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Ministry of Development And New Communities

PORT SAID WATER AND WASTEWATER FACILITIES MASTER PLAN

Final Report

Volume 3 — Wastewater Facilities

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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
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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 3 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 in preparation of the Master Plan. We look forward to successful implementation of the recommended programs.

Very truly yours,

HAZEN AND SAWYER

David Walrath

David Walrath
Resident Project Director

ENGINEERING CONSULTANTS GROUP

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DW:em

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ABBREVIATIONS

Organizations

A.R.E.	The Government of the Arab Republic of Egypt
MDNC	Ministry of Development and New Communities
ACR	Advisory Committee of Reconstruction
GOPS	The Governorate of Port Said
SCA	Suez Canal Authority
GOWS	General Organization for Water Supply
GOSSD	General Organization for Sewerage and Sanitary Drainage
MOI	Ministry of Irrigation
GOPP	General Organization for Physical Planning
CAPMAS	General Agency for Public Mobilization and Statistics
USAID	United States Agency for International Development
PSMP	Port Said Master Plan, prepared by Bullen and Partners; Shankland Cox Partnership; Binnie and Partners; Peat Marwick, Mitchell & Co.; Hanna and Partners - March 1976
PSC	Port Said Canal
U.S.	United States (of America)
WHO	World Health Organization
USEPA	United States Environmental Protection Agency
WWFMP	Water and Wastewater Facilities Master Plan (Port Said)
EEA	Egyptian Electrical Authority

ABBREVIATIONS (Cont.)

Engineering Units

m	meter
km	kilometer
cm	centimeters
mm	millimeters
sq m	square meters
sq km	square kilometers
ha	hectare
cu m	cubic meters
l	liters
ml	milliliter
s	second
min	minute
hr	hour
d	day
yr	year
/	per
cu m/day	cubic meters per day
cu m/hr	cubic meters per hour
lps	liters per second
lpd	liters per day
lcd	liters per capita per day
gm	gram
kg	kilogram
mg	milligram
m/sec	meters per second

ABBREVIATIONS (Cont.)

Engineering Units (Cont.)

t	Tonne (metric)
mg/l	milligrams per liter
HP	horsepower
V	volts
P/ha	people per hectare
hz	hertz (cycles/sec)
lm	linear meter
KV	kilovolts
KVA	kilovolt-amperes
KW	kilowatts
KWH	kilowatt hours

Engineering Terms

Y	wye connected
P.F.	power factor
dia	diameter
O.D.	outside diameter
LS	lump sum
S	slope
EC	Electroconductivity
TU	Turbidity units
TDS	Total dissolved solids
DO	Dissolved oxygen
TDH	Total dynamic head
COD	Chemical oxygen demand
BOD	Biochemical oxygen demand

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ABBREVIATIONS (Cont.)

Engineering Terms (Cont.)

SS	Suspended solids
ea	each
LE	Egyptian Pound
N/A	not applicable
STP	Sewage treatment plant
WTP	Water treatment plant
P.S.	Pumping station
TF	Trickling filter
G	Velocity gradient in reciprocal seconds
D_{60}, D_{10}	Sand sizes (based on sieve analysis) for which 60% (10%) of grains (by weight) are finer.
JTU	Jackson Turbidity Units
MPN	Most Probable Number
CU	Color Units
CPUE	Catch per unit effort
Knots	Nautical miles/hour (0.5 m/sec)
lcpd	Liters/capita/day
Mld	Megaliters/day
ppb	parts per billion
ppt	parts per thousand
ug/l	Micrograms/liter
STDO	Salinity, Temperature and Dissolved Oxygen

The objectives of this study and report may be summarized as follows:

1. To define the existing setting and the present and future needs to implement the Port Said Water and Wastewater Facilities Master Plan (WWFMP). As stipulated in the terms of reference, the 1976 Master Plan for Port Said (PSMP) has provided the basic framework for this undertaking, with adjustments as necessary to reflect more recent information, planning, and decisions.

2. To assess the adequacy of existing wastewater facilities, improvement projects presently underway, and pending programs in the light of future needs, scheduling, and costs.

3. To select and recommend improvements, projects, and programs for improving the Port Said wastewater system under three headings:

   a) High Priority - Those projects needed immediately to deal with problems of existing sewage overflows in built-up areas.

   b) Immediate Phase - Additional projects which in conjunction with High Priority projects will expand and improve the Port Said wastewater facilities to meet needs for proper collection, treatment and disposal, at least through 1982.

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

4. High Priority and Immediate Phase projects are divided into four types:

   a) Local Measures to be carried out by responsible agencies at Port Said, with consultation and assistance by the Engineer's resident staff.

   b) Procurement and Installation of equipment and materials from manufacturers and/or suppliers.

   c) Engineering Design and Construction Contracts for major capital construction projects.

   d) Procurement of Services by contract with organizations having the personnel and equipment needed for the planning and execution of specialized tasks, such as sewer cleaning and training of local personnel.

5. Staged Development projects are limited to procurement of vehicles and equipment and construction of major capital improvements.

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CHAPTER I

PHYSICAL SETTING

I.I LOCATION AND TOPOGRAPHY

Port Said is situated on the Mediterranean Sea at the northern terminus of the Suez Canal. The Project Area for the Port Said Water and Wastewater Facilities Master Plan (WWFMP), as shown on Figure I-A, includes Port Fouad, east of the Canal. To the south the Project Area extends to new developments proposed by the Port Said Master Plan (PSMP), including the proposed new port on the Suez Canal. To the west the Area extends, along the sand bar which separates Lake Manzala from the Mediterranean, to the El Gamil inlet.

Initial development in the Project Area was located on this sand bar. Subsequently, land was extended to the south by filling lake areas with material excavated from the Suez Canal. In addition, west of the Suez Canal, the natural accretion of beach sand against the canal breakwater has gradually extended the sand bar northward some 1,500 meters (see Figure I-B).

Existing land areas are narrowly confined: on the north by the sea; and to the west, south and east, by Lake Manzala and El Mallaha, a former part of Lake Manzala cut off by the Suez Canal. Two narrow corridors connect these land areas to the rest of Egypt - one to the south along the west bank of the Suez Canal, the other to the west along the sand bar toward Damietta.

The "study" area for the WWFMP extends beyond the Project Area to include:

- Receiving Waters Study: Areas of Lake Manzala and El Mallaha shown on Figure I-A (excluding Lake Manzala south of Kom Tannis); the surf zone of the Mediterranean Sea; and the Suez Canal south to Lake Timsah (near Ismailia).

- Raw Water Supply Sources, in particular the Port Said Canal from Qantara to Port Said.

- Agricultural Reclamation Areas to the south and west of Port Said.

The Suez Canal Authority (SCA) has planned and is executing a two-stage project to enlarge the Suez Canal to accommodate bigger vessels, as follows:

	Depth (m)	Maximum Width (m)*
Present	15	89
Stage I	19.5	170
Stage II	23.5	240

*(at 11 m depth)

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This project will include a bypass canal opening into the Mediterranean Sea east of Port Fouad, cutting off possible land connection from the Project Area to the east.

Topography of the Project Area is flat. Ground surface is only 1 to 2 m above sea level. Tidal range at Port Said averages 0.2 m and rarely exceeds 0.4 m. (Elevations in this report are referenced to the National datum at Alexandria.)

1.2 CLIMATE

Port Said has a mild, generally agreeable climate. Temperatures are moderated by the Mediterranean Sea, making winter temperatures higher and summer temperatures lower than at most areas in Egypt. Temperatures at Port Said range from 11-19°C in winter and 23-31°C in summer, with an average of approximately 21.5°C (see Table 1.1).

Most of the meager annual rainfall, averaging some 71 millimeters (mm), occurs in the months of November through March (see Table 1.2). During this period, storms of 2 to 3 days duration cause strong winds and intermittent, sometimes heavy, showers. Interspersed are spells of sunny, pleasant weather with lighter winds.

In spring, the temperature contrast between the still cool waters of the Mediterranean and the rapidly warming desert in Upper Egypt and Sudan results in changeable conditions with cyclonic disturbances passing north of Port Said. Ahead of such storms the region is subject to the Khamseen, strong south and southwest winds which produce thick dust as they pass over the desert. The Khamseen may be accompanied by high temperatures, especially in April and May. Generally, however, temperatures at Port Said rise slowly in the spring because of the surrounding waters.

In the summer, conditions are relatively uniform, with nearly 100 percent sunshine each day, a cooling sea breeze and an absence of rain. In spite of high humidity at low levels in the atmosphere, rain almost never occurs from June through September.

Because the Mediterranean waters cool slowly, summer conditions of continued sunshine and warm temperatures persist well into the autumn. The first winter storm usually occurs in mid-November.

Not only are temperatures moderate and rainfall light, but air quality in Port Said is acceptable almost year-round. The wind is chiefly from the northwest and southwest in winter and from the northwest to northeast in summer.

1.3 LAND RECLAMATION

Because the Project Area is narrowly confined by waters, future development will depend on creation of additional land. The Port Said Urban Land Reclamation Study (September 1978), conducted by Golder Associates, provides plans for reclaiming some 1,210 hectares (ha) of land to the south and west of the present urban area (Figure 1-B).

The Ministry of Irrigation has developed plans to drain and reclaim for agricultural use some 66,000 ha from Lake Manzala. Major reclamation areas will extend from Port Said south to Qantara and from El Gamil west to Damietta.

1.4 GEOLOGY AND SUBSURFACE CONDITIONS

Based on subsurface conditions, the WWFMP Project Area may be divided into three regions (see Figures 1-B and 1-C):

1) The original shoreline or sand bar separating the lakes and the sea at the time the Suez Canal was built.

2) The extensive beach deposits which have accreted behind the breakwaters protecting the approaches to the Suez Canal.

3) Developed areas of Port Said and Port Fouad south of the original sand bar. These areas are covered by sandy fill drawn from the Canal and harbor excavations. Underlying the fill is a thin layer of soft "surface" clay increasing in thickness from near zero adjacent to the original bar to about 1 m at the southern end of the built-up areas.

In the proposed urban land reclamation areas and borrow areas to the south and west of the existing city, surface deposits of the same soft clay increase in thickness from about 0.2 m in the north to as much as 3 m in the south.

According to a report prepared for the WWFMP by Mr. L. W. Tunbridge, a geotechnical consultant familiar with the work of Golder Associates, the deposits beneath the surface of the Project Area are quite uniform. The subsurface consists of a 4 to 12 m stratum of compact-to-dense, medium-to-fine sand covering a "lower" clay extending some 50 m below the present ground level, and resting on an ancient Nile Delta surface of stiff clay and/or dense sands.

The compact-to-dense fine sand has a clearly defined upper boundary and its thickness, at borehole locations, averages about 7 m. The sand grades through a relatively thinly layered transition zone into the firm-to-stiff "lower" clay. Although the clay is overconsolidated, it is subject to significant secondary settlement under sufficient loading conditions. This "lower" clay was laid down under marine conditions over the past several thousand years. Originally, the clay was probably deposited in front of the Nile Delta beach head. Then, as the delta advanced, the soils became coarser grained until, ultimately, sand was deposited on the lower clay over the entire Project Area. The sand bar that separates Lake Manzala and El Mallaha from the Mediterranean Sea is part of the sand stratum. This narrow sand bar, which forms part of the land surface in Port Said and Port Fouad, has moved northward to its present position under the combined effects of sediment deposition, regional subsidence, littoral deposition and erosion. A surface clay deposit behind the sand bar has accumulated from sediments brought down by the Nile.

The geology, soil structure, and high groundwater level in the Project Area will not preclude construction of proposed wastewater facilities. Appendices A and B point out subsurface features which require special consideration in establishing design criteria and construction costs.

1.5 GROUNDWATER

Above the "lower" clay, the groundwater level averages about +0.5 m, reflecting the Lake Manzala elevation. In the building areas of Port Said, water levels are generally 0.5 to 1.5 m below the ground surface. The groundwater is saline and contains high concentrations of sulfate and chloride.

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TABLE I.I

CLIMATIC DATA, PORT SAID

	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
Average Maximum Temperature °C	18.8	19.3	21.3	23.6	26.5	29.3	31.3	31.8	30.6	28.7	25.1	20.7
Average Minimum Temperature °C	10.6	11.2	13.3	15.7	18.6	21.5	23.2	23.8	22.8	21.1	17.6	12.1
Mean Temperature °C	14.7	15.3	17.3	19.7	22.6	25.4	27.3	27.8	26.7	24.9	21.4	16.4
Highest Temperature Recorded °C	29.0	33.1	38.0	40.4	43.0	43.9	38.1	37.2	40.1	37.6	36.5	29.8
Lowest Temperature Recorded °C	3.0	2.3	2.7	9.2	10.2	14.2	19.0	20.6	17.5	13.0	6.3	0.0
Average Relative Humidity %	72	69	67	69	70	71	72	72	69	68	71	72
Most Frequent Wind Direction and % Occurrence	WSW 19.5	WSW 14.0	W 14.7	N 19.9	N 31.2	N 33.5	NNW 30.7	NNW 31.5	N 35.7	N 25.7	NNE 17.9	WSW 18.9
Average Wind Speed km/hr	17.6	19.5	21.5	19.8	17.8	16.7	15.9	14.1	13.9	14.8	15.8	15.6
Frequency of Wind over 63.3 km/hr, days	0.1	0.6	0.6	0.2	0.1	0	0	0	0	0	0.1	0.3

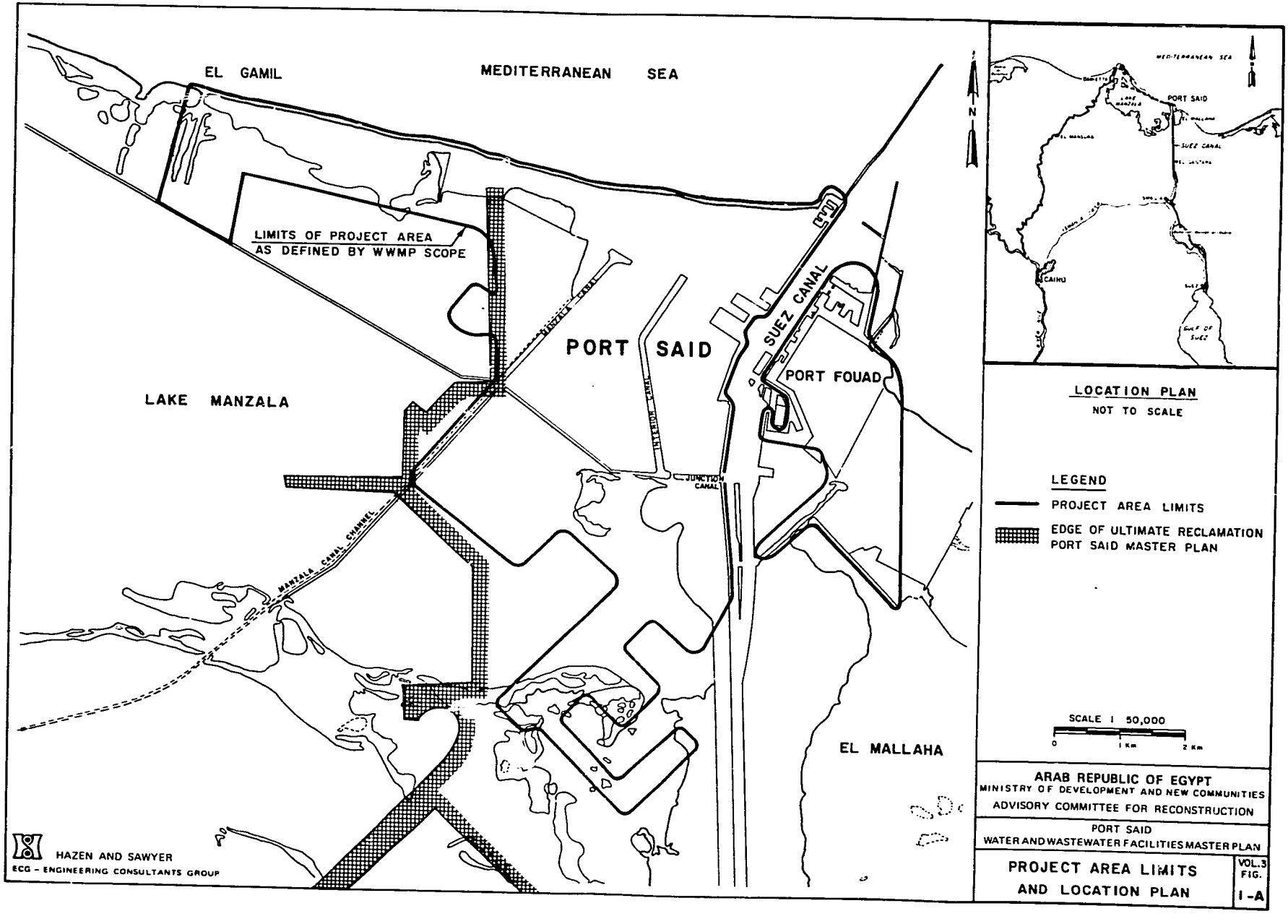
Source: MOHR, Port Said records for 1941-75.

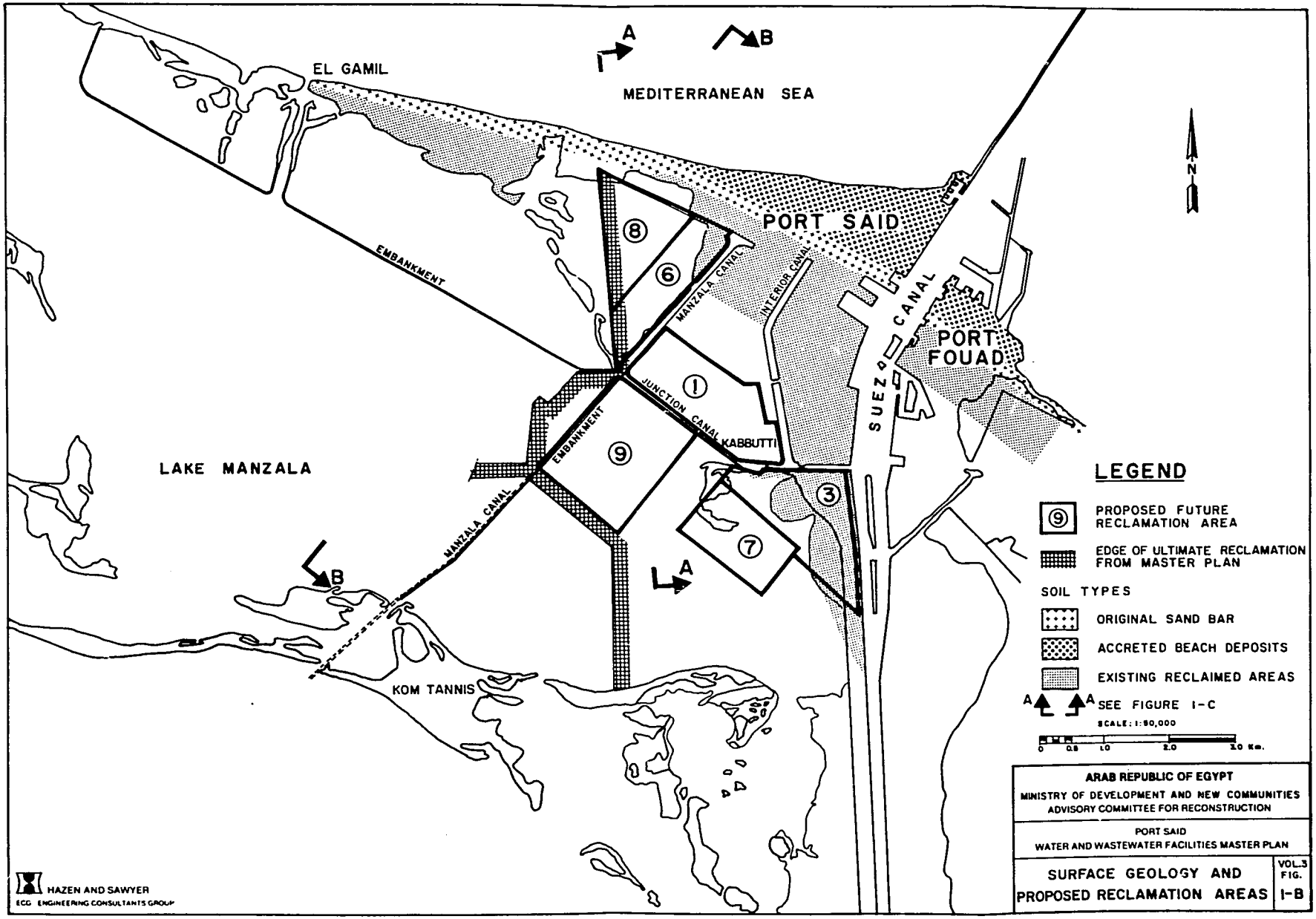
TABLE 1.2

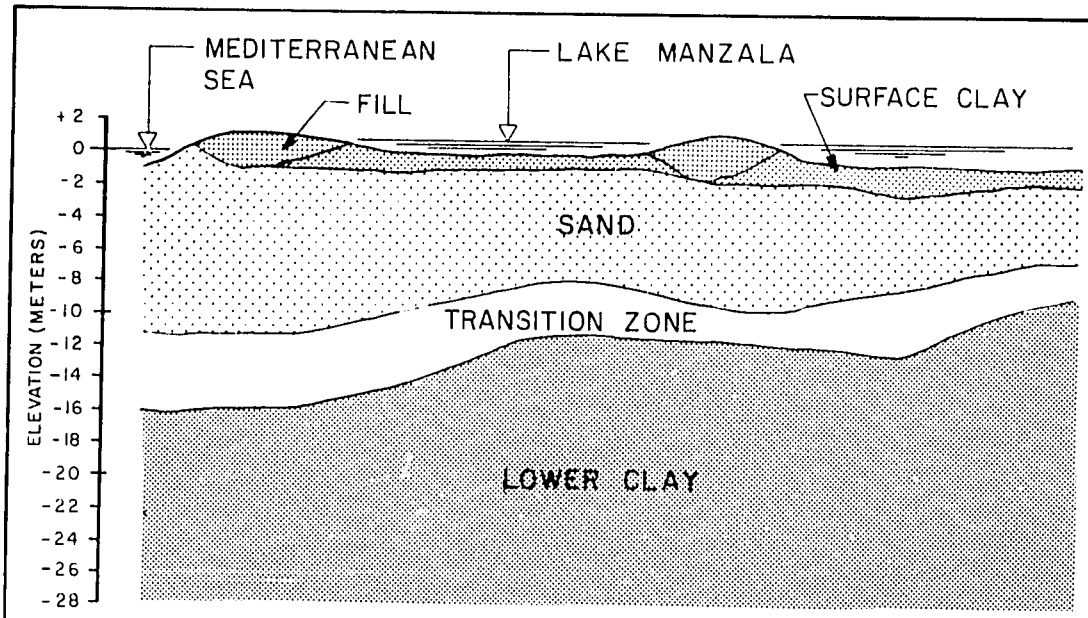
RAINFALL DATA, PORT SAID

	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	TOTAL
Average Rainfall, mm	12.4	11.3	8.5	2.7	2.6	trace	0	trace	0.2	7.3	9.1	17.6	71.7
Max. Recorded Rain in One Day, mm	11.6	15.3	10.9	22.8	19.5	trace	0	trace	5.4	39.6	18.0	47.7	
Number of Days with Rain													
0.1- 1.0 mm	6.6	5.3	4.9	1.3	1.0	0	0	0	0.1	1.9	3.8	5.6	
1.1- 5.0 mm	3.0	2.8	2.4	0.5	0.3	0	0	0	0	1.0	1.9	2.5	
5.0-10.0 mm	0.9	0.5	0.5	0.2	0	0	0	0	0.1	1.0	0.8	0.8	
10.0 mm +	0.2	0.1	0.1	0.1	0.1	0	0	0	0	0.2	0.2	0.4	
Average Total of Days with Rain	10.7	8.7	7.9	2.1	1.4	0	0	0	0.2	5.1	6.7	9.3	52.1

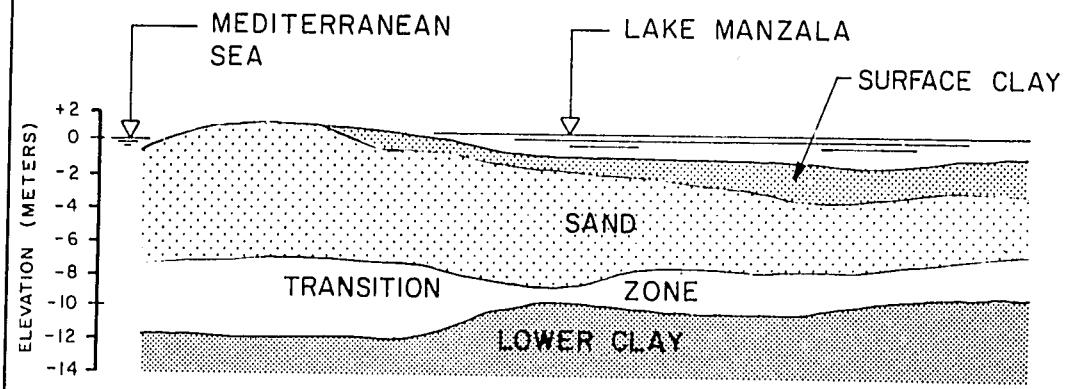
Source: MOHR, Port Said records for 1941-75.


EL GAMIL
MEDITERRANEAN SEA
LIMITS OF PROJECT AREA
AS DEFINED BY WWMP SCOPE
PORT SAID
SUEZ CANAL
PORT FOUAD
LAKE MANZALA
INTERIOR CANAL
JUNCTION CANAL
MANZALA CANAL CHANNEL
EL MALLAHA
N
HAZEN AND SAWYER
ECG - ENGINEERING CONSULTANTS GROUP
LOCATION PLAN
NOT TO SCALE
LEGEND
PROJECT AREA LIMITS
EDGE OF ULTIMATE RECLAMATION
PORT SAID MASTER PLAN
SCALE 1 50,000
0
1 Km
2 Km
ARAB REPUBLIC OF EGYPT
MINISTRY OF DEVELOPMENT AND NEW COMMUNITIES
ADVISORY COMMITTEE FOR RECONSTRUCTION
PORT SAID
WATER AND WASTEWATER FACILITIES MASTER PLAN
PROJECT AREA LIMITS
AND LOCATION PLAN
VOL.3
FIG.
1-A


EL GAMIL
MEDITERRANEAN SEA
A
B
PORT SAID
EMBANKMENT
MANZALA CANAL
INTERIOR CANAL
SUEZ CANAL
PORT FOUAD
JUNCTION CANAL
KABBUTTI
EMBANKMENT
LAKE MANZALA
MANZALA CANAL
KOM TANNIS
N
LEGEND
PROPOSED FUTURE RECLAMATION AREA
EDGE OF ULTIMATE RECLAMATION FROM MASTER PLAN
SOIL TYPES
ORIGINAL SAND BAR
ACCRETED BEACH DEPOSITS
EXISTING RECLAIMED AREAS
SEE FIGURE I-C
SCALE: 1:50,000
0 0.5 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
SURFACE GEOLOGY AND PROPOSED RECLAMATION AREAS
VOL.3 FIG. I-B
HAZEN AND SAWYER
ECG ENGINEERING CONSULTANTS GROUP



SECTION A-A



SECTION B-B

SOURCE OF DATA: GOLDER ASSOCIATES

SCALE: 1:40,000

0 0.5 1.0 2.0 Km.

