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Region 5
230 South Dearborn Street
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March 1988

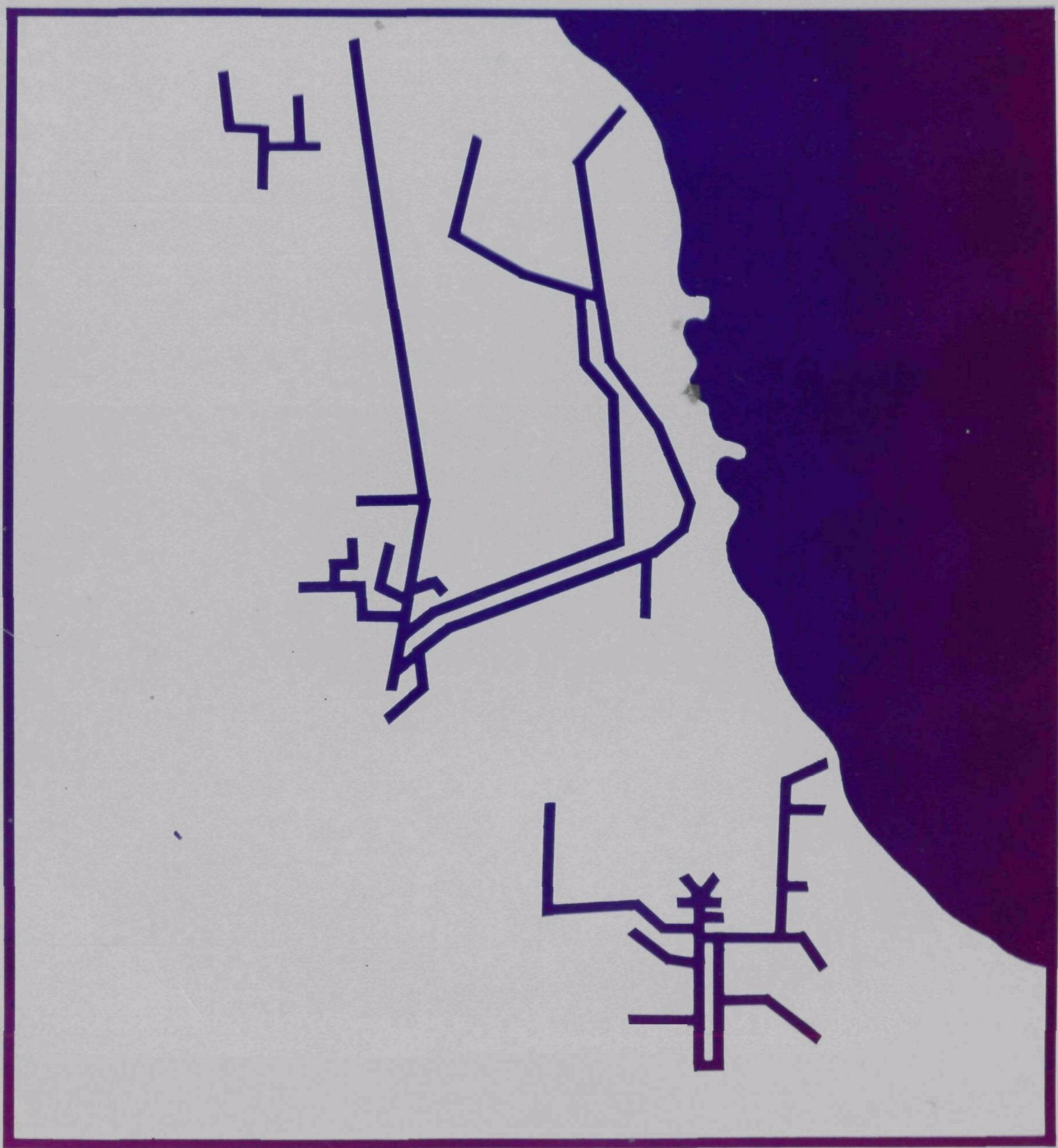
Municipal Facilities Branch - Technical Support Section

EPA

# Metropolitan Sanitary District Of Greater Chicago Tunnel and Reservoir Plan

# Interim Report

## Special Evaluation Project



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of
Greater Chicago
Tunnel and Reservoir Plan
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U.S. Environmental Protection Agency
Region V
Water Division

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## CHAPTER 1

## PURPOSE AND SCOPE

One of the initiatives utilized by the USEPA Region V Water Division Office for monitoring and evaluating the effectiveness of the many programs and projects which are under the purview of the Water Division is the use of special evaluation projects. These special evaluation projects have been utilized in the past to review elements of the Construction Grants Program activities and also have examined the effectiveness, efficiencies, and costs of various technologies.

Since 1975, the USEPA has provided over $944 million in Clean Water Act Construction Grant funds to assist the Metropolitan Sanitary District of Greater Chicago (MSDGC) in the construction of the largest combined sewer overflow project in the Nation. Inasmuch as over half of the segments of the Tunnel and Reservoir Plan (TARP) are complete and operational, the USEPA Region V Water Division decided that it was appropriate to perform a special evaluation project (SEP) on TARP. This SEP provides an analysis of the constructed portion of TARP Phase I.

Specifically, SEP objectives were directed:

1. To compile information on operation and design data pertaining to conditions prior to construction of operational elements of TARP Phase I;

2. To compile information on conditions pertaining to the actual construction and operational data of operational elements of TARP Phase I including effects on ground water quality;

3. To compare and contrast the "design" and "operational" data; and,

4. To evaluate the effect of operation of the TARP Mainstream system on indicators of water quality. The task of collection and analysis of the information in the water quality portion of the study was extended to allow time for the system to stabilize (particularly with respect to existing benthic deposits) and respond to reduced input loads. For this reason, the interim report presents a water quality baseline chapter. (NOTE: The chapter containing the water quality baseline data is under development and is not included in the March 1988 edition of this report). A subsequent report will address the water quality indicators after the water quality system is stabilized. This subsequent report is presently projected for completion in the Plan of Study for Federal Fiscal Year 1990.

### Scope

The evaluation of TARP Phase I operational elements is separated into three areas, with the examination focusing on different aspects of the projects due to their unique characteristics.

Upper Des Plaines TARP

- Historical aspects of the operation of the Upper Des Plaines TARP system, focusing on correlations to current portions of other elements of the system that are now operational.

- Major construction, maintenance and operational characteristics.

Mainstream TARP (Focus of Region V effort)

- Operational characteristics in relation to design parameters (Effectiveness of wastewater capture).

- Effects of operation on WWTP. (Considering ongoing WWTP construction.)

- Major construction, maintenance and operational characteristics.

- Water quality indicators will be assessed in an area that encompasses portions of the Chicago waterways downstream and adjacent to the Mainstream System, e.g., Northshore Channel, North Branch Chicago River, Chicago River, South Branch Chicago River, Sanitary and Ship Canal, and the Lower Des Plaines River. Only an assessment and cataloging of available baseline data will be presented in the interim report. (NOTE: The chapter containing the water quality baseline data is under development and is not included in the March 1988 edition of this report.)

- The effects of TARP operation on Lake Michigan will also be assessed within the context of backflow events and beach closures in the vicinity of the Wilmette and Chicago Lock and Dams. (Note: The chapter which discusses these effects is under development and is not included in the March 1988 edition of this report.)

Calumet TARP

- Major construction, maintenance and operational characteristics.

This study was conducted in accordance with the revised Plan of Study which is attached in Appendix 3.

The findings of USEPA's examination of the constructed portion of TARP are described in Chapters 2-8, with the more noteworthy items highlighted in Chapter 9.

CHAPTER 2

# INTRODUCTION AND BACKGROUND

## HISTORICAL BACKGROUND

The Chicago area has a long history of building tunnels which started with water supply tunnels in 1867. The first water tunnel, placed in operation in March of that year, was a five foot diameter brick tunnel, built in clay, approximately 60 feet below lake level, and extended two miles into Lake Michigan to the Two Mile Crib intake. It was designed to supply lake water to the City of Chicago's first pumping station. As the City grew and its water works system expanded, additional tunnels were built to new pumping stations. During the construction of these tunnels, many difficulties were experienced due to poor soil conditions. In an attempt to avoid the difficulties encountered, City engineers resolved that, wherever feasible, future tunnels would be constructed in rock. The first tunnel built in rock was initiated in 1906 and completed in 1911. Other tunnels were subsequently constructed. The depth of these water tunnels varied from 102 to 148 feet for the land portion and was generally 160 feet below Lake level. Today, there are 65 miles of water tunnels in service and of these, 57 miles are constructed in rock.

Concern over water pollution and public health problems began with the earliest Chicagoans who depended on shallow wells for their water supply and outdoor privies as a means for disposing of their personal wastes. Pollution or contamination of their drinking water occurred when the water table was high and the privies leached into the wells. As a result, typhoid fever and amoebic dysentery were prevalent. To fight these plagues, drinking water dipped from Lake Michigan was peddled from door to door in horse-drawn carts. In time, these carts were replaced by water pipes and tunnels as discussed above. Meanwhile, sewers were laid to drain the swamp and collect excess water. The privies drained into these sewers which emptied into the river and thence to the Lake. On August 2 to 3, 1885, a cloudburst occurred which dumped more than six inches of rain on Chicago streets sweeping the streets clean of debris, dirt and dust. The pollution resulting from this storm reached beyond the pipes that drew in water from the Lake bottom for the City's drinking water needs, thereby contaminating it. The epidemic that followed claimed the lives of 90,000 people of the 750,000 existing population. Within a few days of the storm, a commission was appointed to protect the City against recurrence of the tragedy. By July 1, 1889, a plan was drawn to decisively and permanently reverse the flows of the Chicago and Calumet Rivers away from the Lake and into the Des Plaines River. A canal was dug which not only carried the waters of the two rivers, but also drained a network of intercepting pipes that were placed to catch the burden of the sewers before it reached Lake Michigan. On August 15 of the same year, a petition to organize a Sanitary District of Chicago (SDC) was submitted to the Illinois Legislature, and on November 5, the voters overwhelmingly approved the proposal.

The SDC then proceeded to construct the canal system. In 1900, a suit was filed by the State of Missouri, claiming that typhoid bacteria from the Chicago area was contaminating its water supply. Under the direction of a Master appointed by the Supreme Court, 107 barrels of a less deadly strain of typhoid bacilli were dumped into the Sanitary and Ship Canal at Chicago. In the following weeks, none of the bacilli was found at St. Louis and Missouri lost the case. The United States (U.S.) filed suit against SDC to limit diversion of Lake water to 4,167 cubic feet per second (cfs). The channels were designed for a 10,000 cfs flow. The case was decided in favor of U.S. in 1925. As a result of this decision and in order not to degrade the water quality of the waterways, the District constructed its major treatment facilities. In 1939, a Supreme Court Decision further limited the diversion to 1500 cfs plus domestic pumpage. Additional litigation initiated in 1961 by the State of Illinois resulted in a diversion limit of 3,200 cfs including domestic pumpage. In January 1977, the State of Illinois, Department of Transportation-Division of Water Resources ordered the allocation of Lake water to eligible applicants. Under this order, the District was allocated 307 cfs of water for lockages, leakages, and navigational makeup. This order also transferred the responsibility of discretionary diversion and storm runoff from the District to the State. On December 1, 1980, the Supreme Court amended its 1967 decree allowing Illinois to average within certain limits, the diversion over a period of 40 years instead of 5 years as originally ordered, while keeping the 3,200 cfs limit unchanged. To utilize the flexibility of the long-term averaging clause, Illinois issued a Water Allocation Order LMO 80-4 to municipalities and subdivisions, limiting the usage of water by the District for lockages, leakages, and navigational purpose to 255 cfs.

The reduction of water pollution of the Lake also involved the construction of intercepting sewers. The first sewers in Chicago were constructed in 1843. By 1890, the City's sewer system included 700 miles of sewer serving an area of 170 square miles and a population of 1.1 million people. These sewers were constructed of brick laid in concentric rings and have diameters ranging from 24 inches to 20 feet. Beginning in the 1890's, the increase in the construction of buildings, hard pavements, and sidewalks as well as extending existing sewer lines beyond their original limits caused greater storm runoff than was allowed for in the original sewer designs. This resulted in the flooding of basements at the end of the last century. By 1907, the basic sewer system was completed, and Chicago became the first Great Lakes city to stop using Lake Michigan as a receptor of its domestic sewage. Subsequent and continuous construction that has taken place before and after World War II caused an even greater increase in imperviousness and stormwater runoff, resulting in a construction program to increase sewer capacity within the City. After 1930, sewer technology changed in such a way that brick use declined. Sewers with diameters under 30 inches were constructed of tile pipes while those over 30 inches used reinforced concrete. In 1947, construction began on an area-wide system of large combined relief sewers to supplement existing major main sewers as well as provide every neighborhood with a sewer outlet capable of handling a 5-year frequency storm. Presently, Chicago's sewer system consists of approximately 4,300 miles of sewers covering a land area of 228 square miles.

The Sanitary District of Chicago, now known as the Metropolitan Sanitary District of Greater Chicago (MSDGC), was organized under the Illinois Revised Statutes, Chapter 42, Section 320 to remove obstructions in the Des Plaines and Illinois Rivers. The Revised Statutes authorize MSDGC to treat wastewater, either totally or partially, from any municipality within its designated jurisdiction, as well as to construct, own and operate all wastewater treatment and collection works located within its boundaries. Over the years, the MSDGC grew by annexations until today, its service area is approximately 872 square miles. Approximately 375 square miles are served by combined sewer systems in which wastewater or sewage collected in local sewer systems is conveyed to treatment works. These systems serve 120 municipalities which have a total population of 5.5 million. MSDGC controls and operates 70.5 miles of navigable canals, and owns and operates seven wastewater treatment works, and approximately 524 miles of intercepting sewers. The major treatment works (West-Southwest, North Side, Calumet) have a combined secondary capacity of 1753 MGD. The O'Hare, John E. Egan, and Hanover Park Water Reclamation Plants and the Lemont Sewage Treatment Plant have capacities of 72 MGD, 30 MGD, 12 MGD, and 1.6 MGD, respectively.

## DEVELOPMENT OF THE TUNNEL AND RESERVOIR PLAN (TARP)

The growth of the District's service area and multiplication of captured rainwater volume had exceeded the sewer system's capacity. On an average of 100 times a year, combined sewers overflowed and surged into the Chicago and Calumet Rivers at 640 different locations prior to the operation of TARP. Basement back-ups also occurred. In addition, the combined sewer overflows contributed to poor water quality of the Chicago and Des Plaines River systems and even the Illinois River. Also in the last 30 years, the flood gates of the Chicago and Calumet Rivers have been opened 35 times to prevent the overflowing of their banks, resulting in City beaches being closed to swimmers at times.

Many plans to resolve the Chicago area's flooding and water pollution problems were developed during the 1950's and 1960's by concerned government agencies, local organizations and individuals. At first, the plans focused primarily on the flood control problem. However, as water quality conditions in the area worsened, more emphasis was placed on controlling water pollution. A total of twenty-three plans was formulated, and many were considered and evaluated in detail by the Flood Control Coordinating Committee (FCCC). The FCCC was organized soon after a 1957 rainstorm which caused extensive flooding damage in the Chicago metropolitan area. It was to study various alternatives advocated to solve flooding problems in the area. The Committee members could not reach an agreement and the FCCC was eventually disbanded. In November 1970, it was reactivated and consisted of representatives from the State of Illinois, Cook County, MSDGC and City of Chicago. The new Committee began to consider, screen and evaluate various alternative plans.

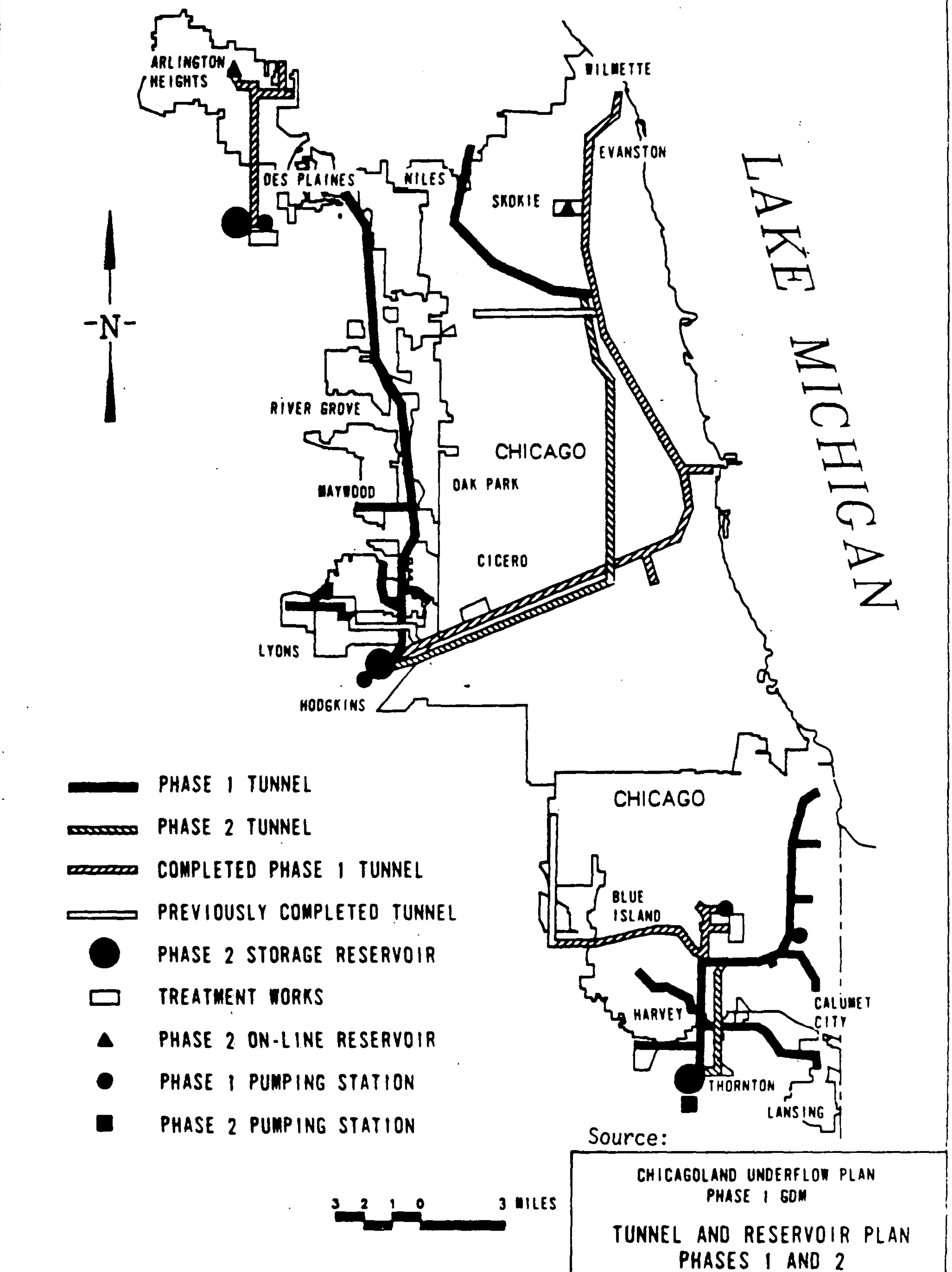
In screening the alternative plans, the FCCC established overall flood and pollution control objectives which provided a basis for evaluating alternative plans. Acceptance of a plan was dependent upon whether it would prevent all backflows to Lake Michigan to protect water supply resources, reduce pollutant discharges caused by combined sewer overflows, and reduce flooding in the combined sewer and downstream areas.

Initial screening by the FCCC resulted in six alternatives being eliminated from further consideration and modifications being made to the remaining 17. These modifications consisted of a combination of different storage capacities and waterway improvement actions. The resulting modifications yielded 51 alternative subsystem plans or subplans to be evaluated by the FCCC. The next screening phase identified eight principal parameters defined by the FCCC, namely: capital costs (1972 dollars), estimated annual operating and maintenance costs (1972), project benefits, land acquisition acreage, underground easement requirements, resident and business relocations, construction impacts, and operation impacts. In order to evaluate the modified alternatives, the FCCC organized a technical advisory committee. The committee issued an interim report recommending a 50,000 acre-feet storage capacity. Upon reviewing the report, the FCCC concluded that the flood and pollution plan should be in the form of one of the four Chicago Underflow plans developed or a combination of these plans, along with the recommended storage level.

In August 1972, the FCCC issued a report which recommended consolidating favorable features of the four Underflow plans into the Tunnel and Reservoir Plan (TARP). What followed was a further development and refinement of TARP and an evaluation of TARP with five selected alternatives including "no action." The FCCC concluded that: (1) very few negative impacts are expected for any of the alternatives incorporating conveyance tunnels when compared to the "no action" alternative; (2) construction impacts of all plans on the environment are expected to be short-term and localized; and, (3) the beneficial impacts far exceed the adverse impacts. The report stated that TARP was selected as the most suitable plan to solve the flood and pollution problems at the lowest cost and with the minimum adverse environmental impact.

TARP, as shown in Figure 1, consists of 131.1 miles of conveyance tunnels, three reservoirs, sewage treatment facilities, pumping stations, drop shafts, and collecting structures. It has four main tunnel systems: Mainstream, Calumet, Lower Des Plaines, and Upper Des Plaines. Other than the Mainstream - Lower Des Plaines tunnel systems which are tied together, each system is a complete, independent operating unit with collection, storage, conveyance, and treatment capabilities.

FIGURE 1




Source:

CHICAGOLAND UNDERFLOW PLAN
PHASE I GDM

TUNNEL AND RESERVOIR PLAN
PHASES 1 AND 2

CORPS OF ENGINEERS CHICAGO DISTRICT

GRANT-FUNDING FOR TARP

When completed, TARP will collect, transport and store the combined sewer overflows for the MSDGC service area. It will serve the dual purpose of pollution abatement and flood control. Pollution abatement will result from capturing and storing the polluted overflows until the MSDGC's wastewater treatment facilities can provide full secondary and advanced treatment. Flood control will be provided simultaneously due to TARP providing an alternative intercepting system capable of accepting combined sewer flows until capacity is reached. Also, overbank flooding will be reduced since combined sewer overflows will not enter the waterways.

At the request of MSDGC, the U.S. EPA examined the funding implications and separated those portions of TARP whose primary function was pollution abatement and are presently known as Phase I from the Phase II portions which primarily relate to flood control. Table 1 identifies the federally funded projects of TARP Phase I. It should be noted that not all segments of TARP - Phase I have been constructed. The Lower Des Plaines TARP segment; the North Branch of the Chicago River segment of the Mainstream system; and 140th Street leg, Torrence Avenue leg, Indiana & Markham Avenue leg, and the Little Calumet legs have not yet been funded.

ENVIRONMENTAL IMPACT STATEMENTS

Environmental impact statements (EIS) are required to be prepared by all Federal agencies for those actions significantly affecting the quality of the human environment. Since the TARP project was identified as being an action which could have a significant impact to the human environment, EIS's were prepared for the Mainstream (with the exception of the Addison to Wilmette Harbor segment), Upper Des Plaines (O'Hare), Calumet, and Lower Des Plaines tunnel systems. These statements described the conditions as they existed at the time of preparation in the natural and man-made environments, provided a summary of alternatives proposed for solving combined sewer overflows, described in detail the selected alternative, assessed the benefits and adverse effects of the construction and operation of the tunnel systems on greater Chicago's natural and man-made environments, and presented the conclusions reached and recommendations. The following is a summarization of the EIS findings, conclusions and recommendations considering groundwater, spoil disposal, and the general effects of construction (including blasting):

- GROUNDWATER - The inflow rate of groundwater for the TARP tunnel systems was estimated to be an average of approximately 0.5 MGD per mile of tunnel. This rate is sufficient to lower the piezometric or hydraulic pressure level of the upper aquifer. The most effective method of reducing this type of infiltration is grouting, and such a program has been incorporated in TARP. Additionally, under surcharged conditions, exfiltration could result in adverse impacts on the groundwater quality of the upper aquifer. Observation wells to monitor grouting integrity during operation are necessary along the entire tunnel alignment.

