville flows. The joint WY84 and WY85 accounting report is included as appendix B.

WY84 was the first year in which the AVM was used to measure the flow in the canal system. In WY84, the AVM measured flow was 314 cfs greater than the Lockport measured flow and in WY85 the AVM flow was 229 cfs greater than the Lockport flow. Had the Lockport measured flows been used rather than the AVM flows, the average diversion for the WY84/WY85 period would have been 3,181 cfs, 19 cfs less than the 3,200 cfs allocation.

The overall budget balance for the three major WRPs resulted in a simulated to recorded ratio of 0.95 for WY84 and 1.01 for WY85 indicating that the simulated flows were 95% and 101% of the recorded flows for the two years. These balances are quite good indicating that the accuracy of the simulation models used to calculate the Romeoville deduction for runoff from the Des Plaines River watershed is quite high.

The budget balance for the smallest of the three WRPs, the Calumet WRP, is not as good as the balance at the other two plants. Although the annual budget balance is quite good, the Calumet simulated flows exhibit greater variation than the Calumet recorded flows. Because the recorded flows at the Calumet WRP exhibit much less variation than the recorded flows at the other two WRPs, it is unclear whether the problem is with the Calumet flow meters or with the Calumet simulation model or both. Because the annual balance is quite good, the problem may be strictly a matter of timing or proper representation of storage in the flow collection system which would impact the diversion calculations very little.

The budget balance for the canal system is a comparison of the inflows to the canal and the outflows from the canal. The inflows are both measured and simulated and virtually the entire outflow is measured using the AVM at Romeoville. The ratios of inflow to outflow were 0.89 and 0.87 (431 cfs and 504 cfs differences) for WY84 and WY85, respectively. The canal system budget balance is not nearly as good as the WRP balances. Because the more accurate AVM is measuring higher flows, the large imbalance did not become evident until the AVM began being used in the WY84/WY85 diversion accounting report. The source of

the imbalance is uncertain at this time. However there are a number of factors that could have contributed to it. The most significant factor may have been leakage and overtopping of the Chicago River Harbor wall. The Chicago Harbor wall was leaking significantly due to disrepair and being overtopped due to high lake levels. Another factor may have been the measured flows at the three lakefront controlling works which are known not to be very accurate. Finally, there may be some unreported discharges to the canal. The Corps intends to investigate the source(s) of the imbalance in the immediate future.

The WY84 and WY85 Lake Michigan Diversion Accounting Report in Appendix B discusses the calculation of the diversion and the budget balances in detail. The report also discusses the differences between the NIPC diversion calculation and the Corps diversion calculation. The NIPC diversion accounting reports for the two years are included as part of the Corps accounting report.

#### ACCOMPLISHMENTS DURING FY89

##### 4.1 ACCOUNTING REPORTS

As discussed previously, the WY84 and WY85 diversion accounting reports were completed during the year.

##### 4.2 REVISION OF COMPUTER MODELS

An A/E consultant (C.B. Burke Engineering Ltd.) was contracted to perform services related to the updating of the computer modeling parameters questioned by the Second Technical Committee and used in Lake Michigan Diversion Accounting. The modeling parameters were updated to 1984 conditions. Additional work tasks completed as part of the contract include development of a computerized base mapping system for the study area. The results are summarized in the report entitled I/I STUDY AND DIVERSION ACCOUNTING MODEL MODIFICATION, (Burke,1989) prepared by the consultant.

##### 4.3 DIVERSION ACCOUNTING

The Northeastern Illinois Planning Commission (NIPC) was contracted to develop the WY86 Accounting Report and to adjust WY87 precipitation data. Precipitation data has been adjusted since the beginning of the new accounting system in WY83 because gages sheltered by nearby obstacles were under-reporting rainfall.

##### 4.4 PRECIPITATION DATA COLLECTION NETWORK INSTALLATION

The Illinois State Water Survey was contracted to install a 25-gage precipitation network and reduce WY90 precipitation data

from the network. Installation of the network will make it no longer necessary to adjust precipitation data as of WY90.

#### 4.5 SOFTWARE CONVERSION

The diversion accounting software developed by NIPC was previously run on a mainframe type computer. A portion of the software is a standard rainfall-runoff model which was converted to run on IBM PC compatible computers by the U.S. EPA and is available to the public. The remainder of the accounting software was obtained from NIPC and was updated by the Chicago District to more fully run on IBM PC compatible computers. The new software was used to certify the WY84 and WY85 accounting reports. Documentation for the PC implementation of diversion accounting will be developed during FY90.