HAZEN AND SAWYER

ECG ENGINEERING CONSULTANTS GROUP

ARAB REPUBLIC OF EGYPT

MINISTRY OF DEVELOPMENT AND NEW COMMUNITIES

ADVISORY COMMITTEE FOR RECONSTRUCTION

PORT SAID

WATER AND WASTEWATER FACILITIES MASTER PLAN

GEOLOGICAL CROSS-SECTIONS

VOL.3 FIG. 1-C

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CHAPTER 2

SOCIO-ECONOMIC SETTING

2.1 EXISTING DEVELOPMENT

Population

In 1976 the population of the Port Said urban core, including Port Fouad and the Kabbutti fishing village, was estimated at 262,620 people by the Central Agency for Public Mobilization and Statistics (CAPMAS), as shown in Table 2.1. This represented a decrease of more than 20,000 persons from the population prior to the 1967 war, estimated by CAPMAS at approximately 283,000 persons in 1966.

Approximately 94% (245,942) of the 1967 population lived in Port Said (Census Tracts 1 through 9, 11 and 12 on Figure 2-A), including an estimated 12,000 people in Kabbutti. The remaining 6% (16,678) of the population resided in Port Fouad (Census Tract 10).

The Port Said Master Plan (PSMP), completed in 1975, estimated the total population at 343,000 people. This figure exceeds the 1976 census by about 31% (80,400). Social surveys of the El Arab shiaka (census tract) conducted by the Port Said Demonstration Project in 1977 indicated that the actual population was very close to the 1976 census figure.

Based on the 1976 census, the 1977 surveys, and an analysis of new housing units constructed, the Water and Wastewater Facilities Master Plan adopted a December 1977 base population estimate of 273,000. Population gains from in-migration are expected to exceed natural increases and consequently overshadow the significance of any difference in the base population for projection purposes.

Economy and Employment

The economy of Port Said is only now returning to the levels of activity which existed before the 1967 war. In 1966 the labor force was approximately 27% (77,000) of the population (283,000), with 2.5% (7,000) unemployed. The tertiary sector of the economy (service, trade, transportation/communications and port activities) supplied some two-thirds of the jobs (49,700), with industry providing 11,000. Fishing and agriculture accounted for 4,900 jobs. A total of 4,500 jobs were in building, construction and utilities. The port itself provided direct employment in shipyards, loading, and warehousing, along with indirect jobs in import/export, customs and recreational facilities. Port Said's designation as a Free Zone in 1976 resulted in increased overall economic activity, particularly in the port area.

Tourism was for many years a major source of economic activity in Port Said. The port was an entry point for passengers and crews from vessels passing through the Canal. Domestic tourists seeking relief from the summer heat of inland cities were attracted to the seaside location. Since the return of population and the reopening of the Canal after the 1973 war, tourism has revived but with a much higher proportion of domestic visitors on day trips. This change reflects both a decline in ship cruises and a response to expanded shopping opportunities following establishment of the Free Zone.

Commercial fishing is centered in Lake Manzala and the Mediterranean, with a minor amount in the Suez Canal. Lake Manzala accounts for 75% of the production of the northern Egyptian delta lakes and more than 26% of the national fish catch. The major Lake Manzala fishing station is located at El Matariya on the southwestern shore of the lake. This station is supplemented by the fishing village at Kabbutti. Fish ponds border Lake Manzala.

Agricultural activity is limited by the dearth of suitable land. Some areas between the Port Said/Ismailia road and the Port Said Canal (PSC) are irrigated, taking water from the PSC. In the absence of adequate drainage, farming in this area is marginal at best.

Land Use

The urban core consists of three kisms (large census tracts): El Manakh, El Arab, and El Shark, which occupy approximately 1,600 hectares (ha), including some 600 ha of water and marginal land (see Table 2.1 and Figure 2-A). At present, 90% of the habitable 1,000 ha is developed.

El Manakh kism, with the largest population of the three kisms, is characterized by medium residential densities (600-800 people/ha). Public housing areas in El Manakh are nearly devoid of commercial services and public amenities.

El Arab kism contains three distinct residential areas: the north (300 persons/ha) overlooking the Mediterranean coast; the local El Arab district (1,500 persons/ha); and the public housing districts (1,000 persons/ha) constructed during the past 15 years. Many governmental/institutional uses and a growing number of manufacturing facilities are also in the area. Industrial uses include small workshops employing less than 10 people, found in residential/commercial areas, and larger scale industries (food processing, textile production and cold storage) along the barge canals.

The Kabbutti fishing village, located in the southwestern corner of El Arab kism, is physically isolated from the other Port Said residential uses by industries adjoining the Interior Canal. Approximately 12,000 people are housed in the village. Residential densities are relatively low (400 persons/ha), primarily because structures in the village are one-story.

El Shark kism, established as the foreign quarter during canal construction, is the prime residential, business and tourism center. Buildings are larger, streets wider and open space greater than in the rest of Port Said. Residential densities in El Shark kism are low, ranging from 150 persons/ha in the northeast to 650 persons/ha in the southwest. Most industrial land uses, primarily cargo handling and vessel servicing facilities, are concentrated in this kism. Cold storage, distribution and light manufacturing operations in El Shark have increased in number since the establishment of Port Said as a Free Zone in 1976.

Port Fouad, a subtract of the El Shark kism, occupies 173 ha (6.4%) of the urban core. Population densities (140-350 persons/ha) are lower in Port Fouad than in most of Port Said. Most residences are three stories, with considerable open space. Streets provide ample room for vehicles. Industrial uses in Port Fouad are limited to the shipyard, small craft repair facilities and warehousing.

2.2 FUTURE DEVELOPMENT

Population

The PSMP projected a year 2000 population of 750,000 people for the Port Said Project Area, which includes the urban core and the proposed El Gamil fishing villages (see Table 2.2). The ultimate holding capacity of the Project Area was estimated at 766,000 people, based upon existing and proposed land use patterns.

Estimates developed for the Water and Wastewater Facilities Master Plan (WWFMP) are based on a lower estimated ultimate holding capacity of 684,000 persons. This reduction of approximately 82,000 persons reflects two specific land use adjustments:

- Continued expansion of Free Zone industrial activity into planned residential areas near the existing port (Area I on Figure 2-B), which reduces the projected population in this area from 100,000 (PSMP estimate) to 5,000 people.

- Development of approximately 22 ha of land in Port Fouad (which the PSMP had shown as already developed) to accommodate an additional 13,300 persons.

The WWFMP assumes that this adjusted capacity of 684,000 people will be reached by the year 2000, which was the PSMP target year. Adjusted population estimates for five-year intervals from 1980 to the year 2000 are shown in Table 2.2, along with the original PSMP projections.

The absolute annual increases estimated in the WWFMP follow closely those in the PSMP. Both population growth estimates are closer to arithmetic series than geometric, with annual increases in the range of 17,000 to 19,800 from 1980 on. The overall population added from 1976 to 2000 is estimated at 422,000 in the WWFMP, only slightly higher than the 408 in the PSMP. The key point is that by controlling development (new land creation, infrastructure installation and housing) in Port Said, the government can limit in-migration and hence population growth.

Economy and Employment

The WWFMP has revised the PSMP employment projections to reflect the population and land use adjustments. As shown in Table 2.3, the estimated labor force is the same percent of the population as in the PSMP. Each category of employment represents virtually the same percent of the labor force as in the PSMP, except that: 1) tertiary sector jobs are reduced due to the possibility of lower port employment; 2) industrial sector employment is increased to eliminate the structural unemployment forecast in the PSMP and to make up for the reduction in tertiary sector employment.

Reductions in tertiary sector employment allow for the possible location of the new national port elsewhere than in Port Said (see "Land Use", below). Installation of this port at Port Said was a premise of the PSMP projections. Since other locations are being seriously considered, it is not prudent to assume this employment for Port Said. The WWFMP allows instead for equivalent employment in the industrial sector.

Based on the PSMP port employment figures shown in Table 2.4, potential reductions in tertiary sector employment were estimated as follows:

Year	Reduction
1980	1000
1985	2000
1990	4000
2000	8800

These estimates assume that if the new port is located elsewhere, port-related employment at Port Said would remain at the 1980 levels for the old port (Table 2.4).

The PSMP forecast structural unemployment of 12% in 1985, decreasing to 8% in 1990 and 1% by the year 2000 (Table 2.3). However, it would be unwise to base wastewater planning on built-in unemployment. Lack of adequate wastewater facilities could itself serve as a brake on economic growth. Once an adequate system is planned, its installation schedule can be stepped up or slowed down to meet developing growth needs.

Additional employment most beneficial to the local economy would be in manufacturing or tertiary sector activities, including the port, to provide products or services to markets beyond Port Said, bringing added income to the local economy. In the absence of definite plans for port expansion, the WWFMP assumes expansion of industrial areas sufficient to provide the jobs needed to eliminate structural unemployment. Statistics are not available to project with certainty future employment from industrial growth. However, encouraging reports of new ventures indicate Port Said's success in attracting investment, especially to the Free Zone.

Based on the WWFMP adjustments, employment in the tertiary sector should account for 53% of all jobs by the year 2000, as shown in Table 2.3, falling below PSMP projections because of lowered port activity. But rapid industrial growth and reduced population capacity could lead to a labor shortage, with 7,000 unfilled jobs in the year 1990. Further industrial development from 1990 to 2000 would continue this shortage at approximately the same rate.

Anticipated tourism employment levels depend on the designation of adequate land for the hotel/casino complex along the Mediterranean beachfront west of Mazrah (see "Land Use", below). In addition, high water quality must be maintained in the Mediterranean, Lake Manzala and barge canals to permit recreational use.

Fishing employment could decline if fishing yields from Lake Manzala are reduced by overfishing and proposed agricultural reclamation (about 19% of the lake area). A fisheries management program would maximize yield and jobs. However, a shortfall in fishing employment could be expected until the effects of such a program are felt.

Land Use

Major land use changes proposed by the PSMP were based on complete development of the existing 1,000 ha of dry land and reclamation of approximately 2,370 ha of additional land for residential, industrial and some agricultural uses. The WWFMP has adjusted land use for the Project Area (Figure 2-B), based on recent construction activities and planning revisions. These include a reduction in the amount of land to be reclaimed by the year 2000 from 2,370 ha to 1,210 ha (Golder Associates, September, 1978, cited in Section 1.1). Major PSMP land use changes and the adjustments to each in the WWFMP are summarized below.

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New Port

The PSMP proposed construction of the new national port at Port Said. Adjustment: The new port will probably be built in Damietta, not Port Said. However, existing cargo handling capacity will be increased to approximately 4 million dead weight tons/year (in area 1, adjacent to the Suez Canal on Figure 2-B).

Road/Rail Corridor

A regional road/rail corridor was proposed to link Port Said to El Matariya and the Eastern Delta and Canal Cities. Adjustment: Assuming that the new port is not built at Port Said and that widening of the existing Port Said/Ismailia Road is completed, the road/rail corridor (area 5 on Figure 2-B) can be postponed until the year 2000 (see "Transportation" in Section 2.3).

Fishing Villages

Construction of a new fishing village at El Gamil, to replace the Kabbutti fishing village, would begin in 1981, with a 1990 target population of 22,900 people. The site of the existing Kabbutti village would be part of a major urban park (area 4 on Figure 2-B). Adjustment: Start of construction of the new fishing village will be delayed until 1986. However, the 1990 population goal should be met, completing the relocation of the Kabbutti community.

Hotel/Casino Complex

A new hotel/casino complex would be built along the Mediterranean beachfront west of the Port Said breakwater (area 3 on Figure 2-B). Adjustment: The 65 ha of land proposed for development by the PSMP does not really exist and could not realistically be reclaimed. Most hotel/casino facilities may have to be located west of Mazrah, displacing some camping and day use recreational facilities.

Urban Blocks

New urban "blocks" (700 to 750 persons/ha), several stories high, with residential units above ground floor commercial establishments, would be developed in Port Said. Adjustment: As noted earlier, the Free Zone has stimulated industrial development which intrudes on the planned residential areas (area 1 on Figure 2-B). Because of the new industrial activity and the retention of existing port facilities, urban "blocks" cannot be developed between the port and the Interior Canal. This area could house only 5,000 instead of the planned 100,000 persons. Port Fouad can accommodate an additional 13,300 persons (350 to 750 persons/ha) on 22 ha of undeveloped land (area 2 on Figure 2-B). The PSMP had assumed that this land (two parcels) was already developed. In fact, it represents future residential development capacity.

Industrial Parks

New industrial parks (estates) would be developed on 440 ha adjacent to the proposed new port facilities and in the planned road/rail corridor. Adjustment: Most of the 440 ha of industrial parks will be developed on land near the existing port facilities (see Table 2.6 and Figure 2-C). However, up to 20% of industrial development is scheduled for reclaimed land. Both types of development will require careful coordination with wastewater planning.

Reclaimed Land

The PSMP proposal for reclamation of 2,370 ha of land included areas to the south related to the proposed new port and transportation corridor. Adjustment: As noted above, the new port and road/rail corridor are unlikely to be developed before the year 2000. Potential land proposed to be reclaimed for a section of the planned urban park (area 6 on Figure 2-B), adjacent to the proposed road/rail corridor, will not be reclaimed.

Reclaimed land and fisheries in El Mallaha adjacent to Port Fouad, as well as existing land on the east side of the Suez Canal, are required by the Suez Canal project now in progress. The Suez Canal Authority is currently widening the Canal, with a new exit to be provided east of Port Fouad (Section 1.1).

A 29 ha area just east of the Mazrah treatment plant (designated as 8A in the small map on Figure 2-C) was included in the reclamation proposals of Golder Associates. This low-lying area, already cut off from Lake Manzala by the road to the refuse fill near Mazrah, is a logical addition to the proposed adjacent reclamation area.

Housing Construction

Housing construction was anticipated by the PSMP to proceed at a rate of 5000 units per year, beginning in 1976. Adjustment: Because of start-up problems, this rate is not expected to be reached until 1981. Furthermore, the phasing of residential development (Figure 2-C) will depend on the reclamation schedule and the provision of utilities. It is assumed that approximately 370,000 people will be located on reclaimed land by the year 2000. Population distribution in the Project Area (Table 2.5) is based on the adjusted holding capacity (684,000 persons) and existing density patterns.

2.3 INFRASTRUCTURE

Effect on Public Health

Present unreliability of the potable water supply and breakdowns of the wastewater collection system are responsible for significant public health problems in Port Said (see Tables 2.7 and 2.8). These include water supply related communicable diseases which result from lack of adequate disinfection and/or contamination from indirect cross connections or back siphoning.

Water Supply

The raw water supply to Port Said is under the control of the Ministry of Irrigation (MOI). The remainder of the public water system is the responsibility of the Suez Canal Authority (SCA), which constructs, operates and maintains the facilities. User charges are billed and collected by SCA, but cover only a portion of operating costs.

Wastewater Collection and Disposal

Sewers, pumping stations, force mains and treatment facilities are constructed by the General Organization for Sewerage and Sanitary Drainage (GOSSD). The wastewater facilities are operated by the Sewer Department of the Governorate of Port Said (GOPS). Sewer connections and house lateral construction are also the responsibility of GOPS. Major lateral extensions and connection to serve new public housing areas are handled as part of the GOPS housing construction program. Information on the present wastewater system is detailed in Chapters 6, 7 and 8.

Storm Drainage

Storm drainage is the responsibility of the GOPS. Although rainfall in Port Said is infrequent (Table 1.2), brief intense storms do occur. The existing sanitary sewer system is inadequate to handle storm flows. In current construction areas, storm water is excluded from sanitary sewers.

A surface system of transport gutters to open space storage and disposal areas is planned. However, a thorough study of storm drainage problems is needed before detailed designs are begun.

Solid Waste (see Appendix C)

Port Said is divided into eight zones for refuse collection. In two zones, collection is handled by private collectors with donkey carts. The operation is door-to-door and collection costs are paid by the individual customers. In the remainder of the city, refuse is collected by GOPS employees, hauled to intermediate sites, and later transferred to landfills operated by the GOPS. Pick-up at the intermediate sites often takes several days, creating unsanitary conditions in some areas of the city.

The present landfills and intermediate dumping sites are improperly operated. Their proximity to residential areas creates an unacceptable public health hazard. Leaching from these sites and the potential for degrading water quality in nearby areas should be considered in planning future solid waste disposal methods.

Fire Protection

Purchase, installation and maintenance of fire hydrants, along with staffing and equipping the fire department, is another major responsibility of the GOPS. The SCA is responsible for providing adequate water for fire flows and installing line tees for hydrant connections. Ground level hydrants presently in service are subject to damage and are a potential source of water supply contamination.

Electricity

Basic responsibility for electrical power supply in Port Said rests with the Egyptian Electricity Authority (EEA), which operates a new 43 MW turbine power station and a diesel power station of about 9 MW capacity. The SCA operates its own power station, providing 7,140 kilovolt-amperes (KVA) to serve the El Raswa Water Treatment Plant and SCA workshops in Port Said and parts of Port Fouad.

The EEA plans to interconnect the power stations in Port Said with the national supply grid. One 220 KV, double-circuit transmission line running from Suez to Port Said via Ismailia and El Qantara is scheduled for completion in June 1979. A similar line from Zagazig to Ismailia, and a main substation south of Port Said should be finished in 1980.

Transportation

Two ground transportation corridors connect Port Said to the rest of Egypt: the road and railway route southward to Ismailia, and the narrow coastal road westward to the eastern (Damietta) branch of the Nile. Both roads are currently being improved. Repair of the railway, which was damaged during the 1967 war, has been completed. Boat and ferry service from Port Said across Lake Manzala to El Matariya carries far less traffic than the

land corridors. Barge traffic on the Suez Canal transports heavy bulk material such as concrete aggregates. Air service to Port Said has been discontinued since the war period.

The new transportation corridor proposed in the PSMP was intended to meet long-term traffic needs for the port and the city, including more direct connections to Cairo and the Eastern Delta. The 1978 Suez Canal Regional Industrial Plan, predicting substantial spare capacity in the existing corridors to Ismailia, recommended postponement of the new corridor and improvement of the existing rail services and highways to Port Said.

The PSMP called for an arterial highway south of the Junction Canal that would link major industrial facilities and the main highway from the south to the Damietta highway. The right-of-way is only partially included (after 1990) in presently scheduled land reclamation. An arterial highway is needed along the north side of the Junction Canal, connecting to the proposed arterials along the new lakefront near Reclamation Areas 6 and 8 (Figure 2-C).

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TABLE 2.1

EXISTING POPULATION AND DENSITY

Census Tracts(1) Kism/Shiaka	Population(2) (November 1976)	Gross Area hectares (ha)	Gross Density (people/ha)	Residential Use (ha)	Residential Density (people/ha)
El Manakh	123,649	663.4	150-1850	—	600-800
1. El Saroya	15,684	8.8	1,782	8.8	1780
2. El Adly	15,731	16.4	959	13.0	300-1500
3. El Gallaa	38,812	308.1	126	49.7	550-1000
4. El Manakh(3)	53,422	330.1	162	78.9	700
El Arab	78,009	383.0	500	—	1500
5. El Abbasey	10,705	25.2	425	14.6	1500
6. Abu El Hassan	11,588	15.1	767	11.0	300-1500
7. Al Taiofiki	10,129	22.0	460	18.5	300-1500
8. Montozet Sand	22,129	30.9	716	25.8	1500-300
9. El Arab(4)	22,641	289.8	78	40.7	400-1000
El Shark	60,962	553.6	100-300	—	300-600
10. Port Fouad	16,678	173.1	96	91.5	140-350
11. Ibrahim Hasson(5)	17,654	97.0	182	76.3	150-275
12. Mostofa Hamza(6)	26,630	283.5	94	50.6	275-650
Total or Average	262,620	1,600.0			

(1) See Figure 2-A for location of census tracts.
(2) Central Agency for Public Mobilization and Statistics (CAPMAS), November, 1976.
(3) Western edge of kism/limits of Mazrah property (airport excluded).
(4) Includes Kabbutti fishing village.
(5) Includes port area.
(6) Includes area now used by military.

TABLE 2.2

ADJUSTMENTS TO FUTURE POPULATION

Year	Original Projection		Adjustment	
	PSMP	Increase per year	WWFMP	Increase per year
1975	343,000	-	-	-
1976(1)	-	8,300	262,600	9,500
1977	-	-	273,000	10,700
1980	384,400	17,300	305,000	17,000
1985	470,800	18,000	390,000(2)	19,400
1990	560,500	18,700	487,000	19,600
1995	653,000	19,200	585,000	19,800
2000	750,000		684,000	

(1) November 21/22 Country-Wide Census.
(2) PSMP adjusted for 5 year lag.

TABLE 2.3

ADJUSTMENTS TO FUTURE EMPLOYMENT

	1980		1985		1990		2000	
	PSMP	WWFMP	PSMP	WWFMP	PSMP	WWFMP	PSMP	WWFMP
Population	384,000	305,000	471,000	390,000	560,000	487,000	750,000	684,000
Labor Force	114,000	93,000	151,000	116,000	184,000	154,000	266,000	229,000
Labor Force/Population	30%	30%	32%	32%	33%	33%	35%	35%
Unemployment(1)	10,000	-	18,000	-	15,000	-	3,000	-
Unemployment/Labor Force	9%	-	12%	-	8%	-	1%	-
Employment	104,000	92,000	133,000	116,000	169,000	161,000	263,000	239,000
Tertiary(2)	64,000	56,000	80,000	59,000	101,000	82,000	161,000	127,000
Industrial(3)	15,000	13,000	22,000	33,000	32,000	45,000	56,000	69,000
Construction	12,000	11,000	12,000	9,000	13,000	11,000	19,000	17,000
Fishing, Agriculture	9,000	8,000	14,000	11,000	17,000	17,000	19,000	19,000
Utilities	4,000	4,000	5,000	4,000	6,000	5,000	8,000	7,000
Percent of Total Employment in:								
Tertiary(2)	56	61	53	51(4)	55	51(4)	61	53(4)
Industrial(3)	12	14	15	29(5)	18	28(5)	21	29(5)
Construction	11	12	8	8	7	7	7	7
Fishing, Agriculture	8	9	9	9	9	11	7	8
Utilities	4	4	3	3	3	3	3	3
Unemployed	9	0	12	0	8	0	1	0
	100	100	100	100	100	100	100	100

(1) Average
(2) Service, trade, port, transportation/communications.
(3) Includes Free Zone and Non-Free Zone
(4) Reduced by following amounts to allow for possible location of new national port elsewhere than Port Said: 1985 - 2%; 1990 - 3%; 2000 - 4%
(5) Increased to eliminate structural unemployment.

Source: Port Said Master Plan, Vol. 1, Table 6.3; PSMP Vol. 4, p. 175.

TABLE 2.4

PSMP PROJECTION OF PORT RELATED EMPLOYMENT

	1980		1990	2000
	Old Port	New Port	New Port	New Port
In The Port				
1. Management Offices	200	50	250	300
2. At Breakbulk Berths	2,500		3,550	5,000
3. At Bulk Cargo Berths	50		150	150
4. At Container Berths		500	750	1,000
5. At Roll On - Roll Off Berths			75	75
Port Warehousing	230	20	425	750
Suez Canal Authority	1,400		1,500	1,500
Customs and Security	450	50	750	1,000
Bunkering	150	50	250	400
Shipping Services	300	50	500	800
Mariners	1,700	300	3,000	5,000
	6,980	1,020	11,200	15,975

Shipyard employment excluded.

Source: PSMP, Vol. 5, p. 101

TABLE 2.5

POPULATION DISTRIBUTION

WATER AND WASTEWATER FACILITIES MASTER PLAN
(Year-End Figures)

Area(1)	1976	1977	1980	1985	1990	1995	2000
A	233,900(2)	243,500	252,300	251,100	226,500	207,300	188,000
B	-	-	-	5,000	5,000	5,000	5,000
C	-	-	19,500	71,800	80,000	80,000	80,000
D	-	-	-	18,500	81,400	82,000	82,000
E	12,000(2)	12,000	12,700	14,100	-	-	-
F	-	-	-	-	17,000	48,700	48,700
G	-	-	-	-	16,400	71,000	76,300
H	-	-	-	-	-	23,600	68,300
I	-	-	-	-	-	-	62,700
J	16,700	17,500	17,500	17,500	17,500	17,500	17,500
K	-	-	3,000	12,000	12,000	12,000	12,000
L	-	-	-	-	8,500	8,500	8,500
M	-	-	-	-	22,900(3)	29,000	35,000
Total	262,600	273,000	305,000	390,000	487,000	585,000	684,000

(1) Location of each area shown on Fig. 2-C.
(2) Breakout of Kabbutti approximated by applying estimated densities to distinct areas.
(3) Assumes new fishing village built and existing Kabbutti converted to park use.

TABLE 2.6

ADJUSTED INDUSTRIAL AREA DEVELOPMENT
(Hectares, Year-End Figures)

	Amount of Land Required[3]					
Area[1]	1977[2]	1980	1985	1990	1995	2000
A	21	21	21	21	13[4]	13
B	-	29	135	191	205	205
D	-	-	-	40	40	40
E	32	32	32	32	32	32
F	-	-	-	8	8	8
G	-	-	-	-	40	40
I	-	-	-	-	-	11
M	-	-	-	44	44	44
N	-	-	-	-	-	7
O	-	-	-	-	17	40
Total[5]	53	82	188	336	399	440

(1) Location of each area shown on Figure 2-C.
(2) Specific area development follows the land reclamation study filling sequence.
(3) Estimated area requirements assume gross density of 100 employees per hectare. This density figure approximates PSMP Table 17.5, Volume I, average.
(4) Reflects relocation of boat works from head of Manzala Canal.
(5) Estimated total sufficient to permit industry to provide full employment.

