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Ministry of Development And New Communities

PORT SAID WATER AND WASTEWATER FACILITIES MASTER PLAN

Final Report
Volume I — Executive Summary

HAZEN AND SAWYER
in association with
ECG-ENGINEERING CONSULTANTS GROUP

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July 26, 1979

Engineer Soliman Abd El Hai, Chairman
Advisory Committee for Reconstruction
Ministry of Development and New Communities
1 Ismail Abaza Street
Cairo, Egypt

Port Said Water and Wastewater
Facilities Master Plan

Dear Engineer Abd El Hai:

In accordance with our Contract with the Advisory Committee for Reconstruction, we submit herewith Volume I of the Master Plan Final Report.

The report is organized in four volumes as follows:

Volume 1. Executive Summary (English and Arabic)

Volume 2. Water Facilities

Volume 3. Wastewater Facilities

Volume 4. Receiving Waters Study

We have enjoyed the opportunity of serving the Advisory Committee for Reconstruction and appreciate the interest you have personally taken in preparation of the Master Plan. We particularly want to acknowledge the support which you and Minister Hassaballah Kafrawi, and your staffs have provided for our work. We look forward to successful implementation of the recommended programs.

Very truly yours,

HAZEN AND SAWYER

David Walrath

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DW/jr

PORT SAID

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PREFACE

The Port Said Water and Wastewater Facilities Master Plan (WWFMP) was prepared after field surveys, engineering and economic investigations, and other studies conducted between January 1978 and July 1979. Included were an examination of present and future needs, an assessment of existing facilities and operations, and a determination of improvements and additions necessary for satisfactory service through the year 2000. The urgency of works recommended is indicated by the classification assigned:

a) High Priority - Those projects needed immediately to increase the adequacy and reliability of the potable water supply and wastewater system.

b) Immediate Phase - Additional projects which in conjunction with High Priority projects will improve the Port Said water and wastewater facilities to meet needs at least through 1982.

c) Staged Development - Additional projects which in conjunction with High Priority and Immediate Phase projects will expand and improve the Port Said water and wastewater facilities to meet needs through the year 2000.

The studies and investigations and the plan recommended are described in four volumes:

1. Executive Summary
2. Water Facilities
3. Wastewater Facilities
4. Receiving Waters Study (as related to wastewater discharges and treatment needed)

Volume I consists of an overview of the water supply and wastewater situation at Port Said, conclusions and recommendations as to correction of present deficiencies, anticipated costs of facilities needed, and methods of financing the projects. The other volumes should be read for supporting data and details.

A. PHYSICAL, SOCIO-ECONOMIC AND ENVIRONMENTAL SETTING

1. PHYSICAL

Port Said lies on the Mediterranean Sea at the northern end of the Suez Canal (Fig. A). The urban area of Port Said, extended by beach sand accretion and fill from canal and harbor excavations, totals 1600 ha. It is generally flat; between 1 and 2 meters above sea level. Subsurface layers of soft clay and the high water table throughout the study area compel special precautions in the construction of sewers, water mains, pumping stations and other deep structures. Cost allowances for this are included in the project estimates. The climate at Port Said is more comfortable than at inland cities of Egypt because of Mediterranean breezes. Rainfall averages less than 70 mm per annum, occurring chiefly in storms between November and March. Surface and ground water in the vicinity of Port Said is saline or brackish and not suitable for public water supply. For commercial fishing and recreation, surface waters are critically important, and must be protected from harmful or toxic contamination.

2. SOCIOECONOMIC

Dependable information on Port Said's population since the 1967 war is limited, with estimates for 1975 and 1976 ranging between 262,620 and 343,000. The first estimate, prepared by the Central Agency for Public Mobilization and Statistics (CAPMAS) seemed the more reliable, and 273,000 was adopted for 1977. The economy is only now returning to prewar levels. Much activity is expected to continue as before including: port operations, construction, food processing, and light industry. Commerce and tourism should flourish under Port Said's Free Trade status, and fishing is sure to continue in Lake Manzala and the Mediterranean. Although statistics are not available, the labor force is presently estimated at 75,000.

Port Said consists of three kisms (large census tracts): El Shark, fronting on the Suez Canal, includes the prime residential and business center, large buildings, industrial

undertakings, cargo handling and vessel servicing; El Arab lying immediately to the west includes residences, governmental and institutional buildings and the Kabbutti fishing village; El Manakh in the northwestern part of the city and Port Fouad (included in El Shark) provide a mixture of residences, housing units, ship yard and open spaces.

With continuing activity the population of Port Said is expected to increase as follows:

1980	1985	1990	1995	2000
305,000	390,000	487,000	585,000	684,000

During this period, the labor force is estimated to increase from 93,000 in 1980 to 229,000 in the year 2000. Land reclamation from Lake Manzala over this period needed to provide space for housing, commerce, and industrial activities is estimated to total 1210 hectares (Fig. B and Fig. C).

3. ENVIRONMENTAL

Habitat diversity in the Project Area is high, ranging from the hypersaline waters of El Mallaha to cultivated agricultural areas. The terrestrial habitats are limited by the shortage of land. The minor areas remaining have been disturbed by reclamation, military installations and urban development. Aquatic habitats are much more intact in spite of some encroachments.

The limited diversity of aquatic and terrestrial systems and the large numbers of small inhabitants suggest that a stable ecosystem, with well developed non-linear food chains and the presence of large predatory species, has not been established.

The Mediterranean Sea features a shallow continental shelf and relatively low biological production; the Suez Canal, many plants and animals from both the Mediterranean and Red Sea. Lake Manzala, fed largely by agricultural drainage and wastewater has a high nutrient concentration and supports an active fishery. El Mallaha, with no fresh water inflow is hypersaline. It produces most of the mullet in the Port Said fisheries, though overall much less fish than Lake Manzala.

Except near the Mazrah wastewater discharge into Lake Manzala and in the Suez Canal in the vicinity of the Junction Canal, the waters surrounding Port Said are free from sewage related bacteria and meet the USEPA criteria for bathing waters. In Lake Manzala, El Mallaha, and the Suez Canal accumulations of heavy metals, insecticides, and other toxic substances are found in benthic deposits. Concentrations of such contaminants in edible fish may pose public health problems. Heavy metals are found in Mediterranean deposits, but in much lower concentrations.

B. WATER SUPPLY SYSTEM

1. CURRENT WATER CONSUMPTION AND FORECAST OF FUTURE DEMANDS

Although metered water services have been used at Port Said for many years, the 1967 war ended most of the benefits derived from effective measurement of customers' water usage. Of some 12,000 services on the books of the Suez Canal Authority (SCA), 4000 have no meters. Of the 8000 meters installed, 40% were broken or missing in 1978. For many customers, bills were estimated from usage in prior years, in some cases before the 1967 war. Casual inspection and testing of meters, and long postponed repair or replacement of faulty meters have created an indifference to high water consumption and waste. The situation is aggravated by the failure of metering equipment at the El Raswa Water Treatment Plant (WTP), which formerly provided a measure of total pumpage.

Metering of the El Raswa output during 1978 indicated flows ranging between 80,000 and 95,000 cubic meters per day, and averaging approximately 90,000 cu m/d. For a population of 273,000 this discharge is equivalent to 330 liters daily per capita. Even after taking into account water sold to passing ships and other port uses, this is a high figure for a community like Port Said with little industry or agriculture. It is 1-1/2 times the prewar consumption by a comparable population.

Estimated water needs, as distinguished from total pumpage at El Raswa were developed from prewar usage, information and forecasts in the reports of the 1976 Port Said Master Plan (PSMP), SCA records, and field investigations of the several categories of consumer. Domestic consumers were divided into low, medium, and high water use as follows:

Use Level	% of Population	Per Capita Use - lpd
Low	40	85
Medium	40	170
High	20	250
	Weighted Average	150

Metering of representative domestic customers and housing projects in the summer of 1978 confirmed generally the validity of the per capita water usage and of the average figure adopted. Round-the-clock and night flow measurements pointed up the high quantities of water delivered to customers and wasted. For domestic users the wastage averaged 40 lcd, ranging from 46% of the "low use" water consumption to 14% of the "high use". At industrial plants operating only one shift, night flows equaled one half of the average. In institutional and governmental buildings, there was little drop in water consumption when offices closed for the weekend or holidays. Wastage, presently estimated at 10,800 cu m/d, or 12% of the total pumpage, is due to indifference, carelessness, and faulty plumbing. Without complete and effective metering and adequate water charges, there is no incentive to reduce wastage.

Water main and service pipe leakage, estimated at 18,000 cu m/d in 1977, accounted for 20% of El Raswa pumpage. Leaks obvious from water escaping to the ground surface and surrounding vegetation and leaks that could be detected by sounding apparatus contribute materially to the current leakage. None, however, is expected to match the 16,000 cu m/d leak in a Port Fouad siphon discovered and valved off in June 1978. Velocity surveys capable of detecting much smaller leaks must await repair or replacement of primary distribution system valves.

Wastage and leakage can be reduced, but only with time and expense. Metering of all services and El Raswa output; improved plumbing, sure to be expensive and beyond the resources of many customers; prompt repair of major main leaks and diligent search for others; and repair or replacement of distribution system valves are needed. For this reason, and because of difficulties sure to be encountered in major expansion of a water system in a few years, liberal allowances for wastage and leakage are included in water demand forecasts through the year 2000.

Estimating future water demands at Port Said was based upon population forecasts, proposed expansion of the urban area, and the development of tourism, commerce and

industry. Taken into account were the proposed schedule of land reclamation and construction of housing and utilities, land use patterns, and opportunities for industrial and commercial growth. Using this information, areal requirements were estimated by allocating expected consumption to 25 water demand districts. Domestic consumption was based upon 150 lcd initially, with a 1 lcd increase per annum until the year 2000. Other demands were based upon PSMP forecasts and information developed in the field.

As shown in Table 1, average water requirements are estimated to increase from 90,000 cu m/d in 1977, to 114,000 cu m/d in 1982, and to 261,000 cu m/d in the year 2000.

2. RAW WATER SOURCES

The Nile River at Cairo through the Ismailia and Port Said Canals is clearly the best source of potable water for the city. Local surface and underground sources are brackish or saline. A supply from the Nile at Damietta would be feasible but would require a long pipeline and heavy pumping.

Under Egyptian regulations, discharge of wastewater and industrial wastes into the Nile River is forbidden. Except for phenols from oil spillage, the water quality at Cairo is good. Extension of these regulations to the Ismailia Canal and strict enforcement are essential to protect eastern delta agriculture and water supplies for the Canal Cities. With such precautions, conventional water treatment facilities, properly designed and maintained, should produce a safe and potable supply for Port Said.

The Ismailia Canal is more than ample for present agricultural demands and for the three Canal Cities. Supply to Port Said, however, is limited by the capacity of the Port Said Canal below Rayah Barrage (Qantara), estimated between 90,000 and 125,000 cu m/d. This is enough to meet current demands. Reportedly designed for 270,000 cu m/d, the Port Said Canal capacity has been reduced by aquatic growth, war damage, structural constrictions, and seepage. Under the program proposed, steps will be taken promptly to reduce unauthorized diversions and canal seepage, and to control weeds as necessary to increase the delivery of water to approximately 138,000 cu m/d, the amount needed through 1981.

At the same time, detailed surveys and hydraulic measurements for the planning and design of still greater capacity should be completed.

To increase the water supply at Port Said, two basic approaches were considered:

(a) Ministry of Irrigation Program

The first approach is a two-stage program by the Ministry of Irrigation (MOI) to increase water for irrigation, municipal, and industrial use in the Suez Canal region, with a first stage allocation of 215,000 cu m/d to Port Said, and a second stage allocation of 750,000 cu m/d. The First Stage would include widening, deepening and removing obstructions from Ismailia and Port Said Canals above Rayah Barrage, and construction of a new concrete-lined canal paralleling the existing canal between Rayah Barrage and El Raswa. The new canal would be designed for 750,000 cu m/d. The Second Stage would include concrete lining of the Ismailia Canal and of the Port Said Canal from Ismailia to Rayah Barrage (Fig. D).

Costs to Port Said for its share of the MOI project shown below are necessarily approximate because of questions as to the unit prices for new canal construction, and the extremely high second stage water allocation to Port Said, over twice the maximum day demand forecast for the year 2000.

Estimated Cost to Port Said to Participate in MOI Project

	Water Allocation to Port Said cu m/d	Cost
First Stage	215,000	LE 9,500,000(1)
Second Stage	750,000 (370,000)	LE 24,000,000 (LE 7,000,000)

(1) 8,500,000 LE (including 10% contingencies) for a new canal between Rayah Barrage and Port Said; 1,000,000 LE for improvements above Rayah Barrage.

(b) Alternatives to New Canal Proposed by MOI

Under the second approach, five alternative plans, more modest and with less ultimate capacity than that proposed by MOI, have been examined. In all cases, the principal effort would be directed to improvements in the 46 km reach of the Port Said Canal between Rayah Barrage and El Raswa. The five projects and their estimated construction costs are as follows:

Alternative		Capital Cost, LE	Present Worth, LE (10% Discount Rate)
1-A	- Booster pumping station and 2000 mm pipeline - Abandon PSC	57,857,000	61,098,000
1-B	- Booster pumping station and 1500 mm pipeline - Retain PSC	34,680,000	38,217,000
2-A	- Four low lift pumping stations within existing canal	6,636,000	11,833,000
2-B	- One low lift pumping station at head of canal	9,823,000	13,373,000
3	- Line existing canal with concrete	10,605,000	11,737,000

Alternatives 1-A and 1-B, involving extensive pipeline construction, were eliminated from consideration because they are prohibitively expensive. While the other three alternatives show some variation in capital costs, the present worth of each are approximately the same. Lining the canal (Alternative 3) is preferable to low lift pumping through an unlined canal (Alternatives 2-A and 2-B). Lining would reduce friction, secure the stability of embankments, curtail seepage, and reduce maintenance. Pumping should be reserved for increasing the capacity of the lined section, should that be necessary in the future. Except for high priority immediate repairs, canal lining alone is recommended.

New Canal vs. Port Said Canal Lining

Comparative capital costs[1] of building a new canal or lining the PSC are:

New Canal - MOI Preliminary Estimate	LE 11,700,000[2]
Lining Existing Port Said Canal	LE 10,600,000

For estimating project costs, lining the old canal was selected. If the MOI project does not proceed, lining of the existing canal should be completed before 1987 in order to meet anticipated water demands.

Raw Water Storage

If Port Said continues to depend upon a single supply canal, an emergency raw water reservoir near El Raswa should be built to cover short term outages of the supply. The reservoir should have a capacity of 1,500,000 cu m, equivalent to 4 days' flow at 370,000 cu m/d. With curtailment of the plant output during water shortages, such a reservoir could provide an emergency supply for 10 to 12 days, time for at least temporary correction of likely difficulties. An earth bank reservoir would cost approximately LE 3,900,000. If the new MOI canal is built and the old canal retained for emergencies, a storage reservoir would be unnecessary.