#### 4.6 ACOUSTIC VELOCITY METER AT ROMEOVILLE

The Chicago District, in cooperation with the United States Geological Survey (USGS), contracted with Accusonic Division, Ferranti O.R.E., Inc. (ORE) for installation of a new AVM for measurement of flow at Lockport. The new AVM system was installed in November/December 1988. Initially, some problems were encountered with respect to calibration of the meter. However, these problems have been resolved and very little data was unusable.

A major accomplishment of the Chicago District, was completion of the report entitled "Chicago Sanitary and Ship Canal at Romeoville Acoustic Velocity Meter Backup System" (USACE, Chicago District, 1989). This report, dated September 1987, discusses the development, through regression analysis, of an accurate set of regression equations which synthesize AVM flows in the event of an AVM malfunction or breakdown. The regression equations use MWRDGC reported flows through the Lockport turbines, the Lockport powerhouse sluice gates, and the Lockport controlling works. In preparation of this report, the Corps took into consideration regression equations previously developed by the USGS and the second Three-Member Technical Committee. A thorough analysis was made of these equations in preparing the report. As recommended by the second Technical Committee, actual Lockport operating conditions were considered in development of the equations. The report was reviewed by the Hydrologic Engineering Center (HEC), the hydrologic research branch of the Corps, and the U.S. Geological Survey (USGS) and finalized in FY89. The equations developed in the report were used to calculate Lockport (Romeoville) flows for the periods of WY84 and WY85 when the AVM was not operating. The equations will be used for diversion accounting through WY87, the year through which data was used in development of the equations. After WY87, the equations will be updated using the most recent data.

As recommended by the second Technical Committee, an annual review of the AVM flow records by all participating agencies will be an on-going activity established and conducted by the Corps. The regression equations used in the AVM backup system will be used to verify the AVM flows. A detailed review of the 15 minute AVM flow record will be conducted for the days that exhibit large discrepancies between the AVM measured flows and the regression calculated flows.

#### 4.7 UPPER DES PLAINES PUMP STATION

In the past, the accuracy of the Upper Des Plaines Pump Station record was questioned. Because the pump station is an important calibration point for the diversion accounting hydrologic simulation models, a study was undertaken to determine the accuracy of the station. As part of the study, pump station flow meter charts were digitized and the flows compared to the simulated record. It was found that with some calibration, the pump station may be able to provide reasonably accurate flow records. Current meter measurements will be made during FY90 to provide calibration data.

#### 4.8 INDIANA FLOWS

The Chicago District reviewed the Grand Calumet Flow split calculation for Indiana Lake Michigan water supply that is a deduction from the Lockport (Romeoville) record. A number of alternatives for improving this calculation were developed which include installation of a streamflow gage, modification of the existing regression equation, and development of a computer simulation model. The most appropriate alternative will be implemented in FY90.

#### 4.9 DATA QUALITY ASSURANCE PROGRAM

The District has been practicing data quality assurance procedures as evidenced by efforts toward calibration of the Upper Des Plaines pump station, development of the AVM backup system regression equations, and installation of the new precipitation gage network. A report on the District's current practices and expansion of the program will be completed during FY90.

#### 4.10 PROPOSED LEGISLATION

The North Central Division Corps Commander submitted by letter dated 15 December 1988 a draft proposed regulation to the Council of Great Lakes Governors for comment. The regulation would have given the Corps authority to make temporary minor deviations in the Lake Michigan diversion for navigation emergencies and periodic repairs to the canal. The proposed regulation was in response to a 21 cfs-year deviation in the Lake

Michigan diversion that was made in September 1988 to make essential repairs to the Lockport lock and dam. The Council of Great Lakes Governors, by letter dated 27 July 1989, recognized the need for temporary deviations for necessary repairs and other possible short term emergencies but did not agree that the Corps should be given the authority to make such deviations. The Council preferred to either not make deviations or to have the Corps consult with the Council as emergencies occur.