TABLE 2.7

INCIDENCE OF PARASITIC DISEASES
(Number of Recorded Cases) (1)

Disease	1975	1976	1977
Schistosomiasis	2,622	2,017	2,126
Ancyclostomiasis	30	57	35
Ascariasis	5,329	5,426	6,486
Oxyuriasis	4,383	4,031	4,533
Heterophiasis	241	381	256
Amoebic Dysentery(2)	1,409	1,742	2,706

(1) Inadequacies in record keeping allow some multiple entries for the same individual.
(2) Dr. Hanne, Director of Preventive Medicine, Ministry of Health, Port Said, estimated that at least 50 percent of the population suffers from amoebic dysentery.

Source: Ministry of Health, Port Said

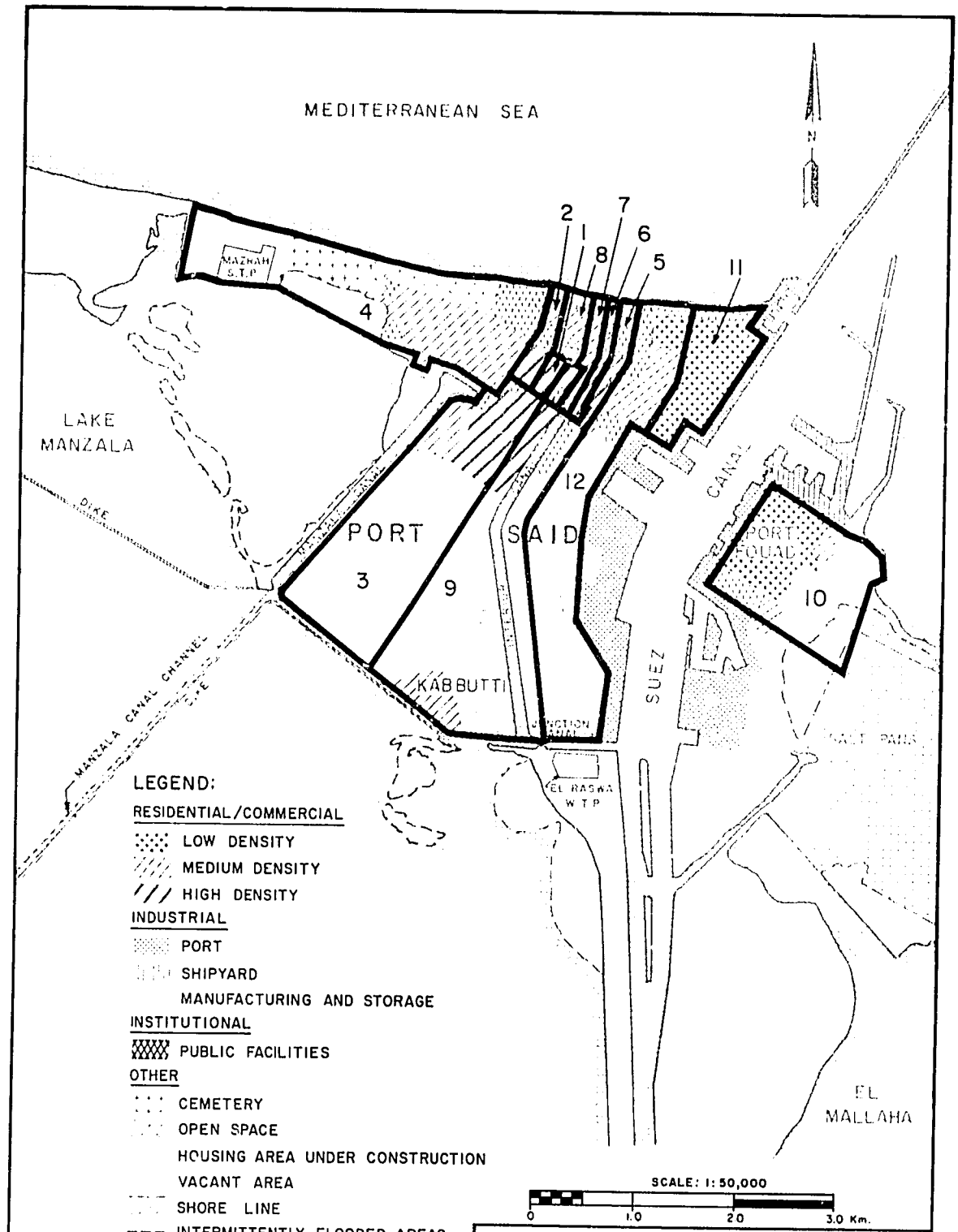
TABLE 2.8

INCIDENCE OF PROBABLE WATERBORNE COMMUNICABLE DISEASES
(Number of Recorded Cases) (1)

Disease	1974	1975	1976	1977	Jan-June 30 1978
Typhoid	75	23	37	15	5
Paratyphoid	11	14	29	17	10
Infectious Hepatitis	273	266	226	395	138
Bacillary Dysentery	0	6	8	19	3
Erisepelas	47	84	105	146	41

(1) Inadequacies in record keeping allow some multiple entries for the same individual.

Source: Ministry of Health, Port Said



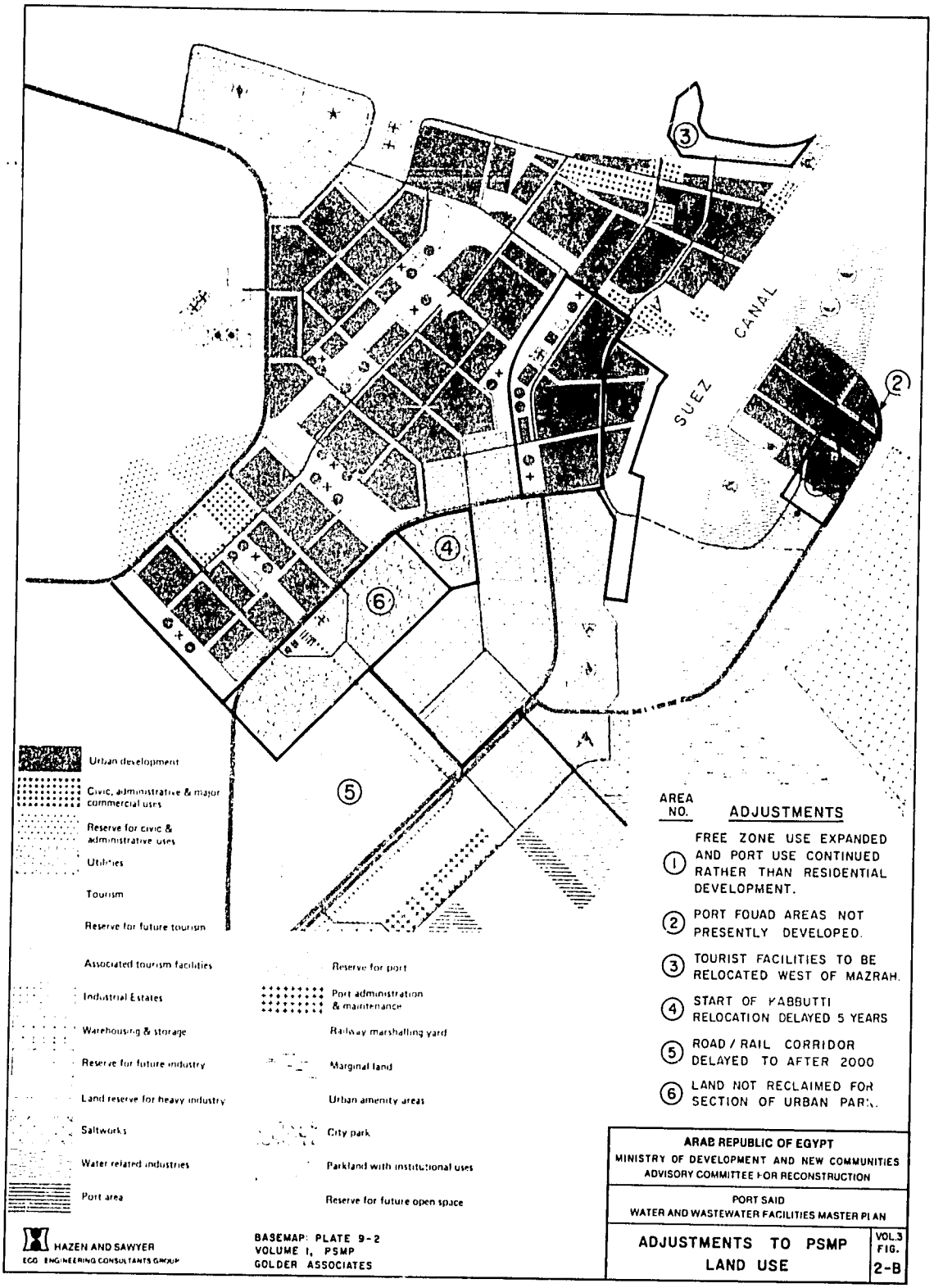
ARAB REPUBLIC OF EGYPT

MINISTRY OF DEVELOPMENT AND NEW COMMUNITIES
ADVISORY COMMITTEE FOR RECONSTRUCTION

PORT SAID
WATER AND WASTEWATER FACILITIES MASTER PLAN

PRESENT URBAN DEVELOPMENT

VOL.3
FIG.
2-A


SUEZ CANAL
1
2
3
4
5
6
Urban development
Civic, administrative & major commercial uses
Reserve for civic & administrative uses
Utilities
Tourism
Reserve for future tourism
Associated tourism facilities
Industrial Estates
Warehousing & storage
Reserve for future industry
Land reserve for heavy industry
Saltworks
Water related industries
Port area
Reserve for port
Port administration & maintenance
Railway marshalling yard
Marginal land
Urban amenity areas
City park
Parkland with institutional uses
Reserve for future open space
AREA NO.
ADJUSTMENTS
1 FREE ZONE USE EXPANDED AND PORT USE CONTINUED RATHER THAN RESIDENTIAL DEVELOPMENT.
2 PORT FOUAD AREAS NOT PRESENTLY DEVELOPED.
3 TOURIST FACILITIES TO BE RELOCATED WEST OF MAZRAH.
4 START OF KABBUTTI RELOCATION DELAYED 5 YEARS
5 ROAD / RAIL CORRIDOR DELAYED TO AFTER 2000
6 LAND NOT RECLAIMED FOR SECTION OF URBAN PARK.
HAZEN AND SAWYER
ECO ENGINEERING CONSULTANTS GROUP
BASEMAP: PLATE 9-2
VOLUME I, PSMP
GOLDER ASSOCIATES
ARAB REPUBLIC OF EGYPT
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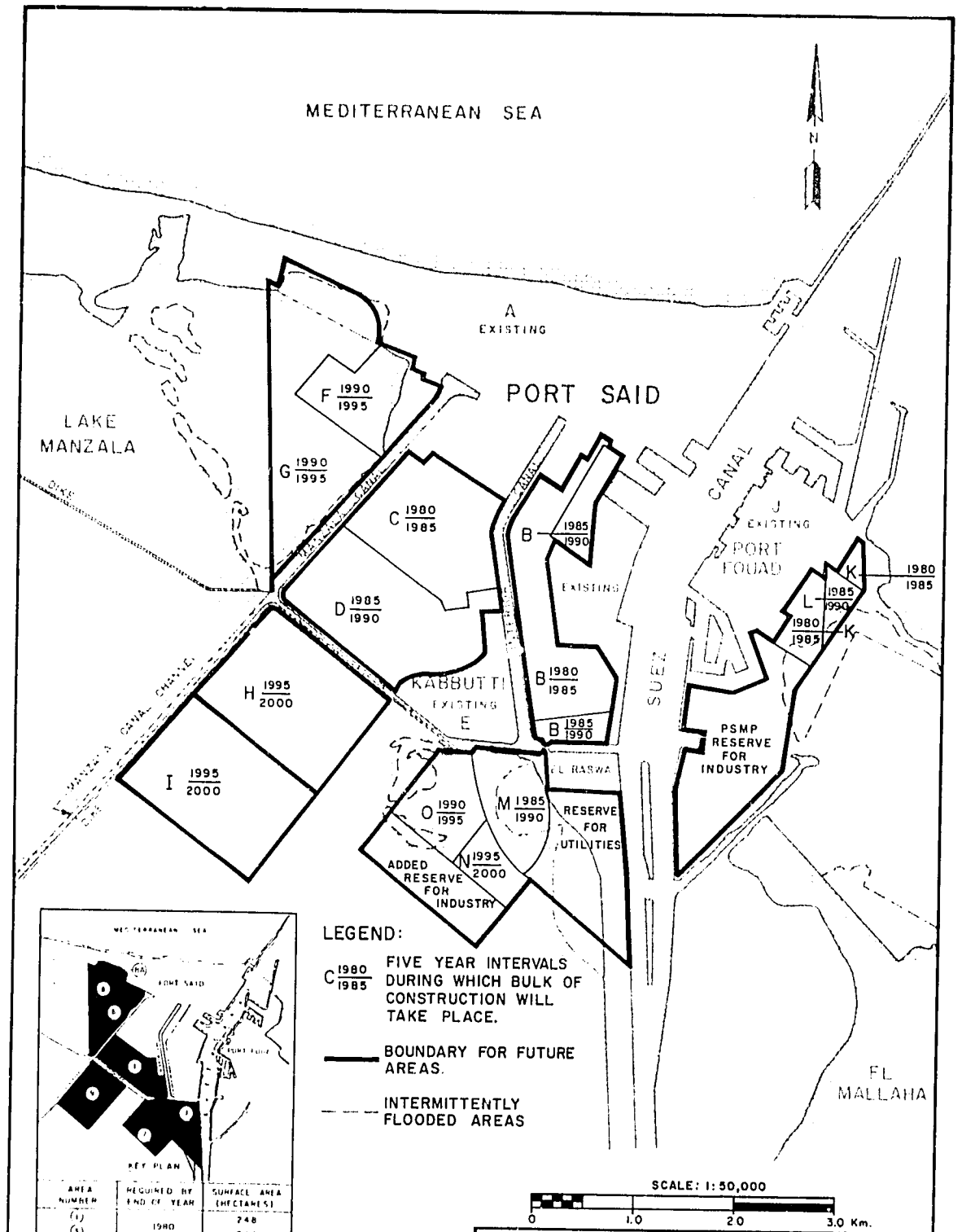
ADVISORY COMMITTEE FOR RECONSTRUCTION
PORT SAID
WATER AND WASTEWATER FACILITIES MASTER PLAN
ADJUSTMENTS TO PSMP LAND USE
VOL.3 FIG. 2-B



AREA NUMBER	REQUIRED BY END OF YEAR	SURFACE AREA (HECTARES)
(1)	1980	248
(3)		214
(4)	1985	172
(8) + (8A)		157
(7)	1990	159
(9)	2000	265

RECLAMATION AREA SCHEDULE
PORT SAID URBAN LAND
RECLAMATION STUDY,
GOLDER ASSOCIATES, SEPTEMBER 1978

HAZEN AND SAWYER
ECG - ENGINEERING CONSULTANTS GROUP

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

PORT SAID
WATER AND WASTEWATER FACILITIES MASTER PLAN

PHASING OF FUTURE AREA DEVELOPMENT

VOL. 3
FIG.
2-C

CHAPTER 3

NATURAL ENVIRONMENTAL SETTING

3.1 HABITATS

Habitat diversity in the Port Said Project Area is high, ranging from the hypersaline waters of El Mallaha to cultivated agricultural areas. The terrestrial habitats, limited in extent by the shortage of land, are in a high state of flux. Intensive activities in land reclamation, urban development, and the military sector have produced large and often irreversible changes in the terrestrial system. Only minor areas of habitat remain undisturbed. Some stands of natural vegetation (Phragmites communis), along the shorelines of Lake Manzala and El Mallaha, function as the interface between the terrestrial and aquatic ecosystems.

The major aquatic habitats (Lake Manzala, El Mallaha, the Suez Canal and the Mediterranean Sea) have been modified by human activity, such as diking and land reclamation, but have remained much more intact than the terrestrial habitats. Characteristics of these aquatic habitats, particularly in relation to wastewater disposal, are analyzed in the Receiving Waters Study, detailed in Volume 4.

Lake Manzala

Lake Manzala is approximately 60 kilometers (km) long and 25 km wide. Depths average 1 meter (m) and seldom exceed 1.5 m. Islands are numerous.

The lake is fed from the River Nile through irrigation and drainage canals. Lake Manzala also receives, in addition to occasional rainfall, the comparatively small but objectionable discharge of Port Said raw wastewater (estimated at 85 percent of the total Port Said wastewater flow). About 30 percent of the inflow evaporates. The excess inflow discharges through the El Gamil opening into the sea, or through the Junction Canal into the Suez Canal.

Freshwater inflows from agricultural drains limit salinity to moderate levels, ranging from as low as 1.62 parts per thousand (ppt) to 14.24 ppt (brackish). These inflows also burden the lake with pesticide and heavy metal residues.

Although the lake is well-mixed vertically, the slow water movement and shallow depths limit the dilution available for wastewater discharges. Average current velocities, influenced by wind direction, are generally below 2 centimeters per second (cm/sec). Under these conditions, solids in sewage discharged to the lake settle close to the discharge point, and impacts of discharges are locally confined.

Lake Manzala is one of Egypt's most important sources of fish, accounting for more than one-quarter of the total national fish catch. Present dissolved oxygen (DO) levels in the lake are sufficient to support fish life except in about 2 sq km of habitat near the Mazrah sewage plant.

Studies have indicated that the Heterophydiasis, a sewage-related parasite, is not being transmitted by Lake Manzala fish. It is likely, however, that a potential public health problem may be presented by the bioaccumulation in certain edible fish of heavy metals and pesticides, which are found at high concentrations in benthic sediments.

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Again with the exception of an area near Mazrah sewage plant, U.S. Environmental Protection Agency (USEPA) coliform criteria for bathing water (200/100 ml MPN) are met in Lake Manzala.

Throughout the lake, nutrient concentrations are well above levels required for high plankton productivity. High levels of ammonia, nitrite, phosphate and silicate occur in the area near the Mazrah sewage plant and near the Junction Canal.

El Mallaha

The configuration of El Mallaha is similar to that of Lake Manzala. Because El Mallaha receives little or no fresh water drainage, it is hypersaline, with salinities of 60 ppt, well above the 37 ppt salinity of the Mediterranean. As a result, El Mallaha is much less productive than Lake Manzala in plankton and fish yields, despite high levels of soluble nitrogen and phosphates. There are no sewage or agricultural drains to the lake. The high rate of evaporation could account for the high nutrient levels. Silica levels are lower than in Lake Manzala.

Suspended solids levels are low (20-32 mg/l). The lake is relatively free from sewage-related bacterial contaminants.

The Receiving Waters Study found the pesticide B-BHC at concentrations of 46.6 parts per billion (ppb) in El Mallaha. Concentrations of DDT derivatives were high throughout the lake. Benthic concentrations of heavy metals were also high.

Suez Canal

The Suez Canal links two distinct geographical units: the Mediterranean Sea and the Red Sea. As a result, marine plants and animals characteristic of both Seas have established themselves in the Canal.

Water movement in the Canal varies with the tidal cycle. Net flow for most of the year is from the south. Salinity and dissolved oxygen levels varied considerably in the area of the Canal where sampling was performed for the Receiving Waters Study, from the Mediterranean in the north to Lake Timsah in the south. The highest values for salinity and DO were at the ends of the survey area, reflecting the influence of the saline, well oxygenated waters of the Mediterranean and Lake Timsah. In all parts of the survey area, DO levels were sufficient to support fish life.

The Suez Canal can have about 5 mg/l BOD_5 without degradation of water quality. Based on observations of surface discharges, assimilative capacity in the Canal appears to be poor. The discharge plume is confined and maintains its freshwater character. This condition prevents assimilation of carbon and nutrients and is therefore likely to be unsuitable for the marine plankton and bacterial types present in the Canal. Lack of settling due to the salinity gradient prevents decomposition of sewage material by benthic bacteria.

Except for the vicinity of the Junction Canal, waters of the Suez Canal within the Project Area are free from sewage-related bacteria and meet USEPA coliform criteria for bathing water.

Concentrations of nutrients are ample for phytoplankton production. The Junction Canal may be a major source of the nutrients in the Suez Canal.

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Benthic concentrations of heavy metals and pesticides are high. The distribution of heavy metals reflects loads from Lake Manzala through the Junction Canal. Similarly, levels of DDE in the Suez Canal are highest near Port Said, probably due to the inflow from Lake Manzala through the Junction Canal.

Mediterranean Sea

The area of interest in the Mediterranean Sea, extending 20 km from west of El Gamil to east of Port Fouad and 15 km offshore, features a very shallow coastal shelf, relatively low biological productivity, and west-to-east offshore currents.

Samples taken for phytoplankton and chlorophyll A in the surf zone indicated low productivity. Benthic levels of heavy metals, generally lower than in the other water bodies, varied little at different sampling stations in the surf zone, indicating minimal contribution of metals from Lake Manzala through the El Gamil connection.

Concentrations of nitrogen, phosphorous and silicon containing compounds were high. Nitrate and phosphate concentrations were higher than those recorded during the non-flood period before construction of the Aswan High Dam. Since the currents along the coast run toward the east, these relatively high concentrations may in part result from the flow of lake waters exiting at El Gamil.

The waters along the Port Said coast are safe for bathing from the standpoint of bacteria concentrations. Samples taken off the Port Said beach, near the El Mazrah outflow and near El Gamil, showed fecal coliform levels well within USEPA recommended bathing criteria.

3.2 LIFE FORMS

A distinct feature of the Port Said surroundings is the limited diversity of biological species. This is true especially of the terrestrial environment. Even the variety of aquatic species is limited in comparison with other locales, such as salt marshes, where a mixing of waters usually is accompanied by highly diverse and productive fauna and flora.

Terrestrial species are limited to a few species of small reptiles, fish-feeding birds, and insects, with flora consisting mainly of sedges and perennial wood shrubs.

Aquatic life forms, more varied than the terrestrial forms, differ in the four main water bodies. However, plankton in Lake Manzala, the Suez Canal and the Mediterranean Sea show similar characteristics.

The Suez Canal exhibits its greatest productivity in the Port Said zone. Many species of plankton and fish found in the Suez Canal and the Mediterranean near Port Said have migrated from the Red Sea. The ecological implications of these migrations have not been established, but it is hoped that these new species will offset the general decline in fish catches which has occurred since the 1960's. Shrimp, crabs and finfish also represent a significant resource in the Mediterranean.

For a detailed description of aquatic life forms, see Volume 4, Receiving Waters Study, Chapters 5 (Biological Characteristics of the Receiving Waters) and 6 (Port Said Fisheries).

3.3 ECOLOGICAL RELATIONSHIPS

The characteristics of the habitats in the Port Said Project Area suggest that a stable ecosystem has not been established. Stable, mature ecosystems are characterized by diversity; a well-developed, non-linear food chain; and the presence of large predatory species. The aquatic and terrestrial systems in the Port Said area lack diversity and contain large numbers of small inhabitants with a highly linear food chain.

Analysis of the Lake Manzala fish community by the Receiving Waters Study has demonstrated the instability of that ecosystem:

Low diversity - Only nine fish species were identified (four of the *Tilapia* genus, two of the *Morone* genus and three of the *Mugil* genus).

Poorly developed food chain - Identified species were confined to plankton feeders. Only one predatory species was identified.

Energy focused toward reproduction - Approximately 90% of the samples were juveniles, with few large individuals.

The current status of the aquatic ecosystem, unlike the terrestrial ecosystem, appears to be a natural function of a homogeneous habitat rather than of pollution. Yearly changes in temperature, salinity and other parameters do not vary significantly, favoring a limited number of species which are well adapted to the conditions.

In the context of wastewater planning, the status of the biological community is important. Both the aquatic and terrestrial systems in the Project Area are extremely sensitive to environmental change.

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CHAPTER 4

CURRENT AND FORECAST WASTEWATER FLOWS AND LOADING

4.1 PRESENT FLOWS AND LOADS

Background

Measurements of present wastewater flows and loads at Port Said are related to the existing drainage areas and discharge points shown in Figure 4-A. Areas in Port Fouad and in the northern end of Port Said have been sewered since the 1930's. Most sewerage in the existing drainage areas designated as R-3, R-4 and part of 12 has been constructed since the 1973 war.

Each existing drainage area in Port Said is tributary to a single pumping station. All stations except R-4 are connected to the sewage treatment facilities at Mazrah, inoperative since the 1967 war. Raw waste discharges from Mazrah to Lake Manzala, from 5 Port Fouad outlets to the Suez Canal, from one Port Fouad force main to the Mediterranean, and from 6 other outlets to the Suez, Junction and Manzala Canals. Similar but smaller discharges escape through surface drains, culverts, abandoned sewers and by seepage through the soil.

Clogged sewers, inadequate pumping capacity and undersized pump station wet wells regularly force surcharged operation of the collection system in Port Said (see Chapter 8). Wastewater overflows are common. Much of the overflow volume ponds in the streets until it evaporates.

Under these conditions, accurate flow measurements are out of the question and even approximate estimates hard to come by. Information on wastewater flows and loadings is therefore necessarily limited.

Measurement of Mazrah Flows

Wastewater from the Mazrah Sewage Treatment Plant (STP) is by far the largest discharge to Port Said waters. By means of a Manning dipper meter, installed temporarily in the bypass channel around the treatment works, daily flows from the Mazrah STP were determined to be as follows:

July 1978		August 1978	
6	22,720 cu m/d	8	28,300 cu m/d
7	24,490	23	37,000
8	22,480		
9	25,120		
10	26,000		
11	18,700		
12	14,700		
Average	22,000 cu m/d	Average	33,000 cu m/d

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No rain fell during the test periods. The very low discharges during certain days were apparently due to:

(a) Partial shutdown of the El Raswa Water Treatment Plant, particularly during the day, because of inadequate raw water supply or breakdown of facilities; and/or

(b) Breakdown or failure of one or more sewage pumping stations, reducing the delivery of wastewater to the Mazrah STP.

The indicated increase in wastewater discharges at Mazrah from July to August is 10,000 ± cu m/d. Although later flow measurements are few, we believe the increase is real and can be attributed to the greater water supply available after the shut-off of a water siphon to Port Fouad which had a 16,000 cu m/d leak.

As shown in Figure 4-B, on July 9 wastewater discharges at Mazrah varied from 8,000 cu m/d at 03:00 hr to 38,000 cu m/d at 13:00 hr, averaging 22,500 cu m/d. On August 23 the discharge ranged from 23,000 cu m/d at 05:00 hr to 55,000 cu m/d at 13:00 hr, with an average of 37,000 cu m/d. Although the graphs for both days show a buildup in flow to peaks near mid day, smaller peaks at frequent intervals were caused by the starting and stopping of pumps.

