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SUMMARY OF FINDINGS

ON

REMAINING SEGMENTS OF TUNNEL AND RESERVOIR PROJECT

AND

METROPOLITAN SANITARY DISTRICT

OF GREATER CHICAGO

ADVANCED TREATMENT FACILITIES

PROPOSED FOR

METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO

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FOREWORD

This report reviews the Tunnel and Reservoir Plan (TARP) and advanced secondary treatment plants of the Metropolitan Sanitary District of Greater Chicago (MSDGC). Only unfunded segments of TARP and the treatment plant projects were reviewed.

This report is one of a series prepared since 1979 in response to Congressional direction that any project incorporating advanced waste treatment, the incremental cost of which exceeds $3,000,000, shall be personally reviewed by the EPA Administrator to determine that the project provides significant water quality benefits and public health improvements.

EPA implemented the Congressional directive in Program Requirements Memorandum (PRM) 79-7. In 1979, the State of Illinois sued EPA regarding these reviews and a settlement agreement was entered into and made a court order. As a part of that settlement agreement, EPA proposed a revision to PRM 79-7 in the June 20, 1980, Federal Register.

In 1979, the General Accounting Office (GAO), in response to a Congressional request, issued a report on TARP. The report is critical of the project. EPA, therefore, decided that the review of the treatment plants would also include a detailed review of the TARP project in relation to EPA combined sewer overflow policy and addressing the issues raised by GAO. These reviews have been combined in this report.

PURPOSE AND SCOPE

- Proposed treatment projects involve expansion and/or upgrading of three wastewater treatment plants, with design flows totalling over 2,000 MGD.

- Proposed CSO facilities considered in this review are three major systems of TARP Phase I. TARP is basically a system of underground tunnels that will hold CSOs until they can be pumped up for treatment at two of the wastewater treatment plants.

- Advanced treatment facilities and TARP facilities reviewed in accordance with Program Reouirements Memoranda (PRM) 79-7 and 75-34.

- Impetus for this review of TARP facilities comes from May 1979 report by GAO which recommended that TARP should be re-evaluated in light of significant cost escalations that have occurred since the original review and approval. In October 1979 response to the GAO report, EPA agreed that this review should be conducted prior to further funding of TARP elements.

- TARP facilities addressed in this review are limited to the unfunded portions of TARP Phase I. A 1975 EPA report distinguished between those portions of TARP designed primarily for pollution control (Phase I) and those portions primarily for flood control (Phase II).

- Figure III-A-1 shows the study area, the status, and location of TARP.

- Capital costs are ($ millions):

  - o Treatment Plants $ 822.73
  - o Unfunded TARP Phase I $1,124.4

- Design for the unfunded TARP Phase I is complete. Construction could begin around 1983, pending the outcome of this review.

- Design of the Calumet treatment plant is near completion; construction is scheduled to begin in FY 81. Design of the other treatment facilities is underway and is scheduled to be completed around 1983.

ABBREVIATIONS

NOTE: The terms benthic demand, benthal demand and sediment oxygen demand are used interchangeably in this report.

ADF	-	average daily flow
ADWF	-	average dry weather flow
AF	-	acre feet
AST	-	advanced secondary treatment
BOD	-	biochemical oxygen demand
BOD_5	-	five-day biochemical oxygen demand
CBOD	-	carbonaceous biochemical oxygen demand
CFM (cfm)	-	cubic feet per minute
cfs	-	cubic feet per second
cnts/ml	-	counts per milliliter
°C	-	degrees centrigrade
CSO	-	combined sewer overflow
CSTW	-	Calumet sewage treatment works
DO	-	dissolved oxygen
DT/D	-	dry tons per day
DWF	-	dry weather flow
E&I	-	expansion and improvement
EPA	-	Environmental Protection Agency
ft	-	feet
ft^2	-	souare feet
°F	-	degrees fahrenheit
GAO	-	Government Accounting Office
gpm	-	gallons per minute
gpcd	-	gallons per capita per day
gpd/ft	-	gallons per day per foot
gpd/sf	-	gallons per day per souare foot
$gm/m^2/day$		gram per souare meter per day
HASMA	-	Harlem Avenue solids management area
HRT	-	hydraulic retention time
HP	-	horsepower
IEPA	-	Illinois Environmental Protection Agency
I/I	-	infiltration/inflow
IPCB	-	Illinois Pollution Control Board
lbs.	-	pounds
MG	-	million gallons
MGD	-	million gallons per day
mg/l	-	milligrams per liter
ml	-	milliliter
MSDGC	-	Metropolitan Sanitary District of Greater Chicago
NBOD	-	nitrogenous biochemical oxygen demand

NH_3-N	-	ammonia-nitrogen
NIPC	-	Northeastern Illinois Planning Commission
NO_3-N	-	Nitrate-Nitrogen
NPDES	-	National Pollutant Discharge Elimination System
NPS	-	nonpoint sources
NSSTW	-	Northside Sewage Treatment Works
O&M	-	operation and maintenance
PO_4	-	Phosphate
POTW	-	publicly-owned treatment works
SOD	-	Sediment-Oxygen Demand
SS	-	suspended solids
STP	-	sewage treatment plant
STW	-	sewage treatment works
TARP	-	Tunnel and Reservior Project
TDS	-	total dissolved solids
TSS	-	total suspended solids
UOD	-	ultimate oxygen demand
WRP	-	water reclamation plant
WSW	-	West-Southwest Treatment Plant
WSWSTW	-	West-Southwest Sewage Treatment Works

I. CONCLUSIONS

A. Attainability of Uses

- Since Des Plaines River, North Branch and Little Calumet River flow through predominately residential areas and forest preserves, toxic conditions are unlikely to exist in these waterways.

- Also, the relatively shallow sediments of these natural waterways will allow rapid reduction in SOD after CSO control measures are taken.

- Thus, beneficial uses are likely to be attained in those waterways if CSO control measures are taken.

- In waterways with instream aeration, including Main Channel Chicago River, North Shore Channel, and Cal-Sag Channel, water quality modeling shows DO standard will be met even if there is no reduction in SOD.

- In Calumet River upstream from O'Brien lock, instream aerators are not proposed; therefore, DO standard might not be achieved in this area unless there is significant reduction in SOD.

- Chemicals and heavy metals believed to be in the sediments of MSDGC waterways, especially in the Main Channel of the Chicago River and in Calumet region as a result of heavy industrialization and urbanization.

- The resuspension of these chemicals and heavy metals in the waters, especially in the Main Channel and Calumet area, resulting from improved DO conditions due to operation of instream aerators and the implementation of TARP to reduce CSOs might prevent attainment of beneficial uses of MSDGC and downstream waters. Dredging, if needed, could correct this potential problem.

B. TARP Facilities

1. North Branch

- Water quality analyses and "knee of curve" analysis show that proposed level of CSO control associated with TARP Phase I for the North Branch segment is reasonable.

- Evaluation of CSO control alternatives is reasonable; proposed TARP Phase I option is the most cost-effective alternative for this segment.

2. Des Plaines

- "Knee of curve" analysis shows that proposed level of CSO control is justified for this segment of TARP Phase I.
- Evaluation of CSO control alternatives is reasonable; proposed TARP Phase I option is the most cost-effective alternative for this segment.

3. Calumet

Little Calumet

- Water quality analyses and "knee of curve" analyses (done for entire Calumet area) show that the proposed 87 percent level of control is justified for the Little Calumet segment of TARP Phase I.
- Evaluation of CSO control alternatives appears reasonable; proposed TARP Phase I option is the most cost-effective alternative for this segment.

Torrence Avenue (Calumet River) and 140 Street Legs (Grand Calumet)

- Persistent SOD due to deep benthal deposits in Calumet River upstream from O'Brien lock may preclude attainment of beneficial uses in this area unless dredged, even with CSO control; benthal depth profiles have not been provided for this area (for the Calumet River upstream of O'Brien Lock).
- Affects of chemicals in benthic deposits should be evaluated prior to funding both segments of TARP.
- CSO control for the Calumet waterway upstream from O'Brien Lock might be needed to prevent standards violations at the South District water supply intake located in Lake Michigan; however, (1) data concerning the frequency and severity of standards violations at this point has not been provided, (2) the linkage between CSO events in the Calumet River and standards violations at the water supply intake has not been established, and (3) even assuming some relationship between CSO events and violations at the water supply intake, it is not clear that the level or type of CSO control requested by TARP Phase I is

the most cost-effective control option for this purpose. Therefore, it is not clear that this segment of TARP is needed to eliminate standards violations at the South District water supply intake (for the Calumet River upstream of O'Brien Lock).

- TARP is the most cost-effective option assuming the proposed 87 percent level of control is justified; however, other options providing lower levels of CSO control may be less costly than TARP (both Torrance Avenue and 140th Street Legs).

4. GAO Report Recommendations

- Some GAO proposed alternatives to TARP are primarily for abating local and basement flooding problems; others would provide for limited pollution control.

- None of GAO options would likely provide sufficient CSO control to ensure attainment of fishery use of North Branch, Des Plaines, and Little Calumet Rivers.

C. Wastewater Treatment Plants

1. Water Quality Analyses

- All conclusions (i.e., Sections 1 and 2, below) assume benthic chemicals and heavy metals will not prevent attainment of water uses or that bottom deposits will be dredged.

- 10 mg/l BOD_5 requirement was established through Illinois State regulation.

- New MSDGC modeling analyses (June 26, 1980) showed that assuming no SOD reduction, with each plant at 1978 treatment levels and with instream aeration, the DO standard can be maintained during warm weather months.

- Results of new modeling (June 26, 1980) suggest that with some SOD reduction, as is expected from CSO control, the 10 mg/l BOD_5 requirement might be unnecessarily stringent.

- Ammonia toxicity analysis shows that nitrification may be needed to prevent ammonia toxicity during warm weather conditions in MSDGC waters.

- It is unclear whether ammonia removal is justified for ammonia toxicity purposes during cold weather conditions due to discrepancy of pH between the effluent and stream data, and also the dilution capacity of the receiving water below the confluence with the Des Plaines River; clarification of pH data and dilution flows of receiving waters is needed. Information has been requested from the State of Illinois but not received at the time of this draft report.

- Because DO modeling analyses of MSDGC waters are based on warm weather conditions, it is unclear whether nitrification for either CBOD or NBOD reduction is needed during cold weather for DO purposes. (During cold weather, reaction rates would be significantly lower, and DO saturation would be higher.)

- Water quality data below Lockport show that DO problems are caused by nitrification resulting from ammonia discharges in MSDGC waters, and by low background DO's, which reflect polluted conditions in MSDGC waters (i.e. existing benthal deposits and point source discharges). If background DO problems are eliminated, it is reasonable that some level of nitrification for discharges in MSDGC waters is needed to prevent DO problems below Lockport. The level of nitrification needed in MSDGC waters under future conditions to attain DO standards in waters below Lockport is unclear; however, it is likely that at least the level of ammonia removal provided by the Calumet STP (about 25 percent of total MSDGC ammonia) is needed.

2. Treatment Plants

<u>All Treatment Plants</u>

- New modeling studies (June 26, 1980) show that the 10 mg/l BOD_5 effluent limitation may not be needed to attain beneficial uses.

- Water quality analyses show that nitrification is needed during warm weather conditions to meet effluent limitations for BOD and NH_3-N; from a water quality standpoint, it is unclear whether nitrification is needed for either BOD or NH_3 removal during cold weather conditions.

<u>Northside Treatment Plant</u>

- Full scale treatability study at the existing plant showed that nitrification followed by clarification could produce an effluent BOD concentration of about 13 mg/l, or about 3 mg/l greater than the design effluent limitation of 10 mg/l; 50 percent tertiary filtration is therefore proposed to assure compliance with effluent limitations.

- With the operation of the new O'Hare plant, NSSTW will receive flows exclusively from combined sewers with lower influent BOD levels; therefore, effluent BOD should decrease somewhat.

- Existing facility used for pilot study provides inadeouate primary clarification and does not have optimum nitrification capabilities.

- Proposed facility will add primary clarifiers, areation basins to optimize nitrification, and additional final clarifiers; it is therefore likely that with these improvements and the elimination of the O'Hare flows, the proposed facility will be capable of achieving an effluent capable of meeting water ouality standards without tertiary filters.

West-Southwest Treatment Plant

- Available data show that secondary treatment followed by nitrification is needed during warm weather conditions to meet permit effluent limitations for BOD and NH_3-N; from a water ouality standpoint, it is unclear whether nitrification is needed for either BOD or NH_3 removal during cold weather conditions.

- Operating data show proposed detention times to provide nitrification are more than needed to achieve effluent BOD or NH_3-N limitations; these data show that detention times would be adeouate to meet effluent limitations if only half of the additional tank capacity is added.

Calumet Treatment Plant

- Operating data and engineering report (Metcalf & Eddy) indicate that facility will be capable of meeting 10 mg/l BOD_5 effluent limitation without filtration.

- Water oualtiy analyses do not show the need for design effluent limitations for suspended solids; therefore, filters are not justified from a water oualtiy standpoint for this purpose.

- The level of nitrification provided at Calumet STW is probably reouired to achieve DO standards downstream of Lockport; nitrification at one or both of the other STWs may be needed as well. Additional modeling to settle the issue of nitrification at the other STWs is being done but the results were not available at the time of this draft report.

II. RECOMMENDATIONS

A. Attainability of Uses

- Studies of possible existing and future contaminant problems in the Calumet and Grand Calumet Rivers should be conducted prior to Step 3 funding of these sections of TARP; first, a rough water quality dilution and other preliminary analyses should be made to determine potential impacts (including sensitivity analysis); more detailed modeling studies should be conducted if simplified analyses show potential problem (see detailed conclusions in Section VI.B.1.).

- If studies show contaminants will preclude attainment of uses, abatement measures, such as dredging, should be assured when remaining TARP Phase I receives Step 3 funding.

- If DO modeling or ammonia contaminant analysis below Lockport does not justify need for nitrification at all the proposed treatment facilities, studies of possible existing and future contaminant problems in the Chicago River should be conducted prior to Step 3 funding of AST facilties for Northside and West Southwest STWs; if studies show contaminants will preclude attainment of uses in the Chicago River, corrective measures (e.g., dredging) should be assured when treatment facilities beyond secondary for the Northside and West Southwest treatment plants are Step 3 funded.

B. TARP

- Funding of remaining portions of TARP Phase I for the North Branch, Des Plaines, and Little Calumet areas should proceed.

- Prior to funding of remaining portions of TARP Phase I for the Calumet and Grand Calumet segments (i.e., Torrence Avenue and 140th Street segments) the following analyses must be completed:

  o studies of possible contaminants problems discussed in Section A demonstrate that contaminants will not preclude attainment of designated water uses or, if these studies show that contaminants will preclude achieving benefiical uses, provisions for corrective measures, such as dredging, are assured when Step 3 grants are awarded.

  o in addition, for the segment upstream from the O'Brien Lock, (1) benthic core sample analyses show that existing SOD due to deep benthal deposits will be substantially reduced in a short period of time after the construction of TARP Phase I (say, 5 to 10 years) to enable attainment of DO standards, or (2) water quality analyses show that the proposed level and type of of CSO control are justified to prevent backflows at Calumet River from causing water quality standards violations at the South District water supply intake in Lake Michigan.

C. <u>Treatment Plants</u>

- Funding of tertiary filtration for the Calumet and Northside treatment plants should be deferred unless it is shown after operation of the funded facilities that filters are needed to achieve water quality standards; the State should re-examine the permits and change them based on results of most recent MSDGC modeling analyses.

- Funding for nitrification facilities at Calumet STW should proceed if mathematical modeling (including sensitivity analyses, but without calibration) currently underway of waters below Lockport justifies nitrification at the Calumet facility in order to achieve water qualiy standards below Lockport.

- For the Northside and West Southwest plants, Step 3 funding of either or both plants, as needed, may proceed if water quality modeling or ammonia contaminant analyses show that ammonia removal is needed at one or both of these plants to prevent standards violations below Lockport. (Modeling studies should be designed to determine the level of ammonia removal required in MSGDC waters to maintain DO standards below Lockport).

- If nitrification at either WSWSTW and NSSTW is not required to protect water quality standards downstream of Lockport, and benthic contaminant studies recommended in section A (above) show that the benthic contaminants will not preclude attainment of uses, nitrification facilities for both plants may be funded (See Chapter VII: Evaluation of Advanced Treatment Issues); however, funding for nitrification for the West-Southwest plant should be provided only for the first stage expansion of Batteries E and F, unless effluent and water quality data from the first stages of operation show that the second and third stages are also needed to achieve water quality standards.

- If contaminant studies show that benthic deposits could preclude attainment of beneficial uses in the Chicago waterways, assurances of dredging or other corrective measures must be provided when Step 3 grants are awarded for the nitrification facilities.

- Cold weather ammonia removal reouirements should be reviewed after resolving apparent inconsistencies in pH data and dilution capacity below Lockport.

- Funding for construction of improvements needed to provide adeouate primary and secondary treatment should proceed, regardless of water ouality and facilities issues discussed above.

III. EXISTING FACILITIES

A. Overview

- Metropolitan Sanitary District of Greater Chicago (MSDGC) was established in 1889 by Illinois State legislature to protect Lake Michigan from pollution.

- MSDGC owns and operates 70.5 miles of navigable waterways, 487 miles of interceptor sewers, and the following seven wastewater treatment plants with combined treatment capacity of approximately 1,870 MGD:

Plant	Present Design Capacity (MGD)	Level of Treatment
Northside	333	Secondary
West-Southwest	1,200	Secondary
Calumet	220	Secondary
O'Hare	72	AST
Lemont	1.6	Secondary
Egan	30	AST
Hanover	12	AST

- Service areas for above plants total approximately 838 square miles. Combined sewers serve forty-four percent of this area, or 375 square miles, utilizes combined sewers which collect wastewater generated by city of Chicago, plus 53 of 124 municipalities within MSDGC service area. Eighty-two percent of MSDGC 5.5 million residents are served by combined sewers. (See Figure III-A.)

- There are 645 combined sewer overflow points. Figure III-A-a shows the distribution of outfall points in the combined sewered area.

- CSO occurs when combination of sanitary sewage, storm drainage and infiltration exceeds capacity of interceptor sewers to convey combined flow to wastewater treatment facilities. Overflow structures bypass excess flow and discharge directly to streams.

- MSDGC officials report CSO events occurring at some locations with as little as one-tenth of an inch of rainfall. Overflow occurs at an average frequency of 96 times each year. MSDGC treatment plants treat an average storm runoff of 43.6 MGD (ref. 7, p. U9-40).

- MSDGC estimates that annual pollutant load discharged to streams when storms cause CSO events is equivalent to BOD load of 43,000,000 lbs. This pollutant load is roughly equivalent to 118 percent (ref. 7, p. U9-36) of BOD load contained in total discharges of all seven plants. Suspended solids (SS) loading is estimated at 199 million lbs. annually.

- During heavy rainfall when combined sewer outfalls lack sufficient capacity to convey excess flows to streams, combined flows may back up through collection system and cause flooding in basements and streets. MSDGC service area is particularly susceptible to backup of CSO because it contains large areas of flat, low-lying land.

B. Existing Treatment Facilities

1. Northside Sewage Treatment Works (NSSTW)

- NSSTW is a 333 MGD activated sludge secondary treatment plant serving a present population of approximately 1,374,000 (ref. 7, p. U9-123). Average daily flow projected for 1980 is 319 MGD (ref. 7, p. U9-125). Plant began operation in 1928 and was expanded twice--once in 1937 and again in 1962--to the current design flow. Effluent discharges into North Shore Channel.

- Plant previously served Northside and O'Hare service areas. O'Hare plant became operational in May 1980; NSSTW presently receives flows originating exclusively from Northside service area (Figure III-B-1-a) (ref. 19, p. N-II-2; ref. 98, p.1).

- Northside service area is approximately 141 square miles (ref. 85, p. III-1 to III-3).

- 414 MGD is present maximum hydraulic limitation imposed by NSSTW in-line siphon. Quantities in excess of 414 MGD are stored in sewers or diverted to either the North Branch of Chicago River or to North Shore Channel (ref. 85, p. VI-7).

- Northside tributary area is served by combined sewer system consisting of three major interceptors with an estimated capacity of 640 MGD without surcharge.

- Figure III-B-1-b presents schematic flow diagram of existing NSSTW. Wastewater treatment processes include primary settling tanks, aeration basins, final settling tanks and chlorination units.

- Primary sludges and secondary waste sludges are concentrated in sludge concentration tanks. All dewatered sludge accumulated within plant is pumped through a 17-mile pipeline for treatment and disposal at West-Southwest sewage treatment works (WSWSTW) (ref. 85, p. V-1 to V-18; ref. 93, p. I-1; ref. 136, p. 1-2).

- Operating efficiency of primary settling tanks is very low (ref. 85, p. V-7) due to inadeouate primary settling capacity.

- Characteristics of raw wastewater, primary settling tank effluent and final settling tank effluent are documented in Table III-8-1.

- Average effluent ouality from 1973 to 1979 as illustrated in Figure III-8-1-c, shows average annual BOD_5 of 10-15 mg/l, SS of 7-14 mg/l, and NH_3-N of 4-7 mg/l.

2. West-Southwest Sewage Treatment Works (WSWSTW)

- WSWSTW is a 1,200 MGD (design flow) activated sludge secondary treatment plant consisting of two separate, but interconnected facilities--Westside facility and Southwest facility. Average flow projected for 1980 was 874 MGD.

- Westside facility (operating since 1930) provides only primary treatment with a design capacity of 472 MGD. Southwest facility (operating since 1939) is an activated sludge plant with a design capacity of 728 MGD for the primary portion and 1,200 MGD for the secondary portion. Secondary portion also treats effluent from Westside facility.

- Four interceptor sewer systems are tributaries to WSWSTW. Salt Creek interceptor and Westside sewer are tributaries to Westside plant. Southwest and Argo interceptors are tributaries to Southwest plant. Cross connection between Westside sewer and Southwest interceptor provides flexibility for balancing flow to both plants for optimum treatment of total flow.

- Treated effluent discharges into main channel of Sanitary and Ship Canal.

- WSWSTW serves an area of MSDGC defined as the Central Drainage Basin, with a drainage area of 259.8 souare miles. Geographical definition of Central Drainage Basin is shown in Figure III-8-2-a. Largest single incorporated area in the Basin is 110 souare mile area of city of Chicago.