The Raw Water Supply facilities are estimated to cost LE 23,022,000, or approximately 34% of the Recommended Water Supply program (Table 3). Expenditures would be staged as shown in Figure E and are as follows:

	Thousand 1978 LE		
	Total	Foreign	Local
High Priority	86	66	20
Immediate Phase	631	266	365
Staged Development	22,305	3,285	19,020
Total	23,022	3,617	19,405

(1) 51.5% of construction costs (20% for contingencies; 31.5% for support service) included.
(2) Original MOI estimate of 8,500,000 LE included 10% contingency.

3. WATER TREATMENT AND PUMPING

Water treatment is necessary at Port Said to provide safe and acceptable water for public consumption. Safe water must be essentially free of toxic substances and pathogenic organisms. Acceptable water is palatable, free from tastes and odors, without excessive turbidity, color, and iron. The facilities at the El Raswa Water Treatment Plant were designed and built along principles developed over the past 100 years in Europe and elsewhere. Rehabilitated and expanded, they should meet Port Said's needs through the year 2000.

As shown in Figure F, El Raswa water treatment at the end of 1977 consisted of 5 slow sand filter trains and a Bamag rapid sand filtration unit. The slow sand filter trains included coagulation and sedimentation tanks, gravel "roughing" filters ahead of the slow sand filters and filtered water storage tanks. The Bamag unit included coagulation and sedimentation tanks, 8 rapid sand filters, filtered water storage tanks and raw and filtered water pumps. The facilities included appurtenances necessary for operation and control such as chemical storage and feeders, mixers, chlorinators, and flow meters. Several of these are presently non-operative and in need of repair or replacement.

The nominal rated capacity of the treatment works at the end of 1977 totaled 81,000 cu m/d, compared with water demands averaging some 90,000 cu m/d and estimated to reach on some days 113,000 cu m/d. Deficiencies in capacity have been met by overloading or bypassing some of the facilities, either of which may result in inadequate treatment and unsafe water. With maximum day demands expected to reach 169,000 cu m/d in 1985, and 326,000 cu m/d in the year 2000, facilities to expand the plant capacity were authorized by SCA in 1977. Works presently underway by European contractors include (1) conversion of slow sand filter trains #2 and #3 to rapid sand filtration (CTE Conversion), and installation of a second, larger Bamag unit. The CTE work, scheduled for completion in 1979, will increase the nominal capacity of filter trains #2 and #3 from 20,000 to 80,000 cu m/d, and provide a total capacity of 141,000 cu m/d. Installation

of the second 70,000 cu m/d Bamag unit by 1982 will increase the nominal plant capacity to 211,000 cu m/d, adequate through 1987.

While these new facilities are of major importance, repair and rehabilitation of existing structures and equipment are needed. Typical of these tasks: level effluent weirs on Bamag clarifiers, filter inlet gutters, and washwater troughs; repair and restore to service filter rate controllers; repair filter underdrains where needed, and clean, grade and replenish filter media. For slow sand filters, install washwater pumps and reactivate air/water washing of roughing filters; check and repair filter underdrains and resand with coarser media. Other measures, less pressing but needed to develop El Raswa's full potential, include centralization and modernization of chemical storage and handling, chemical mixing, chlorination, and metering.

As shown in Table 2, water demands beyond 1987 would be met by (a) conversion of slow sand filter trains 4 and 5, and possibly filter train 1, to rapid sand filtration along the lines of the units under construction, or other arrangements if the CTE performance does not meet expectations; (b) upgrading of the treatment plant by improved coagulation and filtration, use of polymers and other filter aids, rearrangement of filter media, and more precise control of chlorination.

Properly maintained and regulated facilities can be operated safely at higher rates than proposed without harming water quality. This goal should be pursued before investing in additional works.

El Raswa has four separate pumping stations: Main Station, with raw and finished water pumps installed in 1924; Bamag Station, with raw and finished water pumps (1964); Auxiliary Raw Water Station (1946); and Annex Finished Water Station (1946). With the largest pump at each of these stations out of service, the firm raw water capacity is presently 5,160 cu m/hr, or 124,000 cu m/d; the finished water capacity is 5,000 cu m/hr or 120,000 cu m/d.

The 11 raw water and 11 finished water pumps range in capacity from 400 to 1,080 cu m/hr. All are electric motor driven, 22 to 190 hp, with separate switchgear and starters. The age, variety of makes and models, and the unavailability of spare parts for pumps and motors have prevented adequate maintenance and repair of the pumps for several years. For this reason gradual replacement of pumps and electrical equipment, and complete rearrangement of pumping, is recommended. Under this proposal, the present Bamag Station is to be converted to raw water service exclusively. A new finished water pumping station is to be built north of the finished water storage tanks for delivery of water to the city. The Auxiliary Raw Water Station and Annex Finished Water Station would be abandoned, and the Main Pumping Station would either be stripped and refurbished to house chlorination equipment or be made a standby pump station. Pumps inincluded in the present Bamag contract would be installed as planned.

Installation of new pumps should be carried out in stages to meet growing demands without causing service interruptions. Under the program proposed, the capacity available would be as follows:

	Pumps	Total Capacity cu m/hr	Firm Capacity cu m/hr
Stage 1 (1980)			
Raw Water	11	9,280	7,580
Finished Water	11	9,900	7,900
Final Stage (to 2000)			
Raw Water	12	19,320	16,240
Finished Water	14	18,688	15,766

The recommended program also includes reinforcement of the existing SCA electric power system by a connection to the municipal high voltage grid, installation of 11 KV transformers and switchgear, new wiring to load centers; and rehabilitation or replacement of existing flow meters with reliable indicating and recording equipment.

Improvement and expansion of the El Raswa Water Treatment Plant, Pumping Station and Appurtenances shown in Figure F are estimated to cost LE 11,323,000 or approximately 17% of the Recommended Water Supply Program (Table 3). Expenditures would be divided as follows:

	Thousand 1978 LE		
	Total	Foreign	Local
High Priority	4,133	2,697	1,436
Immediate Phase	237	134	103
Staged Development	6,953	4,021	2,932
Total	11,323	6,852	4,471

4. WATER DISTRIBUTION

The Port Said water distribution system, consisting of some 67 km primary mains, smaller laterals, house services, and meters, delivers water from El Raswa to Port Said and to Port Fouad across the Suez Canal. The system is adequate; except in the northwest corner of Port Said, it is capable of meeting normal and peak water demands in most of the city. The frequent and fairly widespread appearance of coliform organisms in distribution system samples point up the dangers of water main contamination through cross connections, leading to water borne diseases (Fig. G). The northwest part of the city, which has inadequate mains and low water pressure, is particularly susceptible.

Economically significant and a wasteful drain on the El Raswa output is the excessive distribution system leakage. A number of substantial leaks are apparent throughout the city from water bubbling to the ground surface and from vegetation patterns. Other non-visible leaks may be traced by sound devices. Velocity surveys, capable of detecting much smaller leaks, require shutting off parts of the distribution system, one section at a time. Since the method depends upon tight closing valves and hydrants, and metered services, this type of survey must await valve, hydrant and other recommended system rehabilitation. Meanwhile, the simpler methods should be initiated, with leaks located as far as possible and repairs completed promptly.

Current SCA water main projects will provide immediate system reinforcement and extensions. Additional facilities to serve adequately the land areas to be reclaimed and the growing population, will involve 60 km of primary mains, valves, hydrants and other accessories (see Plate 1). For planning and scheduling these additions, computer models were developed to determine the adequacy of the present primary water main system and storage of filtered water; and to select the primary main reinforcement, extensions, and distribution storage best to meet the future needs of Port Said. (As provided in our contract, the program used and instructions will be turned over to SCA for future analysis of the Port Said system, or for adaptation to other systems.)

In the distribution system and storage analysis, maximum day demands were estimated at 1.25 x average demands, peak hourly demands at 1.4 x max. day demands, and minimum hourly demands at 0.54 max. day. Pipe sizes were adjusted to meet the following conditions:

(1) At maximum day demand, to assure at least 20 m pressure.

(2) That remote tanks were high enough to empty in 13 hours at peak demands.

(3) That tanks could be filled in 11 hours at minimum demand conditions.

In estimating future storage requirements, the goal is 15% of the maximum day demand for equalization, plus a 5000 cu m fire reserve. The present storage at El Raswa, totaling 15,000 cu m, is enough for equalization, but provides no fire reserve.

Completion of the CTE conversion of flow trains #2 and #3 and the new Bamag unit will increase the storage by 17,000 between 1980 and 1987, and by an additional 10,000 cu m between 1987 and 1990, when flow trains #3 and #4 are converted to rapid sand filtration. While the storage available at El Raswa should be fully utilized to avoid the cost of new reservoirs, distribution system studies indicate that construction of reservoirs nearer the centers of water demands will be more economical. The following installations are recommended:

Year	Location	Capacity
1985	Near Head of Interior Canal	(3000 cu m)
1994	" " " " "	(3000 cu m)
1996	North Port Fouad	(3000 cu m)
	South of Junction Canal	(3000 cu m)
2000	Near Mazrah	(6000 cu m)

Cost estimates today favor ground storage tanks and pumps instead of elevated tanks. The situation may differ when installations are needed, and the choice should be re-examined at those times.

Although principal attention has been directed toward the problems of providing reliable and safe water to a fast growing urban area, this goal cannot be reached without major rehabilitation of the distribution system, including such measures as:

- Replace some 125 valves, 200 to 800 mm diameter; install sectionalizing valves for cutting mains out of service, using only counterclockwise opening valves.
- Eliminate pit type and French fire hydrants; standardize threads; shut off valve for each hydrant; install hydrants in all new areas and additional hydrants in old sections.
- Where redevelopment increases the population density, reinforce or replace secondary mains where needed. Some services are too small; all services need curb stops; old or substandard services should be replaced prior to road repaving, preferably with plastic pipe.
- Standardize meters and phase out of service the large variety of difficult-to-repair equipment. Provide standard setting for meters to protect from damage and vandalism. Provide bypasses on large meters for continued water service

during inspection or repair. Select meters to match probable water consumption. Inspect existing meters house-to-house. Speed up meter repair and testing. Purchase and install thousands of meters for old and new unmetered customers. Give special attention to large industrial and commercial meters and settings. Promote customer ownership and responsibility for meters.

A schedule of repairs, additions, and improvements to the water distribution system and appurtenances is shown in Figure F. Costs are estimated to total LE 33,332,000, approximately 49% of the Recommended Water Supply Program (Table 3), with expenditures staged as follows:

	Thousands of 1978 LE		
	Total	Foreign	Local
High Priority	2,882	1,201	1,681
Immediate Phase	5,777	3,213	2,564
Staged Development	24,673	6,531	18,142
Total	33,332	10,945	22,387

5. FINANCING

In constant value 1978 LE, the capital cost of the water supply system improvements and expansion program over the next 20 years is estimated at LE 68,000,000. Operating and maintenance costs are expected to double from LE 1 million in 1978 to LE 2 million by the year 2000.

In 1977, 83% of SCA water system revenue in Port Said derived from the sale of water, with the balance from the installation and repair of services, meter rents, and meter repairs. Water rates ranged from 3.9 milliemes/cu m for street washing to 100 milliemes/cu m for ships in transit. For domestic use, hotels, and private business, the rate was 18 milliemes/cu m. If the water supply system is to be self-supporting, a marked increase in rates will be necessary.

Three approaches to financing the recommended program were examined:

1. Utility basis - Users would pay the cost of present service and make some contribution to future replacement of facilities. Rates and revenues would be set

to cover operating and maintenance expenses, plus depreciation, and to yield a return of at least 6% on the depreciated investment (including investment in existing facilities).

2. Debt Service basis - Present users would pay for system O&M plus debt service on loans covering new facilities. Customers would have "free" use of existing facilities until they were replaced.

3. Deficit Financing - Rates would be kept at present low levels. General government revenues would be used to cover operating deficits and to fund new construction.

Under Utility basis financing, water supply facilities and operations would be self-sustaining. On a Debt Service basis, the system would fall short of this, but users would bear all operating costs plus the substantial amortization cost of new facilities. Deficit Financing is clearly not self-sustaining. Forecasts indicate that if Deficit Financing were adopted, annual deficits would range from LE 6,000,000 to a peak of LE 25,000,000 in 1987, with an accumulated deficit of LE 288,000,000 through the year 2000. (These estimates include allowance for inflation.)

Detailed financial studies of the water department program and operations were made, taking into account system assets, depreciation, operations, and cash flow. Results of these studies indicated that to make the water supply system self-supporting, a level charge of 113 milliemes/cu m (1978 LE) would be required. Using this rate, cash reserves of over 18 million LE would be built up by the year 2000, and reserves would grow at a more rapid rate soon thereafter. These reserves would be used for system replacements. A rate of 100 milliemes/cu m, which would cover O&M costs and debt service with a more modest buildup of reserves, is considered the appropriate charge on which to base economic impact on customers. The suggested rate would require adjustment for inflation effects.

On a Debt Service basis, the average cost of water, allowing for inflation, would be as follows:

1980	- 39	milliemes/cu m
1985	- 136	
1990	- 267	
1995	- 308	
2000	- 323	

C. WASTEWATER FACILITIES

1. CURRENT AND FORECAST WASTEWATER FLOWS AND LOADING

Wastewater flows at Port Said total approximately 70,000 cu m/d. Approximately 40% of this flow is pumped to the Mazrah Sewage Treatment Plant (out of service since 1967), bypasses the plant and is discharged untreated into Lake Manzala. The balance discharges into the Suez, Junction, and Manzala Canals through 11 identified outlets; or escapes to these waterways through gutters, abandoned sewers, and seepage through the sand. Clogged sewers and inadequate pumping stations cause surcharged operation of the system and periodic flooding of the streets. Much of this wastewater collects in ponds and evaporates. Although many stormwater inlets are connected to the sewers, the system appears to be designed only for sanitary flows. As a result it is grossly overloaded during winter rains. Information on the quantity and characteristics of wastewater is distinctly limited by the lack of facilities and arrangements for gaging and testing.

Wastewater discharges at Mazrah, originating in the residential and commercial areas in the northern part of the city, ranged between 22,000 and 33,000 cu m/d (measured in July and August 1978) for an estimated average per capita flow of about 250 lpd. Flows through five sewer district pumping stations in the same area, serving some 75,000 persons, averaged 225 lcd. Indicated per capita flows in individual districts varied widely due in part to uncertain population breakdown. At Port Fouad, a flow of 5900 cu m/d from 5 outfalls into the Suez Canal included 2650 cu m/d from the SCA shipyard, and 3250 cu m/d from residents. The domestic flow averaged 280 lcd. Twenty-four hour measurements at Mazrah showed peak flows approaching twice the average discharge, and minimum nightfall ates at less than 1/2 the average. Since these rates are affected by the on-and-off operation of pumping stations, they cannot be used in designing sewers.

From sampling at Mazrah, the biochemical oxygen demand (BOD) of raw wastewater was estimated to average 475 mg/l, with minimum and maximum values of 360 and

620 mg/l. Suspended solids averaged 360 mg/l, with a minimum of 150 and maximum of 410 mg/l. For an estimated population of 185,000 the BOD loading is approximately 95 gm/d per capita, and suspended solids 72 gm/d per capita.

Because of the difficulty in measuring wastewater flows, forecasts of these discharges have been estimated from water consumption (see Table 4 and Section B-1). Ratios between wastewater flows and water consumption normally encountered are well established and the method is widely used. For the WWFMP, the following ratios were adopted: domestic use, 80%; institutional, industrial, and public (excluding gardens), 90%; wastage, 100%; leaks and gardens, 0%. The ratio of peak to average wastewater flows was taken as 3, except wastage, which was assumed to be substantially the same throughout the day.