Other Flow Measurements

Other flow measurements included the following:

(a) Total flow of 5900 cu m/d measured by velocity meters and flow depth in 5 outfalls from Port Fouad to the Suez Canal. This flow included an industrial component estimated at 2650 cu m/d, primarily from the Suez Canal Authority (SCA) shipyard. For an estimated population served of 11,700 (17,500 population in 1978, with 2/3 assumed connected to the sewer system), the flow excluding industrial amounted to 280 lcd.

(b) Flow of 2,300 cu m/d from the existing R-4 drainage area. This flow is mainly from the stockyards and slaughterhouse, with only a small residential contribution.

(c) Discharge of 5 wastewater pumping stations by measurement of suction well levels and time of pumping as follows:

Drainage* Area		Measured Flow (cu m/d)	Area Population		Unit Flow (lcd)
1		1,300	6,000		217
4		2,700	13,600		199
5		3,600	14,300		251
6		2,400	3,500		686
7		2,500	37,700		66
	Totals	12,500	75,100	Average	166

*Existing drainage areas shown on Figure 4-A. Each drainage area has one wastewater pumping station.

Industrial Flows

The Port Said Master Plan (PSMP) estimated 1975 industrial water use as follows:

	cu m/d
Shipyard	2500
Port	600
Sales to Ships	1300
Other Industrial	4300
Total	8700

SCA water use billed to industries in 1977 (Table 4.1) totaled only 25 percent of the PSMP estimate. This did not include the shipyard or port. In addition, because of the large number of defective meters (also shown in Table 4.1), many of the remaining billings are estimates, probably on the low side. Nonetheless, the potential industrial contribution to the sewer system is not large. Water sold to ships is for the most part carried away. The measured wastewater flows in Port Fouad and the R-4 drainage area account for the bulk of the remaining industrial use estimates in the PSMP (see "Other Flow Measurements", above).

Wastewater Loads

Raw wastewater discharges at Mazrah were sampled at hourly intervals on August 23/24, 1978. Samples were analyzed at Port Said with the following results:

	Concentration in mg/l		
	Average	Minimum	Maximum
BOD_5	475	390	620
Suspended Solids	360	150	410
Chlorides	800	250	1680
Total Dissolved Solids	1620	750	2930

Applying the average figures to the wastewater flow of 37,000 cu m/d measured on August 23 indicates a loading of approximately 17,600 kg/d BOD_5 and 13,300 kg/d suspended solids.

For an estimated tributary population of 185,000, the unit flow is 200 lcd, the BOD load 95 gm/d per capita and the suspended solids 72 gm/d per capita.

Five grab samples of the Mazrah discharge (two on May 23 and three on May 31, 1978) showed relatively uniform concentrations of BOD and suspended solids, averaging 480 and 308 mg/l, respectively. These concentrations agreed reasonably well with the more extensive August readings. A grab sample of discharge from the R-3 drainage area pumping station after drawdown yielded 640 mg/l BOD and 130 mg/l chlorides. The low chlorides suggested little infiltration of groundwater. A sample at Port Fouad, where all sewers are above sea level, showed chlorides of 95 mg/l. Pumping station discharge at Kabbutti showed 1200 mg/l BOD and 5100 mg/l chlorides, both relatively high because of slaughterhouse wastewater. For a flow of 2300 cu m/d, the BOD load would amount to 2760 kg/d or about 10 gm/d/c for the overall Port Said population. This discharge carries all known high BOD industrial wastes.

4.2 PROJECTED FLOWS AND LOADS

Flow Estimates from Water Consumption

Because of the difficulty in measuring wastewater flows at Port Said and the probability of errors (see "Background in Section 4.1, above), wastewater discharges were estimated from water consumption for the WWFMP (see Table 4.2). This commonly used method is relied upon by thousands of communities to determine sewerage service charges. The ratio between metered water consumption and wastewater generated is established within reasonably close limits. For Port Said the following ratios were applied:

Water User Category	Ratio of Wastewater Generated to Water Use (Percent)	Wastewater Peak to Average Flow Ratio
Domestic	80	3
Institutional (including Tourism)	90	3
Industrial	90	3
Public (excluding Garden Use)	90	3
Wastage	100	1
Leaks, Garden Use	0	-

In addition to the sewage generated from water supply, wastewater flow allowances must include expected infiltration of groundwater and entry of storm flow into the system. At present, surcharging prevents infiltration and no allowance is needed. For the existing system after rehabilitation and with no surcharge, we have applied an infiltration allowance of 12 cu m/d/ha. For new systems the corresponding allowance is 0.5 cu m/d/ha.

All stormwater is assumed to be eliminated from the system under measures recommended in Chapter 8.

Not all water users in existing drainage areas are currently connected to the sewer system. In addition, the R-4 drainage area is totally isolated from the main system in Port Said. The percent of water users connected to main systems (Port Said and Port Fouad) is expected to increase as follows:

Water User Category	Percent of Water Users Connected To Main Sewer Systems			
	1978	1982	1985	1990 and After
Port Said				
Domestic	80	87	90	95
Institutional	80	87	90	95
Public	80	87	90	95
Industrial	0	0	100	100
Port Fouad				
Domestic	67	72	90	95
Industrial	100	100	100	100

It is expected that all water users in new drainage areas will be connected to the sewer system by 1982. The present overflow of wastewater from the R-3 drainage area pumping station to the Manzala Canal is assumed to be eliminated by 1982. Of the new

flows from tourist development, 10% is assumed tributary to the existing system and 90% to a new system serving areas west of Mazrah.

Estimated wastewater flows to the year 2000 for the 18 WWFMP drainage areas (Figure 4-A) are shown in Table 4.3. The seven areas in northern Port Said reflect consolidation of existing smaller drainage areas in accordance with recommendations presented in Chapter 8. The size and boundary lines of the other areas reflect the boundaries of proposed land reclamation areas and practical limits for gravity collector lengths to avoid excessive depths. The drainage area limits differ from those of water service areas, but population and water use figures developed for the water areas have been readily allocated to the sewer drainage areas.

Design Flows

The peak flows in Table 4.3 were the basis for sizing local pump stations and discharge force mains. In effect this means that local facilities are designed for 100 percent of water users connected to the sewers. We believe this slight extra capacity is warranted in the local drainage areas because of uncertainties as to location of the existing water users not connected to the sewers.

Overall sewage flow figures for treatment plants and for major collection areas (see Chapter 8) were based on the expected percent of water users connected to the sewer system. In addition, for large interceptors serving multiple drainage areas, the peak flow factors for domestic, institutional, industrial and public flow were taken as 2 instead of 3, reflecting damping of peaks in the gravity system. (The factor of 3 was maintained for combined discharges from multiple force mains - where the peaks from the local drainage areas could all coincide.)

Wastewater flows are expected to reach 189,000 cu m/d by the year 2000. Table 4.4 presents projected overall sewage flows, taking into account the projected percent connected in each water user category. For comparison, figures are given for overall water use and for percent of water use reflected in the sewage flow.

Projected Loads

Wastewater loads were based upon residential population at 90 grams BOD and 80 grams suspended solids per capita per day. These values were adjusted from the August 1978 field estimates to eliminate suspected effects of present deposition of solids in the sewers. (Deposition reduces measured solids; decomposition of the deposits adds to observed BOD. The BOD estimate also allows for high strength wastes - e.g., slaughterhouse - not now collected in the wastewater treatment works.)

As shown in Table 4.5, the BOD of wastewater discharges is expected to increase from 28,800 kg/day in 1982 to 59,600 kg in 2000, and suspended solids from 25,600 kg/d in 1982 to 53,000 kg/d in the year 2000.

TABLE 4.1

INDUSTRIAL WASTEWATER

Name of Industry	Product	Number of Employees	Billed Water Use(1) 1977 cu m	Water Meter Condition	Receiving Water	Wastewater Treatment	Remarks
Marinjac	Injection molded plastics	120	630	Buried	Interior Canal	None	
Edfina	Frozen fruit, veg. and meat	140	17,904	Not found Operating	Interior Canal	None	Solid waste to livestock
Slaughter House	3000 head per month dressed cattle	27	52,252	Damaged	Junction Canal (Kabbutti P.S.)	None	Solid waste to fertilizer & stock feed
Ice Company	3000 25 kg blocks per day	45	9,591	Operating	City Sewers		
Port Said Co. for Engineering	Ship repair	100	11,703	Operating	Suez Canal	None	
Canal Rope Co.	Rope, twine carpets	200	21,100	Damaged	Suez Canal (dye waste)	None	Sanitary waste to septic tank
CONSUP	Water supply to ships	50	457,860	Not found Operating	Suez Canal	None	
Defrex "Fina"	Frozen foods	200	9,092	Operating Stopped	Suez Canal	None	Solid waste to livestock
Gereco Freezing Co.	Frozen food storage	15	9,076	Stopped	None	Septic tank on site	No food processing
Egyptian Tea Co.	Tea blending and packing	250	7,773	Operating	Interior Canal	None	
Canal Naval Construction Co.	Ship building and repair	Unknown	1,150	Operating Not read since 1967	Suez Canal	None	Company on island No. 4
El Nasser Dehydration Co.	Vegetable drying	150	44,507	Operating	Interior Canal	None	
El Nasar Salines Co.	Salt drying	300	9,963	Damaged	None	None	
Port Said Shipyard Co.	Ship building and repair	3,000		(2)	Mediterranean Sea	None	
Marinjac Cold Storage	Frozen food storage	6	660	Damaged Operating	Suez Canal	None	Cold storage capacity being doubled
Portex	Spinning, weaving and dying	1,400	45,456	Operating Damaged	Junction Canal (Kabbutti P.S.)	None	
Thick Cover	Spinning, weaving and drying		38,920	Damaged	Junction Canal	None	
Egyptian Miller	Flour	70	13,936	Buried	City sewer		
Nalco	Chemical warehouse	Unknown	7,486 230	Operating Buried	City sewer Suez Canal	None	Not yet operating
NAAVCO	Auto warehouse	Unknown	540	Not found Buried		None	
Freon Corp.	Refrigeration servicing	5	340	Not found Operating	Interior Canal	None	Sanitary waste only
Attard	General warehouse	10	300	Not found		None	Agricultural products
Ivaco	Agricultural warehouse	0	0	Not found		None	Not yet operating

TABLE 4.1 (Cont.)

INDUSTRIAL WASTEWATER

Name of Industry	Product	Number of Employees	Billed Water Use(1) 1977 cu m	Water Meter Condition	Receiving Water	Wastewater Treatment	Remarks
El Nil Packing Co.	Produce Packing and Grading	25 full-time 300 part-time	2,618	Operating	Interior Canal	Part to septic tank on site	Seasonal solid waste to land fill or stock feed
Industrial Gas Co.	Acetylene and oxygen	65	6,455	Operating		Primary sedimentation	Solid waste to landfill
EPIXCO	Import export agricultural products	20	No charge	No meter		Septic tank on site	No process water
National Marketing Center	Food and hardware warehouse	20	770	Not found		Septic tank on site	Condemned food to landfill
Prison	Correctional institute	600	15,539 312	Buried under building		None	Solid waste contracted to haulers
Electric Generating Plant	Power generation	100	400	Damaged	Interior Canal	None	

(1) From SCA records.
(2) Shipyard - 17 meters total (3 operating, 14 damaged).

TABLE 4.2

FORECAST OF WATER DEMANDS

WATER AND WASTEWATER FACILITIES MASTER PLAN

	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 4.3

ESTIMATED TOTAL WASTEWATER FLOWS
BY YEAR AND DRAINAGE AREA

Drainage Area(1)	1978 Avg. Cu m/hr(2)	1978 Peak(3) Cu m/hr	1980 Avg. Cu m/hr	1980 Peak Cu m/hr	1985 Avg. Cu m/hr	1985 Peak Cu m/hr	1990 Avg. Cu m/hr	1990 Peak Cu m/hr	1995 Avg. Cu m/hr	1995 Peak Cu m/hr	2000 Avg. Cu m/hr	2000 Peak Cu m/hr
Port Said												
1	290	690	330	790	320	770	320	780	320	790	320	780
2	490	1060	490	1200	500	1230	490	1220	490	1210	480	1200
3	180	460	190	480	190	480	190	470	180	470	180	460
4	420	930	460	1050	530	1200	520	1220	480	1140	440	1060
5	230	520	230	520	240	540	200	460	190	440	180	410
6	260	620	300	700	300	720	300	710	290	710	290	700
7	360	860	360	870	370	880	350	850	340	810	320	780
8	-	-	240	520	700	1720	800	1990	820	2040	830	2090
9	-	-	140	360	410	1160	550	1550	550	1550	550	1550
10	140	360	140	370	140	370	240	650	240	650	240	650
11	-	-	-	-	200	560	610	1730	640	1800	650	1850
12	-	-	-	-	-	-	110	310	170	480	260	740
13	-	-	-	-	-	-	150	420	510	1450	520	1510
14	-	-	-	-	-	-	90	250	540	1530	600	1690
15	-	-	-	-	-	-	-	-	140	390	580	1640
16	-	-	-	-	-	-	-	-	-	-	590	1700
Kabbutti(4)	60	120	60	130	70	160	80	180	90	210	110	240
Total Port Said	2430		2940		3970		5000		5990		7140	
Port Fouad												
1	210	520	220	550	280	730	330	880	390	1030	430	1180
2	130	300	140	330	230	550	300	730	310	750	310	770
Total Port Fouad	340		360		510		630		700		740	
TOTAL cu m/hr	2770		3300		4480		5630		6690		7880	
cu m/d(5)	66500		79200		107500		135100		160600		189100	

(1) Revised drainage area numbers are based on consolidation of existing areas.
(2) Hourly figures rounded to nearest 10.
(3) Peaking factor is applied only as three times the average sewage flow, excluding flow due to infiltration or wastage and leakage components of the wastewater flow.
(4) To be replaced by new fishing village, 1990. Comparable sewage flows are assumed.
(5) Daily figures rounded to nearest 100.

TABLE 4.4

ESTIMATED COLLECTED WASTEWATER FLOWS
BY YEAR AND WATER USER CATEGORY
(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	178,000
Water Delivered (production minus leakage, gardening water and ships 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%

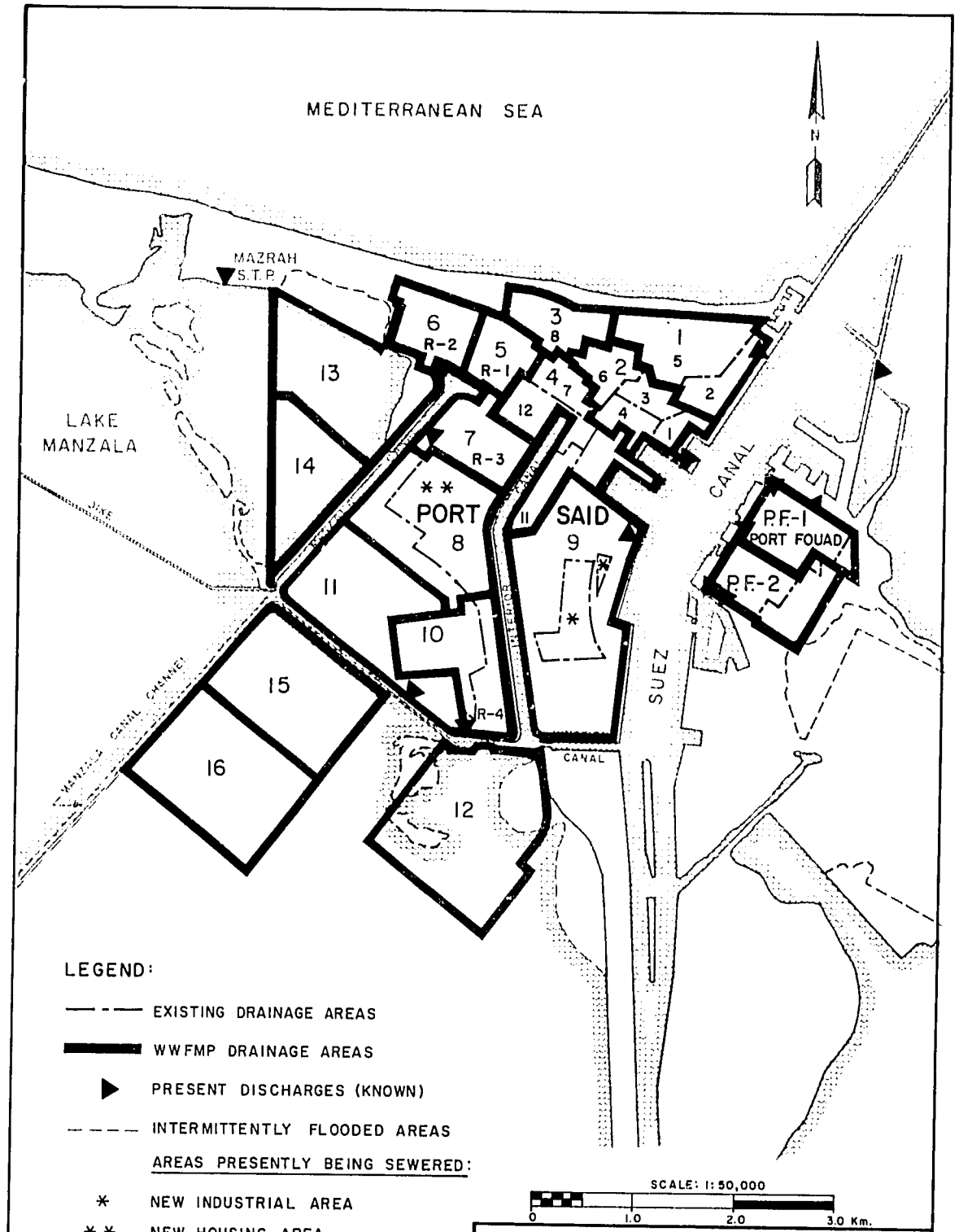
(1) Estimated flow delivered to Mazrah STP.
(2) Based on water demands summarized in Port Said WWFMP Final Report, Vol. 2, Table 4.9.

TABLE 4.5

ESTIMATED WASTEWATER LOADS

	1982	1985	1990	1995	2000
Average Flow cu m/d					
Port Said	73,000	89,000	118,000	142,000	171,500
Port Fouad	9,000	12,000	15,000	16,000	17,500
Total	82,000	101,000	133,000	158,000	189,000
BOD(1) kg/d					
Port Said	27,200	31,600	39,400	47,800	56,300
Port Fouad	1,600	2,400	3,300	3,300	3,300
Total	28,800	34,000	42,700	51,100	59,600
Suspended Solids(2) kg/d					
Port Said	24,200	28,100	35,000	42,500	50,100
Port Fouad	1,400	2,100	2,900	2,900	2,900
Total	25,600	30,200	37,900	45,400	53,000

(1) Based on 90 gm/c/d
(2) Based on 80 gm/c/d



ARAB REPUBLIC OF EGYPT

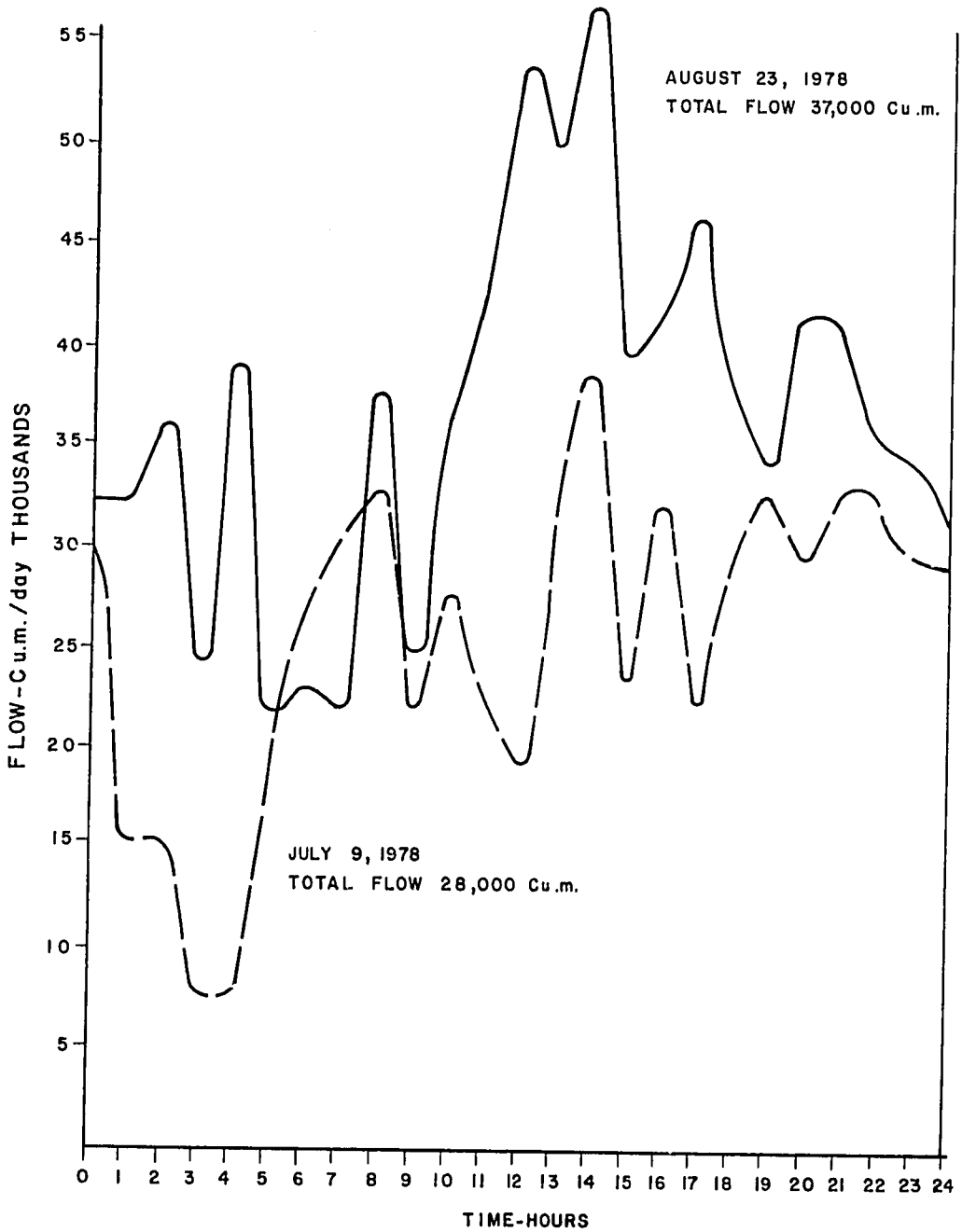
MINISTRY OF DEVELOPMENT AND NEW COMMUNITIES
ADVISORY COMMITTEE FOR RECONSTRUCTION

PORT SAID
WATER AND WASTEWATER FACILITIES MASTER PLAN

HAZEN AND SAWYER
ECG · ENGINEERING CONSULTANTS GROUP

DRAINAGE AREA BOUNDARIES

VOL.3
FIG.
4-A



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ECG - ENGINEERING CONSULTANTS GROUP

MAZRAH-FLOW PATTERNS

VOL.3
FIG.
4-B

CHAPTER 5

BASIS OF FEASIBILITY STUDIES

Development of effective recommendations for improvement of the Port Said wastewater system required carefully conducted feasibility studies. These were used to screen alternatives and to establish the technical, financial and economic soundness of the recommended program, so that interested national and international agencies may evaluate the program's merits. This chapter reviews the basic methodology and information used in the feasibility studies.

5.1 ENVIRONMENTAL QUALITY STANDARDS

The goal of the wastewater system is to properly remove and dispose of wastewater from developed areas, without public health hazards, aesthetic nuisance or adverse impact on the receiving waters on lands to which effluent is discharged.

The quality goals for receiving waters are: to maintain an environment favorable to growth and propagation of normal aquatic plant and animal life; to safeguard the health of persons using the waters for bathing and recreation; and to prevent obnoxious odors, unsightly floating material or other nuisances.

The quality goal for agricultural utilization of wastewater effluent is to restrict to safe levels any substance or organisms likely to be harmful to plant life, wildlife, persons raising or consuming the crops, or likely to inhibit the growth and quality of proposed crops.

Table 5.1 summarizes effluent standards established under Egyptian Law No. 93 of 1962 and Decree No. 649/1962. These define limits for specific characteristics in effluents discharged to the Nile River and to drains. In addition, limits are defined for effluent to be used for irrigation.

No effluent limits have been established for the local receiving waters at Port Said (Lake Manzala, El Mallaha, the Suez Canal and the Mediterranean Sea). Discharges to such bodies of waters are "permitted provided no harmful effects result on aquatic life or beaches".

Volume 4 of this report presents a study of the proposed receiving waters at Port Said. This study is designed to define the water quality considerations that determine the disposal requirements in Chapter 6 of the present volume.

5.2 TECHNICAL FEASIBILITY ELEMENTS

Under the WWFMP scope, program elements are considered technically sound if: 1) all pertinent technical aspects have been considered; 2) the projects conform to accepted engineering standards; and 3) the projects are cost effective in relation to reasonable alternatives.

Analysis of technical feasibility involved comprehensive review of:

- Design criteria (see Section 5.5, below and Appendix A)
- Construction and operating cost information (Section 5.6 and 5.7, below and Appendix B)
- Capacity, location and characteristics of major facilities, as related to service requirements and justified in relation to available alternatives (Chapters 6 through 8)
- Investigations, surveys, and preliminary engineering sufficient to eliminate foreseeable critical problems in final design and construction (Chapters 6 through 8)
- Conceptual plans adequate for reasonably firm cost estimates (Chapters 6 through 8)
- Operational aspects, including organization, staffing and training (Chapter 10)
- Project execution, including methods of construction, practical schedules, availability of skilled personnel, adequate materials, equipment and services (Chapter 11)
- Environmental effects (Chapter 13)

5.3 FINANCING

Present Situation

Responsibility for the wastewater system lies with the Governorate of Port Said (GOPS) and the General Organization for Sewerage and Sanitary Drainage (GOSSD). GOSSD designs and constructs all major wastewater facilities. Capital projects are financed by the National Government through the GOSSD budget. Operation and maintenance of the facilities is paid for out of GOPS revenues derived from a 6 percent tax levied on all goods entering Port Said. The division of responsibility between GOSSD and GOPS is not entirely clear-cut. GOSSD supplies operation equipment and GOPS undertakes minor capital projects.

Port Said sewer users have never paid a service charge. The only direct charge is an assessment for service connections. To put the wastewater facilities on a self-supporting basis would require charges substantially higher than those currently levied for water service.

Financial Feasibility

The WWFMP scope requires that, for each stage of development, revenues be sufficient to cover fixed charges, amortization, maintenance and operating costs, and a return on investment of not less than six percent. For the WWFMP, it is assumed that loan interest is equivalent to return on investment. Revenues and user charges to meet these requirements were determined as set forth in Chapter 12. Also presented in Chapter 12 are pro forma financial statements, through the year 2000, including balance sheets, income statements, and source and application of funds statements.