- WSWSTW serves a present population of approximately 2,431,000 (ref. 7, p. U-9-123).

- 1975-1978 effluent quality information indicates average annual BOD_5 of 5-7 mg/l, SS of 6-7 mg/l and NH_3 of 1.8-2.6 mg/l (see Table III-B-2). Excellent effluent quality is attributable to good plant design, light hydraulic load and excellent operation and maintenance (O&M).

- Figures III-B-2-b and III-B-2-c show existing plant layout and schematic flow diagram.

- WSWSTW plant has handling, stabilization and recycle systems for Northside solids output and for its own solids generation.

- Figure III-B-2-d presents flow chart for sludge processing system. Sludge from Northside plant is pumped through a 17-mile force main to the facility for processing.

3. Calumet Sewage Treatment Works (CSTW)

- Existing facility has a design capacity of 220 MGD and a maximum hydraulic capacity of 330 MGD. It is designed to provide preliminary and secondary treatment to the combined sewage of Calumet Basin.

- During 1978, average daily wastewater flow at the Calumet plant was 223 MGD. Lowest and highest daily flows during 1978 were 176 MGD and 316 MGD, respectively. Table III-B-3-a summarizes flows at the Calumet plant for the past several years.

- Calumet Basin, located in southern part of Cook County, includes part of city of Chicago and the suburban county communities. It is bordered on the south and west by Will and Du Page Counties, Illinois, and on the east by Lake County, Indiana. To the northeast is Lake Michigan.

- Area served by the Calumet plant, under MSDGC jurisdiction, is shown on Figure III-B-3-a. Present service area is 295 square miles. Northeastern sector of the area is highly developed and contains more than half of the area's population. It also contains a large percentage of the present industrial development, most of which is located between Lake Calumet and Lake Michigan.

- Northeast sector of service area contains combined sewers serving the city of Chicago and a number of suburban communities of Cook County. Approximately 70 square miles of the present service area are served by combined sewers. Outside of the highly developed northeastern sector, existing land use is predominantly suburban or rural. Potential demand for sewage collection and treatment facilities exists primarily in these more thinly populated outlying areas away from the Calumet plant. It is in these areas, adjacent to the corridors of transportation, that significant growth is taking place.

- Census population of present service area is 921,000. Table III-B-3-b shows past census data for present as well as proposed service areas.

- There are three main components of dry-weather flow: domestic flow, industrial flow, and infiltration flow. Estimates of present waste flows are 100 gpcd domestic flow, 60 gpcd industrial flow and 28 gpcd infiltration flow for a total present per capita dry-weather flow of 188 gcpd.

- Process flow schematic diagrams of existing treatment system and sludge process system for Calumet plant are shown in Figures III-B-3-b and III-B-3-c, respectively.

- Sludge is gravity thickened, anaerobically digested and lagooned on plant site.

- Design data for existing treatment units of Calumet plant are summarized in Table III-B-3-c.

- Performance of existing Calumet facilities during 1978 shows an average effluent BOD of 13 mg/l and NH_3-N 15.1 mg/l (Table III-B-3-d).

- Combined sewer system contributes periodic peak loads to the plant and causes storm flow bypassing.

C. CSO Facilities

1. North Branch and Mainstream System

- For purpose of this review, existing CSO facilities include the funded segments of TARP Phase I and three existing tunnels, one built by the city of Chicago and two by MSDGC, prior to MSDGC program which have since been incorporated into TARP project. (See Figure III-A-1.)

- Funded segments of Mainstream system contain approximately 31 miles of tunnels excavated in deep rock with associated collection structures and drop shafts. Funded pump stations have capacity sufficient to dewater tunnels of Mainstream TARP Phase I plus Des Plaines TARP Phase I. Construction contracts were awarded in sequence such that all funded segments can be made operational with no additional tunnel construction.

- Failure to complete TARP Phase I could result in excess pumping capacity under the present MSDGC facilities programs.

- WSWSTW is scheduled to treat CSO waters of North Branch and Mainstream systems.

- Tables III-C-1 and III-C-2 give descriptive data for funded and unfunded segments of TARP Phase I, respectively. Storage capacities in funded segments of Mainstream TARP Phase I are 2,558 acre-feet.

- MSDGC estimates funded segments of TARP Phase I would "capture" an average of 18,290,000 lbs. BOD load each year, or 83 percent of load discharged by some 222 overflows within funded segments (ref.7, appendix G).

2. Des Plaines System

- TARP Phase I tunnels for upper Des Plaines system have been funded and are not included in this review. (See Figure III-A-1.)

- No segment of lower Des Plaines tunnel system has been funded.

- WSWSTW is scheduled to treat CSO waters of lower Des Plaines system.

- Failure to complete TARP Phase I could result in excess pumping capacity at WSW STW under the present MSDGC facilities programs.

3. Calumet System

- Funded segments of Calumet system contain approximately 9.2 miles of main tunnels with associated collection structure and drop shafts. Funded pump stations have capacity sufficient to dewater funded plus unfunded tunnel segments of the Calumet system. Construction contracts were awarded in sequence such that funded segments can be made operational with no additional tunnel construction.

- Calumet sewage treatment plant is scheduled to treat CSO waters of the Calumet system.

- Storage capacities available in the funded and unfunded segments of Calumet TARP Phase I are 348 and 1,290 acre-feet, respectively. (See Tables III-C-1 and III-C-2.)

- Failure to complete Calumet Phase I could result in excess pumping capacity under the present MSDGC facilities programs.

- MSDGC estimates funded segments of TARP Phase I would "capture" an average of 3,806,000 lbs. BODs loads per year, or 78 percent of load discharged at 16 outfalls within the area (ref.7, appendix G).

IV. EXISTING QUALITY AND OTHER CHARACTERISTICS OF WATERS

A. Overview

- MSDGC area includes about 35 miles of Lake Michigan shoreline. In addition, there are over 200 miles of major streams within the MSDGC. Major streams are identified in Figure IV-A-1.

- In order to protect the area's prime water supply, Lake Michigan, the flows of the Chicago and Calumet River systems were reversed early this century. Approximately 54 miles of canals were constructed (North Shore, Main, and Cal-Sag Channels). Figure IV-A-1 shows the present 7Q10 flow regime of the study area.

- With the exception of drainage from a thin area of shoreline, occasional deliberate back flows at three diversion points to prevent urban flooding from very large storm runoffs are the only contributing flows to Lake Michigan.

- All streams within the MSDGC are classified as either General Use or Secondary Contact. The principal criteria for these uses are:

  - o General Use Water Standards: DO not less than 6 mg/l for more than 16 hours a day, never less than 5 mg/l; fecal coliforms 200 MPN/100 ml (geometric mean); NH_3-N never greater than 1.5 mg/l; sulfates 500 mg/l; TDS 1000 mg/l; chloride 500 mg/l.

  - o Secondary Contact Water Standards: DO not less than 5 mg/l for more than 8 hours a day, never less than 4 mg/l; fecal coliforms 1000 MPN/100 ml (geometric mean); other components have same standards as General Use Waters.

  - o General use waters shall also meet the following standards:

    - -- Freedom from unnatural sludge or bottom deposits, floating debris, visible oil, odor, unnatural plant or algal growth, unnatural color or turbidity, or matter in concentrations or combinations contaminant or harmful to human animal, plant or aouatic life of other than natural origin.

  - o In addition, secondary contact waters shall meet the following standards:

    - -- Freedom from unnatural sludge or bottom deposits, floating debris, visible oil, odor, unnatural plant or algal growth, or unnatural color or turbidity.

- Most of the major streams within MSDGC are classified as Secondary Contact streams.

- Violations of DO, NH_3-N, and coliform standards are observed in all MSDGC waters. Table IV-A-1 shows the range of 1977 average monthly concentrations of DO, BOD, NH_3-N, SS and fecal coliform bacteria in the three major water systems.

- Chicago and Calumet River systems are severely degraded, especially during summer periods. Although less severely degraded, the Des Plaines River also appears to have serious water quality problems.

- Throughout the water system, large benthal oxygen uptake rates have been measured. In situ studies indicate a range in oxygen demand rates of 2.0 to 23 gm/m^2/day (an unpolluted stream would characteristically have an uptake rate of about 0.5 gm/m^2/day).

- It is assumed that high benthal oxygen demands are the result of the discharge of untreated combined sewer overflows.

- Major source of NH_3-N in receiving waters is effluent of MSDGC sewage treatment facilities.

B. North Branch Chicago River and Mainstream System

1. Use Classification and Characteristics

- North Branch Chicago River and a short reach of Chicago River are classified General Use waters.

- North Shore Channel and Sanitary and Ship Canal are classified as Secondary Contact and Indigenous Aquatic Life waters.

- North Branch is a natural, free-flowing stream through residential and light industrial areas, bordered by parks, and supporting some fish and birdlife species.

- Upper section of Chicago River flows through heavily urbanized areas; mid-section through commercial and industrial areas; and lower section through commercial areas.

- Channels are primarily used for navigation but also some recreational boating and fishing. Portions of the channels are concrete lined and water levels are controlled for navigation and flood control.

- Waters are not used for water supply; groundwater and Lake Michigan are water supply sources for metropolitan Chicago.

2. Contributing Flows

- Flow enters North Shore Channel from Lake Michigan through Wilmette Diversion Lock, 7Q10 is 29 cfs.

  NSSTW discharges 453 cfs.

- North Branch contributes 27 cfs (7Q10) from Lake Michigan through Chicago River Control Works.

- WSWSTW discharges 1,309 cfs.

- Cal-Sag Channel adds 393 cfs.

- 7Q10 at Lockport is 1,700 cfs (1974).

- 263 CSO points are located along these reaches; 222 are affected by funded portions of TARP Phase I.

3. Water Quality

- North Shore Channel shows 1977 summer minimum DO of 6.4 to 7.1 mg/l; minimums range from 0.0 to 4.2 mg/l in North Branch, Chicago River and 0.2 to 2.5 mg/l in Sanitary and Ship Canal. North Branch Chicago River and Sanitary and Ship Canal have frequent violation of DO standards.

- The problems of North Branch are primarily due to sediment oxygen demand.

- The North Shore Channel and Chicago River contained diverse fisheries and good water quality only in those areas dominated by diverted Lake Michigan water.

- Annual average BOD values in reaches range from 4 to 8 mg/l.

- Some fecal coliform violations have been recorded.

- Biological survey concluded waters were degraded with respect to aquatic habitats.

- Lake diversion waters enter system with low levels of ammonia nitrogen but the ammonia concentrations increase substantially to levels exceeding stream quality standards downstream of sewage treatment facilities.

- Sludge blanket up to 7 feet deep in channel. Tubificids (pollution tolerant organisms) are predominant macroinvertebrate. (See Figure IV-B-1.)

- Measured sediment oxygen demand (1976) ranged from 9 to 15 gm/m^2/day in North Branch; and from 3 to 14 gm/m^2/day in Sanitary and Ship Canal.

C. <u>Des Plaines River</u>

1. Use Classification and Characteristics

- Des Plaines River is classified for General Use and Water Supply north of the I-55 bridge; south of this point, the river is classified for Secondary Contract. Presently Des Plaines is not used for water supply.

- Des Plaines River is generally free-flowing and unmaintained, but has a number of stage control devices. River flows predominantly through rural forest preserves and residential areas. Large portions of immediate bank area are parks and recreational areas.

2. Contributing Flows

- Upstream flow from Lake County.

- O'Hare WRP (45 MGD) (under construction; 4/5/1.5 plant).

- Several large tributaries.

- 197 CSO points located along river (TARP Phase I unfunded).

- Converges with Sanitary and Ship Canal below Lockport.

3. Water Quality

- Minimum 1977 DO values along river ranged from 0.5 to 3.3 mg/l; annual averages ranged from 4.7 to 9.5 mg/l. Frequent violations of DO standards are observed.

- Annual average BOD ranged from 2.6 to 9.9 mg/l in 1977.
- Average 1977 ammonia nitrogen concentrations ranged from 2.8 to 0.1 mg/l. Frequent violations of ammonia concentration level in water quality standards are observed.
- Fecal coliform geometric mean values ranged from 155/100 ml to 11,400/100 ml in 1977. Fecal coliform levels appear to be frequently in violation of standards.
- Biological study indicates Des Plaines River has fair water quality; pollution tolerant fish species predominate.
- Macroinvertebrate populations appear to indicate unbalanced or semi-polluted conditions.

D. <u>Little Calumet River, Calumet River, Grand Calumet River, and Cal-Sag Channel</u>

1. Use Classification and Characteristics

- Little Calumet River is a General Use water.
- Calumet River, Grand Calumet River and Cal-Sag Channel are classified as Secondary Contact and Indigenous Aquatic Life waters.
- Grand Calumet and Calumet Rivers flow through heavily industrialized areas.

2. Contributing Flows

- Some flow enters Grand and Little Calumet Rivers from Indiana; this is variable and unpredictable, based on rainfall patterns. Flow for 7Q10 flow into Grand Calumet has been estimated as 20 cfs.
- O'Brien Lock and Dam releases water into Calumet from Lake Michigan; 7Q10 is 30 cfs. During high flow conditions, Calumet River can backflow into Lake Michigan.
- Calumet STW discharges 343 cfs.
- 7Q10 flow leaving Cal-Sag Channel is 293 cfs (1974).
- 66 CSO points in system.

3. Water Quality

- Minimum monthly DO in 1977 ranged from 1.5 mg/l in Little Calumet River, 1.0 to 6.3 mg/l in Calumet River and 0 to 0.8 mg/l in Cal-Sag Channel. Violations of DO standard are observed regularly.
- Average monthly DO in 1977 ranged from 9.6 mg/l in upper areas to 2.3 mg/l in Cal-Sag Channel.
- 1977 average monthly BOD in Calumet River lakeside of lock was 3.9 mg/l. It was 9.0 mg/l below the Calumet STW and 5.3 mg/l just above confluence with the Sanitary and Ship Canal.
- Ammonia nitrogen levels in Grand Calumet, above treatment plant, averaged 5.2 mg/l in 1977; downstream of treatment plant this value was 6.4 mg/l. These levels are well above the ammonia standard of 1.5 mg/l.
- High fecal coliform values were recorded in the lower part of the Cal-Sag Channel (12,400/100 ml).
- Biological study concluded that due to poor water quality, the majority of the watershed supports a very limited fish population.
- Channel bottom mostly clay in the Calumet and Little Calumet Rivers.
- Channel bottom in Cal-Sag Channel mostly sludge and debris.
- Measured SOD ranged from 2.4 to 12.0 gm/m^2/day.

E. <u>Downstream Considerations</u>

- Waters downstream of Lockport are classified as General Use waters.
- All MSDGC waters flow past Lockport. Additional flow downstream is contributed by several tributaries including Des Plaines River, Du Page River, and Kankakee River.
- First city to use the Illinois River as a water supply is Peoria, Illinois, 150 miles downstream of the Chicago Area.
- Ammonia concentrations in the water downstream of Lockport ranged from 2.5 to 5 mg/l; levels above ammonia standards of 1.5 mg/l (ref. 123).
- Dissolved oxygen standard of the waters below Lockport was frequently violated (ref. 123).

- Waters downstream of Lockport showed a gradual decrease of NH_3-N and a gradual increase of NO_3-N: an indication of nitrification which was believed to have caused oxygen reduction in the waters (ref. 123).

V. PROPOSED FACILITIES

A. Overview

- MSDGC has proposed an integrated program which is intended to serve the purposes of pollution abatement, urban drainage and flood control. Overall program consists of:

  - o Construction of tunnel interceptor systems to intercept CSOs and transport these flows to reservoir storage and treatment plants;
  - o Construction of storage basins utilizing existing quarries and subsurface storage;
  - o Expansion and upgrading of treatment plants;
  - o Installation of instream aeration;
  - o Channel improvements.

- Tunnel and Reservoir Plan (TARP) comprises the tunnel and reservoir system for controling CSO's.

- TARP Phase I consists of the Mainstream, the Des Plaines (upper and lower) and the Calumet Systems which will collect the CSOs from 645 overflow structures and store this flow in deep underground tunnels until pumped into the MSDGC treatment plants. TARP Phase I, when completed, will serve the objective of pollution control.

- TARP Phase II consists of storage basins for the Mainstream, Des Plaines and Calumet Systems and additional rock tunnels. Storage basins will provide about 95 percent of the total storage capacity and will be constructed by widening and deepening existing quarries. Under TARP Phase II, tunnels would be constructed to supplement the conveyance capacity of Phase I tunnels to these converted quarries.

- Major portions of TARP Phase I have already been funded under EPA's Construction Grants Program. See Figure III-A-1 for TARP project status.

- Unfunded segments of TARP Phase I include the North Branch leg of the Mainstream, the lower Des Plaines system and major portions of the Calumet system.

- Expansion and improvement of treatment plants is closely coordinated with TARP. MSDGC has proposed to expand and upgrade three treatment plants; Northside, West-Southwest and Calumet.

- Calumet and West-Southwest plants will treat flows stored in the TARP tunnel system. Northside plant will not provide treatment for TARP CSOs.

- This review is limited to the following portions of the MSDGC program:

  o Unfunded segments of TARP Phase I; and
  o Expansion and upgrading of the Northside, the West-Southwest and the Calumet treatment facilities.

B. Treatment Facilities

1. Northside Sewage Treatment Works (NSSTW)

- Project involves upgrading existing 333 MGD secondary facility to provide single-stage nitrification and 50 percent tertiary filtration; also will expand maximum hydraulic capacity from 414 MGD to 500 MGD. No increase in the present design flow at this facility is proposed.

- Also, other improvements are proposed, as listed in Table V-B-1-a.

- Flow in excess of plant maximum hydraulic capacity of NSSTW, after improvement, will be diverted to mainstream tunnel of the TARP system rather than receiving streams. This will provide flow equalization for plant influent.

- Population projections (ref. 7, p. U9-125) and flow projections (ref. 98, p. 8) are presented in Table V-B-1-b. Projected population and total flow in 1990 are 1,387,000 and 332 MGD, respectively.

- Design effluent limitations are:

BODs	10 mg/l	(30 days average)
Suspnded solids	12 mg/l	(30 days average)
NH_3-N	2.5 mg/l	April-October
	4.0 mg/l	all other times

- Total costs of the proposed plant improvements and expansions are (ref. 129, p. 2-5):

o	Capital	$ 101,867,000
o	Investment Cost	$ 14,261,400
o	Salvage Value	$ 33,955,700
o	Yearly O&M	$ 11,224,000
o	Total Present Worth	$ 225,742,100

- Incremental AST cost (ref. 129, p.2):

  o Capital

Nitrification	$50,337,000
Filtration	$23,494,000
Total:	$73,831,000

  o Investment Cost $10,336,300

  o Salvage Value $24,610,300

  o Yearly O&M

Nitrification	$ 337,000
Filtration	$ 978,000
Total:	$ 1,315,000

  o Present Worth

$73,831,000 + ($10,336,300)(0.8734) - ($24,610,300)(0.2584) + (10.7086)($1,315,000) = $90,581,200

2. West-Southwest Sewage Treatment Works (WSWSTW)

- Existing capacity of 1,200 MGD at WSWSTW facility is to be expanded to 1,358 MGD. Expansion includes 455 MGD capacity to treat dewatered flow from TARP system (See Table V-8-2-a). Without TARP even more capacity for handling wet weather peak flows may be required because TARP provides for wet weather flow equalization.

- Dry weather flow (DWF) for 1990 is 830 MGD. This is based on 1990 population of 2.45 million (ref. 7, pp. 49-123, 49-125), calculated at 315 gpcd, which includes domestic, industrial and commercial and a small combined sewer flow estimated at 6 percent on an annual average.

- TARP dewatering capacity (1990) is designed based on 320 gpcd and is equivalent to 50 percent of dry weather flow.

- Proposed facility is designed to utilize a single-stage nitrification process to meet the following effluent limitations:

BOD_5	10 mg/l	(30 days average)
Suspended Solids	12 mg/l	(30 days average)
NH_3-N	2.5 mg/l 4.0 mg/l	April-October all other times

- Proposed improvements include:

  - o Rehabilitation of existing units;
  - o Increase aeration capacity for single-stage nitrification by adding 207 MG (103 MG first phase, 52 MG each in 2nd and 3rd phases) to existing aeration volume of 204 MG; and
  - o Construction of additional sludge concentration tanks, anaerobic digesters, and dewatering facilities.

- Total cost of the proposed plant improvement and expansion (ref. 129, p. 3-5):

o Capital	$480,723,000
o Investment Cost	$ 67,301,200
o Salvage Value	$160,241,000
o Yearly O&M	$ 38,658,500
o Total present worth	$536,756,100

- Incremental AST costs (ref. 129, p. 3):

o Capital	
Nitrification	$425,928,000
o Investment Cost	$ 59,630,000
o Salvage Value	$141,976,000
o Yearly O&M	
Nitrification	$ 3,263,000

  - o Present Worth
    425,928,000 + ($59,630,000)(0.8734) - ($141,976,000)(0.2584) + (10.7086)($3,263,000) = $476,264,400

3. Calumet Sewage Treatment Works

- Proposed project involves expanding plant from existing design flow of 220 MGD to a design flow of 354 MGD (1990); this expansion includes a capacity of 118 MGD to treat dewatered flows from the Calumet TARP system.

- Facility will be upgraded to two-stage nitrification; this will be accomplished by expanding the existing capacity of the secondary treatment facility from 220 MGD to 354 MGD, and by adding a new 354 MGD second-stage nitrification facility. In addition, tertiary filtration of nitrified effluent is also proposed, but the amount of flow to be filtered is not specified pending completion of a pilot plant study. Also, capacity of primary clarifiers to be expanded from 220 MGD to 354 MGD.

- Design effluent limitations are:

BOD_5	10 mg/l	(30 days average)
SS	12 mg/l	(30 days average)
NH_3-N	2.5 mg/l	April-October
	4.0 mg/l	all other times

- Proposed process flow diagram is shown in Figure V-B-3 (accompanying Table V-B-3-a shows the wastewater quality at significant points in the treatment train).

- Proposed design flow conditions for the year 1990 and design population 1,140,800 (NIPC) are summarized in Table V-B-3-b.