TABLE 1 FEDERALLY FUNDED TARP PROJECTS

| U.S. EPA GRANT NO. C17 | DESCRIPTION | DATE OF ORIGINAL AWARD | DATE OF CONSTRUCTION COMPLETION | CURRENT GRANT AMOUNT ($) |
|---|---|---|---|---|
| | UPPER DES PLAINES (O'HARE) | | | |
| 5322 01 | TARP TUNNELS 20, 20B, 20C & 21 AND DROP SHAFTS | 06/23/75 | 09/28/80 | 47,977,568 |
| 5322 03 | TUNNEL 20 A AND CONNECTING STRUCTURES | 09/27/77 | 05/28/81 | 3,953,535 |
| 5111 01 | O'HARE WRP PUMPING STATION | 05/23/75 | 12/82 | 15,000,000 |
| | | | SUBTOTAL | 66,931,103 |
| | MAINSTREAM | | | |
| 5321 01 | TARP TUNNELS ADDISON ST. TO WILMETTE HARBOR | 06/30/75 | 01/15/82 | 49,232,475 |
| 5321 02 | TARP CONNECTING STRUCTURES ADDISON ST. TO WILMETTE HARBOR | 06/30/75 | 09/28/82 | 67,854,975 |
| 5321 04 | TARP TUNNELS, DROP SHAFTS & CON. STRUCTURES: OGDEN AVE. TO ADDISON ST. | 07/01/76 | 08/15/83 | 74,476,997 |
| 5321 05 | TARP TUNNELS, DROP SHAFTS & CON. STRUCTURES; ROOSEVELT RD. TO OGDEN AVE. | 07/01/76 | 10/01/83 | 85,659,225 |
| 5321 06 | TARP TUNNELS, DROP SHAFTS & CON. STRUCTURES; DAMEN AVE. TO ROOSEVELT | 07/01/76 | 06/15/84 | 92,718,110 |
| 5321 07 | TARP TUNNELS, DROP SHAFTS & CON. STRUCTURES; CENTRAL AVE. TO DAMEN AVE. | 06/23/76 | 09/16/83 | 73,450,573 |
| 5321 08 | TARP CONNECTING STRUCTURES 59TH STREET TO CENTRAL AVENUE | 06/30/78 | 12/10/82 | 22,658,644 |
| 5321 09 | TARP TUNNELS & DROP SHAFTS 59TH STREET TO CENTRAL AVENUE | 06/23/76 | 02/15/83 | 64,338,692 |
| 5321 20 | TARP PUMPING STATION - PART I: PUMPING STATION | 03/26/79 | 01/30/85 | 138,943,575 |
| 5321 21 | TARP PUMPING STATION - PART II: DISCHARGE & BRANCH TUNNELS | 09/29/78 | 08/04/84 | 50,258,534 |
| 5321 22 | TARP PUMPING STATION - PART III: INTAKE & TRANSFER TUNNELS | 09/29/78 | 08/15/83 | 20,175,989 |
| 5297 04 | TARP TUNNELS, DROP SHAFTS, & CON. STRUCTURES; WEST LEG - 13A EXT. | 09/21/84 | T 02/02/88 | 16,096,050 |
| | | | SUBTOTAL | 755,863,839 |
| | CALUMET | | | |
| 5365 01 | TARP TUNNELS & DROP SHAFTS; CRAWFORD AVE. TO TARP PUMPING STATION | 01/31/77 | 10/01/82 | 58,093,145 |
| 5365 02 | TARP CONNECTING STRUCTURES; CRAWFORD AVENUE TO TARP PUMPING STATION | 09/29/78 | 10/15/83 | 12,589,509 |
| 5365 20 | TARP PUMPING STATION | 09/29/78 | 10/85 | 47,160,900 |
| | | | SUBTOTAL | 117,843,554 |
| | | | GRAND TOTAL | 944,122,396 |

Should pollutants be detected in the wells, mitigative measures were to be implemented to protect the upper aquifer including the groundwater recharge system;

SPOIL DISPOSAL - It is the policy of the MSDGC to place on the construction contractors the responsibility of disposing of material excavated from each Phase I tunnel system with the exception of a relatively small amount of material retained by the Cook County Forest Preserve District. MSDGC's expectation was that the contractors will either find markets for the excavated materials or would utilize suitable, environmentally acceptable waste disposal sites. Approximately 17,620,000 bulk cubic yards of rock and soil was estimated to be produced as a result of the excavation. The suitability of the rock excavated from the tunnels was limited to low grade commercial uses and for fill. This is due to the fines, angular shape of the cutrock, shale and other constituent content in the rock. The environmental impacts associated with the disposal of the spoil depend on the availability of landfill disposal sites. The impacts on the environment include exhaust and dust emissions to the atmosphere from truck traffic and noise, the reduction of space at the disposal site for municipal refuse or other solid waste, and the shortening of the landfill's life expectancy. However, due to the stable nature of the rock spoil, the sort of environmental problems (methane gas production, leachate contamination of groundwater or surface waters) associated with landfilling of municipal refuse were not expected. Some temporary storage included the McCook Quarry, Birsch Brick Yard, and Paschen Construction Company yard located on Archer Avenue; and,

GENERAL EFFECTS OF CONSTRUCTION: The construction of the tunnel systems was expected to result in temporary public annoyance and inconvenience from the cumulative effects of noise, handling of construction debris, vibration from blasting, disruption of vehicular and pedestrian traffic, and glare from the illumination of construction areas at night. Specifically, construction of access and drop shafts would require some blasting operations. These operations would create noise and vibrations, increase the sensitivity of people to the duration of the project, and would raise concern over possible property damages. A well-planned operation could allay many of the concerns the public may have over the effects of blasting. MSDGC could make certain that no structural damage occurs by placing blasting limitations in the project's construction specifications. Further reductions in the allowable limits could be made to make blasting less noticeable. Steps could be taken to keep the public sufficiently informed so that observers of the blasting will have no cause for alarm and would be willing to accept some minor irritation in return for the benefits which the project can bring to the community.

As a result of the EIS's findings and conclusions, a groundwater monitoring program was implemented for all TARP systems. Similarly, MSDGC was required to submit a report and develop detailed plans for the utilization or disposal of rock spoil for the Mainstream and Calumet systems. MSDGC has also limited blasting to levels lower than those set by the U.S. Department of Interior - Bureau of Mines.

## CHAPTER 3

## UPPER DES PLAINES TARP SYSTEM

### INTRODUCTION

Due to development of the northwest area of the MSDGC jurisdiction in the early 1960's, MSDGC investigated possible alternatives to provide relief to the existing sewers. The initial recommendation was to construct an intercepting sewer system to convey all of the sewage to the West-Southwest Treatment Works in Stickney. However, the cost and magnitude of the project would have required such implementation time as to necessitate temporary treatment plants in the northwest area, making this alternative not cost-effective. As a result, the northwest area was divided into four facility areas corresponding to the existing drainage basins. One of these is the Upper Des Plaines (O'Hare) facility area.

The Upper Des Plaines facility area is located in the northwest portion of Cook County. It has a drainage area of 88.7 square miles, 13.7 square miles being combined sewer area with 119 outfalls. Facility planning in the mid-1970's for this area, which was originally tributary to the MSDGC North Side Sewage Treatment Works, resulted in the selection of a plan that included a regional treatment facility and a tunnel system which is part of MSDGC's TARP.

Along with the diversion of sanitary sewage flow from existing intercepting sewers, the Upper Des Plaines TARP captures combined sewer overflows (CSO's). These flows are treated at the O'Hare Water Reclamation Plant (WRP), designed specifically to include capacity for treating stored combined sewer overflows.

### CONSTRUCTION

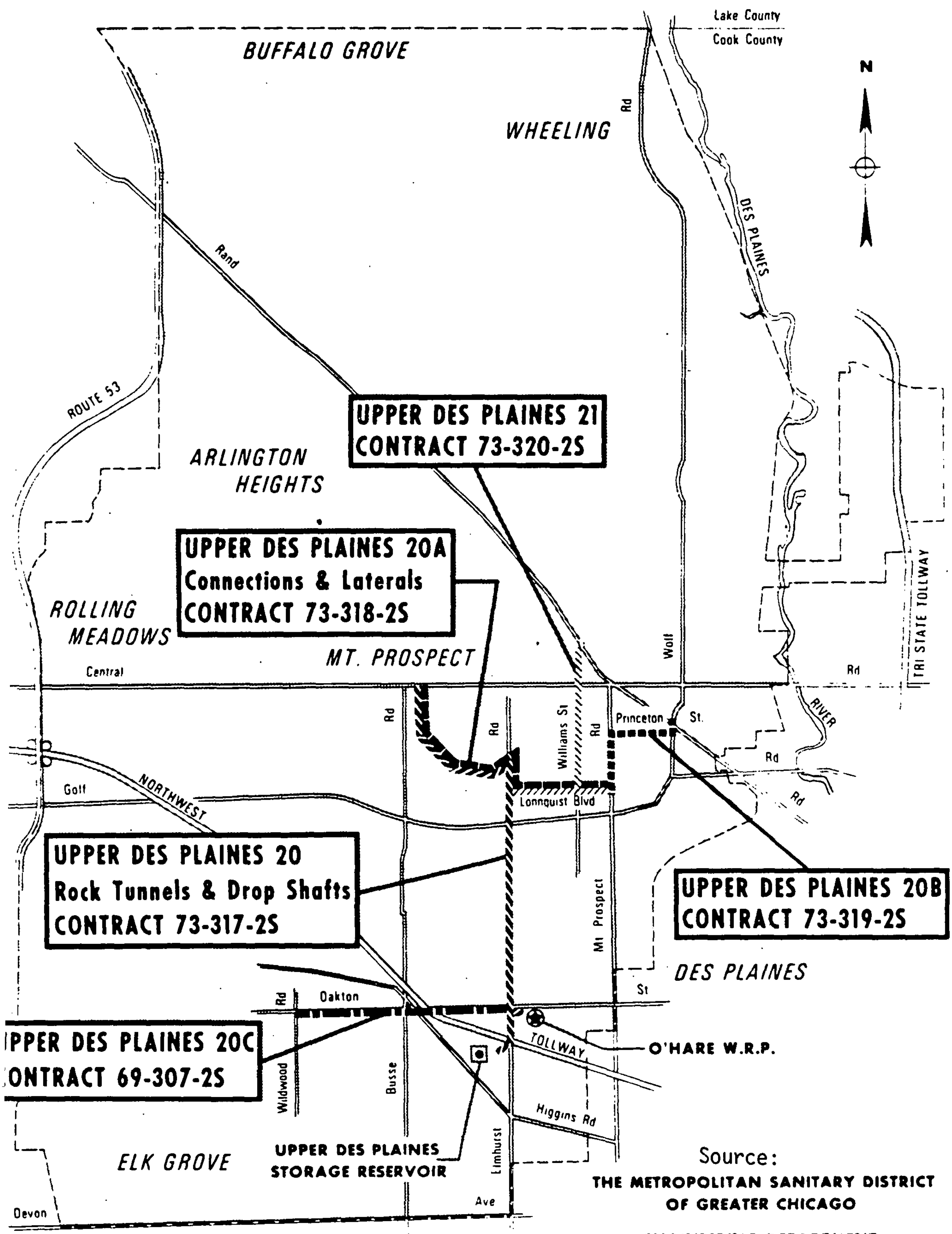
The Upper Des Plaines TARP tunnel system consisted of four construction contracts. The tunnel system includes 6.6 miles of rock tunnels, 8 drop shafts, and 18 connecting structures for a phase I storage capacity of 212.8 acre-feet (see Figure 2). The four construction projects are as follows:

The Upper Des Plaines No. 20 consisted of 22,000 linear feet of 20 foot diameter tunnels at depths ranging from 130 to 180 feet and 5 drop shafts. This tunnel section can convey 489 cubic feet per second (cfs) of peak sanitary flow to the treatment plant. With an average design dry weather flow of 204 cfs, these tunnels provide some storage for CSO's from smaller storms.

The Upper Des Plaines No. 20A consisted of special connecting structures and lateral sewers to control and divert flow from existing intercepting sewers and CSO outfalls to the drop shafts and tunnels in the system.

The Upper Des Plaines No. 20B consisted of 6000 linear feet of 5 foot diameter earth tunnels to divert sanitary sewage flows from the northern and western portions of the facility area to the O'Hare WRP. These tunnels have a capacity to divert 86 cfs of peak sanitary flow that would have been conveyed to the North Side treatment plant.

FIGURE 2: UPPER DES PLAINES SYSTEM OF TARP




Source:
THE METROPOLITAN SANITARY DISTRICT
OF GREATER CHICAGO

ENGINEERING DEPARTMENT

F.J.K.

The Upper Des Plaines No. 21 consisted of 11,200 linear feet of 16 foot diameter deep rock tunnels, 2,000 linear feet of 9 foot diameter deep rock tunnels, and 3 drop shafts. These tunnels have a capacity to convey 266 cfs of peak sanitary flow. With an average design dry weather flow of 102 cfs, there is some capacity for storage of CSO's.

At the same time the collection system was constructed, the O'Hare WRP was built. It is designed to operate as a two-stage activated sludge process with tertiary filtration. The first phase of plant construction, now completed, is designed to treat a flow of 72 MGD. Space and engineering design considerations have been provided for future construction to expand plant treatment capacity to 96 MGD. As previously mentioned, the treatment plant design includes the capacity for treating stored combined sewer overflows in the peaking requirements. The O'Hare WRP became operational in May 1980. Because of energy considerations, operational changes were made in October 1981. The plant presently provides preliminary and single stage nitrification treatment with chlorination.

Two problems were encountered during the start up of the Upper Des Plaines TARP. During the initial dewatering of the system, a vibration problem was encountered. The discharge pipe from the pumping station caused several floors of the pump station to vibrate. This vibration of the floors was caused by harmonic motion and misalignment of the pipe. The vibration was remedied by realigning and adding extra support to the discharge pipe. The other problem that occurred during the start up of the system was sewage odors coming from the drop shafts. Under normal operation, water flow through the tunnel system causes air to move in the direction of the flow. However, under certain weather conditions, air currents are expelled from the drop shafts. This problem was solved by installing louvers to control the air flow in the system. The air is directed toward the main construction shaft near the treatment plant, where the air is deodorized with ozone and expelled. The experience gained from the handling of this odor problem has been used in both the Mainstream and the Lower Des Plaines systems. Louvers have been installed at potentially sensitive urban drop shaft locations in the Mainstream system and are designed into many drop shafts in the Lower Des Plaines TARP.

## OPERATION

The operation of the Upper Des Plaines TARP is quite flexible. The system has been designed and operated so that sanitary sewage flows into the rock tunnels unrestricted. Combined sewage flow is regulated by control structures on the combined sewer outfalls. The present operation of the system is geared to prevent surcharging of the sanitary sewers. When the water level in the rock tunnels reaches 25 feet above the tunnel invert (60% full), the sluice gates may be closed or throttled down to limit the tunnel inflow to unrestricted separate sanitary sewage flow and dry weather equivalent combined sewer flow. This restriction of the inflow from the combined sewers causes overflows into the waterways. When the tunnel water level is 20 feet above the tunnel invert and falling, the sluice gates are reopened.

An additional amount of flexibility is gained because of the fact that the intercepting sewer of the drainage basin had originally been designed to convey flows to the North Side treatment plant. Two control structures put in to isolate flows from the North Side plant contain gates that may be opened to allow flows through. The flows that can be diverted to the North Side plant are sanitary and/or combined. The system of control structures, which regulate the overflow and/or diversion of flows, is operated by computer at the O'Hare WRP. Information on water levels in the tunnel system, water levels at the gates, gate positions, and other necessary information is available at the plant to allow for decision making by the computer or by the operator in the event of failure of the automatic control system. In the event of power failure, the sluice gates are equipped with hydraulic accumulator devices so they can be closed.

One of the important factors in determining the available tunnel capacity is the dewatering done at the O'Hare WRP. The primary objectives for the pumping procedures are:

(1) maximize the use of tunnel storage volume;
(2) maximize the capture and treatment of flows;
(3) minimize solids deposits in the tunnel by daily scouring; and,
(4) minimize electrical costs for pumping.

Based on these objectives, the pumping rate is dependent upon the time of day and the weather conditions. During dry weather, between 9 a.m. and 10 p.m. when electric costs are at their peak, pumping is limited to 24 MGD until the tunnel level reaches 8-feet. Then the rate is increased up to a maximum of 40 MGD or the third highest value that was used during the current billing period to maintain the 8-foot tunnel level. During dry weather, off peak hours (including weekends and holidays), the tunnels are pumped to draw down the water level as low as possible to promote solids removal. During wet weather, peak periods, flow is limited to 24 MGD until the tunnel level reaches 8 feet. When above the 8 foot level, the pumping is increased incrementally as follows: 10 feet and rising, 60 MGD; 12 feet and rising, 75 MGD; 14 feet and rising, 90 MGD; 16 feet and rising, 120 MGD; 18 feet and rising, 140 MGD. During wet weather, off-peak periods, pumping is increased at a greater rate as follows: 8 feet and rising, 75 MGD; 10 feet and rising, 90 MGD; 12 feet and rising, 120 MGD; 14 feet and rising, 140 MGD. Flows may be increased at a faster rate as dictated by good judgement.

O'Hare WRP operating data from MSDGC's "Monthly Plant Operating Data" for the period of June 1985 to December 1986 have been examined and the system appears to be operating as designed. Tables 2 and 3 summarize this operating data. For most of the significant rainfall events, there has been an associated increase in the total flow into the treatment plant. Even though the plant has a design capacity of 72 MGD, on 33 occasions flows greater than 72 MGD were treated with no appreciable effect on effluent quality. For the rainfalls over one inch, there have been noticeable decreases in the BOD and suspended solids concentration of the raw influent which would be expected with the dilution caused by the stormwater captured by the tunnel system. Despite the increased hydraulic loading, the treatment plant has performed well. There is a proposed NPDES permit for the O'Hare WRP that would limit discharges to monthly averages of 4 mg/l and 5 mg/l for $BOD_5$ and total suspended solids, respectively. For the time period mentioned above, 15 of the 19 months had monthly $BOD_5$ averages of 2 mg/l and 13 of the 19 months had monthly total suspended solids averages of 2 mg/l. The highest monthly average for either parameter was 3 mg/l, still under the permit limits. Also, the O'Hare WRP did not approach the proposed daily maximum concentrations for $BOD_5$ or total suspended solids, 20 mg/l and 24 mg/l, respectively. The highest daily values during these 19 months were 8 mg/l for $BOD_5$ and 12 mg/l for total suspended solids. The proposed NPDES permit also limits discharges of ammonia nitrogen. From April to October, the maximum daily discharge is 1.5 mg/l. From November to March, the ammonia nitrogen discharges are limited to a monthly average of 4 mg/l. Over the 19-month period examined, none of the monthly averages exceeded the limit and the daily maximum was only exceeded 3 times.

## MAINTENANCE

The tunnels and sewers of the Upper Des Plaines TARP are made of materials that the MSDGC feels are permanent in nature. Thus, with the exception of a minimum amount of mechanical equipment, the TARP system is largely maintenance free, requiring only periodic inspections for leaks and blockages. Drop shafts are relatively maintenance free also, requiring an inspection every 1-2 years after initiation of operation and then once every five years afterwards. Control structures are inspected at least once a month and after every rain storm. This seems to be sufficient, as the normally monitored functions at the O'Hare WRP control panel will indicate any problems that occur. Table 4 contains the operating and maintenance costs for the Upper Des Plaines TARP system.

TABLE 2

SUMMARY OF O'HARE WRP FLOW DATA

| | Total Monthly Plant Flow (MG) | Monthly precip (in) | Average Daily Plant Flow (MGD) |
|---|---|---|---|
| June 1985 | 908.9 | 1.72 | 30.3 |
| July | 847.2 | 1.82 | 27.33 |
| August | 973.4 | 3.96 | 31.4 |
| September | 772.0 | 1.45 | 25.73 |
| October | 1109.2 | 3.69 | 35.78 |
| November | 1854.8 | 5.93 | 61.83 |
| December | 1323.50 | 1.53 | 42.69 |
| January 1986 | 849.5 | 0.45 | 27.4 |
| February | 943.6 | 1.88 | 33.7 |
| March | 1118.2 | 1.10 | 36.07 |
| April | 796.5 | 1.72 | 26.55 |
| May | 1104.7 | 3.00 | 35.64 |
| June | 1136.3 | 5.47 | 37.88 |
| July | 1213.9 | 3.00 | 38.16 |
| August | 886.1 | 1.95 | 28.58 |
| September | 1487.9 | 7.68 | 49.60 |
| October | 1543.70 | 1.96 | 49.80 |
| November | 927.40 | 1.10 | 30.91 |
| December | 985.20 | 0.43 | 31.78 |

Source: Data from Monthly Plant Operating Data

TABLE 3

FINAL EFFLUENT DATA FOR O'HARE WRP

| | BOD$_5$ (mg/l) | | | TSS (mg/l) | | | $NH_3$-N (mg/l) | | |
|---|---|---|---|---|---|---|---|---|---|
| | Avg | Min | Max | Avg | Min | Max | Avg | Min | Max |
| June 1985 | 2 | 2 | 3 | 2 | 1 | 4 | 0.2 | 0.1 | 0.4 |
| July | 2 | 2 | 5 | 2 | 1 | 4 | 0.2 | 0.0 | 0.5 |
| August | 3 | 2 | 6 | 3 | 1 | 5 | 0.2 | 0.0 | 0.5 |
| September | 2 | 2 | 2 | 2 | 1 | 5 | 0.2 | 0.0 | 2.2 |
| Occtober | 2 | 2 | 3 | 2 | 1 | 7 | 0.1 | 0.0 | 0.7 |
| November | 2 | 2 | 3 | 2 | 1 | 6 | 0.2 | 0.1 | 0.2 |
| December | 2 | 2 | 3 | 2 | 1 | 6 | 0.3 | 0.1 | 0.8 |
| January 1986 | 2 | 1 | 4 | 2 | 1 | 6 | 0.3 | 0.1 | 0.8 |
| February | 3 | 2 | 8 | 3 | 2 | 8 | 0.6 | 0.1 | 4.5 |
| March | 3 | 2 | 7 | 3 | 1 | 8 | 0.4 | 0.1 | 1.5 |
| April | 2 | 2 | 3 | 2 | 1 | 3 | 0.4 | 0.1 | 1.5 |
| May | 3 | 2 | 7 | 3 | 1 | 5 | 0.4 | 0.0 | 2.1 |
| June | 2 | 2 | 5 | 2 | 1 | 4 | 0.2 | 0.1 | 0.6 |
| July | 2 | 2 | 8 | 2 | 1 | 12 | 0.1 | 0.0 | 0.4 |
| August | 2 | 2 | 2 | 2 | 1 | 9 | 0.1 | 0.0 | 0.6 |
| September | 2 | 2 | 5 | 2 | 1 | 4 | 0.1 | 0.0 | 0.6 |
| October | 2 | 2 | 2 | 2 | 1 | 5 | 0.1 | 0.0 | 0.2 |
| November | 2 | 2 | 2 | 1 | 1 | 3 | 0.1 | 0.0 | 0.3 |
| December | 2 | 2 | 2 | 1 | 1 | 2 | 0.1 | 0.0 | 0.5 |

Source: Data from Monthly Plant Operating Data

TABLE 4

OPERATION AND MAINTENANCE COSTS

UPPER DES PLAINES TARP SYSTEM

| | O&M Costs ($) | | |
|---|---|---|---|
| Category | 1985 | 1986 (Proj.) | 1987 (Proj.) |
| Operating Labor | $ 82,720 | $ 85,970 | $ 87,670 |
| Maintenance Labor | 132,370 | 80,190 | 84,200 |
| Parts and Material | 61,740 | 41,500 | 24,600 |
| Utilities | | | |
| Electricity | 630,000 | 713,000 | 748,000 |
| Others | 28,600 | 28,800 | 31,000 |
| Overhead | 46,390 | 49,280 | 50,760 |
| Total | $981,820 | $998,740 | $1,026,230 |

Source: Data supplied by MSDGC

# CHAPTER 4

## MAINSTREAM TARP SYSTEM

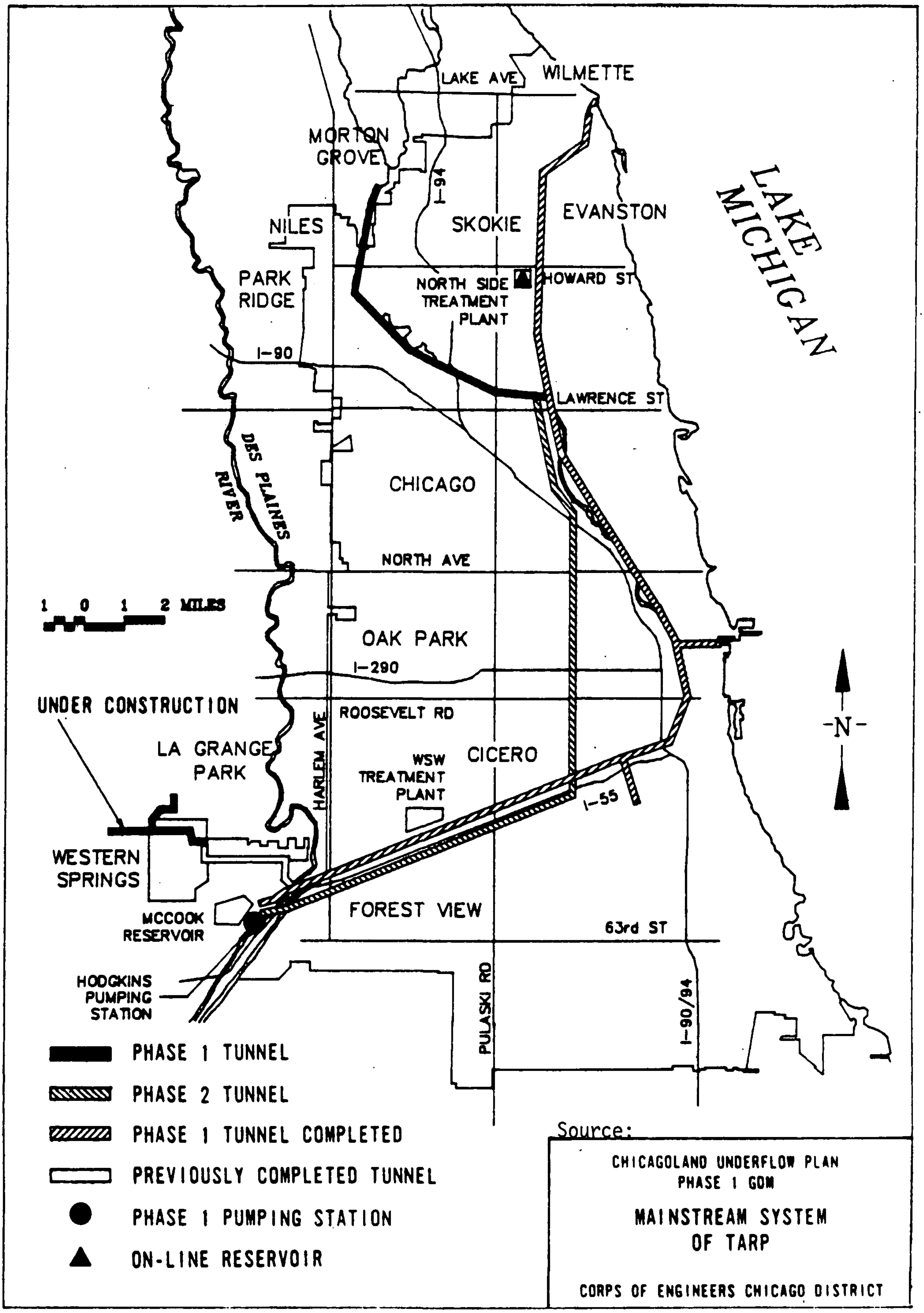
### DESCRIPTION

The TARP Phase I Mainstream system, shown in Figure 3, involves a development of tunnels, and a pumping station. The total length of tunnels is 40.3 miles. Construction of 31.2 miles of tunnels has been completed including 116 drop shafts, 245 connecting structures, and a pumping station which was placed in operation in mid-1985. The remaining segment of the Mainstream system that has yet to be constructed is the North Branch - Chicago River tunnel including connecting structures. Another 3.5 miles of tunnel is currently under construction. This tunnel is an extension to a previously constructed tunnel know as Tunnel 13A. The tunnels range in size from 13 to 33 feet in diameter and were constructed approximately 240 to 300 feet below ground level. The tunnel, positioned predominately in the Joliet formation and away from known fault zones, runs from Wilmette, Illinois (located north of Chicago), south and southwest through Chicago to McCook, Illinois. Combined sewage enters the tunnels through the drop shafts and are carried to the new pumping station, where the flow is pumped to MSDGC's West-Southwest Wastewater Treatment Works (WSWTW).

