US Army Corps
of Engineers
Chicago District

Lake Michigan Diversion Accounting-
1987 Annual Report

JULY 1988

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DEPARTMENT OF THE ARMY
Chicago District, Corps of Engineers
219 South Dearborn Street
Chicago, Illinois 60604-1797

ANNUAL REPORT

MONITORING OF DIVERSION OF LAKE MICHIGAN WATER AT CHICAGO, ILLINOIS

INTRODUCTION

1.1 EXECUTIVE SUMMARY

This document is an 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. The report provides an overview and audit of flow measurements and accounting conducted by the State of Illinois.

The 1987 Annual Report on Lake Michigan Diversion includes a summarization of all events occurring during the 1987 water year. Since completion of the 1986 Annual Report, a draft of the 1984 water year accounting report has been submitted by the State of Illinois for review. As this report is currently in the process of being finalized, the 1987 Annual Report does not include an analysis of the 1984 water year accounting report.

Major events covered in this report include the performance and evaluation to date of the Acoustic Velocity Meter to measure flow passing through Lockport, refinement of the new diversion accounting system, and the progress made by the second technical committee.

The following conclusions were reached:

a. Major problems with the Acoustic Velocity Meter have been resolved. The meter functioned well for all but five days during water year 1987.

b. The second Technical committee has completed their report and the recommendations are being reviewed and will be incorporated into the District's diversion accounting procedures.

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. This report is the fourth in a continuing series of Annual Reports prepared by the Corps. The reports summarize the monitoring activities of the Corps and are distributed to the parties of the diversion litigation (individual states and Department of Justice) as well as other involved concerns. This report covers the accounting year from 1 October 1986 through 30 September 1987 inclusive.

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.W. 426,87 S.Ct. 1774 (1967) as modified 449 U.S. 48, 101 S.Ct. 557 (1980), the Corps is responsible for monitoring the measurement and computation of diversion of Lake Michigan water by the State of Illinois. The Illinois Department of Transportation, Division of Water Resources (IDOT) is the state agency responsible for diversion accounting. 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 point in time, averaged about 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 Sanitary District of Greater Chicago (MSDGC) 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. Figures 1-1 and 1-2 show the schematic flow reversal and the affected watershed.

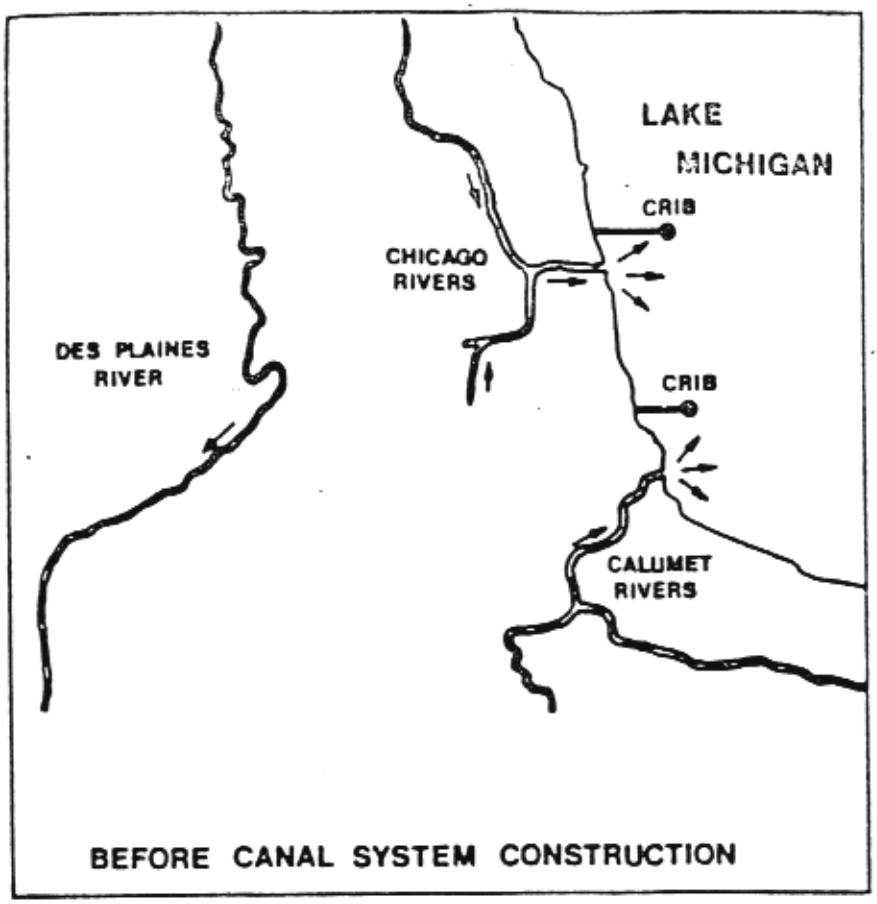
In 1922, 1925, and 1926, several Great Lakes States filed similar original actions in the U.S. Supreme Court seeking to restrict diversion at Chicago. A Special Master, appointed by the Court to hear the combined three suits, found the 1925 permit to be valid and recommended dismissal of the action. The Supreme Court, however, reversed his finding. Subsequently, the Court instructed the Special Master to determine the steps necessary for Illinois and MSDGC to reduce diversion. Consequently, a 1930 decree reduced the allowable diversion (in addition to domestic pumpage) in three steps: 6,500 cfs after 1 July 1930; 5,000 cfs after 30 December 1935; and 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 extended the period for determining the running average diversion rate allowable from five years to forty years. Additionally, the beginning of the accounting year was changed from 1 March to 1 October.

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 is primarily responsible for measurement and computation of diversion flows, the decree allows the Corps to take over this function subject to a cost sharing agreement. Although negotiations have been 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 have been done by IDOT through its consultants, the Northeastern Illinois Planning Commission (NIPC), the Metropolitan Sanitary District of Greater Chicago (MSDGC), and the United States Geological Survey (USGS).

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


LAKE
MICHIGAN
CRIB
CHICAGO
RIVERS
DES PLAINES
RIVER
CRIB
CALUMET
RIVERS
BEFORE CANAL SYSTEM CONSTRUCTION

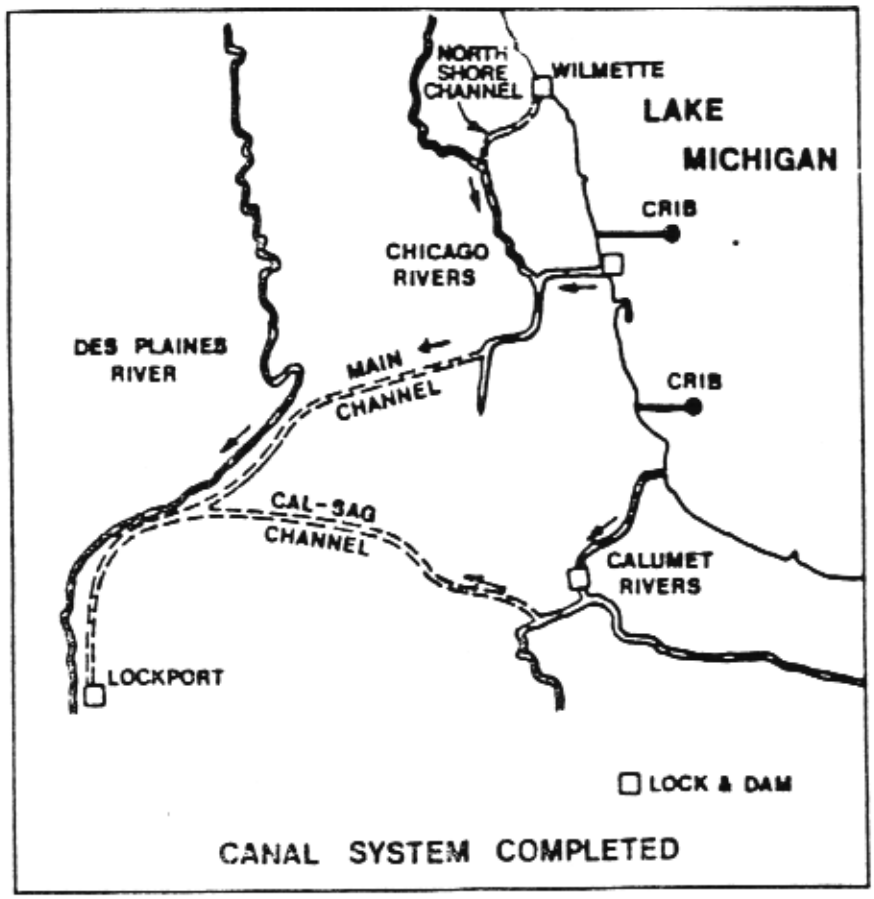

NORTH
SHORE
CHANNEL
WILMETTE
LAKE
MICHIGAN
CRIB
CHICAGO
RIVERS
DES PLAINES
RIVER
MAIN
CHANNEL
CRIB
CAL-SAG
CHANNEL
CALUMET
RIVERS
LOCKPORT
LOCK & DAM
CANAL SYSTEM COMPLETED