Funding

USAID intends to fund major foreign exchange needs for the High Priority Projects of the WWFMP. Local capital costs would be funded through appropriate agencies of the A.R.E. Sources of funding for further projects is undetermined at this time.

The analysis of user charge financing in Chapter 12 is based on constant value (1978) Egyptian Pounds (LE). This permits year-to-year comparison of costs or revenues and simplifies relating user charges to household income (see Section 5.4, below). However, since actual funding must cover inflation, Chapter 12 also projects funding needs through 1985 based on expected escalation of capital and operating costs. In addition, the accumulated deficit is estimated should user charges be limited, as at present, to the cost of service connections (adjusted for inflation), rather than being increased to make the wastewater system self-financing. In the absence of adequate user charges, funding will be needed to cover both capital programs and operating deficits.

5.4 ECONOMIC SOUNDNESS

The WWFMP scope calls for determining economic soundness based on an internal rate of return which is "adequate and significantly higher than ... other technically feasible alternatives". Internal rate of return is defined as that value of the discount rate which will make the present worth of benefits and costs equal.

Benefits of the recommended program accrue principally to the users of the water system. These benefits cannot be quantified with meaning beyond the extent that they are 'captured' in the form of user charges to support the system. Hence the economic evaluation in Chapter 13 focuses on whether user charge financing is possible. It does not attempt to calculate internal rate of return based on theoretical or arbitrary benefit values. The recommended program is tested for cost effectiveness. If it also can be financed by user charges, with a six percent return on capital, presumably the scope intent as to economic soundness would be met.

5.5 FACILITIES DESIGN CRITERIA

Criteria for functional design of wastewater collection, treatment, and disposal of facilities and electrical installations, and for design of foundations, are presented in Appendix A. These criteria are sufficiently detailed for direct application to the final design of the facilities. Key functional elements are discussed in Chapters 7 and 8.

5.6 CAPITAL COST ESTIMATES

The basis established for estimating capital costs of projects and project elements in the WWFMP is presented in Appendix B. Information on basic labor and material costs, unit construction costs, and cost curves for principal elements, was obtained from government agencies, local construction contractors, engineering firms, material and equipment suppliers, and other ACR consultants. Appropriate adjustments were made for Port Said conditions.

Cost estimates reflect the impact of physical factors (climate, soils, groundwater, traffic congestion, conflict with existing utilities) and economic factors (contractors' capabilities, skilled labor availability, quality of workmanship and availability of materials).

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Most of the basic construction materials required are manufactured locally, but there are chronic shortages of cement, reinforcing bars, and structural steel. To avoid delays, these items will likely have to be imported. Project costs allow for this but are not high enough to cover supplying these materials from U.S. sources.

Ductile iron piping and fittings, and almost all electrical and mechanical equipment, will also have to be imported. Costs for these are based on U.S. origin.

For guidance in project selection and determination of financing needs, costs are divided into local and foreign exchange components, as detailed in Appendix B. Foreign exchange needs related to use of imported cement, reinforcing bars and structural steel are identified separately.

Cost curves reflect commercial prices, excluding duties on imported equipment and material. It is assumed that financing of foreign exchange components would come from agencies outside Egypt and that these agencies would object to imposition of such duties. Curves do not allow for demurrage or construction delays due to hold up of project items by customs.

It is absolutely essential that the national agencies responsible for project construction obtain specific prior agreement of top level customs officials that will avoid delays and haggling over duty free entry of project materials once construction is underway.

5.7 OPERATING COST ESTIMATES

For use in cost comparisons and financial projections, operating costs were calculated in constant value (1978 level) LE.

Operation and maintenance budgets for 1976 and 1977 were obtained from the GOPS (Table 5.2). These were analyzed to determine outlays for personnel, electricity, miscellaneous costs (chiefly parts and materials used in maintenance) and major repairs.

Future operating costs were projected as follows:

- Personnel costs were based on the staffing and compensation levels recommended in Chapter 10.

- Electrical cost estimates were based on energy needs for each individual pumping station, assuming power purchased from the Egyptian Electricity Authority (EEA) (see Chapter 7). Energy needs were based on pump capacity, head and operation time, with an added allowance of 5 percent for auxiliaries and lighting. Rates were determined on the basis of installed transformer capacity, using the EEA schedule in Table 5.3.

- Costs for other materials and services were estimated on the bases shown in Table 5.4. Resulting allowances are well above current levels of expenditure, reflecting levels needed for adequate upkeep of the system.

5.8 COST EFFECTIVENESS

Two significant alternatives were identified to meet long term needs for proper collection, treatment and disposal of wastewaters. Cost-effectiveness studies provided the basis for selection of the recommended program (see Chapter 9). Comparisons were based

on present worth, taking into account capital outlays, including construction costs; operation and maintenance costs, calculated as outlined in Section 5.7; costs for replacement of project components during the evaluation period (through the year 2000); and salvage value of facilities at the end of this period. Inflation effects were not included.

For comparison of alternatives a discount rate of 10 percent was used. Sensitivity analyses were made of the effect of higher and lower discount rates for critical selections. "Shadow pricing" of cost elements was performed where shadow price ratios differed greatly from 1.0, with replacement schedules and salvage based on the useful life figures indicated below (see Section 5.9).

5.9 SHADOW PRICING

Shadow pricing is an attempt to determine the real cost (or benefit) to the national economy of goods and services, the market price of which reflects serious distortions due to government subsidies, government imposed wages and prices, foreign exchange restrictions and import duties.

The consultants for the Greater Cairo and Helwan Wastewater Studies made extensive analyses to determine shadow to market price ratios for expected cost elements of their projects. For the Port Said WWFMP project a review was made of these reports (Greater Cairo Wastewater Project, Special Report No. 2, Volume 3, Construction Methods and Costs, John Taylor & Sons & Binnie & Partners, June 1977 - and - Helwan Wastewater Master Plan, Special Report No. 2, Volume 3, Unit Prices, EPC, 1977). The following conclusions were drawn:

- Key elements in shadow price calculations, particularly shadow price ratios for skilled and unskilled labor, are highly judgmental.
- Shadow price ratios for materials in the two reports agree quite closely.
- Shadow price ratios of the largest project cost elements (e.g., concrete, piping) have the highest impact on cost comparisons.
- Locally produced materials of importance to project costs (cement, reinforcing steel, piping) are generally underpriced, with shadow price ratios up to 1.5.
- Shadow prices of imported items primarily reflect customs duties.
- Electrical energy has a shadow price ratio of over 3, indicating that it is being sold at a small fraction of the marginal cost of generating and distributing additional amounts.

In an effort to bring shadow price ratios closer to unity, commercial prices estimated for the Port Said WWFMP reflect these factors:

- Customs duties are not included.
- International rather than local market prices of cement and reinforcing steel were used since it is not certain that adequate local supplies will be available.

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Comparison studies for the WWFMP did not use an elaborate set of shadow price ratios. Instead, comparisons were based on market prices and tested if the conclusions were altered by applying shadow price ratios (in the general range indicated in the Greater Cairo and Helwan studies) to important cost elements such as concrete, piping materials and electrical energy. This use of shadow pricing was limited to cost elements for which shadow price ratios are not highly judgmental.

Application of shadow prices did not significantly alter the present worth comparisons nor did it affect the final recommendations.

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TABLE 5.1

EFFLUENT LIMITS FOR WASTEWATER(1)

Characteristics	For Disposal To: General Sewerage System	Nile & Canals (No sewage permitted)	Drains For Sewage	Drains For Ind. Wastes	Lakes & Sea (2)	Sandy Soil	Irrigated Clayey Soil
Suspended Solids mg/l		30	50	80			80
BOD mg/l		20	40	60			80
COD mg/l		15	30	40			50
Sulfide mg/l	1.0	1.0		1.0		1-10	0.1
Cyanide mg/l		0.1		0.1			0.1
Phenol mg/l				0.1			
Chlorine mg/l			minimum 0.5 after 10 min				
Total Dissolved Solids mg/l				5000			2000
Settling Materials (by volume) ml/l							
for 10 min	5						
for 30 min	10						
for 60 min							
Coarse Material (dia) mm	15					1	
Heavy Metals (collective) mg/l				1.0			
Transparency (after 1 hr) mm				100			
Percolation Rate						(3)	(3)
Toxicity to Fish	nil	nil					
Oils, Fats, Resins	100	10		10		20	5
pH	6-10	6-9		6-9			6-9
Temperature (°C)	40	35		35			

(1) Egyptian Law No. 93, 1962, and Decree No. 649, 1962.
(2) No effluent limits for disposal to Lake Manzala, El Mallaha and Mediterranean Sea. Discharges "permitted provided no harmful effects result on aquatic life or beaches".
(3) Must exceed proposed application rate sufficiently to assure no surface ponding.

TABLE 5.2

RECENT ANNUAL OPERATING COSTS (LE) - GOVERNORATE OF PORT SAID
(PORT SAID WASTEWATER SYSTEM)

	1976	1977
Civil Division		
Materials	40,000	40,000
Major Repairs	10,000	10,000
Labor	26,000	32,000
Sub-Total	76,000	82,000
Mechanical Division		
Power	40,000(1)	40,000(1)
Materials	60,000	77,000
Major Repairs	20,000	30,000
Labor	42,000	53,000
Sub-Total	162,000	200,000
Treatment Division(2)		
Labor	12,000	15,000
Sub-Total	12,000	15,000
TOTAL	250,000	297,000

(1) Estimate
(2) No materials, power, or repairs at Mazrah Sewage Treatment Plant.

TABLE 5.3

ELECTRICITY TARIFF

EGYPTIAN ELECTRICITY AUTHORITY
(January 1, 1978)

A. Energy on Extra High Voltages

1) At 220 and 132 KV 5.072 milliemes/KWH
2) At 66 and 33 KV 6.464 milliemes/KWH

B. Energy Supplied for Motive Power

1) For connected loads of 500 KW and above, fed at the intermediate voltage, the annual rate is LE 5.620/KW connected, plus energy charges with steps based on connected load as follows:

Step in KWH	Rate in Milliemes/KWH
1st 1000 hr x connected load(1)	10.103
next 500 " x " "	9.503
next 1000 " x " "	8.303
next 1000 " x " "	7.103
next 1500 " x " "	5.403
Remaining KWH	4.603

2) For connected loads of 8 to 500 KW, there is no charge for connection KW. The energy charge is:

Step in KWH	Rate in Milliemes/KWH
1st 7,000 per yr	20.347
Next 100,000 per yr	16.697
Above 107,000 per yr	15.847

(1) e.g., for connected load of 1000 KW this rate step applies to first 1,000,000 KWH per yr.

TABLE 5.4

WASTEWATER FACILITIES

BASIS FOR ANNUAL MATERIALS AND SERVICES COSTS(1)

Wastewater Facilities Categories	Basis(2)
Civil Works	1% of Capital Cost
Mechanical Equipment(3)	4% of Capital Cost
Force Mains	0.75% of Capital Cost
Sewers and Service Connections	0.1% of Capital Cost
Vehicles and Construction Equipment(4)	LE 1200/unit
Sludge Hauling Trucks	LE 6000/unit
Sewer Cleaning Machines	LE 1000/unit(5)

(1) Material costs include spare and replacement parts and consumables such as grease, packing, paint. Also included are allowances for materials used in major repairs to sewers and force mains. Labor costs are covered in Chapter 10.

(2) Capital cost includes installation where applicable, but excludes contingencies and support services.

(3) Excluding vehicles and construction equipment.

(4) Including fuel for operation.

(5) Pairs of bucket machine rigs.

CHAPTER 6

WASTEWATER AND SLUDGE DISPOSAL

6.1 USE OF EFFLUENT FOR IRRIGATION

The use of treated wastewater for irrigation near Port Said was examined as an alternative to disposal by discharge to local receiving waters. This possibility was opened by proposals for agricultural reclamation south of the city (see Figures 1-B and 2-B). Much of this area is now seasonally inundated by Lake Manzala or is flooded year-round.

Agricultural utilization of wastewater effluent has not been widely practiced in Egypt due to the availability of Nile River water and concern with disease transmission. As available Nile River flows become fully utilized, more reuse of treated wastewater effluent and water from drains may be expected.

At present within reasonable distance of Port Said, no land is available to which application of wastewater effluent could be considered. Evaluation of this disposal alternative was confined to planned reclamation areas to the south of the city, including parts of Lake Manzala which will be drained and reclaimed for agricultural purposes.

A cost comparison was made, based on applying a unit volume of wastewater versus supplying irrigation water from the Nile at the same location. It was assumed that wastewater would be treated to meet standards for application to clay soils as set forth in Egyptian Law 93-1962, Article 12-4 (excluding standards for mineral quality) and that crops would not require special treatment of wastewater to improve sanitary quality. Garden vegetables, for example, could not be raised in effluent irrigated areas. Mineral quality of effluent is expected to be poor due to infiltration of saline groundwater into the collection system (and to evaporation in stabilization lagoons if these are used for treatment). Chlorides may be as high as 2,500 mg/l, suggesting an allowance for up to ten-to-one dilution with Nile water.

With allowance for evaporation in stabilization lagoons, effluent volume in the year 2000 is estimated at 140,000 cu m/d, sufficient to irrigate some 2,000 ha. Allowing for dilution, the total irrigated area may amount to as much as 20,000 ha. If a 10 km strip is reclaimed south of Port Said, a 20 km length would have to be devoted to irrigation with the diluted effluent. Assuming irrigation areas as close as 4 km from the treatment facilities discharge, transport distance of up to 24 km must be considered.

Evaluation on the basis outlined above indicated that to treat and deliver wastewater effluent to planned agricultural areas south of Port Said would cost nearly twice as much as delivering Nile water to the same areas (see Section 6.2, Volume II - Water Facilities for estimated MOI "Second Stage" canal costs). In view of this cost disadvantage and the uncertainities as to when these or other areas near Port Said may be reclaimed, effluent irrigation should not be considered further at this time. Other disposal arrangements would not preclude future irrigation use if more favorable conditions develop.

6.2 POTENTIAL RECEIVING WATERS

El Mallaha, Lake Manzala and the Suez Canal were studied in depth as potential receiving waters for wastewater disposal. Hydrographic information and assessments of existing water quality and its impact on fisheries are detailed in Volume 4 of this report

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(Receiving Waters Study). Characteristics of these potential receiving waters are summarized in Section 3.1 of this volume.

Elimination of Mediterranean

By agreement with the Advisory Committee of Reconstruction (ACR), wastewater outfalls to the Mediterranean Sea were eliminated from consideration prior to the Receiving Waters Study. Studies in the Mediterranean were limited to bacterial sampling along the beaches. Results indicated that existing discharges to Lake Manzala and the Suez Canal have no impact on bathing water quality in the Mediterranean.

Elimination of El Mallaha

Based on information gathered in the Receiving Waters Study, discharge to El Mallaha appears precluded by the following factors:

- The aquatic environment of El Mallaha is hypersaline waters of high clarity. El Mallaha receives no significant freshwater inflow. Introduction of fresh-water through sewage disposal would cause significant environmental changes and disruption of the biological community. Mullet populations, now dominant, would likely be displaced by the less desirable Tilapia.

- The planned Suez Canal bypass and expanded salt works would limit the area of El Mallaha available for dilution of wastewater.

- Wastewater discharge would cause economic losses to the planning area. In addition to reduced productivity of the mullet fishery, the operation of the salt works would be adversely affected.

The total wastewater flow to be disposed of from the Port Said area in the year 2000 is estimated at 189,000 cu m/d (Table 4.1). Planning is based on discharging to Lake Manzala the combined flow of 171,500 cu m/d from Port Said and the new fishing village at El Gamil. Discharge of this large flow to the Suez Canal was not considered in view of:

- the canal's direct connection to the Mediterranean

- slow movement in the canal during slack water

- the potential benefit to the Manzala fisheries of a properly planned discharge.

For the smaller Port Fouad flow (17,500 cu m/d), alternatives considered were based on discharge to the Suez Canal, or transport of this flow by siphon under the Suez Canal, for treatment and discharge with the Port Said wastewater.

Critical Parameters

The most critical parameter in determining treatment and outfall structure requirements for discharge to Lake Manzala and the Suez Canal is BOD_5 loading and the related adverse impact on dissolved oxygen (DO) and the fishery. Extent of impact is determined by: effluent BOD levels, the amount of initial dilution provided by the outfall structure, and the assimilative capacity of the receiving water.

Appropriate outfall location is determined by public health considerations. We recommend against chlorination. Chlorination would not be effective against the parasitic

diseases endemic to Port Said. Potential toxic effects of chlorine residuals could adversely affect the fishery. We believe that natural die-off of pathogens and parasites will be sufficient to protect the public health. Generally, the infective stage of the helminthic parasites endemic to Port Said occur in soils and cannot survive for extended periods in brackish/saline water environments. No problems with schistosomiasis would be caused by discharge of unchlorinated effluents to Lake Manzala or the Suez Canal. Brackish water or marine environment is unsuitable for the survival of the snail host and its supportive vegetation. Absence of the snail host breaks the reinfection cycle by preventing the formation of the cercariae in the infective stage of the parasite.

Outfalls should be located so that before effluent fields reach residential shorelines or areas used for primary contact recreation, dilution and die-off will reduce pathogen levels sufficiently to protect public health.

Lake Manzala Alternatives

Three alternatives for discharge to Lake Manzala were examined:

1) Anaerobic lagoons followed by oxidation ponds

2) Conventional primary treatment with a diffuser at the end of an outfall

3) Conventional secondary treatment with an open ended outfall or diffuser

In evaluating the alternatives, priority was given to protection of the Lake Manzala fishery. The oxidation ponds would have to be constructed in the lake because land is unavailable. Construction of the ponds would preempt 500 ha of fishery habitat for enclosed processes which, with proper design, could proceed as well in the open lake. By comparison, the present untreated discharge at Mazrah eliminates some 200 hectares from fishery use. Treatment by oxidation ponds was therefore eliminated from consideration.

Calculations early in the Receiving Waters Study indicated that Lake Manzala can absorb increases in ambient BOD_5 of about 6.0 mg/l and still maintain 3.0 mg/l of DO at all times. To meet the 6.0 mg/l BOD_5 criteria, primary effluent (210 mg/l BOD_5) from Port Said would require dilutions of 35:1; secondary treated effluent with BOD_5 levels of 25 mg/l would require a 4:1 dilution. Later field data in certain areas of the lake showed that the fish community is not adversely affected by BOD_5 levels of 13 mg/l, even though anaerobic conditions occur during early morning hours.

To obtain these dilutions, diffusion of the effluents would be needed, with the length of diffuser dependent upon the BOD of the effluent. Projections for primary treatment effluents made with diffusers 500, 1000, 1500, 2000 and 2500 meters long, indicated that to meet the 6.0 mg/l limit in all areas of Lake Manzala would require a 1500 m diffuser for primary treatment effluent and a 250 m diffuser for secondary treatment effluent.

Further examination shows that with primary treatment and a 1000 meter diffuser, a maximum BOD_5 increase of 10.3 mg/l would occur, causing ambient BOD_5 levels of about 13.0 mg/l in Zone B of Lake Manzala.

Capital costs for secondary treatment of Port Said wastewater would be at least LE 30 million more than for primary treatment. The results of the Receiving Waters Study do not appear to justify this substantial added expense.

With a minimum diffuser length of 1000 meters, adverse impacts of primary effluent on the lake would be minimal.

Coliform levels in the Port Said effluent were found to be 10^6/100 ml in the Receiving Waters Study. It was also found in the Receiving Waters Study that die-off and dilution would lower raw sewage fecal coliform levels of 10^6 organisms/100 ml to an acceptable level of near 100 organisms/100 ml in 15 to 18 hours regardless of treatment levels or diffuser length (Volume 4, Appendix D).

We recommend that the discharge point be no closer than 3.5 kilometers to any residential area to the southeast, the predominant direction of transport.

To achieve maximum dilution, the diffuser should be oriented perpendicular to the predominant currents. Current flow is generally to the southeast at bearings of 120 degrees to 130 degrees. The recommended location and orientation of the outfall and diffuser are shown on Figure 6-A.

Suez Canal

In the area of Port Said the Suez Canal is highly saline and is about 18 m deep. Vertical salinity profiles show no significant stratification with the exception of the Suez Canal/Junction Canal confluence. The allowable BOD_5 increase from sewage discharge to the Suez Canal is approximately 5.0 mg/l (Volume 4, Appendix C). For primary treated effluent a dilution of 42:1 is required to meet this criteria. Calculated initial dilution for a discharge at 15 m depth is approximately 43:1. Currents in the canal are sufficient to provide clean dilution water above the discharge. With these dilutions, the assimilative capacity is ample to accept the projected 17,500 cu m/d of primary effluent from Port Fouad, with no significant impact on DO levels.

Projected coliform distributions for the subsurface discharge indicated that the discharge should be located no closer than 2 km to any area in the canal used for swimming. Primary effluent concentrations of 10^6 MPN/100 ml would be reduced to 23,000 MPN/100 ml by initial dilution. With Suez Canal current velocities of 23 cm/sec, horizontal dispersion would reduce coliform levels to about 100 MPN/100 ml in one hour or 2000 m downstream of the discharge. A suitable location is shown on Figure 6-A.

6.3 SLUDGE AND OTHER RESIDUES

Sale of Sludge

Under normal practice of the General Organization for Sewerage and Sanitary Drainage (GOSSD), raw sludge is dried and stored to promote parasite die-off before disposal. Based on GOSSD experience in Cairo, sludge is in demand as a low grade fertilizer and soil builder. Sale price is LE 1.00/cu m picked up at the drying beds.

Such agricultural use poses no significant health hazard, assuming that sludge temperatures are kept sufficiently high to promote parasite die-off and that sludge is not applied to crops for human consumption. Other disposal alternatives warrant future consideration, but for present planning we have assumed continuation of normal GOSSD practice at Port Said.

Port Said is at least 40 km from existing agricultural areas where sludge could be utilized. Reclamation of agricultural land closer to Port Said would ultimately shorten this distance, but possible effects of haul costs on the demand for sludge must be taken into

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account. Operators of the cattle manure drying business in Kabbutti have expressed some interest in purchasing wastewater sludge. In addition, there is a possible market for sludge if fish culture operations would develop close to Port Said. However, to plan carefully, we have included in the wastewater utility operating budget (Table 11.3) costs of hauling sludge to agricultural areas 40 km away. Proceeds from sale of sludge at LE 1.00/cu m would more than offset haul costs even for 40 km.

Composting

Aerobic composting of wastewater sludge with municipal refuse produces a high quality soil builder/fertilizer in volumes well above those of sludge alone. Process temperatures of 50°C or more virtually eliminate infective parasites, yielding a product that can be used much more widely than dried sludge.

In view of these advantages, we have evaluated composting as an add-on process to follow sludge drying. Composting costs were based on the static pile process currently being successfully used in the U.S. In this process, shredded refuse and sludge are windrowed over air suction lines. Blowers draw air through the windrows, promoting active aerobic composting. When the batch process is complete, the product is removed and screened prior to disposal. A portion of the product is used to cover new windrows and to absorb odors from the blower discharge.

Estimated Port Said year 2000 sludge load is 32 T/day dry solids (Table 7.2). A composting facility with capacity for this load plus 570 cu m/d of refuse (35 to 40 percent of the estimated year 2000 solid waste production in Port Said) would cost nearly LE 1,000,000. Almost 500 cu m/d of compost would be produced at an operating cost of LE 0.50 to 0.80 per cu m. Total cost over 20 years would be LE 1.10 to 1.40 per cu m of compost.

The economics of the operation obviously relate to the costs of alternatives for solid waste disposal. Unless the compost can be sold at a price that will result in savings in solid waste disposal, composting will represent an unnecessary additional cost for wastewater sludge disposal.

It can be reasonably assumed that the greater acceptability of compost as compared to dried raw sludge would be reflected in its price. Because a market already exists for sludge, the wastewater utility could expect its cost to be no higher for composting than for direct sale of dried sludge.

The solid waste study recommended among the High Priority projects for Port Said (Chapter 8) should determine whether composting can show economic benefits.

Other Residues

It is recommended that grit and scum be removed from the sewage treatment plant by truck and transported to solid waste disposal sites. Anticipated quantities of 2 to 4 cu m/d are less than 0.7 percent of the estimated daily solid waste production in the Port Said/Port Fouad area.

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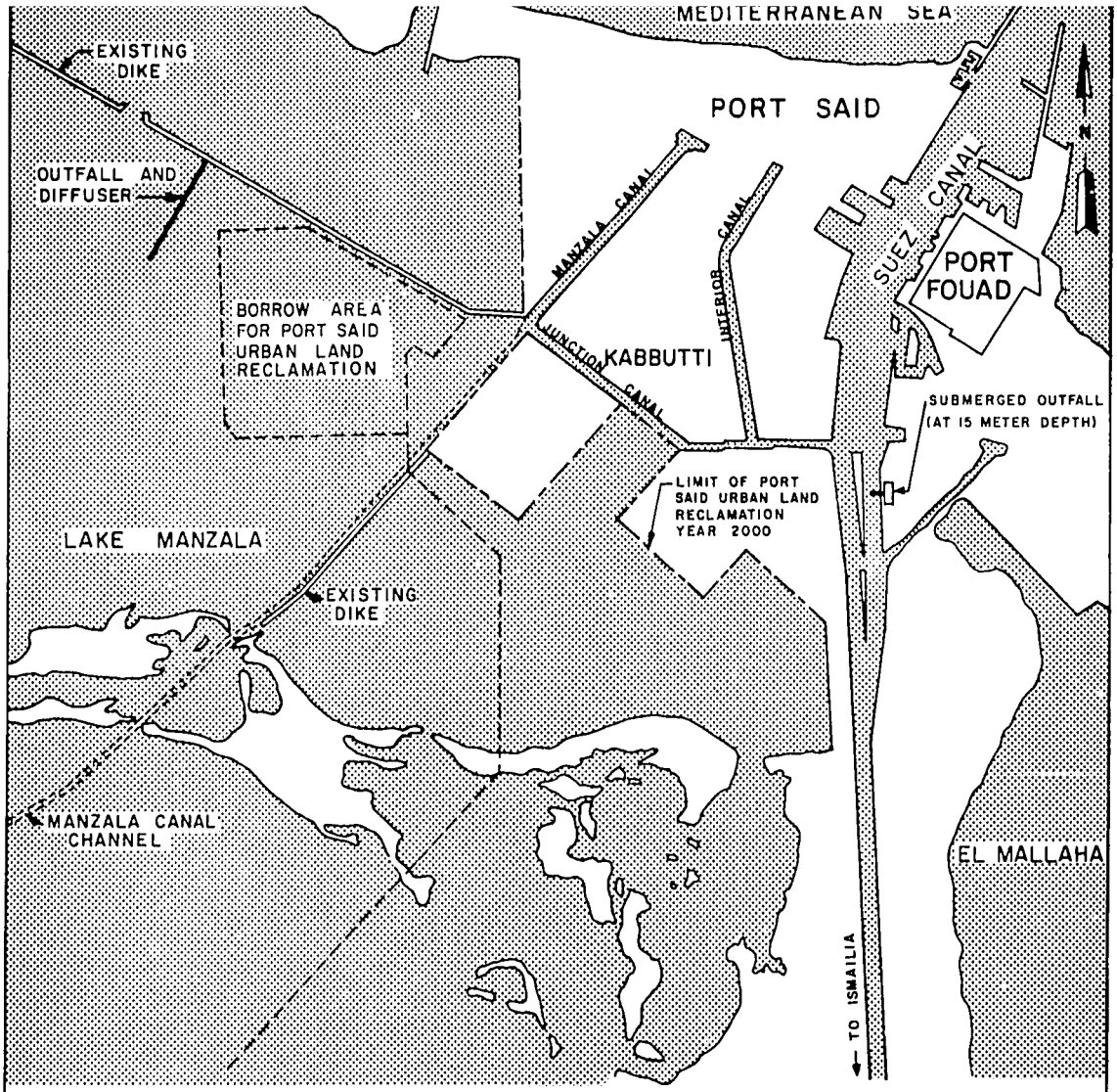

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ARAB REPUBLIC OF EGYPT

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

RECOMMENDED LOCATIONS FOR OUTFALLS

VOL.3 FIG. 6-A

CHAPTER 7

WASTEWATER TREATMENT

7.1 WASTEWATER TREATMENT FACILITIES

Existing Facilities

The Mazrah Sewage Treatment Plant provided treatment for most of Port Said until the 1967 war. Since then raw wastewater has been bypassed around the plant and has discharged into Lake Manzala. About one third of the wastewater in Port Fouad is treated and disposed of through individual on-site systems, while the remaining flows are collected and discharged without treatment.