The pumping station is located in Hodgkins, Illinois and has the capacity to dewater not only the constructed Mainstream tunnels, but also the proposed Des Plaines system and North Branch - Chicago River segment of the Mainstream system. The station provides space for eight pumps, six of which are in operation. Four of the installed pumps have a total capacity of 1,100 cubic feet per second (cfs) (710 MGD) at 330 feet of head, and the remaining two can handle 490 cfs (316 MGD) at 150 feet of head. These pumps are housed in twin pumping chambers 370 feet below ground and can be used in four modes: pump from the tunnels to the treatment plant, pump from the tunnels to the proposed reservoir, pump simultaneously from the tunnels to the reservoir and treatment plant, and pump from the reservoir. The first mode above is currently being used. Vertical single suction pumps with vertical constant speed motors are used exclusively. Pump casings are encased in concrete to support the heavy motors and control vibrations. Pump motor cooling is by a four part ventilation system serving two pumps each. Energy for the 85,000 hp of pumping (58,700 hp high head and 10,970 hp low head) is supplied through two independent substations tying into independent 138 KV transmission lines with switchover capability in case of failure of one system. In addition, batteries and a diesel engine-driven generator are provided to supply highly critical station loads in case of complete electrical failure.

In addition to the facilities building, the pumping station includes trash and grit removal facilities, two cylindrical vent shaft buildings a gate control building, a valve chamber access building, and two 90 foot surge towers.

FIGURE 3



WILMETTE
LAKE AVE
MORTON GROVE
I-94
SKOKIE
EVANSTON
LAKE MICHIGAN
NILES
PARK RIDGE
NORTH SIDE TREATMENT PLANT
HOWARD ST
I-90
LAWRENCE ST
DES PLAINES RIVER
CHICAGO
NORTH AVE
1 0 1 2 MILES
OAK PARK
I-290
UNDER CONSTRUCTION
ROOSEVELT RD
LA GRANGE PARK
HARLEM AVE
WSW TREATMENT PLANT
CICERO
I-55
-N-
WESTERN SPRINGS
MCCOOK RESERVOIR
FOREST VIEW
63rd ST
HODGKINS PUMPING STATION
PULASKI RD
I-90/94
PHASE 1 TUNNEL
PHASE 2 TUNNEL
PHASE 1 TUNNEL COMPLETED
PREVIOUSLY COMPLETED TUNNEL
PHASE 1 PUMPING STATION
ON-LINE RESERVOIR
Source:
CHICAGOLAND UNDERFLOW PLAN
PHASE 1 GDM
MAINSTREAM SYSTEM
OF TARP
CORPS OF ENGINEERS CHICAGO DISTRICT

The performance of the Mainstream system is monitored and controlled by the computer-equipped control center at the MSDGC's WSWTW. Conventional monitoring and control serves not only as a back-up control system of Mainstream TARP, but also controls the operation of the pumping station.

Table 5 identifies the various legs or segments of the Mainstream TARP system and presents basic information including tunnel length and diameter, number of drop shafts and connecting structures, and the tunnel storage capacity. Included in this table is information on the 13A extension segment which is still under construction. It excludes the North Branch - Chicago River segment which is yet to be constructed. The next table, Table 6, gives the percent of the combined sewer overflow BOD that each segment eliminates within the area tributary to the particular segment. Finally, precipitation and flow data for TARP and the WSWTW are given in Table 7. The source of the precipitation data in this table is the National Weather Service, while the remaining data came from the monthly plant operating reports as prepared by MSDGC. This table presents the total flows at the WSWTW and in TARP as well as the precipitation data for each month covering the period from October 1985 to December 1986. The relationship between the precipitation and flow data is illustrated in this table. Table 8 shows the final effluent data of the WSWTW for a similar period. The table gives the monthly minimum, maximum, and average discharge of $BOD_5$, total suspended solids and ammonia nitrogen for each month in the referenced period of time.

## GRANT HISTORY

The first Federal grant to be made on the Mainstream TARP system occurred on June 30, 1975. This grant was made to construct the Wilmette to Addison segment. During the next 3 years, ten additional grants were given to MSDGC to construct the other segments of Mainstream TARP and the pumping station. A total of twenty construction contracts were awarded. Construction of the funded portions of the system was initiated in December 1975 and completed in January 1985. The Mainstream TARP was dedicated in May 1985 and has been in operation for over a year. All the Federal grants awarded are physically completed (except 13A Ext.) and are scheduled for or are under audit review prior to being closed out. The current total grant amount (semi-final) for the system is $755,863,839. This figure may change due to unresolved construction contractor claims, results of audits, and associated administrative and engineering costs. The U.S. Army Corps of Engineers Quarterly Status of Construction Claims for December 1986, shows that six of eleven Federal grants for Mainstream TARP listed in Table 1 have 21 unresolved contractor claims amounting to $26,952,477.

TABLE 5: MAINSTREAM TARP SEGMENTS

| ·AINSTREAM TARP SEGMENT | TRIB. DRAINAGE AREA ACRES/SQ. MI.) | EXIST. POP. SERVED IN C.S. AREA | TUNNEL DIAMETER (FT.) | TUNNEL LENGTH (FT./MI.) | NO. OF DROP SHAFTS | NO. OF CONNECTING STRUCTURES | STORAGE CAPACITY (TUNNELS ONLY) (MG) |
|---|---|---|---|---|---|---|---|
| DISON ST. TO LMETTE HARBOR 2-049-2H & 3-058-2H | 32,842/ 51.3 | 778,237 | 22 & 33 | 51,770/9.8 | 32 | 79 | 215.0 |
| DEN AVE. TO DDISON ST. 5-123-2H & 5-118-2H | 15,808/ 24.7 | 553,386 | 30 | 22,607/4.3 | 18 | 26 | 120.0 |
| OSEVELT RD. TO GDEN AVE. 5-124-2H & 5-119-2H | 4,096/ 6.4 | 105,992 | 13 & 30 | 20,374/3.9 | 17 | 63 | 79.0 |
| .MEN AVE. TO .OOSEVELT RD. 5-124-2H & 5-120-2H | 30,848/ 48.2 | 1,101,963 | 30 | 25,189/4.8 | 26 | 43 | 133.0 |
| NTRAL AVE. TO )AMEN AVENUE 5-126-2H & 3-163-2H | 20,480/ 44.5 | 567,818 | 33 | 26,000/4.9 | 12 | 22 | 166.0 |
| )TH STREET TO :ENTRAL AVENUE '3-160-2H & '3-163-2H | 18,368/ 28.7 | 360,665 | 33 | 18,804/3.6 | 8 | 12 | 120.3 |
| | | | | | | | TOTAL STORAGE CAPACITY (MG) 833.3 |
| | | | | | | | |
| UNDER CONSTRUC-TION) EST LEG-EXT 13A 73-130-2H | 1,217/ 1.9 | 10,100 | 10 | 18,260/3.5 | 5 | 7 | 10.7 |
| | | | | | | | |

TABLE 6
MAINSTREAM TARP FLOW/LOAD EXPECTATIONS

Source: Facilities Planning Study MSDGC Update supplement & summary May 1984

| | estimated yearly* avg overflow lb. of BOD | diverted and collected by project due to tunnel storage volume: overflow | BOD |
|---|---|---|---|
| 1) Addison St. to Wilmette Harbor 72-049-2H & 73-058-2H | 6,260,000 lb | 56% | 85% |
| 2) 59th to Central Avenue 73-160-2H & 13-163-2H | 2,743,000 lb | 56.1% | 84% |
| 3) Central Ave. to Damen Ave. 75-126-2H & 73-163-2H | 4,066,000 lb | 54% | 80.3% |
| 4) Damen Ave. to Roosevelt Rd. 75-125-2H & 75-120-2H | 5,480,000 lb | 53.4% | 80.8% |
| 5) Roosevelt Rd. to Ogden Ave. 75-124-2H & 75-119-2H | 728,000 lb | 84.8% | 84% |
| 6) Odgen Ave. to Addison St. 75-123-2H & 75-118-2H | 2,810,000 lb | 65.7% | 84% |

*Based on calculated average 11.4 inches of rain result in overflows per year.

TABLE 7: MAINSTREAM TARP - PRECIPITATION AND FLOW DATA

| YEAR | MONTH | NORMAL PRECIPITATION (IN. - EST.) | NO. OF PRECIP. EVENTS | PRECIPITATION (IN.) ACTUAL | TARP FLOW (MG) | TOTAL FLOW (MG) |
|---|---|---|---|---|---|---|
| 1985 | OCTOBER | 2.28 | 11 | 4.32 | 2582 | 23542 |
| | NOVEMBER | 2.06 | 20 | 8.22 | 4143 | 31733 |
| | DECEMBER | 2.10 | 11 | 1.49 | 1793 | 22937 |
| YEAR 1985 TOTALS | | 6.44 | 42 | 14.03 | 8518 | 78212 |
| 1986 | JANUARY | 1.60 | 7 | 0.39 | 1020 | 19830 |
| | FEBRUARY | 1.31 | 13 | 2.60 | 2131 | 23424 |
| | MARCH | 2.59 | 8 | 2.49 | 1745 | 25981 |
| | APRIL | 3.65 | 11 | 1.84 | 619 | 20948 |
| | MAY | 3.15 | 10 | 3.11 | 2072 | 26304 |
| | JUNE | 4.08 | 11 | 3.49 | 2972 | 28268 |
| | JULY | 3.63 | 12 | 4.30 | 2207 | 29422 |
| | AUGUST | 3.53 | 6 | 1.11 | 1798 | 23964 |
| | SEPTEMBER | 3.35 | 14 | 7.12 | 3058 | 25791 |
| | OCTOBER | 2.28 | 10 | 3.75 | 2751 | 27039 |
| | NOVEMBER | 2.06 | 11 | 1.41 | 1379 | 23792 |
| | DECEMBER | 2.10 | 7 | 1.09 | 1194 | 22105 |
| YEAR 1986 TOTALS | | 33.33 | 120 | 32.70 | 22946 | 296778 |
| | | | | | | |

NOTES TO TABLE

1. TOTAL FIGURES (OCT. 1985 TO DECEMBER 1986)
   NORMAL PRECIP. (EST.): 39.77 in.
   NO. OF PRECIP. EVENTS: 162
   PRECIPITATION (ACTUAL): 46.73 in
   TARP FLOW (MGD): 31464 MGD
   TOTAL FLOW (MGD): 374990 MGD

TABLE 8: FINAL EFFLUENT DATA FOR WSWTW

| MONTH/YEAR | FINAL EFFLUENT DATA MG/L | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | $BOD_5$ | | | TSS | | | AMMONIA NITROGEN | | |
| | AVE. | MIN. | MAX. | AVE. | MIN. | MAX. | AVE. | MIN | MAX. |
| October 1985 | 5.0 | 2.0 | 9.0 | 6.0 | 4.0 | 8.0 | 1.4 | 0.1 | 3.6 |
| November | 5.0 | 1.0 | 11.0 | 7.0 | 4.0 | 22.0 | 0.8 | 0.0 | 2.7 |
| December | 6.0 | 2.0 | 12.0 | 11.0 | 7.0 | 16.0 | 1.2 | 0.1 | 3.7 |
| | | | | | | | | | |
| January 1986 | 11.0 | 8.0 | 15.0 | 9.0 | 7.0 | 22.0 | 3.6 | 1.7 | 7.9 |
| February | 11.0 | 4.0 | 18.0 | 18.0 | 6.0 | 60.0 | 3.4 | 1.0 | 5.9 |
| March | 12.0 | 7.0 | 23.0 | 30.0 | 6.0 | 152.0 | 5.3 | 1.9 | 9.9 |
| April | 11.0 | 6.0 | 14.0 | 9.0 | 6.0 | 13.0 | 4.8 | 0.2 | 12.7 |
| May | 8.0 | 4.0 | 13.0 | 9.0 | 3.0 | 20.0 | 2.4 | 0.3 | 4.9 |
| June | 4.0 | 2.0 | 11.0 | 5.0 | 2.0 | 8.0 | 0.7 | 0.0 | 2.5 |
| July | 7.0 | 2.0 | 13.0 | 7.0 | 3.0 | 18.0 | 2.8 | 0.2 | 7.9 |
| August | 7.0 | 3.0 | 14.0 | 8.0 | 2.0 | 31.0 | 3.7 | 0.8 | 7.8 |
| September | 8.0 | 3.0 | 14.0 | 9.0 | 3.0 | 22.0 | 4.2 | 0.6 | 8.0 |
| October | 8.0 | 4.0 | 13.0 | 9.0 | 3.0 | 28.0 | 2.0 | 0.1 | 3.9 |
| November | 11.0 | 3.0 | 20.0 | 14.0 | 5.0 | 48.0 | 3.1 | 1.2 | 5.9 |
| December | 12.0 | 6.0 | 20.0 | 11.0 | 6.0 | 20.0 | 5.5 | 2.9 | 8.0 |

Source: Data from Monthly Plant Operating Data

## CONSTRUCTION

Construction on the Mainstream system, exclusive of West Leg - 13A Extention, was performed under 11 different construction grants and 20 individual contracts between June 30, 1975 and January 30, 1985. Included were the 3 contracts for the Mainstream Pumping Station for which construction first started in May 1979.

Construction was initiated by the construction contractors excavating a large (greater than 25 feet) diameter construction shaft down to the specified tunnel elevation. The construction shaft excavations were accomplished by a combination of two methods: drill-and-blast; and machine drill. The bottoms of these shafts were typically oversized so that the tunnel boring machine could be assembled. Additionally, small (3.5 feet) diameter access shafts were installed during construction so that no point in the tunnel was more than 3000 feet from surface access.

The drop shafts, used to convey combined sewer overflow from the high level sewers to the tunnel, are constructed in a similar manner. Drop shafts range in size from 4.5 to 17 feet in diameter, and are of two main types: those with the vertical shaft divided into two sections (one to allow air entrained in the water to be vented); and, those 12 ft. diameter and larger with a separate air vent shaft. All shafts are concrete lined either with precast concrete (9 ft. or smaller) or cast in place concrete. Segments of the main tunnel are lined with a minimum 12-inch thickness of concrete. Concrete for tunnel lining was produced by stationary batching plants located above ground at access shafts. The exception was the use by one contractor of a moveable batching plant situated in the tunnel itself which moved along the tunnel as construction progressed. This method provided no apparent cost benefit to the project. The lining of the tunnels with concrete contact grouting was performed to fill any voids left during the lining operation and to minimize groundwater inflow. Presence of dripping water, wet concrete surfaces and vertical construction joints was used in locating contact grout holes. The amount of grout used varied considerably in each segment of the tunnel depending on the type of rock, number and size of fault lines and bedding planes, number of joints, and amount of structural disturbance. Grouting is heavier where drill and blast occurred in the tunnel and shafts. Grouting is generally effective in reducing groundwater inflow to within specified limits. The joints where shafts connected with the tunnel are especially susceptible to inflow even after grouting. Inflow in the major tunnel portion between Addison Street and 59th Street (tunnel length 21.4 miles) is 1046 gallons per minute (gpm) (1.5 MGD) after grouting was completed, compared with an estimated 2267 gpm before grouting. Target inflow is 50,000 gallons per day per mile of tunnel (1.07 MGD for this tunnel portion). Though substantially reduced, groundwater inflow into the tunnel and shafts exceeded the target rate by 50 percent. Groundwater inflow to the tunnel, even at 1.5 MGD, represents a small increment in terms of the total volume of water processed through TARP.

## BLASTING

Excavation of the drop shafts, contractor shafts and tunnel boring machine setup chamber was done by blasting and/or downbore methods. Drill-and-blast excavation consisted of drilling a pattern of holes, loading the holes with explosives, and detonating the explosives. The construction shafts were located at undeveloped surface areas so that blasting of the shafts and chambers would not result in undesirable effects from blast induced vibrations.

The contract documents required the contractor to hire a qualified seismologist to monitor and record all blast induced vibrations. Recommendations for blasting methods and size of charges, as well as monitoring of the vibrations, were made by VME-NITRO Consult, Inc. Residents and businesses in the vicinity of blasting were notified in advance. A detailed preblast survey was then usually conducted. The survey consisted of documenting the existing conditions of structures located in the proximity of the proposed blasting with photographs and descriptions.

Three out of five contractors (5 contracts on Mainstream) conducted the preblast survey. This was done on Contracts 73-160-2H ($38,000), 75-125-2H ($7,700), and 75-123-2H ($30,800) for a total cost of $76,500. Particular restrictions were enforced on Contract 73-160-2H, which passed thru the Villages of Summit and Forest View. The Village of Forest View passed a more restrictive blasting ordinance after the contract was awarded, resulting in delays to the blasting operations. The Contractor was required to pre-survey every residential and business structure in the Village and guarantee to repair all damage resulting form this work. A $300,000 bond, requested by the Village due to the close proximity of the Village's waterline to the blasting area, was waived when MSDGC and the Contractor agreed to immediately repair any damages that may be caused to the waterline.
In the Village of Summit, the contractor was required to only allow blasting activities from 8:00 A.M. to 8:00 P.M. Additionally, copies of all blasting complaints had to be submitted to the Village Clerk.

At the present time, due to numerous complaints from homeowners regarding alleged damage resulting from blasting, the MSDGC board has set up a temporary committee (Property Owner's Protective Committee) to study ways that this issue may be resolved to the satisfaction of everyone concerned. In addition, alternative methods of excavating the drop shafts are currently being investigated.

## MAINSTREAM OPERATION

Mainstream TARP collects and stores for subsequent treatment the combined sewer overflows from a large part of the Chicago area. The tunnel system presently consists of 31.2 miles of tunnel with an associated storage capacity of 3020 acre feet. Any flow exceeding the capacity of the tunnel system is discharged untreated to the local waterways. To effectively operate this system, 128 collecting, 66 regulating, and 3 control structures are used to divert flows to 115 TARP drop shafts. The system also includes 110 interceptor connections to the tunnel system.

Data on the Mainstream TARP is included in the MSDGC "Monthly Plant Operating Data" as part of the WSWTW Chapter. This data which includes WSWTW process streams (influent, effluent, pumpage, etc.), only includes the daily volume of pumpage from Mainstream TARP. Qualitative data is not regularly collected but several short duration special studies collected a minimal amount of information.

Because the present storage capacity of the system is exclusively that of the tunnel, the processing flow rate at the WSWTW establishes allowable tunnel inflow rates and dewatering schedules. The tunnel inflow is regulated by sluice gates which are controlled and monitored at the WSWTW process control building through the supervisory control and monitoring system.

The operation of the tunnel system occurs in two phases:

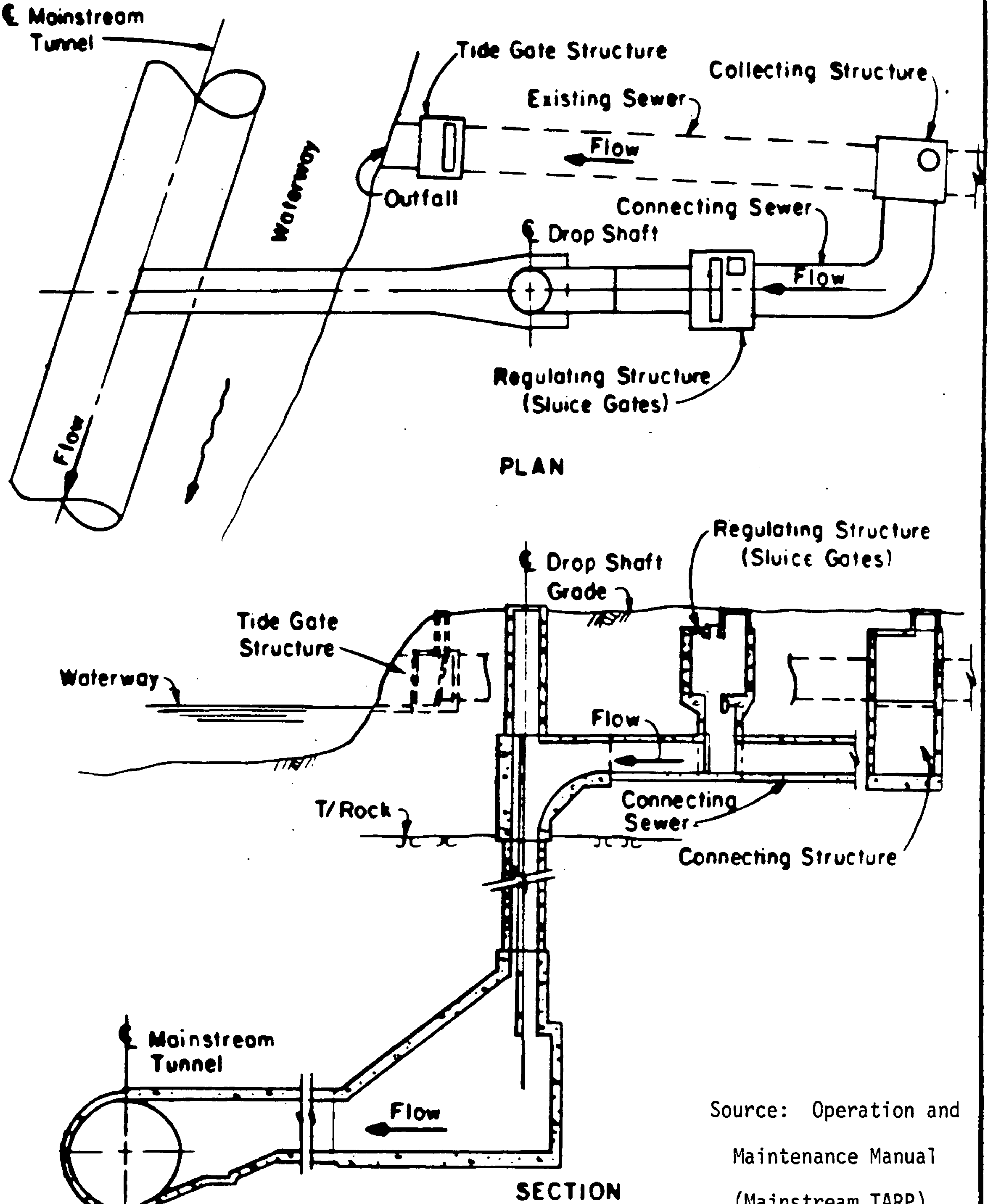
(1) tunnel filling and flushing; and,
(2) pumping.