## ACTIVITIES FOR FY90

### 5.1 PRECIPITATION DATA ADJUSTMENT

A contract with the ISWS for adjustment of WY88 and WY89 precipitation data will be developed in FY90. The data adjustment will be completed by the end of FY90 and the accounting for WY88 and WY89 will be completed after the data is adjusted. Beginning with WY90, data from the newly installed precipitation gage network will be available and the data should require no adjustment. This should significantly reduce time required to prepare usable precipitation data and reduce the delay in preparation of the accounting reports.

### 5.2 ACCOUNTING REPORTS

The WY86 Accounting Report is scheduled to be completed by NIPC and certified by the District. The report was begun in FY89 and will be completed by July 1990. The accounting report will be certified with the FY90 Annual Report.

Data collection for the WY87 accounting report was completed in FY89 with the exception of precipitation data. The precipitation data adjustment is scheduled for completion by the end of the second quarter of FY90. The accounting will be performed during FY90 and FY91 after receipt of the adjusted precipitation data. The WY87 accounting report will be certified with the FY91 Annual Report.

Data collection, including precipitation data adjustment, for WY88 and WY89 accounting will be completed during FY90. The reports will be prepared in-house during FY90 and FY91 after receipt of the adjusted precipitation data. The WY88 and WY89 reports will be certified with the FY91 Annual Report.

### 5.3 PRECIPITATION DATA COLLECTION

Data from the network of 25 precipitation gages installed in FY89 will be collected by the ISWS under contract with the Corps. The Corps will exercise an option on the current ISWS contract for collection of WY91 data.

#### 5.4 ACOUSTIC VELOCITY METER

At the end of FY89, nearly a full year of flows had been measured with the new AVM from ORE. The reliability of the system will be reviewed as well as the flows. The flows from the new AVM will be compared to those calculated using the backup system regression equations. The comparison will indicate any differences in calibration between the old and new equipment that has not already been detected by periodic current meter measurements.

The District will coordinate with the USGS for collection of WY90 AVM data.

#### 5.5 THIRD TECHNICAL COMMITTEE

In accordance with the provisions of the modified Supreme Court Decree of 1 December 1980, procurement procedures for the Third Technical Committee for review of Lake Michigan diversion flow measurements and calculations will begin in the second quarter of FY90. Selection of the committee and contract negotiations will take place in FY90 while the contracts with the committee members will be awarded in FY91. It is anticipated that this committee will review the reports of the first two committees as well as evaluate current accounting procedures to insure that the diversion measurements and calculations are conducted according to the "best current engineering practice and scientific knowledge" as required by the decree.

#### 5.6 DATA QUALITY ASSURANCE PROGRAM

The report on a Data Quality Assurance Program will be completed in FY90. Additionally, the program will be implemented in FY90 at the WRPs and other locations where measurements are made and data quality assurance procedures have not already been practiced.

#### 5.7 UPPER DES PLAINES PUMP STATION

Calibration and verification of the flow measurement system at the pump station will be completed in FY90.

#### 5.8 CALUMET WRP FLOW BUDGET

The Calumet WRP simulation model exhibits much greater flow variation than the plant's recorded flow. A review of the Calumet flow records and Calumet simulation model will be conducted during WY90.

#### 5.9 CANAL SYSTEM FLOW BUDGET

The canal system flow budget indicates a large difference between the inflows to and the outflows from the canal. Potential

sources of the difference include leakage through the lakefront structures, inaccurate ratings for the lakefront structures, and unreported discharges to the canal. An investigation to identify the source(s) of the flow imbalance will be conducted during FY90.

#### 5.10 INDIANA FLOW DEDUCTION

A procedure for computing the Indiana flow deduction will be selected from the alternatives developed in FY89. The selected procedure will be incorporated into the WY87 diversion accounting report.

#### 5.11 O'HARE FLOW TRANSFER

The District will develop a procedure to better calculate the flow transfer, and its components, from the O'Hare WRP in the Des Plaines River watershed to the Northside WRP in the Lake Michigan watershed. This task will continue into FY91.

#### 5.12 NAVIGATION MAKEUP COMPONENT REVIEW

The Corps of Engineers and the State of Illinois will explore alternatives for reducing the Navigation Makeup component of the Lake Michigan Diversion. The reduction of navigation makeup water may be accomplished by operational changes in the canal system upstream of Lockport. Any reduction in the water used for the navigation makeup component would provide more water for domestic use and aid the State in bringing their diversion down to the level specified by Supreme Court Decree.