As shown in Figure 7-A, the facilities at Mazrah consist of three liquid treatment systems plus sludge drying beds:

System 1 includes a grit chamber, primary sedimentation basins rated at 17,500 cu m/d, and trickling filters nominally rated at 3,000 cu m/d but actually of less capacity because of clogged media, clogged underdrains, or both.

System 2 consists of screening and grit removal equipment (2,400 cu m/d), primary clarifiers (14,200 cu m/d), aeration basins and final clarifiers (7,400 cu m/d).

System 3 includes primary sedimentation basins presently rated at 12,000 cu m/d. Removal of the internal compartment walls would raise the capacity of these units to 33,000 cu m/d.

Sludge drying beds, of unknown capacity and flooded six months of the year presumably because of poor drainage through sand and/or underdrain system.

An inventory of existing facilities at Mazrah including dimensions, capacity, and other details is included in Table 7.1.

Except for minor damage to the blower building during the war and cracking or spalling of concrete in walkways, stairs, and walls, the plant structures are basically sound. A rehabilitation program by the Governorate of Port Said (GOPS) has been underway some time and is expected to be completed in the near future. This program includes completion of the new settling tanks, repair of structural damage, replacement of damaged mechanical equipment, and other facilities needed for a workable plant.

It has been demonstrated in Vol. 4 and in Chapter 6 of this volume that wastewater can be discharged safely into Lake Manzala after primary treatment only, and that secondary treatment facilities will not be needed. Accordingly, further work on secondary structures and equipment should be deferred until engineering studies are conducted to determine their appropriate use or disposition. Furthermore, work on the primary facilities should be limited to fairly simple and inexpensive repairs and modifications needed to return these units to service promptly, if found necessary or desirable.

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7.2 WASTEWATER TREATMENT ALTERNATIVES

In planning for a larger population, a greater service area, and wastewater flows in the year 2000, which will be more than twice the present flows, a number of possible alternatives have been examined. Of these, four have been selected as most promising:

Alternative	Area Served	Treatment Plant	Discharge 1000 cu m/d 1982	Discharge 1000 cu m/d 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

The daily flows taken from Table 7.2 indicate approximate division of loads anticipated between 1982 and 2000.

Principal elements of the alternatives are shown in Figure 7-B and 7-C. They include the three plant locations (Mazrah, Southwest and Fouad), effluent discharge for Port Fouad, and alternatively, a force main under the canal to Port Said; proposed landfill for the Southwest plant, sludge treatment area, and existing and proposed dikes for access and to carry force mains and effluent lines.

The estimated population served, average daily flow, BOD, SS, sludge solids and volume are shown in Table 7.2 for the wastewater treatment alternatives in 1982, 1985, 1990, 1995, and 2000; and design data for Alternatives 1-A, 2-A, and 2-B in Tables 7.3, 7.4, and 7.5.

7.3 MAZRAH STP IMPROVEMENTS

The layout of facilities at Mazrah under Alternatives 1-A and 2-A or 2-B is shown in Figures 7-D and 7-E. Under Alternative 1-B new primary tanks would be somewhat larger. Figure 7-F shows a typical primary sedimentation basin. Existing tankage at Mazrah would be utilized as follows:

System 1: under Alternatives 2-A and 2-B, would be converted to preliminary treatment of the entire flow; new screens and inlet channels would be added, and

the existing primary tanks would be converted to grit tanks. Under Alternative 1-A, new preliminary facilities would be built similar to those shown on Figure 7-H.

System 2: The aeration tank volume would be converted to (a) primary settling tanks and (b) a suction well for the effluent pumping station. The settling tanks would be similar to the proposed new facilities, with traveling bridge scraping mechanisms if they can be installed beneath the cross bracing at the top of the walls. If not feasible, chain type collectors should be used. The tank floor is to be built up as required for the scraper mechanism, sumps, and sludge drawoff. Existing primary settling tanks would be retained, and secondary settling tanks would be converted to sludge storage. New sludge pumping stations would be added.

System 3: Compartment walls and baffles would be removed and walls braced as needed. Collector mechanisms and sludge drawoff arrangements would be similar to those for new primary tanks (Figure 7-F). Tank floors would be built up with sludge sumps and channels installed as required for the mechanisms. Existing influent, screen and grit channels would be filled in as needed to assure velocities high enough to avoid deposition of solids.

Mazrah alternatives would include an effluent pumping station discharging through force mains to the outfall, with the force main constructed in a new dike from Mazrah to the existing dike and inlet end of the proposed outfall (see Figure 7-B). To limit peak flows to the outfall, the pumping station would draw from the suction well formed from part of the existing aerators. A detention of 36 minutes with the well full should limit peak pumpage to 1.6 times the average daily flow. Raw sludge would be discharged through a force main to new drying beds located on reclaimed land at the inlet end of the proposed outfall.

If the water table at the existing drying beds at Mazrah can be lowered, these beds should be used until land development in Drainage Area 13 encroaches on the buffer zone around the plant (expected in 1990). After that time, raw sludge drying should be removed to the remote location. If dewatering existing sludge drying beds can be accomplished by the installation of pumps to lower the water level in existing underdrain sumps this should be done. If, however, rebuilding of the underdrains is needed, an alternative interim measure such as sludge lagoons should suffice until the sludge pumping station force main and new remote drying beds can be completed. For early resumption of primary treatment, funds for dewatering the beds or construction of an interim lagoon are included in the High Priority Program.

7.4 SOUTHWEST STP AND PORT FOUAD

The Southwest treatment plant would be located on reclaimed land along the dike at the inlet end of the outfall, shown on Figure 7-G. The preliminary treatment unit layout is similar to that shown on Figure 7-H. Drying beds would handle sludge pumped from Mazrah and from the Southwest plant (Figure 7-F). The primary tanks would be built with a maximum water surface elevation of +4.7 m, providing sufficient head for gravity discharge through the outfall. The tanks would be designed to permit flow line variations of up to 0.5 m. This would be sufficient to reduce the maximum outflow to the design flow of 1.6 times average daily flow.

Port Fouad

Under Alternatives 1-A or 2-A, separate primary treatment facilities for Port Fouad would be located along the Suez Canal about 3 km south of the presently developed

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area. The proposed layout is shown on Figure 7-I. Raw sludge would be dried in beds at the plant.

Under Alternatives I-B and 2-B, preliminary treatment to prevent deposition of grit or coarse solids in the siphon under the Suez Canal would be provided at the Port Fouad main pumping station as shown in Figure 7-J.

7.5 CAPITAL COSTS

On the basis of preliminary designs outlined above, the costs of the treatment and effluent disposal facilities under Alternatives I-A, 2-A and 2-B have been estimated as summarized in Tables 7.6 through 7.9.

TABLE 7.1

INVENTORY OF EXISTING FACILITIES AT MAZRAH SEWAGE TREATMENT PLANT

Process and Unit	Units	Depth (m)	Length (m)	Width (m)	Diameter	Slope (m/100 m)	Volume (cu m)	Surface (sq m)	Capacity (cu m/d)
							TOTAL		
1) Trickling Filter System:									
a) Incoming Sewer	1	-	-	-	600 mm	Force Main	-	-	-
b) Distribution Box	1	0.85	1.05	1.05	-	-	0.94	1.10	-
c) Screen Chamber	2	2.00	1.40	2.50	-	30 degrees	-	10.0 (1)	140,000(2)
d) Grit Chamber	2	2.00	4.30	2.75	-	-	30.25	23.65	17,000(3)
e) Settling Tanks	2	2.00	35.00	10.00	-	-	1,400.0	700.0	17,500(4)
f) Effluent Channel	1	0.85	62.00	0.60	-	0.001	-	-	28,850(5)
g) Trickling Filters	4	0.90	-	-	30.0 m	-	2,500.0	2,800	3,000
h) T.F. Collection Channels	4	0.60	92.0	0.40	-	0.006	-	-	104,000
	4	0.60	6.0	0.40	-	0.006	-	-	104,000
i) T.F. Effluent Channels	4	0.40	65.0	0.60	-	0.005	-	-	22,000
2) Activated Sludge System									
a) Incoming Sewer	-	-	-	-	355 mm	Force Main	-	-	Abandoned
b) Distribution Box	1	1.50	1.50	1.70	-	-	3.83	2.55	-
c) Screen Chamber (Mechanical)	1	0.85	0.95	0.60	-	-	-	0.52	16,800
d) Effluent Channel	1	0.80	5.00	0.60	-	0.001	-	-	24,000
e) Grit Chamber (Mechanical)	1	0.85	4.0	3.00	-	-	10.2	12.0	8,600(3)
f) Parshall Flume	1	3.00	5.00	0.23	-	-	-	-	34,280
g) Piping to Settling Tanks	2	-	11.00	-	450 mm	0.005	-	-	34,000
h) Primary Settling Tanks	2	3.60	-	-	19.0 m	2.040	14.18	567.0	14,200(4)
i) Channel to Aeration Tanks	1	3.60	38.0	0.95	-	0.001	-	-	36,000
j) Aeration Tanks	8	-	-	-	-	-	-	-	-
No. 1	1	4.0	50.0	1.50					
No. 2 & 3	2	4.0	50.0	3.00		-	6,000	1,425(6)	36,000(7)
No. 4,5,6,7 and 8	5	4.0	50.0	4.50					
k) Piping to Secondary Settling Tanks	2	-	7.50	-	450 mm	0.005	-	34,000	
l) Secondary Settling Tanks	2	2.50	-	-	14.0 m	-	770	308.0	7,700(7)
m) Return Sludge Pipe	2	-	-	-	-	-	-	-	-
n) Activated Sludge Pipes									
i) to Aeration Tank	1	-	-	-	-	-	-	-	-
ii) to Primary Clarifiers	1	-	-	-	-	-	-	-	-

TABLE 7.1 (Cont.)

INVENTORY OF EXISTING FACILITIES AT MAZRAH SEWAGE TREATMENT PLANT

Process and Unit	Units	Depth (m)	Length (m)	Width (m)	Diameter	Slope (m/100 m)	Volume (cu m)	Surface (sq m)	Capacity (cu m/d)
			"	TOTAL					
3) New Units (Primary Treatment)									
a) Incoming Sewer	-	-	-	-	300 mm	Force Main	-	-	-
b) Distribution Box	1	2.54	-	-	6.00 m	-	45.3	-	-
(Conical)					2.50 m				
c) Approach Channels	2	0.75	20.0	0.60	-	0.0005	-	-	-
d) Screen Chambers	4	1.00	5.0	2.0	30°	-	-	2.0(1)	55,600(2)
(Openings 4 cm)									
e) Grit Chambers	4	1.0	8.0	2.0	-	-	64.0	64.0	46,000(3)
f) Desanders	4	3.00	8.0	5.25	-	-	-	-	-
g) Settling Tanks									
(3 per tank) (series)									
No. 1	4	3.0	8.0	8.0	-	-	768.0	256.0	-
No. 2	4	3.0	15.0	8.0	-	-	1,440.0	480.0	12,000(8)
No. 3	4	3.0	15.0	8.0	-	-	-	480.0	-
h) Sludge Collecting Channel	2	-	38.2	-	0.50 m	0.00026	-	-	-
i) Wastewater Effluent Pipe	2	-	-	-	300 mm	-	-	-	-
4) Drying Beds									
a) Beds	-	-			-				-
b) Underdrain									
i) Sand	unknown								
ii) Gravel	"								
iii) Pipe	"		21.0	-	100 mm	unknown	(one at center of bed)		
c) Discharge Channels	1	0.50	2,300(T)	0.50	-	"			
d) Discharge Pipe	1	SUP.	475(T)	-	150 mm	"			
e) Drainage System									
i) Pipe	-	1.60	2.700	(total)	150 mm	"			
ii) Open Ditch	1	0.90	140.0	1.20	-	"			

(1) Projected vertical area.
(2) Peak capacity with 2.5 cm bar spacing and 0.45 m/s velocity.
(3) Peak capacity at 720 m/d overflow rate.
(4) Capacity at 25 m/d, 35% BOD removal.
(5) Capacity at a BOD loading of 0.4 kg/d/cu m, assuming raw BOD concentration = 432 mg/l, settled BOD concentration = 280 mg/l.
(6) Excluding the 1.5 m wide channel (Aeration Tank No. 1).
(7) Capacity as a primary settling tank at 25 m/d.
(8) Based on largest compartment at 25 m/d would be 30,400 if entire tank functioned as a unit.

TABLE 7.2

WASTEWATER TREATMENT ALTERNATIVES

ESTIMATED FLOWS AND LOADS

	1982	1985	1990	1995	2000
Alternative 1-A (All Port Said flow to Mazrah)					
Population	314,700	360,500	448,100	546,000	646,000
Average daily flow cu m/d	73,000	89,000	118,000	142,000	171,500
BOD kg/d	25,300	29,800	39,100	47,600	56,600
SS kg/d	22,500	26,800	34,800	42,200	50,200
Sludge solids kg/d(1)	13,500	16,100	20,900	25,300	30,100
Sludge volume cu m/d(2)	270	321	418	506	602
Alternative 2-A and 2-B (Mazrah)					
Population	257,600	256,100	287,700	361,000	353,000
Average daily flow cu m/d	52,000	53,000	63,000	80,000	81,000
BOD kg/d	20,200	20,400	24,600	30,900	30,200
SS kg/d	17,900	18,400	21,900	27,400	26,800
Sludge solids kg/d(1)	10,700	11,000	13,100	16,400	16,100
Sludge volume cu m/d(2)	214	221	263	329	322
Alternative 2-A (Southwest)					
Population	57,100	104,400	161,400	185,600	293,000
Average daily flow cu m/d	21,000	36,000	55,000	61,000	89,000
BOD kg/d	5,100	9,400	14,500	16,700	26,400
SS kg/d	4,600	8,400	12,900	14,800	23,400
Sludge solids kg/d(1)	2,800	5,000	7,700	8,900	14,100
Sludge volume cu m/d(2)	55	100	155	178	281

(1) At 60% removal of SS
(2) At 5% concentration

TABLE 7.2 (Cont'd)

WASTEWATER TREATMENT ALTERNATIVES

ESTIMATED FLOWS AND LOADS

	1982	1985	1990	1995	2000
Alternative 1-A and 2-A (Port Fouad)					
Population	24,300	29,500	38,000	38,000	38,000
Average daily flow cu m/d	12,000	12,000	15,000	16,000	17,500
BOD kg/d	1,600	2,400	3,200	3,200	3,200
SS kg/d	1,400	2,100	2,900	2,900	2,900
Sludge solids kg/d(1)	800	1,300	1,700	1,700	1,700
Sludge volume cu m/d(2)	17	25	35	35	35
Alternative 1-B (All flow to Mazrah)					
Population	339,000	390,000	486,100	584,600	684,000
Average daily flow cu m/d	85,000	101,000	133,000	158,000	189,000
BOD kg/d	26,900	32,200	42,300	50,800	59,800
SS kg/d	23,900	28,900	37,700	45,100	53,100
Sludge solids kg/d(1)	14,300	17,300	22,600	27,100	31,900
Sludge volume cu m/d(2)	287	347	452	541	637
Alternative 2-B (Southwest)					
Population	81,400	133,900	199,400	223,600	331,000
Average daily flow cu m/d	33,000	48,000	70,000	78,000	108,000
BOD kg/d	6,700	11,800	17,700	19,900	29,600
SS kg/d	6,000	10,500	15,800	17,700	26,300
Sludge solids kg/d(1)	3,600	6,300	9,500	10,600	15,800
Sludge volume cu m/d(2)	72	126	190	212	316

(1) At 60% removal of SS
(2) At 5% concentration

TABLE 7.3

ALTERNATIVE 1-A

DESIGN DATA

Location	Mazrah		Port Fouad	
Year	1990	2000	1985	2000
Plant Influent				
Avg daily flow cu m/d	118,000	171,500	12,000	17,500
BOD kg/d	39,100	56,600	2,400	3,300
SS kg/d	34,800	50,200	2,100	2,900
Primary Treatment				
Surface area req'd sq m	4,720	6,800	480	680
No. of tanks	13	17	4	4
Length x width m	(1)	(1)	6 x 30	6 x 30
Surface area provided sq m	5,490	6,930	720	720
Sludge production kg/d	20,900	30,100	1,300	1,700
(5%) cu m/d	418	602	26	35
Primary effluent				
BOD kg/d	25,400	36,800	1,600	2,100
SS kg/d	13,900	20,100	900	1,300
Sludge Beds				
Sludge flow cu m/d	418	502	26	35
Bed area req'd sq m	25,080	36,120	1,600	2,100
Area provided sq m	25,200	36,400	1,600	2,400
No. of beds	126	182	8	12
Dry sludge production cu m/d	139	200	9	12

(1) Existing System 1: 2 tanks 10 x 35 — 700 sq m
Existing System 2: 2 19 m dia — 570 sq m
Existing System 2: 1 30 x 50 — 1500 sq m
Existing System 3: 4 tanks 8 x 40 — 1280 sq m
New additional tanks: 8 at 8 x 45 — 2880 sq m

TABLE 7.4

ALTERNATIVE 2-A

DESIGN DATA(1)

Location	Mazrah		Southwest	
Year	1990	2000	1990	2000
Plant Influent				
Avg daily flow cu m/d	63,000	82,000	55,000	89,000
BOD kg/d	24,600	30,200	14,500	26,400
SS kg/d	21,900	26,800	12,900	23,400
Primary Treatment				
Surface area req'd sq m	2,520	3,240	2,200	3,560
No. of tanks	7	7	4	6
Length x width m	(2)	(2)	12 x 50	12 x 50
Surface area provided sq m	3,350	3,350	2,400	3,600
Sludge production kg/d	13,100	16,100	7,700	14,100
(5%) cu m/d	263	322	155	281
Primary effluent				
BOD kg/d	16,000	19,600	9,400	17,200
SS kg/d	8,800	10,700	5,200	9,300
Sludge Beds				
Sludge flow cu m/d			418	602
Bed area req'd sq m			25,080	36,120
Area provided sq m			25,200	36,400
No. of beds			126	182
Dry sludge production cu m/d			139	200

(1) Port Fouad design data same as under Alternative 1-A (Table 7.3).
(2) Existing System 2: 2 tanks 19 m dia 570 sq m
Existing System 2: aerator 30 x 50 1500 sq m
Existing System 3: 4 tanks 8 x 40 1280 sq m

TABLE 7.5

ALTERNATIVE 2-B

DESIGN DATA

Location	Mazrah		Southern	
Year	1990	2000	1990	2000
Plant Influent				
Avg daily flow cu m/d	63,000	81,000	70,000	108,000
BOD kg/d	24,600	30,200	17,700	29,600
SS kg/d	21,900	26,800	15,800	26,300
Primary Treatment				
Surface area req'd sq m	2,520	3,240	2,800	4,240
No. of tanks	7	7	4	6
Length x width m	(1)	(1)	14 x 50	14 x 50
Surface area provided sq m	3,350	3,350	2,800	4,200
Sludge production kg/d	13,100	16,100	9,500	15,800
(5%) cu m/d	263	322	190	316
Primary effluent				
BOD kg/d	16,000	19,600	11,500	19,200
SS kg/d	8,800	10,700	6,300	10,500
Sludge Beds				
Sludge flow cu m/d			453	638
Bed area req'd sq m			27,180	38,280
Area provided sq m			28,000	39,200
No. of beds			140	196
Dry sludge production cu m/d			151	213

(1) Existing System 2: 2 tanks 19 m dia 570 sq m
Existing System 2: aerator 30 x 50 1500 sq m
Existing System 3: 4 tanks 8 x 40 1280 sq m

TABLE 7.6

ALTERNATIVE I-A COST SUMMARY

PORT SAID

(Thousands of 1978 LE)

	Pipeline Costs	Equipment Installa-tion	Structures & Misc.*	TOTAL
High Priority & Immediate Phase				
Preliminary Treatment		561	274	835
Primary Sedimentation		550	175	725
Sludge Pump Station		16	18	34
Sludge Force Main	102	-	-	102
Land Reclamation			391	391
Drying Beds	85	6	347	438
Underdrainage Pump Station		15	20	35
Yard Piping	640			640
Subtotal	827	1148	1225	3200
Contingencies (20%)	165	230	245	640
Support (31.5%)	260	362	386	1008
TOTAL	1252	1740	1856	4848
Staged Development Phase Works				
Preliminary Treatment		374	182	556
Primary Sedimentation		420	580	1000
Sludge Pump Station		4	0	4
Drying Beds	37	2	149	188
Yard Piping	437			437
Subtotal	474	800	911	2185
Contingencies (20%)	95	160	182	437
Support (31.5%)	149	252	287	688
TOTAL	718	1212	1380	3310

*E.g., landscaping, roads and drainage.

TABLE 7.7

ALTERNATIVE 2-A COST SUMMARY

PORT SAID

(Thousands of 1978 LE)

	Pipeline Costs	Equipment Installa-tion	Structures & Misc.*	TOTAL
High Priority & Immediate Phase				
Mazrah				
Preliminary Treatment		330	72	402
Primary Sedimentation		380	130	510
Sludge Pump Station		10	20	30
Sludge Force Main	68			68
Yard Piping	377			377
Southwest				
Land Reclamation			490	490
Preliminary Treatment		371	180	551
Primary Sedimentation		355	482	837
Drying Beds	83	6	339	428
Underdrainage P.S.		15	20	35
Yard Piping	461			461
Subtotal	989	1467	1733	4189
Contingencies (20%)	198	293	347	838
Support (31.5%)	312	462	546	1320
TOTAL	1499	2222	2626	6347
Staged Development Phase Works				
Mazrah				
Preliminary Treatment		110	24	134
Primary Sedimentation		70	10	80
Yard Piping	70			70
Southwest				
Preliminary Treatment		124	60	184
Primary Sedimentation		175	238	413
Drying Beds	37	2	152	191
Yard Piping	180			180
Subtotal	287	481	484	1252
Contingencies (20%)	57	96	97	250
Support (31.5%)	90	152	152	394
TOTAL	434	729	733	1896

*E.g., landscaping, roads and drainage.

TABLE 7.8

ALTERNATIVE 2-B COST SUMMARY

PORT SAID

(Thousands of 1978 LE)

	Pipeline Costs	Equipment Installa-tion	Structures & Misc.*	TOTAL
High Priority & Immediate Phase				
Mazrah				
Preliminary Treatment		330	72	402
Primary Sedimentation		380	130	510
Sludge Pump Station		10	20	30
Sludge Force Main	68			68
Yard Piping	377			377
Southwest				
Land Reclamation			490	490
Preliminary Treatment		420	198	618
Primary Sedimentation		440	600	1040
Drying Beds	93	6	376	475
Underdrainage P.S.		15	20	35
Yard Piping	523			523
Subtotal	1061	1601	1906	4568
Contingencies (20%)	212	320	381	913
Support (31.5%)	334	504	600	1438
TOTAL	1607	2425	2887	6919
Staged Development Phase Works				
Mazrah				
Preliminary Treatment		110	24	134
Primary Sedimentation		70	10	80
Yard Piping	70			70
Southwest				
Preliminary Treatment		140	66	206
Primary Sedimentation		220	300	520
Drying Beds	37	2	153	192
Yard Piping	189			189
Subtotal	296	542	553	1391
Contingencies (20%)	59	108	111	278
Support (31.5%)	93	171	174	438
TOTAL	448	821	838	2107

*E.g., landscaping, roads and drainage.