POPULATION FORECASTS (in thousands)

Area (sq mi)	1970	1980	1990	2000	2010	2020	2030
294.6	988	1082	1187	1302	1371	1440	1508

- Average dry-weather flow forecast for 1990 is 194 gpcd as compared to corresponding figure of 188 gpcd for 1978 (based on flow records.)

- Dewatering flow based on assumption that dewatering flow rate is 50 percent of the average daily dry-weather flow (ADDWF).

- Calumet plant flow forecasts (MGD) are as follows:

1978	1980			1990			2000		
(ADF)	ADDWF	TDW	ADF	ADDWF	TDW	ADF	ADDWF	TDW	ADF
223	210	-	233	230	118	278	251	118	299

Notes:
1. ADF - Average Daily Flow
   TDW - TARP Dewatering Flow
   ADDWF - Average Daily Dry Weather Flow
2. TDW - is 50 percent of ADDWF
3. 1990 design flow is ADDWF + TDW or 354 MGD

- Total costs: (ref. 129, January 1979):

  - o Capital Cost: $240,139,000
  - o Investment Cost: $ 33,619,500
  - o Salvage Value: $ 80,046,300
  - o Yearly O&M: $ 18,972,000
  - o Present Worth $451,982,300

- Incremental AST costs (ref. 129, January 1979):

	Nitrification (Battery E)	Filtration	Total
Capital:	$111,300,000	53,000,000	164,300,000
Investment Cost:	15,582,000	7,420,000	23,002,000
Salvage Value:	37,100,000	17,666,700	54,766,700
Yearly O&M:	1,963,000	1,160,000	3,123,000
Present Worth:	136,343,700	67,337,500	203,681,200

C. TARP

1. North Branch and Mainstream System

- For purposes of this review, the unfunded segments of TARP Phase I constitute the proposed facilities. In the North Branch and Mainstream System, the "North Branch Leg" is the only unfunded segment of TARP Phase I. (See Figure III-A-1.)

- North Branch leg contains approximately 9.1 miles of main tunnels with associated dropshafts and collection structures. Proposed tunnels generally follow route of North Branch of Chicago River from its confluence with Chicago River and North Shore Channel.

- North Branch Leg has a storage volume of 612 acre-feet (See Table III-C-2).

- CSO flows from the North Branch Leg are to combine with flows from tunnels of the Mainstream system for treatment at WSWSTW.

- MSDGC estimates North Branch Leg can capture 3,630,000 lbs. BOD annually, amounting to 86 percent of load discharged at 41 overflow points in the area (ref.7, appendix G).

- Costs of North Branch Leg (ref. 131): (January 1980 cost)

o	Capital Cost:	$174,900,000
o	Investment Cost:	$ 24,486,000
o	Salvage Value:	$104,940,000
o	O&M Annual:	$ 217,000 (including energy cost)
o	Present Worth:	$172,119,600
o	Per Capita Cost:	$3.03/year

2. Des Plaines System

- For purpose of this review, the unfunded segments of TARP Phase I constitute the proposed facilities. Except for pump stations, the entire lower Des Plaines System is unfunded.

- Des Plaines tunnel system contains approximately 26.4 miles of main tunnels with associated drop shafts and collections structures. Tunnels generally follow course of Des Plaines River. (See Figure III-A-1.)

- Proposed Des Plaines tunnels have a total storage volume of 1,267 acre-feet. (See Table III-B-2).

- CSO flows from Des Plaines System combine with flows from Mainstream system for treatment at WSWSTW.

- MSDGC estimates the proposed Des Plaines system can capture 3,913,000 lbs. BOD which amounts to about 90 percent of total annual overflow loading (ref. 7, appendix G).

- Costs of Des Plaines System (ref. 131): (January 1980 cost)

o	Capital:	$517,200,000
o	Investment Cost:	$ 72,408,000
o	Salvage Value:	$310,320,000
o	O&M Annual:	$ 1,554,000 (including energy cost)
o	Present Worth:	$521,364,400
o	Per capita cost:	$9.11/year

3. Calumet System

- For purposes of this review, the unfunded segmemts of TARP Phase I constitute the proposed facilites. Unfunded segments of Calumet Phase I system contain approximately 27.1 miles of main tunnels with associated collection structures and drop shafts.

- Proposed tunnel system is located in southeast portion of MSDGC service area. It consists of following major branches located under the Calumet River, Calumet Sag Channel and Little Calumet River (See Figure III-A-1):

    - o Torrence Ave Leg (Calumet River);
    - o 140 St. Leg (Grand Calumet River);
    - o Indiana Ave Trunkline and Markham Branch;
    - o Little Cal Leg (Dixmore and Lansing Branch).

- Proposed Calumet system has a total storage capacity of 1,290 acre-feet. See Table III-C-2 for breakdown.

- CSO flows from Calumet TARP system are to be pumped to the CSTW for treatment.

- MSDGC estimates proposed (unfunded) segments of Calumet TARP Phase I can capture 4,759,000 lbs. BOD which amounts to 88 percent annual load from 50 overflow points.

- Costs of proposed Calumet System (ref. 131): (January 1980 cost)

o	Capital:	$432,300,000
o	Investment Cost:	$ 52,860,000
o	Salvage Value:	$259,380,000
o	Annual O&M:	$ 1,530,000 (including energy cost)
o	Present Worth:	$438,926,200
o	Per capita cost:	$7.66/year

D. Annual Costs Per Household

Existing per capita cost	$ 26.11
O&M for TARP in operation	0.83
Per capita cost for remaining TARP Phase I	20.45
Per capita cost for STW improvement	18.80
Total per capita cost	$ 66.19/year (MSDGC's letter to EPA May 13, 1980)

Assuming 3.0 persons per household

Annual cost per household = $66.19 x 3.0 = $198.57

1979 median household income = $22,903

Ratio = $198.57/$22,903 = 0.867 percent

VI. EVALUATION OF TARP ISSUES

A. Identification of Major Issues

- Project evaluated based on the following four criteria:

  - o the applicant should demonstrate that the level of pollution control provided will be necessary to protect a beneficial use;
  - o provision has been made for funding of secondary treatment of dry weather flows in the area;
  - o the proposed combined sewer overflow control is the most cost-effective technique to protect the beneficial uses; and
  - o marginal costs are not substantial compared to marginal benefits.

- The major issues are:

  - o whether existing benthic deposits will preclude attainment of beneficial uses even with CSO controls and advanced wastewater treatment facilities in place;.
  - o justification for the proposed level of CSO control; and
  - o cost-effectiveness of proposed CSO controls.

- Attainability of beneficial uses:

  - o This issue must be determined before a final decision on level of CSO control or cost-effectiveness can be made; recommendations regarding level of control and cost-effectiveness in the following sections are contingent on showing that existing benthic deposits will not preclude attainment of beneficial uses.

B. Evaluation of Issues

1. Attainability of Beneficial Uses

- Significant benthal deposits exist throughout much of MSDGC waters; in the Main Stream system (Grand Calumet, Calumet), deposits average about 3.9 feet, and reach up to 10 feet in depth; in the Des Plaines, North Branch and Little Calumet, benthal deposits average less than 1 foot in depth. Predicted oxygen demand resulting from these deposits accounts for 2.0 - 5.0 mg/l DO deficit. Benthal profiles were not provided for the Calumet and Grand Calumet Rivers.

- New MSDGC modeling indicates that the DO standard will not be violated even if there is no reduction in SOD due to instream aeration; model did not address area upstream of O'Brien lock in the Calumet River where aerators will not be installed.

- Attainment of beneficial uses might be precluded in certain industrial and urbanized areas within Grand Calumet and Calumet waterways due to chemicals and heavy metals in water column and sediment beds.

- MSDGC data indicate that no significant concentrations of heavy metals exist at any of the sampling stations.

- In the highly industrialized and urbanized waterways (Grand Calumet and Calumet) high concentrations of contaminants (IEPA) are known to exist. Due to the lesser degree of industrialization and urbanization, contaminants should not be a problem in the North Branch, Des Plaines, or Little Calumet.

- Implementation of TARP will alter the sedimentation process in the Grand Calumet, Calumet and other Chicago waterways due to a reduction of suspended solids loading. Reduction of CSO loading could result in resuspension of existing benthal deposits and release of contaminants from the sediment bed.

- The dynamics for benthal stabilization may involve stabilization of the upper sludge layer, scouring away of residuals, stabilization of the next lower layer, and so on (ref. 156). Thus, the contaminant potential may be exerted for the entire depth of benthal deposits, rather than just the upper layer. It is therefore necessary to evaluate concentrations of contaminants for the entire depth of benthal deposits to determine future impact of these substances on water quality and on use attainability.

- Previous studies have shown the long-term effects of contaminant sediment resuspension on the water quality of rivers, lakes and estuaries (ref. 157, 158, 159). Problems have been projected to persist in these various systems for 10-75 years depending upon rate of resuspension, characteristics of the contaminants, and flushing ability of the system.

- With implementation of TARP, present and future contaminants found in the water column might be bio-accumulated more readily and might adversely affect downstream water intakes. This would occur because resuspended contaminant sediments would exist more frequently in the dissolved state than under existing conditions because of reduced solids loadings after TARP is in place. Dissolved contaminant concentrations increase as suspended solids decrease; it is only the dissolved fraction that may be bio-accumulated by organisms (ref. 160, 161). Dissolved fraction is easily transported downstream and often difficult to remove with conventional water treatment technologies, thus affecting downstream users.

- Because of uncertainties involving the persistence of existing benthal deposits, analysis of potential long-term impacts of these deposits in the Calumet and Grand Calumet Rivers should be made to determine when and to what extent these deposits will influence water use.

- Investigation of SOD persistence should be conducted for area above O'Brien lock.

- Preliminary analyses of heavy metals data from MSDGC received by EPA indicate that heavy metals will not preclude attainability of beneficial uses.

- Information is still needed for organic and other chemicals.

- EPA will analyze the benthic data and conduct simple dilution studies to determine whether these may be a contaminant problem.

- If a problem exists, a detailed analysis will be made of Calumet and Grand Calumet; this would include:

  o Benthal analysis should involve core sampling and laboratory testing to determine the depth and composition of deposits for the entire core depth. The following parameters should be measured:

    * Porosity
    * Suspended solids
    * Volatile solids
    * BOD
    * COD
    * Nitrogen series
    * Heavy metals
    * Other contaminants (i.e., pesticides, organics, etc.)
    * C_s 137, pollen or Pb 210 dating to determine core age and mixing depth
    * Anaerobic activity
    * All concentrations given in Mass Toxicant/Mass Solids width depth distribution

- Also, the following water quality data should be collected above the sediment bed sampling points:

  o Suspended solids
  o BOD
  o COD
  o Nitrogen series
  o Heavy metals
  o Other contaminants (i.e., pesticides, organics, etc.)
  o DO
  o All metal and contaminantant concentrations given as total dissolved and particulate

- Sampling should be conducted for four event types:

  1. quiescent conditions (low winds, limited or no barge traffic)
  2. average conditions (normal wind velocity, average barge traffic)
  3. turbulent conditions (heavy barge traffic)
  4. storm or post storm conditions (heavy rains, very high winds)

- Water column samples should be taken at varying depths: surface, mid-depth, and 1 foot above sediment layer.

- Prior to funding of TARP Phase I for Grand Calumet and Calumet areas, EPA must determine whether recommended contaminant studies show concentrations of contaminants are or will be sufficient to prevent attainability of designated beneficial uses; if contaminants are shown to be an existing or potential problem, corrective measures, such as dredging, must be assured as a basis for Step 3 funding of TARP Phase I.

- For the area above O'Brien lock, prior to funding of TARP Phase I, EPA must determine whether recommended SOD studies show that benthal demand will be adequately reduced and high rates of SOD would prevent attainment of DO standard; if DO standard in waterway can not be met, funding could still proceed if it is shown that this TARP segment is needed to prevent standards violations at the South District water supply intake in Lake Michigan.

2. Segment Evaluation

   a. Dynamic Water Quality Modeling

- NIPC developed a dynamic model to show ability of TARP to maintain water quality standards after implementation of all control devices (aerators, TARP Phase II, AST); model simulation included predictions of runoff and CSO loadings from storm events which are beyond the ability of TARP Phase II to control.

- The following calibrated models were used to develope loadings:

  - o LANDS - simulates runoff over differing land surfaces.

  - o SCALP - simulates combined sewer system flow routing.

  - o FUELO - routes channel flow through channel networks.

  - o QUALITY - simulates the physical, chemical and biological interactions and produces temporal concentration profiles.

- NIPC model incorporated algal effects on DO concentrations; predictions of increased algal activity due to improved water quality were also made but data to substantiate these calculations were not available.

- NIPC model based on the following assumptions:

  - o effluent limitations of 10 mg/l BOD_5, which are based on WLA developed by MSDGC from steady state modeling.

  - o 80 percent SOD reduction below existing rates.

  - o K_d of .055 - .090/day (MSDGC used .23 - .46/day).

  - o no instream nitrification.

  - o reaeration rates based on O'Connor-Dobbins formula or lake reaeration formula; highest of two values used.

- Dynamic model predicted the following:

  - o total elimination of DO violations for the majority of MSDGC waters.

  - o Cal-Sag Canal predicted to violate 4 mg/l DO standard once per year (presently 140 violations per year).

- o Des Plaines and North Branch DO standards violations will be reduced by 50 percent.
- o significant increase in chlorophyll "a" concentrations, up to mean levels of 51 mg/l (factor of 2 - 9 above present levels).

- Based on model output, MSDGC waterways will show significant improvement in DO after full implementation of TARP Phase II if all modeling assumptions are correct (i.e., 80 percent SOD reduction).

- Model does not show effects of intermediate SOD reductions or for construction of only TARP Phase I on the frequency of standards violations; since TARP Phase I will capture 85 percent of the BOD_5 loading, it may be inferred that the majority of water quality benefit (i.e., reduction in frequency of DO violations) would be realized with construction of TARP Phase I; therefore, Task Force concludes that TARP Phase I would result in significant water quality benefits if contaminant and SOD problems do not preclude attainment of uses.

b. North Branch

Level of Control:

- There are 41 CSO points in the North Branch reach.

- The North Shore Channel flows into the North Branch of the Chicago River. Presently DO standards are regularly violated in the North Shore Channel.

- The relative contributions by CSOs to the total annual BOD loading in the North Branch are about 20 percent on an annual basis, but much greater during CSO events.

- Simulation results indicate that up to an 80 percent reduction in the present benthal demand in the North Shore Channel would be required in addition to STW upgrading and instream aeration in order to meet DO standards.

- Water quality standards would be violated 10 percent of the time even with TARP Phase II based on analyses of water quality modeling; it may therefore be inferred that at least the level of control provided by TARP Phase I would be required to prevent even more frequent violations.

- "Knee of the curve" analysis shows that proposed level of control is appropriate. (See Figure VI-1.)

- Based on above considerations, the level of control provided by TARP Phase I is justified.

Cost-Effectiveness:

- The analysis of the alternatives to the proposed plan include sewer separation, multiple detention reservoirs and retention basins at overflow points.

- The cost-effectiveness analyses by EPA generally support MSDGC's conclusion that TARP Phase I is the most cost-effective alternative. A summary of the results of these analyses appears below (cost in $ millions):

Alternative	Land, Construction Engr., Adm., Legal & Others EPA	MSDGC	O&M EPA	MSDGC	Total Present Worth EPA	MSDGC
Multiple Detention Basins in Localized Upstream Area	185.40*	210.50	3.42*	1.36	188.82	211.86
Multiple Reservoirs at Each Outfall	185.40*	233.60	3.42*	2.95	188.62	236.50
TARP	174.90	174.90	2.95	2.95	177.85	177.85

*The cost methodology comes from EPA - 430/9-79-003, "1978 Needs Survey, Cost Methodology for Control and Combined Sewer Overflow and Stormwater Discharge."

**Sewer separation would be more expensive than any of these options.

- It is therefore concluded that TARP Phase I would be the most cost-effective CSO control alternative for the North Branch segment.

c. Des Plaines

Level of Control:

- Des Plaines waterway has a high use potential; river is classified for General Use and Water Supply. Existing uses include fishing, canoeing and swimming.

- Model study shows that DO standard violations occur about 24 percent of the time. Heavy benthal oxygen uptake rates have been measured. Ammonia standard violations are calculated to occur 40 percent of the time. Fecal coliform measurements have ranged from 155/100 ml to 11400/100 ml.

- Simulations assuming 80 percent removal of benthal oxygen demand indicate DO standards would be violated about 11 percent of the time with TARP Phase II. Violations of ammonia standards will be reduced to 10 percent of the time. It may therefore be inferred that at least the level of control provided by TARP Phase I would be needed to prevent even more frequent violations. The SOD for future conditions is not expected to be a problem due to shallow benthic deposits and CSO control.

- "Knee of the curve" analyses for Des Plaines River show that the proposed level of control is justified. (See Figure VI-2.)

Cost Effectiveness:

- Alternatives evaluated were sewer separation, multiple detention basins in upstream areas or at outfall points and TARP Phase I as proposed.

- MSDGC provided detailed cost analyses of three alternatives. The summary of the cost analyses is listed as follows (cost in $ millions):

Alternative	Land, Construction Engr., Adm., Legal & Others	O&M	Total Present Worth
Multiple Detention Basins in Localized Upstream Area	796.50	29.60	826.10
Multiple Reservoirs at Each Outfall	607.30	27.03	634.33
TARP	517.20	21.08	538.28

*Sewer separation would be more than any of these options.

- EPA reviewed the MSDGC detailed cost analyses and found tha unit costs are in line with the recent actual cost figures in the area; the cost analysis methodology is reasonable and the cost-effectiveness analysis has complied with the EPA cost-effectiveness analysis guidelines.

- It is concluded that TARP is the most cost-effective CSO control alternative for the Des Plaines segment.

d. Calumet

o Little Calumet Leg, and Indiana Ave and Markham Leg (Little Calumet system):

Level of Control:

- These reaches of the Calumet River system flow through primarily residential areas; thus the water use potential in these areas may be greater than in the heavily industrialized areas in the Calument system.

- Currently, benthic conditions exist throughout the Little Calumet system. These waters are polluted to heavily polluted as indicated by frequent violations of DO, ammonia nitrogen, and fecal coliform criteria. The 208 study estimates that 36 percent of the BOD contributed to the Little Calumet system comes from boundaries, 30 percent from CSOs, 22 percent from other sources.

- MSDGC estimates that 1,761,000 pounds per year of BOD is contributed by CSOs in this leg and that TARP Phase I could remove 1,586,000 pounds per year (90 percent capture).

- CSO pollutant loadings have been judged to be a major source of untreated solids which causes the high benthal oxygen demand. In addition, they contribute floatables and objectionable materials to the waterways and appear to affect fecal coliform levels.

Cost Effectiveness:

- Alternatives to the proposed plan in the Calumet system include sewer separation, multiple detention reservoirs and retention basins at overflow points.

- Shortage of open space in this area would make the costs of options to TARP prohibitive; therefore, TARP appears to be the most cost-effective option for these segments.

o 140th Street Leg (Grand Calumet) and Torrence Avenue Leg (Calumet):

Level of Control:

- CSOs in these legs contribute to the benthal oxygen demand not only in these areas but downstream as well. In addition, they contribute floatables and appear to contribute to the violation of fecal coliform standards (both Calumet and Grand Calumet Rivers).

- Since parts of these areas are heavily industrialized, and have extensive benthal deposits, it is unclear whether the warm water fishery use classification is attainable (both Calumet and Grand Calumet Rivers).

- The MSDGC estimates that 1,266,000 pounds per year of BOD is contributed by overflows in these legs. MSDGC estimates that TARP could capture 1,107,000 pounds per year of this load, or about 87 percent.

- The Grand Calumet was not incorporated into the MSDGC model. The water quality in this leg appears to be predominantly influenced by CSOs and upstream loads from Indiana. Available information is inadequate to estimate the relative percentage of these loads and the nature and extent of existing water quality degradation (both Calumet and Grand Calumet Rivers).

- Four CSO points are located upstream from the O'Brien Lock in the Calumet River may contribute to the CSO backflow in Lake Michigan (the Calumet River upstream of O'Brien Lock).

- Since dynamic water quality modeling analyses were not done for Calumet and Grand Calumet Rivers, the water quality improvement resulting from CSO controls is not known; modeling for other areas indicate that TARP Phase I plus instream aeration would enable DO standards to be achieved. It is not clear whether TARP would enable DO standards to be achieved upstream from O'Brien lock where no aerators are proposed (Calumet River upstream of O'Brien Lock).

- CSO controls may also be needed to prevent backflows from CSOs above the O'Brien Lock from causing standards violations at the South District water supply intake located in Lake Michigan. However, data concerning the severity and frequency of standards violations at the water supply intake has not been provided; also, the linkage between backflows in the Calument River and violations at the water supply intake has not been established; also, it has not been shown that TARP Phase I is needed to prevent these violations (i.e., less costly CSO measures providing lower levels of control may be adequate to prevent violations at the intake) (Calumet River upstream of O'Brien Lock only).

- Based on above considerations, the proposed level of control is justified for Calumet and Grand Calumet Rivers, except the Calumet River upstream from O'Brien lock. Water qualtiy analyses of impacts on South District water supply intake should be made to better define CSO induced water quality problems and determine the type and level of CSO control needed.

Cost Effectiveness:

- Shortage of open space in 140th Street segment makes the costs of alternatives to TARP prohibitive; therefore, TARP appears to be the most cost-effective alternative for this segment.

- MSDGC provided details of cost analyses of two CSO control alternatives at Torrence Avenue segment. The summary of the cost analyses is listed as follows:

TORRENCE AVENUE SEGMENT
Cost-Effectiveness Analysis
(cost in $ millions)

Alternative	Multiple Reservoirs At Outfall Points	TARP Phase I
Land	6.70	--
Construc., Engr., Adm., Legal & Others	192.52	144.32
O&M	9.52	5.33
Total Present Worth	208.74	149.65

*Sewer separation would be more expensive than any of these options.

- EPA reviewed the MSDGC detailed cost analyses and found that unit costs are in line with the recent actual cost figures in Chicago area; the cost analysis methodology is reasonable and the cost-effectiveness analysis has complied with the EPA cost-effectiveness analysis guidelines.