It is likely that any operational changes that would reduce the navigation makeup component would also reduce the flow required to draw the canal down for other purposes such as repairs to the canal. Potential reductions in the diversion required to make repairs to the canal will be evaluated in conjunction with the navigation makeup review.

### PROJECTED ACTIVITIES

#### 6.1 ACCOUNTING REPORTS

The WY87, WY88, and WY89 diversion accounting reports will be certified in the FY91 Annual Report

Data collection and preparation of the WY90 accounting will be performed in-house during FY91. The report will be completed in FY92 and certified with the FY92 annual report. It is anticipated that all subsequent accounting reports will be prepared and certified in the year following the diversion and transmitted with that years annual report.

## 6.2 EVALUATION OF THE NEW RAIN GAGE NETWORK

FY90 is the first year in which data will be available from the new precipitation gage network installed at the end of FY89. Under this task, the diversion accounting model will be updated to reflect the new gages and the impact of the network on the diversion accounting simulations will be evaluated.

## 6.3 PRECIPITATION DATA COLLECTION

Collection of precipitation data for WY91, and all subsequent years, from the 25 gage network will be coordinated with the ISWS. Contracts will be developed with the ISWS for data collection as necessary.

## 6.4 ACOUSTIC VELOCITY METER

Collection of WY91 AVM data will be coordinated with the USGS. Review of the WY90 AVM data using Lockport flows and the AVM backup system regression equations will also be performed under this task.

## 6.5 THIRD TECHNICAL COMMITTEE

The committee will begin their review in FY91 and the Corps will conduct briefings for the committee on the diversion accounting procedures. Subsequent to FY91, the Corps will implement improvements to the diversion accounting procedures which may be recommended by the committee. The fourth technical committee is scheduled to be convened in WY96.

## 6.6 REVIEW O'HARE BASIN TRANSFER

The District will implement procedures for better computing the flow transfer, from the O'Hare WRP to the Northside WRP, into the diversion accounting procedure. The procedure is scheduled for use in WY90 accounting.

## 6.7 NAVIGATION MAKEUP CONSERVATION

Any feasible procedures developed in WY90 for reducing the navigation makeup component of the diversion will be implemented in WY91. These procedures will also be used in the event that the canal system must be drawn down to make repairs.

## 6.8 TARP REVIEW

The Des Plaines River TARP tunnel is scheduled to be constructed and brought on line in WY93. Prior to preparing the accounting report for that year, the impact of the tunnel on diversion accounting will be evaluated and the appropriate revisions to the accounting models made.

A 5-year Master plan detailing scheduled tasks is included as Appendix C. The plan shows not only the accounting report certification schedule but also a schedule of improvements and other tasks to be performed during the 5-year planning period.

## SUMMARY AND CONCLUSIONS

### 7.1 SUMMARY

In previous years, the Lake Michigan diversion accounting program went through significant modifications to the technical methodology used in computing the total flows at Lockport and in computing the deductions. During FY89, significant updates were made to the modified methodology including revision of the modeling parameters, development of a backup system for the AVM, installation of a precipitation data collection network, and conversion of the accounting system to the micro-computer environment. These updates were made in addition to certifying two accounting reports.

Although significant updates have been made, there are several tasks yet to be completed. The scheduled updates include updating the procedure for calculating the deduction for Indiana water supply discharge entering the canal system, updating the calculation of the flow transferred from the O'Hare WRP basin to the diverted Lake Michigan watershed, and completion of a comprehensive data quality assurance program.

The Third Technical Committee is scheduled to begin their review in the beginning of FY91. It is anticipated that their review will find that the diversion accounting procedure, with the completed and planned improvements, is consistent with the best current engineering practice and scientific knowledge. In any case, all of the committee's findings and recommendations will be given careful consideration.

### 7.2 CONCLUSIONS

The WY84 and WY85 Lake Michigan Diversion Accounting Reports have been completed to the standards required by the Supreme Court Decree.

The State of Illinois exceeded their 3,200 cfs allocation in both WY84 and WY85 and the running average diversion from WY81 through WY85 was 242 cfs greater than 3,200 cfs. Exceeding the 3200 cfs allocation for WY84 and WY85 was partially the result of the AVM reporting higher flows than the Lockport facility. As discussed in section 3.4, had Lockport flows been used rather than AVM flows, the average diversion for the WY84/WY85 period would have been 3,181 cfs rather than the certified 3,452 cfs.