In addition to wastewater, the sewer system must accomodate expected infiltration of groundwater and entry of storm flow. Because surcharging currently prevents infiltration, no allowance is needed for Port Said. For the existing system after rehabilitation with no surcharge, an infiltration allowance of 12 cu m/d/ha was applied. For new sewers, the allowance is 0.5 cu m/d/ha. Storm water inflow is assumed to be eliminated.

In Port Said (west of the Suez Canal) the percentage of domestic, institutional, and public water users connected to sewers is expected to increase from 80% at present to 95% by 1995. None of the industries is connected; all are expected to be by 1995. In Port Fouad, domestic water users connected to sewers are expected to increase from 67% to 95% in 1995. Existing industries in Port Fouad are connected and connection of new industries will be required.

Areal distribution of present wastewater flows and the future growth of such flows follow naturally those developed for water consumption. Taking into account the proposed reclamation schedule, land use patterns, and favorable topography for the construction of sewers, the average and peak wastewater flows were allocated to 18 drainage districts and the village of Kabbutti. As shown in Table 4, the average collected wastewater flows are

estimated to increase rapidly from 38,000 cu m/d in 1978 to 82,000 cu m/d in 1982, and thereafter more gradually to 189,000 cu m/d in the year 2000. The average BOD loading is expected to increase from 28,800 kg/d in 1982 to 42,700 kg/d in 1990, and to 59,600 kg/d in the year 2000. For suspended solids, the loadings are estimated at 25,600 kg/d in 1982, 37,900 kg/d in 1990, and 53,000 kg/d in 2000.

2. WASTEWATER DISPOSAL

Selection and planning of wastewater collection and treatment facilities for Port Said is dictated by the surrounding receiving waters and measures needed to protect them. Land disposal by irrigation was rejected because of inadequate suitable land near Port Said, the high levels of dissolved solids in wastewater requiring fresh water dilution, and the greater estimated cost than for Nile River water.

Of four available receiving areas, two were quickly eliminated:

Outfalls into the Mediterranean Sea by agreement with the Advisory Committee on Reconstruction (ACR) because of potential harm to bathing beaches; and El Mallaha because of potential harm to the mullet population, economic losses in the area, and the projected reduction of water area resulting from construction of the Suez Canal bypass and expansion of the salt works.

The other two available water bodies are the Suez Canal and Lake Manzala. The Receiving Waters Study (Volume 4 of the WWFMP) indicated that the Suez Canal could safely assimilate treated wastewater flows anticipated from Port Fouad through the year 2000, but could not be used for the entire city of Port Said. Conversely, the shallow waters of Lake Manzala could serve the entire city including Port Fouad.

The critical parameter in selecting the degree of treatment needed is the BOD_5 loading on the receiving water (resulting in increases of no more than 6.0 mg/l for Lake Manzala, and 5.0 mg/l for Suez Canal) and the related adverse effect on the dissolved oxygen and the fishery.

Alternatives examined for treating wastewater discharges into Lake Manzala included the following:

1. Anaerobic lagoons followed by oxidation ponds.
2. Conventional primary treatment with a 1000 m long diffuser.
3. Conventional secondary treatment with outfall and no diffuser.

The first alternative was rejected because the oxidation ponds would preempt 500 ha of fishery habitat. The second alternative was selected over the third because the capital costs for secondary treatment would be at least LE 30 million higher than for primary treatment. Results of the Receiving Waters Study do not appear to justify this substantial added expense.

With a minimum diffuser length of 1000 meters, the adverse effects of primary effluent on Lake Manzala would be minimal. The outfall and diffuser would be located in the lake several km west of the city, providing ample time for wastewater dilution and dispersion, die-off of pathogenic organisms, and protection of waters used for recreation and other purposes. Experience at Mazrah and tests during the Receiving Waters Study showed clearly that wastewater had no harmful effect on the fishery. Wastewater chlorination was determined to be unnecessary and potentially toxic to fish.

Unlike Lake Manzala, water in the Suez Canal is saline, 18 m deep, and subject to horizontal and vertical movement from the tides and wind. Discharges into the Canal will be mixed quickly and diluted. Diffusers will not be necessary; only a short outfall from the plant.

The prospects of selling wastewater sludge for fertilizer or soil conditioner appear good. Revenues are expected to offset hauling costs to distant agricultural areas. Other disposal methods (composting with refuse, use for fish culture) are noted as possibilities which cannot be properly evaluated at present.

3. WASTEWATER TREATMENT

Until the 1967 war the Mazrah plant treated most of the Port Said wastewater. Septic tanks and untreated outfall discharges into the Suez Canal served Port Fouad. Since 1967, as noted above, wastewater pumped to Mazrah has bypassed the plant and discharged untreated into Lake Manzala.

The Mazrah facilities (out of service but for the most part structurally sound despite some damage) consist of a trickling filter unit, an activated sludge plant, and more recently built primary settling basins (Fig. H). With some modifications, 65,000 cu m/d capacity of primary treatment could be provided. The secondary treatment capacity is much smaller, but is not of great importance in light of the Receiving Waters Study's conclusion that primary treatment effluent can be discharged safely into Lake Manzala and the Suez Canal. Sludge drying beds at Mazrah are of questionable value because of seasonal flooding.

To best utilize the existing facilities at Mazrah, repair and modification should be directed to the upgrading and improvement of the present settling basins; conversion of aeration tanks to settling basins and pump suction well; elimination of compartment walls and baffles in the new basins; and the addition of an effluent pumping station and other appurtenances. An attempt should be made to lower the water table at the site of the sludge drying beds so they can be utilized. If this proves unsuccessful, sludge should be lagooned until new remote drying beds can be constructed.

Of several alternative wastewater treatment projects examined, four proved most promising:

Alternative	Area Served	Treatment Plant	Discharge 1000 cu m/d 1982	2000	Receiving Water
1-A	Pt. Said	Mazrah	73	171	LM
	Pt. Fouad	Pt. Fouad	12	18	SC
			85	189	
2-A	Pt. Said (part)	Mazrah	52	81	LM
	Pt. Said "	Southwest	21	90	LM
	Pt. Fouad	Pt. Fouad	12	18	SC
			85	189	
1-B	Pt. Said	Mazrah	85	189	LM
	Pt. Fouad	"			LM
2-B	Pt. Said (part)	Mazrah	52	81	LM
	Pt. Said "	Southwest	33	108	LM
	Pt. Fouad	"			LM
			85	189	

LM - Lake Manzala; SC - Suez Canal

Alternative 1-B (see Figure I), treating all Port Said and Port Fouad wastewater at Mazrah (eliminated early in the analysis as not cost-effective), demonstrated the need for one or two additional treatment plants. Of the three remaining possibilities, Alternative 2-A (see Figure J) was found the best and most economical; therefore it is recommended. Under this plan, wastewater treatment by 1982 would be divided between Mazrah (61% of the flow), the new Southwest plant (25%), and Port Fouad (14%). In the year 2000 Mazrah would account for 43%, new Southwest 47%, and Port Fouad 10%. As shown in Figure J, the new Southwest plant would be located on an existing dike in Lake Manzala, west of the city, where the Mazrah and Southwest effluents would discharge through a joint outfall and diffuser. A separate treatment plant would be built at Port Fouad, discharging into the Suez Canal approximately 3 km south of the existing built-up area.

The treatment and disposal facilities recommended, including rehabilitation and expansion of Mazrah and construction of the new Southwest and Port Fouad plants are

estimated to cost LE 16,014,000, or approximately 20% of the total capital expense projected. Expenditures on waste treatment would be distributed as follows:

	Thousand 1978 LE		
	Local	Foreign	Total
High Priority	-	-	-
Immediate Phase	8,023	6,095	14,118
Staged Development	999	897	1,896
	9,022	6,992	16,014

4. WASTEWATER COLLECTION

The wastewater collection system extends to all built up sections of Port Said except the SCA area adjacent to the port and a portion of the Kabbutti fishing village. At Port Fouad, two-thirds of the population is served by gravity sewers discharging into the Suez Canal and the Mediterranean Sea. Unsewered buildings at Port Fouad have individual septic tanks. Few industrial plants are connected to the wastewater collection system.

The wastewater service area, principally in the northern part of Port Said, was divided into drainage areas. Originally, these drainage areas were connected to pneumatic ejectors discharging through force mains to the Mazrah treatment plant. In 1963 the ejectors were removed in favor of the "Japanese Project" under which 10 new pumping stations and a system of force mains to Mazrah were installed. Since 1963, four additional pumping stations have been built in reconstruction zones.

Trunk and lateral sewer lines totalling 105 km have been installed at Port Said and Port Fouad. The sewers range in diameter from 150 to 600 mm, with most laterals 180 or 230 mm. Locally made, standard strength vitrified clay pipe, with jute and mortar joints is used. At least since 1956, pipe less than 450 mm diameter has been encased in concrete. Larger pipe is encased to the center line only. Manholes are spaced at 30 meters so that each building can feed into a manhole. From observations in the field, the sewer pipe and installation appear to be of high quality, and the concrete encasement should make for tight joints and little infiltration. Reliable field measurements of infiltration could not be

obtained because of the sewer surcharging throughout much of the city and blockage of the system by garbage and trash.

The 14 existing pumping stations are small, with shallow wet wells, and subject to frequent flooding. Spillage of raw sewage on the streets is a common problem, aggravated by faulty maintenance and equipment failure. During winter rains, surface runoff floods the system and spreads over streets and first floors of buildings.

With the system surcharged much of the time, scouring velocities in sewers are lost. Clogging of manholes and sewers is inevitable. Other deficiencies include sewers too small or laid on flat slopes; broken sewers; dumping of waste into manholes; inadequate pumps and force mains; and misguided operation of pumping stations. Widespread clogging of sewers at Port Said precluded hydraulic measurements and limited field surveys, leveling, and inspection to only a small portion of the system.

Because sewer clogging and inadequate pumping facilities have led to poor performance and failure of many parts of the Port Said wastewater collection system, High Priority was assigned to a sewer cleaning, inspection, and repair program, and replacement of pumping stations and equipment. The sewer work should be performed by a contractor with successful experience, trained personnel, and adequate equipment to carry out the program expeditiously. Early recommendations to replace pumping stations individually were modified to include consolidation of existing small drainage areas into fewer, larger areas with benefits of operating economy (Fig. K).

The program recommended for satisfactory wastewater collection through the year 2000 contains chiefly the following measures:

- Clean, inspect, grout or repair, and map the sewer system.
- Reconstruct the pumping system, including new station locations and equipment to serve the larger drainage areas.
- Extend collecting sewers, pumping or lift stations, and force mains as necessary to serve newly developed areas.

- Install facilities to transport wastewater from collection centers to the Mazrah and Southwest treatment plants. Collect Port Fouad sewage at a central point for discharge to a new primary treatment plant on the Suez Canal.

Figure L shows an overall schedule through the year 2000 and Plate 2 presents the overall system plan. Wastewater system improvements are estimated to cost about LE 84 million (Table 5). The sewer cleaning, inspection, and grouting program is estimated to cost LE 938,000, of which LE 195,000 would be local expense and LE 743,000 would be foreign. This High Priority program, costing approximately 1% of the capital project costs recommended, should be completed as quickly as possible.

The capital cost of the collection and transport system needed to deliver the wastewater to the treatment plants is estimated at LE 65,861,000, or 78% of the total program capital expense. This cost would be distributed as follows:

	Thousand 1978 LE		
	Local	Foreign	Total
High Priority	3,210	3,277	6,487
Immediate Phase	11,119	6,471	17,590
Staged Development	33,113	8,671	41,784

5. FINANCING

The capital cost of the wastewater facilities improvements and expansion is estimated at LE 84,000,000. Operating and maintenance costs are estimated to increase from LE 358,000 at present to LE 1,575,000 in the year 2000. Existing expenses are financed out of governmental general operating funds; except for service connection charges (at cost) no revenues are collected through user charges. Some form of charge for wastewater obviously is necessary if the works and operations are to be self-supporting. As with water charges, a level rate of 100 milliemes/cu m (1978 LE) would be appropriate.

Financial analyses were made of the wastewater system similar to those of the water supply system. Financing the system on a utility basis would provide insufficient cash flow to meet operating costs and debt service, but a level charge of 0.1 LE/cu m of water sold would generate sufficient revenue to maintain the necessary cash flow. Were

deficit financing used, deficits would range from 2,000,000 LE to as much as 41,000,000 LE (in 1982) and the total deficit through the year 2000 would amount to 255,000,000 LE (including inflation). For the wastewater program to be self-supporting on a Debt Service basis, the sewer service charge per cubic meter of water sold should reach the following levels (allowing for inflation):

1980 - 46 milliemes/cu m
1985 - 154
1990 - 180
1995 - 243
2000 - 265

D. ECONOMIC AND ENVIRONMENTAL CONSIDERATIONS

As part of the overall effort to reconstruct and expand Egypt's vital physical infrastructure, the Port Said Water and Wastewater Facilities Master Plan will require an enormous investment. Investment in new infrastructure has not kept pace with social and economic needs, funds for regular maintenance have been totally inadequate, and damage from the 1967 and 1973 wars still remain.

The investments called for in the WWFMP are many times those projected in the Ministry of Planning's five year plan (1978-82) and in the WHO/World Bank Needs Projection through the year 2000. A new national needs projection based upon current water and wastewater plans should be prepared.

In the face of stiff competition for available funds, municipal and public undertakings showing clear and specific gains for people and nation are most likely to succeed. Water supply and wastewater projects may well be in this group, but the economic benefits are difficult to quantify.

More than 60% of the water supply from 1982 through year 2000 is expected to be used by domestic customers; industry accounts for 17 to 22%, and other users about 15%. Taking into account the estimated income of low, medium, and high water users, and applying the LE .100 charge for water suggested above indicate annual water costs as summarized below. Since the same rate is proposed for wastewater service, the total annual costs will be twice the water charges noted.

	Low	Medium	High
1978 Water Charge LE	21	35	49
% of annual income	2.6-5.6	3.1-4.4	1.0-4.2
Water and Wastewater-LE	42	70	98
% of annual income	5.2-11.2	6.2-8.8	2.0-8.4
2000 Water Charge LE	24	38	51
% of annual income	2.1-4.2	2.4-3.3	0.8-3.2
Water and Wastewater - LE	48	76	102
% of annual income	4.2-8.4	4.8-6.6	1.6-6.4

From water cost data in other countries, the proposed unit charge appears reasonable and within the ability of Port Said residents to pay. For example, recently planned water improvements for a number of Middle Eastern and African cities are to be self-financed at rates equivalent to more than US $0.30/cu m, much higher than the proposed Port Said rates:

	US $/cu m 1978	LE/cu m 1978
Amman, Jordan	0.76	0.53
Mombasa, Kenya	0.55	0.38
Mogadishu, Somalia	0.48	0.34
Taiz, Yemen	0.44	0.31
Nairobi, Kenya	0.33	0.23
Blantyre, Malawi	0.29	0.20

The World Bank states that 5% of household income is commonly regarded by funding agencies as a reasonable maximum for water bills of the lowest income group. The LE .100/cu m charges for water supply and wastewater service are recommended also for industrial customers. Comparison of annual water and wastewater service costs with payrolls for a number of factories showed water costs at a slaughterhouse 21% of salary cost; for five other plants water costs were between 1 and 6%; and for 4 plants, less than 1%. If wastewater charges are included these percentages would be doubled. Hence water and wastewater charges would be small items in most industrial budgets.