Figure 1-1

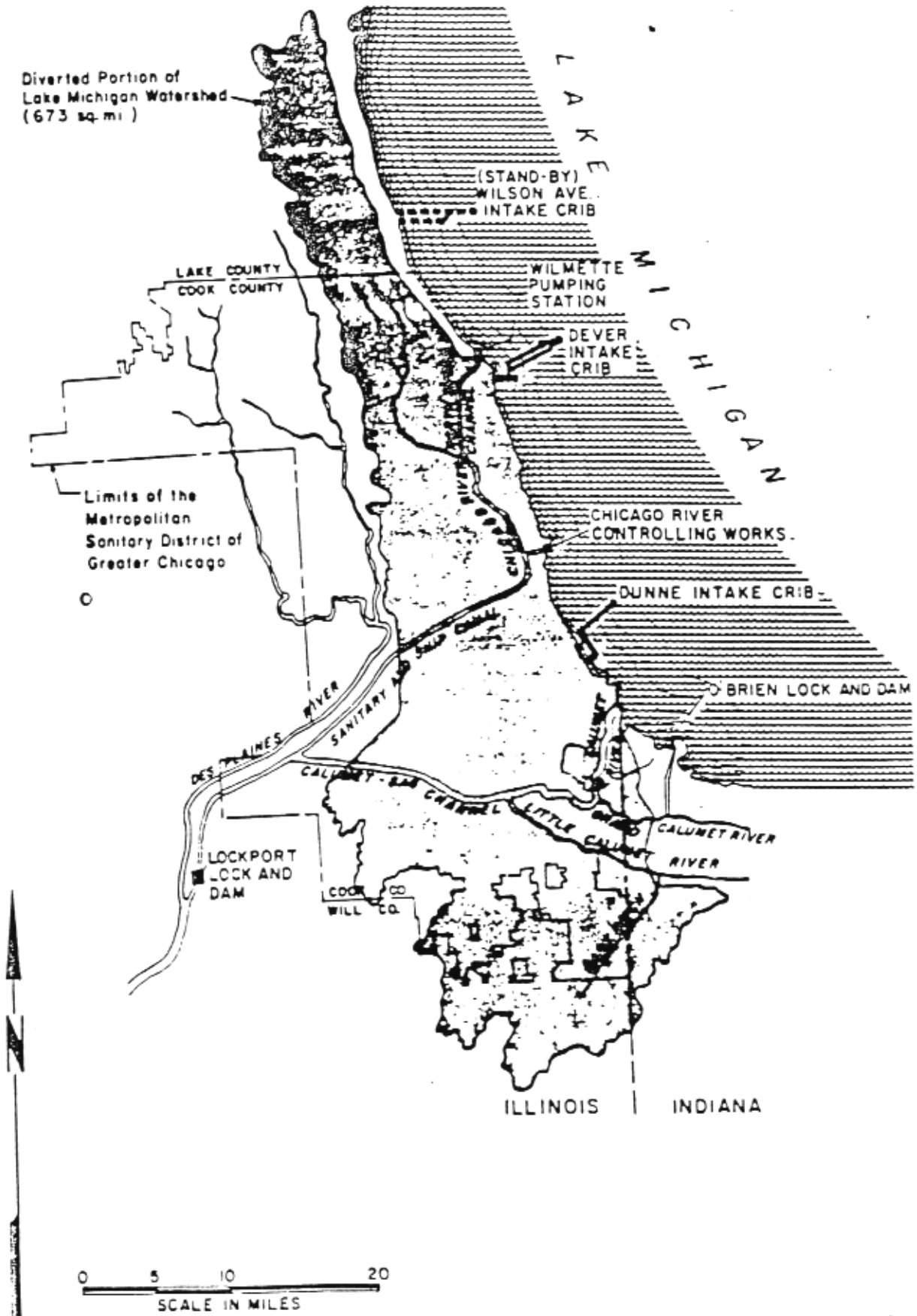


Figure 1-2

LOCATION PLAN - LAKE MICHIGAN DIVERSION AT CHICAGO

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," and 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.

Additionally, based on the Water Resources Development Act of 1986, PL 99-662, the Corps assumed total responsibility for the measurements and computations necessary to account for the amount of water diverted from Lake Michigan at Chicago, effective 1 October 1987.

CORPS AUDIT AND OTHER ACTIVITIES DURING 1987

2.1 SIGNIFICANT EVENTS

During 1987 there were a number of significant events that transpired. These events were both non-hydrologic and hydrologic in nature. The non-hydrologic events are itemized in Appendix A and are related primarily to coordination with the technical committee and preparation of the WY 1986 Annual Report. The three significant hydrologic events of water year 1987 are itemized in Appendix B.

2.2 OUTSTANDING 1986 ACTIONS

The Corps' 1986 Annual Report discussed several IDOT recommendations regarding future actions as well as the status of each of the recommendations. An update on this information is included below:

(a) IDOT Recommendation

Further investigations into the accuracy of recorded flows at the Controlling Works and Powerhouse at Lockport are needed. Particular attention is needed to quantify submergence at the Controlling Works and its cause.

Status:

This action is being considered as part of the District's review of a back-up system for the Acoustic Velocity Meter. This review will be completed during water year 1988.

(b) IDOT Recommendation

The MSDGC should incorporate the revised Corps ratings for free flow discharge into their calculations of discharge for the Controlling Works and Powerhouse. The MSDGC should also establish a continuous record of tailwater elevations at a suitable location downstream of the Controlling Works.

Status:

This action is being considered as part of the District's review of a back-up system for the Acoustic Velocity Meter. This review will be completed during water year 1988.

(c) IDOT Recommendation

Further investigation is needed to determine the reasons for imbalances between estimated and recorded flows at the three major MSDGC treatment plants. Areas for investigation include the following: (1) Model assumptions with respect to sanitary return flow and infiltration and inflow quantities; (b) Possible leakage from the Canal through combined sewer overflow structures; (c) Possible unreported major discharges to the plant from groundwater or surface water supply return flows.

Status:

This District will perform a study of inflow and infiltration into the system during water year 1989.

(d) IDOT Recommendation

The monitoring of flow at the Upper Des Plaines Pumping Station should be discontinued for diversion accounting purposes due to uncertainties in its record which cannot be resolved without significant increased maintenance and flow monitoring changes.

Status:

The District is reviewing the need for a gaging station to improve the reliability of flow records at this location.

(e) IDOT Recommendation

Investigations into the possibility of long-term biases among precipitation gages reporting to NOAA, MSDGC and the City of Chicago should be undertaken based on significant differences noted during the 1983 water year.

Status:

The Illinois State Water Survey has completed a draft report for the 1984 water year. This report was submitted for review in May 1987 and discusses biases in the precipitation data along with methodologies for data adjustment as appropriate. A final report is expected in water year 1989.

(f) IDOT Recommendation

Flow monitoring at the Summit Conduit should be discontinued due to problems with frequent gage malfunctions, the relatively small amount of flow from this area, and the ability to reasonably estimate flows from this area using pumpage data and runoff simulation.

Status: The gage at the Summit Conduit is no longer in use.

(g) IDOT Recommendation

The flow transfer from the MSDGC's design O'Hare service area to the Northside Treatment Plant should be metered to provide a better estimate of quantity and flow variations.

Status:

The District is considering the need for a gage at this location.

2.3 FIELD CHECKS

In complying with the terms of the modified Supreme Court decree, the Corps conducted several supervisory activities during the 1987 accounting year (1 Oct. 1986 through 30 Sept. 1987 inclusive). Specifically, during this accounting year, the Corps conducted independent field inspection visits of facilities involved with diversion accounting. An itemization and summarization of these visits is indicated below.

On 26 January 1987, a field test at the AVM site was conducted by USGS personnel. Additionally, Corps personnel were present to observe several sets of discharge measurements conducted by the USGS throughout the course of the 1987 accounting year. These measurements were made in the Chicago Sanitary and Ship Canal at Romeoville. An itemization of the nine discharge measurements made by the USGS during the 1987 accounting year is shown in table 3-1.