- It is therefore concluded that TARP Phase I is the most cost-effective CSO control alternative for the Torrence Avenue segment.

C. EPA Comments Regarding GAO Suggested Alternatives to TARP

- The GAO report (May 1979) had proposed the following alternatives:

  - o retaining the water in above-ground storage areas such as using rooftop reservoirs, parking lot ponding, or temporary flooding of natural and recreational areas;

  - o slowing the flow of water into the sewer system to reduce peak loads such as disconnecting downspouts, using restrictors in sewer inlets or catch basins to reduce runoff to the sewers or using porous pavement to reduce runoff;

  - o educating the public on devices which can be installed in individual basements to prevent flooding;

  - o using on-line or off-line storage devices in the system: storage within sewer lines activated by automatically monitoring flows in the sewer system, off-line storage achieved by such devices as tanks, tunnels, and holding basins;

  - o constructing relief sewer projects in limited areas.

- The GAO proposed alternatives are primarily for reducing local and basement flooding problems. Although some of the alternatives will offer some degree of pollution control, none of them is a cost-effective pollution control alternative to TARP Phase I in achieving beneficial water uses. The following are some comments regarding each of the proposed alternatives:

  - o retaining the water using rooftop reservoirs will require substantial structural changes and reinforcements to existing homes and buildings and is therefore not feasible except for new buildings yet to be constructed;

  - o temporary storage on remote sections of parking lots is probably not feasible due to lack of such available additional parking space in Chicago in addition to the expense of regrading the existing parking lots;

  - o temporary flooding of natural and recreational areas is not sufficient to solve the problem due to inadequate open space in the critical CSO problem areas;

- disconnecting downspouts will not provide enough peak flow reduction in congested residential areas due to easy access of the water to reach the stormdrain inlets over the pavement;

- using restrictors in sewer inlets would alleviate basement flooding by preventing back-pressure in sewers, but would contribute little toward pollution control;

- using holding basins to reduce runoff has been reviewed and found to be less cost-effective than TARP Phase I (see Section VI.b. through VI.d);

- upgrading sewer maintenance and cleaning is a continuing process, but not adequate for water quality improvement;

- streetcleaning has been evaluated and found to be inadequate for pollution control (see Figure 2);

- devices for preventing basement flooding have limited water quality improvement benefits;

- on-line storage in the sewer line does not provide enough storage capacity;

- off-line storage using tunnels and holding basins is the concept of TARP;

- constructing relief sewer projects has been reviewed and found to be less cost-effective than TARP Phase I.

VII. EVALUATION OF ADVANCED TREATMENT ISSUES

A. Identification of Issues in Accordance with PRM 79-7

- In addition to cost-effectivelness, criteria for review contained in PRM 79-7 are:

  o Seasonal treatment has been fully evaluated;
  o Land application alternatives have been considered;
  o Advanced treatment will definitely result in significant water quality benefits, and mitigation of public health problens where they exist;
  o Public is aware of the costs.

- Land application is not viable for these projects because of the large land reouirements and high cost. The Corps of Engineers examined this alternative in detail in 1971 and 1972.

- Total average annual household cost for TARP Phase I and AST combined is about $198.57, or about 0.867 percent of median annual household income. The public has been informed of the costs.

- The major issues are:

  o Is 10 mg/l BOD_5 reouirement technically justified?

  o Will attainment of design effluent limitations result in significant water ouality benefits?

  o Are unit processes designed to neet effluent limitations justified?

  o Has seasonal treatment been fully evaluated?

- Evaluations and recommendations presented below are contingent on showing that possible existence of toxic substances will not preclude attainment of beneficial uses (See Section VI.B.1.).

B. Evaluation of Major Issues

1. Water Quality Justification for Filtration and Nitrification (All Treatment Plants)

Carbonaceous BOD Removal Requirements

- Steady-state Streeter-Phelps type model used to justify treatment levels for all three treatment facilities. Model assumed the following:

Kc (base e, 1/day)	=	0.23-0.46 @ 20°C
Ka (base e, 1/day)	=	not provided; minimum is 0.23
Kn (base e, 1/day)	=	0
SOD ($gm/m^2/day$)	=	0.2-7.0
Temperature (°C)	=	25.0
Background DO (mg/l)	=	7.4
Target DO (mg/l)	=	4.0
Effluent DO (mg/l)	=	7.0
Streamflow (MGD)	=	not provided for each STP; total diverted is 278
Treatment Plant Flow (cfs)	=	453 (Northside)
	=	1,309 (West-Southwest)
	=	343 (Calumet)
Photosynthetic Effects	=	Not considered

- BOD decay rates (K_d) were preassigned based on literature values, depending upon wasteload type; these rates were calibrated further during model runs and appear to be reasonable, although they might be expected to be slightly lower if a fully nitrified effluent is being modeled; decay rates were not developed from instream BOD data.

- Reaeration rates based on O'Connor-Dobbins formula, with minimum value of 0.23 for slow moving sections; minimum value was used in 94 percent of the reaches from the Northside plant to Lockport; sensitivity analysis on reaeration rates was not performed.

- Benthal demand (SOD) used for wasteload allocation run was 20 percent of existing <u>in situ</u> rate (determined from full studies). Projected reduction in SOD based on reduced benthal demand resulting from CSO controls. Although benthal demand for Chicago waterways would be expected to be lower after CSO controls are in-place, 80 percent reduction may be optimistic.

- Data show that nitrification is not now occurring, although the reason for this is unclear. However, downstream users (i.e. outside MSDGC study area) have complained of high ammonia levels and DO impacts. Inhibition of nitrification in MSDGC water could be due to channel conditions, chlorine contaminant, or existing low DO levels. It is unclear whether these conditions will change under future conditions to enable nitrification to occur.

- Model reported to be calibrated, but reports comparing calibration results with in-stream BOD, NH_3, and DO data were not provided. However, plots comparing two independent sets of calculated DO concentrations were provided. These plots compare well.

- Results of the modeling show that an effluent BOD_5 concentration of about 10 mg/l for all treatment plants, in conjuction with in-stream aeration and CSO control, is needed to maintain DO standards.

<u>New MSDGC Model (June 1980)</u>

- New MSDGC model was based on the following assumptions:

  o background DO greater than 9.0 mg/l (previously 6.0 - 7.0 mg/l)
  o diversion flow of 1152 cfs (previously 320 cfs)
  o ten instream aerators (same as previous run)
  o no SOD reduction (previously 80 percent reduction)

- Results of new model show that DO standard can be met with the use of instream aerators under <u>existing</u> conditions (without TARP and STP improvements). These results are considered to be reasonable.

- From this model, it can be inferred that if SOD is reduced, allowable effluent BOD could be higher than 10 mg/l design effluent limitation.

<u>Ammonia Removal Requirements</u>

Warm Weather:

- Ammonia removal requirement based on four concerns:

  o ammonia contaminant;
  o need to remove additional carbonaceous BOD beyond secondary treatment levels;
  o potential for future nitrification in MSDGC waters;
  o existing and future nitrification in downstream waters.

- Assuming a stream temperature of 30°C, and a pH of 7.5, a total in-stream ammonia concentration of 2.5 mg/l would result in an un-ionized concerntration of 0.06 mg/l; thus assuming these conditions, and no stream dilution, ammonia removal would be needed during warm weather to prevent ammonia contaminant.

- Nitrification may be necessary to reduce CBOD and NOD. Without nitrification (i.e. at secondary treatment level), effluent BOD_5 concentrations would exceed the BOD effluent limitation of 10 mg/l and would result in failure to meet the DO criterion for MSDGC waters.

- Reduction of BOD beyond secondary could be accomplished via tertiary filtration, rather than nitrification. However, because filtration would not reduce nitrogeneous oxygen demand (NOD), there would be potential for DO problems if nitrification begins to occur in MSDGC waters. Since it is presently unclear why nitrification is being inhibited, it is not possible to conclusively predict whether nitrification will occur in MSDGC waters. However, improved DO conditions (resulting from upgraded treatment plants and CSO controls) will make it more likely that nitrification will occur. Therefore, because nitrification will reduce NOD as well as CBOD, nitrification would be a more effective option than filtration in terms of UOD reduction. Also, if filters were built now rather than nitrification units, and in-stream nitrification begins to occur, it would be necessary to add nitrification at a later date in addition to the filters already in place.

- Even if nitrification is not a problem in MSDGC waters, it would still be a possible problem in downstream waters. Information suggests that nitrification resulting from NH_3 discharged from Chicago may be causing DO problems in these areas now. (ref. 123) Since wastewater discharged from Chicago makes up a large portion of the flow in these waterways during low flow conditions, this potential secondary DO sag could be significant. However, evidence regarding this potential problem is inconclusive at this time.

- Based on the above considerations, the Task Force concludes that a warm weather effluent limit of of 2.5 mg/l is needed. Considerations affecting exactly when nitrification should be provided are discussed further below.

Cold Weather:

- Although a winter NH_3 effluent limitation of 4mg/l is proposed, lower levels of nitrification may be acceptable during cold weather conditions for the following reasons:

  o At colder temperatures, carbonaceous deoxygenation rates will be lower and DO saturation higher; therefore, it may not be necessary to provide as stringent levels of CBOD removal as during warm weather conditions;

  o During cold weather, in-stream nitrification would be more likely to be inhibited. Thus, it may not be necessary to remove NH_3-N for DO purposes;

- o During cold weather, the ratio of un-ionized to total ammonia is lower, thus permitting greater concentrations of total ammonia to be discharged.

- Annual operating costs for nitrification are ($ millions):

Northside	0.3
West Southwest	3.3
Calumet	1.9

- Toxicity analyses by the State of Illinois showed that during cold weather, NH_3 contaminant standard would be violated 8 of 11 times just above Lockport (where there is little dilution flow) and 9 of 10 times below Lockport (after dilution effects); Illinois did not account for dilution in their analysis.

- Plant data provided by MSDGC show pH effluent values average about 7.5 to 7.6; instream pH data provided by Illinois show pH values generally in excess of 8.0 even in areas without any dilution. The reason for this discrepancy is unclear.

- MSDGC has extensive records of effluent pH data, whereas IEPA has provided only 11 pH samples; therefore, it might be that IEPA data are not typical for areas without dilution flows.

- In natural waterways, such as the Des Plaines River, pH values are often greater than 8.0; therefore, pH values provided by IEPA for these areas are typical. However, in assessing ammonia contaminant in waters affected by these dilution rates, the effects of this dilution must be considered.

- For water without any dilution effect, the need for nitrification for control of contaminants during cold weather is inconclusive because of discrepancies in pH values measured by MSDGC and IEPA. These discrepancies should be resolved to determine what pH values should be used for the contaminant analysis. Such determination and review of instream ammonia contaminant during cold weather will permit a decision on the need for winter nitrification.

- For diluted waters (i.e., below confluence of Des Plaines River), contaminant analysis should consider effects of dilution (this is now being evaluated in the MSDGC model below Lockport; results will be considered in final report). Nitrification should not be provided during cold weather to prevent ammonia contaminant in downstream waters unless analysis that accounts for dilution flows shows it is needed.

2. Treatment Facilities

Northside:

- Proposed design based on full scale (76 MGD) study using existing facility, this study showed that single stage nitrification followed by clarification would produce an effluent of 13/8/2 (BOD/SS/NH_3). Thus, the study concluded that 50 percent tertiary filtration would be needed to remove additional BOD to meet the 10 mg/l effluent BOD limit.

- Proposed facility will not treat more concentrated flows to be treated by O'Hare STP; thus, effluent quality for proposed plant may be better than during treatability study.

- Existing facility used for tests was not optimized:

  - o Primary clarifiers were then capable of removing only about 25 percent BOD, rather than the approximate 35 percent attainable from proposed design;

  - o Aeration time ranged only between 3.6 and 4.4 hours;

- Optimization of proposed facility should enable BOD limitations to be met without filters, although filters can serve an important function in controlling the variations of the operation of treatment facilities and delivering more uniform effluent qualities.

- Proposed facility will have additional primary clarifiers, which should increase primary BOD removal to about 35 percent. Also, aeration time in the proposed facility will be about 5.5 hours, which should further improve BOD removal in comparison with the existing faciltiy. Moreover, operation of proposed facility could be optimized in terms of return sludge and pH control.

- Capital and annual O&M costs for tertiary filtration are $24 million and $0.98 million, respectively.

- The Task Force concludes that the proposed facility should be capable of meeting design effluent limitations without filtration. Also, new modeling by MSDGC shows that 10 mg/l BOD_5 limitation may be more stringent than needed to meet water quality standards. Therefore, construction of proposed tertiary filters should be deferred until operation studies and water quality analyses following operation of the plant without filters show such facilities to be necessary.

- The Task Force concludes that proposed nitrification is needed to meet BOD and ammonia limitations during warm weather; however, it is unclear whether nitrification is needed during cold weather pending resolution of apparent discrepancies in pH data and further instream ammonia contaminant analyses.

West-Southwest:

- Major issue is the need for proposed 7.5 hour detention time in nitrification units.

- Proposed increase in aeration tankage from 204 MG to 411 MG will increase detention time from about 5.0-6.0 hours to about 7.5 hours.

- Optimizing the operation procedures such as controlling the waste sludge return of sludge can improve the nitrification efficiency.

- Operating data show that single stage nitrification followed by clarification is needed to meet effluent limits.

- Operating data for March through September 1978, show that permit NH_3-N limits can be met at detention times ranging from 5.0-6.0 hours. (See Table V-C-5.) For example, in March 1978, average and maximum ammonia levels were 0.6 mg/l and 2.3 mg/l respectively (at 52_0C, 5.9 hours detention time).

- Flow projections estimate design flow will increase from 1,200 MGD to about 1,358 MGD (including dewatering). At this flow rate, a 6.0 hour detention time could be achieved if only the first phase aeration tankage (half the total proposed additional aeration tankage) were added.

- Proposed increase in aeration tankage to be accomplished in three phases:

    - 50 percent (about 103 MG)
    - 25 percent (52 MG)
    - 25 percent (52 MG)

- Total capital and O&M costs of proposed nitrification facilities about $426 million and $3.3 million, respectively.

- Task Force concludes that nitrification is needed to meet BOD and ammonia limitations during warm weather; however, it is unclear whether nitrification is needed during cold weather pending resolution of apparent discrepancies in pH data and further instream ammonia contaminant analyses.

- Based on above considerations, the Task Force concluded that the first phase of aeration tank additions (i.e. about 103 MG) are needed but that the second and third phases (i.e. half of batteries E and F) are not justified at this time. Therefore, construction of phases two and three should be deferred unless effluent and water quality data from the first phase of operation show that the second and third phases are also needed to achieve water quality standard limits (i.e. effluent limits based on further water quality studies of cold weather BOD and NH_3-N removal requirements. (See discussion above.)

Calumet:

- Two-stage nitrification (as opposed to single-stage at other facilities) proposed at this facility because of industrial waste inputs.

- Design engineer's report (Metcalf & Eddy) states that proposed two-stage nitrification system should be capable of meeting 10 mg/l BOD limitation without tertiary filtration; this assessment appears reasonable in view of existing operating data, which shows that BOD effluent from existing secondary facility is about 13 mg/l during the summer months.

- 10 mg/l BOD_5 limitation may be too stringent based on results of new MSDGC modeling (June 26, 1980).

- Filters would be needed to reduce suspended solids to the 12 mg/l limitation; however, since there is no water quality justification for this suspended solids limitation, filters are not needed for this purpose, although filters can serve an important function of assuring uniform effluent qualities by controlling the variations of treatment facility operations.

- Capital and annual O&M costs of tertiary filters are $53 million and $1.2 million, respectively.

- Based on above considerations, the Task Force concludes that tertiary filters are not justified at this time for the Calumet facility.

- Task Force also concluded that nitrification is needed to meet BOD and ammonia limitations during warm weather; however, it is unclear whether nitrification is needed during cold weather pending resolution of apparent discrepancies in pH data and further instream ammonia contaminant analyses.

- Nitrification at Calumet STW is probably needed, regardless of attainability issues in MSDGC waters, to improve water quality below Lockport; mathematical modeling, including sensitivity analyses, is needed to verify need for the level of NH_3-N attainable from the proposed Calumet STW.

CHICAGO TARP PROJECT
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134. EPA memorandum on Clarification of Criteria Used on Advanced Treatment Reviews, from H.L. Longest II to Water Division Directors, November 19, 1979, 7 pages.

135. letter from MSDGC to EPA regarding the 1978 Needs Survay, Cost Merhodology for Control of Combined Sewer Overflow and Stormwater Discharges, dated December 21, 1978, 6 pages. (Attacnments not included).

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152. U.S. EPA Quality Criteria for Water, 1976.

153. The Metropolitan Sanitary District of Greater Chicago, May 5, 1980, From: Frank E. Dalton, Deputy Chief Engineer; To: Dr. Wen H. Huang, Facility Requirements Division:

Cost Breakdown of alternatives a,b,c, and d for the Des PLaines, Calumet and North Branch into their separable components.

Present worth analysis of the four alternatives.

154. In addition the following information is submitted as requested:

No. of combined sewer overflow points to Des Plaines River - 90 individual overflow points.

Maximum flow from each of these overflows - This information as well as the number of overflow locations is listed in the tables starting after page I-14 of the report submitted to you under our cover letter 4/11/80.

155. The Metropolitan Sanitary District of Greater Chicago, May 6, 1980, From: Frank E. Dalton, Deputy Chief Engineer; To: Dr. Wen H. Huang, Facility Requirements Division:

A copy of the November 27, 1970 final calibration of the Sanitary District's DO model.

A copy of the November 10, 1970 verification (correlation) run off the Sanitary District's DO model. This run utilized the model calibrated for an August 1961 condition for a May - April 1961 verification run.

A copy of the August 31, 1970 intermediate calibration run referencing water quality data for 1970.

A set of information which includes--on computer sheets labeled MSDWTR--the Sanitary District's model SOD loads in grams per square meter per day based on the model's 1975 calibration. Also included are copies of the SOD demand values (dated May 1977) which were measured by the Sanitary District for the 208 Study; and calculation sheets (dated October 4, 1977 and noted May 2, 1980) which compare measured (208) SOD values against those obtained by the 1970 and 1975 calibrations of the Sanitary District's model.

It is to be noted that the Sanitary District's model calibrations were for a hot weather, August, conditions. The SOD values obtained for the 208 Study are not always directly comparable.

Calculation sheets (dated April 29, 1980) show effluent ammonia loads in pounds per day emanating from the Sanitary District's treatment plants tributary to the Main Channel. The years 1976 and 1977 are represented. Additionally the average ammonia flow through the lockport facility in pounds per day for these two years is given. These ammonia mass balance indicate that no evidence of significant nitrification within the Sanitary District's waterways exists under present conditions. This was also a conclusion of the 1970 Sanitary District modeling work.

In 1976 the average ammonia flow from the Sanitary District's treatment facilities was approximately 57,000 pounds per day; and through the Lockport approximately 78,000 pounds per day. More ammonia flows through Lockport than is generated by the treatment plants. It is assumed that the remaining ammonia load on the waterways is combined sewer overflows and the resultant benthic deposits.

156. Personal conversation with Tom Meinholz, Consultant, Ecol-Sciences, Milwaukee, Wisconsin (July 1980).

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159. Hetling, L., E. Horn and J. Tofflemire, "Summary of Hudson River PCB Study Results," Technical Paper #51, 88 pages, New York State Department of Environmental Control, Albany, New York, 1978.

160. Thomann, R. V., "Steady State Model of Fate of Chemicals in Diverse Aquatic Food Chains," 46 pages, Environmental Engineering and Science Division, Manhattan College, Bronx, New York, 1980.

161. "Modeling of Toxic Substances in Natural Water Systems," Manhattan College Summer Institute Notes, Bronx, New York, 1980.

162. Butts, Thomas A., and Ralph L. Evans, "Sediment Oxygen Demand Studies of Selected Northeastern Illinois Streams," January 1978.

163. Illinois EPA letter to Wen Huang, EPA, July 18, 1980, and attached IEPA comments on USEPA "Draft Summary of Findings on Remaining Segment of TARP and MSDGC Advanced Treatment Facilities Proposed for MSDGC," (July 1980).

164. MSDGC letter to Henry Longest, EPA, July 18, 1980, and the attached MSDGC comments on USEPA "Draft Summary of Findings on Remaining Segment of TARP and MSDGC Advanced Treatment Facilities Proposed for MSDGC," (July 1980).