Tunnel filling during a storm event is initiated either after an overflow condition exists and the WSWTW process control building operator opens the sluice gates to divert flow into the tunnel (Figure 4) or when CSO is diverted through uncontrolled tunnel diversion structures. All controlled sluice gates are normally kept closed to avoid unnecessary diversion of dry weather flow to TARP. During the initiation of a rainfall event, the flow in the sewers increases until at a prescribed level, flow is channeled through the collecting structure to the CSO outfall sewer. Sufficient flow through the outfall sewer opens the tide gate which activates an alarm warning light on the TARP control panel located at the WSWTW, alerting the operator that the outfall is discharging to the river. If there is sufficient storage capacity within the tunnel, the operator will open an appropriate number of sluice gates (one or more depending on location) to divert sewage from the overflow to the tunnel via the drop shaft. This is usually sufficient to stop the overflow. If after 20 minutes the tide gate alarm light remains lit, additional sluice gates are opened. This 20-minute cycle continues until the tide gate closes.

This prescribed operating procedure virtually assures that some amount of the combined sewers' "first flush" of pollutants enters the receiving waters prior to diversion to the tunnel. The amount of this discharge will vary depending upon the activities of the operator at the time of initiation of an overflow, as well as the time of response in order to open multiple sluice gates in sequence as an overflow event proceeds. Though potentially low in volume, the initial "first flush" of the combined sewer system typically has elevated suspended solids and organic levels. MSDGC has estimated that this represents less than 1.0 percent of the combined sewage pollution load.

Diversion of sanitary sewage to the tunnel can also be accomplished when individual interceptor sewer or WSWTW plant capacity is exceeded. This can be done by opening the tunnel drop shaft sluice gates in one of thirteen areas

FIGURE 4




Source: Operation and Maintenance Manual (Mainstream TARP)

PROJECT: TUNNEL AND RESERVOIR PLAN
THE METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO.

TYPICAL COMBINED SEWER OUTFALL CONNECTION TO MAINSTREAM TUNNEL

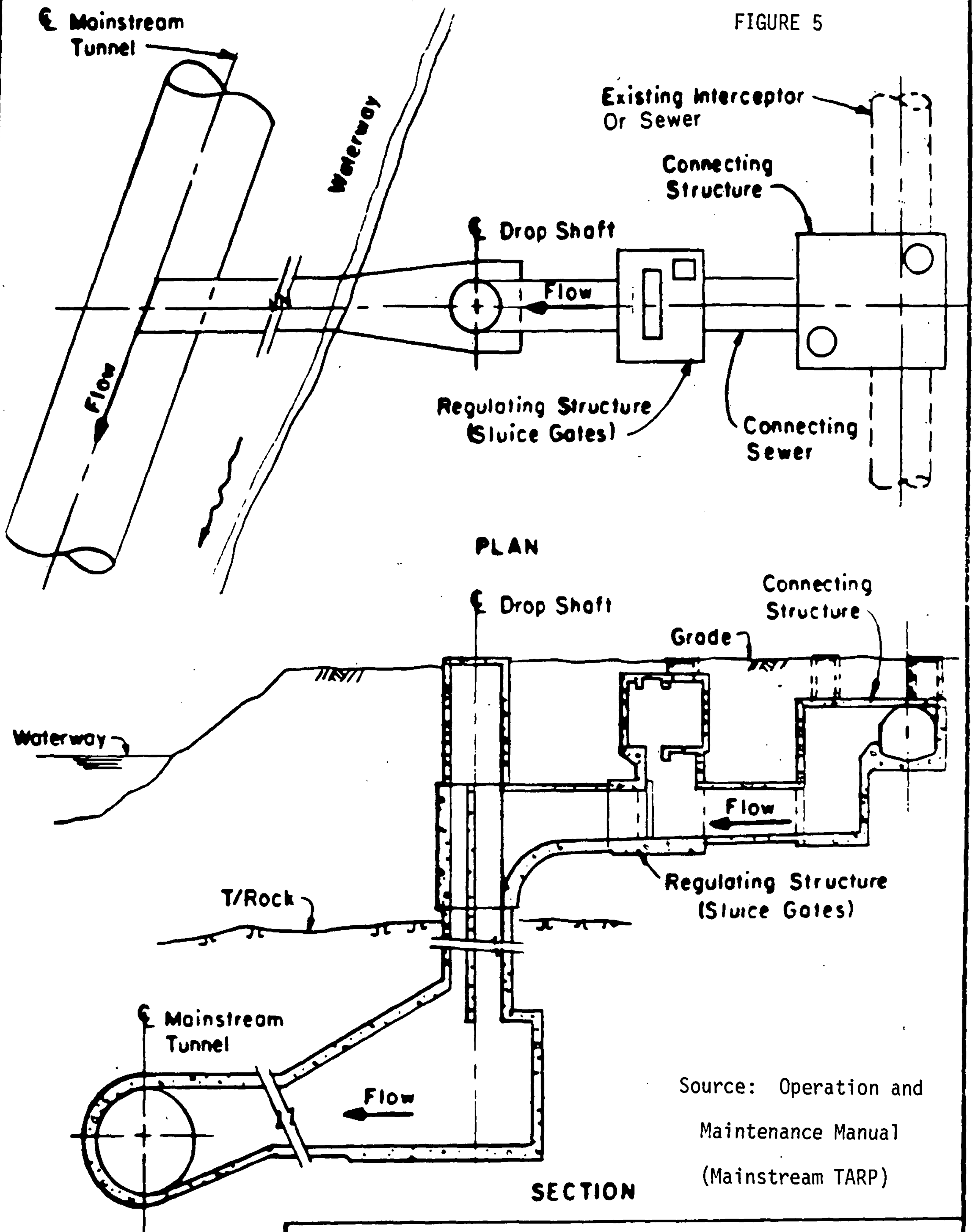
(Figure 5). This is a function of TARP which has never been used but can protect the system from sporadic treatment plant overloads and/or isolated dry weather bypassing.

The diversion of wet weather flow continues until certain tunnel levels are reached. For rains forcasted to be less than one inch, the pump stations at Racine and Lawrence Avenues are activated at 40% tunnel capacity, pump ing their overflows into the waterways. At 50% capacity, all controlled sluice gates are closed, starting with the northern most gates. Inflow to TARP continues from the uncontrolled gates, which account for 10% of the total flow to the tunnel system. Overall, there are 52 ungated locations on the Mainstream system. Of these, the MSDGC is putting in slide gates on the 15 largest flow contributors, each presently allowing 150 cfs or greater. Table 9 contains information on the ungated Mainstream drop shafts. For rains forecasted to be greater than 1-inch, all controlled inlets into TARP remain closed. The only flow into TARP is from the uncontrolled dropshafts. This operation strategy is a result of past operating experiences where geysering problems were caused by TARP filling up too quickly. The geysering was the result of water being entrained in the air vented from the tunnel during filling. The Mainstream Operation and Maintenance Manual, developed by Harza Engineering Company, recommended closing the sluice gates when the tunnel is full. MSDGC is having St. Anthony Falls Laboratory model the hydraulics of the Mainstream TARP in order to get a better idea of how the system operates. This knowledge will be utilized to modify the operating procedures to operate TARP more efficiently. The modeling is expected to be completed in early 1988.

Mainstream TARP is dewatered by the Mainstream Pumping Station, located near the junction of the Mainstream and the proposed Lower Des Plaines tunnel systems. The pumping station has a total capacity of 1100 cfs at 330 feet of head and 490 cfs at 150 feet of head. The captured combined sewage is pumped to WSWTW for treatment. According to the Mainstream Operation and Maintenance Manual, a 60-hour dewatering criterion has been established for the tunnels. Primary considerations in the dewatering of TARP are the available capacity at WSWTW to treat the extra flow and the necessity of having storage capacity available for upcoming rainfall events. Peak capacity at WSWTW, with all four aeration batteries working, is 1440 MGD. The MSDGC targets peak flow normally used at 1200 MGD. However, construction at WSWTW has temporarily reduced the available treatment capacity to 1080 MGD peak flow, with a normally used target of 900 MGD peak.

Another major consideration is the high electricity cost to run the Mainstream pumps. Unless conditions dictate otherwise, the pumping, which is ideally controlled at the WSW process control building but can also be controlled at the pumping station, is scheduled to take advantage of off-peak electric rates which are less than one-half of the peak energy rate (2.756 vs 5.811¢ per kilowatt hour). This energy savings represents

FIGURE 5




Source: Operation and Maintenance Manual (Mainstream TARP)

PROJECT: TUNNEL AND RESERVOIR PLAN
THE METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO.

TYPICAL INTERCEPTOR CONNECTION TO MAINSTREAM TUNNEL

TABLE 9: MAINSTREAM TARP - Ungated Locations

| Category | Total Flow (cfs) | % of Total Flow | Locations | Cumulative Location |
|---|---|---|---|---|
| 1 - >200 cfs | 2827 | 49 | 10 | 10 |
| 2 - 150 - 200 | 844 | 15 | 5 | 15 |
| 3 - 100 - 150 | 685 | 12 | 5 | 20 |
| 4 - 50 - 100 | 990 | 17 | 14 | 34 |
| 5 - <50 | 410 | 7 | 17 | 51 |

Cat. 1 includes 300 cfs @ Howard Street connection still under construction several hundred thousand dollars per year in operating costs. The off-peak times are 10:00 p.m. to 9:00 a.m. on weekdays, anytime on weekends, holidays, and the Mondays or Fridays associated with Tuesday/Thursday holidays. Normal dewatering during dry weather is performed during these off-peak times. During wet weather, the same schedule is followed except the starting time on weekdays is moved up to 5:00 p.m. An item that is taken into account in the dewatering process is the hydrogen sulfide generated by the stored combined sewage. Hydrogen sulfide poses problems from the standpoint of being a poisonous gas as well as the potential for corrosion in the sewer and at the treatment plant. Hydrogen sulfide is formed when the sewage is retained between pumpings in the tunnels from the Mainstream Pumping Station to the WSWTW. When this combined sewage is pumped, hydrogen sulfide is detected at WSWTW. If the hydrogen sulfide levels are a problem during pumping, the dewatering is cut off at 7:00 a.m., before many of the WSWTW dayshift begin work. MSDGC has attempted to remedy the hydrogen sulfide problem by injecting oxygen into the pumped sewage. This has been found to help after the pumping has started. However, the concentration of hydrogen sulfide is still high at the onset of pumping. MSDGC is looking into other alternatives to control the hydrogen sulfide. One of these methods being considered is the addition of hydrogen peroxide to the stored sewage.

## MAINSTREAM PERFORMANCE

The performance of Mainstream TARP has been a result of the procedures described earlier. The system has not been operating as originally anticipated for three reasons. First, an unknown amount of combined sewer overflow is discharged to the receiving water prior to diversion to TARP. Second, actual operating experience has required the modification of the way the tunnel system is operated during large storm events due to the geysering problem. Third, construction at the WSWTW has temporarily reduced the capacity available to dewater TARP.

Over the 15 months on which this report is based, 31,464 MG of stored combined sewage has been pumped to WSWTW. Over this time period, 46.73 inches of rain has fallen in the Mainstream drainage area. There has been an increase in the solids handled at WSWTW from approximately 400 tons per day for 1982-84 to approximately 436 tons per day in 1985, with TARP in operation only part of the year, to approximately 500 tons per day in 1986 with TARP in operation the full year. This increase in solids is partially due to the operation of Mainstream TARP and to the increased recycle from the treatment plant imhoff tank and sludge digester.

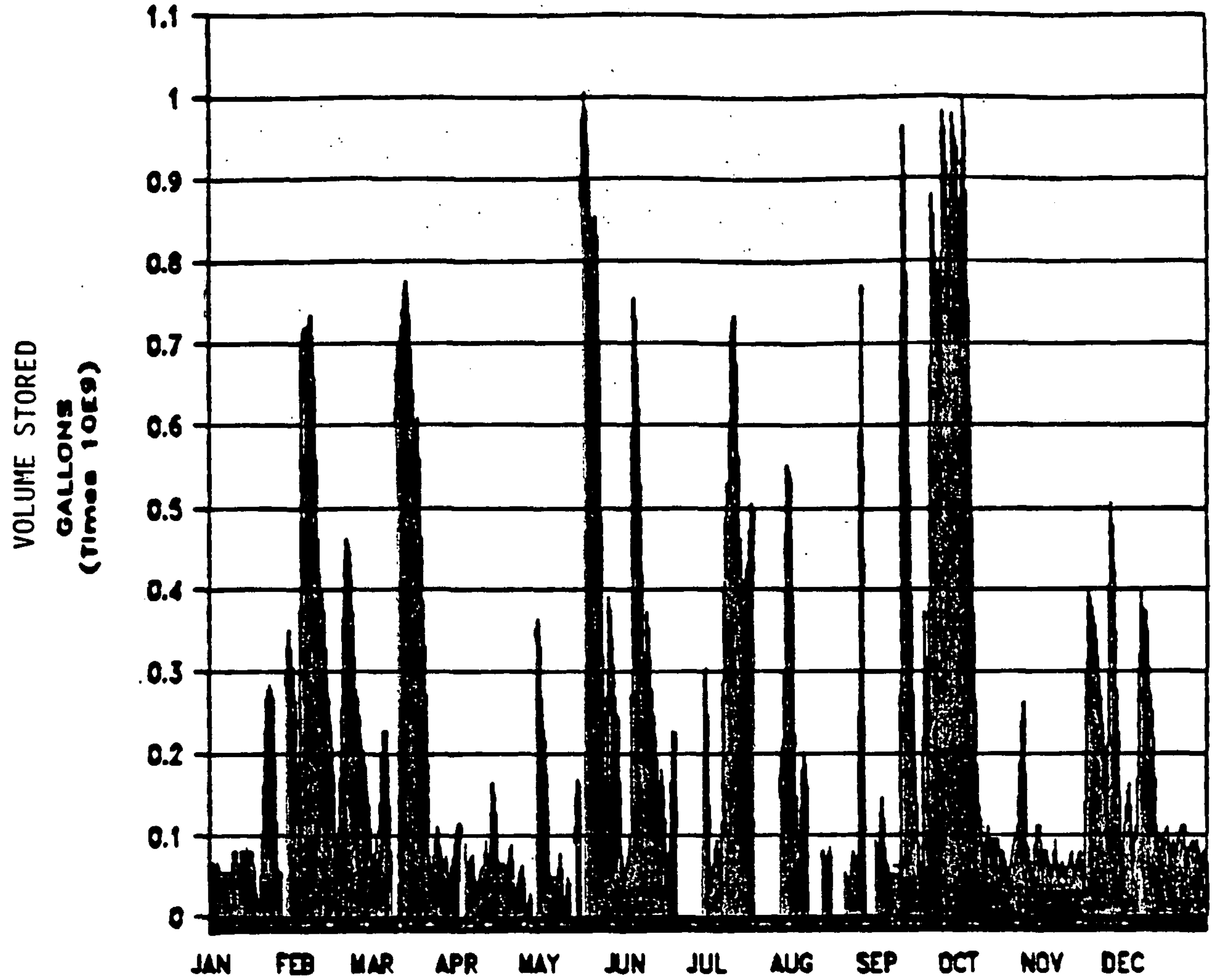
Pumpback from TARP is limited by the operator to available hydraulic capacity at the plant. This ensures that total flow to the plant is within the design limits or available capacity based upon currently ongoing construction projects. As such, there appears to be no degradation of effluent as a result of TARP pumpbacks. On the contrary, pumping during the off-peak electrical rate hours (nights and weekends) helps to equalize diurnal flow variations to the plant which potentially results in more consistent operation.

The main detriment to TARP pumpback at non peak energy rate times is that the tunnels are not dewatered within the 60-hour dewatering criterion originally established for the system. Figure 6 illustrates the volume of storage capacity available in Mainstream TARP for 1986. For reference, a plot of the rainfall events is also included in the figure. As can be seen, the TARP tunnels are filled for extensive periods of time. However, full tunnel storage capacity is generally available except for extreme wet weather conditions such as those that occurred in October 1986. As such, it appears that the operating cost savings of the slower tunnel dewatering rate would have only a minimal effect on potential CSO discharges over an extended period of time.

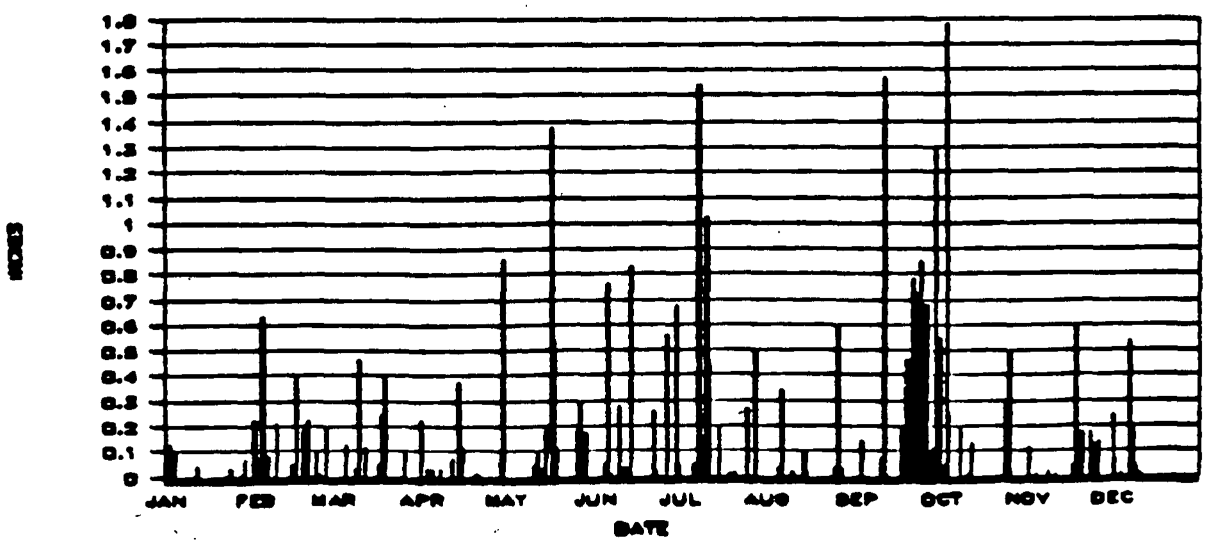
# MAINSTREAM TUNNEL VOLUME STORED

FIGURE 6

1986




RAINFALL




NOTES: Tunnel storage volumes include the Mainstream, 13A, Nashville Ave., and Lawrence Ave. tunnels and shafts.

Discontinuity of Mainstream Tunnel Volume Stored graph results from unavailable data points.

CHAPTER 5

## CALUMET TARP SYSTEM

### DESCRIPTION

The present TARP Phase I system for the Calumet area consists of 9.2 miles of deep tunnels (27.7 miles yet to be completed for a total of 36.9 miles of deep tunnels), the Calumet TARP pumping station, and the Calumet treatment plant (see Fig. 7 and Table 10). A second pumping station (yet to be constructed) will be located near the O'Brien Locks. This station will provide supplemental conveyance capacity to prevent combined sewer overflows from entering the waterway on the Lake Michigan side of the O'Brien Locks. The present storage capacity of the Phase I Calumet TARP tunnel system is 180 MG. When the tunnel system is completed, it will have the capacity to store more than 540 MG of untreated wastewater. The tunnels are sized to permit limited spillage to the Little Calumet River and the Calumet - Sag Channel. None of the overflow will be allowed to spill into that portion of the Little Calumet River upstream of its junction with the Calumet - Sag Channel. Two-thirds of the Calumet TARP tunnel system has controls (i.e., for 2/3 of the system, flows to the tunnels can be controlled by means of automated sluice gates at the drop shafts to the TARP tunnels).

There are 5 connections from intercepting sewers to the Calumet TARP tunnels that discharge wet weather flow into TARP, with no built-in capability to limit these flows. These connections continue to discharge into the Calumet TARP tunnels 3-4 days after rain events due to rainwater storage capacity in the local intercepting sewer. In addition, the Calumet TARP tunnels are also currently accepting dry weather flows from a recently completed (November 1986) tunnel extension. This dry weather flow is estimated to be about 3-5 MGD. It is anticipated that when the Calumet TARP tunnel system is fully operational, some dry weather flow will be continuously entering the system due to the overloaded capacity of the area's intercepting sewers.

### CONSTRUCTION

The construction of the Calumet TARP pumping station, as well as, the Calumet TARP tunnels has generally proceeded on-schedule. The Calumet TARP pumping station went on-line in October 1985. The station was scheduled to become operational in early 1985, but vibrational problems with the pumps had to be resolved before commencing operations.