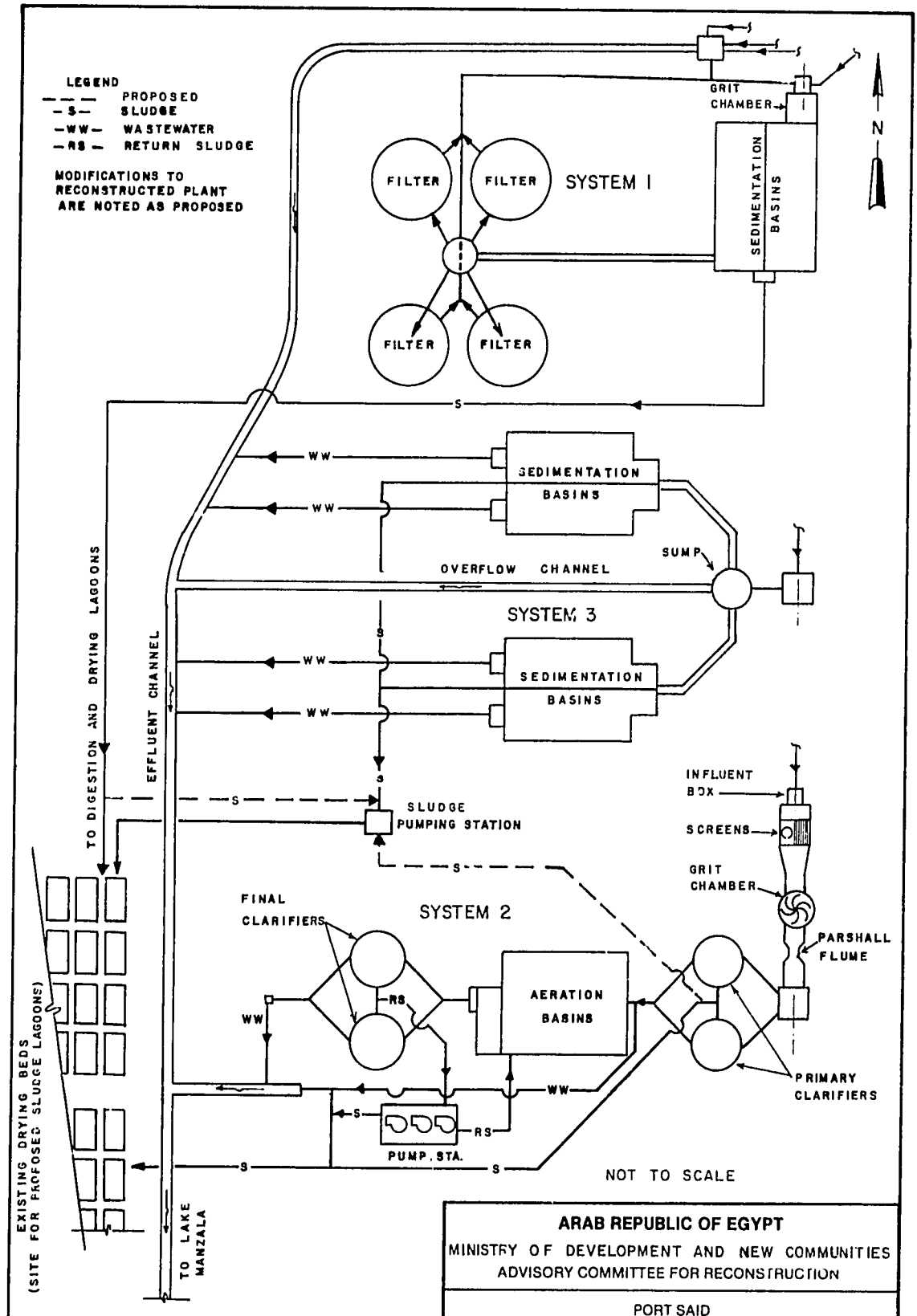
TABLE 7.9

ALTERNATIVES 1-A & 2-A COST SUMMARY

PORT FOUAD

(Thousands of 1978 LE)

	Pipeline Costs	Equipment Installa-tion	Structures & Misc.	TOTAL
Immediate Phase Works				
Preliminary Treatment		165	54	219
Primary Sedimentation		100	140	240
Drying Beds	9	4	35	48
Underdrainage P.S.		15	20	35
Yard Piping	115	—	—	115
Subtotal	124	284	249	657
Contingencies (20%)	25	57	50	132
Support (31.5%)	39	89	78	206
TOTAL	188	430	377	995



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PORT SAID
WATER AND WASTEWATER FACILITIES MASTER PLAN

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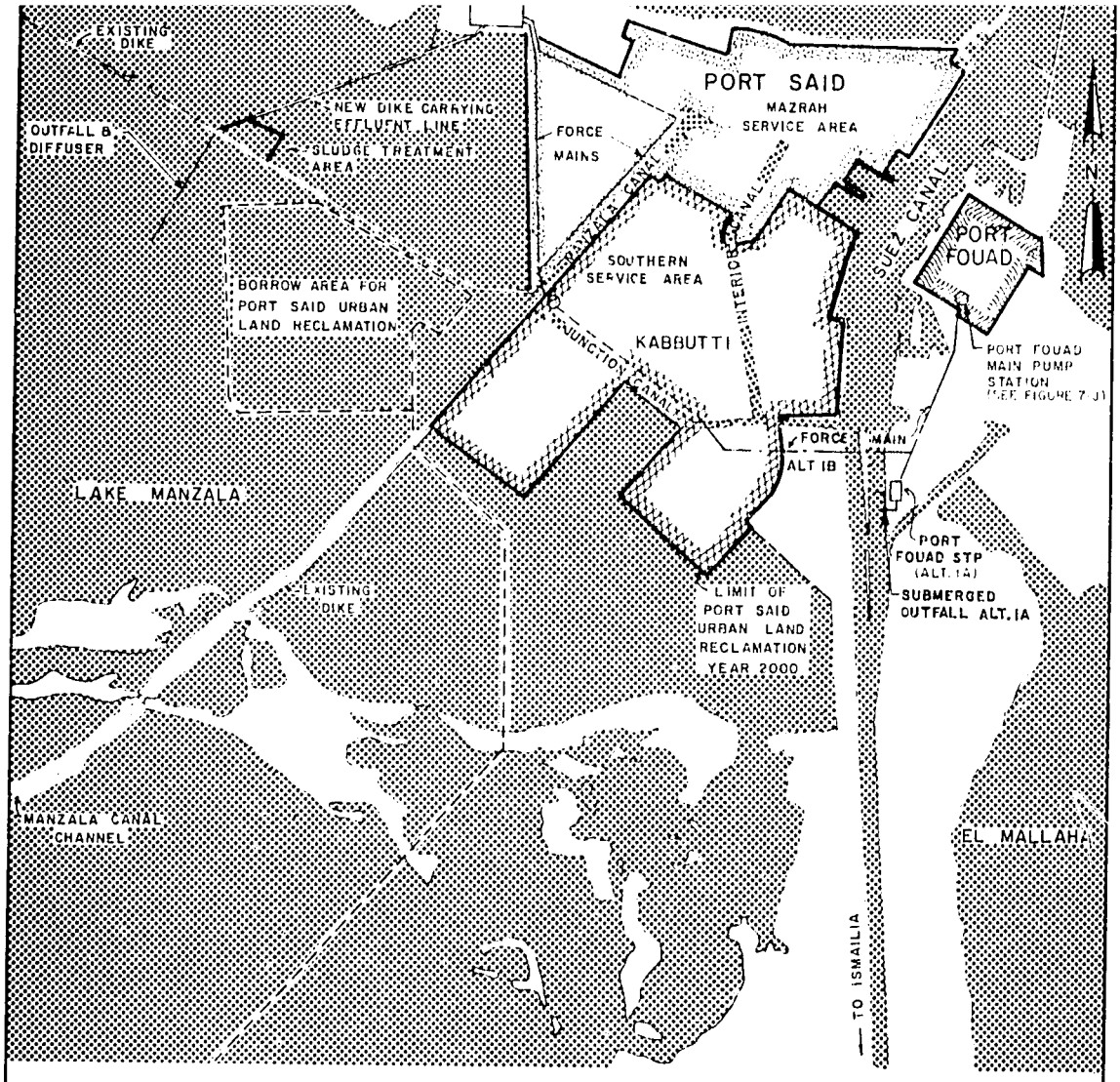
EXISTING MAZRAH SEWAGE TREATMENT PLANT SCHEMATIC FLOW DIAGRAM

VOL.3
FIG. 7-A



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

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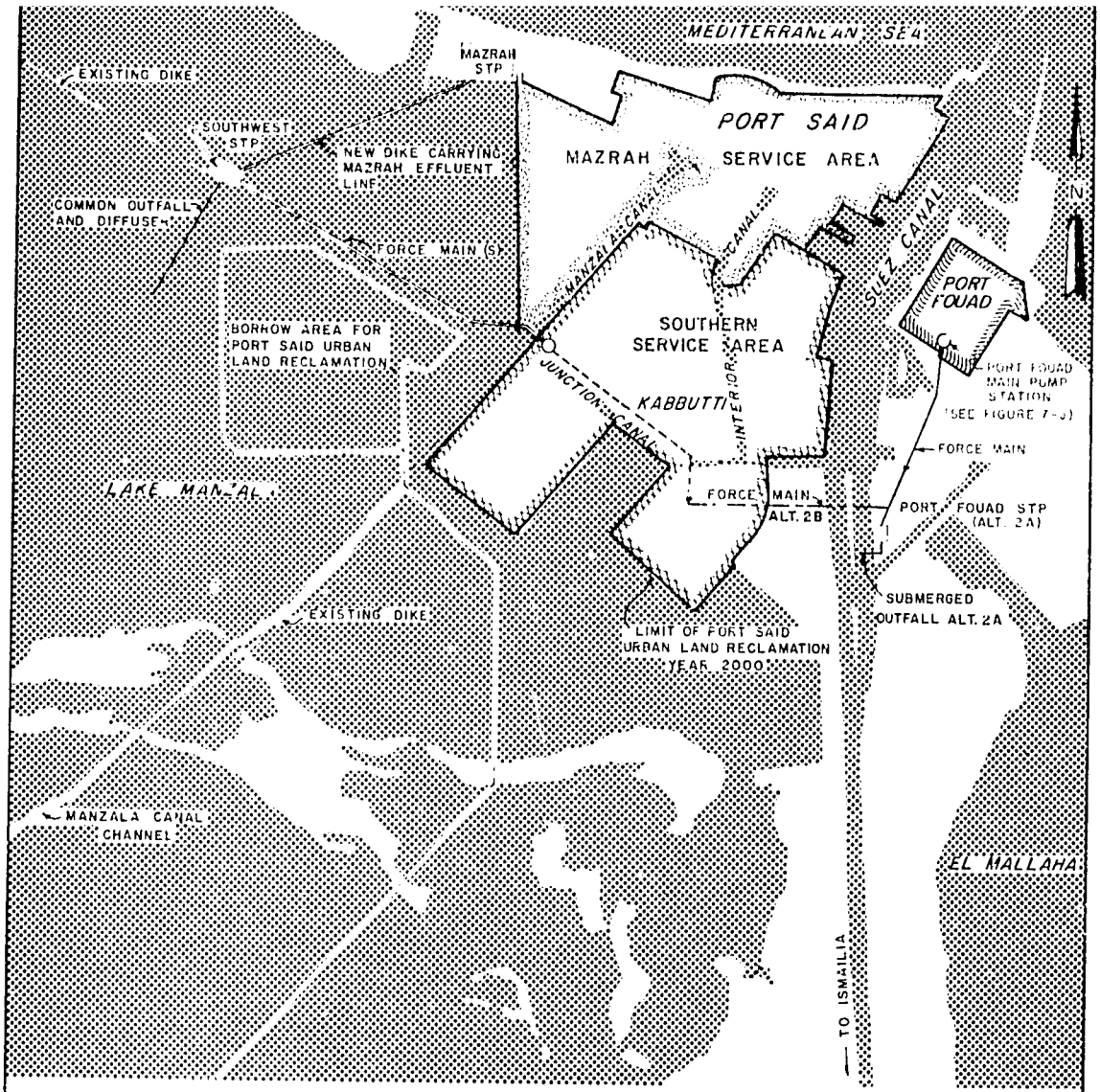
WASTEWATER TREATMENT ALTERNATIVES IA & IB

VOL.3
FIG.
7-B

a1



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

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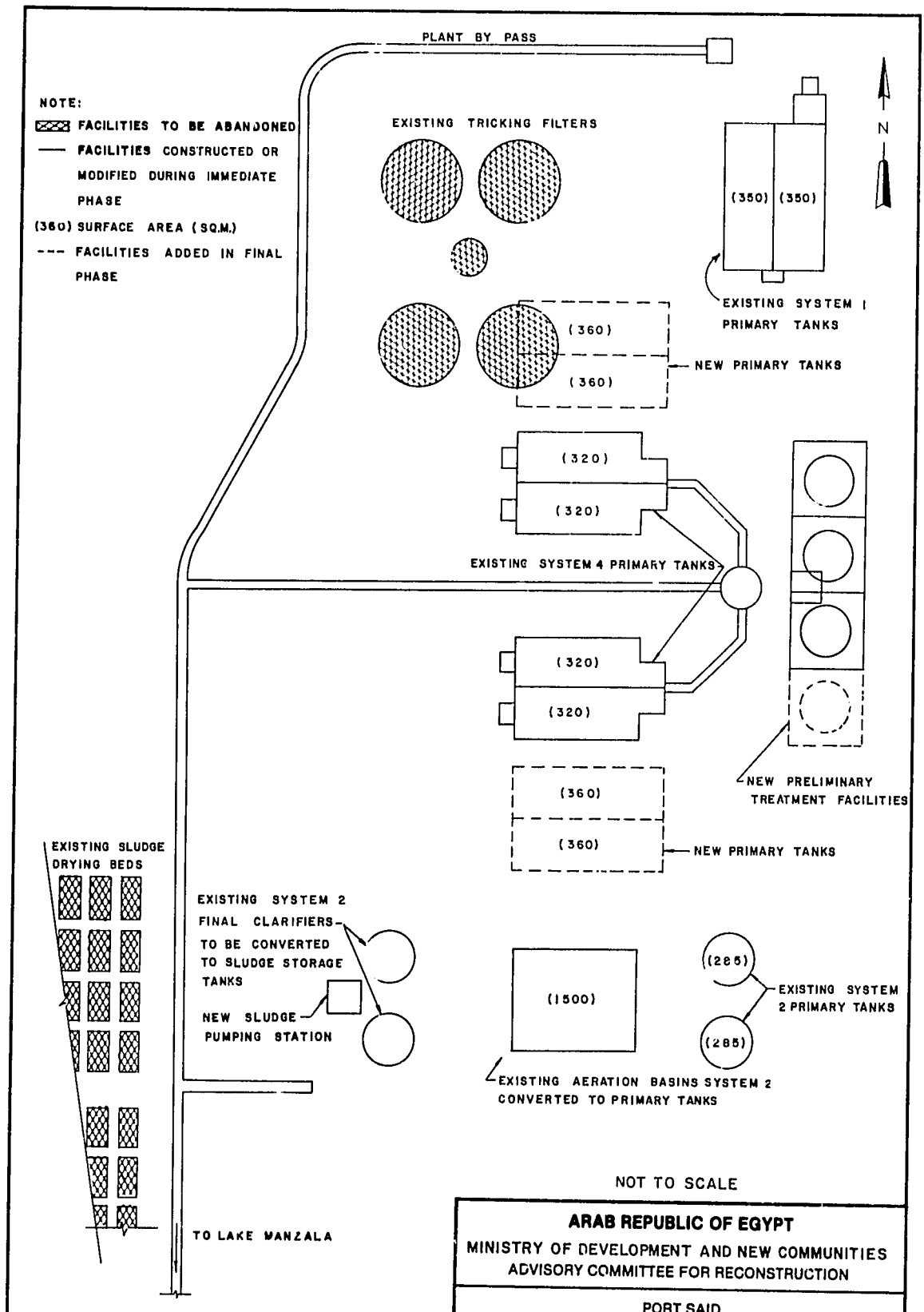
WASTEWATER TREATMENT ALTERNATIVES 2A & 2B

VOL.3
FIG.
7-C

92


PLANT BY PASS
NOTE:
FACILITIES TO BE ABANDONED
FACILITIES CONSTRUCTED OR MODIFIED DURING IMMEDIATE PHASE
(360) SURFACE AREA (SQ.M.)
--- FACILITIES ADDED IN FINAL PHASE
EXISTING TRICKING FILTERS
N
(350) (350)
EXISTING SYSTEM 1 PRIMARY TANKS
(360)
(360)
NEW PRIMARY TANKS
(320)
(320)
EXISTING SYSTEM 4 PRIMARY TANKS
(320)
(320)
NEW PRELIMINARY TREATMENT FACILITIES
(360)
(360)
NEW PRIMARY TANKS
EXISTING SLUDGE DRYING BEDS
EXISTING SYSTEM 2 FINAL CLARIFIERS TO BE CONVERTED TO SLUDGE STORAGE TANKS
NEW SLUDGE PUMPING STATION
(1500)
(285)
(285)
EXISTING SYSTEM 2 PRIMARY TANKS
EXISTING AERATION BASINS SYSTEM 2 CONVERTED TO PRIMARY TANKS
TO LAKE MANZALA
NOT TO SCALE
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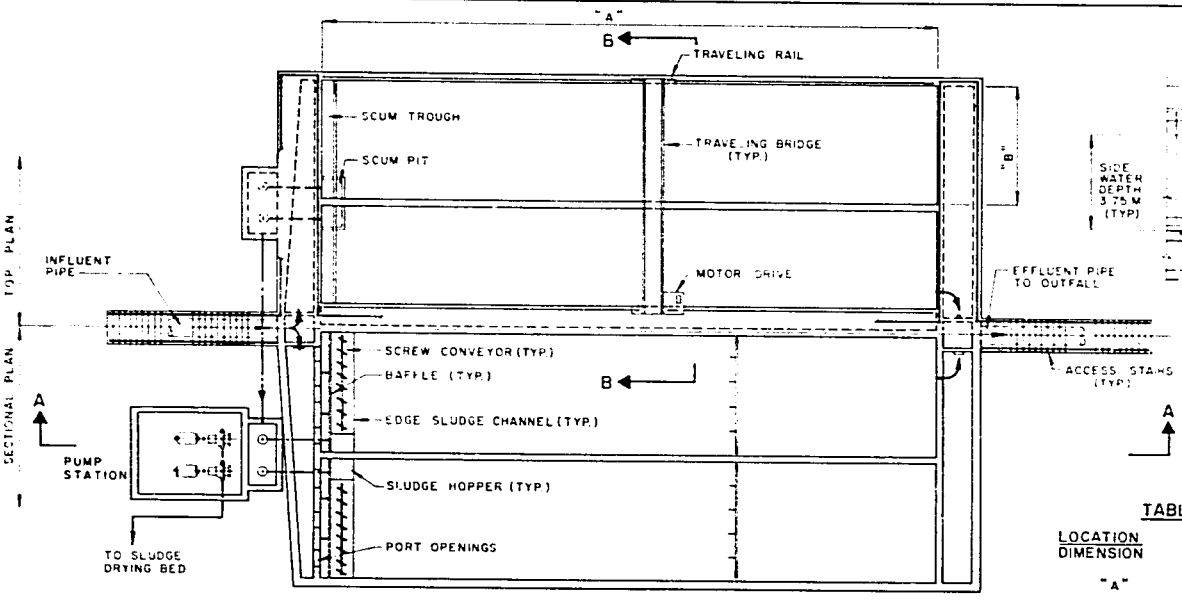
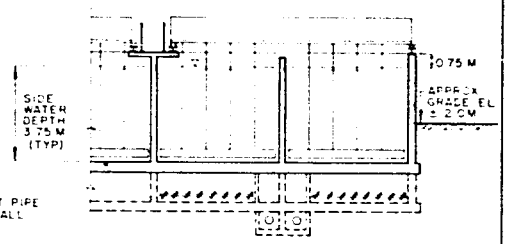
MAZRAH LAYOUT
ALTERNATIVE IA
VOL.3
FIG.
7-D

(97)



PLAN

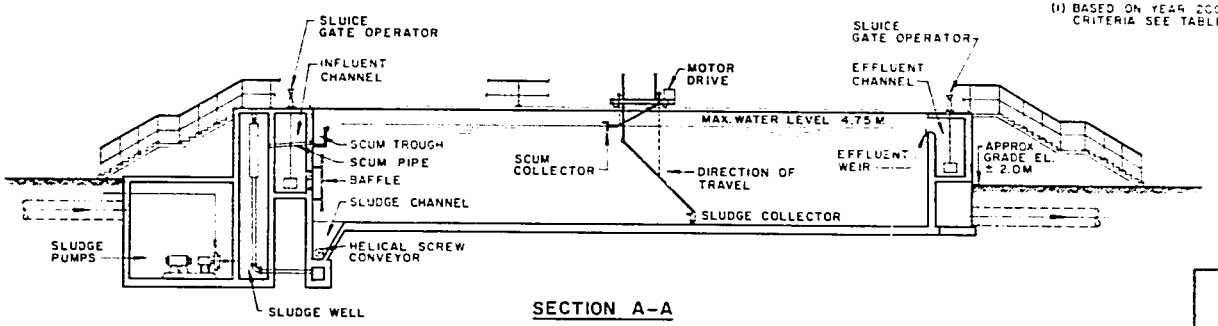


SECTION B-B

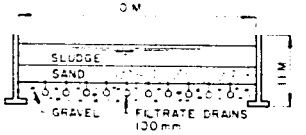
TABLE OF CRITICAL DIMENSIONS (1)

LOCATION / DIMENSION	PORT FOUAD	MAZRAH	SOUTHWEST
"A"	30	45	50
"B"	6	6	12
NUMBER OF TANKS	4	9	6

(1) BASED ON YEAR 2000 DESIGN CRITERIA SEE TABLES 7.3 & 7.4



SECTION A-A



TYPICAL SLUDGE DRYING BED SECTION
NTS

SCALE 1:200
0 5 10 M

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WATER AND WASTEWATER FACILITIES MASTER PLAN

PRIMARY SEDIMENTATION BASIN (ALL ALTERNATIVES)

VOL 3
FIG 7-F

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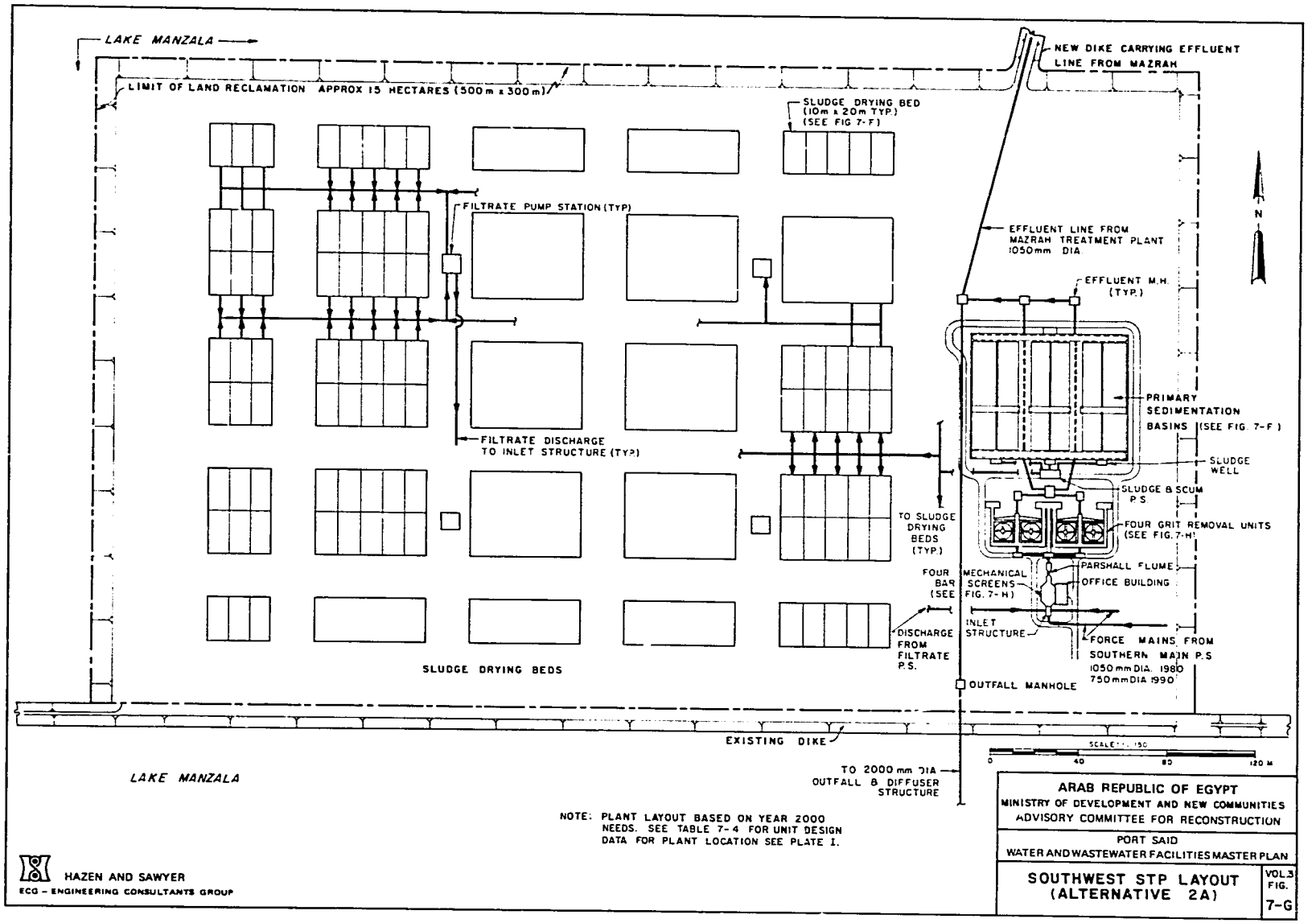
LAKE MANZALA
LIMIT OF LAND RECLAMATION APPROX 15 HECTARES (500m x 300m)
NEW DIKE CARRYING EFFLUENT LINE FROM MAZRAH
SLUDGE DRYING BED (10m x 20m TYP.) (SEE FIG 7-F)
FILTRATE PUMP STATION (TYP)
EFFLUENT LINE FROM MAZRAH TREATMENT PLANT 1050mm DIA
EFFLUENT M.H. (TYP.)
N
PRIMARY SEDIMENTATION BASINS (SEE FIG. 7-F)
FILTRATE DISCHARGE TO INLET STRUCTURE (TYP)
SLUDGE WELL
SLUDGE & SCUM P.S.
TO SLUDGE DRYING BEDS (TYP.)
FOUR GRIT REMOVAL UNITS (SEE FIG. 7-H)
PARSHALL FLUME
FOUR BAR MECHANICAL SCREENS (SEE FIG. 7-H)
OFFICE BUILDING
INLET STRUCTURE
DISCHARGE FROM FILTRATE P.S.
FORCE MAINS FROM SOUTHERN MAIN P.S
1050 mm DIA. 1980
750 mm DIA 1990
SLUDGE DRYING BEDS
OUTFALL MANHOLE
EXISTING DIKE
SCALE 1:150
0 40 80 120 M
LAKE MANZALA
TO 2000 mm DIA OUTFALL & DIFFUSER STRUCTURE
NOTE: PLANT LAYOUT BASED ON YEAR 2000 NEEDS. SEE TABLE 7-4 FOR UNIT DESIGN DATA FOR PLANT LOCATION SEE PLATE I.
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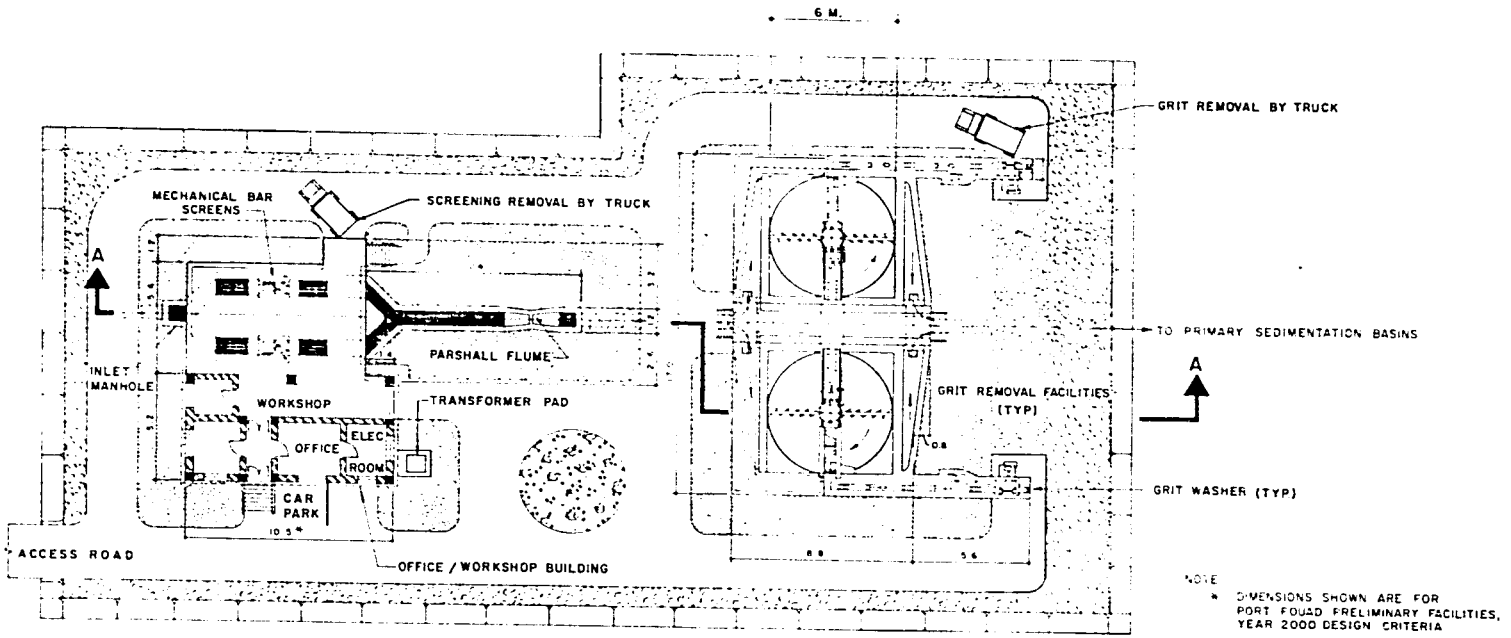
PORT SAID
WATER AND WASTEWATER FACILITIES MASTER PLAN
SOUTHWEST STP LAYOUT (ALTERNATIVE 2A)
VOL.3 FIG. 7-G