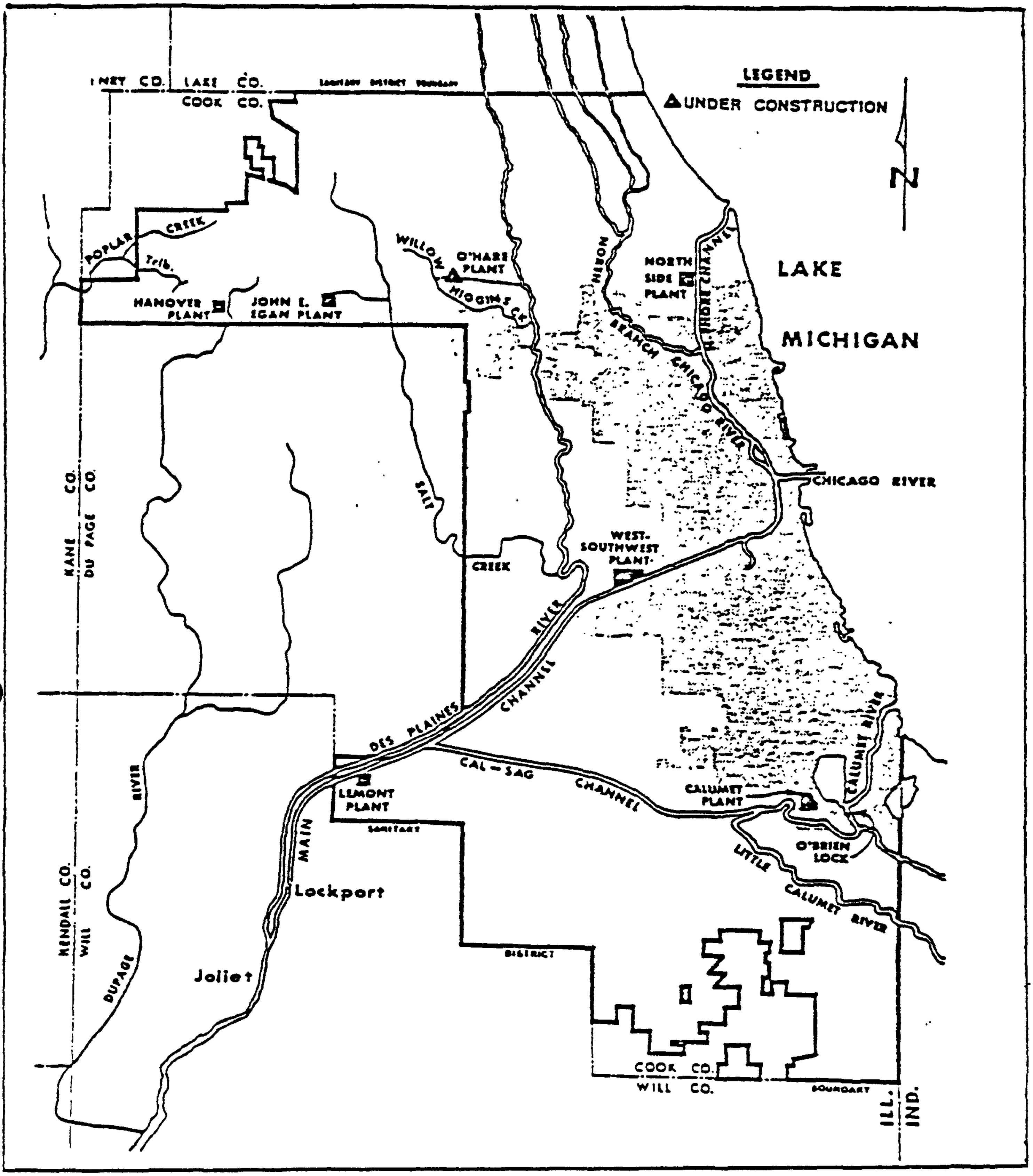
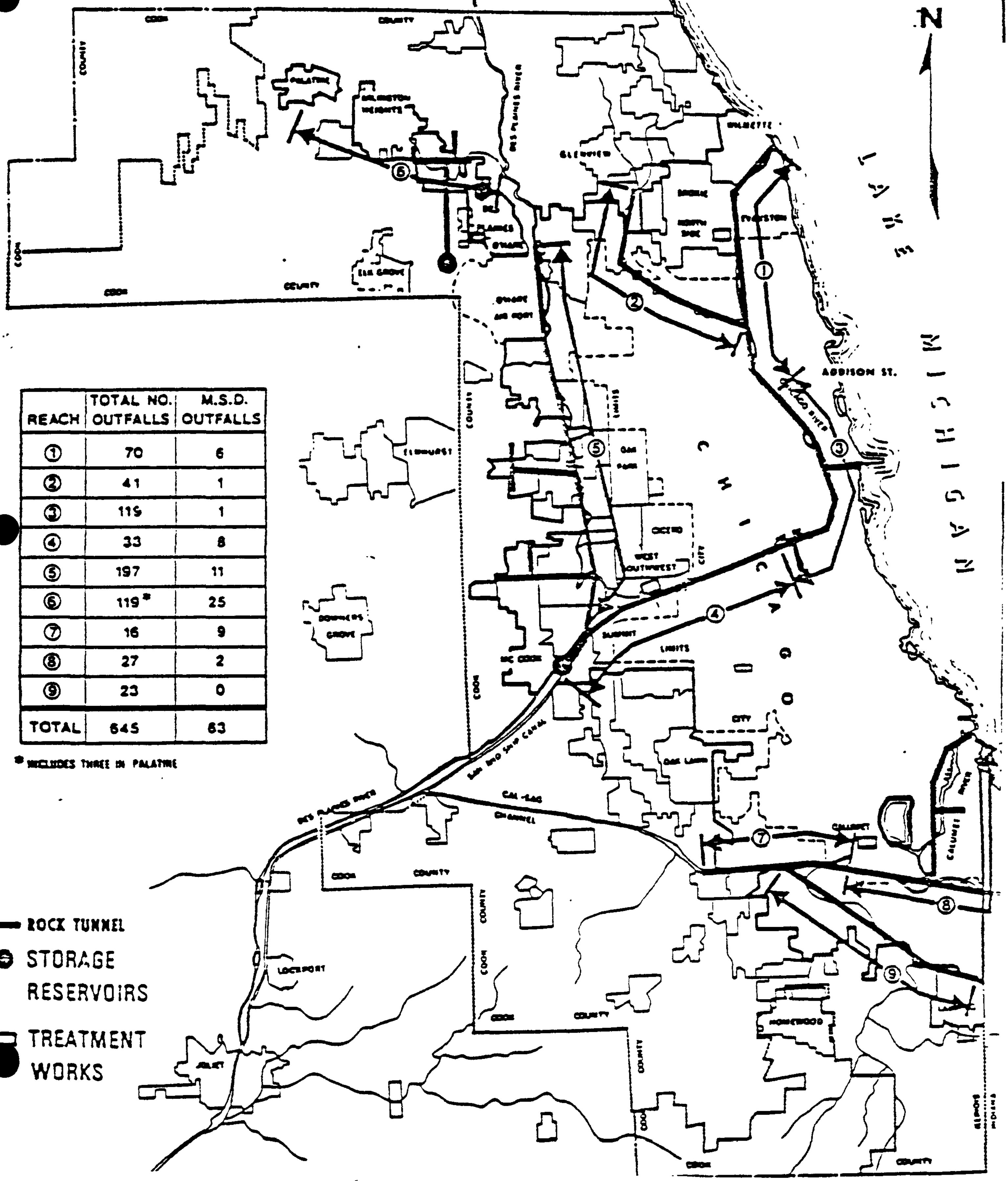


FIGURE II-A

THE METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO

OUTFALLS IN COMBINED SEWERED AREA

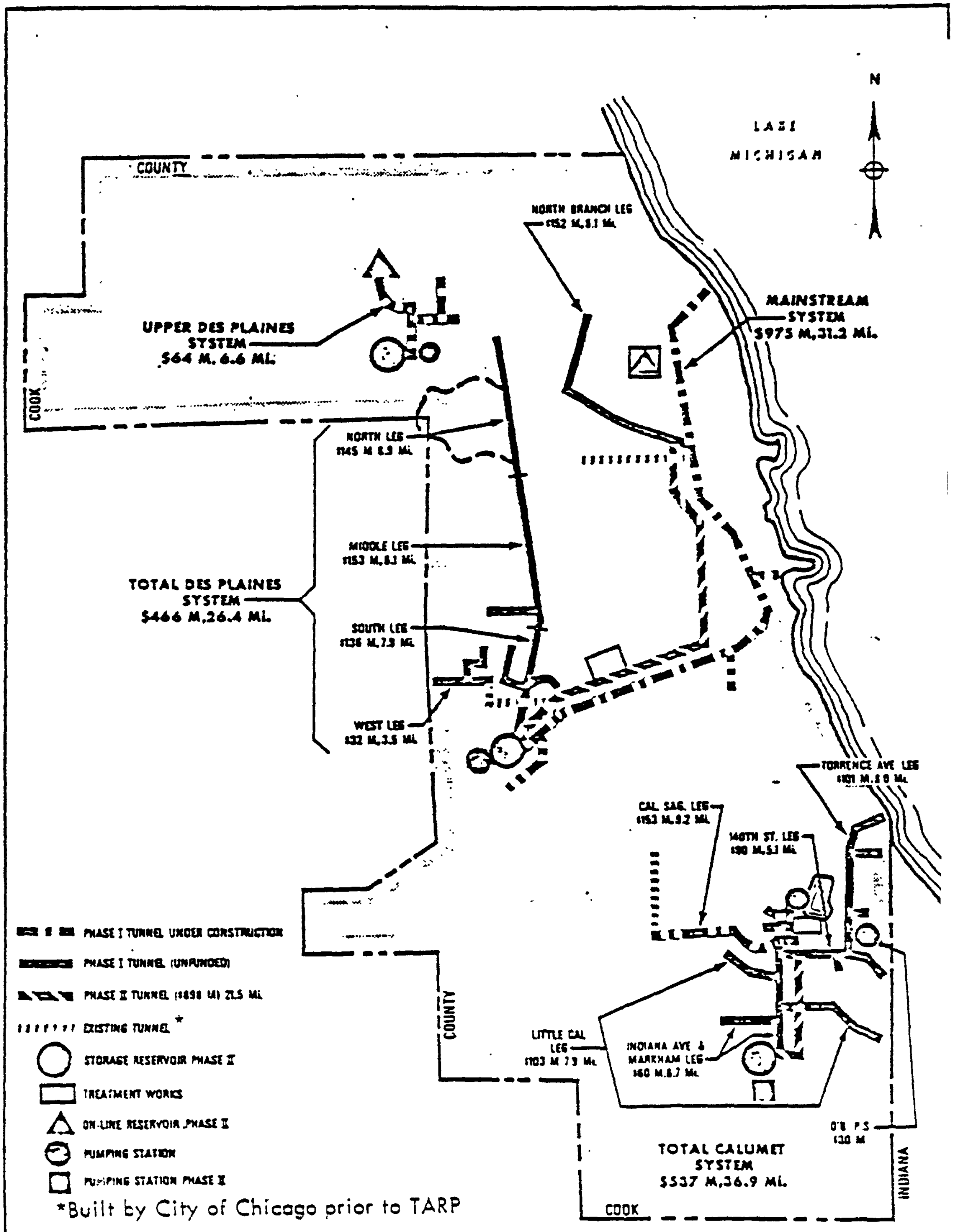
FIGURE III-A-2



REACH	TOTAL NO. OUTFALLS	M.S.D. OUTFALLS
①	70	6
②	41	1
③	119	1
④	33	8
⑤	197	11
⑥	119*	25
⑦	16	9
⑧	27	2
⑨	23	0
TOTAL	645	63

* INCLUDES THREE IN PALATINE

FIGURE III-A-1 TARP Project Status



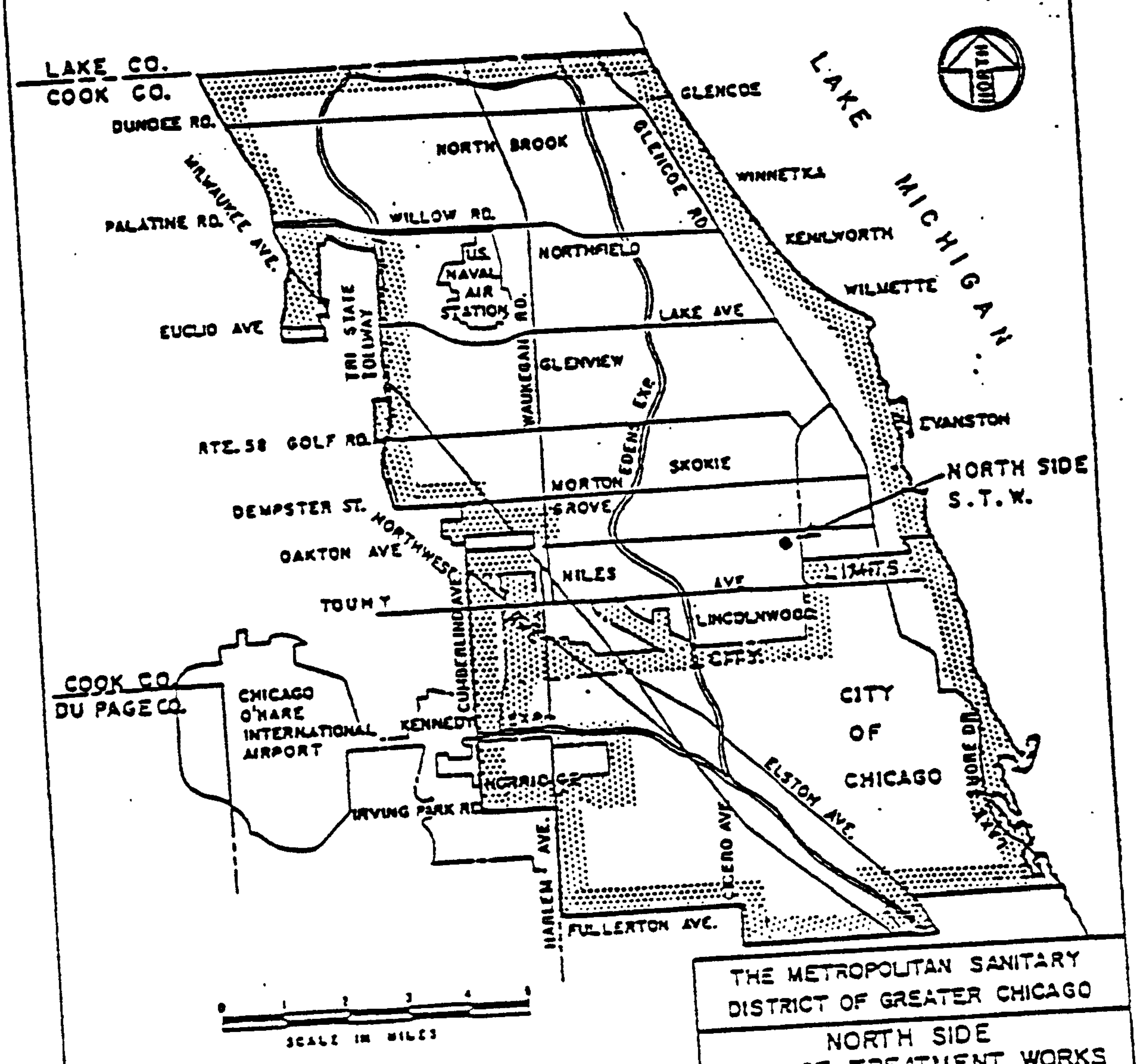
TUNNEL AND RESERVOIR PLAN

THE METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO ENGINEERING DEPARTMENT

FIGURE III-B-1-a
(Ref. 85, Fig. III - 2)

NORTH SIDE SEWAGE TREATMENT WORKS

FUTURE (1978) TRIBUTARY AREA

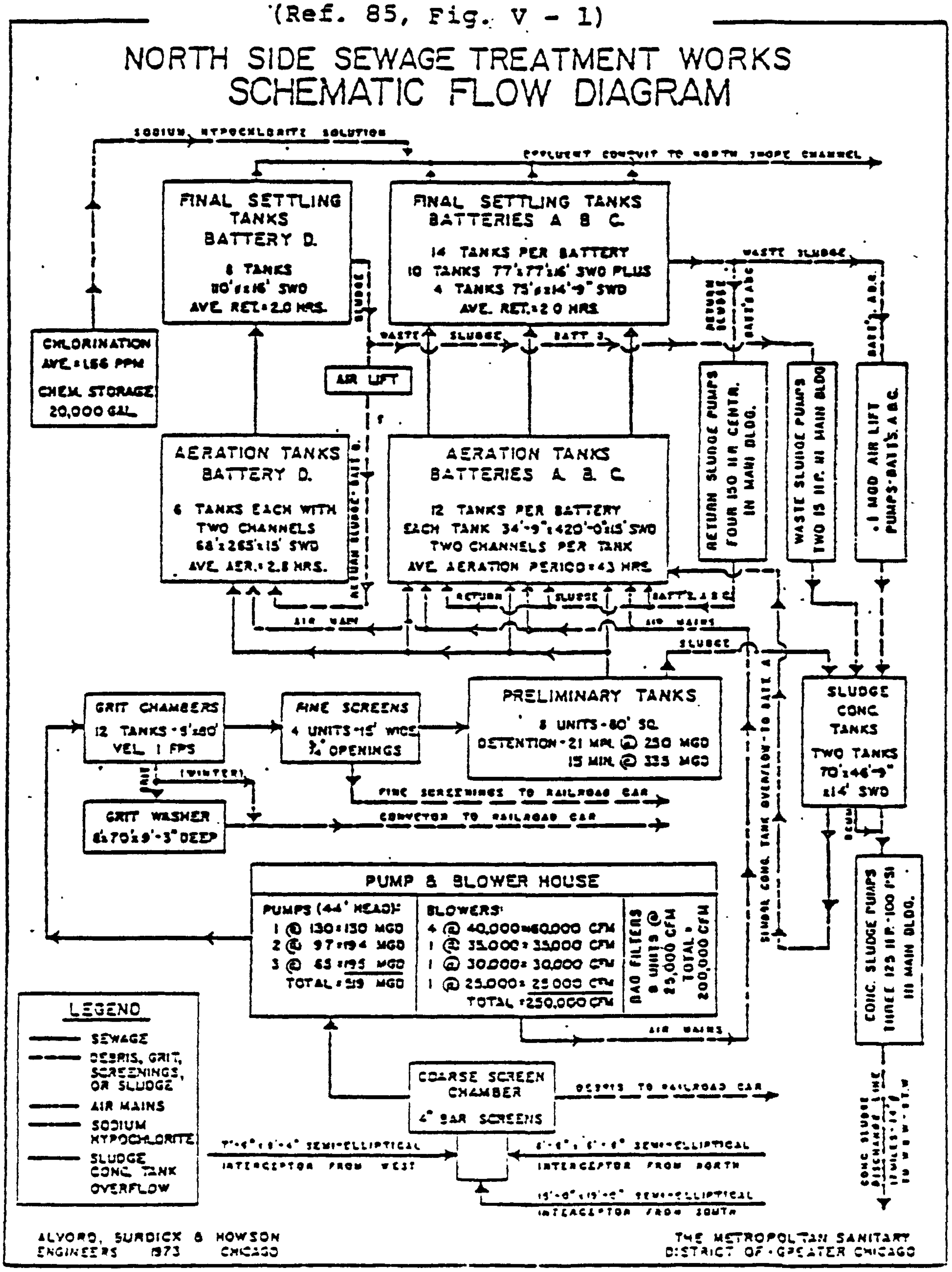


THE METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO

NORTH SIDE SEWAGE TREATMENT WORKS

ALVORD, BURDICK & HOWSON
ENGINEERS CHICAGO
1973

FIGURE III-B-1-b
(Ref. 85, Fig. V - 1)



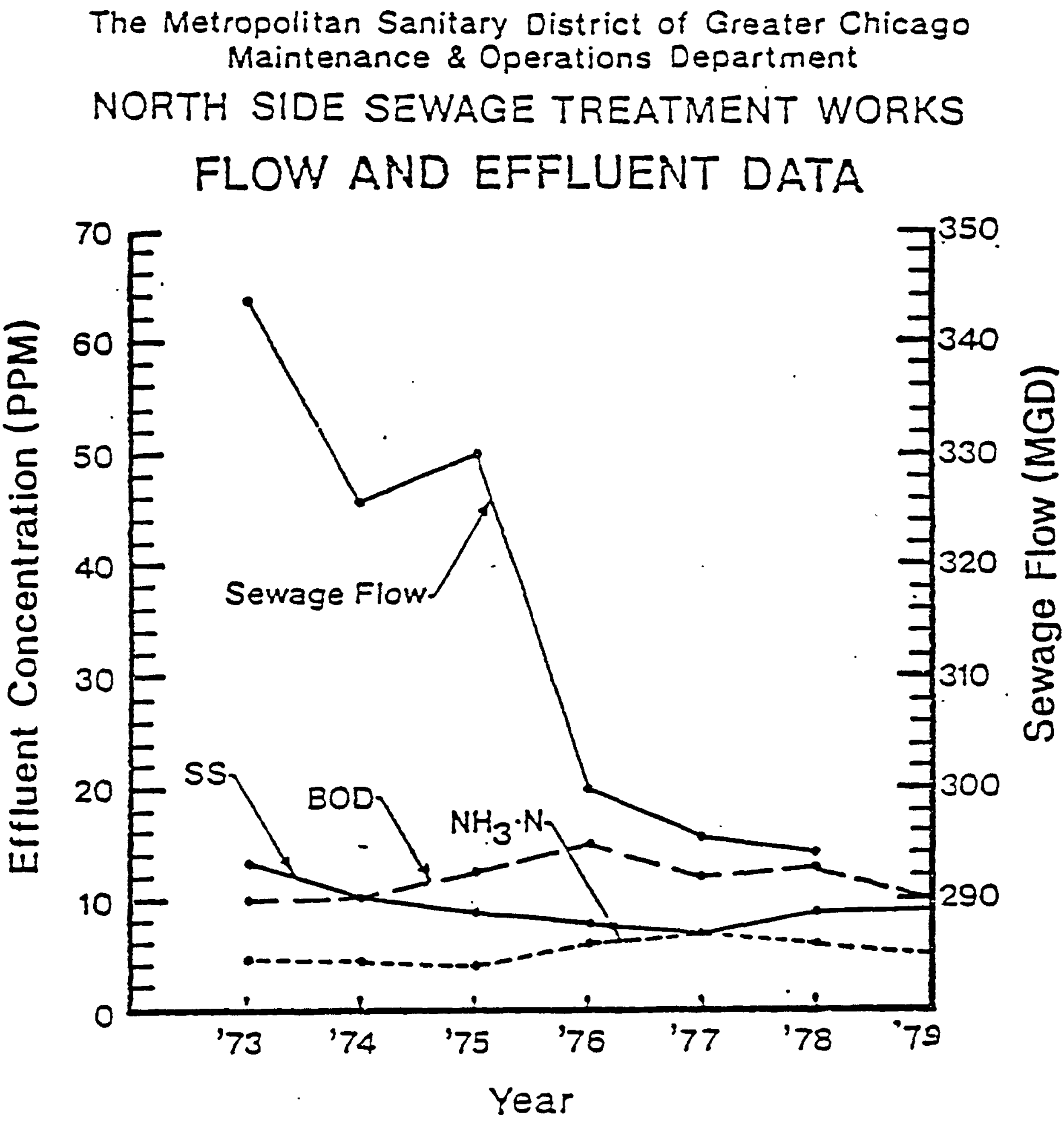


Figure III-B-1-c
(Compiled by B & R based on Ref. 60 & 136)
WASTEWATER CHARACTERISTICS OF NSSTW

TABLE III-8-2

PERFORMANCE OF WEST-SOUTHWEST FACILITY

(ref. 4,5,6,7)