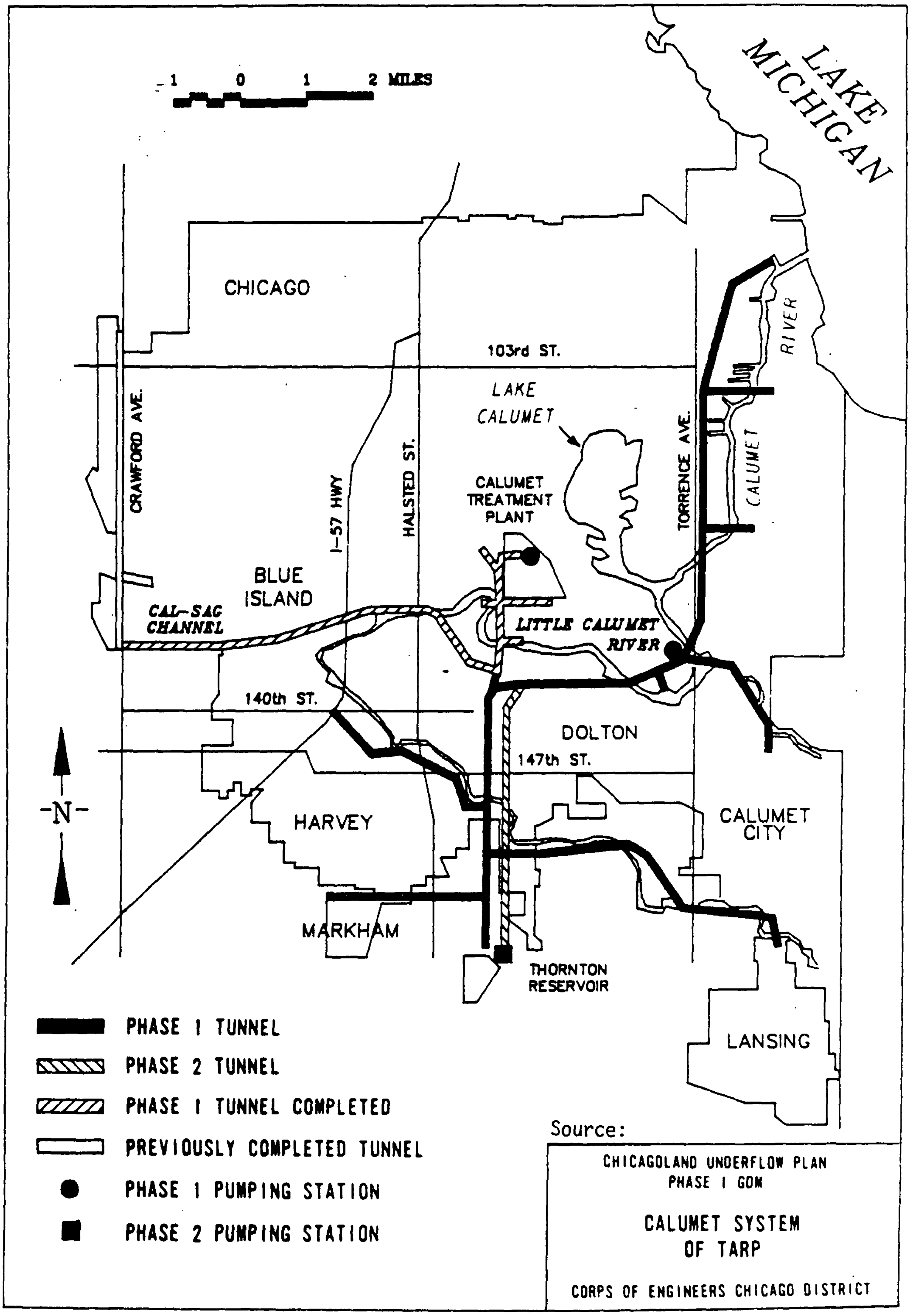

LAKE MICHIGAN
1 0 1 2 MILES
CHICAGO
103rd ST.
LAKE CALUMET
CRAWFORD AVE.
I-57 HWY
HALSTED ST.
CALUMET TREATMENT PLANT
TORRENCE AVE.
CALUMET RIVER
BLUE ISLAND
CAL-SAG CHANNEL
LITTLE CALUMET RIVER
140th ST.
DOLTON
147th ST.
-N-
HARVEY
CALUMET CITY
MARKHAM
THORNTON RESERVOIR
LANSING
PHASE 1 TUNNEL
PHASE 2 TUNNEL
PHASE 1 TUNNEL COMPLETED
PREVIOUSLY COMPLETED TUNNEL
PHASE 1 PUMPING STATION
PHASE 2 PUMPING STATION
Source:
CHICAGOLAND UNDERFLOW PLAN
PHASE I GDM
CALUMET SYSTEM OF TARP
CORPS OF ENGINEERS CHICAGO DISTRICT

TABLE 10

CALUMET TUNNEL SYSTEM (CRAWFORD AVENUE TO PUMPING STATION)

CONTRACTS 73-287-2H and 73-273-2H

I. General Data

| | |
|---|---|
| Design Area | 27,450 acres/42.9 sq. mi. |
| Existing Population Served in Combined Sewered Area | 417,300 |
| Yearly Average Rainfall | 33.2 inches |
| Yearly Average Overflow | 11.4 inches |
| Yearly Average BOD in Overflow | 4,880,000 pounds |
| Runoff Captured by Project | 59% |
| BOD Captured by Project | 78% |
| Tunnel Storage Capacity | 113,400,000 gal. = 562,000 cu. yds. - 348 acre - feet = 0.5 in. of runoff |

II. Contract 73-287-2H (Tunnels and Shafts)

Estimated Construction Time = 1,684 days/4.6 years

Tunnel Sizes

| | | |
|---|---|---|
| 21' - 0" | Dia. (unlined) | 42,029 feet/7.96 miles |
| 21' - 0" | Dia. (lined) | 370 feet/0.07 miles |
| 12' - 0" | Dia. (unlined) | 317 feet/0.06 miles |
| 9' - 0" | Dia. (unlined) | 5,491 feet/1.04 miles |
| | | 48,207 feet/9.13 miles |

| | |
|---|---|
| Drop Shafts - | 17 |
| Access Shafts - | 4 |
| Construction Shafts - | 1 |
| Total | 22 |

III. Contract 73-273-2H (Connecting Structures)

Estimated Construction Time = 1,340 days/3.7 years

Type of Connection

| | |
|---|---|
| Drop Shaft Connection | 16 |
| Drop Shaft Connection and Existing Interceptor Relief | 6 |
| Overflow Connection to Existing Interceptor | 6 |
| Total | 28 |

Source: Facilities Planning Study - MSDGC
Update Supplement and Summary, May 1984

## OPERATION

The operating goal is to dewater the Calumet TARP system daily during the 12-8 a.m. time slot in order to equalize the flows to the Calumet treatment plant. At the present time, dewatering is limited by insufficient treatment plant capacity. The capacity of the Calumet plant during the study period was at an average dry weather flow of 236 MGD, an extended dry weather flow of 250 MGD, and a maximum flow (handled on a limited basis) of 280 MGD. The current set point for dewatering TARP is 245 MGD. That is, if all incoming flows to the Calumet plant are less than 245 MGD, the Calumet TARP tunnels will be dewatered until a flow, to the plant, of 245 MGD is achieved. The completion of the Calumet wastewater treatment plant expansion has been delayed by the unforeseen circumstance of the bankruptcy of the blower construction contractor. The tentative schedule for bringing the capacity of the Calumet plant up to 1.5 times the average dry weather flow in order to be able to treat all incoming flows, calls for aeration capacity to be installed by the fall of 1987. Once the aeration capacity is installed, it will take about 6 months before efficient operation of the total system can be expected. The ultimate design flow of the Calumet treatment plant is 354 MGD. This is the required capacity of the Calumet treatment plant to accommodate a TARP dewatering rate of 118 MGD.

The operating procedures for the Calumet TARP tunnels in terms of controlling flows into TARP, as well as dewatering, are contained in the document: "Operational Plan - Supplemental to Operation Manuals - Tunnel and Reservoir Plan, Calumet System (March 1983)." Due to the inadequate treatment capacity of the Calumet treatment plant at this time, however, the Calumet TARP system is not being operated according to the procedures set forth in this manual. As mentioned previously, if incoming flows to the Calumet treatment plant are less than 245 MGD, dewatering of the TARP tunnels will commence until a 245 MGD rate is achieved. As there is continuous inflow of dry weather flows to the TARP tunnels, this situation has resulted in flows being bypassed. From October 1985 (when the Calumet TARP tunnels became operational) to November 1986, about 86% of the total flow pumped from the Calumet TARP tunnels has been bypassed to the Little Calumet River.

Data on the Calumet treatment plant process streams (influent, effluent, pumpage, etc.) is collected daily and compiled in a monthly operating report (see Table 11). Beginning in September 1986, data from the operation of the Calumet TARP system has also been included in the reports. This data consists of electrical energy consumption by the Calumet TARP pumping station and pumpage rates from the TARP tunnels to either the treatment plant or the Little Calumet River. The MSDGC has also compiled separate records of pumpage rates from the Calumet TARP tunnels beginning in October 1985. This data includes number of hours pumps (in TARP pump station) were operated, as well as the rate of flow to either the plant or the river on a monthly basis (see Table 12). Qualitative data (BOD and SS) on flows pumped from the Calumet TARP tunnels is collected Monday thru Friday by grab sampling (see Table 13).

TABLE 11

CALUMET EFFLUENT DATA

| MONTH/YEAR | $BOD_5$ (mg/l) | | | TSS (mg/l) | | | $NH_3$ - N (mg/l) | | |
|---|---|---|---|---|---|---|---|---|---|
| | AVE. | MIN. | MAX. | AVE. | MIN. | MAX. | AVE. | MIN | MAX. |
| October 1985 | 19 | 9 | 33 | 21 | 11 | 65 | 11.7 | 5.2 | 16.3 |
| November | 18 | 11 | 30 | 13 | 6 | 24 | 5.6 | 1.1 | 12.9 |
| December | 27 | 12 | 37 | 20 | 11 | 27 | 7.5 | 1.6 | 11.5 |
| | | | | | | | | | |
| January 1986 | 32 | 19 | 76 | 26 | 17 | 37 | 12.9 | 8.6 | 17.0 |
| February | 18 | 12 | 24 | 23 | 13 | 35 | 12.9 | 9.0 | 18.2 |
| March | 17 | 11 | 24 | 21 | 9 | 40 | 12.5 | 9.1 | 21.2 |
| April | 23 | 12 | 34 | 23 | 16 | 39 | 14.3 | 9.2 | 20.4 |
| May | 21 | 12 | 33 | 23 | 12 | 38 | 15.8 | 7.2 | 20.6 |
| June | 20 | 11 | 39 | 17 | 5 | 48 | 11.1 | 5.8 | 18.0 |
| July | 15 | 7 | 28 | 10 | 5 | 32 | 6.5 | 3.2 | 11.6 |
| August | 15 | 9 | 25 | 11 | 5 | 21 | 8.2 | 3.0 | 54.0 |
| September | 20 | 14 | 35 | 16 | 9 | 32 | 9.2 | 3.0 | 13.0 |
| October | 19 | 11 | 28 | 11 | 6 | 17 | 5.7 | 1.2 | 11.3 |
| November | 27 | 10 | 45 | 21 | 15 | 42 | 6.5 | 2.1 | 10.0 |
| December | 24 | 12 | 31 | 14 | 4 | 22 | 5.4 | 2.5 | 10.0 |

TABLE 12

CALUMET TARP PUMPING

1985

| MONTH | PUMP | MILLION GALLONS FLOW TO | | |
|---|---|---|---|---|
| | HOURS | PLANT | RIVER | TOTAL |
| OCT | 129.6 | 68.5 | 257.9 | 326.4 |
| NOV | 163.7 | 267.2 | 0 | 267.2 |
| DEC | 7.6 | 12.8 | 0 | 12.8 |
| | | 1986 | | |
| JAN | 36.7 | 75.9 | 0 | 75.9 |
| FEB | 81.1 | 105.3 | 108.3 | 213.6 |
| MAR | 287.6 | 0 | 738.1 | 738.1 |
| APR | 128.5 | 0 | 202.7 | 202.7 |
| MAY | 262.0 | 0 | 458.7 | 458.7 |
| JUN | 370.4 | 0 | 669.4 | 669.4 |
| JUL | 353.6 | 0 | 969.8 | 969.8 |
| AUG | 97.7 | 0 | 247.6 | 247.6 |
| SEPT | 337.1 | 103.6 | 774.3 | 877.9 |
| OCT | 338.9 | 118.1 | 748.0 | 866.1 |
| NOV | 273.1 | 152.4 | 468.2 | 620.6 |

TABLE 13 CALUMET TARP DISCHARGE QUALITY

Below is listed laboratory data generated in 1986 on the Tarp samples collected.

| | pH | SS | VSS | BOD |
|---|---|---|---|---|
| 12/13/86 | NA | 57 | 33 | 50 |
| 12/11/86 | 7.6 | 46 | 30 | 75 |
| 12/4/86 | 7.1 | 33 | 24 | 60 |
| 12/1/86 | NA | 180 | 120 | 40 |
| 11/28/86 | NA | 80 | 50 | 110 |
| 11/25/86 | 7.3 | 340 | 160 | 200 |
| 11/24/86 | 7.3 | 32 | 20 | 51 |
| 11/19/86 | 7.2 | 170 | 120 | 67 |
| 11/14/86 | 7.2 | 46 | 28 | 81 |
| 11/5/86 | NA | 118 | 78 | 123 |
| 11/2/86 | NA | 400 | 330 | 375 |
| 10/16/86 | NA | 72 | 68 | NA |
| 10/15/86 | 7.3 | 76 | 38 | 38 |
| 10/14/86 | 7.0 | 84 | 54 | 178 |
| 10/13/86 | 7.6 | 116 | 62 | NA |
| 10/7/86 | 7.2 | 2130 | 1630 | NA |
| 10/6/86 | 7.4 | 154 | 66 | NA |
| 10/1/86 | 7.6 | 74 | 50 | 69 |
| 9/26/86 | 7.2 | 26 | 18 | 98 |
| 9/18/86 | NA | 32 | 16 | 135 |
| 9/17/86 | NA | 290 | 194 | NA |
| 8/19/86 | 7.3 | 74 | 44 | 86 |
| 8/4/86 | NA | 46 | 40 | 85 |
| 8/1/86 | NA | 184 | 102 | 170 |
| 7/31/86 | NA | 39 | 28 | 75 |
| 7/25/86 | NA | 144 | 74 | 110 |
| 7/21/86 | 7.5 | 118 | 76 | 71 |
| 7/20/86 | 7.4 | 610 | 290 | 86 |
| 7/19/86 | NA | 160 | 66 | 123 |
| 7/18/86 | NA | 118 | 60 | 83 |
| 7/17/86 | NA | 496 | 216 | 115 |
| 7/16/86 | 7.2 | 152 | 78 | 107 |
| 7/11/86 | 7.5 | 61 | 37 | 44 |
| 7/7/86 | 7.2 | 166 | 106 | 77 |
| 6/30/86 | 7.1 | 92 | 64 | 130 |
| 6/29/86 | 7.1 | 396 | 210 | 173 |
| 6/5/86 | 7.2 | 86 | 44 | 43 |
| 5/31/86 | 7.3 | 51 | 34 | NA |
| 5/30/86 | 7.4 | 126 | 62 | 105 |
| 5/29/86 | 7.5 | 73 | 42 | 97 |
| 5/28/86 | 7.2 | 132 | 102 | 43 |
| 5/27/86 | 7.3 | 150 | 68 | 60 |
| 5/20/86 | 7.5 | 102 | 62 | 116 |
| 5/14/86 | 7.6 | 74 | 52 | 76 |
| 5/1/86 | NA | 215 | 151 | 101 |
| 4/25/86 | NA | 40 | 31 | NA |
| 4/2/86 | 7.3 | 258 | 142 | NA |
| 4/1/86 | 7.6 | 98 | 71 | 156 |
| 3/31/86 | 6.7 | 43 | 28 | 94 |
| 3/28/86 | 7.4 | 36 | 12 | 73 |
| 3/26/86 | 7.3 | 54 | 36 | 84 |
| 3/20/86 | 6.6 | 47 | 31 | 63 |
| 3/14/86 | 7.6 | 21 | 19 | 13 |
| 3/13/86 | NA | 46 | 23 | 61 |
| 3/12/86 | 7.8 | 35 | 21 | 47 |
| 3/11/86 | 7.6 | 31 | 21 | 70 |
| 3/7/86 | 7.2 | 89 | 73 | 20 |
| 3/6/86 | 7.5 | 66 | 40 | 94 |
| 3/5/86 | 8.0 | 33 | 26 | 86 |
| 3/4/86 | 8.0 | 67 | 49 | 104 |
| 3/3/86 | 7.3 | 25 | 19 | 42 |

The projected operations and maintenance (O&M) costs for the Calumet TARP system (see Table 14) will increase as more of the system comes on-line and becomes fully operational. As can be seen, the biggest expense is for electricity which accounts for about 64% of O&M costs in 1986 and 74% of O&M costs in 1987.

PERFORMANCE

At this time, no judgement can be made as to the effect Calumet TARP dewatering will have on the performance of the Calumet treatment plant. The plant is currently being upgraded to include additional aeration capacity in order to accommodate the additional flows resulting from TARP dewatering activities. Also, the treatment plant will be expanded to an ultimate design capacity of 354 MGD, so that all dry weather flows, as well as anticipated flows resulting from TARP dewatering, can be treated to the levels indicated in Calumet's NPDES permit.

TABLE 14

OPERATION AND MAINTENANCE COSTS

CALUMET TARP SYSTEM

(Projected)

| Category | O & M Costs ($) 1986 | 1987 |
| --- | --- | --- |
| Operating Labor | 167,500 | 190,000 |
| Maintenance Labor | 119,200 | 131,000 |
| Parts and Material | 74,300 | 62,000 |
| Utilities | | |
| Electricity | 744,000 | 1,240,000 |
| Water | 30,000 | 35,000 |
| Overhead | 35,000 | 20,000 |
| TOTAL | 1,170,000 | 1,678,000 |

Source: Data supplied by MSDGC

CHAPTER 6

# GROUNDWATER MONITORING

## INTRODUCTION

This chapter evaluates the groundwater monitoring programs implemented by MSDGC for each of the three TARP Phase I segments examined in this project. The Environmental Impact Statement (EIS) for each segment recommended a groundwater monitoring program to evaluate the impacts of infiltration and exfiltration that might occur during the operation of the tunnels. This chapter describes the monitoring programs recommended by the EIS's, the proposed MSDGC programs, and the programs as implemented by MSDGC. Based on a review of the data collected and reported by MSDGC, this chapter assesses the adequacy of the existing programs and also makes recommendations for improving the effectiveness of these programs in monitoring impacts to groundwater from the TARP Phase I projects.

The TARP tunnels are located within the Silurian Dolomite system. This system is considered tight and very impervious. Concrete lining and grouting to seal joints and bedding planes were proposed to provide a barrier to the surrounding groundwater. nfiltration of water into the tunnels due to hydraulic pressure outside the tunnels was identified during planning as one potential problem. Infiltration can lead to lowering of the local water table and decreased tunnel capacity. Without grouting, the infiltration was estimated to be as high as 1.4 MGD/mile (average 0.5 MGD/mile.) This could represent up to 15% of the tunnel capacity. The design limit for the grouting program was 0.05 MGD/mile. Infiltration occurs during dry periods (when the tunnel is empty) or small storm events, when the pressure in the tunnels is below the piezometric level. The grouting was designed to mitigate this impact of infiltration to the tunnels.

Another concern during planning was the potential for exfiltration of wastewater from the tunnels into the surrounding aquifer. Exfiltration could prove to be a long term negative impact on the quality of the groundwater. The natural high groundwater exerts an inward pressure on the tunnels most of the time. Following major storm events or when the tunnels are full, the pressure in the tunnel is greater than that outside, thus exfiltration occurs. It was expected that exfiltration would occur during these "surcharge" events, but that a rebound effect would occur in which the infiltration of water into the tunnel would account for any contaminants that were exfiltrated into the acquifer. Again, grouting is essential in minimizing the amount of exfiltration that occurs. A worst case analysis was conducted during facilities planning to assess the potential for exfiltration to impact water mains. Since the tunnels will be located nearly 70 feet below any main, it was determined to be unlikely that exfiltration would have any impacts. Quality sampling wells were located in areas of high grout uptake and in areas with unfavorable geologic conditions, where exfiltration potential is greatest.

## MAINSTREAM

° Proposed/Approved Monitoring Program

The May 1976, EIS (p.X-7) recommended a routine groundwater monitoring program to determine whether exfiltration or infiltration was occuring in the tunnels. It was recommended that the monitoring wells be equipped with continuous level recorders to be used for correlating aquifer pressure with tunnel pressure. The EIS also recommended a quality sampling program for the monitoring wells. The sampling of the wells was recommended to occur weekly and after major storm events. As a minimum program, it was recommended that the following parameters be measured on a weekly basis:

- $NH_3$ (as nitrogen)
- Total Bacteria Plate Count
- Conductivity (or calculated TDS)
- Total Organic Carbon

The EIS stated that a monitoring program would be included as a grant condition for the Mainstream tunnel system and that specific design criteria for the monitoring would be included in construction permits. The final EIS called for USEPA, IEPA and MSDGC agreement on the location, depth and time parameters for the monitoring program.

The Step 3 grant agreement of July 1, 1976, for the Mainstream project included a condition for a groundwater monitoring program. The grant condition was as follows:

> "The grantee agrees to submit a plan, prior to any actual construction which may affect groundwater conditions, for implementation of a groundwater monitoring system with sampling parameters and frequencies mutually agreeable to the Illinois Environmental Protection Agency and the U.S. Environmental Protection Agency, sufficient to detect any changes in groundwater quality resulting from construction and operation of the Mainstream Tunnel System, of which the project scope defined below is a part, and further agrees to plan and develop an emergency groundwater recharge program and to implement same in the event of significant exfiltration of combined sewer waters from the tunnel system into the groundwater aquifer."

A monitoring program was developed by MSDGC in 1979. A technical report entitled Groundwater Monitoring Program Mainstream Tunnel System - Addison St. to 59th Street was prepared in January 1979, and revised in January 1980, June 1980, and July 1983. This report indicated that the monitoring program would be included in the Mainstream O&M manual. The program would include: maintenance of 25 groundwater level observation wells along the tunnel alignment and at the Mainstream Pumping Station; monitoring of hydraulic grade line measurements and pumpage records; and installation and operation of 17 groundwater quality monitoring wells. MSDGC would provide semi-annual reports to IEPA.

Fifty-three observation wells were used during the pre-construction phase for subsurface exploration. Due to construction activities, vandalism or new paving, only two of the original wells were found to be usable for the groundwater monitoring program.

The two original wells and twenty-three new wells were planned for use as level observation wells. The plan called for bi-weekly monitoring of piezometers.

These level observation wells were to be installed such that they would allow entrance of groundwater from 25 feet below the top of the bedrock to 3 feet below the tunnel invert. Seventeen groundwater quality wells were planned for monitoring both the quality and level of the groundwater. The quality wells would be uncased approximately 20 feet below the tunnel invert to approximately 20 feet above the crown. The groundwater level would be monitored by continuous level recorders. Quality analysis would be monitored according to USEPA procedures outlined in the Handbook for Analytical Quality Control in Water and Wastewater Laboratories, EPA /600/ 4-79-019. Quality monitoring was planned to occur on a bi-weekly basis or until less frequent monitoring is justified and approved by IEPA. Monitoring would also occur after storm events. The monitoring program would address the following parameters: pH, Chlorides, $BOD_5$, Hardness, Alkalinity, $NH_3$-N (as nitrogen), Total Phosphorus, COD, Conductivity, Total Suspended Solids, and Fecal Coliform.

Appendices C and D of the July 1983 Technical Report identified the locations of the wells. Fifteen quality and nineteen level wells would be located along the tunnel alignment, and two quality and six level wells would be located at the Mainstream Pumping Station. Monitoring wells would be located in areas of heavy grouting, in close proximity to potable water tunnels, and uniformly spaced (every $3/4$ mile) along the alignment. The wells would be offset thirty feet from the edge of the tunnel.

The Mainstream TARP Groundwater Monitoring Program (January 1980 with June 1980 revisions) was found to be acceptable by USEPA and IEPA on December 3, 1980. It was noted that the sampling frequency was changed from weekly to biweekly in the July 1983 revision, but was not approved by USEPA.

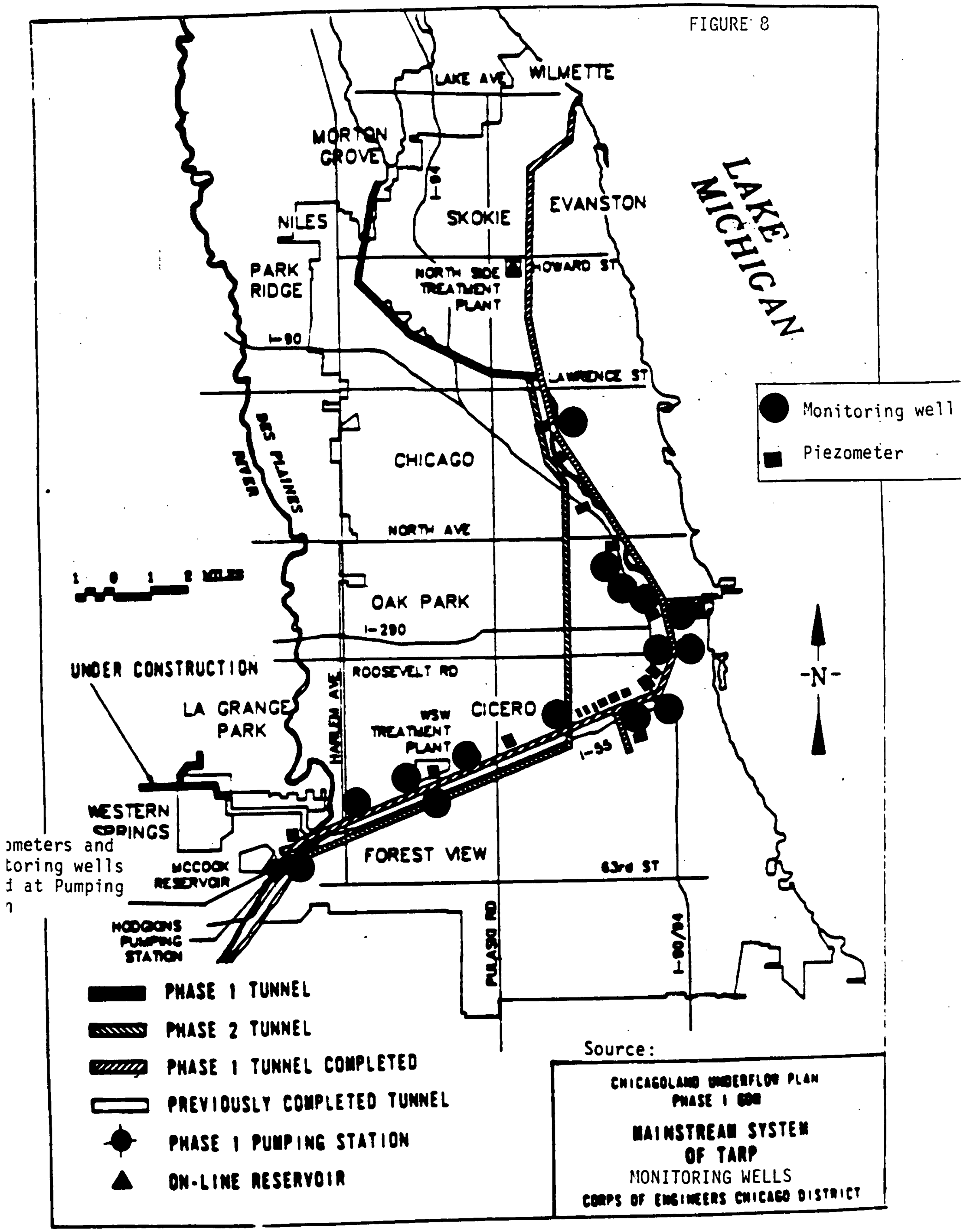
° Analysis of MSDGC Data

The analysis of the groundwater monitoring data is based upon the following documents:

- Groundwater Monitoring Program - Mainstream January 1980 (Revised July 1983)
- Groundwater Monitoring Program - Appendices C and D Mainstream July 1983
- Groundwater Monitoring Program - Mainstream - December 1986.