Table 3-1

SUMMARY OF DISCHARGE MEASURMENTS
CHICAGO SANITARY & SHIP CANAL AT ROMEOVILLE
ACCOUNTING YEAR 1987

No.	Date	Measured Discharge(cfs)	AVM Discharge(cfs)	Shift Adjustment(cfs)	AVM Adjusted(cfs)	% Difference
1	3 October 1986	16039	15725	None	15725	+2.0
2	12 December 1986	3382	3275	None	3275	+3.3
3	26 January 1987	2851	2903	None	2903	-1.8
*4	26 March 1987	1949	2180	None	2180	-10.6
5	7 April 1987	2431	2383	None	2383	+2.0
6	15 May 1987	3074	3114	None	3114	-1.3
**7	19 June 1987	7194	6838	None	6838	+4.9
8	24 July 1987	3972	3992	None	3992	-0.5
9	17 August 1987	14491	14325	None	14325	+1.2

* Only one acoustical path working
** Large change in discharge during measurement

2.4 MASTER PLAN

As discussed in the 1986 Annual Report, and for the reasons outlined therein, a master plan for Lake Michigan diversion monitoring activities has been established. In conjunction with the completion of the second technical committee's report, the master plan has been revised and updated during FY88. The Master Plan includes the FY88 and FY 89 schedules, generic schedule, five-year plan update, listing of inspection sites and a review of the quality assurance program.

A copy of the revised master plan is included as Appendix C to this report. Subsequently, the master plan will be reviewed and updated on an annual basis.

2.5 IN-HOUSE STUDIES

Throughout accounting year 1987, the Corps was active in assisting the technical committee in its work. In-house assistance was provided to the committee members by Corps' personnel. Assistance provided to the committee included answering inquiries as well as performing supporting studies. More specifically, the Corps assisted the technical committee in performing several regression analyses of AVM flows versus Lockport flows based on varying flow regimes at Lockport.

2.6 CONTRACTED STUDIES

Due to the effort necessary to assist the second technical committee in fulfilling their contract, no other contracts were executed during accounting year 1987.

2.7 SECOND THREE-MEMBER TECHNICAL COMMITTEE

As discussed in the 1986 Annual Report, the second technical committee was convened in July 1986. The first two workshops were completed during the 1986 accounting year. The work of the committee continued throughout the course of the 1987 accounting year, with two additional workshops held for further discussions.

The third workshop was held in Chicago from 21-24 October 1986 inclusive. Participating agencies included the Corps, IDOT, NIPC, USGS, MSDGC, and Illinois State Water Survey (ISWS). Presentations were given by the ISWS and MSDGC. These presentations covered Chicago area precipitation patterns and the Tunnel and Reservoir Plan (TARP), respectively. A field trip to Lockport and the Sewer System 13A extension was also included.

The fourth workshop was held in Chicago from 27-30 January 1987 inclusive. Participating agencies included the Corps,

IDOT, NIPC, USGS, and MSDGC. A field trip to the Lockport area was included.

All parties of the litigation were invited to attend the above workshops. None of the parties attended with the exception of the State of Illinois.

The initial draft of the committee report was provided to the Corps on 9 June 1987. A second draft was provided on 3 August 1987. Comments on the draft reports were subsequently provided to the committee members. The final report of the committee was provided to the Corps in November 1987. Copies of the report were provided to all parties of the litigation as well as other involved agencies. The Corps will conduct a thorough review of all recommendations made by the second technical committee. It is expected that this review will take place during the balance of the 1988 accounting year (ending 30 September 1988). Furthermore, it is anticipated that implementation of the recommendations will occur throughout the 1989 and 1990 accounting years. The second committee was in general agreement with the findings and recommendations made by the first committee in 1981. The principal recommendations of the second committee are summarized at the end of this report.

IDOT ACTIVITIES DURING 1987

3.1 LAKEFRONT LEAKAGE

As discussed in the 1986 Annual Report, repair work has essentially eliminated the lakefront leakage problem.

3.2 ACOUSTIC VELOCITY METER

The installation of the acoustic velocity meter was completed in March 1984. The meter is located on the Sanitary and Ship Canal upstream from Lockport at the Romeoville bridge. Initial calibration efforts were discussed in the 1986 Annual Report.

During the course of the 1987 accounting year, nine sets of field measurements were made. The dates of these measurements were as follows:3 October 1986, 12 December 1986, 26 January 1987, 26 March 1987, 7 April 1987, 15 May 1987, 19 June 1987, 24 July 1987 and 17 August 1987. With the exception of the measurements taken on 26 March and 19 June, percentage differences between the discharge measurements and AVM readings ranged from -0.5% to +3.3%. Percentage differences of -10.6% and +4.9% were observed on 26 March and 19 June. These percentage

differences can be explained as follows: On 26 March, only path #4 was working while on 19 June there was a large change in discharge during measurement which caused an inaccuracy in the field measured flow. Table 3.1 summarizes the discharge measurements made by the USGS during the 1987 accounting year.

During the course of the fourth committee workshop, the USGS provided a copy of a draft report for review and comment. This report was entitled "Adjustments to the Acoustical Velocity Meter Discharge for the Chicago Sanitary and Ship Canal at Romeoville, Illinois for the period October 1, 1984 to October 31, 1986." The purpose of the report was to summarize the evaluation of the AVM discharge record during the time period of major AVM system problems. This time period extended from 17 March 1985 to 23 September 1986. Discharge records from 1 October 1984 to 31 October 1986 collected at Lockport by the MSDGC and at Romeoville by the USGS were used for analysis purposes. Extensive analyses completed by the USGS yielded the following categories of data:

(a) The period from 1 October 1984 to 20 March 1985 can be characterized as a "good" period. AVM discharges during this time period required no adjustments. The period from 23 September 1986 to 31 October 1986 was also considered to be a good period.

(b) The period from 21 March 1985 to 5 November 1985, during which time developed regression equations were used to synthesize AVM discharge values(also used for other periods of no AVM data).

(c) The period from 6 November 1985 to 22 September 1986, during which time constant discharge values of 410 cfs and 450 cfs were added to the AVM discharges. More specifically, the constant adjustment of 410 cfs was used from 6 November 1985 to 2 June 1986 inclusive, while the constant adjustment of 450 cfs was used from 3 June 1986 to 22 September 1986 inclusive.

The USGS is currently in the process of finalizing the above report. A final report is expected by September 1988.

On 16 December 1986, IDOT submitted a report prepared by Harza Engineering Company entitled "Investigation of the Impact of the Acoustical Velocity Meter on Lake Michigan Diversion Accounting." The purpose of the report was to determine the long term differences which could be expected between measured AVM flows and those flows historically calculated at Lockport. Relationships to relate AVM flows to Lockport flows were also developed. The report concluded that use of the AVM as a measuring device could have a significant impact on the 40-year average diversion flow of 3200 cfs as allowed by the Supreme Court Decree. The report also stated, however, that insufficient

time has elapsed since concurrent operation of the two systems in order to draw any definitive conclusions. Additionally, the report emphasized the need for greater consistency in AVM records in order to more easily discern definitive trends in the data.

With regard to the development of a backup system for the AVM, the use of a second AVM system is currently being considered. This second AVM would be used as a backup to the initial AVM as opposed to the computational procedures formerly used at Lockport. A final decision concerning implementation of a backup system, taking into full account the recommendations of the second technical committee, will be made during the second half of the 1988 accounting year.

3.3 CONTRACTUAL SERVICES

The 1986 Annual Report discussed a series of contractual services in effect during the 1986 accounting year. An itemization of these contractual services as well as their current status is as follows:

(a) Preparation of the 1984 annual diversion accounting report by IDOT and NIPC.

Status:

IDOT submitted a draft of the above report to the Corps in January 1987. Following submission of comments by the Corps, a second draft was submitted in May 1987. IDOT, in coordination with its agent NIPC, is currently revising the input parameters used in the hydrologic simulation models. A final report is due by the end of water year 1988.

(b) Preparation of a report by the Illinois State Water Survey, as an agent of IDOT, regarding examination of Chicago precipitation patterns for FY 1984.

Status:

The Illinois State Water Survey submitted a draft of the above report in May 1987, with completion due in water year 1989.

(c) Conversion of the accounting model software for execution on a personal computer (to be completed by IDOT in coordination with NIPC).

Status:

The above is currently being coordinated with IDOT/NIPC.

(d) Investigation of the impact of the AVM on Lake Michigan diversion accounting (to be completed by Harza Engineering Company as an agent of IDOT).

Status:

The above described study was completed by Harza and the final report submitted on 16 December 1986. A description of the conclusions is included in section 3.2 of this report pertaining to AVM operations.

(e) Analysis of leakage at the lakefront, navigational make-up water, and impact of TARP on accounting (to be completed by Harza Engineering Company as an agent of IDOT).

Status:

The above analysis is currently being coordinated with IDOT.

(f) Incorporation of new online TARP system components in the computerized accounting program (to be completed by NIPC as an agent of IDOT).

Status:

The above is currently being coordinated with IDOT/NIPC.

3.4 ON-LINE TARP SYSTEM IMPACTS

The 1986 Annual Report provided a discussion of the TARP system. There has been no activity regarding the TARP system since then. As improvements or expansions to TARP are implemented by MSDGC, modeling parameters will be revised to reflect these changes.