Since wastewater facilities have traditionally been financed by property taxes and other sources of municipal income, information regarding wastewater services charges are limited. In the United States and many other countries, the need for wastewater treatment has added substantially to the cost. In many places the cost of wastewater collection, treatment and disposal now exceeds the cost of water supply.

The beneficial environmental impact of well operated and adequate water supply and wastewater facilities at Port Said will be marked:

> They will reduce substantially the incidence of waterborne diseases and, through improved sanitation, the health of all cities.

- They will make Port Said an attractive place to live and work, important for a labor force of higher quality with better training and education.
- They will permit the development of hotels, beaches, and other facilities sought by tourists and the increase of commercial activity in the community.
- Needed now, expanded water supply and wastewater facilities will become even more critical in the next twenty years as the population grows to the target set for the year 2000.
- Construction and operation of the new facilities will provide opportunities for employment to a wide variety of mechanics, artisans, and supporting staff.
- The wastewater facilities will protect the surrounding waters from pollution, preserve the Lake Manzala and El Mallaha fisheries, and protect bathing beaches on the Mediterranean.
- Undesirable impacts include the inconvenience and interruption of normal life construction measures and associated dirt and noise. These are negligible compared to the benefits.

The provision of adequate water and wastewater facilities to the incremental population anticipated will improve the viability of Port Said/Port Fouad which benefits all of Egypt in its present position as one of the key ports and in its future role as a free port manufacturing zone. Further, any reduction in disease in Egypt must benefit the entire country through the improved health of an entire city. The importance of the improved water and wastewater facilities for the continued development and well-being of Port Said cannot be overstated.

TABLE I

FORECAST OF WATER DEMANDS

	1977	1982	1985	1990	1995	2000
Population	273,000	339,000	390,000	487,000	585,000	684,000
Demands in cu m/d						
Average Day						
Domestic	41,200	53,800	64,000	83,900	106,300	131,000
Tourism/Seasonal	800	1,300	1,700	2,200	2,600	3,000
Institutional	6,800	8,100	9,400	12,700	15,600	22,300
Industrial	9,400	15,600	20,700	32,100	38,400	43,200
Public Taps/Toilets	2,000	2,000	2,000	2,000	2,000	2,000
Gardens	1,000	3,500	5,000	6,500	8,000	9,500
Wastage	10,800	15,000	15,700	17,300	18,700	20,000
Leaks	18,000	15,000	17,000	20,000	25,000	30,000
Total(1)	90,000	114,000	136,000	177,000	217,000	261,000
Maximum Day(2)	112,000	142,000	169,000	220,000	271,000	326,000
Peak Hour(3)	153,000	194,000	230,000	299,000	369,000	444,000

(1) Rounded to nearest thousand
(2) 1.25 x average day
(3) 1.7 x average day

TABLE 2

EL RASWA WTP CAPACITIES VS. SUPPLY REQUIREMENTS

Flow Trains	With CTE Modifications and New Bamag Plant		With Initial System Upgrading		Possible Ultimate Capacities	
	cu m/d	cu m/hr	cu m/d	cu m/hr	cu m/d	cu m/hr
1	6,000	250	10,000	415	35,000	1,460
2	40,000	1,670	40,000	1,670	50,000	2,085
3	40,000	1,670	40,000	1,670	50,000	2,085
4	10,000	415	35,000	1,460	50,000	2,085
5	10,000	415	35,000	1,460	50,000	2,085
SUBTOTAL	106,000	4,420	160,000	6,675	235,000	9,800
Existing Bamag	35,000	1,460	50,000	2,085	50,000	2,085
SUBTOTAL	141,000	5,880	210,000	8,760	285,000	11,885
New Bamag	70,000	2,915	70,000	2,915	70,000	2,915
TOTAL	211,000	8,795	280,000	11,675	355,000	14,800

		1978	1982	1985	1990	1995	2000	For 750,000 Population(3)
Average Day Demand	cu m/d	90,000	116,000	138,000	178,000	216,000	258,000	290,000
Maximum Day Demand(1)	cu m/d	113,000	145,000	173,000	223,000	270,000	323,000	364,000
Peak Hour Demand(2)	cu m/d	153,000	197,000	235,000	303,000	367,000	439,000	495,000
Peak Hour Demand	cu m/hr	6,375	8,210	9,790	12,620	15,290	18,290	20,600

(1) 1.25 times average day demand
(2) 1.7 times average day demand
(3) At year 2000 per capita flows

TABLE 3

RECOMMENDED WATER SUPPLY PROGRAM - ESTIMATED COSTS
(Thousands of 1978 LE)

	Local	Foreign	TOTAL
HIGH PRIORITY			
Raw Water Supply	20	66	86
El Raswa WTP	1436	2697	4133
Distribution System	1681	1201	2882
Subtotal High Priority	3137	3964	7101
IMMEDIATE PHASE			
Raw Water Supply	365	266	631
El Raswa WTP	103	134	237
Distribution System	2564	3213	5777
Subtotal Immediate Phase	3032	3613	6645
STAGED DEVELOPMENT			
Raw Water Supply	19020	3285	22305
El Raswa WTP	2932	4021	6953
Distribution System	18142	6531	24673
Subtotal Staged Development	40094	13837	53931
TOTAL - RECOMMENDED PROGRAM	46263	21414	67677
REHABILITATION	324	334	658
COSTS NOT INCLUDING REHABILITATION	45939	21080	67019

TABLE 4

ESTIMATED COLLECTED WASTEWATER FLOWS
(cu m/d)

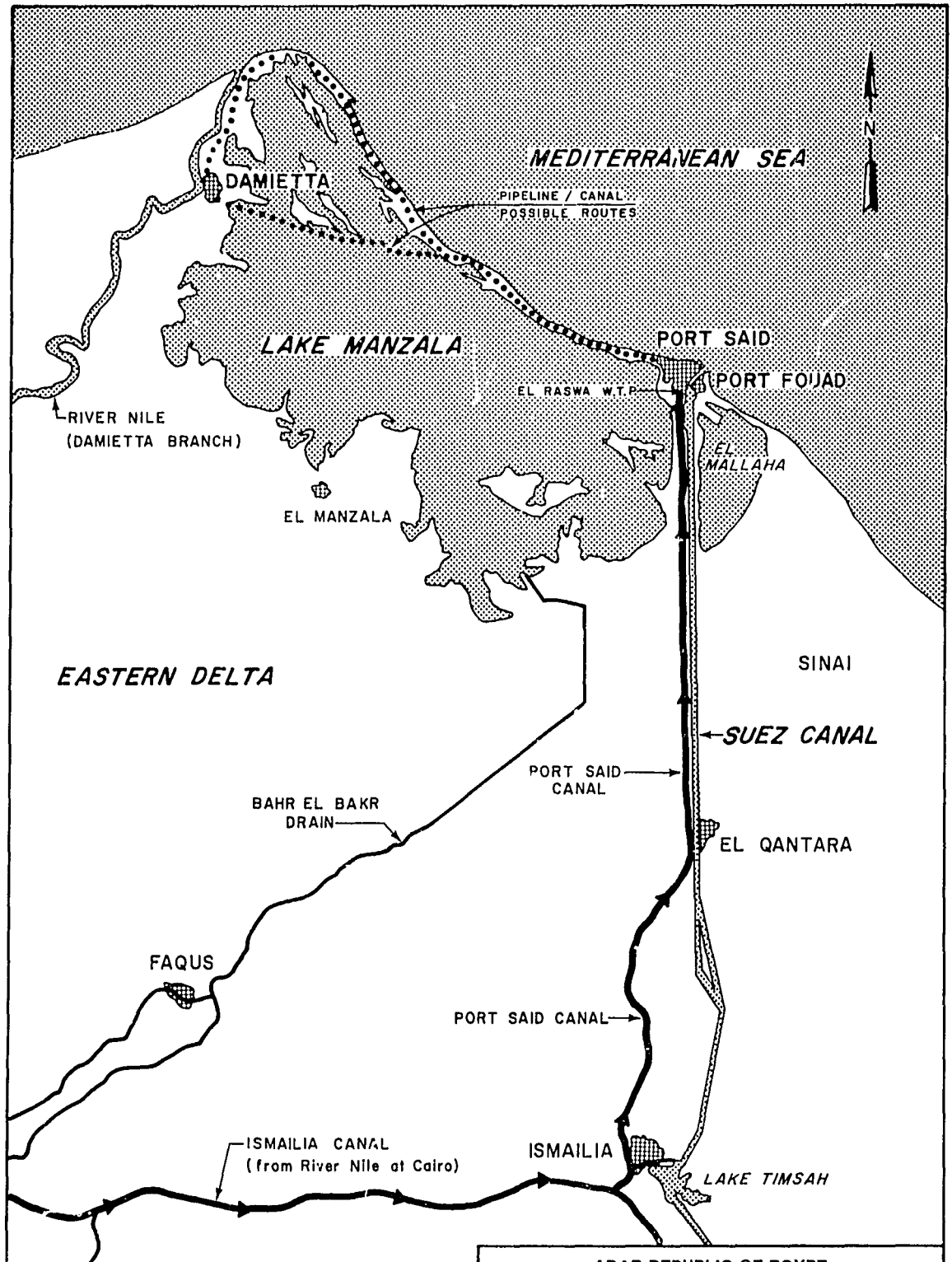
	1978	1982	1985	1990	1995	2000
Domestic	22,500	37,200	47,500	65,000	83,100	104,000
Institutional	4,800	6,700	8,700	10,300	12,600	17,200
Industrial	0	11,400	15,700	26,400	30,500	34,300
Seasonal/Hotel	0	1,000	1,000	1,000	1,000	1,000
Public	900	1,000	1,000	1,000	1,000	1,000
Wastage	10,100	14,700	16,600	18,500	19,400	20,400
Infiltration	0	10,300	10,400	10,700	10,700	10,800
Total Daily Average	38,000(1)	82,000	101,000	133,000	158,000	189,000
Sub-Total w/o Infiltration	38,000	72,000	91,000	122,000	148,000	177,000
Water Delivered (production minus leakage, gardening water and ship water)	70,000(2)	95,000	112,000	148,000	181,000	217,000
Sewage as a % of Water Delivered	54%	75%	81%	82%	82%	82%

(1) Estimated flow delivered to Mazrah STP.
(2) Based on water demands summarized in Port Said WWFMP Final Report, Vol. 2, Table 4.9.

TABLE 5

COST SUMMARY OF RECOMMENDED WASTEWATER FACILITIES PROGRAM

	Estimated Capital Costs (Thousands of 1978 LE)		
	Local	Foreign	Total
High Priority			
Equipment Procurement & Local Measures	70	298	368
Procurement of Services			
Sewer Cleaning Program	133	458	591
Sewer Inspection & Grouting Program	62	285	347
Solid Waste Study	15	40	55
Major Capital Projects			
Port Said Collection & Transport	3,210	3,277	6,487
Subtotal High Priority Works	3,490	4,358	7,848
Immediate Phase			
Major Capital Projects			
Port Said Collection & Transport	4,733	4,555	9,288
Port Fouad Collection & Transport	1,391	1,184	2,575
Port Said Treatment & Disposal	7,365	5,440	12,805
Port Fouad Treatment & Disposal	658	655	1,313
Sewer Rehabilitation	500	-	500
Secondary Collection System 1979-1982	4,495	732	5,227
Equipment Procurement			
Vehicle & Maintenance Equipment	-	336	336
Procurement of Services			
Surface Drainage Study	18	52	70
Subtotal Immediate Phase	19,160	12,954	32,114
Staged Development			
1983-1985			
Secondary Collection	3,924	639	4,563
PS-12, PS-13	950	1,252	2,202
Additional Vehicles & Equipment	-	64	64
1986-1990			
Secondary Collection System	9,820	1,600	11,420
LS-14	418	312	730
PS-17, PS-18	312	432	744
Expansion of Southern Main P.S.	658	1,078	1,736
Expansion of Mazrah & Southwest Wastewater Treatment Plants (WTP)	999	897	1,896
Additional Vehicles & Equipment	0	101	101
1991-1994			
Secondary Collection System	8,127	1,320	9,447
LS-15	573	381	954
Additional Vehicles & Equipment	0	81	81
1995-2000			
Secondary Collection System	7,758	1,265	9,023
LS-16	573	392	965
Additional Vehicles & Equipment	0	70	70
Subtotal Staged Development	34,112	9,884	43,996
TOTAL CAPITAL COSTS ALTERNATIVE 2-A	56,762	27,196	83,958
Subtotal Secondary Collection System	34,124	5,556	39,680



ARAB REPUBLIC OF EGYPT
MINISTRY OF DEVELOPMENT AND NEW COMMUNITIES
ADVISORY COMMITTEE FOR RECONSTRUCTION

PORT SAID
WATER AND WASTEWATER FACILITIES MASTER PLAN

AREA MAP

VOL. I
FIG.
A

HAZEN AND SAWYER
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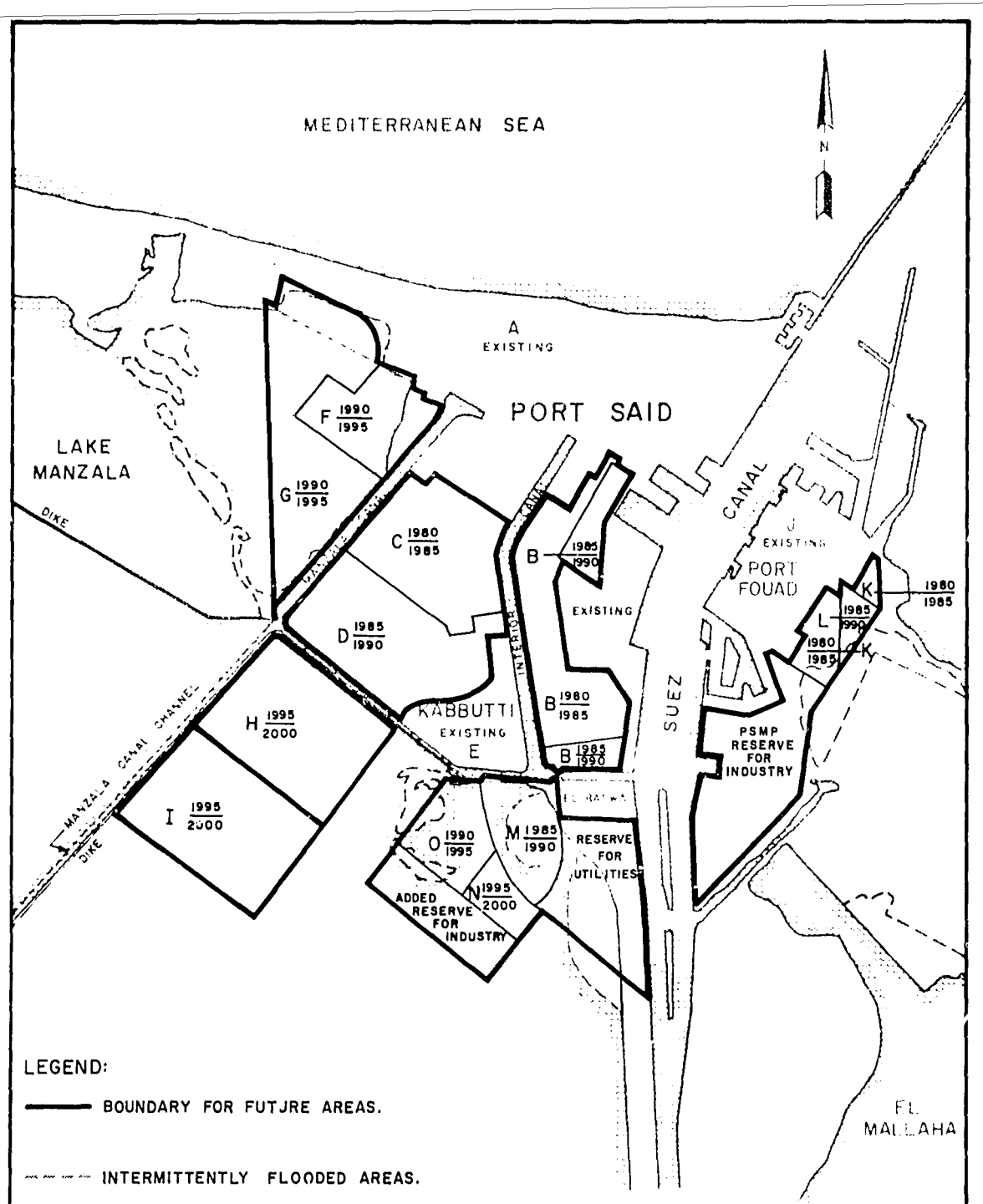


LEGEND:

BOUNDARY FOR FUTURE AREAS.