In all, 17 groundwater quality monitoring wells and 25 observation wells are used to assess the Mainstream system (See Figure 8). The quality monitoring wells are equipped with continuous level recorders which record the level in the wells every 12 hours. This data is retrieved from the recorder every three months and stored in a computer. The water quality and level data are available for the period from November 1985 through October 1986. This short period of time is not sufficient to establish any seasonal or yearly trends. The sampling frequency is for the most part bi-weekly, except for instances where conditions make it impossible to collect samples.

FIGURE 8


LAKE AVE
WILMETTE
MORTON GROVE
LAKE MICHIGAN
EVANSTON
SKOKIE
NILES
PARK RIDGE
NORTH SIDE TREATMENT PLANT
HOWARD ST
I-90
LAWRENCE ST
Monitoring well
Piezometer
DES PLAINES RIVER
CHICAGO
NORTH AVE
OAK PARK
I-290
UNDER CONSTRUCTION
ROOSEVELT RD
HARLEM AVE
LA GRANGE PARK
WSW TREATMENT PLANT
CICERO
I-55
-N-
WESTERN SPRINGS
ometers and
toring wells
d at Pumping
n
MCCOOK RESERVOIR
FOREST VIEW
63rd ST
HODGKINS PUMPING STATION
PULASKI RD
I-90/94
PHASE 1 TUNNEL
PHASE 2 TUNNEL
PHASE 1 TUNNEL COMPLETED
PREVIOUSLY COMPLETED TUNNEL
PHASE 1 PUMPING STATION
ON-LINE RESERVOIR
Source:
CHICAGOLAND UNDERFLOW PLAN
PHASE I GDM
MAINSTREAM SYSTEM
OF TARP
MONITORING WELLS
CORPS OF ENGINEERS CHICAGO DISTRICT

- Water Level Measurements

The general trend for the 17 quality monitoring wells located along the tunnel indicates the water levels are decreasing with time during the November 1985 to October 1986 period for most of the wells. Data taken in the late 1970's, as summarized in the previous reports, stated there was no trend. However only summary data was reported so this statement could not be confirmed.

We recommend the future monitoring program continue monitoring wells as decribed in the Overview Section of this chapter, to determine if there is a correlation between tunnel water levels and piezometric head in the monitoring wells.

- Water Quality Results

The Mainstream tunnel system can be divided into two sections:

1. Archer Avenue and Halsted Street and north

2. Archer Avenue and Halsted Street to the Mainstream Pump Station.

The first system section experienced little groundwater contamination. The fecal coliform levels did not exceed 2/100 ml and interestingly the hardness and alkalinity did not vary as much as the downstream tunnel system. The second section also experienced higher fecal coliform counts as much as 6000/100 ml, with six wells reporting at least 580/100 ml during the sampling period. The large variations in hardness and alkalinity could indicate the intrusion of contaminated tunnel water and infiltrating surface water.

° Recommendations

Clearly, the monitoring wells by the lower section of the Mainstream tunnel indicate groundwater contamination is occuring, but the cause and the potential long term extent of this contamination are not clear. Additional water level measurements should be performed as decribed in the overview portion of this chapter to determine if the tunnel is interconnected with the dolomite strata during potential exfiltration events. In addition, the hydrogeologic relationship of the Chicago River, the Des Plaines River and the Sanitary and Ship Canal to the aquifer system should be documented.

If a relationship between the tunnel and the aquifer system is defined, a water quality plan can be designed to accommodate the lag time in the well's exfiltration response.

UPPER-DES-PLAINES (O'HARE)

° Proposed/Approved Monitoring Program

The May 1975, EIS for the O'Hare Service Area - Wastewater Conveyance System (Upper Des Plaines tunnel project) stated that the operation of the tunnels should have little impact on the surrounding groundwater since all the tunnels would be lined. The concerns addressed in the EIS included the potential for contamination of the aquifer and the potential drawdown of the local water table. The EIS concluded that there would be less than 300 gpm of inflow to the tunnels. This inflow would be reduced by tunnel lining and grouting. It was also concluded that the drawdown of the aquifer would be virtually zero due to operation of the tunnels. As far as exfiltration potential, it was determined that approximately 18 hours of surcharged conditions (pressure greater inside tunnel) would occur with a 100 year storm. MSDGC proposed a monitoring program to "demonstrate that the project is not causing contamination of the groundwater...."

The proposed program called for continuous level recording and quality sampling for the following parameters: pH, BOD, Chlorides, Hardness, Alkalinity, $NH_3$-N, Total Phosporus, Phenol, COD, Cyanide, Mercury, Total Bacteria Plate Count, Coliform, Fecal Coliform, Fecal Strep, Conductivity, and Total Suspended Solids. Sampling would occur bi-weekly and after major storm events. The monitoring wells would be installed at approximately $1/_2$ to $3/_4$ mile intervals along the alignment at a minimum offset of thirty feet from the tunnel edge. According to Figure 5-5 of the EIS, eight monitoring wells were proposed by MSDGC.

° Analysis of MSDGC Data

The analysis of the Upper Des Plaines system was based upon the following documents:

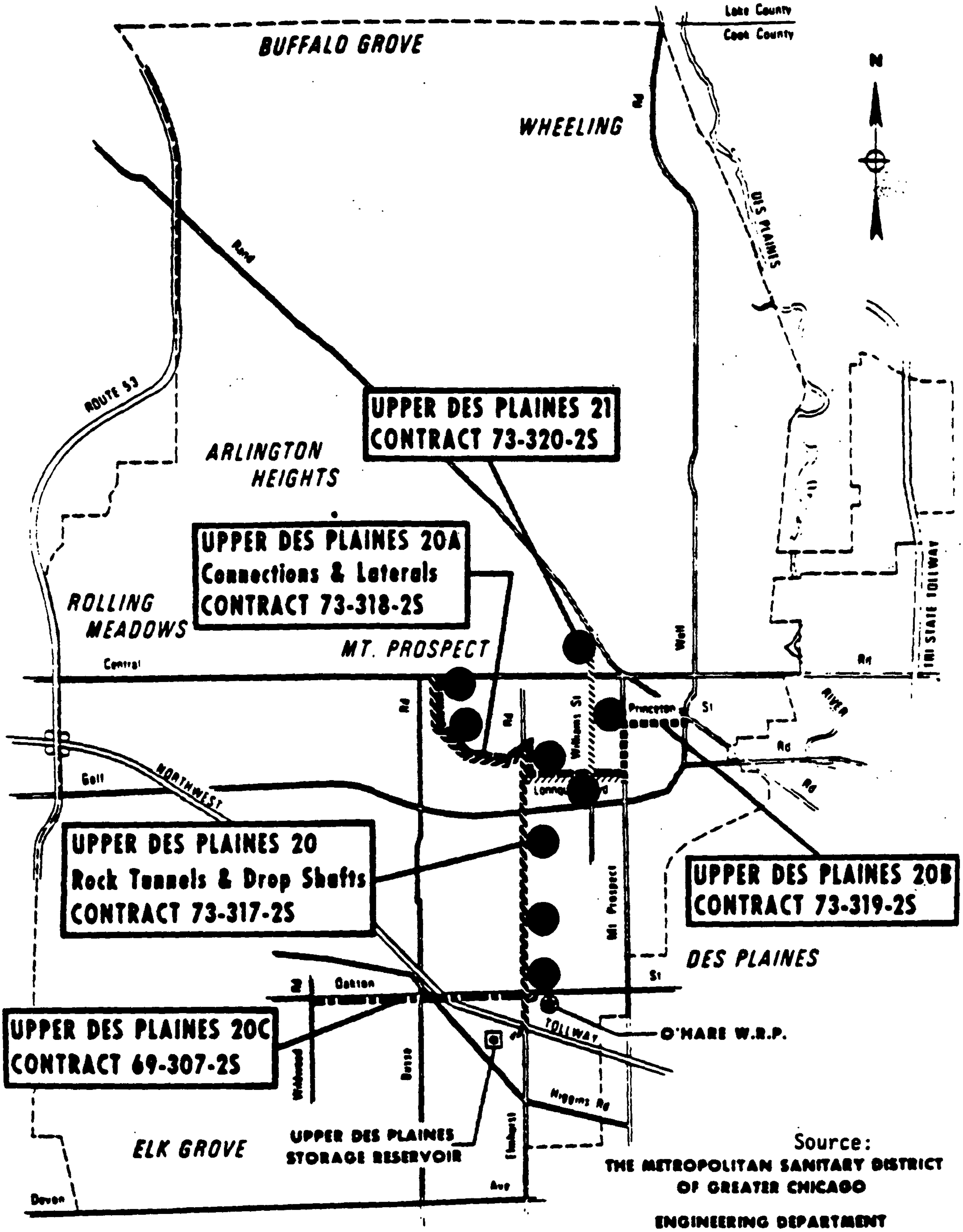
- ° Raw data reports from April 1985 - to September 1986 (Upper Des Plaines System)

There are nine monitoring wells (See Figure 9) which were sampled bi-weekly from April 1985 to September 1986. Only the raw data were presented to IEPA, with no analysis of results. Upon inspection of the data sets there appeared to be only two sample periods which indicated elevated fecal coliforms. The MW-1 well on the "21" tunnel showed elevated fecal coliforms on October 10, 1985 and August 13-25, 1986. In addition, the water well levels do not appear to have either an upward or downward trend.

° Recommendations

If MSDGC can document that the Upper Des Plaines system is operating at full capacity and that potential exfiltration events have occurred, then analysis of continuous level monitoring data for at least well MW-1 of the "21" Section should be performed to evaluate the interconnection between the tunnel and the aquifer. If this analysis shows the tunnel is interconnected, then additional quality sampling based upon this relationship should be performed.

FIGURE 9 TARP UPPER DES PLAINES MONITORING WELLS




Source:
THE METROPOLITAN SANITARY DISTRICT
OF GREATER CHICAGO
ENGINEERING DEPARTMENT

F.J.K.

● Monitoring well

## CALUMET

° Proposed/Approved Monitoring Program

As was the case for the Mainstream and Upper Des Plaines tunnels, the EIS (December, 1976) for the Calumet tunnels recommended a groundwater monitoring program to measure the effects of exfiltration and infiltration on the surrounding groundwater. The EIS (p.X-7) recommended that the monitoring wells be equipped with continuous level recorders to be used for correlating aquifer pressure with tunnel pressure. The EIS also recommended a quality sampling program for the monitoring wells. The sampling of the wells was recommended to occur weekly and after major storm events. As a minimum program, it was recommended that the following parameters be measured on a weekly basis:

- ° $NH_3$ (as Nitrogen)
- ° Total Bacteria Plate Count
- ° Conductivity (or calculated TDS)
- ° Total Organic Carbon

The EIS also indicated that the groundwater monitoring program would be a grant condition (see Mainstream grant condition, p. 47) and would be appended to the Calumet Pumping Station O&M manual.

A monitoring program was developed by MSDGC in 1981. The September 1981 (revised July and August, 1983) Technical Report entitled, Groundwater Monitoring Program Calumet Tunnel System - Crawford Ave. to Calumet Plant, outlined MSDGC's proposed program. The proposed program included recording of groundwater levels along the alignments, periodic observation in tunnels to note infiltration locations, and quality sampling to measure for exfiltration from the tunnels. The program would include: eleven new level observation wells along the alignment; monitoring of hydraulic grade line and pumpage records; and two new quality sampling wells.

All of the wells used during the pre-construction phase have been abandoned. Eleven new level wells were proposed to be located every 3500' to 4000'. These wells would have piezometers to measure abrupt changes in the groundwater level and would be monitored bi-weekly.

Two quality monitoring wells were included in the proposed program. The two wells would be located in areas of expected exfiltration (areas of unfavorable geologic conditions). The wells would be located downstream of the tunnel, in the direction of groundwater flow and would be sampled bi-weekly in accordance with USEPA's quality assurance procedures for well flushing, sampling, and analysis (EPA 600/4-79-091). The wells would include continuous water level recording and would be sampled for pH, $BOD_5$, Hardness, Alkalinity, $NH_3$-N, Total Phosporus, COD, Conductivity, Total Suspended Solids and Fecal Coliform. The groundwater monitoring reports would be sent to IEPA in a semi-annual basis.

The Calumet groundwater monitoring program was approved by USEPA in a memorandum of December 6, 1983.

° Analysis of MSDGC Data

The analysis of the Calumet Tunnel System is based upon the following two documents:

- ° Groundwater Monitoring Program - Crawford Avenue to Calumet Plant August 1983
- ° Groundwater Monitoring Program - Crawford Avenue to Calumet STP November 1986

There are two monitoring wells for groundwater quality and eleven monitoring wells for water level measurements. These monitoring well locations are depicted on the map in Figure 10. The sampling frequency was bi-weekly plus additional samples during high water level conditions. The data analysis presented in a November 1986 report was not very extensive and did not attempt to determine if any interrelationships existed between the various parameters evaluated. For example, the report stated there was not a strong correlation between the tunnel water levels and the monitoring well data or groundwater contaminants. However, the two do appear to be related if one uses a lag in the well response. Though the wells are equipped with continuous level recorders, exact lags could not be calculated since well levels were only reported twice a month. See Figure 11 for the correlation. More importantly there is a direct relationship between elevated fecal coliforms and elevated well levels as shown in Figure 12. This was also found to occur during the testing of the tunnel with river water, when elevated fecal coliform levels were detected in a monitoring well after a simulated surcharge condition. In addition, the hardness of the groundwater increased during periods of high water while the alkalinity usually decreased during the same periods. This is circumstantial evidence that water from outside sources is entering the aquifer during these periods, most likely due to exfiltration from the tunnel.

Recent data provided by MSDGC for the QC-2 monitoring well confirms the conditions (specifically, the prolonged periods of elevated fecal coliform levels), as discussed above. MSDGC has indicated that increased monitoring will occur at the QC-2 well to determine the nature of the problems there and to indicate the types of mitigation measures that may be necessary.

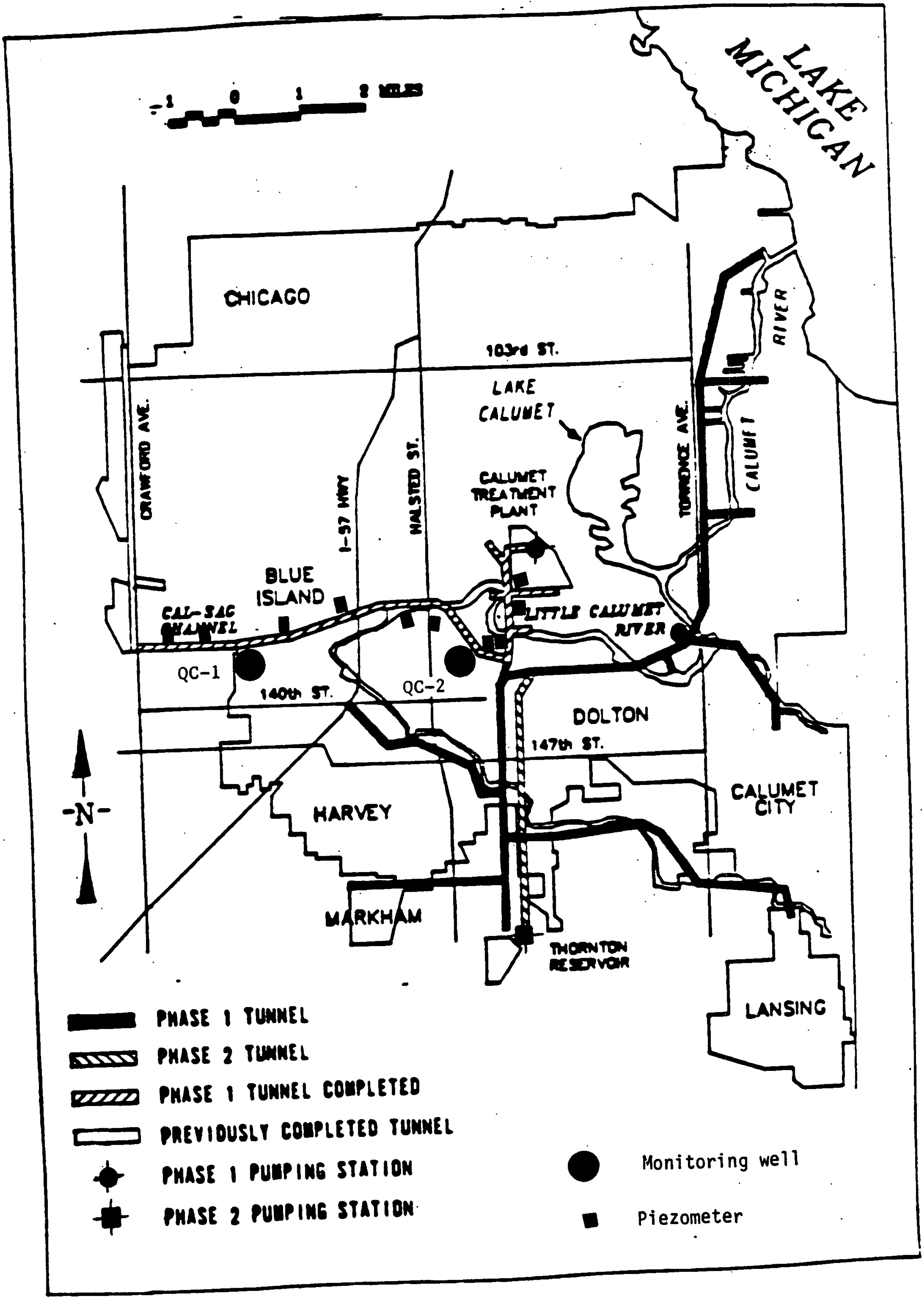
Several of the water level monitoring wells showed a decreasing trend. However the map provided did not identify specific monitoring wells, so the area of the tunnel susceptable to infiltration is not readily apparent.

° Recommendations

The MSDGC should perform a correlation analysis using the continuous level recorder data for the QC-2 well to better define the lag time between high water in the tunnel and the rise in the water well level. Clearly the aquifer around the QC-2 well is experiencing some periodic contamination. This phenomenon should be studied for a longer period of time to determine if the change in water quality has any long term impacts.

The other wells should be monitoring for water levels to determine if the downward trend will stabilize with time. If this trend continues, at least one of these wells should be sampled for the water quality parameters, especially if the well water level rises after major tunnel water rises.

FIGURE 10 TARP CALUMET SYSTEM MONITORING WELLS



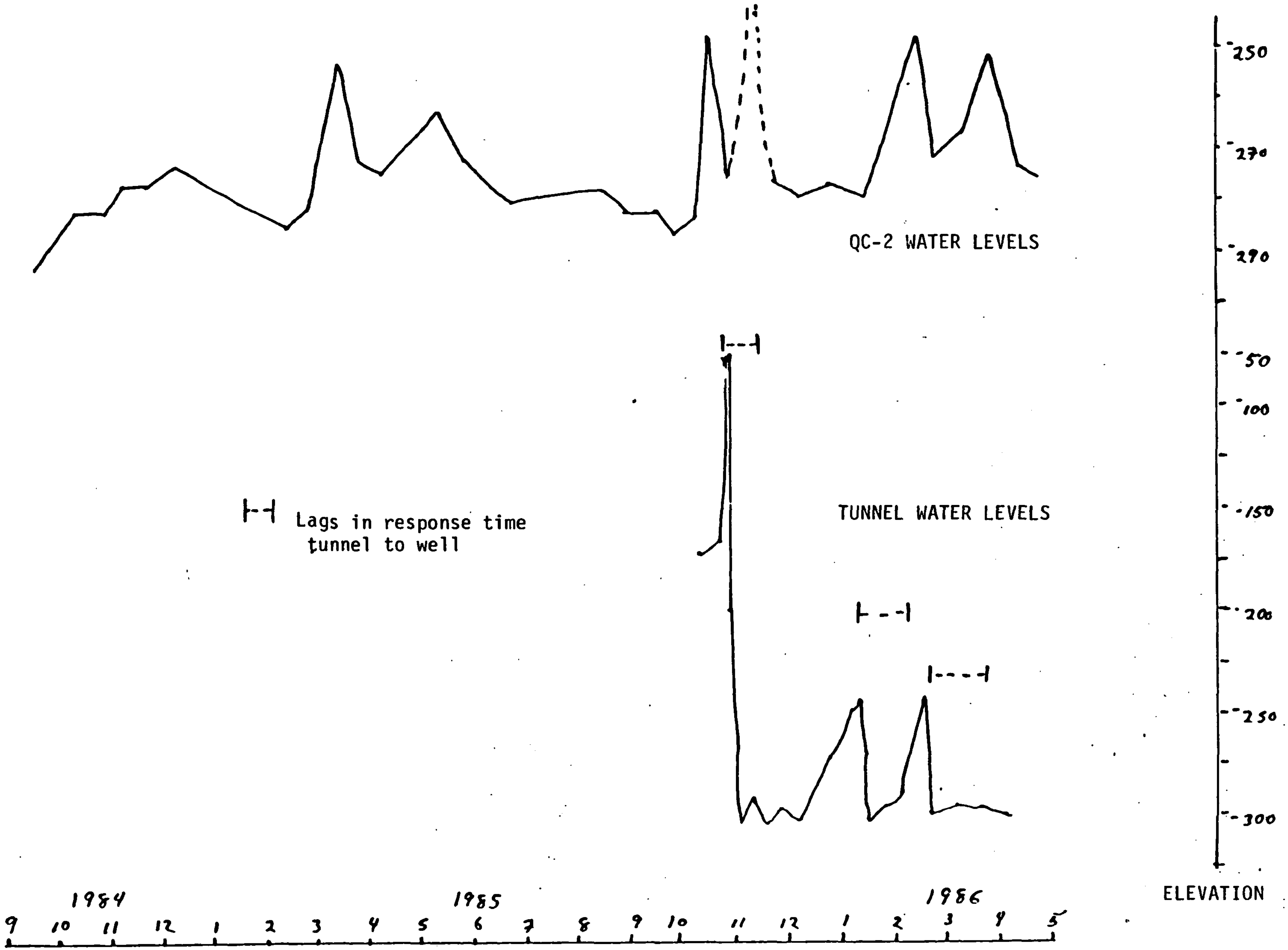



FIGURE 11: COMPARISON OF TUNNEL AND QC-2 WATER LEVELS

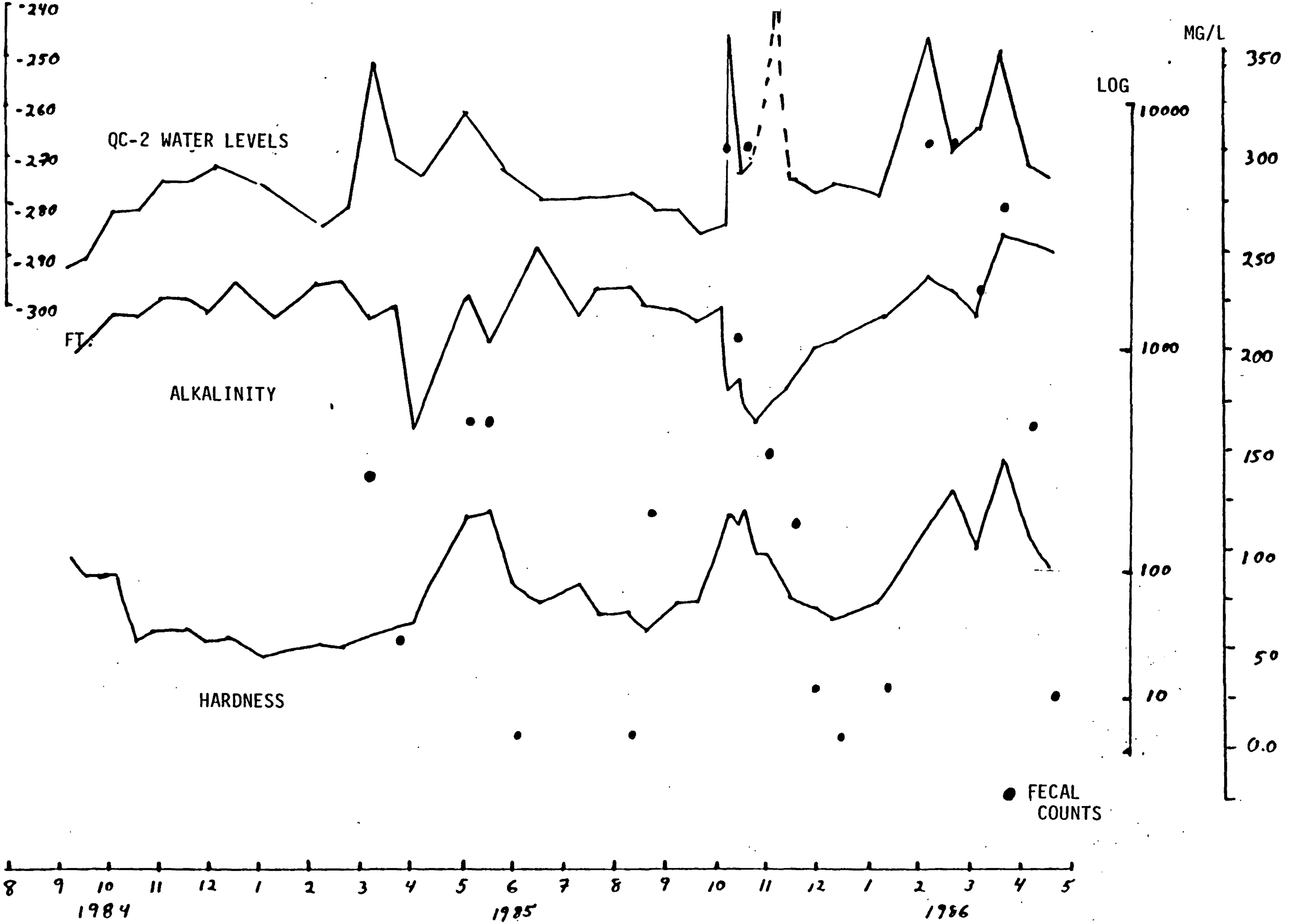



FIGURE 12: QC-2 MONITORING WELL DATA

OVERVIEW OF THE GROUNDWATER MONITORING PROGRAM

The sampling frequency for observation well water levels is bi-weekly, although there are continuous level recorders on the quality wells which make measurements every 12 hours. Quality sampling was also taken bi-weekly, and some attempts were made to sample after storm events of one inch or greater. The sampling procedure of pumping the well dry and then allowing the well to refill, was altered for some wells to allow for optimum sampling. The continuous level data are retrieved every 3 months and stored by computer, but are not reported to IEPA.