## REFERENCES

Burke, Christopher B., December 1989, I/I Study and Diversion Accounting Model Modification, for U.S. Army Corps of Engineers, Chicago District.

Espey, Dr. W.H., Barnes, Harry H., and Westfall, David, November 1987, Lake Michigan Diversion Findings, of the Second Technical Committee for Review of Diversion Flow Measurements and Accounting Procedures.

Northeastern Illinois Planning Commission, June 1985, Lake Michigan Diversion Accounting Manual of Procedures.

U.S. Army Corps of Engineers, Chicago District, Lake Michigan Diversion Accounting Section, September, 1989, Chicago Sanitary and Ship Canal at Romeoville Acoustic Velocity Meter Backup System.

Wisconsin et al, v. Illinois et al, Michigan v. Illinois et al, New York v. Illinois et al, U.S. 2, 3, and 4, Original 1-18, 1980

**APPENDIX A**  
**SIGNIFICANT EVENTS (NON-HYDROLOGIC)**

SIGNIFICANT EVENTS - WY89  
NON-HYDROLOGIC

3 October 1988 - Letter from the Metropolitan Sanitary District of Greater Chicago (MSDGC) to the Chicago District enclosing pump specifications and a full set of detailed plans for the Upper Des Plaines Pumping Station.

14 October 1988 - Meeting held between the Chicago District and C.B. Burke Engineering LTD. for discussion of revisions to hydrologic modeling parameters.

18 October 1988 - Fourth quarterly status report submittal to Corps' North Central Division (NCD).

19 October 1988 - Letter from the Chicago District to MSDGC forwarding monthly diversion lockage report for month of September 1988 for the Chicago River Lock.

24 October 1988 - Letter from the United States Geological Survey (USGS) to the Chicago District forwarding comments on the draft report prepared by District and entitled "Acoustic Velocity Meter Regression Analysis."

26 October 1988 - Letter from the USGS to the Chicago District forwarding daily discharges for Chicago Sanitary and Ship Canal at Romeoville for period of 1 October 1987 to 30 September 1988.

4 November 1988 - Letter from the Chicago District to MSDGC forwarding monthly diversion lockage report for month of October 1988 for the Chicago River Lock.

18 November 1988 - USGS performs discharge measurement in Chicago Sanitary and Ship Canal at Romeoville.

22 November 1988 - Letter from the Chicago District to the Northeastern Illinois Planning Commission transmitting a request for proposal for an indefinite delivery contract for hydrologic and hydraulic analysis and Lake Michigan diversion accounting.

7 December 1988 - Letter from the Chicago District to MSDGC forwarding monthly diversion lockage report for month of November 1988 for the Chicago River Lock.

15 December 1988 - Letter from the North Central Division to the Council of Great Lakes Governors requesting comments on draft legislation giving the Corps authority to make temporary minor deviations in the Lake Michigan diversion for navigation emergencies and periodic repairs to the canal.

19 December 1988 - Letter from the State of Illinois to the Chicago District summarizing the amount of water diverted into the Sanitary and Ship Canal system to restore canal elevations in association with Corps' navigation repair project during months of August and September 1988.

5 January 1989 - Letter from the Chicago District to the Metropolitan Water Reclamation District of Greater Chicago (MWRDGC) stating that Corps was in the process of revising the modeling parameters of the hydraulic models used in diversion accounting. Letter further stated that area tributary to the Upper Des Plaines Pump Station was being calibrated with observed flows at the pump station. Letter requested pump station flow measurement charts for analysis.

5 January 1989 - Letter from the Chicago District to MWRDGC forwarding monthly diversion lockage report for month of December 1988 for the Chicago River Lock.

12 January 1989 - Letter from MWRDGC to the Chicago District forwarding comments on Corps' 1987 Annual Report.

1 January 1989 - USGS performs discharge measurement in Chicago Sanitary and Ship Canal at Romeoville.

16 January 1989 - Fifth quarterly status report submittal to Corps' North Central Division (NCD).

18 January 1989 - Letter from the State of Illinois to the Chicago District regarding allocation of lockage and leakage components of the Lake Michigan diversion to the Corps and a proposed method of water conservation under the navigation makeup component of the diversion.

20 January 1989 - Letter from the State of Illinois to the Chicago District forwarding a copy of the Lake Michigan Diversion Accounting Report for the 1985 water year as prepared by the Northeastern Illinois Planning Commission (NIPC).