INTERMITTENTLY FLOODED AREAS.

$C\frac{1980}{1985}$ FIVE YEAR INTERVALS DURING WHICH BULK OF CONSTRUCTION WILL TAKE PLACE.

SCALE: 1:50,000

0 1.0 2.0 3.0 Km.

ARAB REPUBLIC OF EGYPT

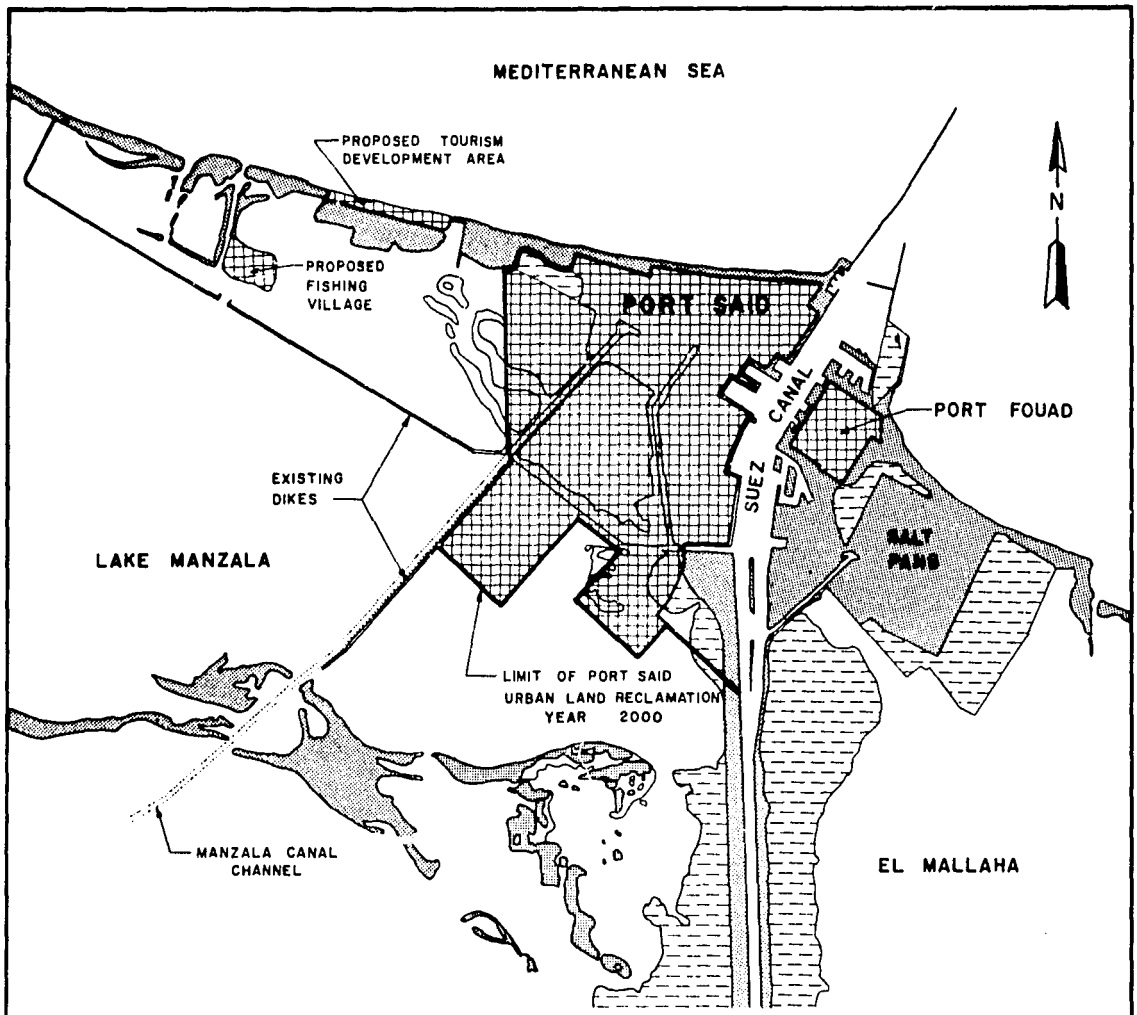
MINISTRY OF DEVELOPMENT AND NEW COMMUNITIES
ADVISORY COMMITTEE FOR RECONSTRUCTION

PORT SAID
WATER AND WASTEWATER FACILITIES MASTER PLAN

HAZEN AND SAWYER
ECG - ENGINEERING CONSULTANTS GROUP

PHASING OF FUTURE AREA DEVELOPMENT

VOL. I
FIG.
B



YEAR 2000 SERVICE AREA.

OTHER DRY LAND AREA

INTERMITTENTLY FLOODED AREAS.

APPROX. SCALE: 1:100,000

0 1.0 2.0 3.0 4.0 Km.

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PORT SAID

WATER AND WASTEWATER FACILITIES MASTER PLAN

HAZEN AND SAWYER

ECG - ENGINEERING CONSULTANTS GROUP

YEAR 2000 SERVICE AREA

VOL. I FIG. C

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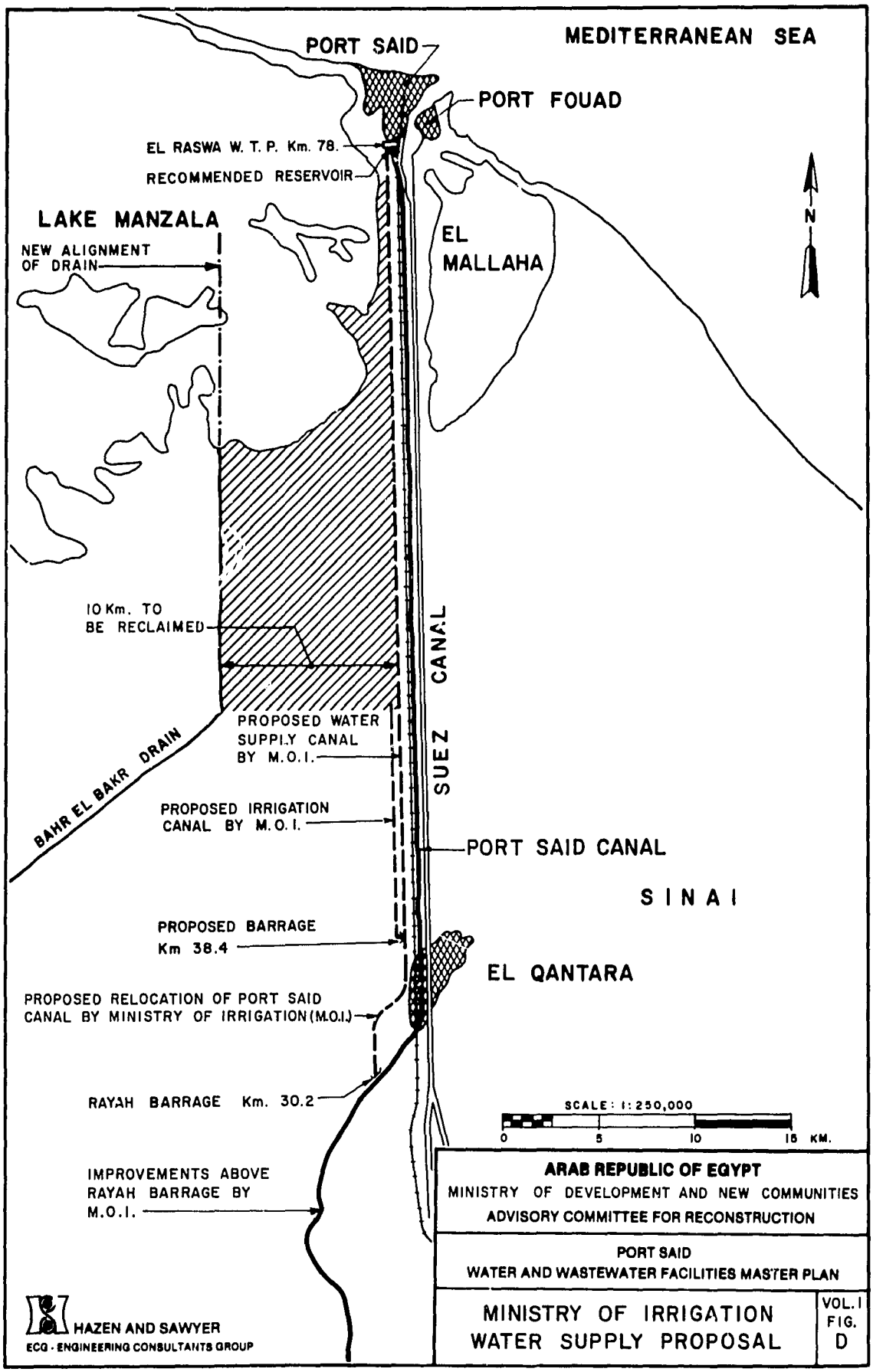
MEDITERRANEAN SEA
PORT SAID
PORT FOUAD
EL RASWA W. T. P. Km. 78.
RECOMMENDED RESERVOIR
LAKE MANZALA
NEW ALIGNMENT OF DRAIN
EL MALLAHA
N
10 Km. TO BE RECLAIMED
SUEZ CANAL
PROPOSED WATER SUPPLY CANAL BY M.O.I.
BAHR EL BAKR DRAIN
PROPOSED IRRIGATION CANAL BY M.O.I.
PORT SAID CANAL
SINAI
PROPOSED BARRAGE Km 38.4
EL QANTARA
PROPOSED RELOCATION OF PORT SAID CANAL BY MINISTRY OF IRRIGATION (M.O.I.)
RAYAH BARRAGE Km. 30.2
SCALE: 1:250,000
0 5 10 15 KM.
IMPROVEMENTS ABOVE RAYAH BARRAGE BY M.O.I.
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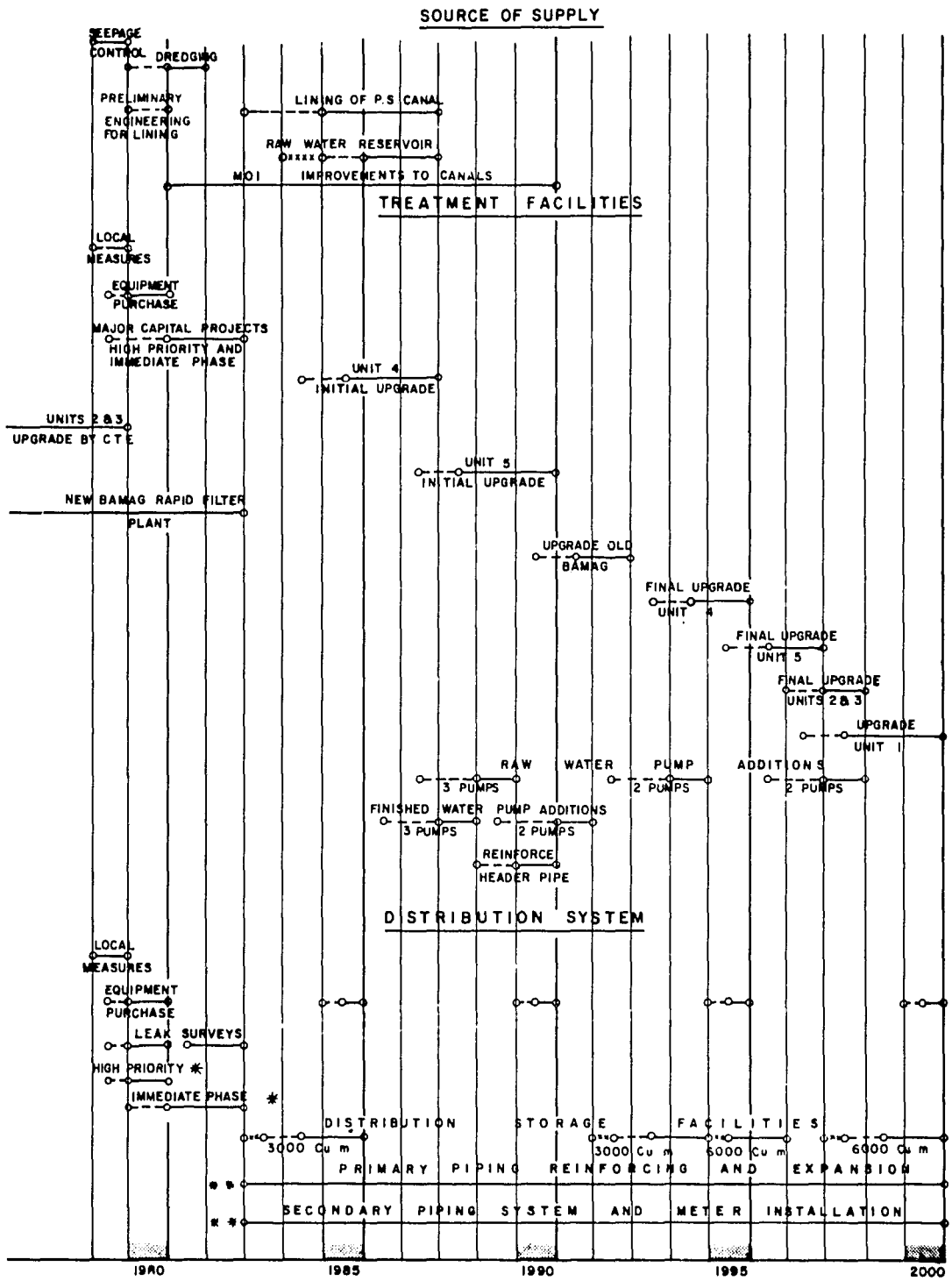
MINISTRY OF IRRIGATION
WATER SUPPLY PROPOSAL
VOL. I
FIG.
D