The amount of data available to make meaningful conclusions regarding the trends in groundwater quality and piezometric head near the tunnel system is not adequate. Though it appears that well water levels are decreasing over time, more data are needed to determine if this is an impact of the tunnels or a regional trend. For all three systems, the groundwater quality data should be taken for at least two successive years to determine if there are any seasonal trends developing. Currently, the available data only represent a year or less of system performance.

The groundwater monitoring network appears to have been designed to monitor the areas most susceptable to exfiltration along the tunnel. Areas where the geologic strata, principally dolomites, are interbedded and zones associated with areas of the tunnel which required significant grouting were monitored for water levels and quality parameters.

However, many of these monitoring wells were finished in zones with little fracturing. This is evidenced by the length of time (up to 48 hours) it takes some wells to recover from pumping one well volume during the sampling procedure. These less fractured bedrock zones would not be as exposed to exfiltrating water from the tunnel as other regions with more fracturing, where water would tend to flow due to less flow resistance. It is noted that even in these less fractured zones, groundwater contamination was observed within one month of major storm events.

The presence of contaminated groundwater in Calumet well QC-2, which is 60 feet from the tunnel, occurs within one month of high water levels in the Calumet tunnel. The flow velocity of the observed contaminated groundwater is much greater than the predicted contaminant flow of 70 feet in 288 days, as predicted by the Harza Engineering model in 1972. The QC-2 well is finished in a less fractured zone and still has a relatively quick response, as compared to predicted flow velocities. In order to properly assess the extent of the contaminant flow, a model based upon flow in fractured bedrock (the Harza model used a worst-case homogeneous permeability factor) would be required. In addition to the modelling effort, a series of wells in a line perpendicular to the axis of tunnel could be established at the QC-2 site to assess the extent of the contaminant plume during exfiltration events.

In general, the data analysis provided by the MSDGC in the semi-annual reports is cursory. Very little actual analysis of the data was performed. The current analyses include only the development of summary tables and some plots of water levels. Even when this level of analysis was provided, little discussion of the results was presented. For example, the Calumet System data indicate water levels in most of the wells were decreasing with time but the report did not discuss this trend. When episodes of high fecal coliform contamination occured in some Mainstream system wells the data was called "erratic...but not showing a net increase in contaminant levels."

The lack of analysis of the other measured parameters such as Hardness, Alkalinity, TDS, TSS and Chlorides indicates MSDGC did not make a serious effort to identify other indicator parameters for combined sewer contamination. A more comprehensive data analysis could also provide information on the general water quality of the aquifer system, if the data is compared to wells finished in the same formations but away from the tunnel system.

## CONCLUSIONS

The EIS's for the Mainstream, Calumet, and Upper Des Plaines TARP projects called for groundwater monitoring to detect any adverse changes in the groundwater in the vicinity of the tunnels. The purpose of the monitoring would be to detect any alterations of groundwater due to infiltration or exfiltration, and when necessary, to implement measures to mitigate any adverse affects.

The EIS for Mainstream recommended that the monitoring wells and tunnels be equipped with continuous water level recorders "... so that aquifer pressure can be correlated with tunnel pressure," (EIS px-7). The EIS also recommended bi-weekly sampling for quality data.

The monitoring program employed by MSDGC does collect the quality data that the EIS recommends. Based on a review of the monitoring program reports prepared by MSDGC, it is evident that the level of analysis of the data is insufficient. The semi-annual reports prepared by MSDGC do not reflect any attempt at correlation of tunnel pressure with aquifer pressure data, as recommended by the EIS. This is extremely critical in attempting to determine if there is an interconnection between the tunnels and the aquifer.

A recent analysis conducted by MSDGC attempts to correlate tunnel level, well levels and fecal coliform levels. This type of analysis should be conducted for all the quality monitoring wells. Results of this type of analysis can yield information about the lag times between surcharge events and short term ground water contamination due to exfiltration and the return times during infiltration.

Since some wells are already equipped with continuous level recorders, the 12 hour interval data on these wells should be collected, plotted and compared to the tunnel water levels in order to determine the degree of hydraulic interconnection between the tunnel system and the surrounding geologic formations. In addition, rainfall events should be documented and plotted so that aquifer recharge impacts can be evaluated.

The monitoring program data from all three systems indicate that there are at least some episodes which produce contaminated groundwater near the TARP tunnels. At this time there is not enough data to determine conclusively if there will be a long term impact on the aquifer as a result of TARP operation.

According to MSDGC, some periodic exfiltration is expected from normal operation of the tunnels. It was expected that after surcharge events the exfiltrated water would return to the tunnels by infiltration. Apparently, the tunnel systems are not being operated as designed. Specifically, the tunnels are not being dewatered as quickly as originally predicted, thus maintaining high water levels for longer periods of time.

It is likely that there are contamination zones forming along some stretches of the tunnel system. The natural infiltration into the tunnel should minimize the extent of the contamination zone. However, the current operation of the tunnels allows for more exfiltration. Also, extreme exfiltration events may enable contaminated water to travel outside the normal infiltration capture zone. This would allow contaminated water to travel beyond the immediate tunnel area, especially in areas where there are more fractures in the bedrock.

As was stated previously, the monitoring programs for TARP may be collecting sufficient data to determine the potential for impacts to the aquifer. The level of analysis (especially the lack of correlation analysis between tunnel levels and well levels) conducted by MSDGC and reported to IEPA is unsatisfactory. The purpose of the monitoring program was and is to collect data for analysis to determine if the tunnel operation impacts the aquifer, and if so, to take action to mitigate any regative impacts. Tunnel level data and well level data (from the continuous recorders) must be analyzed for all monitoring wells to determine if there is an interconnection between the tunnel and the aquifer. If a monitoring well shows an interconnection, additional quality sampling may be warranted to determine the extent of the impact. With the MSDGC reporting on correlation analyses between the tunnels and wells to IEPA, the State can then make determinations on the extent of additional quality sampling and/or mitigative measures which may be warranted.

## CHAPTER 7

## U.S. ARMY CORPS OF ENGINEERS STUDIES

The U.S. Army Corps of Engineers (CoE) has been involved in both the Phase I and Phase II portions of the TARP project. The Phase I involvement of the CoE has been primarily through the review and comment on plans and specifications for USEPA construction grants and by onsite overview during construction of these grant projects in accordance with the interagency agreement between the CoE and the USEPA. The CoE has been more extensively involved in the Phase II portion of TARP since the CoE has a national program which provides funds for flood control projects. Due, in part, to the extensive nature of the TARP project and flooding problems in the Chicago Area, Congress authorized the CoE under Section 108 of the 1976 Water Resources Development Act to prepare a Chicago Underflow Plan, Phase I General Design Memorandum. The scope of this study consisted of a comprehensive analysis of the flooding problems in the Chicago Metropolitan combined sewer area. This chapter will discuss the potential impacts of the recently completed CoE Chicago Underflow Plan Phase I General Design Memorandum documents conclusions on the TARP Phase I system. Since the TARP project is designed to provide a combination of pollution reduction and flood control benefits to the Chicago Metropolitan Area; a document which proposes significant revisions to one aspect (flood control) of the project could have an effect upon the other aspect (pollution reduction). With this potential interrelated effect in mind, the recently completed CoE documents were examined.

The CoE has completed the following two documents as part of the Chicago Underflow Plan study:

1. Final Feasibility Report and Environmental Assessment; Chicago Underflow Plan Phase I General Design Memorandum; O'Hare System Interim Report: April 1984.

2. Feasibility Report and Environmental Assessment; Chicago Underflow Plan Phase I General Design Memorandum: December 1986.

These two reports contain a detailed feasibility study for the entire TARP project (Upper Des Plaines, Des Plaines, Mainstream and Calumet Systems). The CoE studies examined alternative flood damage reduction measures and plans in order to identify the most cost-effective solution to the flooding problems in the combined sewer area. Additionally, the studies identified the Federal interest in the Phase II (flood control) portions of TARP. The CoE evaluation yielded the following major conclusions:

- Watercourse modifications, such as channel widening and deepening, would have to be very extensive, would not be cost-effective, and would cause significant adverse environmental and social impacts;

- Reservoir storage is best suited to reducing flood damages associated with sewer outfall submergence which generally occurs during rainfalls of long duration;

- Sewer upgrading is generally best suited to reducing flood damages associated with the high intensity, short duration storm events; and,

- The use of check valves, stand pipes, and other flood proofing measures is not well suited for regional application since these measures transfer the problem to other areas, and may cause sewers to burst or basement floors to crack due to the hydraulic pressure.

Based on the CoE analysis of alternative measures, it was further concluded that:

- A systematic, regional approach is needed to effectively reduce the combined sewer back-up flooding problem;

- Reservoir storage, in combination with the TARP Phase I tunnel systems, is the most cost-effective measure for reducing flood damages caused by submergence of the sewer outfalls due to inadequate watercourse capacity;

- Adding sewer upgrading to a basic reservoir plan, possibly in combination with temporary local ponding or in-line sewer storage in certain areas, would further reduce sewer back-up flooding damages, however, the local costs increase dramatically; and,

- Flood proofing devices such as overhead sewers and backflow regulators, could be used by some homeowners on a selective basis, and with care, to supplement the reservoir storage and sewer improvements, and further reduce residual damages.

In April 1984, the interim CoE General Design Memorandum (GDM) was completed on the O'Hare System. That report recommended Federal participation in the construction of a 450 acre-foot floodwater storage reservoir to relieve basement and street flooding due to outfall submergence along the watercourses in the O'Hare System. The benefit-cost ratio was calculated to be 1.7. The USEPA had no adverse comments to the interim GDM on the O'Hare System. A larger 1,050 acre-foot O'Hare Reservoir was authorized by the Water Resources Act of 1986 at an estimated cost of $18.4 million and a benefit-cost ratio of 1.0.

The Final CoE GDM recommends Federal participation in the construction of two additional flood control reservoirs to relieve flooding in the Mainstream, Des Plaines, and Calumet Systems. The CoE did reduce the sizing of the McCook and Calumet Reservoirs, combined storage capacity at the reservoirs was reduced from 124,000 acre-feet to 46,700 acre-feet and TARP Phase II tunneling paralleling the Mainstream and Calumet Phase I tunnels was not recommended.

The CoE report did not recommend a direct connection of the Lower Des Plaines Tunnel to the reservoir, but rather suggests the use of the Mainstream pumping station to achieve a 14-year - 24-hour rainfall event level of protection. The Mainstream and Calumet systems would furnish protection from flooding caused by anything less than a 50-year - 24-hour storm event. The revisions, proposed by the CoE to the TARP Phase II project will have no effect to TARP Phase I water pollution control efficiencies and only minor effects to the supplemental water pollution benefits of the original TARP Phase II project which was proposed by the MSDGC in its facilities plan.

The USEPA did forward comments of the final GDM concerning various elements of the CoE plan which were generally addressed by the CoE (See Appendix 2). The majority of USEPA comments dealt with concerns this Agency had during the development of EIS documents for various components of TARP Phase I (groundwater, blasting, odors) and these concerns should be addressed by comprehensive programs based primarily upon experiences gained during the first part of TARP Phase I construction and operation.

The general analysis and conclusions of the CoE GDM reports on TARP support the basic assumptions of the USEPA approved facilities plan. As such, the CoE GDM reports provide no reason to re-evaluate the basic assumptions and plan for the remaining TARP Phase I components.

# CHAPTER 8

## WATER QUALITY BASELINE

This chapter is currently under development. The completion of the first draft of this chapter is now anticipated to be sent for comments on April 30, 1988

## CHAPTER 9

## SUMMARY

This chapter summarizes the more noteworthy findings revealed by USEPA's examination of the constructed portion of TARP Phase I. For the most part, each of the three systems has been constructed as designed. However, the operation of the systems has been varied. The Upper Des Plaines TARP system has been operating as designed but because of the circumstances at the treatment plants and/or the geyersing problem, the Mainstream and Calumet TARP systems operating procedures were revised.

The following are the major findings.

### Upper Des Plaines TARP System

- Major construction, maintenance and operational characteristics are in accordance with design and planning documents. The system accepts unrestricted sanitary sewage at all times, while combined sewage is regulated by control structures on the combined sewer outfalls.

- Combined sewer overflow treatment does not cause significant deterioration of the O'Hare Water Reclamation Plant effluent. For the period from June 1985 to December 1986, the average monthly values for $BOD_5$, total suspended solids, or Ammonia - Nitrogen met all NPDES permit limits.

- Experience gained by control of odor problem from Upper Des Plaines drop shaft vents will be utilized in the Lower Des Plaines TARP system. Louvers were added to the Upper Des Plaines system to control the flow of air and are designed into the Lower Des Plaines system.

### Mainstream TARP System

- During the period of this study (October 1985 to December 1986) 31.464 billion gallons of stored combined sewage has been pumped to the West-Southwest Wastewater Treatment Works from the Mainstream TARP system.

- Major construction and maintenance characteristics are in accordance with design documents. However, potential blasting damage has become a controversial issue and must be thoroughly addressed on future projects.

- Under current operational procedures, a small amount of the first flush of the combined sewage is discharged to the receiving stream prior to diversion of the overflow into TARP.

- TARP dewatering is controlled so that the flows to the treatment plant are within design limitations, taking into account the extensive ongoing plant modifications. As a result of this control, effluent quality is not adversely affected though this procedure partially limits storage capacity during extended rainfall events.

- TARP filling procedures have been modified due to a geysering problem. For rainfall events forecasted to be less than 1 inch, all controlled TARP inlets are closed when tunnel is 50% full. For rainfall forecasted to be greater than 1 inch, all controlled inlets remain closed. The hydraulics of TARP are being modelled in an effort to use the system more efficiently.

Calumet TARP System

- Major construction and maintenance characteristics are in accordance with design documents.

- Due to an unforeseen delay in the Calumet Wastewater Treatment plant improvement and expansion to 354 MGD from the present 236 MGD capacity (delay caused by contractor default), a substantial portion (86%) of the flow from Calumet TARP was pumped directly to the Little Calumet River from October 1985 to November 1986. The combined sewer overflow capture water in the Calumet TARP system includes 3 to 5 million gallons per day of dry weather sanitary sewer wastewater flow. This condition is considered to be a temporary problem which will be remedied once the Calumet Treatment plant is able to treat 354 MGD of flow.

Ground Water Monitoring

- The MSDGC ground water monitoring program consists of bi-weekly monitoring of 9 monitoring wells on the Upper Des Plaines System, 25 observation and 17 water quality monitoring wells on the Mainstream System, and 11 observation and 2 water quality monitoring wells on the Calumet System.

- The MSDGC is utilizing Ground Water Monitoring Plans for each TARP segment which were approved by IEPA and USEPA.

- The groundwater monitoring data collected and reported by MSDGC indicate some possible interconnection between the tunnels and the aquifer.

- Because the MSDGC data indicates that some ground water contamination is occurring, a more elaborate data analysis is necessary to better assess the extent of the contamination. This data analysis should be submitted as part of the semi-annual ground water monitoring report to IEPA and should include a graphical correlation analysis of the continuous well water level data with the tunnel water level data to determine the lag times in the aquifer response to surcharges. Once the lag times have been determined, quality samples should be taken during subsequent storm events at the proper lag time to determine maximum contamination levels. If the contamination appears to be increasing with time, then a tunnel exfiltration mitigation plan should be developed. Such a plan could include regrouting of the tunnel segment, additional monitoring or other mutually agreeable solution.

U.S. Army Corps of Engineer Studies

° The general analysis and conclusions of the recently completed General Design Memorandum provided no reason to re-evaluate the basic assumptions and plan for the remaining TARP Phase I components.

Water Quality Baseline Report

° This section is not scheduled for drafting until April 1988.

# APPENDICES

APPENDIX NO. 1

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2) CONSTRUCTION REPORT: VOLUME I - PROJECT ADMINISTRATION AND CONSTRUCITON METHODS (Mainstream TARP) by Harza Engineering Company, May 1984.

3) CONSTRUCTION REPORT: VOLUME II - GEOLOGY AND HYDROLOGY (Mainstream TARP) by Harza Engineering Company, May 1984.

4) Excerpts from O'HARE WATER RECLAMATION PLANT OPERATION AND MAINTENANCE MANUAL - Raw Sewage Pump Operating Procedures, May 1984.

5) Excerpts from West - Southwest Wastewater Treatment Plant Operator's Notebook.

6) FACILITIES PLANNING STUDY - O'HARE FACILITY AREA by Metropolitan Sanitary District of Greater Chicago, revised January 1975.

7) FACILITIES PLANNING STUDY - SOUTH FACILITY AREA by Metropolitan Sanitary District of Greater Chicago, revised January 1975.

8) FACILITIES PLANNING STUDY - OVERVIEW REPORT by Metropolitan Sanitary District of Greater Chicago, revised January 1975.

9) FACILITIES PLANNING STUDY - UPDATE SUPPLEMENT AND SUMMARY by Metropolitan Sanitary District of Greater Chicago, May 1984.

10) FACILITIES PLANNING STUDY - UPDATE SUPPLEMENT AND SUMMARY ACTION PLAN by John Variakojis and Bob Kuhl, Metropolitan Sanitary District of Greater Chicago, May 1985.

11) FACILITY REVIEW OF CHICAGO PROJECTS by Paul D. Lanik, P.E., Burns & Roe Industrial Services Corporation, May 1980.

12) FEASIBILITY REPORT AND ENVIRONMENTAL ASSESSMENT - CHICAGOLAND UNDERFLOW PLAN, FINAL PHASE I, GENERAL DESIGN MEMORANDUM by Department of the Army-Corps of Engineers - Chicago District, December 1986.

13) FINAL ENVIRONMENTAL IMPACT STATEMENT - METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO O'HARE SERVICE AREA WASTEWATER CONVEYANCE SYSTEM, by U.S. EPA, May 1975 (Draft: March 1975).

14) FINAL ENVIRONMENTAL IMPACT STATEMENT - TUNNEL COMPONENT OF THE TUNNEL AND RESERVOIR PLAN PROPOSED BY THE METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO - MAINSTREAM TUNNEL SYSTEM - 59TH STREET TO ADDISON STREET by U.S. EPA, May 1976, (Draft: March 1976).

15) FINAL ENVIRONMENTAL IMPACT STATEMENT - TUNNEL COMPONENT OF THE TUNNEL AND RESERVOIR PLAN PROPOSED BY THE METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO - CALUMET TUNNEL SYSTEM by U.S. EPA, December 1976, (Draft: July 1976).

16) FINAL FEASIBILITY REPORT AND ENVIRONMENTAL ASSESSMENT - CHICAGO UNDERFLOW PLAN, PHASE I, GENERAL DESIGN MEMORANDUM by Department of the Army-Corps of Engineers - Chicago District, April 1984.

17) GROUNDWATER MONITORING PROGRAM - CALUMET TUNNEL SYSTEM by Engineering Department: Metropolitan Sanitary District of Greater Chicago, revised August 1983.

18) GROUNDWATER MONITORING PROGRAM - MAINSTREAM TUNNEL SYSTEM by Engineering Department: Metropolitan Sanitary District of Greater Chicago, revised July 1983 (with Appendices A, B, C, and D).

19) GROUNDWATER MONITORING PROGRAM - TUNNEL AND RESERVOIR PLAN CALUMET TUNNEL SYSTEM - CRAWFORD AVENUE TO THE CALUMET STP by J.R. Pivnicka and L. S. Sakamoto, Tunnel and Reservoir Unit, Collection Facilities Division, Engineering Department, Metropolitan Sanitary District of Greater Chicago, November 1986.

20) GROUNDWATER MONITORING PROGRAM TUNNEL AND RESERVOIR PLAN MAINSTREAM TUNNEL SYSTEM - ADDISON STREET TO 59TH STREET (Summary Report) by J. R. Pivnicka and L. S. Sakamoto, Tunnel and Reservoir Unit, Collection Facilities Division, Engineering Department, Metropolitan Sanitary District of Greater Chicago, December 1986.

21) GROUNDWATER MONITORING PROGRAM - TUNNEL AND RESERVOIR PLAN MAINSTREAM TUNNEL SYSTEM - ADDISON STREET TO 59TH STREET (Supplemental Report) by J. R. Pivnicka and L. S. Sakamoto, Tunnel and Reservoir Unit, Collection Facilities Division, Engineering Department, Metropolitan Sanitary District of Greater Chicago, April 1987.

22) HOW TO BOTTLE RAINSTORMS by Metropolitan Sanitary District of Greater Chicago, April 1978.

23) MONITORING REPORTS FOR UPPER DES PLAINES from Raymond Doralek, MSDSGC to Richard Carlson, IEPA, April 1985 to September 1986.

24) MONITORING WELLS - CHICAGO TARP by William Macaitis and Joe Sobanski, Metropolitan Sanitary District of Greater Chicago, May 1985.

25) MONTHLY PLANT OPERATING DATA prepared by Operations and Maintenance Department, Metropolitan Sanitary District of Greater Chicago, June 1985 - December 1986.

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28) RATE 6L LARGE GENERAL SERVICE from Commonwealth Edison Company, October 29, 1985.

29) TARP GROUNDWATER MONITORING SUMMARY REPORT by Department of Research and Development, Metropolitan Sanitary District of Greater Chicago, Report No. 78-9, June 1978.

30) TARP REVIEW - REMAINING PHASE I by Metropolitan Sanitary District of Greater Chicago, April 1980.

31) TARP UPPER DES PLAINES SYSTEM OPERATION AND MAINTENANCE MANUAL by Collection Facilities Division, Engineering Department, Metropolitan Sanitary District of Greater Chicago, April 1979.

32) FINAL ENVIRONMENTAL IMPACT STATEMENT - TUNNEL COMPONENT OF THE TUNNEL AND RESERVOIR PLAN PROPOSED BY METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO - LOWER DES PLAINES TUNNEL SYSTEM by the U.S. EPA, August 1977.