PROJECTED ACTIVITIES AND AGENCY RESPONSIBILITIES

4.1 WATER YEAR ACCOUNTING REPORTS

As discussed in the 1986 Annual Report, IDOT initiated use of the newly developed diversion accounting system with the preparation of the 1983 water year accounting report. This report was evaluated and the flows certified as part of the Corps' 1985 Annual Report.

As discussed in section 3.3 of this report, IDOT currently is in the process of finalizing the 1984 water year accounting report, and is expected to submit the final report during the

fourth quarter of FY88. IDOT will also be responsible for preparation of the 1985 water year accounting report, which is expected to be available in FY89. The Corps, as part of its new mission under the Water Resources Development Act of 1986, will be responsible (per agreement with IDOT) for preparation of all future reports commencing with the 1986 accounting report. During the transition period, IDOT has agreed to provide assistance to the Corps in the data collection process necessary for preparation of the accounting reports. The completion dates for all future reports will be coordinated among the involved agencies.

4.2 SECOND THREE-MEMBER TECHNICAL COMMITTEE ACTIVITIES

Section 2.7 of this report discusses the events associated with the completion of the committee's final report as well as follow-up activities planned by the Corps.

4.3 WATER RESOURCES DEVELOPMENT ACT OF 1986

The 1986 Annual Report provided a thorough discussion of the above Water Resources Development Act of 1986 as well as its impact on the Corps with respect to diversion accounting. As noted previously, the new mission became effective on 1 October 1987.

During the course of the 1987 accounting year, the Corps held several coordination meetings with IDOT. The purpose of these meetings was to discuss provisions for the formal transfer of diversion accounting responsibilities to the Corps. It is expected that these coordination sessions will continue in the future.

4.4 PAST RESPONSIBILITIES

Under the terms of the modified Supreme Court decree, the State of Illinois was charged with the responsibility for diversion measurements and computations. The task of accounting for the diversion was accomplished by the State of Illinois through its agent, the Metropolitan Sanitary District of Greater Chicago (MSDGC) and later the Northeastern Illinois Planning Commission (NIPC). IDOT, through the above agents, produced monthly hydraulic reports and later annual diversion accounting reports for each water year. The Corps was responsible for reviewing the reports and backup documentation as well as providing certification of the diversion flows.

The monthly hydraulic reports which included diversion accounting were prepared by the MSDGC through 30 September 1982, inclusive.

After water year 1982, MSDGC reported Lockport and direct diversion flows but did not provide monthly diversion accounting. NIPC was retained at this time by IDOT to do the diversion accounting computations and develop the annual accounting reports for each water year. NIPC developed the currently used diversion accounting computer model.

The Corps was charged with issuing an annual report which provided the Corps' certification of the diversion flow rates reported by IDOT. The Corps' report also provided a record of the past year's significant hydrologic events and various actions taken by the Corps to monitor the diversion accounting process.

The role of the United States Geological Survey (USGS) was one of expert consultant in the area of flow measurements.

4.5 INVOLVED AGENCIES/CURRENT RESPONSIBILITIES

The principal agencies involved either directly or indirectly in the diversion accounting and verification process along with a brief description of individual functions are summarized as follows: (a) Corps of Engineers - responsible for diversion accounting and certification of flows; (b) USGS - responsible for conducting flow measurements; (c) IDOT - responsible for completing the 1984 and 1985 accounting reports. IDOT has no subsequent responsibilities with respect to diversion accounting but still maintains water allocation responsibilities; (d) NIPC - being retained by the Corps to do the 1986 and 1987 accounting reports and to transfer the diversion accounting computer models to the Corps. NIPC has no subsequent responsibilities; and (e) MSDGC - is responsible for collection of direct diversion data and preliminary flow information at Lockport.

4.6 OTHER ACTIVITIES AND STUDIES

Due to the extensive review by the second technical committee, many associated activities and studies were carried over into the 1988 accounting year. The substance of these activities and analyses will be reported in the 1988 Annual Report. Currently, the Corps is planning to complete the following tasks during FY88: (a) Review of IDOT's 1984 water year accounting report; (b) Development of an open ended sole source contract with NIPC for preparation of the FY86 and FY87 accounting reports, with all subsequent reports commencing with the FY88 report to be completed by the Corps; (c) Begin

preparation of an SOP report describing the data requirements, parameters and modeling procedures required to perform diversion accounting; (d) Preparation of a set of procedures for inspecting the measuring devices used in the accounting process; (e) Development of a backup system for the AVM; (f) Coordination and review of hydrologic model parameters with IDOT and NIPC; (g) Review of model changes made by NIPC with respect to impacts of TARP; (h) Preparation of a contract to purchase microcomputers to give the Corps the capability of running and updating the NIPC models in house; (i) Coordination with the Illinois State Water Survey to modify two precipitation gages and perform an adjustment of gage records; and (j) Evaluation of the need for gaging the flow from subarea 13A; (k) Preparation of an SOP report describing, evaluating, and selecting an accounting procedure for lock leakage; (l) Preparation of an A/E work order for the determination of infiltration and inflow parameters.

4.7 SECOND THREE-MEMBER COMMITTEE RECOMMENDATIONS

As discussed previously, the second committee was in general agreement with the findings and recommendations made by the first committee. The second committee recommended that the evaluation and implementation of the first committee's recommendations should be continued to completion, and that periodic review and updating of the diversion Master Plan should be regarded as an essential component of the accounting program. A listing of the committee's recommendations, with a current status report, is as follows:

(A) Diversion Accounting Reports

(1) The report of the diversion accounting certification should provide the reader with narrative descriptions of the review process and facts which support the certification evaluation.

(2) At some appropriate time, probably no earlier than after the completion of the 1987 Water Year, the diversion records for Water Years after 1980 should be reviewed and if appropriate revised as necessary, to account for the apparent errors in the Lockport discharge ratings used during the 1981-84 water years.

Status:

The Corps is cognizant of the fact that inherent inaccuracies exist in the Lockport measurement system and that previous years' diversion flow data has been certified irrespective of the fact that these deficiencies were known. However, it is the Corps' view that each water year is certified

based on the best available information and techniques at the time of the accounting and it would be impractical to revise all past reports as better information or technology becomes available. Thus, previously certified reports are considered final and will not be modified. This annual report will serve as an addendum qualifying that the previously completed reports contained deficiencies and acknowledges the fact that a statement should have been included in the prior reports to summarize these deficiencies. In future reporting, deficiencies in the Lockport system will be considered in the evaluation and analysis process.

(B) Diversion Accounting Procedures

(1) Columns 7 and 9, representing the sewer induced groundwater inflow, should be withdrawn from the diversion accounting format because sewer induced groundwater pumpage is no longer considered a deduction.

(2) Columns 14 and 15 of the Diversion Accounting Report should be discontinued until measurements at the Lakefront Structures are state-of-the-art and the magnitude of infiltration and inflow from the waterways to the interceptor sewers can be quantified to eliminate the double accounting which would occur when these two columns are added together.

(3) Action should be initiated to address the deficiencies in the data bases for parameter values, and model calibration, verification, and simulation, especially as they pertain to those drainage areas used directly in computing diversion.

(4) Examine the constancy of the relation between water supply pumpage and sewage treatment plant inflows and its applications for the purpose of estimating infiltration and inflow deductions for the Des Plaines watershed.

(5) Reconsider the alternatives for estimating the annual runoff from the Lake Michigan watershed, i.e., the merits of model simulation and associated data collection programs versus abstraction methods based on improved measurement of inflow at the lakefront.

(6) Redefine or restate the goals and technical objectives for the simulation modeling.

(7) Evaluate the simulation modeling requirements within the frame of reference provided by recommendations 2-6 above. Given the modeling objectives, data bases available or obtainable, and specific simulation tasks; examine the available models, ranging from simple to sophisticated, in terms of

hydrologic representation, data requirements, and costs of implementation and operation.

(8) Measures should be taken, depending on the response to the broader recommendations given above to deal with the unreported inflows perceived to be derived from the waterways, and reported in columns 8 and 14.

Status:

IDOT is currently providing funding to NIPC to review the subarea designations within their model. The Corps will provide corrections for the infiltration and inflow calculations performed by the NIPC models. During FY 88, a review of the parameters and computations will be undertaken by the District and presented in the 1988 annual report. At this time, therefore, no re-evaluation of the model selection is planned. The Corps did not anticipate the Committee's recommendation to evaluate measures to deal with unreported inflows derived from canals and waterways. The Corps will hopefully have the capability to evaluate this inflow problem in FY 89.

(C) Acoustical Velocity Meter - Romeoville

(1) The recently initiated efforts by the USGS to establish written guidelines to promote improvement in the quality of the AVM records should be continued. The guidelines in use and proposed should address the following:

(a) Coordination of measurement scheduling with MSDGC and Corps to minimize occurrences of rapid changes in discharge at Lockport during measurements at the Romeoville bridge.