LEGEND :

- SITE ACQUISITION
- ENGINEERING, BIDDING.
- CONSTRUCTION, TESTING AND START UP.
- * INCLUDES PRIMARY AND SECONDARY PIPING SERVICE CONNECTION, METERS
- ** ENGINEERING NOT SHOWN SEPARATELY

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PORT SAID
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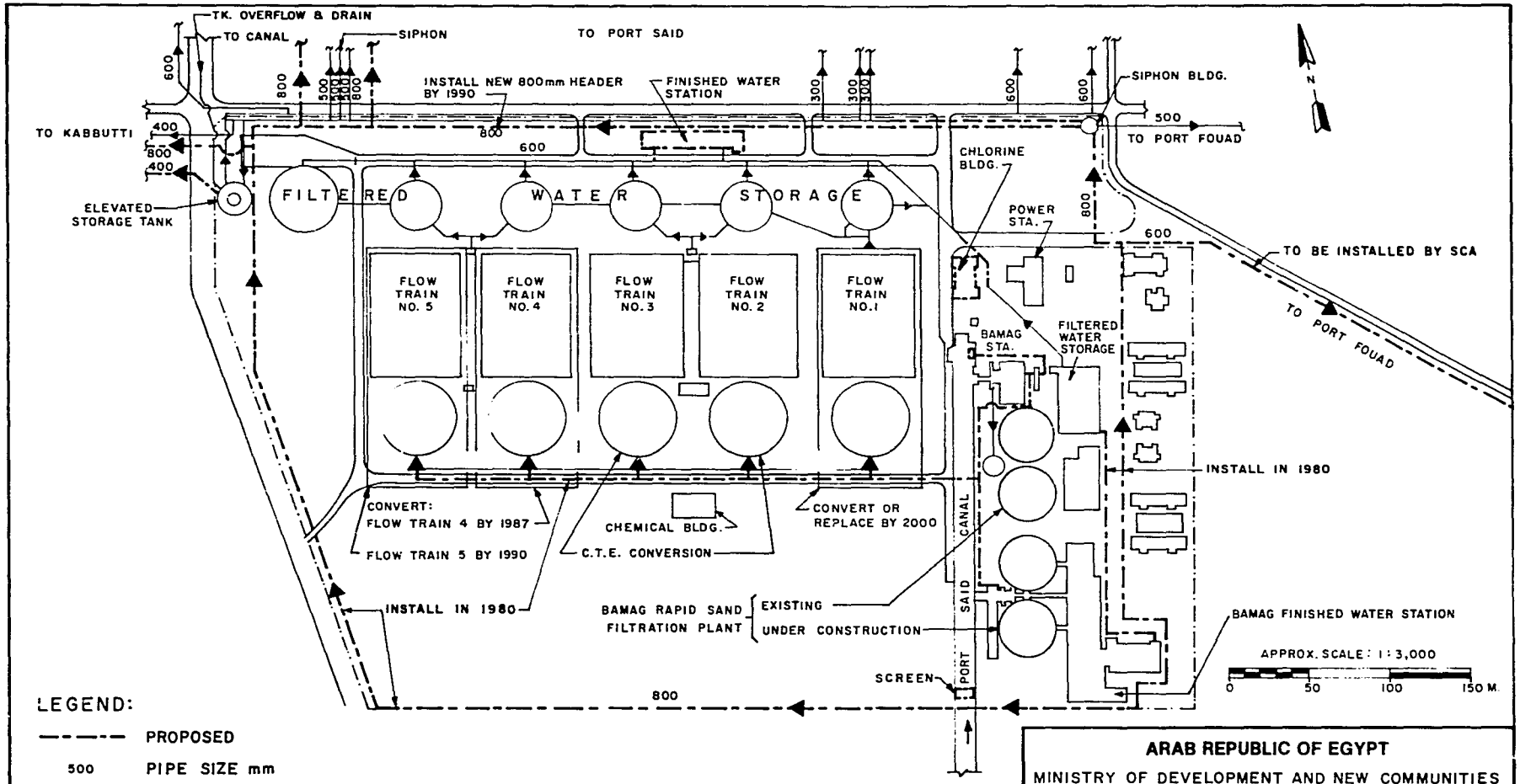
WATER FACILITIES PROGRAM EXECUTION

VOL. I
FIG. E


TK. OVERFLOW & DRAIN
TO CANAL
SIPHON
TO PORT SAID
INSTALL NEW 800mm HEADER BY 1990
FINISHED WATER STATION
SIPHON BLDG.
TO KABBUTTI
TO PORT FOUAD
CHLORINE BLDG.
ELEVATED STORAGE TANK
FILTERED WATER STORAGE
POWER STA.
TO BE INSTALLED BY SCA
TO PORT FOUAD
FLOW TRAIN NO. 5
FLOW TRAIN NO. 4
FLOW TRAIN NO. 3
FLOW TRAIN NO. 2
FLOW TRAIN NO. 1
BAMAG STA.
FILTERED WATER STORAGE
INSTALL IN 1980
CONVERT: FLOW TRAIN 4 BY 1987
FLOW TRAIN 5 BY 1990
CHEMICAL BLDG.
C.T.E. CONVERSION
CONVERT OR REPLACE BY 2000
INSTALL IN 1980
BAMAG RAPID SAND FILTRATION PLANT
EXISTING
UNDER CONSTRUCTION
PORT SAID CANAL
SCREEN
BAMAG FINISHED WATER STATION
APPROX. SCALE: 1:3,000
0 50 100 150 M.
LEGEND:
PROPOSED
500 PIPE SIZE mm
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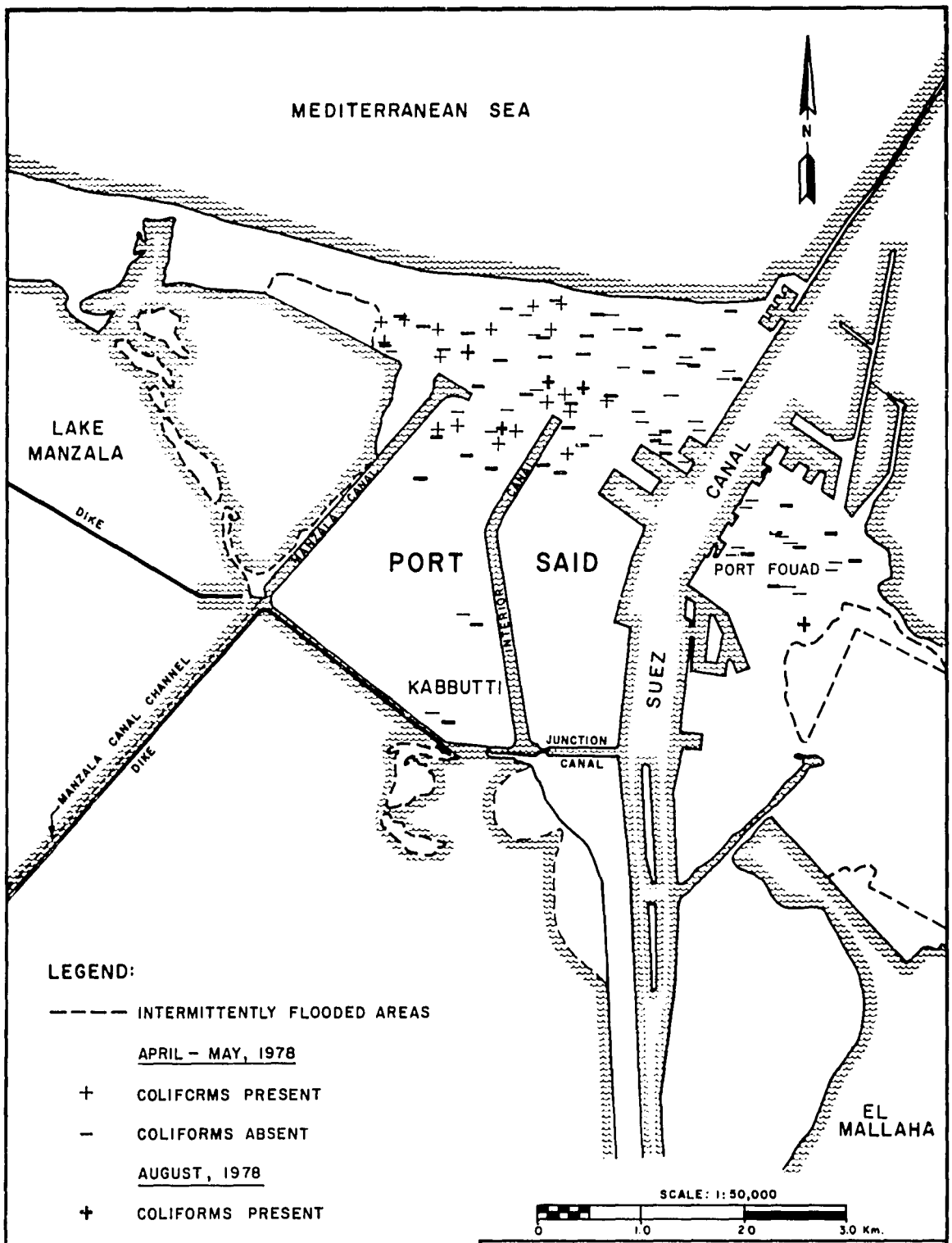
PORT SAID
WATER AND WASTEWATER FACILITIES MASTER PLAN
EL RASWA
WATER TREATMENT PLANT
VOL. I
FIG. F



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PORT SAID
WATER AND WASTEWATER FACILITIES MASTER PLAN

WATER DISTRIBUTION SYSTEM
BACTERIOLOGICAL TESTING

VOL. I
FIG.
G

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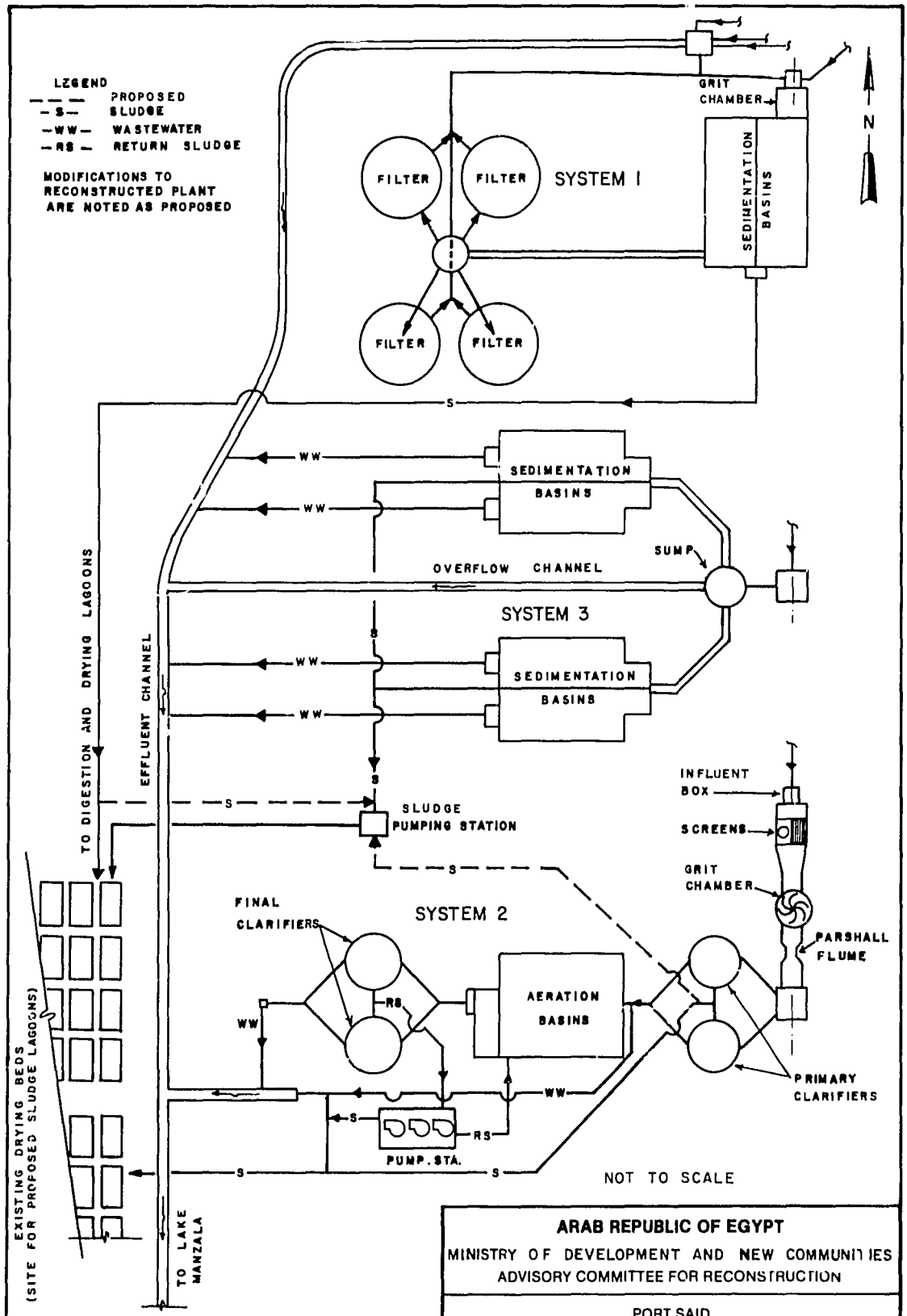

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HAZEN AND SAWYER
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MAZRAH
SEWAGE TREATMENT PLANT
SCHEMATIC FLOW DIAGRAM