		1975	1976	1977	1978
Flow:	Average	847	786	797	821
MGD:	Range	744-1446	744-1446	570-1370	569-1530
BOD:	Influent	166	153	168	138
Mg/L:	Effluent	7	5	5	6
	% Removal	94	97	97	96
SS:	Influent	199	232	269	196
Mg/L:	Effluent	7	6	7	7
	% Removal	97	97	97	96
NH_3:	Influent	-	-	10.4	7.7
Mg/L:	Effluent	-	2	2.6	1.8
	% Removal	-	-	75	77

West-Southwest Treatment Facility
Solid Train

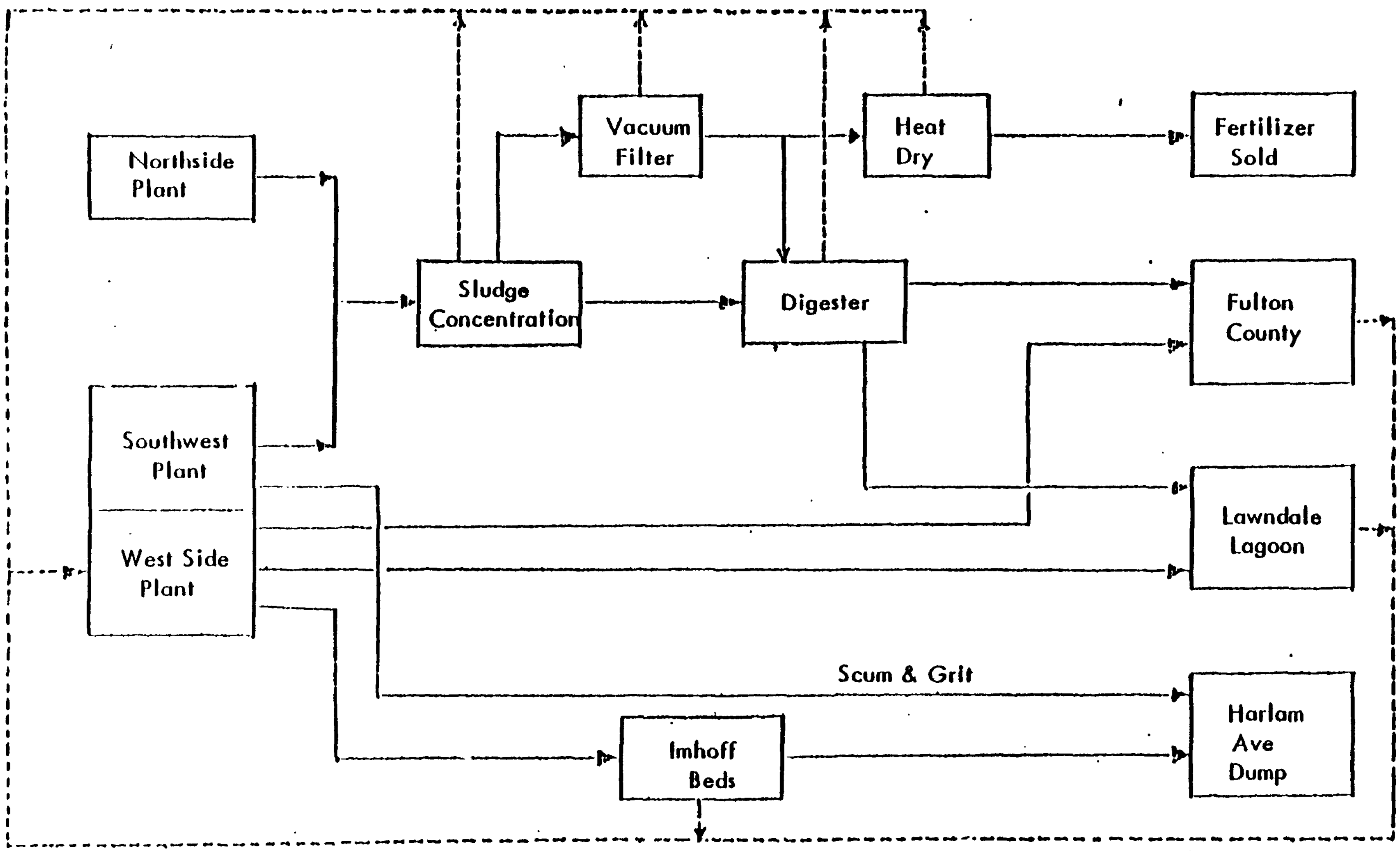


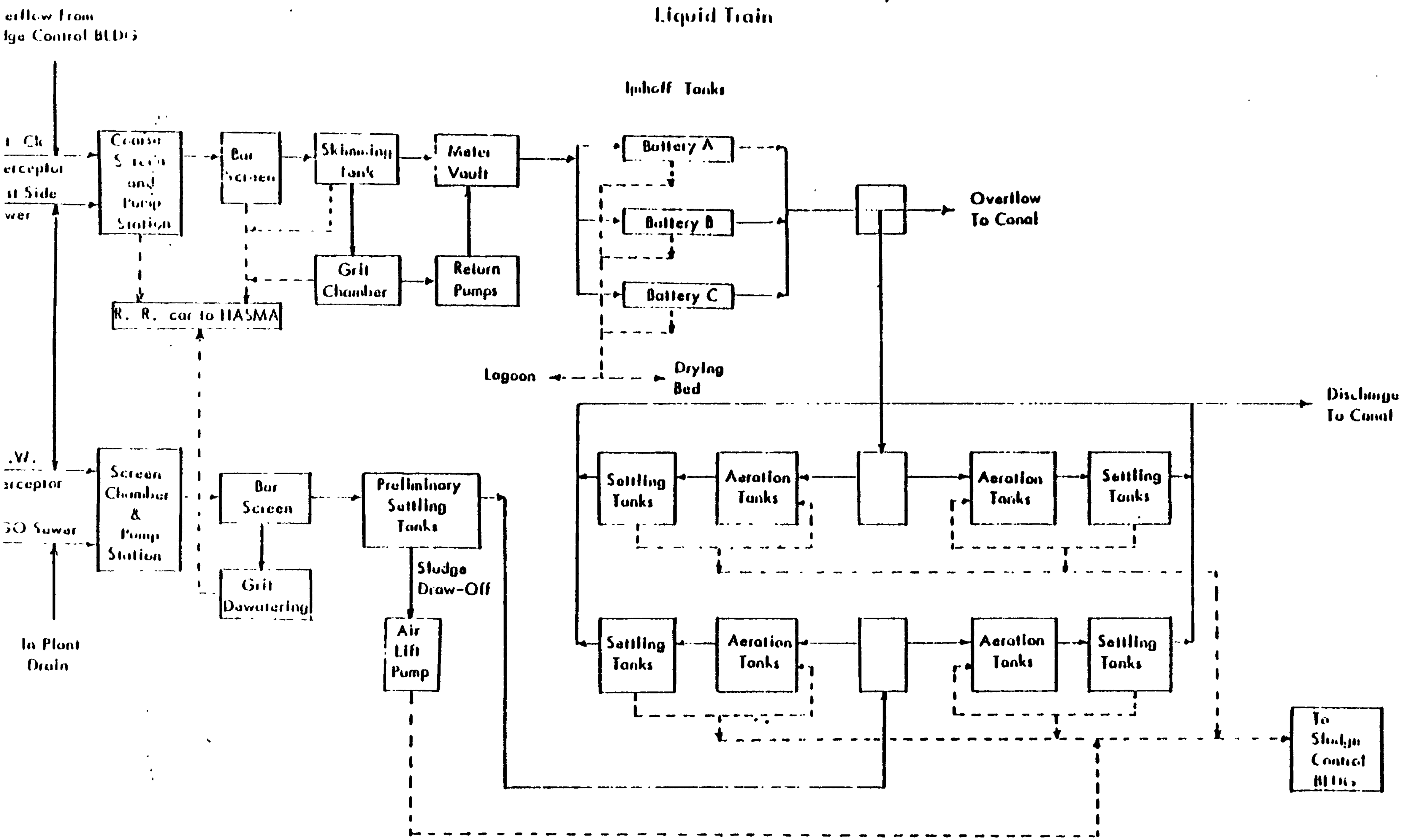
TABLE III-B-3-a

WASTEWATER FLOW AT CALUMET PLANT (1960-78)

(ref.84, p.2-5)

Year	Estimated population millions	Average flow MGD	Average flow GCD	Average dry-weather flow MGD	Average dry-weather flow GCD	Average dry-weather flow percent of average flow
1960	0.614	126.0	205	119	193	94
1969	0.894	177.5	198	151	169	85
1970	0.921	197.5	214	168	182	85
1971	0.950	177.2	187	158	166	89
1978(1)		223.0(1)			188(1)	
1940	-	-	197	-	185	94 -range
1965					167	85

Fig. III-B-2-c
West-Southwest Treatment Facility
Liquid Train



WEST-SOUTHWEST SEWAGE TREATMENT WORKS SERVICE AREA

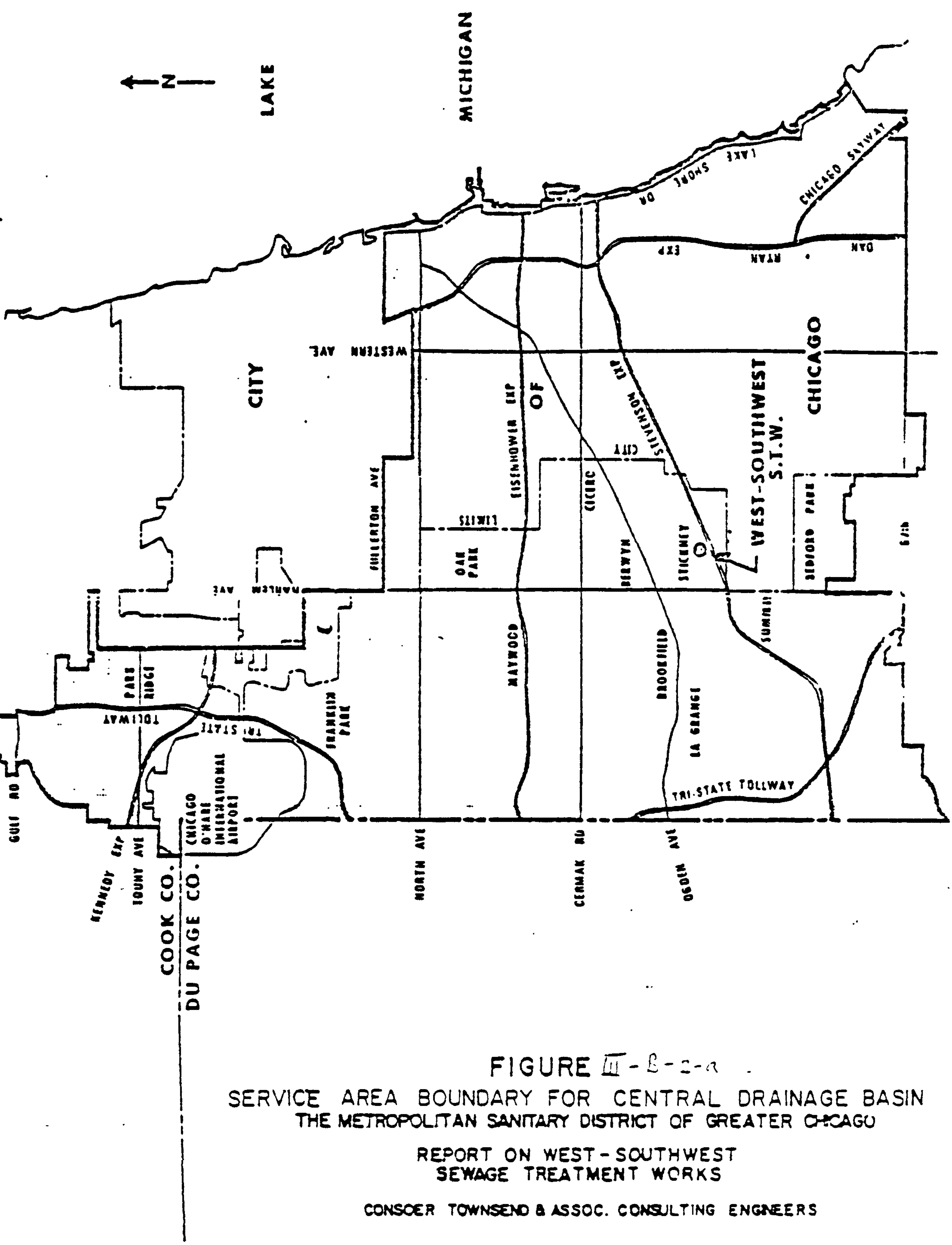


FIGURE III-B-2-a

SERVICE AREA BOUNDARY FOR CENTRAL DRAINAGE BASIN

THE METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO

REPORT ON WEST-SOUTHWEST SEWAGE TREATMENT WORKS

CONSOER TOWNSEND & ASSOC. CONSULTING ENGINEERS

TABLE III-B-3-b

PAST CENSUS POPULATION DATA

(ref.64, p.2-2)

	Basin study area population			Future service area population		
Year	Suburban Cook County	City of Chicago	Total	Suburban Cook County	City of Chicago	Total
1930	120,573	254,509	375,082	96,561	254,509	351,078
1940	140,794	261,929	402,723	116,496	261,929	378,425
1950	214,794	326,096	540,535	179,621	326,096	505,717
1960	451,856	368,250	820,106	383,489	368,250	751,739
1970	653,047	403,368	1,056,415	576,586	403,368	979,954 (1)

1. Census population of Present Service Area is 921,000.

Table II-B-3-c

DESIGN DATA FOR EXISTING CALUMET TREATMENT UNITS
(ref. 5, p. U7A-118)

	Design Data
Plant Design Capacity - (MGD)	220
Total Hydraulic Capacity - (MGD)	330
Blower Capacity	
Total (CFM)	184,000
Firm (CFM)	140,000
Screens	
Design Flow (MGD)	220
Grit Chamber	
Design Flow (MGD)	220
Primary Settling	
Design Flow (MGD)	220
Secondary Treatment	
Design Flow (MGD)	300
Return Sludge (MGD)	152
Chlorination Capacity	
Design Flow (MGD)	330

Table III-8-3-d

PERFORMANCE OF EXISTING CALUMET FACILITIES - 1978 AVERAGE VALUES
(ref. 7, p.U9-58)

Parameter	Influent (mg/l)	Effluent (mg/l)	Percent Reduction
BOD	.168	13	92
SS	328	22	93
NH_3-N	17.6	15.1	14

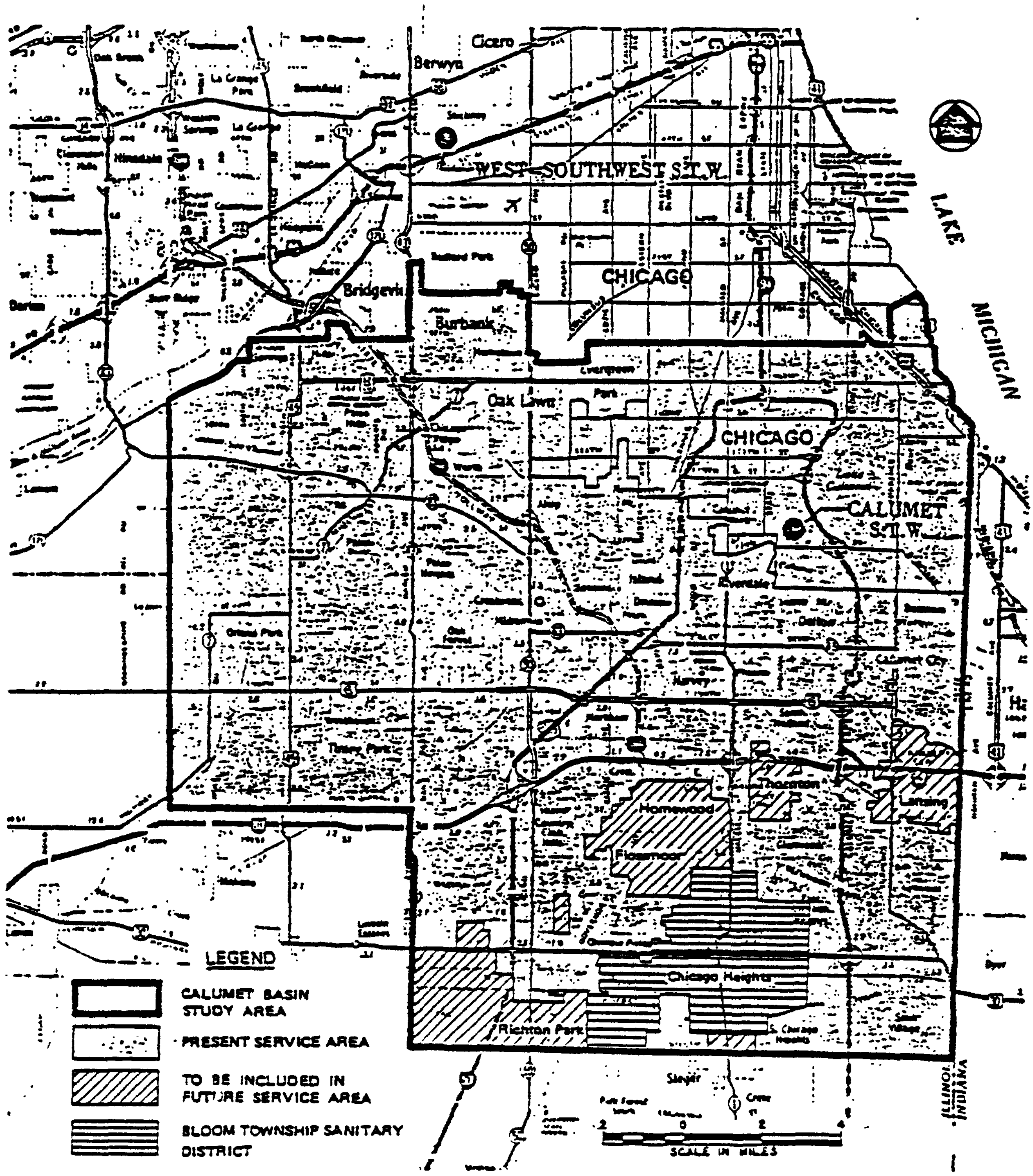


Figure III - 6 - 3 - 3
(ref. 84, p.2-2)
Existing and future service areas of Calumet Plant

TABLE III-B-1
(Compiled based on ref. 61)

North Side Sewage Treatment Works
1978 Sewage Treatment Operating Record
Raw Sewage Characteristics and Plant Performance

Parameter	Raw Sewage	Primary Effluent	Secondary Effluent
Flow, MGD			
mo. min.	208		
mo. max.	395		
yr. avg.	294		
BOD_5, mg/l			
mo. min.	17	21	2
mo. max.	188	207	40
yr. avg.	87	65	13
TSS, mg/l			
mo. min.	13	9	2
mo.max.	288	358	32
yr. avg.	104	73	10
Organic-N, mg/l			
mo. min.	0.4	0.3	0.0
mo. max.	32.5	33.9	7.2
yr. avg.	7.1	5.6	1.5
NH_3-N, mg/l			
mo. min.	0.1	1.3	0.1
mo.max.	19.3	17.0	13.7
yr. avg.	11.3	7.8	6.0

TARP Phase I Funded Summary

(ref. 7, appendix G and ref. 46)

Contracts	Yearly Ave. BOD Overflow, lbs.	Yearly Ave. Overflow, BOD Capture, lbs.	Percent BOD Captured by Project	Estimated Const. Cost 1979 dollars	Main Tunnel Length (miles)	Tunnel Storage Volume (Acre-ft.)	Benefit $/# BOD Capture *
Mainstream Tunnel System							
1. Contract No. 72-049-2H & 73-358-2H (Addison Street to Wilmette Airpor)	6,250,000	5,321,000	85.0	63,140,480.-	9.8	660	13.44
2. Contract No. 73-058-AH Mainstream (Addison-Wilmette Conn. Str.)				34,966,400.-			
3. Contract No. 73-058-BH Mainstream (Addison-Wilmette Conn. Str.)				27,413,300.-			
4. Contract No. 73-358-CH Mainstream (Addison-Wilmette Conn. Str.)				13,571,740.-			
5. Contract No. 73-358-DH Mainstream (Addison-Wilmette Conn. Str.)				12,220,875.-			
6. Contract No. 73-160-2H & 73-163-2H (59th Street to Central Avenue)	2,743,000	2,304,000	84.0	86,493,875.- 26,440,052.-	2.6	369	49.02
7. Contract No. 75-126-2H & 75-121-2H (Central Avenue to Damen Avenue)	4,066,000	3,265,000	80.3	98,985,250.-	4.9	510	30.32
8. Contract No. 75-125-2H & 75-120-2H (Damen Avenue to Roosevelt Road)	5,480,000	4,428,000	80.8	107,837,300.- 19,877,570.-	4.8	409	28.84
9. Contract No. 75-124-2H & 75-119-2H (Roosevelt Road to Ogden Avenue)	728,000	612,000	84.0	101,976,680.- 16,901,774.-	3.9	243	194.23
10. Contract No. 75-123-2H & 75-118-2H (Ogden Avenue to Addison Street)	2,810,000	2,360,000	84.0	85,205,910.- 11,162,159.-	4.3	367	40.83
Subtotal Mainstream System	22,087,000	18,290,000		712,387,515.-	31.3	2,558	38.94
Upper Des Plaines (O'Hare) System							
1. Contract No. 73-317-2S	660,000	610,500	92.5	35,749,664.-			
2. Contract No. 73-318-2S	-	-	-	4,398,650.-			
3. Contract No. 73-320-2S	340,000	314,500	92.5	21,371,607.-			
4. Contract No. 73-319-2S	-	-		2,883,943.-			
Total Upper Des Plaines System	1,000,000	925,000		64,403,864.-	6.6	212*	69.62
Calumet Tunnel System							
Contract No. 73-287-2H & 73-273-2H (Crawford Avenue to Pumping Station)	4,880,000	3,806,400*	78	79,256,370.- 19,173,509.-	9.2	348	
Subtotal Calumet System		3,806,400					
Total for Phase I Funded Tunnels		23,021,400*		875,221,258.-*	47.1	3,118*	38.01

Contracts	Capacity	Estimated Const. Cost 1979 dollars	Benefit $/# BOD Capture
Mainstream Pumping Station Part I Contract No. 73-162-AH	1100 CFS C	168,811,300.-	
Mainstream Pumping Station Part II Contract No. 73-162-BH		64,755,000.-	
Mainstream Pumping Station Part III Contract No. 73-162-CH		28,012,400.-	
Mainstream Pumping Calumet Plant Contract No. 74-205-2H	388 Capacity	54,841,825.-	
Total Pump Stations		261,578,700.-	5.46
Total Funded Segments of TARP Phase I		1,191,641,783.-	38.01 + 5.46 = 43.47*

Pump Stations have capacity for both the funded and unfunded segments of TARP Phase I.