(b) Limits of acceptability for differences in mean AVM and current meter measured discharges.

(c) Provisions for follow-up measurements when the acceptable difference limit is exceeded.

(d) Time corrections for synchronization of AVM with MSDGC and Corps Lockport gages.

(e) Inspection routines to assure that changes in transducer alignment and position are not allowed to go undetected.

(2) A continuing dialogue should be maintained with AVM factory representatives to improve and develop routine inspection procedures to check transducer signal characteristics and CPU performance.

(3) The current regressions of the daily discharges for the AVM and MSDGC Lockport, used for the AVM back-up, should be reconsidered specifically giving attention to the actual Lockport operating configurations.

(4) Efforts should be made to renew MSDGC interest in the Lake Michigan diversion process and, as operator of the Chicago Sanitary and Ship Canal system, in the accuracy of the Lockport ratings.

(5) A technical review of the AVM flow records should be conducted annually by the participating agencies.

(6) The flow records for the AVM and MSDGC Lockport should be reviewed and compared for consistency on an annual basis.

(7) The review of AVM operations and flow records should be included in the USGS national program for quality assurance of water resources data.

(8) Analyses of the vertical velocity measurement and AVM path velocity data should be conducted to define the impact of loss of transducer paths on the accuracy of the computed discharge. Of particular interest is path four which is most likely to be lost when the water level in the canal falls below the system threshold water level.

(9) The mean bed elevation for the canal in the reach defined by the transducer locations should be determined, as well as along the transducer paths. The cross-sections surveyed by the Corps' Rock Island District may suffice for this task.

Status:

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 Chicago District is currently reviewing the sets of regression equations developed by the USGS and the technical committee. As part of that review, the Corps has developed a set of regression equations. These regression equations are used to compute synthetic AVM flows given discharges at Lockport. All of the committee's recommendations will be reviewed and addressed in the 1988 annual report.

(D) Lockport Lock and Dam Facilities

(1) The Lockport facilities of MSDGC and the Corps should be used for the back-up to the AVM system at Romeoville.

(2) The WES report provides as much information about the rating definition of the Powerhouse and Controlling Works sluice gates as may be expected on the basis of available data. In order to achieve needed confidence in the Lockport ratings the following measures should be taken:

(a) Assess the adequacy of the Lockport water level gages for the purpose of computing the discharge through the Powerhouse sluice gates using the WES ratings.

(b) A site reconnaissance and evaluation should be made to determine the upstream and downstream water level gage requirements necessary to insure prudent application of the WES ratings for the Controlling Works.

(c) Plan and execute a set of field measurements designed to verify, or modify if necessary, the WES ratings for both the Lockport Powerhouse sluice gates and the Controlling Works.

(d) Assess the operating conditions for which reverse flow through the Controlling Works may occur and the probable consequences in terms of diversion measurement and accounting.

Status:

The issue of a backup system to the AVM is of paramount importance to the diversion program. The Corps will resolve this issue during the last six months of FY88. As potential backup systems for the AVM, several alternatives are being considered. One possibility is the use of a second AVM system. This second AVM would serve as a backup to the existing AVM in addition to providing a means for verifying and calibrating the initial AVM. Another alternative for a backup of the AVM is a regression analysis that can be used to estimate Acoustic Velocity Meter flows from uncorrected flows at Lockport. The Corps has performed this analysis. The third alternative would be to improve measurements at Lockport and use this data as a backup system. This would require calibration and/or further evaluation of powerhouse controlling works ratings, turbine ratings and upstream controlling works ratings. A final alternative would be to use alternate measurement systems. This would include using measurements at Brandon Road Lock, establishing a stream gage on the Des Plaines River, or establishing a stream gage at Summit Conduit.

(E) Lock Leakage and Discharge - Standard Operating Procedures

(1) The draft standard operating procedure for measurement of lock leakage and discharge should be revised in order to be consistent with the technical objectives of diversion accounting.

Status:

The lock leakage SOP will be finalized in WY 1988.

(F) TARP

(1) Infiltration and inflow of ground water into the TARP tunnels should be treated as a deduction to the flows measured at Lockport. It should be computed by using the inflow rate of 0.05 MGD per mile of tunnel.

(2) The runoff to the TARP system from the Lower Des Plaines combined sewer system should be determined and included in Column 8 as a deduction.

(3) The runoff from the 5.4 square mile drainage area of Contract 13 A should be used as a deduction in Column 8 of the new accounting report.

(4) The net rainfall (precipitation minus evaporation) falling on the Phase 2 TARP Mainstream reservoir at McCook should be considered as runoff from that area and used as a deduction in Column 8.

(5) Any occurrence of ground-water seepage into the McCook reservoir should be counted as a deduction to the flows measured at Lockport.

(6) When Phase 2 of TARP comes on-line water will be stored in reservoirs at McCook and Thornton for extended periods of time. This stored storm runoff may be in residence from one accounting year into the next. Provisions should be made in the accounting process to quantify the amount of runoff captured in each accounting year.

Status:

The implementation of the Tunnel and Reservoir Plan (TARP) will have definite impacts on the diversion accounting process. The incremental construction of the tunnel system will require continuous modifications to the modeling of the basins. The construction of the deep tunnels and their corresponding

reservoirs will have several effects. First, the deep tunnels may re-allocate sewered storm water between the Lake Michigan basin and the Des Plaines River basin. During storm events, water from one basin may enter a deep tunnel destined for the other basin. Second, in the event of a major storm occurring near the end of a water year, water may be resident in a TARP Reservoir. A study will be completed in FY 89 to determine how this water should be treated in the accounting process. The technical committee recommendations will be considered in the modification of the models to account for the TARP system. This could include gaging or evaluating flow from area 13A.

CONCLUSIONS

5.1 SUMMARY

The Lake Michigan diversion accounting program has been going through significant modifications of the technical methodology used in computing the total flows at Lockport and in the computation of the deductions. As discussed in the Corps' review, some minor inconsistencies still exist within the accounting system. Notwithstanding these inconsistencies, the results represent an improvement in the accounting procedures. Just as the physical features of the diversion basin are dynamic, so is the accounting system itself.

It is expected that the implementation of the second Technical Committee's recommendations will, over the next several years, continue to improve the diversion monitoring system.

Based on the review of the State of Illinois' FY 87 accounting program, data collected by agencies of the State of Illinois, computation sheets, field investigations and special studies conducted by or for Corps of Engineers, the Corps reaches the following conclusions:

a. The current procedures for hydrologic simulation are consistent with the "best engineering practice and scientific knowledge" as required by Supreme Court Decree.

b. A backup system for the Acoustic Velocity Meter for measuring flows at Lockport is necessary and is currently being developed.

REFERENCES

1. Espey, Dr. W.H., Barnes, Harry H., and Vigander, Dr. Svein. October 1981. Lake Michigan Diversion Findings of the Technical Committee for Review of Diversion Flow Measurements and Accounting Procedures.

2. 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.

3. Chicago District. January 1987. Lake Michigan Diversion Accounting - 1986 Annual Report.

APPENDIX A

SIGNIFICANT EVENTS (NON-HYDROLOGIC)

SIGNIFICANT EVENTS-FY87
NON-HYDROLOGIC

3 October 1986 - United States Geological Survey (USGS) performed discharge measurement in Chicago Sanitary and Ship Canal at Romeoville.

8 October 1986 - Letter sent from Chicago District to Metropolitan Sanitary District of Greater Chicago (MSDGC) with copy furnished to Illinois Department of Transportation (IDOT). Letter requested information regarding leakage tests performed at Lockport Lock (as requested by members of second three-member technical committee).

9 October 1986 - Letters sent from Chicago District to all parties of diversion litigation. Letters informed parties that second workshop with second technical committee had been completed along with forwarding copies of a Memorandum for Record (MFR) covering workshop proceedings. Letters additionally informed parties of dates for third workshop (21-24 Oct. 1986) and extended invitation to all parties to attend.

16 October 1986 - Letter sent from Chicago District to MSDGC requesting assistance in planning field trip to Lockport and Sewer System 13A extension on 22 October 1986 (during course of third workshop).

20 October 1986- Letter sent from MSDGC to Chicago District in response to 16 October 1986 letter above confirming assistance on part of MSD for 22 October field trip with technical committee members.

21-24 October 1986- Third workshop held in Chicago with second three-member technical committee. Participating agencies included Corps, IDOT, Northeastern Illinois Planning Commission (NIPC), USGS, and the MSDGC. A field trip to Lockport and the Sewer System 13A extension was included.

24 October 1986- Letter sent from Chicago District to MSDGC (copy furnished to IDOT) requesting copies of powerhouse daily log sheets at Lockport for analysis by committee members. Letter requested this information for specific dates (26 September 1986-5 October 1986) during which time the acoustic velocity meter (AVM) was out of service.