VOL. I
FIG.
H

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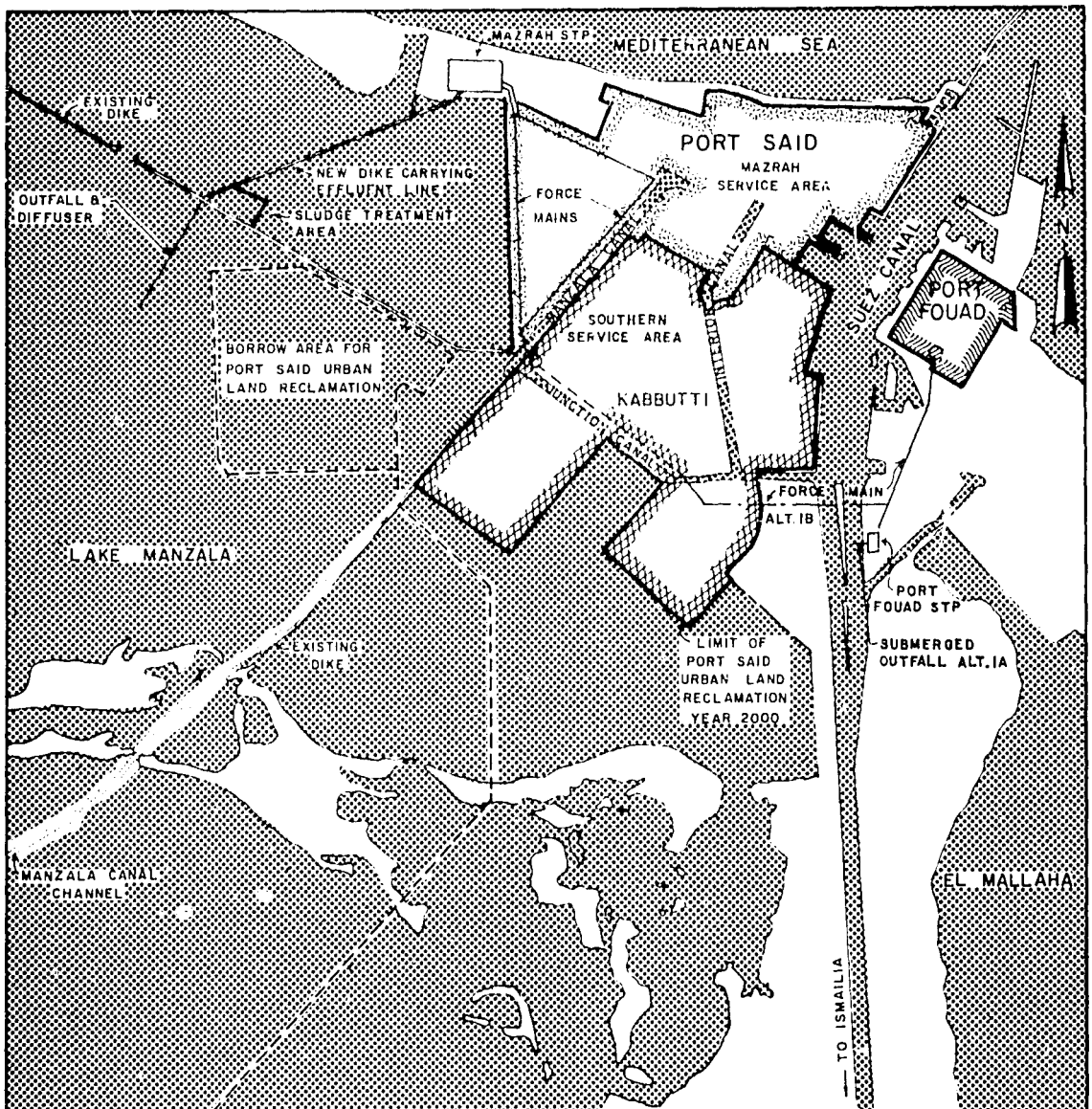

SCALE 1:75,000
(APPROX)
0 1.0 2.0 3.0 Km.

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WASTEWATER TREATMENT ALTERNATIVES IA & IB

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FIG. I

HAZEN AND SAWYER
ECO - ENGINEERING CONSULTANTS GROUP

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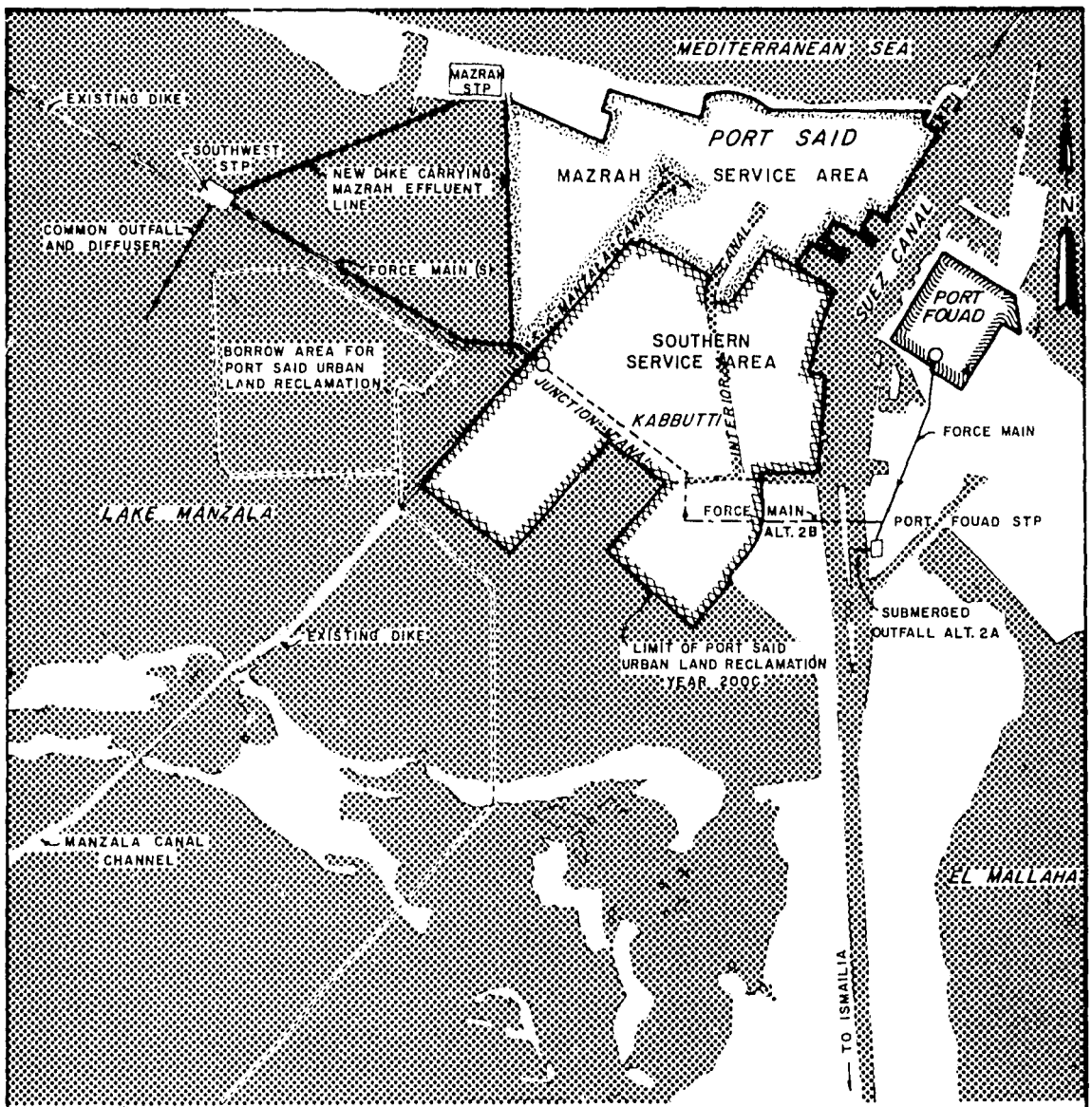

SCALE 1:75,000
(APPROX)
0 1.0 2.0 3.0 Km.

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WATER AND WASTEWATER FACILITIES MASTER PLAN

WASTEWATER TREATMENT ALTERNATIVES 2A & 2B

VOL. I
FIG. J

HAZEN AND SAWYER
ECG - ENGINEERING CONSULTANTS GROUP

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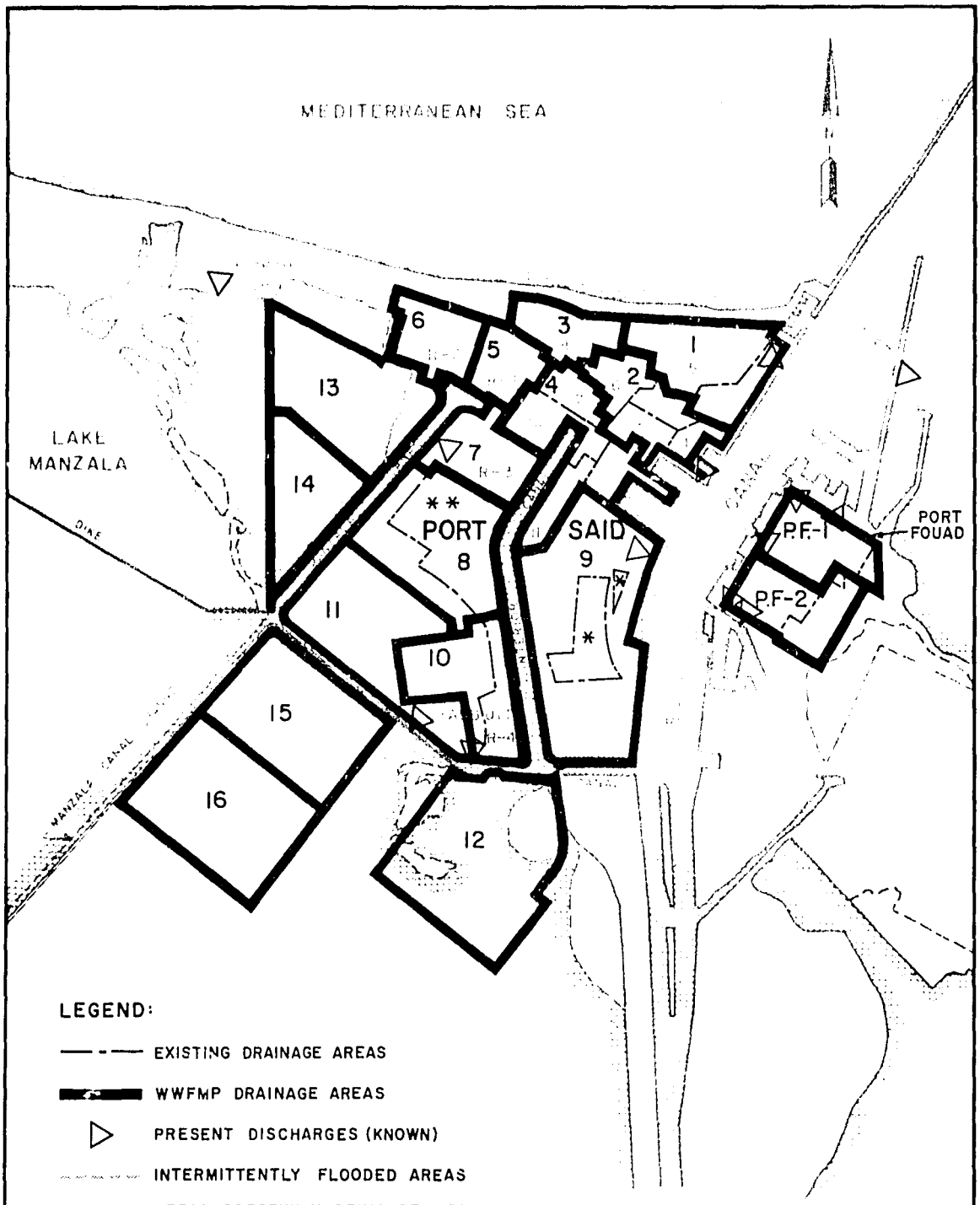

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HAZEN AND SAWYER
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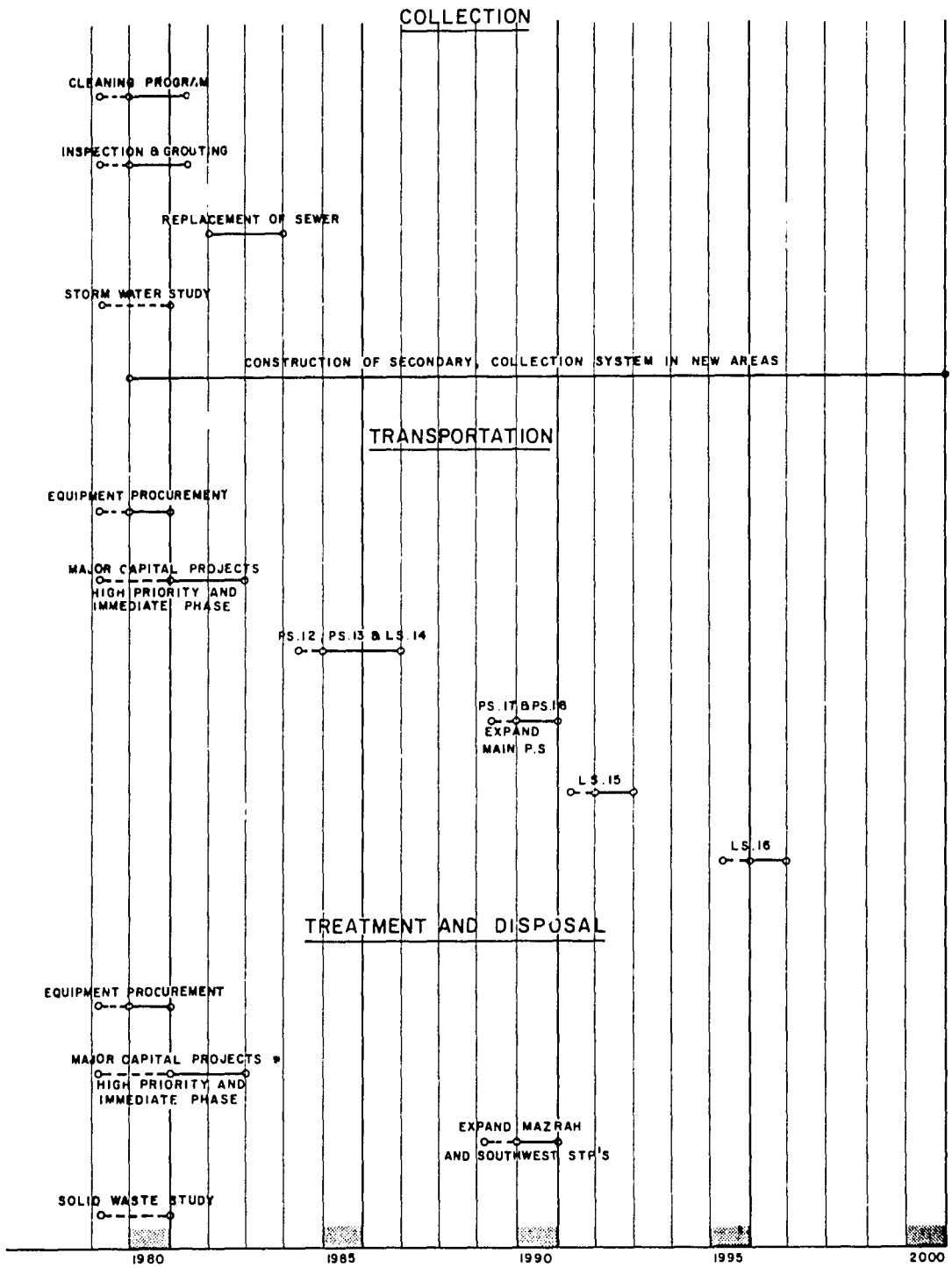
DRAINAGE AREA BOUNDARIES

VOL. I
FIG.
K



LEGEND :

- ENGINEERING, BIDDING.
- CONSTRUCTION, TESTING AND START UP
- * INCLUDES CONSTRUCTION OF MAZRAH SOUTHWEST AND PORT FOUAD STP'S

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WASTEWATER FACILITIES PROGRAM EXECUTION

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FIG.
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APPENDIX

APPENDIX

Recommended improvements in the Suez Canal Authority organization are detailed in Chapter 10, Volume 2 (Water Facilities). These include the provision of adequate tools and replacement parts, modern-type service connections, better record keeping, education programs, and especially strengthened technical supervision of the water treatment and pumping operations. The WWFMP recommends key modifications to the local SCA water organization chart; suggests qualifications, education and compensation to be paid water system employees; and assigns the number of personnel needed for the several divisions and departments of the SCA. In forecasting future operating costs, the SCA staff was estimated to increase from 174 in 1977 to 205 in 1985, and 252 in the year 2000.