Assume pumping cost proportional to tunnel storage:

$$\frac{3118}{3118 + 3369} = 0.4806$$

$$\frac{0.4806 \times 261,578,700}{23,021,400} = 5.46$$

Note: Since updated O&M costs are not available, the above benefit ratios have not been converted to present worth.

(Ref. 7, Appendix G, and Ref. 46)

P PHASE I Unfunded Segments (proposed facilities)

	Yearly Ave BOD Overflow, lbs	Yearly Ave Overflow BOD Capture, lbs*	Percent BOD Captured By Project	Estimated Cost 1979 Dollars	Main Tunnel Length (Miles)	Storage Volume (Acre-ft.)	Benefit $/# BOD_5 Capture/yr *
nstream System							
ontract No. 3-060-2H orth Branch of icago River	4,221,000	3,630,000	86.0	151,800,000	9.1	612	3.08** $ 41.82
otal Mainstream System resent Worth Mainstream System		3,630,000		151,800,000 177,850,000	9.1	612	3.08** $ 41.82 48.99 3.61**
Plains System							
ntract 73-164-2H th Street to Cermak Rd	940,171	832,000	88.5	135,704,000	7.9	556	12.01** $163.11
ntract 75-132-2H rmak Rd to llerton Ave	1,607,829	1,433,000	89.1	153,029,000	6.1	360	7.86** $106,79
ntract 75-131-2H llerton Ave to airie Ave	1,615,000	1,454,000	90	145,262,790	8.9	318	7.35** $ 99.91
ntract 75-130-2H Extension	216,100	194,000	90	31,940,000	3.5	33	12.12** $164.64
otal Des Plaines Systems esent Worth Des Plaines System	4,379,030	3.913,000		465,935,798 538,310,000	26.4	1,267	8.76** $119.07/lb/ 137.57 10.13**
s Phase I Unfunded tal Phase I Unfunded Present Worth		12,302,000		1,001,898,363 1,169,250,000	67.1	3,369	$ 81,44 5.99**
Inc. Calculation							
ortized Cost Assuming a 50 Year Life by MSD							95.05
SD Calculation (Dated 5/16/80)							7.00**

TABLE III-C-2 (page 2 of 2)

(Ref. 7, Appendix G, and Ref. 46)

ARP PHASE I Unfunded Segments (proposed facilities)

	Yearly Ave BOD Overflow, lbs	Yearly Ave Overflow BOD Capture, lbs*	Percent BOD Captured By Project	Estimated Cost 1979 Dollars	Main Tunnel Length (Miles)	Storage Volume (Acre-ft.)	Benefit $/# BOD5 Capture/y *
alumet System							
Contract No. 73-271-2H	1,266,000	1,108,000	87.5	90,011,110	5.2	278	5.98* $81.23
140th St. & Cal. City Contract No. 73-274-2H	71,000	65,000	91	60,502,395	6.5	371	6.85* $93.00
Indiana Ave. Trunkline & Markham Branch Contract No. 75-200-2H	2,360,000	2,065,000	87.5	101,239,230	7.9	405	4.97* $49.03
Torrence Ave							
Contract No. 75-213-2H	1,010,000	909,000	90	102,742,830	2.6	108	4.97* $67.54
Dixmor Branch Contract No. 75-213-2H (Little Calumet Leg)	680,000	612,000	90		4.6	120	$67.54
Lansing Branch Contract No. 73-272-2H Low Lift Dewatering PS to Reservoir				29,667,000	Capacity 2,200 cfs	200	
ubtotals Calumet System		4,759,000		384,162,565 453,090,000	31.6	1,490	$80.72 5.94*
**Present Work Calumet System							95.21 7.01*

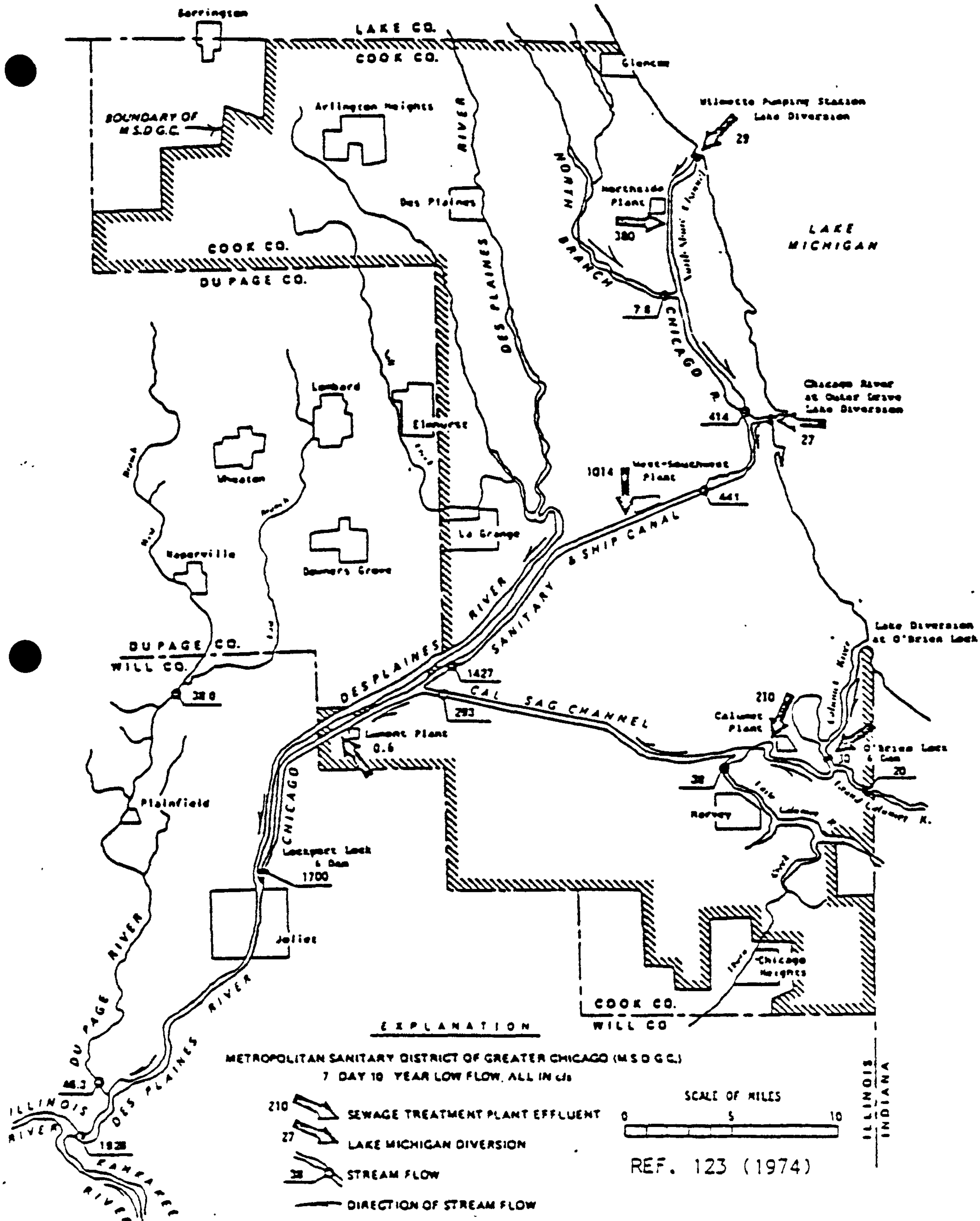


FIGURE IV-A-1

FLOW REGIME AT 7Q10

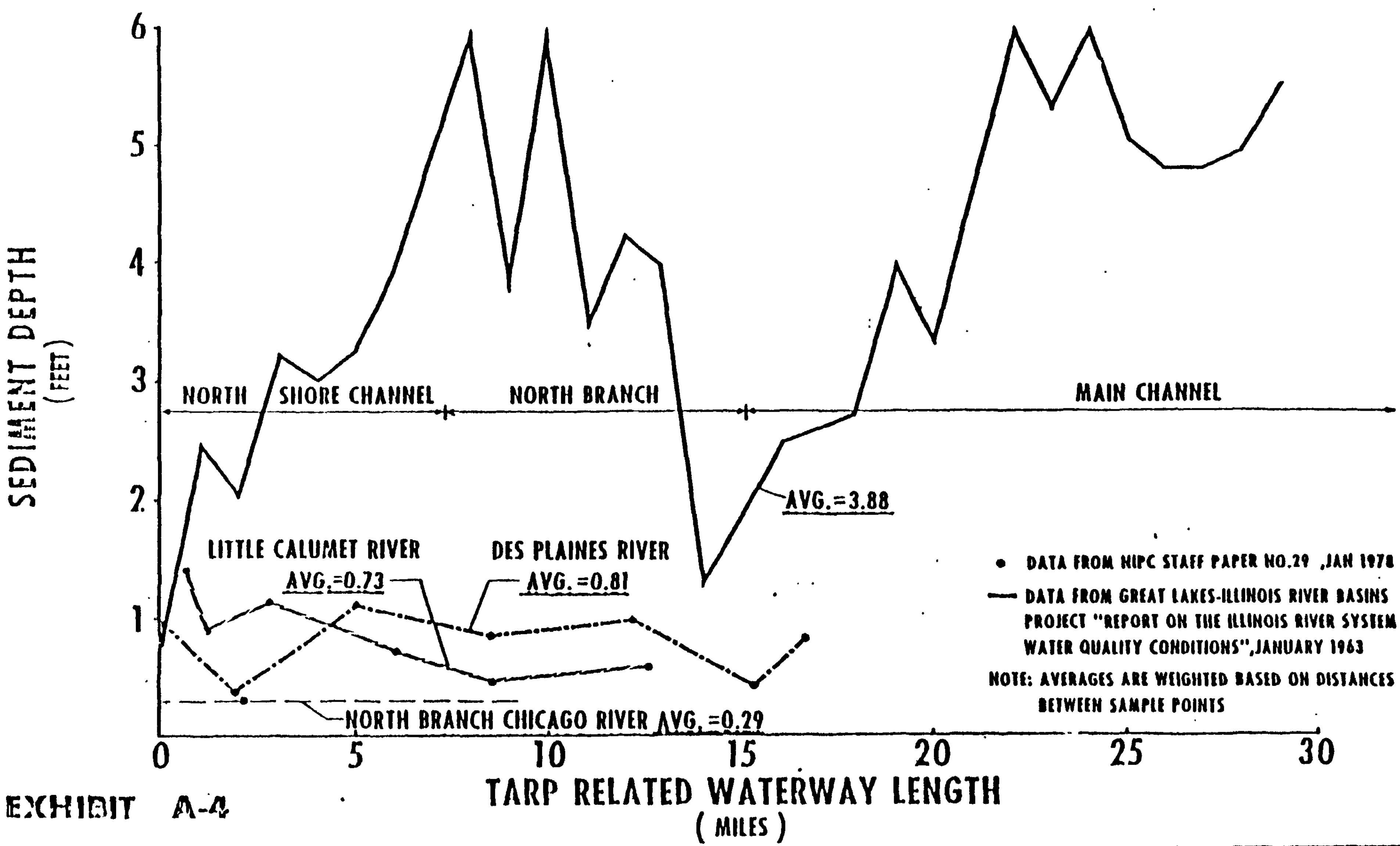


EXHIBIT A-4

USEPA REVIEW OF REMAINING SEGMENTS OF TARP PHASE 1
BENTHIC SEDIMENT DEPTH

THE METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO
ENGINEERING DEPARTMENT
7-80 PLANNING KK:GK

FIGURE IV - B-1

TABLE IV-A-1

SUMMARY OF 1977 AVERAGE MONTHLY POLLUTANT CONCENTRATIONS IN CHICAGO's SURFACE WATER SYSTEMS

	Chicago River-- Sanitary and Ship Canal System	Calumet River System	Des Plaines River System
)issolved oxygen (DO)	2.4 to 9.4 mg/l	2.3 to 9.7 mg/l	4.7 to 9.5 mg/l
3iochemical oxygen lemand (BOD)	3.8 to 8.2 mg/l	3.9 to 9.0 mg/l	2.6 to 9.9 mg/l
Ammonia (as N)	0.03 to 5.2 mg/l	0.05 to 6.4 mg/l	0.10 to 2.80 mg/l
Suspended solids (SS)	13 to 23 mg/l	0.9 to 43 mg/l	24 to 108 mg/l
Fecal coliform bacteria	62 to 11,100 (counts/100 ml)	99 to 12,400 (counts/100 ml)	155 to 11,400 (counts/100 ml)

Range represents variation in average monthly values among stations in stated reach.
(Ref. 7)

TABLE V-B[illegible]a (page 1 of 4)

(Compliled by Burns and Roe based on References 7, 85 and 98)

SUMMARY OF FACILITIES REQUIREMENTS
NORTHSIDE SEWAGE TREATMENT WORKS
EXPANSION AND NITRIFICATION

Item	Existing Facilities	Additional Facilities Or Capacity To Be Provided In Exp. & Imp.	Total After Expansion & Improvement	Process Parameter @ Design Flow
1) Design Flow	333 MGD Secondary Treatment		333 MGD Advanced Treatment	
2) Hydraulic Capacity	414 MGD	86 MGD	500 MGD	
3) Raw Sewage Pumps	6 Constant Speed Pumps Inst. Cap=519 MGD Firm Cap=389 MGD	Replace Pumps Nos. 4 & 5 w/new Constant Speed Pumps	Inst. Cap= 649 MGD Firm Cap= 519 MGD	
4) Siphon Spillway (elevations shown are Chicago City Datum)	Low Siphon El.= 24.67 High Siphon El.= 26.42 Top of Concrete Floor El.=29.0	Raise Siphons	Low Siphon El.=27.31 High Siphon El.=27.58 Top of Con-crete El.= 29.0 Top of Curb around Siphons El. = 30.5	
5) Grit Chambers			Improvement	
6) Fine Screens			Replacement	

TABLE V-B-[illegible] (page 2 of 4)

SUMMARY OF FACILITIES REQUIREMENTS
NORTHSIDE SEWAGE TREATMENT WORKS
EXPANSION AND NITRIFICATION
(Continued)

Item	Existing Facilities	Additional Facilities Or Capacity To Be Provided In Exp. & Imp.	Total After Expansion & Improvement	Process Parameter @ Design Flow
7) Preliminary Settling Tanks	8 Tanks Liquid Volume= 3.63 MG	8 Circular Tanks Liquid Volume =6.82 MG	16 Tanks Liquid Volume =10.45 MG	Det. Time= 45 min.
8) Meter Station/ Building	Meter Station		New Meter Bldg.	
9) Aeration Tank Batteries (Liquid Vol.)	A=18.38 MG B=18.38 MG C=18.38 MG D=11.74 MG	Battery E =11.74 MG	Total=78.62 MG	Det. Time (hrs) A=6.0 B=6.0 C=6.0 D=5.0 E=5.0
10) Flow Distribution to Batteries	A=83 MGD B=83 MGD C=83 MGD D=83 MGD	Battery E	A=73.4 MGD B=73.4 MGD C=73.4 MGD D=56.4 MGD E=56.4 MGD	
11) Blowers	7 Centrifugal Blowers Inst. Cap= 250,000 cfm Firm Cap.= 210,000 cfm	Replace Existing Blowers with 6 New Blowers	Approx: Inst. Cap= 312,000 cfm Firm Cap= 260,000 cfm	1 ft^3 per gallon of sewage treated
12) Air Mains	Two Air Mains	One new Air Main	Three Air Mains	

TABLE V-B[illegible]a (page 3 of 4)

SUMMARY OF FACILITIES REQUIREMENTS
NORTHSIDE SEWAGE TREATMENT WORKS
EXPANSION AND NITRIFICATION
(Continued)

Item	Existing Facilities	Additional Facilities Or Capacity To Be Provided In Exp. & Imp.	Total After Expansion & Improvement	Process Parameter @ Design Flow
13) Final Settling Tanks (Surface Area ft^2)	A=77,000 ft^2 B=77,000 ft^2 C=77,000 ft^2 D=76,000 ft^2	4 Circular Supplemental Final Tanks Each for Batteries A, B, C A=15,400 ft^2 B=15,400 ft^2 C=15,400 ft^2 8 Circular Final Tanks for Battery E= 76,000 ft^2	Total Per Battery A=92,400 ft^2 B=92,400 ft^2 C=92,400 ft^2 D=76,000 ft^2 E=76,000 ft^2 Total=429,200 ft^2	Surface Settling Rate (gpd/ft^2) A=800 B=800 C=800 D=740 E=740
14) Chlorination	One dosing pt.	New sodium hypochlorite generation and addition facilities; dosing before filtration		Contact Time=15 min. including conduits & filters
15) Return Activated Sludge Capacity	Battery A=33 MGD Battery B=33 MGD Battery C=33 MGD Battery D=40 MGD 140 MGD	193 MGD	333 MGD Incl. Battery E	100% Return Rate

METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO
REPORT ON WEST-SOUTHWEST SEWAGE TREATMENT WORKS
TABLE V-B-2-b

POPULATION PROJECTIONS-TREND METHOD TOTALS

	1990	2030		1990	2030
Chicago (Part.)	1,970,000	1,930,000	Leydon Township (Uninc)	2,600	4,800
Bedford Park	960	1,060	Lyons	17,000	21,000
Bellwood	27,300	32,000	Lyons Township (Uninc)	15,500	16,000
Berkeley	6,800	8,300	McCook	500	500
Berwyn	56,000	62,000	Maywood	31,000	31,000
Bridgeview (Part.)	13,000	21,000	Melrose Park	38,000	52,000
Broadview	12,000	13,000	Niles (Part.)	3,300	4,200
Brookfield	23,000	23,000	North Lake (Part.)	36,000	56,000
Burr Ridge (Part.)	4,000	7,700	North Riverside	8,100	8,400
Cicero	70,000	75,000	Oak Park	62,000	62,000
Countryside	11,000	34,000	Park Ridge (Part.)	24,000	25,000
Des Plaines (Part.)	62,000	73,000	Proviso Township (Uninc)	1,500	1,000
Elmwood Park	27,500	29,000	River Forest	15,000	19,000
Forest Park	15,300	16,000	River Grove	17,000	25,000
Forest View	940	960	Riverside	11,700	14,000
Franklin Park	34,000	42,000	Rosemont	12,000	20,000
Hillside	10,300	14,000	Schiller Park	29,000	52,000
Hinsdale (Part.)	4,900	7,800	Stickney	10,000	12,000
Hodgekins	3,200	6,500	Stickney Township (Uninc)	100	0
Hometown	21,000	32,000	Stone Park	4,200	4,200
Indian Head Park	750	1,300	Summit	14,000	16,000
Justice	11,000	18,000	Westchester	22,000	26,000
La Grange	22,000	26,000	Western Springs	25,000	34,000
La Grange Highlands (Uninc)	7,000	7,000	Willow Springs	6,600	9,300
La Grange Park	21,000	26,000	Totals	2,841,050	3,020,020

TABLE V-B a (page 4 of 4)

SUMMARY OF FACILITIES REQUIREMENTS
NORTHSIDE SEWAGE TREATMENT WORKS
EXPANSION AND NITRIFICATION
(Continued)

Item	Existing Facilities	Additional Facilities Or Capacity To Be Provided In Exp. & Imp.	Total After Expansion & Improvement	Process Parameter @ Design Flow
16) Return Activated Sludge Station/Building			New Stations and Building	
17) Waste Sludge Pumping Facils.			Modification or Replacement	
18) Central Control Room	None	New	New Central Control Room	
19) Tertiary Filters	None	New Tertiary Facility	Sur. Areas 21,600 ft^2 to filter 50% of ADF. 41,400 to filter 100%	6.0 gpm/ft^2 w/Two Filters in Backwash
20) Microstrainer Building	Yes	Demolition	Space for Filter Building	
21) Storage/Service Building	Service Building		Service Building Expansion or New Storage Building	
22) Sludge Concentration Tanks	2 Gravity Type Tanks Total Area = 6,500 ft^2	Unclear (Ref. 98, p. 12)	6,500 ft^2 Gravity	39 $lbs/ft^2/day$

Table V-B-1-6

(Ref. 98, p.8; Ref. 7, p. U9-125)

Projected Flows
North Side Sewage Treatment Works [a]

Year	Population (1000)	Domestic and Industrial	Infiltration	Average Dry Weather Flow (ADWF)	Exist. Inflow	Future Inflow	Total Flow
1970	1392	189	82	271	20	--	---
1980	1374	196	83	279	20	20	319
1990	1387	208	84	292	20	20	332
2000	1388	219	85	304	20	20	344
2010	1398	225	85	210	20	20	350
2020	1409	231	85	316	20	20	356
2030	1421	237	85	322	20	20	362

NOTES: [a] All figures in millions of gallons per day (MGD)

Table 7-8-2-a

PLANT SIZING

1. Base Dry Weather Flow (at 315 gpcd and 2.84 million population*)	895 MGD
2. Lawndale Lagoon Return Flow	5.2 MGD
3. Water Treatment Plant Sludge	2.3 MGD
4. TARP Dewatering Capacity**	455 MGD
	1357.5 MGD

* Population Projection from Ref. 82

**Estimated at 50% of DWF, based on 320 gpcd

Table V-8-3-a

(Ref. 5, P. U7A - 145)
Proposed Calumet Process
Condition Table
(To Accompany Figure V-8-3)

Positions*	1	2	3	4	5	6	7
ADWF (MGD)	194	42	236	236	236	236	236
Design Flow (MGD)	194	160	354	354	354	354	354
BOD_5 (ppm)	145	145	145	126	17	20	10
SS (ppm)	214	214	214	168	16	18	12
NH_3-N (ppm)	21	21	21	NA	21	2.5	2.5
DO (ppm)	0	0	0	0	4	5	5
RC (ppm)	0	0	0	0	0	0	1
Hydraulic Capacity (MGD)	300	160	460	460	460	460	460