17 November 1986- Congressional approval of Water Resources Development Act of 1986. As of 1 October 1987, the law gives the Corps total responsibility for the measurements and computations necessary to compute the amount of water diverted from Lake Michigan.

17 November 1986- Letter sent from Chicago District to MSDGC (copy furnished to IDOT) requesting copies of powerhouse daily log sheets at Lockport for analysis by committee members. Letter requested this information for specific dates during time periods in 1977 and 1979 when Corps' Detroit District conducted flow measurements in the Chicago Sanitary and Ship Canal at Lemont and Lockport.

17 November 1986- Letter sent from Chicago District to Corps' North Central Division (NCD) forwarding initial draft copy of Corps' 1986 Annual Report on Lake Michigan diversion for review.

18 November 1986- Letters sent from Chicago District to all parties of diversion litigation. Letters informed parties that third workshop with second technical committee had been completed along with forwarding copies of a Memorandum for Record (MFR) covering workshop proceedings. Letters additionally informed parties of dates for fourth workshop (12-16 January 1987) and extended invitation to all parties to attend. (note: Workshop dates later changed to 27-30 January 1987).

1 December 1986- Letter sent from MSDGC to Chicago District in response to 17 November letter above forwarding copies of powerhouse daily log sheets as requested.

3 December 1986 - Letter sent from NCD to Chicago District forwarding comments on initial draft copy of Corps' 1986 Annual Report.

12 December 1986- USGS performed discharge measurement in Chicago Sanitary and Ship Canal at Romeoville.

15 December 1986-Letter sent from Chicago District to MSDGC requesting information for review by second technical committee. Specifically, letter requested copies of Lockport powerhouse daily log sheets (commencing 1 Oct. 1986) on ongoing basis for days when either the powerhouse sluices, controlling works sluices or both are in use. Letter also requested this information for day prior to and day after sluice flows cease.

9 January 1987 - Letter sent from Chicago District to NCD in response to 3 December letter above. Letter forwarded revised version of Corps' 1986 Annual Report for approval.

22 January 1987 - Letter sent from IDOT to Chicago District. Letter requested that Corps prepare written response to State of Wisconsin regarding previous correspondence received from Wisconsin (9 September 86) relating to study of hydrologic simulation techniques completed by Corps' Hydrologic Engineering Center (HEC) in June 1986. Specifically, correspondence from

Wisconsin stated that HEC findings indicated that use of hydrologic simulation procedures underestimated actual diversion by several hundred cfs. IDOT requested that Corps' letter clarify findings of HEC report.

26 January 1987- USGS performed discharge measurement in Chicago Sanitary and Ship Canal at Romeoville.

27 January 1987 - 30 January 1987- Fourth workshop held in Chicago with second three-member technical committee. Participating agencies included Corps, IDOT, NIPC,USGS, and the MSDGC. A field trip to the Lockport area was included. Additionally, on 27 January, USGS provided two draft reports to Corps for review regarding adjustments to AVM discharges and activities associated with AVM maintenance. Also, on 27 January, IDOT provided initial copy of draft 1984 Lake Michigan diversion accounting report to Corps for review purposes.

28 January 1987- Letter sent from NCD to Chicago District forwarding comments on revised version of Corps' 1986 Annual Report.

4 February 1987- Letter sent from IDOT to USGS (copy furnished to Chicago District) stating that State of Illinois had reviewed two draft reports regarding operation of AVM as presented at three-member committee workshop on 27 January. Letter provided comments on draft reports.

5 February 1987- Chicago District provides copy of draft 1984 Lake Michigan diversion accounting report to NCD for review purposes. Letter requested comments by 16 February 1987.

12 February 1987- Letter sent from Chicago District to NCD in response to 28 January letter above. Letter forwarded second revised version of Corps' 1986 Annual Report for approval.

12 February 1987- Letter sent from NCD to Chicago District forwarding comments on draft 1984 Lake Michigan diversion accounting report (as requested in 5 Feb. letter above).

17 February 1987- Letter sent from Chicago District to State of Wisconsin (copy furnished to IDOT) in response to request from State of Illinois in 22 January letter above. Letter clarified statements made in HEC report regarding use of simulation modeling techniques. Letter stated that role of hydrologic simulation is relatively minor with respect to the computation of the annual diversion.

17 February 1987- Letter sent from NCD to Chicago District regarding need for field measurement calibration checks of the sluice gates at both the Lockport Powerhouse and the Controlling Works. Letter emphasized need for additional investigation due to high flow discrepancies between MSDGC total flow readings and AVM readings. Letter recommended that one-day test be undertaken in order to obtain clearer understanding of the flow conveyance characteristics of the canal system. Letter requested District comments by 5 March 1987.

10 March 1987- Letter sent from Chicago District to Metropolitan Sanitary District of Greater Chicago (MSDGC) requesting copy of microfiche record of hydraulic report data for time period from 1978 -1985 inclusive.

11 March 1987- Letters sent from Chicago District to all parties of diversion litigation forwarding copies of Corps' 1986 Annual Report for informational purposes.

13 March 1987 - Letter sent from Chicago District to NCD in response to 17 February letter above. Letter stated that District supports concept of field measurement test to verify WES rating curves. Letter also stated that District was awaiting recommendation from three-member committee regarding suggested methods and schedule for implementation.

16 March 1987- USGS performed discharge measurement in Chicago Sanitary and Ship Canal at Romeoville.

30 March 1987- Letter sent from MSDGC to Chicago District in response to 10 March letter above. Letter stated that MSD would lend to Chicago District original cartridges for duplication. Letter also recommended names of two potential contractors.

7 April 1987- USGS performed discharge measurement in Chicago Sanitary and Ship Canal at Romeoville.

13-17 April 1987- Committee members meet in private workshop in order to consolidate their findings into initial version of draft report.

21 April 1987 - Letter sent from Chicago District to IDOT. Letter requested clarification of IDOT's intentions to complete Lake Michigan diversion accounting reports for water years 1986 and 1987. Letter stated that IDOT has reporting responsibility for 1986 and 1987 water years. Letter requested IDOT to advise Corps as to plans for completion of 1986 and 1987 water year reports.

1 May 1987- Letter sent from USGS to IDOT (copy forwarded to Chicago District) forwarding adjusted AVM discharge data for water years 1985 and 1986. Letter stated that data provided would be published in the water data report.

5 May 1987- Letter sent from Office of Chief of Engineers (OCE) to NCD regarding implementation of PL 99-662, Section 1142, Measurement of Lake Michigan diversion. Letter requested that prior to initiating work authorized by PL 99-662, a listing of planned FY88 expenditures was to be submitted for review and approval. Line items were requested for the following tasks: (a) flow measurement; (b) hydraulic and hydrologic computations; (c) report preparation; (d) downstate interests coordination; and (e) periodic engineering review of measurement program. Letter requested proposed plan to be submitted by 29 May 1987.

11 May 1987 - IDOT provides revised version of draft 1984 accounting report to Corps for review purposes. Revised version incorporated Corps' comments on initial draft previously provided in January 1987.

15 May 1987- USGS performed discharge measurement in Chicago Sanitary and Ship Canal at Romeoville.

20 May 1987- Letter sent from NCD to Chicago District forwarding above 5 May 1987 letter for action.

20 - 22 May 1987- Corps' representative met with committee members to review initial draft of report.

27 May 1987- Letter sent from Chicago District to NCD in response to 20 May letter above. Letter provided list of line item tasks, as well as corresponding descriptions and costs. Additionally, a summary table of costs was provided.

5 June 1987- Letter sent from USGS to Chicago District regarding formation of review committee to review the acoustic velocity meter (AVM) discharge record prior to publication. Letter stated that committee would be composed of representatives from IDOT, Corps, USGS, and MSDGC and that committee would be responsible for reviewing the record each year and documenting its findings prior to publication. More specifically, letter provided copies of daily values tables for the 1985 water year (published and revised) and the 1986 water year (proposed) for review and comment.

9 June 1987- Initial draft of second technical committee report provided to Chicago District for review purposes (copies provided to NCD,IDOT,USGS and HEC).

19 June 1987- USGS performed discharge measurement in Chicago Sanitary and Ship Canal at Romeoville.

23 June 1987 - Letter sent from Chicago District to USGS in response to 5 June letter above. Letter stated that Corps would be interested in participating on review committee to evaluate AVM discharge records. Additionally, as an interim response, letter enclosed copy of draft technical committee report (sections regarding adjustment of AVM records).

17 July 1987- Letter sent from USGS to Chicago District (copy provided to IDOT) regarding USGS review of draft committee report (section on AVM system). Letter stated that review focused primarily on proposed procedure for relating flow computed by MSD at Lockport to flows at gaging station at Romeoville.