30 January 1989 - Letter from MWRDGC to the Chicago District providing flow charts for the Upper Des Plaines Pumping Station (UDPPS) for use in calibration as requested in 5 January letter above.

3 February 1989 - Letter from the Chicago District to MWRDGC forwarding monthly diversion lockage report for month of January 1989 for the Chicago River Lock.

13 February 1989 - Letter from the Chicago District to MWRDGC regarding data collection required for computation of Lake Michigan diversion for the 1988 water year. Letter included list of data required for computation of the diversion.

3 March 1989 - USGS performs discharge measurement in Chicago Sanitary and Ship Canal at Romeoville.

6 March 1989 - Letter from the Chicago District to MWRDGC forwarding monthly diversion lockage report for month of February 1989 for the Chicago River Lock.

7 March 1989 - Letters from the Chicago District to all parties of the diversion litigation forwarding copies of Corps' 1988 Annual Report on Lake Michigan diversion for informational purposes.

7 March 1989 - Letter from the Chicago District to NIPC forwarding copy of Corps' 1988 Annual Report on Lake Michigan diversion for informational purposes.

7 March 1989 - Letter from the Chicago District to the Office of the Chief of Engineers (OCE) through Corps' North Central Division (NCD) forwarding copies of Corps' 1988 Annual Report on Lake Michigan diversion for informational purposes.

15 March 1989 - Letter from the Chicago District to MWRDGC regarding data collection required for computation of the Lake Michigan diversion for the 1987 water year. Letter included list of data needed for computation of the diversion.

17 March 1989 - Letter from MWRDGC to the Chicago District in response to 13 February letter above. Letter forwarded information and data needed for performing diversion accounting for water year 1988.

3 April 1989 - Letter from the Chicago District to the State of Illinois responding to 18 January letter from the State and declining to accept permits for lockage and leakage flow from the lake front structures.

5 April 1989 - USGS performs discharge measurement in Chicago Sanitary and Ship Canal at Romeoville.

5 April 1989 - Letter from the Chicago District to MWRDGC forwarding monthly diversion lockage report for month of March 1989 for the Chicago River Lock.

17 April 1989 - Sixth quarterly status report submittal to Corps' North Central Division (NCD).

18 April 1989 - Letter from the Chicago District to the United States Geological Survey transmitting a revised report on the AVM backup system regression equations and requesting comments.

24 April 1989 - Letter from MWRDGC to the Chicago District in response to 15 March letter above. Letter forwarded information and data needed for performing diversion accounting for water year 1987.

24 April 1989 - Letter from the Chicago District to the Northeastern Illinois Planning Commission initiating the first work order of the indefinite delivery contract.

28 April 1989 - Memorandum from the Chicago District to HEC requesting their review of the Chicago District Report on the AVM backup system regression equations.

1 May 1989 - Letter from the Chicago District to the Northeastern Illinois Planning Commission transmitting awarded indefinite delivery contract.

3 May 1989 - USGS performs discharge measurement in Chicago Sanitary and Ship Canal at Romeoville.

4 May 1989 - Letter from the Chicago District to MWRDGC forwarding monthly diversion lockage report for month of April 1989 for the Chicago River Lock.

9 May 1989 - Letter from MWRDGC forwarding specification sheets for totaling flow measurement and an outline of monthly maintenance procedures.

10 May 1989 - Request for Proposal transmitted to the Illinois State Water Survey for installation of rain gage network and data collection from the network.

1 June 1989 - USGS performs discharge measurement in Chicago Sanitary and Ship Canal at Romeoville.

1 June 1989 - Letter from the Chicago District to MWRDGC forwarding monthly diversion lockage report for month of May 1989 for the Chicago River Lock.

5 June 1989 - Letter from the A/E contractor forwarding first draft and drawings for the Modeling Parameter Review Contract.

8 June 1989 - Letter from the State of Illinois to the North Central Division proposing a procedure to reduce the Navigation Makeup component of the diversion. A portion of the proposed procedure required modification of the Federal Code for operation of the canal system for navigation purposes. The State requested that the Corps review the potential for modifying the code and aid the State in estimating the potential diversion reduction.

14 June 1989 - Draft report on HEC review of the AVM backup system report transmitted to the Chicago District. In the review, HEC endorsed the regression equations and the backup system.