Deficiencies similar to those found in the water system are described in Chapter 10, Volume 3 (Wastewater Facilities) for the Engineering Department of the Governorate of Port Said. Recommendations are made for the many departments and divisions involved in the wastewater system, including employee qualifications and salaries. In forecasting future operating costs, the wastewater system staff was estimated to increase to 321 in 1983, to 405 by 1990, and 461 by the year 2000.

Steps to be taken and administrat. . arrangements for initiating and carrying out the several parts of the recommended program are set forth in Chapter 11, Volume 2, and Chapter 11, Volume 3. For the water facilities program, annual capital outlays are estimated to increase from LE 386,000 in 1979 to a peak of LE 8,085,000 in 1987, and thereafter dropping to LE 2,413,000 in the year 2000. Local currency cos's will increase from LE 175,000 in 1979 to LE 6,173,000 in 1987, and lower to LE 1,528,000 by the year 2000. For the wastewater program, the coverage was essentially the same with annual capital outlays estimated to increase from LE 1,306,000 in 1977 to a maximum of LE 6,342,000 in

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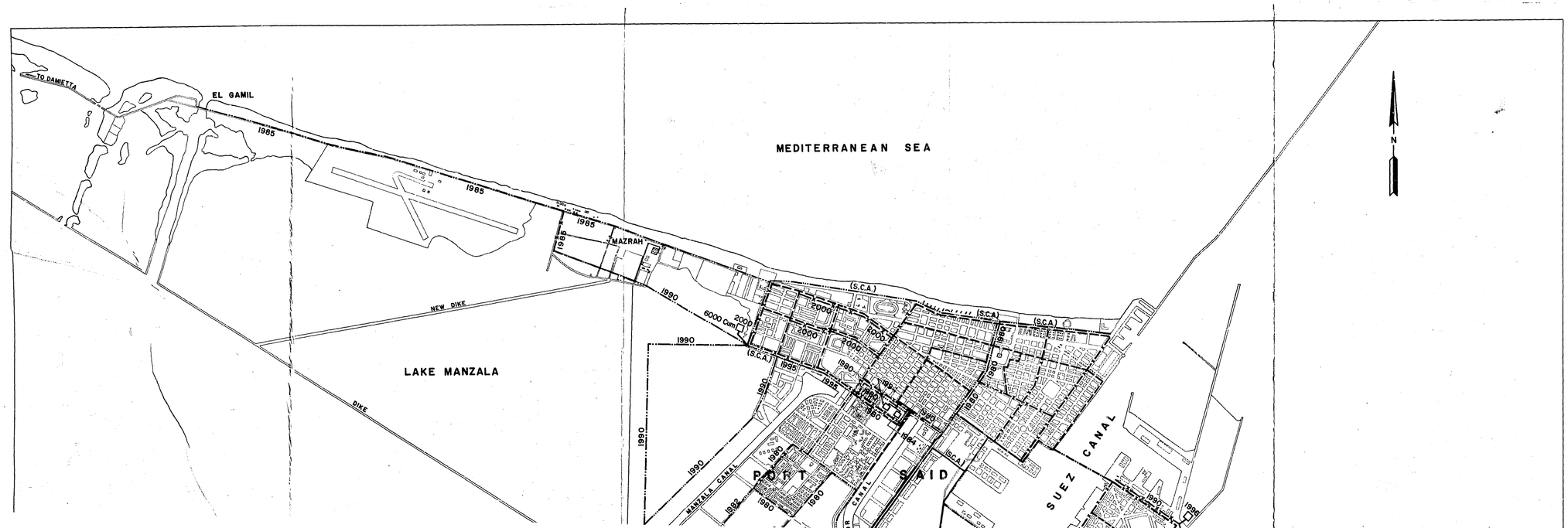
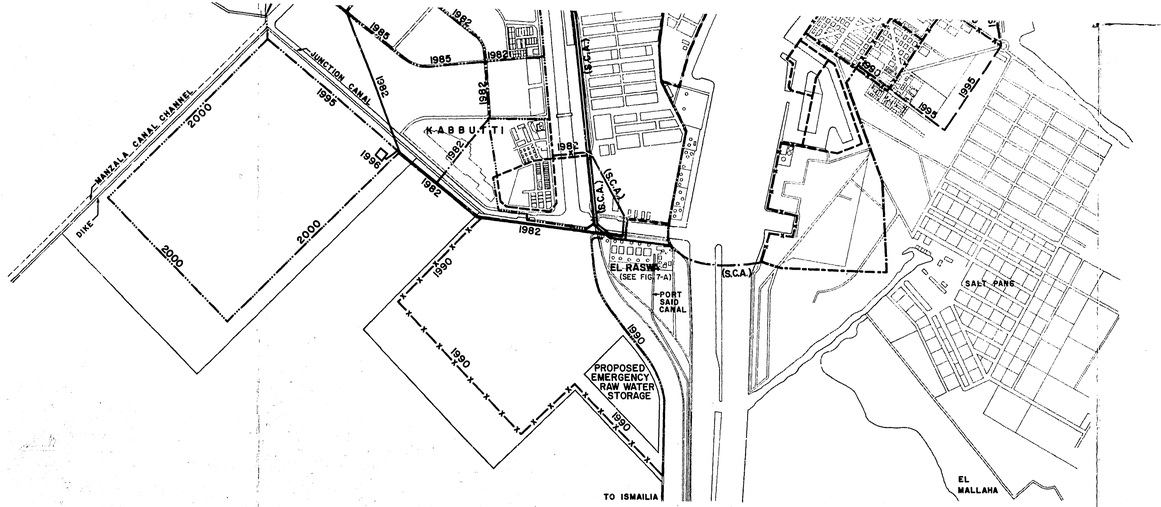
1990, and LE 1,805,000 in year 2000. Local currency costs will increase from LE 1,123,000 in 1977, to LE 3,928,000 in 1990, and LE 1,552,000 in 2000.

Important elements of technical feasibility, financial feasibility, economic soundness, design criteria, capital and operating cost estimates, cost-effectiveness and "shadow pricing" are presented in Chapter 5 and related appendices of Volume 2. Similar information is covered in Chapter 5, Volume 3, with emphasis on receiving water quality and the environment.


TO DAMIETTA
EL GAMIL
1985
MEDITERRANEAN SEA
N
MAZRAH
NEW DIKE
LAKE MANZALA
DIKE
1990
6000 cum
2000
(S.C.A.)
MANZALA CANAL
PORT SAID
SUEZ CANAL
1980
1982



LEGEND

EXISTING PIPE	DIA. mm	FUTURE PIPE
	1000	
	800	
	600	
	550	
	500	
	400	
	300	
	200	
	TANK	

NOTES

- LATEST YEAR REQUIRED NOTED ON PIPE OR TANK.
- PIPES MARKED S.C.A. ARE PROJECTS IN PROGRESS.
- HIGH PRIORITY LINES ARE MARKED 1980.
- IMMEDIATE PHASE PROJECTS ARE MARKED 1982.
- SECONDARY PIPES SMALLER THAN 200 mm NOT SHOWN.
- TANKS ARE OF CAPACITY 3000 Cum EACH, UNLESS OTHERWISE NOTED.

SCALE 1:20,000

500 0 500 1000 METERS

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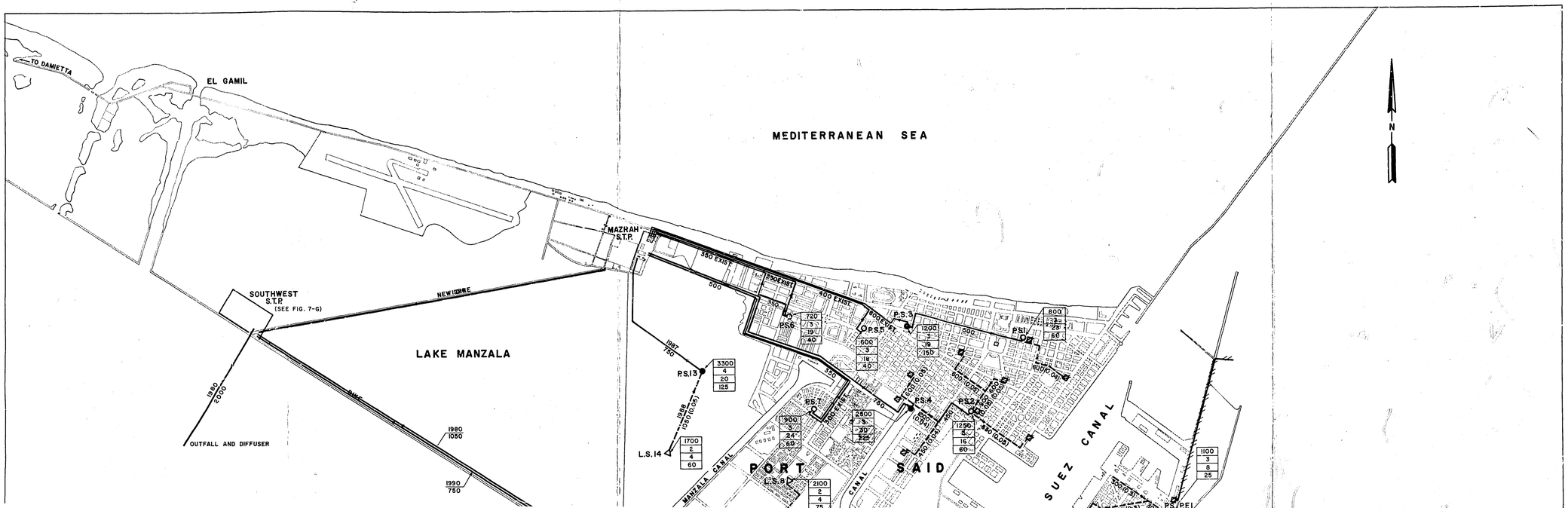
WATER AND WASTEWATER FACILITIES MASTER PLAN

STAGED DEVELOPMENT WATER DISTRIBUTION SYSTEM ADDITIONS

HAZEN AND SAWYER ECG - ENGINEERING CONSULTANTS GROUP	DATE JUNE 1979	VOLUME I PLATE No. I

1.0 1.1 1.25 1.4 1.6 1.8 2.0 2.2 2.5


TO DAMIETTA
EL GAMIL
MEDITERRANEAN SEA
N
MAZRAH S.T.P.
SOUTHWEST S.T.P.
(SEE FIG. 7-G)
NEW 1500 RE
LAKE MANZALA
PIPE
OUTFALL AND DIFFUSER
1980
5000
1980
1050
1990
750
1987
700
1988
1200 (0.01)
P.S.13
3300
4
20
125
L.S.14
1700
2
4
60
MANZALA CANAL
PORT SAID
CANAL
SUEZ CANAL
L.S.8
2100
2
4
75
P.S.7
1900
3
24
60
P.S.6
720
3
19
40
P.S.5
600
3
16
40
P.S.4
2600
3
20
265
P.S.3
1200
3
30
150
P.S.2
1250
3
16
60
P.S.1
800
3
25
60
P.S.PEL
1100
3
8
25
330 EXIST.
500
400 EXIST.
300 EXIST.
400
350
300
400 (0.01)
500 (0.01)
600 (0.01)
800 (0.01)
900 (0.01)
1200 (0.01)
1500 (0.01)
1800 (0.01)
2000 (0.01)
2500 (0.01)
3000 (0.01)
3500 (0.01)

LEGEND

1250	CAPACITY (CUM/HR)
3	No. OF PUMPS
16	TOTAL DYNAMIC HEAD (m)
60	MOTOR HP, EACH PUMP

DATE CONSTRUCTED 1987 — 750 DIAMETER mm — FORCE MAIN

DATE CONSTRUCTED 1988 — 1050 (0.05) — DIAMETER mm — SLOPE m/1000m — GRAVITY SEWER

EXISTING FORCE MAIN

EXISTING PUMP STATION

P.S. 2 NEW SUBMERSIBLE TYPE PUMP STATION

P.S. 4 NEW DRY PIT TYPE PUMP STATION

L.S. 8 NEW HELICAL SCREW LIFT STATION

MANHOLE

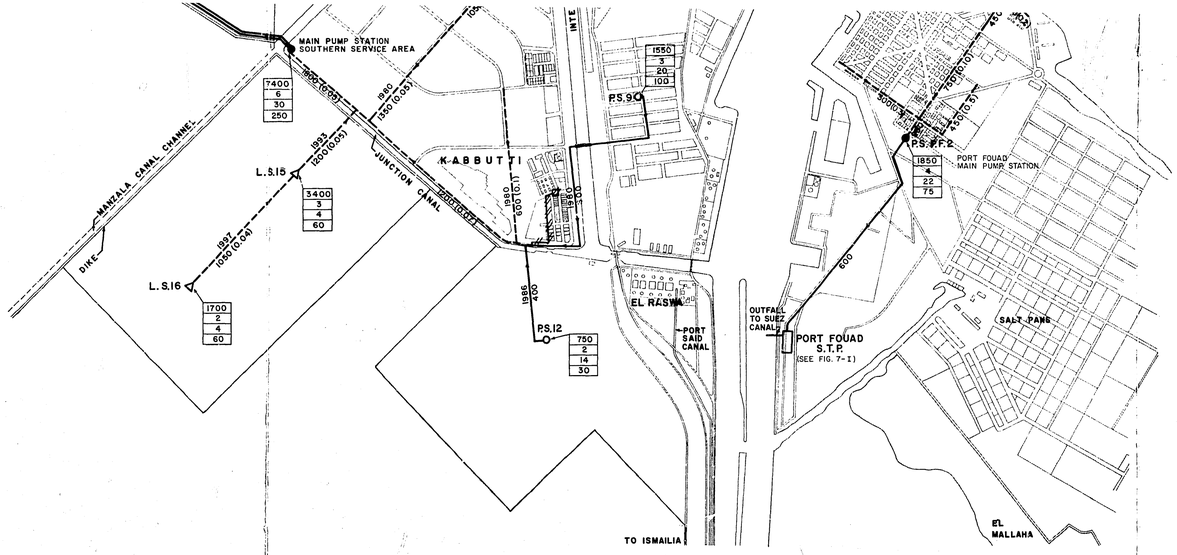
TO BE ABANDONED

NOTES

1 – WHERE NO DATE IS SHOWN THE STRUCTURE OR LINE IS PART OF THE HIGH PRIORITY WORKS TO BE COMPLETED BY THE END OF 1982.

2 – P.S.3 IS AN EXISTING STATION AND REMAINS UNCHANGED.

3 – P.S.5, P.S.6 AND P.S.7 INVOLVE MODIFYING EXISTING STRUCTURES AND INSTALLING NEW EQUIPMENT.



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WATER AND WASTEWATER FACILITIES MASTER PLAN

STAGED DEVELOPMENT WASTEWATER COLLECTION SYSTEM ADDITIONS

HAZEN AND SAWYER ECG - ENGINEERING CONSULTANTS GROUP	DATE JUNE 1979	VOLUME I PLATE No. II