24 July 1987- USGS performed discharge measurement in Chicago Sanitary and Ship Canal at Romeoville.

3 August 1987- Second draft of second technical committee report provided to Chicago District for review purposes (copies provided to NCD,IDOT,MSD,NIPC and HEC).

4 August 1987- Letter sent from Chicago District to MSDGC requesting copy of Hydraulic Report program used by MSDGC to generate flow data at Lockport.

12 August 1987 - Letter sent from NCD to Chicago District enclosing review comments on second draft of technical committee report. Letter also requested that schedule should be developed for meeting items of concern to diversion program.

17 August 1987- USGS performed discharge measurement in Chicago Sanitary and Ship Canal at Romeoville.

18 August 1987- Meeting held between Corps, NIPC, and IDOT for discussion of computer simulation model.

3 September 1987- Technical committee requests time extension thru 30 November 1987 for completion of final report.

APPENDIX B

SIGNIFICANT EVENTS (HYDROLOGIC)

SIGNIFICANT EVENTS-FY87
HYDROLOGIC

13 August 1987-16 August 1987 - During this period, a record rainfall event occurred in the Chicago area. During the major storm event of 13-14 August, 9.35 inches of precipitation was recorded at O'Hare Airport. The rainfall was greater than a 100-year, 24-hour event. An additional rainfall of 2.9 inches on 16 August brought the total rainfall for the entire storm period to over 12.0 inches. As a result of the intense precipitation, the Deep Tunnel (operated by the MSDGC) was filled to its 1 billion gallon capacity. Subsequently, the MSDGC began backflowing water into Lake Michigan at the Wilmette Controlling Works and the Chicago River Controlling Works. An estimated 2 billion gallons of polluted water were discharged into the lake, representing the largest such untreated release in the MSDGC's history.

25 - 26 August 1987 - During this period, 2.94 inches of precipitation was recorded at O'Hare Airport. Due to extremely wet antecedent conditions, 1 billion gallons of runoff filled the Deep Tunnel within hours, forcing the MSDGC to release untreated runoff water into Lake Michigan at the Wilmette Controlling Works. An estimated 18 million gallons of polluted water were discharged into the lake.

27 August 1987 - Overflow from Des Plaines River into main channel of Sanitary and Ship Canal (between Route 83 and Willow Springs Road).

APPENDIX C
MASTER PLAN

Master Plan for
Lake Michigan Diversion
Accounting Program

1. Purpose: This Master Plan is developed to define the responsibilities of the Corps of Engineers with regard to Lake Michigan Diversion Accounting, establish routine annual goals and objectives, establish a generic annual schedule of activities and to provide specific short and long range objectives for the accounting program.

2. History and Authority: In 1908 and again in 1913, the United States brought actions to enjoin the Metropolitan Sanitary District of Greater Chicago (MSDGC) 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.

In 1922,1925, and 1926, several Great Lakes States filed similar original actions in the U.S. Supreme Court seeking to restrict 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 his finding. Subsequently, the Court instructed the Special Master to determine the steps necessary for Illinois and MSDGC to reduce diversion. Consequently a 1930 decree reduced the allowable diversion (in addition to domestic pumpage) in three steps: 6,500 cfs after 1 July 1930; 5,000 cfs after 30 December 1935; and 1,500 cfs after 31 December 1938.

In 1967, the Supreme Court issued another decree limiting the diversion, including domestic pumpage, of Lake Michigan water into the Illinois Waterway by the State of Illinois and its municipalities, 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 nmeasurements and computations. The role of the Corps of Engineers, as specified in the decree, was to be one of "general supervision and direction."

In 1980, the 1967 decree was modified when the Court increased the period for determining compliance with the 3,200 cfs limit from a five year running average to a forty year running average. Additionally, the beginning of the diversion accounting year was changed from 1 March to 1 October. A limit was placed on the average diversion in any accounting year (3,680 cfs) except for

an average diversion of 3,840 cfs to be allowed in any two accounting years within a forty year period. A limit was placed on the cumulative algebraic sum of the average annual diversion credits and deficits (amount above or below 3,200 cfs for a given year) during the first 39 years. This limit is 2,000 cfs-yrs. These changes allow the State of Illinois to more effectively utilize and manage the 3,200 cfs of Lake Michigan water allocated previously by the Court. The 1 December 1980 modification also directed the Chief of Engineers to appoint a three-member technical committee to recommend the method for measuring the diversion using the best current engineering practice and scientific knowledge. The Corps was also directed to reconvene such a committee at least once every five years to report on the method of accounting and operation of the accounting procedures. Finally, the modified decree directed the Corps to prepare an annual report summarizing activities relating to the diversion program and certifying diversion flows.

3. Water Resources Development Act of 1986: The Water Resources Development Act of 1986 gave the Corps total responsibility for the computation of diversion flows as formerly done by the State of Illinois.

4. Involved Agencies and Current Responsibilities: The principal agencies involved either directly or indirectly in the diversion accounting and verification process along with a brief description of individual functions are summarized as follows: (a) Corps of Engineers - responsible for diversion accounting and certification of flows; (b) United States Geological Survey (USGS) - responsible for conducting of flow measurements; (c) State of Illinois (IDOT) - responsible for completing the 1984 and 1985 accounting reports. IDOT has no subsequent responsibilities with respect to diversion accounting but still maintains water allocation responsibilities; (d) Northeastern Illinois Planning Commission (NIPC) - being retained by the Corps to do the 1986 and 1987 accounting reports and to transfer the diversion accounting computer models and data to the Corps. NIPC has no subsequent responsibilities; and (e) MSDGC - is responsible for collection of direct diversion data and preliminary flow information at Lockport.

5. Procedure: The intent of this Master Plan is to provide a framework through which long and short term planning can be expedited. This framework, based upon the specifics of the modified Supreme Court decree of 1 December 1980, allows flexibility within the program to meet changes in the physical make-up of diversion control structures, as well as allowing for technical advancements in accounting procedures and modifications in the decree itself.

6.Scheduling: Schedules of activities are provided for FY 88 as well as FY 89 (Attachments 1 & 2). These schedules allow for the required effort needed for review and implementation of the major recommendations made by the second three-member technical committee.

7.Routine Activities: A generic annual schedule is provided (Attachment 3). The generic schedule summarizes milestone dates for those activities that are accomplished on a routine basis. It is anticipated that this schedule will have little variance, yet be sufficiently flexible to accomodate modifications within the system as well as unique, non-reoccurring events.

8.Annual Reporting: The annual schedule follows the fiscal year, identical to the water year calendar. The Corps' Annual Report will cover activities occuring within the 1 October to 30 September period. Events spanning the end of the year, or multiple years, will receive interim reports and will be discussed in detail following completion. Certification of diversion flow data will be discussed in the Annual Report. It is anticipated that flow data for multiple accounting years may be certified in a single annual report. An annual report shall be published at the conclusion of each accounting year, regardless of whether diversion flow data is available to be certified. The annual report shall, as a minimum, discuss significant events occurring during the accounting year as well as projected future activities associated with the diversion accounting program. A five-year, long range plan (Attachment 4) presents an itemization of anticipated significant events, modifications to the system and major studies expected to be undertaken. The five-year plan will be updated on an annual basis and shall include studies or modifications recommended by the State of Illinois, the Corps of Engineers, the three-member technical committee or other interested parties to the diversion program.

9.Annual Activities: The Lake Michigan diversion accounting program centers around several annual activities. The primary purpose of these activities is to ensure that diversion flows are being measured in accordance with the best current engineering practice and scientific knowledge, as required by the modified Supreme Court decree.

10.Operating Procedures: The procedures of routine reoccuring activities are detailed in standard operating procedures (SOP's) maintained by the Chicago District. As the diversion accounting program changes, these SOP's will also be changed to reflect new conditions. The SOP's include methods for verifying computations as well as procedures followed during site inspection visits.

11. Inspection Techniques: The Corps shall inspect the primary diversion metering sites at least annually. In conjunction with a physical inspection of the measuring equipment, the Corps shall review maintenance and calibration procedures and records for appropriateness and completeness. A listing of the primary metering sites is included in Attachment 5. The Corps shall inspect calibration documents for major metering devices. An instrument logbook for each instrument is encouraged. This instrument log is to be maintained at the location of each instrument, where feasible, and is to contain, at a minimum, the following sections: (a) instrument history; (b) service record - manufacturer's repairs, battery replacement dates, cleaning, etc.; (c) routine performance tests - to include spaces for date, initials of technician, comments, and other instrument parameters, as applicable; (d) calibration results; and (e) instrument settings and changes during calibration. The Corps shall review calibration schedules of the acoustic velocity meter (AVM), pump stations and treatment plants to determine if calibration follows major repairs and maintenances as well as regular periodic checks. The Corps shall conduct flow measurements or equipment calibration tests only when the measurements or calibrations conducted by the responsible agency are suspect. The Corps may then conduct or directly supervise such tests or studies necessary to verify or disprove the suspect data. The Corps shall review all data as it is made available for reasonableness within the context of the limits of the data collection systems. Where possible, data are to be cross-checked by comparing with similar data collected through alternative sources. The results of the Corps' supervisory and audit role shall be published in the annual report. Recommendations by the Corps shall also be included in the annual report.