33) HANDBOOK FOR ANALYTICAL QUALITY CONTROL IN WATER AND WASTEWATER LABORATORIES by U.S. EPA, (EPA 600/4-79-019).

34) RAW DATA REPORTS FROM APRIL 1985 to SEPTEMBER 1986 (UPPER DES PLAINES SYSTEM) by Metropolitan Sanitary District of Greater Chicago.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
230 SOUTH DEARBORN ST.
CHICAGO, ILLINOIS 60604

REPLY TO THE ATTENTION OF:
5ME-14

26 NOV 1986

Colonel Frank R. Finch
District Engineer
Department of the Army
Chicago District, Corps of Engineers
219 South Dearborn Street
Chicago, Illinois 60604-1797

Dear Colonel Finch:

In accordance with our responsibilities under the National Environmental Policy Act (NEPA) and Section 309 of the Clean Air Act (CAA), the U.S. U.S. Environmental Protection Agency, Region 5, has reviewed the draft of the Final Phase 1 General Design Memorandum (GDM) on the Chicago Underflow Plan (CUP). We also have reviewed the revised pages and report summary dated October 15, 1986, which were submitted subsequently.

The report contains an Environmental Assessment (EA) and Finding of No Significant Impact (FNSI) for the proposed project, which recommends the construction of two floodwater reservoirs. The reservoirs would be constructed at existing rock quarries at McCook and Thornton, Illinois, to reduce basement flooding in the Chicago metropolitan area due to sewer back-ups because of the inadequate capacity of the waterways in this relatively flat, highly urbanized area.

<u>Description of the Project</u>

The reservoir to serve the Mainstem and Des Plaines Systems would be designed to contain 32,000 acre-feet of water (10.43 billion gallons), and would cover an area of approximately 203 acres. Approximately 30,000 acre-feet of floodwater storage would be provided for the Mainstream System and about 2,000 acre-feet for the Des Plaines System. The storage capacity for the Mainstream System would be sufficient to hold the runoff from a 50-year, 24-hour storm event. The storage allocated for the Des Plaines System would be sufficient to hold the runoff from a 14-year, 24-hour event.

The Calumet System reservoir would be combined with a Congressionally-authorized U.S. Soil Conservation Service reservoir in the Thornton Quarry area. This reservoir would be designed to contain 24,200 acre-feet (7.9 billion gallons) of water to reduce overbank flooding in the Little

Calumet River Basin. The combination of the two reservoirs into one would result in a significant cost savings. The storage volume includes 9,600 acre-feet for the Little Calumet River Basin and 14,600 acre-feet for the Tunnel and Reservoir (TARP) Calumet System. The facility would provide storage for runoff from the 100-year flood event in the Little Calumet River Basin and the 11-year, 24-hour storm event in the Calumet System. The reservoir would cover approximately 129 acres, and would be constructed in two phases. The SCS portion would be constructed as soon as sufficient floodwater storage capacity became available to accomodate the Thorn Creek flood flows, through commercial quarrying procedures. The second phase, constructing the TARP Calumet System portion, would be begun after the necessary acre-feet of storage capacity became available through the same procedures. Both reservoirs would have connecting hydraulic structures, an aquifer protection system, an aeration system, and a grit removal system.

Based on our review of the documents provided, and on the attendance of our staff at the public meetings, we have several questions and comments. These are indicated by area of concern in the following paragraphs.

Relationship to Previous Studies and Overall Project

Overall, we believe that the draft feasibility report adequately reflects the results of a series of four Environmental Impact Studies (EISs) prepared by USEPA, Region 5, on the TARP Phase I subsystems (O'Hare, Mainstream, Calumet, Lower Des Plaines) and the impacts of these subsystems on surface water quality. Phase II facilities, which are the subject of the feasibility report, also were evaluated in terms of water quality impacts as part of that effort, which focused on Phase I components.

1. The present proposal does not include the Phase II tunnels. During the worst storm, this lack could be a constraint to conveyance in the system. The plan does project storage to capture runoff from a 50-year event, but the summary does not explicitly address whether the conveyance is adequate for the same event. The final report and EA should discuss this concern.

Design Concerns

2. As presently proposed, the system would not reduce overbank flooding by direct diversions from the Chicago River or the Des Plaines River (emptying the sewers into the tunnel will have some indirect reduction). Some inflow of river water may be necessary to reduce the incidence of backflows to Lake Michigan to the level generally expected. The summary contains projections of backflows of once in 8 to 9 years at the Wilmette Locks and once in 12 to 13 years at the Chicago Locks and the O'Brien Locks. The Metropolitan Sanitary District of Greater Chicago (MSDGC) proposal was approximately once in every 25 years (or 4 times in the existing 100 years of record). The recent (summer 1986) flooding is an example of where this difference in design would be significant.



Response

1. The TARP Phase I tunnel in the Mainstream System has sufficient capacity to carry the runoff from the Mainstream area to the McCook Reservoir up to approximately the 45-year flood event. During a 50-year event some combined sewer overflows to the watercourses might occur depending upon the timing of the peak discharge. The main report identifies the capacity of the Phase I tunnels on page 89.

2. The tunnel and reservoir system is not designed divert water directly from the area watercourses and thereby reduce the incidence of backflows to Lake Michigan. The system is designed to substantially reduce the number and volume of combined sewer overflows to the watercourses, thereby reducing the volume of runoff discharging into the watercourses and reducing the number of times floodwater will have to be backflowed to Lake Michigan. Backflows of once in 8 to 9 years at Wilmette and 12 to 13 years at the Chicago and O'Brien locks reflect the floodwater storage capacity (46,700 acre-feet) of the recommended reservoirs (NED plan). In the original TARP, the combined storage capacity of the McCook and Thornton Reservoirs was 124,000 acre-feet. Therefore, the number of backflows would be less under the original plan than under the NED plan.

3. The Des Plaines system is designed for a protection level of the 14-year, 24-hour event, because pumping facilities would be used to transfer the water to the reservoir. We understood previously that the Des Plaines Tunnel would connect to the Mainstream Tunnel by gravity. Although the USEPA EIS (August 1977) for the Mainstream Tunnel does not explicitly show such a connection, it does include a description of common use of the pumping station for dewatering. The text on pages V-11, V-24, and V-8 of that EIS implies that there is gravity discharge from both systems to the reservoirs. Because the Illinois Environmental Protection Agency (IEPA) has indicated that the Des Plaines Tunnel may be proceeding in the near future, and USEPA will need to reevaluate the system under current regulations; and because COE is relying in part on this previous EIS, the water quality ramifications of using such a pumping system need to be explored prior to issuance of the final version of the General Design Memorandum. We understand that there could be a significant cost savings if this step is taken.

Ground Water Quality

4. The Region 5 EISs were not conclusive in terms of beneficial, neutral, or negative impacts on ground water quality. Therefore, a ground water monitoring system was required, as well as back-up mitigation measures, in the event that the Phase I tunnels contributed to or caused ground water contamination. Because there is the potential for exfiltration of wastewater from the proposed Phase II reservoirs into the ground water, and because the sealing technique to be used would not apply to 100 percent of the reservoir floors and walls, we recommend that the Corps of Engineers develop a ground water monitoring plan and mitigative measures. The mitigative measures would be used only if ground water contamination due to operation of the Phase II reservoirs is detected by means of the monitoring system.

Blasting

Blasting would be used to deepen the primary basins. COE has indicated that U.S. Bureau of Mines standards will be followed. We support the use of these standards, which we understand are more protective than those used for the Phase I dropshafts. The use of those standards caused adverse public reaction.

Odors

5. Several mechanisms are identified in the Final Design Memorandum to control odors from the reservoirs. Paddle aerators would be installed, and the central basins would be washed down after they are emptied. The solids from these basins would be flushed to the inlet/outlet structure and then conveyed to the treatment plant. The solids in the primary basins would be removed by means of a floating dredge, dewatered, and loaded into trucks for land disposal. We would like more information on the methods to be used for dewatering, loading the trucks, and land disposal. Because the primary basins would not be emptied, aeration would continue during non-use periods.

2-21

Response

3. There will be no difference in the water quality benefits attributable to TARP Phase I, funded in-part by the USEPA, under a Phase 2 TARP pump station operation as compared to a Phase 2 TARP gravity fill operation. The flow from the Phase I tunnels would pass through the pump station to the West-Southwest Treatment Plant under either type of oepration. There will be some reduction in water quality benefits attributable to Phase 2 TARP under the recommended NED reservoir plan compared to the original TARP. The reduction in potential benefits is reflected in the benefit-cost analysis of the recommended McCook Reservoir project.

4. The proposed aquifer protection plan elements are described on page 118 and illustrated on plate 5 of the main report. The proposed plan at both reservoirs will consist of pressure grouting the existing quarry rock walls, applying a bitumen coating on the reservoir walls that have fragmented areas, and sealing the floor of the reservoir with a bituminus or rollcrete pavement. The grouting will occur around the entire perimeter of both reservoirs. The pavement will cover the entire floor of each reservoir.

In addition, to prevent hydrostatic pressure from building-up beneath the floor of the reservoir and to prevent the outward migration of water which might penetrate the aquifer protection system, an underdrain system will be utilized to collect groundwater from beneath the reservoir and pump it into the reservoir interior. A system of drain tiles will be placed in the aggregate material between the reservoir floor pavement and the rock floor of the quarry and around the reservoir perimeter at floor depth to collect groundwater from below and around the reservoir. This underdrain system will slope toward a central sump where it will be pumped into the interior of the reservoir. The underdrain system will, in effect, maintain a groundwater gradient in the vicinity of the reservoir which is sloped toward the reservoir thus prohibiting the possibility of exfiltration from the reservoir from migrating away from the reservoir into the local groundwater.

A groundwater monitoring program will be developed during the detailed design phase of each reservoir. A system of wells will be installed around the perimeter of each reservoir early in the construction phase. The wells will be monitored during the construction period to develop baseline data on the quality of the groundwater in the vicinity of each reservoir. Monitoring of the wells will continue during the operation phases of the reservoirs to confirm the effectiveness of the aquifer protection system. Should groundwater contamination be detected due to operation of the reservoirs, mitigative measures could include increasing the rate of pumping of the underdrain system beneath the reservoir floor to create a greater cone of depression and greater migration of groundwater toward the reservoir. Mitigation measures could also include providing denser pressure grouting and further bitumen coating of the reservoir walls and floor in the area of suspected exfiltration.

5. The dredged solids will be pumped to a dewatering the washing facility located at the surface adjacent to the reservoir. The settled solids will be washed and augered to truck loading hoppers and then transported to an approved commercial land disposal area. The supernatant will be returned to the reservoir. The disposal procedure would be similar to the process presently used to dispose of grit from the existing MSDGC waste treatment plants.

6. The 1977 EIS indicated on page V-12 that the West-Southwest treatment facility needed to be expanded to 1,358 million gallons per day (mgd) to accomodate the Phase I project. The summary provided by COE did not address the capacity required at the treatment plants to handle the additional loadings. It also was not made clear whether the economics of the project provide for any additional treatment works, or if the present design makes use of off-peak capacity. These topics should be addressed in the Final Design Memorandum.

We believe that the proposed project will provide significant water quality benefits to the watercourses in the area, and that the impacts from the construction and operation of the project will be minor, of short duration, and would not adversely affect human health or the environment. We have no objection to the overall concept of the project. However, we do have reservations, as indicated in the previous paragraphs, regarding some of the design and operational details. We would appreciate receiving the additional information we requested regarding these concerns. Also, if there are any modifications proposed in the construction or operation of the project as a result of comments received at the public meetings or during the public comment period, we would appreciate being informed of these proposed changes.

Thank you for the opportunity to review the documents regarding this project. If you have any questions regarding our comments, please contact Ms. Kathleen Brennan of my staff at FTS 886-6873 (commercial 312/886-6873).

Sincerely yours,

William D. Franz

William D. Franz, Chief
Environmental Review Branch
Planning and Management Division

Response

6. The capacity of the West-Southwest Treatment Plant will be increased to 1,358 mgd in three stages of construction which will be sufficient to dewater the TARP tunnels. The Calumet facility is being expanded and upgraded to a design capacity of 354 mgd which will accommodate dewatering of the TARP tunnels. This capacity is equal to 1.5 times the average dry weather flow. The expansion of the Calumet plant is nearly completed. The designs of the recommended reservoirs are consistent with these treatment plant capacities. No further increase in treatment plant capacity will be required in connection with operation of the reservoirs.

APPENDIX NO. 3

# Plan of Study
# Tunnel and Reservoir Plan
# Special Evaluation Project
# 86-2

## Background - TARP Objectives and Current Status:

The development of the Tunnel and Reservoir Plan (TARP) began in mid-1960 and culminated in 1972 with the Chicago Underflow Plan. The multi-purpose plan was modified by the Metropolitan Sanitary District of Greater Chicago (MSDGC) and renamed TARP, but its objectives remained as:

- ° Control Flooding Impacts
- ° Control Waterway Pollution Impacts
- ° Eliminate Polluted Backflows to Lake Michigan

TARP's original planning was devoted to combined sewer overflow (CSO) impacts and waterway capacities. Parallel planning was accomplished for wastewater treatment needs. The distinction between the plans for flood and pollution control was largely obscured due to the close integration of facilities. Consequently, the title has evolved to embrace all of the flood (Phase II) and pollution (Phase I) control elements.

Subsequently, between 1975 and 1984 the USEPA provided 972.7 million dollars in funds for 19 TARP projects in the Upper Des Plaines, Lower Des Plaines, Mainstream and Calumet TARP systems. The current status is summarized below:

| System | # Grants | Grant Amount (million) | Status |
|---|---|---|---|
| Upper Des Plaines | 4 | $75.3 | Operational/1982 |
| Lower Des Plaines | 1 | $19.6 | Under Construction |
| Mainstream | 11 | $759.3 | Operational/1985 |
| Calumet | 3 | $118.5 | Operational/1986 |

Based on the TARP Phase I elements that are operational and the objectives of the TARP Phase I, the USEPA Region V office has put together the following Plan of Study.

## Purpose:

This Special Evaluation Project (SEP) will provide an analysis of the constructed portion of TARP Phase I.

Specifically, SEP objectives will be directed:

1. To compile information on operation and design data pertaining to conditions prior to construction of operational elements of TARP Phase I.

2. To compile information on conditions pertaining to the actual construction and operational data of operational elements of TARP Phase I including effects on ground water quality.

3. To compare and contrast the "design" and "operational" data.

4. To evaluate the effect of operation of the TARP Mainstream system on indicators of water quality. The task of collection and analysis of the information in the water quality portion of the study is extended to allow time for the system to stabilize (particularly with respect to existing benthic deposits) and respond to reduced input loads as identified on the attached extended project schedule (Page 7).

Scope:

The evaluation of TARP Phase I operational elements will be separated into three areas, with the examination focusing on different aspects of the projects due to their unique characteristics.

Upper Des Plaines TARP

- Historical aspects of the operation of the Upper Des Plaines TARP system, focusing on correlations to current portions of other elements of the system that are now operational.

- Major construction, maintenance or operational characteristics.

Mainstream TARP (Focus of Region V effort)

- Operational characteristics in relation to design parameters (Effectiveness of wastewater capture).

- Effects of operation on WWTP. (Note: Allowances will be made for ongoing WWTP construction.)

- Major construction, maintenance or operational characteristics.

- Water quality indicators will be assessed in an area that encompasses portions of the Chicago waterways downstream and adjacent to the Mainstream System, e.g., Northshore Channel, North Branch Chicago River, Chicago River, South Branch Chicago River, Sanitary and Ship Canal, and the Lower Des Plaines River.

- The effects of TARP operation on Lake Michigan will also be assessed within the context of backflow events and beach closures in the vicinity of the Wilmette and Chicago Lock and Dams.

Calumet TARP

- Major construction, maintenance or operational characteristics.

Specific Study Questions:

1. What operational data are available for TARP?

2. Is TARP operating as designed?

3. Were problems encountered during construction?

4. What was the result of the problem and how was the problem resolved?

5. What performance data is available for wastewater treatment plant operation prior to TARP dewatering?

6. What flows and loadings are coming out of TARP?

7. Does TARP dewatering significantly impact treatment plant performance?

8. Do recent COE reports on Phase II of TARP have any impact on the basic assumptions inherent to constructing the remaining TARP Phase I components?

9. Has the operation of Upper Des Plaines TARP identified areas of unexpected benefits or concerns?

10. Does a correlation exist between these benefits and concerns, (see 9. above) and any other TARP construction?

11. Has TARP affected the number of backflows to Lake Michigan?

12. Will operation of TARP influence future water quality and biological conditions in the Chicago River waterways?

13. What records and facilities are available as part of the TARP Phase I ground water monitoring program?

14. Do the general water records show any interconnection between the tunnel system and the aquifer.

15. Does the TARP ground water monitoring program effectively monitor potential ground water contamination?

16. Will TARP influence the frequency of backflow events (and consequently beach closures) in Lake Michigan?

Work Description for Water Quality Studies

° The water quality analysis is designed to review, evaluate and analyze past, current and future data collection results related to specific water quality indicators.

° Water quality indicators of potential biological, chemical and physical influences from TARP Mainstream operation will consist of:

  - Biological parameters including fish, benthic macroinvertebrate and phytoplankton community structure, and bacteriological quality;

  - Chemical parameters including D.O., $BOD_5$, $NH_3$-N, TKN, TDS, TSS, SOD, volatile solids, metals, turbidity;

  - Historical and ongoing records relating to backflow events and beach closures.

° To examine the influence of other factors which may affect water quality, correlation analyses will be analyzed between water quality parameters and:

  - River discharge/diversion data;

  - Rainfall/runoff information;

  - Municipal treatment plant inputs; and

  - Combined sewer overflow inputs.

° Specific outputs will include:

  - Baseline Water Quality Report and documentation of analytical methods for ongoing data collection efforts, September, 1987;

  - Interim Water Quality Report (1986 - 1987), September, 1988;

  - Water Quality Report (1986 - 1989), September, 1990.

<u>Specific Information Sources (in addition to USEPA files):</u>

Metropolitan Sanitary District of Greater Chicago (main information source) -

° Examination and compilation of available data regarding the operation of the TARP Phase I system and related treatment plants.

° Observations of officials who oversaw construction, design and operation/maintenance of the project.

° Description of ground water monitoring systems and data reports.

° Detailed results and analyses of chemical, physical, and biological monitoring in Chicago River Waterways (historic and ongoing efforts).

U.S. Army Corps of Engineers -

- Examination of any COE files for information pertaining to TARP start-up.
- Examination of potentially related general design memorandum.
- Examination of related environmental documents prepared by the COE concerning TARP.
- Observations of project managers.

Illinois Environmental Protection Agency -

- Examination of grants and permits files.
- Observations of project managers, Grants Administration Section coordinators, Permits Section and Planning personnel.

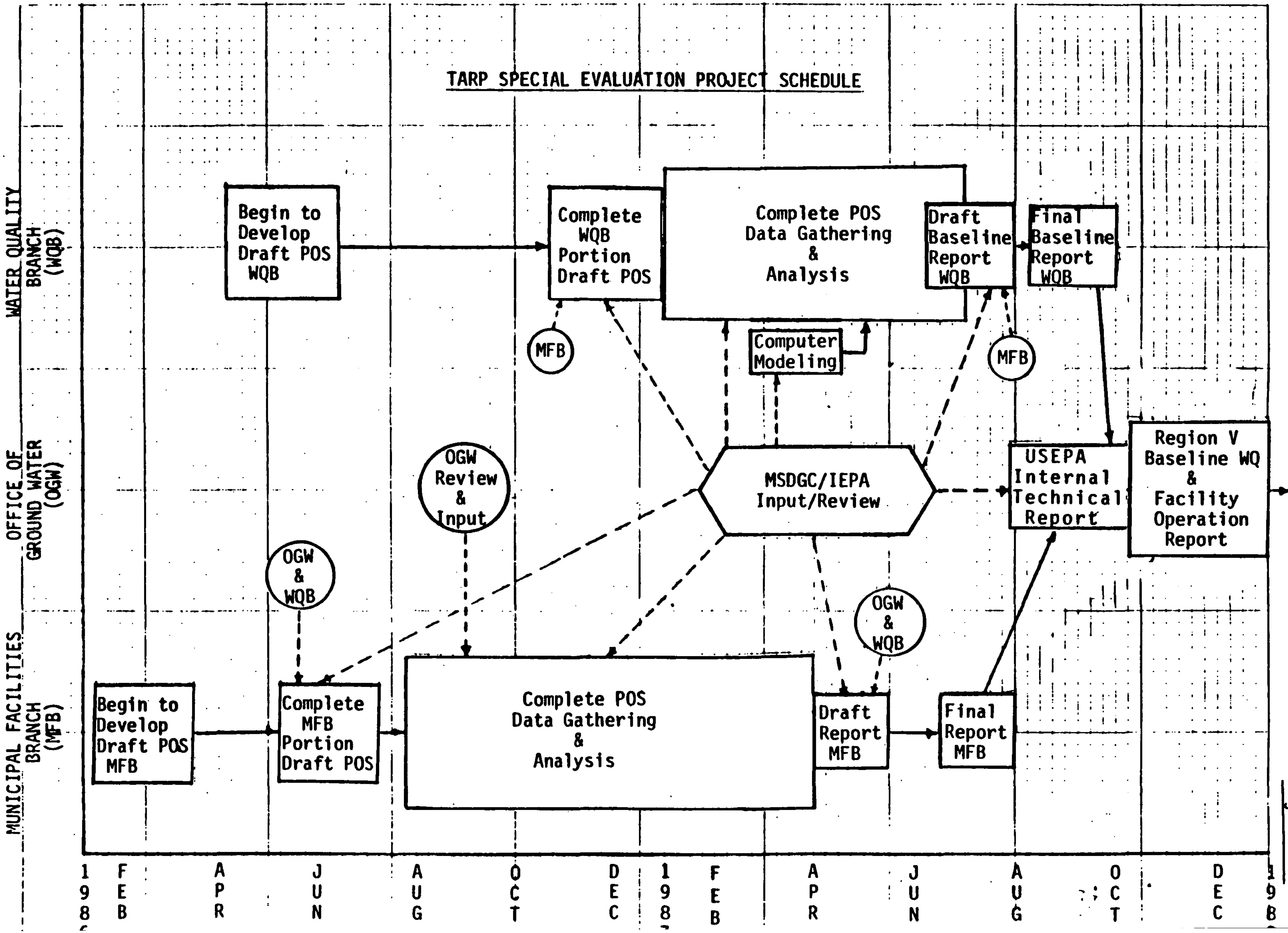
U.S. Geological Survey -

- Potential use of results from a 3.5 year pilot water quality study of the upper Illinois River basin.

USEPA Responsibilities:

| | |
|---|---|
| Valdis Aistars | ° COE Coordinator.<br>° Calumet TARP focus. |
| Noel Kohl | ° Team Leader, Water Quality Branch. |
| Ernesto Lopez | ° Mainstream TARP focus. |
| James Luey | ° Water Quality Standards. |
| Russell Martin | ° Team Leader, Municipal Facilities Branch (MSDGC Contact).<br>° Project scheduling, coordination and report. |
| Thomas Poy | ° Upper Des Plaines TARP focus.<br>° MSDGC planning and design focus. |
| Charles Pycha | ° IEPA Coordinator.<br>° Mainstream TARP focus. |
| David Siebert | ° Ground Water focus.<br>° Contact for Office of Ground Water. |

Scheduling: See pages 6 and 7.


TARP SPECIAL EVALUATION PROJECT SCHEDULE
WATER QUALITY BRANCH (WQB)
OFFICE OF GROUND WATER (OGW)
MUNICIPAL FACILITIES BRANCH (MFB)
Begin to Develop Draft POS WQB
Complete WQB Portion Draft POS
Complete POS Data Gathering & Analysis
Draft Baseline Report WQB
Final Baseline Report WQB
Computer Modeling
MFB
MFB
MSDGC/IEPA Input/Review
USEPA Internal Technical Report
Region V Baseline WQ & Facility Operation Report
OGW Review & Input
OGW & WQB
OGW & WQB
Begin to Develop Draft POS MFB
Complete MFB Portion Draft POS
Complete POS Data Gathering & Analysis
Draft Report MFB
Final Report MFB
1986
FEB
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1987
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198

LONG-RANGE TARP SCHEDULE

| | WQB | MFB |
|---|---|---|
| FY 87 | Data Collection Baseline | Data Collection and analysis of Operational TARP systems |
| FY 88 | WQ Data Collection Interim Report | Supplemental report based on fully operational Calumet WWTP |
| FY 89 | WQ Data Collection | Supplemental report based on fully operational West-Southwest WWTP. |
| FY 90 | TAPR Interim WQ Improvement Reprot | |