*Positions have following definitions:
1&2: Plant influent
3: Influent to grit chambers
4: Preliminary tank effluent
5: First-stage aeration tank effluent
6: Second stage effluent
7: Tertiary filter or final effluent

PROPOSED CALUMET PLANT FACILITIES - EXPANSION AND UPGRADE

(Ref. 5, p. 117A-118)

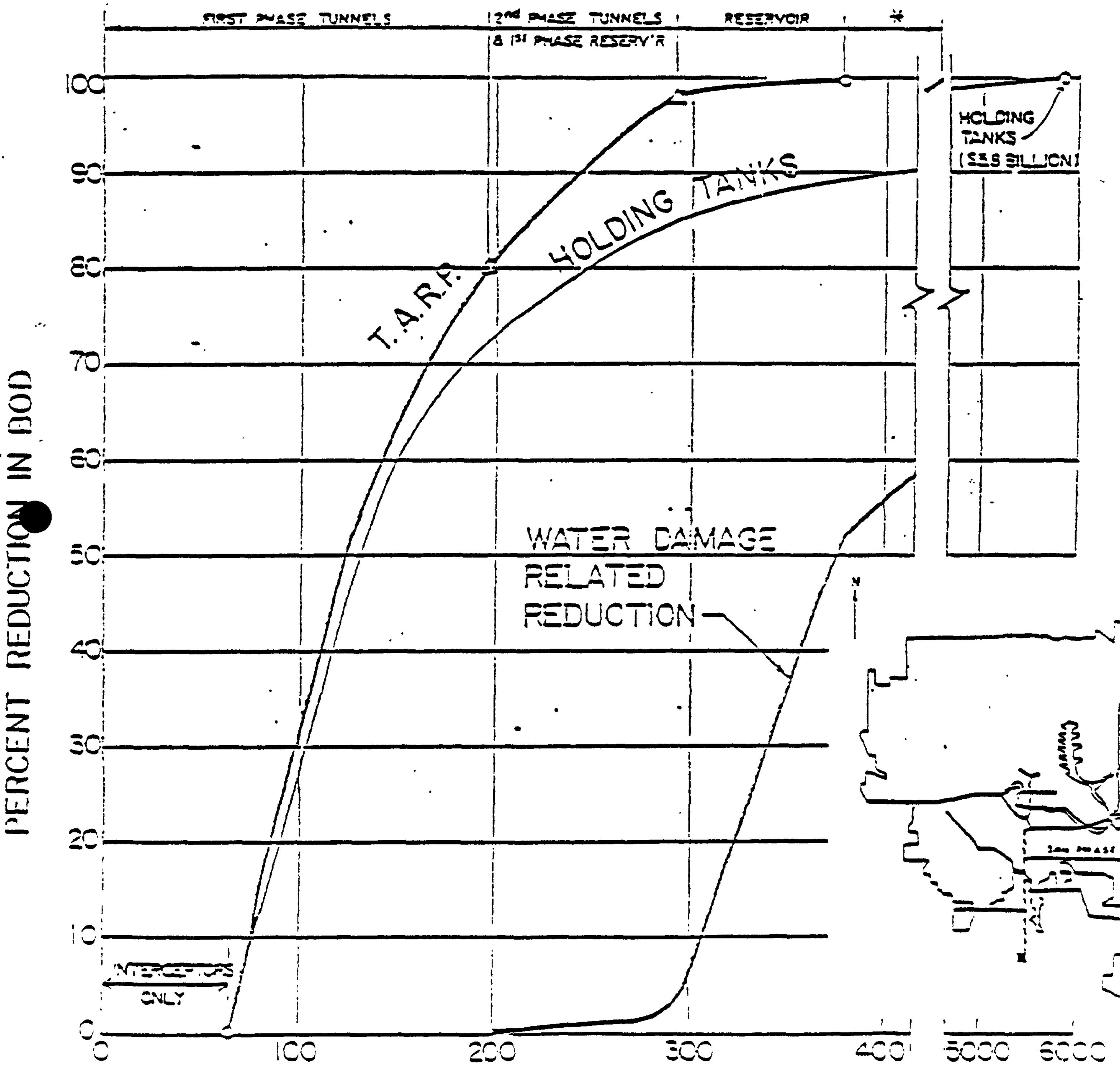
Unit	Existing Facilities	New Facilities	Total
Projected Average Dry Weather Flow (MGD)			236
TARP Dewatering Flow (MGD) (based on 149 days/yr pumpback)			118
Design Flow (MGD			354
Pumping Capacity			
Wetwell Firm (MGD)	224	219	443
Stand-by (MGD)	110	50	160
Total Hydraulic Plant Capacity (MGD)	330		460
Present Design Capacity	220		
Blower Capacity			
Total (CFM)	184,000		
Firm (CFM)	140,000	404,000	544,000
Screens			
Design Flow (MGD)	220	220	440
Grit Chamber			
Design Flow (MGD)	220	354*	354
Primary Settling			
Desing Flow (MGD)	220	134	354
First Stage Secondary Treatment			
Design Flow (MGD)	300	54	354
Return Sludge	152**	54	354
Nitrification			
Design Flow (MGD)	0	354	354
Return Sludge (MGD)	0	354	531
Filter Influent Pump			
Station Firm	0	465	465
Tertiary Treatment (Filtration)			
Design Flow (MGD)	0	354	354
Backwash (MGD)	0	22	22
Chlorination			
Desing Flow (MGD)	330		354

* Consideration shall be given to either completely replacing existing aerated grit tanks or to retaining them.

Ref 5.3

EXHIBIT 4

CALUMET SYSTEM



COST IN $1,000,000s

* $0.29 BILLION LOCAL SEWER IMPROVEMENTS, BASED ON PRELIMINARY CORPS REPORT

THE METROPOLITAN SANITARY
OF GREATER CHICAGO
ENGINEERING DEPARTMENT

B O D REDUCTION

VS

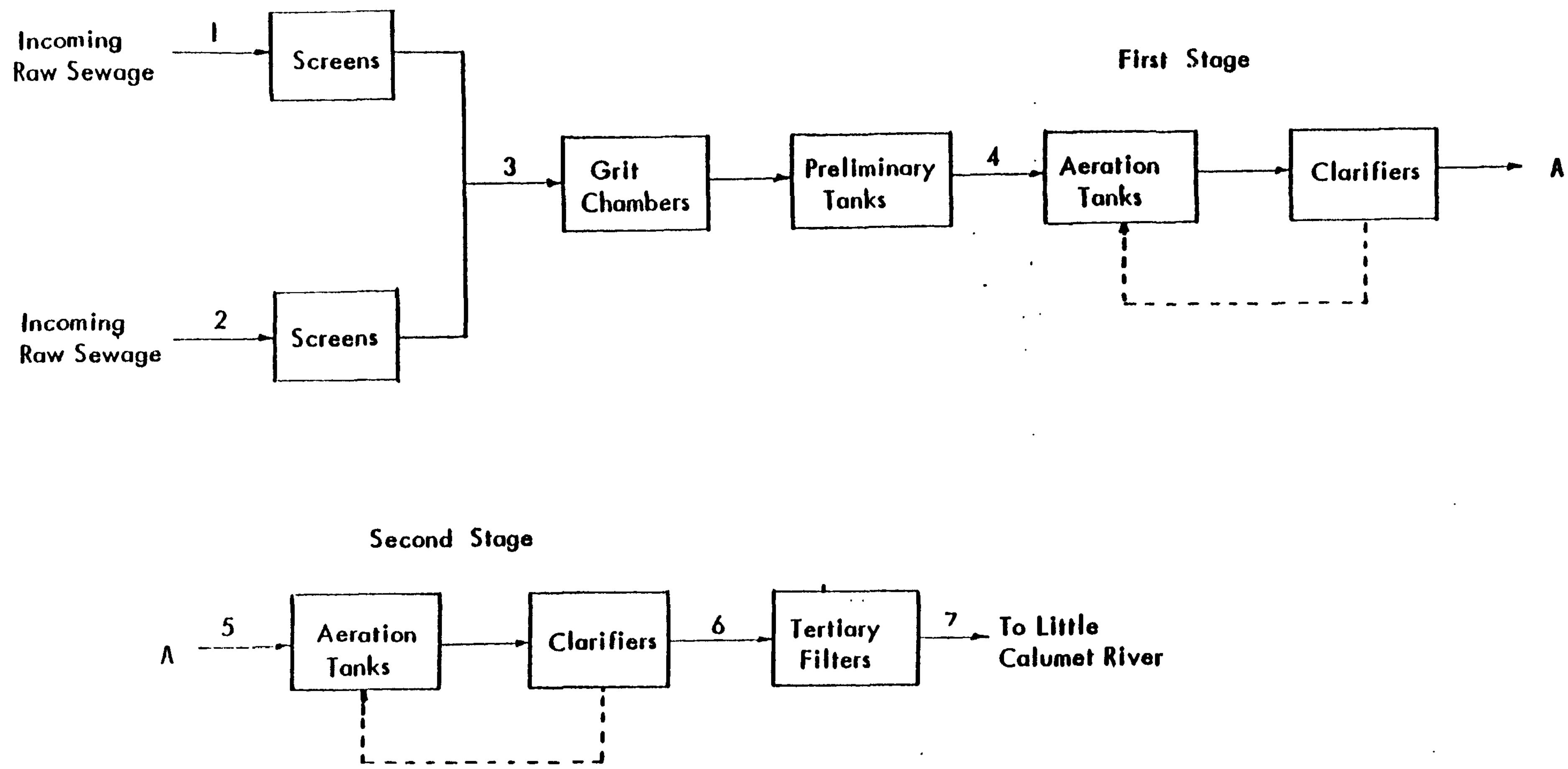
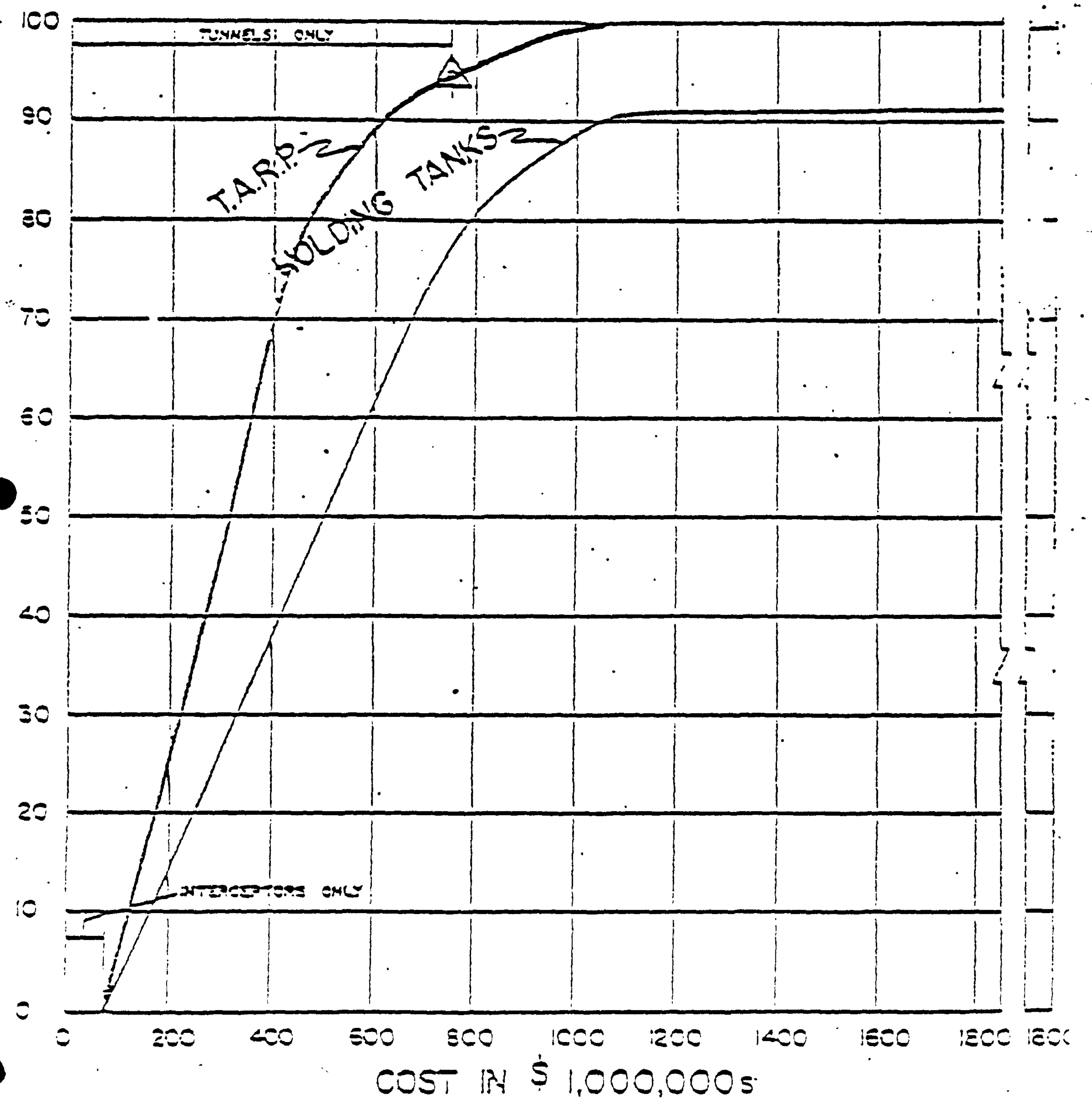


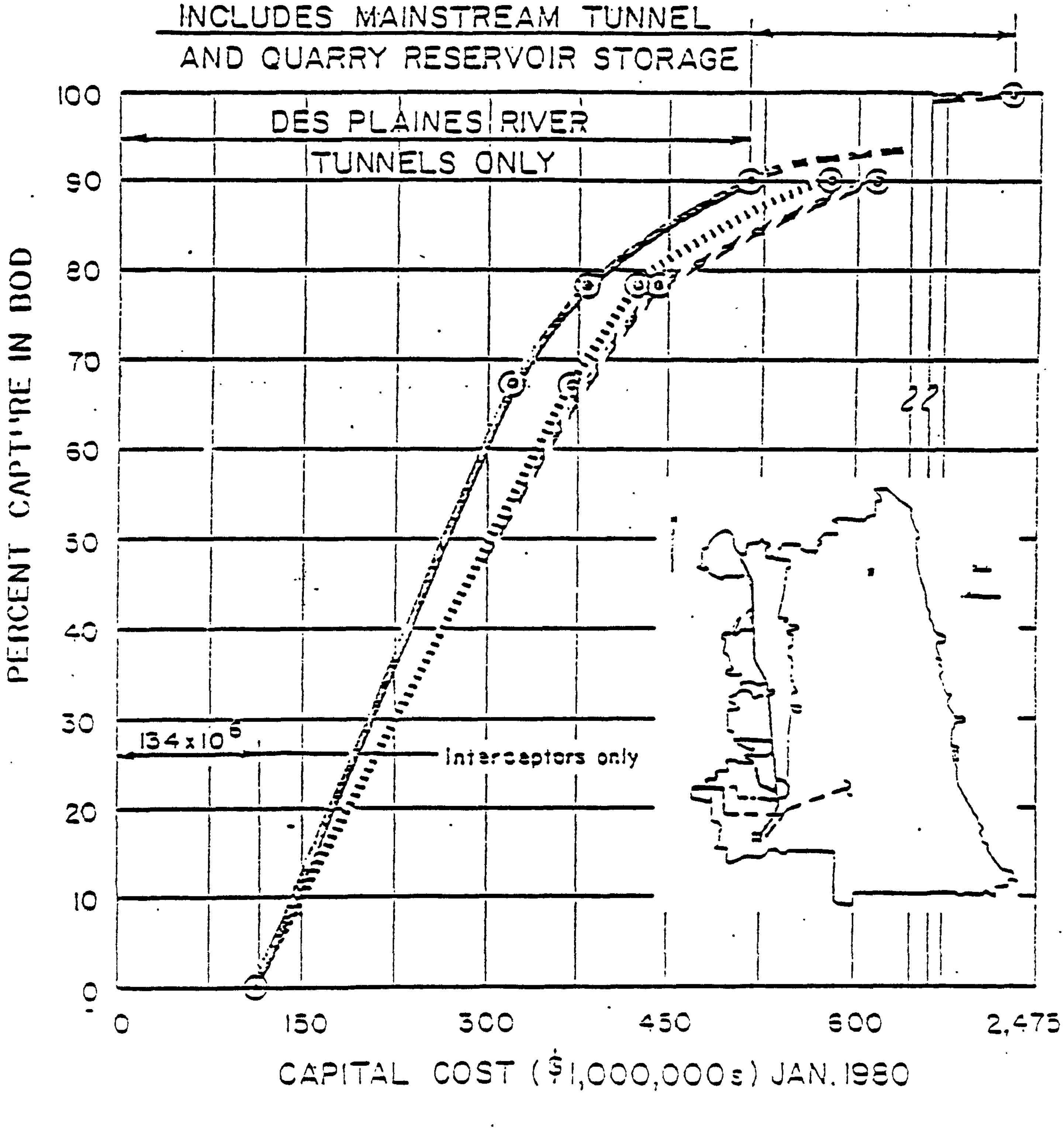
Fig. V-B-3 CALUMET PROPOSED PROCESS FLOW DIAGRAM

MAINSTREAM SYSTEM



B O D REDUCTION

TARP REVIEW - REMAINING PHASE I
DES PLAINES SYSTEM



THE METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO

BOD CAPTURE VS. CAPITAL COSTS

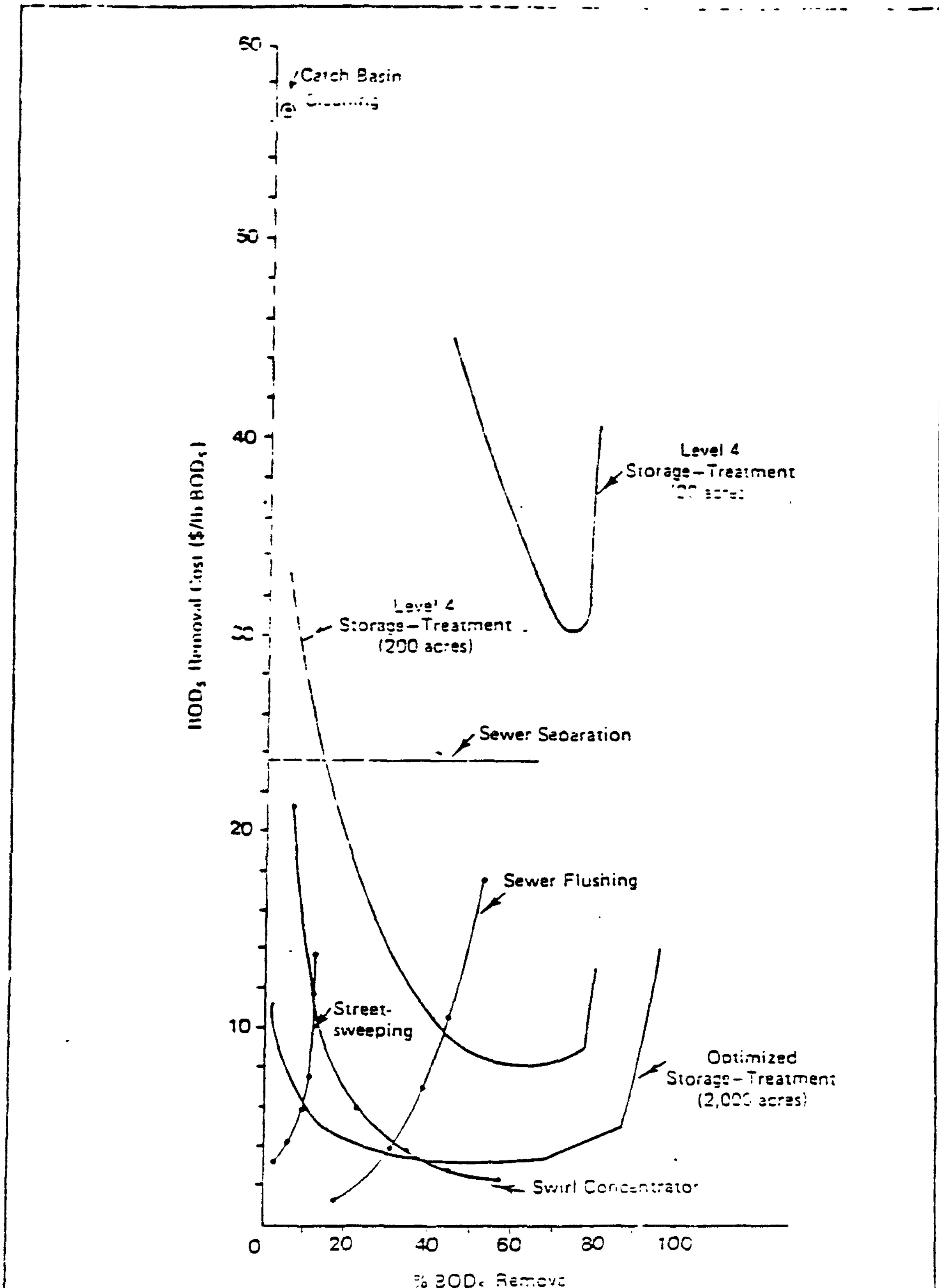
Table V-c-5

1978 Operative Data for Battery D

(Ref. 61)

	Temp. °F	Detention Time, hrs.	NH_3 mg/l Average	NH_3 mg/l Maximum
January	52	7.3	---	---
February	52	7.7	0.1	0.5
March	52	5.9	0.6	2.3
April	56	4.8	0.4	2.7
May	61	5.8	0.1	0.3
June	68	5.5	0.2	1.1
July	70	5.1	0.3	1.1
August	71	5.4	0.2	0.9
September	72	5.4	0.4	2.3
October	69	7.0	1.5	6.8
November	64	7.2	2.7	5.6
December	55	6.9	0.3	2.0

FIGURE 2



Unit removal cost for a typical combined sewer service area