22 June 1989 - Letter from the Chicago District to MWRDGC requesting permission to make site visits to UDPPS to collect data.

29 June 1989 - Letter from the State of Illinois to the Chicago District forwarding a report entitled "Reduction of 1985 Water Year Precipitation Data for Chicago" as prepared by the Illinois State Water Survey.

7 July 1989 - Letter from the Chicago District to MWRDGC forwarding monthly lockage report for month of June, 1989 for the Chicago River Lock.

11 July 1989 - Letter from the North Central Division responding to the 8 June 1989 letter from the State. In the letter, the Corps agreed to review the State's proposal and requested a meeting.

18 July 1989 - USGS performs discharge measurement in Chicago Sanitary and Ship Canal at Romeoville.

24 July 1989 - Seventh quarterly status report submittal to Corps' North Central Division (NCD).

27 July 1989 - letter from the Council of Great Lakes Governors to the North Central Division responding to the 15 December 1988 letter above. The council declined to endorse the draft legislation proposed in the 15 December letter.

4 August 1989 - USGS performs discharge measurement in Chicago Sanitary and Ship Canal at Romeoville.

4 August 1989 - Letter from the Chicago District to MWRDGC forwarding monthly lockage report for the month of July, 1989 for the Chicago River Lock.

8 August 1989 - Letter from the Chicago District to the Illinois State Water Survey transmitting the awarded contract for installation of a precipitation gage network and collection of WY90 precipitation data.

17 August 1989 - Letter from the Chicago District to the Northeastern Illinois Planning Commission giving notice to Proceed for Work Order No. 1, of indefinite delivery contract, for WY86 Lake Michigan diversion accounting and WY87 precipitation data adjustment.

18 August 1989 - Letter from the United States Geological Survey to the Chicago District responding to the 18 April 1989 letter from the Corps and endorsing the AVM backup system regression equations.

12 September 1989 - USGS performs discharge measurement in Chicago Sanitary and Ship Canal at Romeoville.

14 September 1989 - Letter from the Chicago District to the United States Geological Survey requesting that the published Romeoville flow record be updated to reflect use of the AVM backup system regression equations.

21 September 1989 - Meeting between the Corps and the State to discuss the State's proposal for reducing the Navigation Makeup component of the diversion.

APPENDIX B

LAKE MICHIGAN DIVERSION ACCOUNTING  
WY84 AND WY85 REPORT

**APPENDIX C**  
**MASTER PLAN**

LAKE MICHIGAN DIVERSION MASTER PLAN  
5 YEAR PLAN

ACCTG. YR.

SCHEDULED ACTIVITY

1990

Prepare and Transmit 89 Annual Report  
Complete and Certify 86 Accounting Report  
Begin Preparation of 87 Accounting Report  
Begin Preparation of 88 Accounting Report  
Begin Preparation of 89 Accounting Report  
Develop Procedure for Estimating Flow  
Transfer from O'Hare Basin  
Complete Report on Grand Calumet Flow  
Deduction Computation  
Calibrate Upper Des Plaines Pump Station  
Complete Report on Data Quality  
Assurance Procedures  
Review Proposal for Navigation Makeup  
Reduction  
Commence procurement process for third  
technical committee

1991

Prepare and Transmit 90 Annual Report  
Convene and Coordinate Third Technical  
Committee  
Complete and Certify 87 Accounting Report  
Complete and Certify 88 Accounting Report  
Complete and Certify 89 Accounting Report  
Begin Preparation of 90 Accounting Report  
Evaluate Precipitation Gage Network  
Implement Navigation Makeup Water  
Conservation Procedures  
Implement Procedure O'Hare Basin Flow  
Transfer

ACCTG. YR.

SCHEDULED ACTIVITY

1992

Prepare and Transmit 91 Annual Report

Review Report of Third Technical Committee and Develop Plan for Implementing Recommendations

Complete and Certify 90 Accounting Report

Complete Preparation of 91 Accounting Report

1993

Prepare and Transmit 1992 Annual Report

Implement Recommendations of Third Technical Committee

Certify 91 Accounting Report

Complete Preparation of 92 Accounting Report

1994

Prepare and Transmit 1993 Annual Report

Continue Implementing Recommendations of Third Technical Committee as necessary

Certify 92 Accounting Report

Complete Preparation of 93 Accounting Report

Update Procedure For Modeling TARP for Additional Tunnels and Reservoirs