12. Summary Reports: Quarterly status reports will be prepared. These status reports will serve to summarize, for each quarterly period, the major accomplishments with respect to the accounting program. These status reports will be task oriented and will include budgetary data for the quarterly period being covered. The reports will be reviewed by the Corps' higher authority with internal records to be maintained for reference purposes.

ATTACHMENT 1
LAKE MICHIGAN DIVERSION MASTER PLAN
ANNUAL SCHEDULE - FY 88

LIST OF TASKS	WORK INTERVAL
IN HOUSE TASKS	
1. Preparation of FY 87 Annual Report	1 Dec-15 Jun
2. Review of IDOT's FY 84 Accounting Report	1 Jun-30 Sep
3. Report on Review of Past Modeling Procedure	1 Oct-30 Sep
4. Inspection of Measuring Devices	1 Oct-30 Sep
5. AVM Backup System Proposal	1 Mar-30 Sep
6. Hydraulic and Hydrologic Computations*	1 Apr-30 Sep
7. Coordination of interested parties	1 Oct-30 Sep
8. Implement changes due to TARP	1 Oct-30 Sep
9. Supervision, Management and Typing	1 Oct-30 Sep
OUTSIDE SERVICES	
1. Computer Services	1 Apr-30 Sep
2. NCD support to diversion program	1 Oct-30 Sep
3. Travel	1 Oct-30 Sep
4. Reproduction	1 Oct-30 Sep
5. A/E Special Studies-Hydrologic Parameters*	1 Apr-30 Sep
6. Illinois State Water Survey**	1 Jun-30 Sep
7. USGS for AVM	1 Oct-30 Sep
8. USGS new Lockport stage gages***	1 Sep-30 Sep
9. Unprogrammed studies and hardware	1 Oct-30 Sep
10. NIPC to prepare accounting report for FY85	1 Apr-30 Sep

NOTES

* Open ended A/E contract to be developed with NIPC for completion of task. Funding will be obligated during FY88 with activities scheduled to carry-over into FY89.

** Sole source contract to be prepared. Funding will be obligated during FY 88 with expected carry-over into FY89.

*** Item to be reviewed following completion of AVM backup system report at end of FY88.

ATTACHMENT 2
LAKE MICHIGAN DIVERSION MASTER PLAN
ANNUAL SCHEDULE - FY 89

LIST OF TASKS	WORK INTERVAL
IN HOUSE TASKS	
1. Preparation of FY88 Annual Report	1 Oct-31 Dec
2. Preparation of FY86, FY87 Accounting Reports*	1 Oct-30 Sep
3. Inspection of Measuring Devices	1 Mar-30 Sep
4. AVM Backup System	1 Oct-28 Feb
5. Hydraulic and Hydrologic Computations*	1 Oct-30 Sep
6. Coordination of Interested Parties	1 Oct-30 Sep
7. Implement changes due to TARP	1 Feb-30 Sep
8. Review of records at Upper Des Plaines Pumping Station	1 Feb-30 Sep
9. Supervision, Management and Typing	1 Oct-30 Sep
OUTSIDE SUPPORT	
1. Computer Services	1 Oct-30 Sep
2. NCD Support to Diversion Program	1 Oct-30 Sep
3. Travel	1 Oct-30 Sep
4. Reproduction	1 Oct-30 Sep
5. A/E Special Studies-Hydrologic Parameters*	1 Oct-15 Jan
6. Illinois State Water Survey (verification and adjustment of precipitation gage records)**	1 Apr-30 Sep
7. USGS for AVM (O&M)	1 Oct-30 Sep
8. Unprogrammed Studies and Hardware	1 Oct-30 Sep
9. NIPC for preparation of accounting reports for FY86, FY87*	1 Dec-31 May

NOTES

* Open ended A/E contract to be developed with NIPC for completion of task. Funding will be obligated during FY 88 with activities scheduled to carry-over into FY89. Task is scheduled for completion during FY89.

** Sole source contract to be prepared. Funding will be obligated during FY88 with expected carry-over into FY89. Task is scheduled for completion during FY89.

ATTACHMENT 3
LAKE MICHIGAN DIVERSION MASTER PLAN
GENERIC ANNUAL SCHEDULE

LIST OF TASKS	WORK INTERVAL
IN HOUSE TASKS	
1. Preparation of Annual Report	
a. Review of available data and events	1 Oct-31 Dec
b. Perform technical analysis	1 Oct-31 Dec
c. Prepare text of report	1 Oct-31 Dec
2. Preparation of Accounting Reports	
a. Compile data	1 Oct-28 Feb
b. Execute hydrologic modeling procedure	1 Mar-31 May
c. Perform accounting and prepare report	1 Mar-31 May
d. Review/coordinate with IDOT/NIPC	1 Jun-30 Sep
3. Inspection of Measuring Devices	
a. Inspect Treatment Plants	1 Oct-30 Sep
b. Inspect precipitation gages	1 Oct-30 Sep
c. Inspect water intakes	1 Oct-30 Sep
e. Inspect AVM site and equipment	1 Oct-30 Sep
4. Review of AVM records	
a. Coordinate interested parties	1 Oct-30 Nov
b. Complete technical analysis	1 Dec-31 Jan
c. Certify flow data	1 Feb-31 Mar
5. Hydraulic and Hydrologic Computations	
a. Review current computation methodologies	1 Oct-31 Jan
b. Revise methodologies where necessary	1 Feb-30 Jun
c. Summarize changes in metholodogies	1 Jul-30 Sep
6. Coordination of interested parties	
a. Coordinate meetings	1 Oct-30 Sep
b. Schedule activities	1 Oct-30 Sep
7. Supervision, Management and Typing	1 Oct-30 Sep
OUTSIDE SUPPORT	
1. Computer Services	1 Oct-30 Sep
2. NCD Support to diversion program	1 Oct-30 Sep
3. Travel	1 Oct-30 Sep
4. Reproduction	1 Oct-30 Sep

5. USGS for AVM	1 Oct-30 Sep
6. Special studies	1 Oct-30 Sep

TECHNICAL COMMITTEE ACTIVITIES*

1. CBD Advertisement	1 Oct-31 Oct
2. Review Resumes/Selection Process	1 Nov-31 Jan
3. Bidding/Negotiation Process	1 Feb-31 Mar
4. Convene Committee/Workshop Sessions	1 Apr-31 Aug
5. Review Committee Findings (Final Report)**	1 Sep-30 Sep

NOTES

* Three-member technical committee to be convened at least once every five years in accordance with provisions of modified Supreme Court decree of 1 December 1980. Committee members are responsible for reviewing current techniques for measuring Lake Michigan diversion and making recommendations based on best current engineering practice and scientific knowledge.

** Receipt of committee's final report and review of committee's findings expected to carry-over into following accounting year.

ATTACHMENT 4
LAKE MICHIGAN DIVERSION MASTER PLAN
5 YEAR PLAN

ACCTG. YR.	SCHEDULED ACTIVITY
1988	Complete review of second technical committee recommendations
	Complete review of NIPC's modifications to hydrologic modeling procedures
	Complete development of AVM backup system
	Review of TARP/effects on diversion acctg.
1989	Implementation of second technical committee recommendations
	Follow-up study of AVM backup system
	Review of calibration procedures for flow metering devices
	Review of TARP/effects on diversion accounting
1990	Field Measurement of flow through lakefront structures
	Commence procurement process for third technical committee
	Study effects of new suburban water sources on accounting model
	Review of TARP/effects on diversion accounting
	Completion of FY88 accounting report and initiation of FY89 accounting report
1991	Convening of third technical committee
1992	Review report of third technical committee

ATTACHMENT 5
LAKE MICHIGAN DIVERSION MASTER PLAN
PRIMARY METERING SITES

1. Metropolitan Sanitary District of Greater Chicago (MSDGC) Treatment Plants
   a. Calumet Sewage Treatment Plant
   b. West-Southwest Treatment Plant
   c. Northside Sewage Treatment Plant
   d. Lemont Sewage Treatment Plant

2. Acoustic Velocity Meter (AVM) at Romeoville

3. Lockport Lock and Powerhouse
   a. Powerhouse turbines
   b. Powerhouse sluice gates

4. Lockport Controlling Works

5. MSDGC Sewage Pumping Stations
   a. Upper Des Plaines Pumping Station
   b. 13A Pumping Station

6. MSDGC/NOAA precipitation gages in Chicago area

7. Lakefront Controlling Structures
   a. Chicago River Controlling Works (CRCW)
   b. O' Brien Lock and Dam
   c. Wilmette Controlling Works