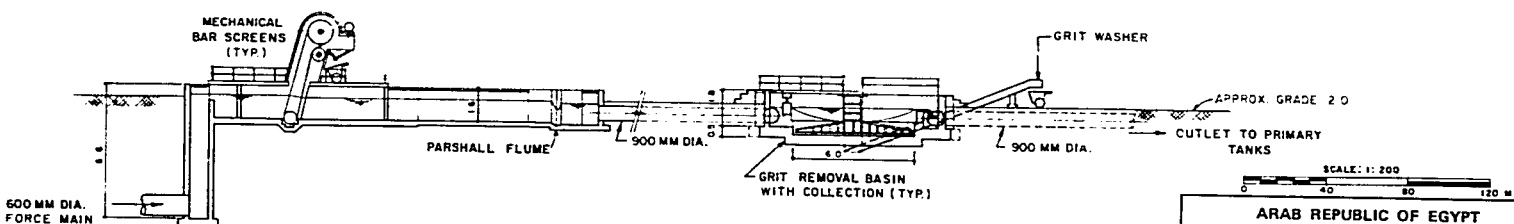


PLAN

NOTE

* DIMENSIONS SHOWN ARE FOR PORT FOUAD PRELIMINARY FACILITIES, YEAR 2000 DESIGN CRITERIA

FOR SOUTHWEST STP. FACILITIES ARE EXPANDED TO FOUR MECHANICAL BAR SCREENS AND FOUR GRIT REMOVAL UNITS (SEE FIG. 7-G)



SECTION A-A

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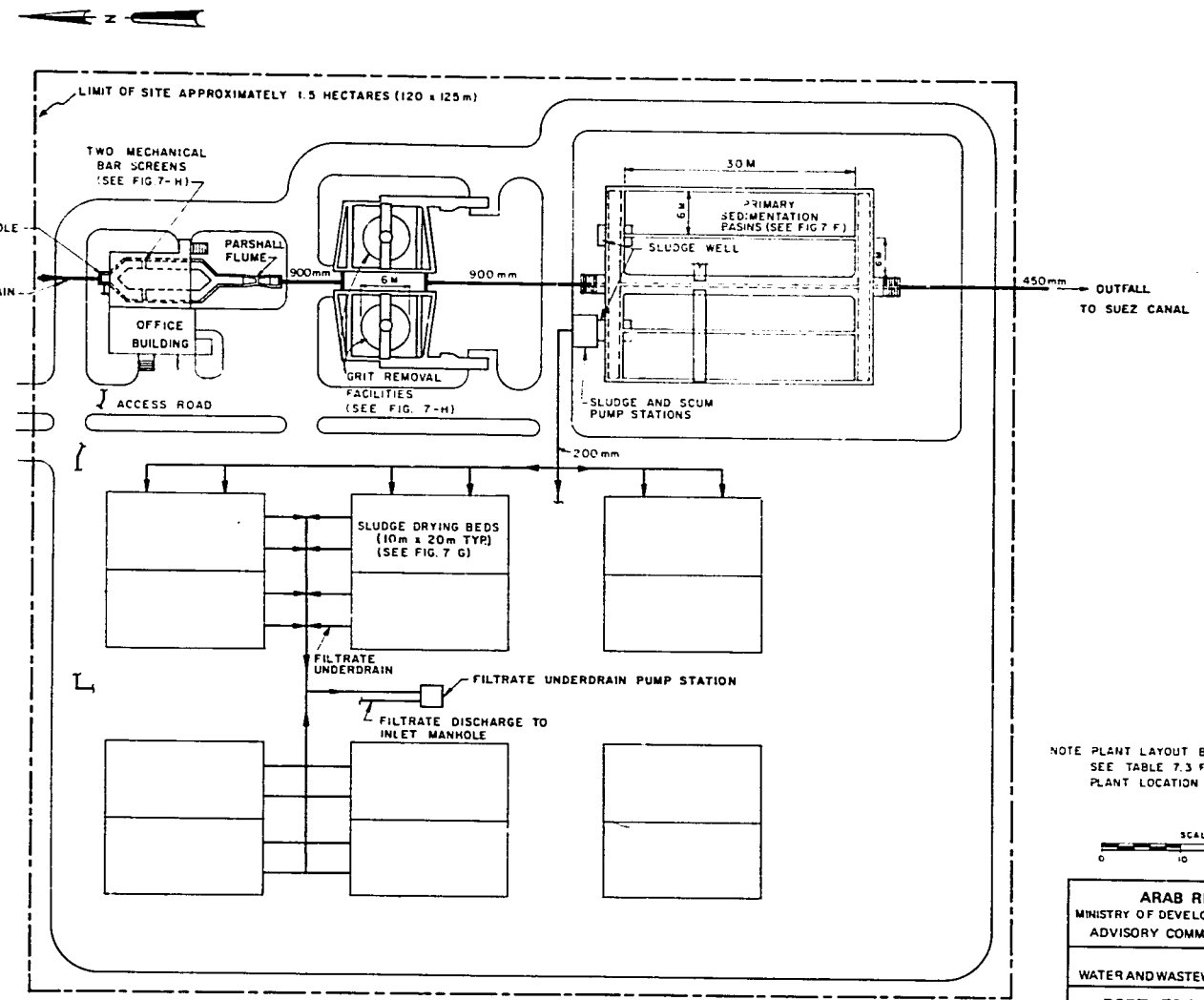
WATER AND WASTEWATER FACILITIES MASTER PLAN

PRELIMINARY TREATMENT UNITS (ALTERNATIVES 1A, 2A & 2B)

VOL.3 FIG. 7-H



NOTE PLANT LAYOUT BASED ON YEAR 2000 NEEDS. SEE TABLE 7.3 FOR DESIGN DATA. FOR PLANT LOCATION SEE PLATE I.

SCALE: 1:500

0 10 20 30 M

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PORT FOUAD STP LAYOUT
(ALTERNATIVES 1A & 2A)

VOL. 3
FIG.
7-I

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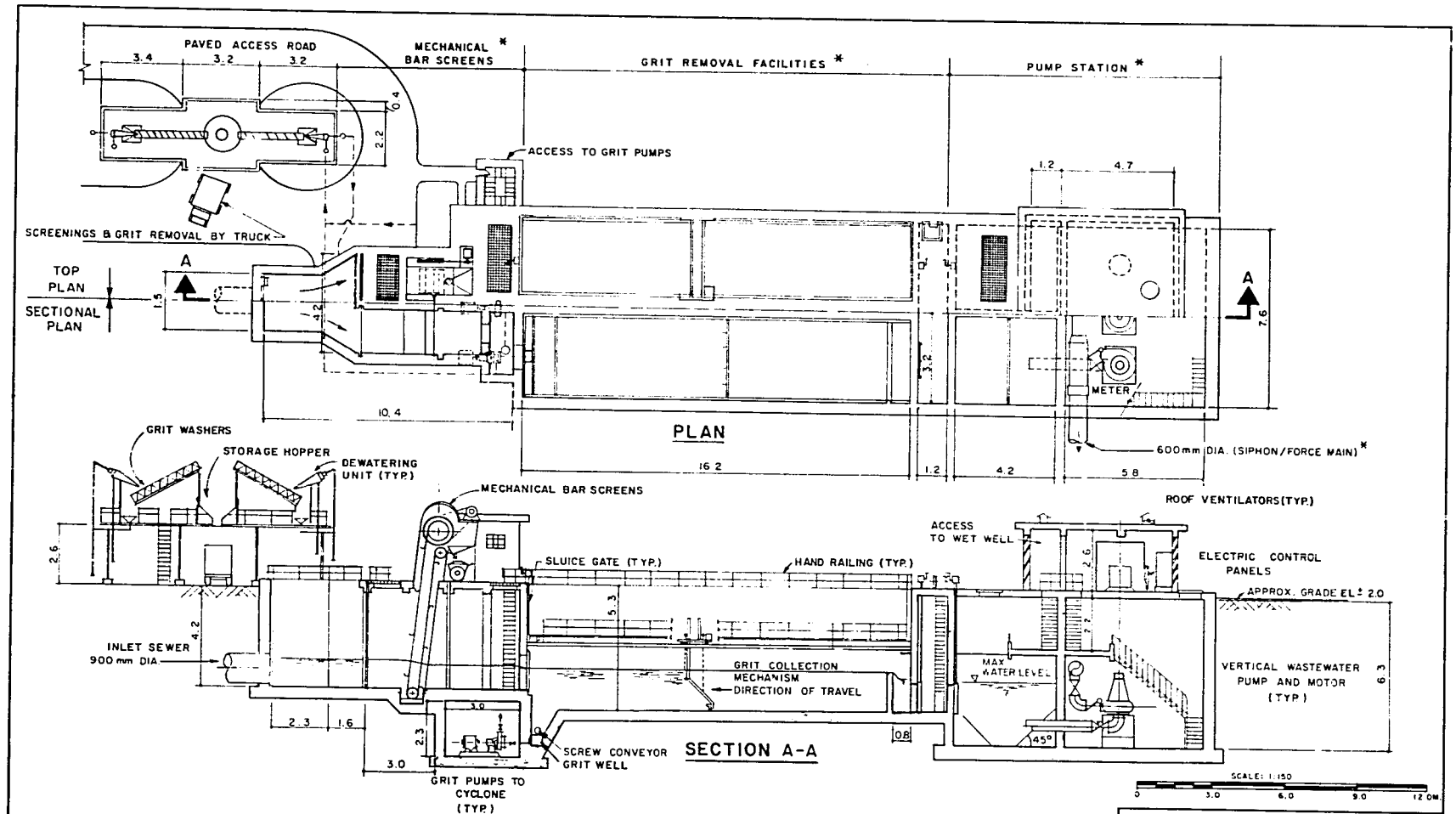

NOTE:

* PUMP STATION WITH PRELIMINARY TREATMENT UNITS (SCREENING AND GRIT REMOVAL) INCLUDED IN ALTERNATIVE 1B AND 2B PUMP STATION TO DISCHARGE BY SIPHON TO PORT SAID STP.

UNDER ALTERNATIVE 1A AND 2A PUMP STATION TO BE INSTALLED ALONE. PUMP STATION TO DISCHARGE BY FORCE MAIN TO PORT FOUAD STP.

ALL DIMENSIONS IN METERS.

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WATER AND WASTEWATER FACILITIES MASTER PLAN

PORT FOUAD
MAIN PUMP STATION LAYOUT
(ALTERNATIVES 1-B & 2-B)

VOL. 3
FIG. 7-J

CHAPTER 8

WASTEWATER COLLECTION

8.1 GENERAL DESCRIPTION

Port Said is served by a wastewater collection system extending to all built-up areas, except for the SCA area in the port vicinity and portions of the Kabbutti fishing village.

The sewered area in Port Said is divided into 14 drainage areas, each served by its own pumping station (see Figure 4-A).

Although numerous storm water inlets are connected to them, these systems appear to have been designed only for sanitary flows. Within the service area, approximately 185,000 people are served. The summary of CAPMAS 1976 census data indicates that in the sewered area there are 3,500 permanent buildings not connected to the system.

About two-thirds of Port Fouad's population are served by a gravity system which discharges to the Suez Canal through five known outfalls and to the Mediterranean through one force main. Unsewered buildings in Port Fouad are served by individual septic tanks.

8.2 COLLECTION OF INDUSTRIAL WASTE

Existing Situation

Few industries are currently served by sanitary sewers. As shown in Table 4.1, industries dispose of their untreated sanitary and process waters directly to receiving waters. A few have septic tank systems, generally not operating properly.

Central sewage collection systems should be made available to industry so that pollution from industrial discharges is controlled without forcing the industries into large direct capital and operating costs, which would be a deterrent to industrial expansion in Port Said.

Present industrial discharges at Port Said consist mainly of sanitary or food processing wastes and cooling water. Small amounts of toxic materials may be discharged from establishments such as metal shops, but there is no evidence of problems likely to affect treatment and disposal. Discharges from future industries are likely to be similar in character to those existing.

Recommended Regulations

Regulations controlling liquid and solid industrial wastes and air pollution, properly enforced, will provide for orderly development of Port Said and its industrial complex. These should be enacted by the Government, with enforcement mechanisms set up before problems develop. Waste oil and grease, heavy solids and toxic materials should be excluded from drains or separated from wastewaters by pretreatment. To encourage cooperation by industry, the agency responsible for wastewater collection and disposal should, in its own interest, operate and maintain collection vehicles and proper disposal facilities for such wastes. Separate collection is especially needed for the residue from the heavy fuel oil used in bakeries and other establishments.

To reserve collection capacity for wastes requiring treatment, unpolluted cooling waters should, in general, be excluded from the sewers and discharged to the closest receiving waters able to accept the heat load without undue stress.

Although pollution from ships in the Suez Canal does not appear serious at present, local regulations should be developed conforming to international agreements on control of pollution in the Mediterrean. Regulations should cover emptying of bilges and discharge of sanitary wastes and refuse. Dump stations should be provided for wastes from vessels berthed in Port Said.

Discharges which should be pretreated include those from the following sources.

Type of Establishment	Pretreatment Needed
Service Stations, Repair and Machine Shops, Metal Fabricating	Grease and sand traps
Metal Plating and Finishing	Neutralization Chemical precipitation Oxidation of cyanides
Restaurants and Bakeries	Grease traps
Slaughterhouse	Grease traps Settling of heavy solids (paunch manure)
Vegetable Processing	Sand traps

8.3 EXISTING FACILITIES

Gravity Sewer System

Construction

Gravity sewers are constructed of standard strength, 1.5+ m - length, vitrified clay pipe with jute and mortar joints. Since 1956 and probably earlier, installation of sewer pipes less than 450 mm in diameter has included encasement in concrete. Larger pipes are encased only to the center line of the pipe. Except for building connections, pipes are installed with a minimum of 1 m of cover. Pipe is manufactured locally, according to Egyptian standard dimensions.

Approximately 105 km of sewers ranging in diameter from 150 to 600 mm serve Port Said and Port Fouad. Most laterals are either 180 mm or 230 mm; collector and trunk sewers are 300, 380 and 450 mm. Due to the flatness of the terrain and the difficulty of deep excavation with high groundwater, most sewers are installed on minimum slopes. GOSSD indicates that since 1956 sewers have been laid at minimum slopes ranging from 1:150 for 180 mm diameter to 1:550 for 750 mm. As high as 90 percent of existing sewers are surcharged during at least a part of the day.

Manholes on lateral sewers are spaced as closely as 30 m so that each building connection can feed into a manhole. Manholes are made of cast-in-place concrete. Building connections are normally 100 mm, encased in concrete, and originate at concrete boxes (1 m sq x 0.5 m deep) located at the foot of building waste stacks.

Sewer Mapping and Field Surveys

In preparation of the WWFMP, a major effort was made to collect available sewer maps from all sources. Maps were located for approximately 70% of the sewers, but these showed varying levels of detail and often did not indicate whether they represented as-built conditions or just designs.

After the existing maps were compiled into composite sheets, field surveys were undertaken to expand and verify the coverage (see Figure 8-A). Since very little data existed for the Port Fouad system, all of the Port Fouad collection system was surveyed. One of the drainage areas in Port Said was surveyed to check the accuracy of the existing mapping for that area.

The field surveys showed that locations and distances between manholes were fairly accurate, but many of the slopes were less than indicated on the maps. Table 8.1 compares slopes as shown on the maps with those measured in the field.

Survey work was hampered by vertical offsets in the manholes, by the many surcharged sewers, and by the large amounts of material deposited in the system. These conditions made it difficult to establish elevations and locations of pipes. It was also found that not all incoming and outgoing lines entered the sewer at the manhole invert elevation, making it difficult to locate precisely the invert of such pipes.

For those areas where no mapping existed, all the manholes were located and the direction of flow within the sewers was determined. Based on the existing mapping and the field survey, the Sewer Inventory in Table 8.2 was prepared. Complete sewer maps showing all inverts and diameters can be made only after a sewer cleaning and inspection program is carried out.

General Appraisal of System

The limited inspection presently feasible and the information available from the Sewer Department staff permit the following general appraisal of the gravity collection system:

1. Surcharged operation is a major cause of the heavy solids deposition and accumulation, which in turn reduce the hydraulic capacity and increase the likelihood of overflows.

2. Where observation was possible, physical condition of the sewers generally appeared to be good.

3. There is a lack of proper equipment, trucks and tools to maintain the wastewater collection system.

4. Material being removed from pumping station wet wells and sewer manholes is fine fibrous organics typically found in household waste, with little sand or coarse trash.

5. Inadequate solid waste removal contributes to sewer clogging particularly at building connection boxes, the top slabs of which are frequently missing or removed intentionally to prevent surcharges from backing up into ground floor apartments. With covers missing the boxes become solid waste receptacles. Appendix C outlines present solid waste practices and recommends study of more effective removal methods.

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6. Few additions to the lateral sewer system in existing drainage areas will be needed to serve buildings not presently connected to sewer system. Such work should be well within the capacity of the local utility's own crews. ACR has requested locations of these buildings from CAPMAS.

7. Trunk sewer capacities in existing drainage areas cannot be determined definitely until a sewer cleaning and inspection program is carried out. Substantial needs for reinforcement are not likely.

8. The sewer system capacity is totally inadequate to accommodate storm flows. Appendix D recommends such flows be excluded from the sewers and outlines a scope for study of drainage alternatives.

9. Inspection of sewers before they are placed in service shows little or no groundwater infiltration - probably because of the concrete encasement. Manholes inspected in the Port Fouad system showed no cracks or leaks, and new construction inspected appeared extremely tight. Major sewer line breaks, involving pavement collapses, and requiring pipe replacement, are infrequent - perhaps two a year - giving no indication of major structural problems with sewers.

Infiltration Analysis

Infiltration, the wastewater flow component consisting of groundwater leakage, depends in quantity on the physical condition of sewers and on their hydraulic gradient in relation to the groundwater table. At present most of the sewer system in Port Said and Port Fouad is surcharged so that wastewater levels are higher than the crown of the sewers and also higher than the surrounding groundwater table. This condition keeps groundwater from entering the sewer. In fact exfiltration of wastewater into the ground is more likely, and is probably occurring throughout most of the system.

Infiltration will show up as a flow component only after the collection system is operating under gravity conditions. However, to aid in planning future facilities and in characterizing anticipated infiltration problems, we prepared the preliminary analysis in Appendix E based on general estimates of infiltration for similar systems and on general costs to remove or to convey and treat estimated infiltration from various sources.

This preliminary analysis indicates it will be cost effective to remove infiltration in excess of the average infiltration allowance (3,000 lpd/cm dia-km of sewer) used to project wastewater flows. The quantity of excessive infiltration is estimated at 32,000 cu m/d and the cost for its removal at LE 516,000.

These figures are quite approximate and costs, two or three times as high (in relation to quantities of flow removed) are possible. We are quite confident, however, that it will be cost effective to reduce infiltration to the levels indicated, since the costs for transport and treatment are expected to be several times the estimated costs for removal of the same flow. Based on a limit of 3000 lpd/cm dia-km, the eventual flow component attributable to infiltration will be less than 10 percent of base wastewater flow.

The following conditions in Port Said suggest that infiltration can be removed quite inexpensively and effectively:

1. Leakage at most joints is unlikely due to the practice of encasing sewer pipes in concrete. What leaks exist are likely to be associated with structural cracking of the encasement. Such leaks will in general be large, evident and readily repaired.

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2. Seasonal variations in groundwater levels are small, making it possible to spot problems whenever inspections are made.

3. In Port Said, service connections, normally the source of significant and difficult to-deal-with infiltration, make up very little of the collection system. In addition, the service connections which do exist are normally less than a meter deep and are concrete encased, minimizing the likelihood of leakage.

A definitive cost effectiveness analysis on infiltration reduction should be carried out in conjunction with a sewer cleaning and inspection program. This analysis would take into account costs of collection transport and treatment as indicated by the WWFMP, and size and distribution of leaks actually encountered during the inspection.

Pumping Stations and Force Mains

General Description of System

Each of the drainage areas in the Port Said system was originally connected to one of twelve pneumatic ejectors. These discharged through a common force main system to the Mazrah Treatment Plant. In 1963, the ejector system was abandoned and a system of ten new pumping stations and force mains was then constructed under what is known as the "Japanese Project". These pumping stations were numbered the same as the ejectors whose sites they occupied: Nos. 1 to 8, 11, 12. The areas tributary to ejectors 9 and 10 were in reconstruction zones (see below).

The "Japanese Project" also included a new system of force mains which replaced many of the former ejector system force mains. A portion of the 600 mm force main to Mazrah, however, was retained and used as the force main for the New Main Pumping Station No. 8. The discharge pipelines from ejectors 2 and 5 were also used as the force mains for the new pumping stations at these locations.

Nine of the pumping stations (Nos. 1 through 7, 11 and 12) discharge to a Main Pumping Station (No. 8) which pumps the wastewater to the treatment plant at Mazrah, via a single 600 mm force main, 2.5 km long. To discharge to the Main Station, several of the other stations depend on shared use of a common force main.

Since 1963, four additional pumping stations have been built in reconstruction zones (Nos. R-1, R-2, R-3 and R-4). Reconstruction zones 1 and 2 were formerly served by ejectors 9 and 10, respectively. Stations No. R-1, R-2 and R-3 have individual force mains to Mazrah. The force main from station R-4 discharges to the Junction Canal.

All of the "Japanese Project" stations are of similar design. Each consists of a circular concrete caisson five meters in diameter and approximately four meters deep. A concrete dividing wall, offset from the caisson's centerline, separates the wet and dry wells. The floor levels of the wet and dry wells are the same (see Figure 8-B). The pump station wet wells fill regularly with solids, requiring periodic cleaning. (See below.)

The dry well of each station contains two vertical, centrifugal, two-speed pumps, rated at 144 cu m/hr and 250 cu m/hr at the two speeds. The pump suction pipe inverts in the wet well are located about 20 cm off the floor, with the influent sewer invert about 1 m above the floor.

Table 8.3 lists the flows, pump models and capacities, force main data, topographic data and deficiencies in capacities for each of the pump stations.

Figure 8-B shows a plan and section of a typical pump station constructed under the "Japanese Project". This design is common to existing station Nos. 1 through 7, 11 and 12.

The Main Pump Station No. 8 and the stations in Reconstruction Zones 1 through 4 have substructures similar to but larger than the other stations. Each of these stations has a superstructure which houses above-ground pump motor drives and other equipment.

Every station has up to four diesel engine or electric motor driven auxiliary portable pumps. The portable pumps at station R-3 are run continuously since the main pumps are too small to handle the incoming flow alone. The portable pumps at station Nos. 4 and 5 are used in preference to the main pumps. At the other stations, the portable pumps are used to pump down the wet wells when settled debris has clogged the suctions of the main pumps. Once the wet wells are pumped down and cleaned, the main pumps are again utilized. This procedure takes over two to three weeks to accomplish. Each station is cleaned once per year, and the more troublesome ones more frequently.

At pump stations 2, 5, R-1 and R-4 the portable pumps are connected to the station force mains. The four portable pumps at station R-3 discharge directly to the Manzala Canal. The auxiliary pumps at all the remaining stations discharge to the former ejector force main system, which carries the discharge from the Main Pumping Station No. 8.

The fourteen existing pumping stations receive electric power supply as follows: Power at Main Pumping Station No. 8, is obtained from the municipal system. In addition, a 625-KVA diesel generator provides standby power at this pumping station. Stations 2, 3, 5, 6, 7, 11 and 12 are fed from the Main Pumping Station through a distribution loop maintained by the Sewer Department of the GOPS. Station Nos. 1 and 4 were disconnected from the loop as a result of the war damage and are now supplied directly from the municipal system. Stations R-1, R-2, R-3 and R-4 are fed from the municipal system. Four stations (2, 3, 5 and 6) can be fed from the municipal power system, as well as from the loop.

Total connected loads of the wastewater pump stations amount to 1,300 KW. There are no records of the maximum demand, but it is not likely to be more than half the connected load.

Appraisal of Pumping Stations and Force Mains

The existing pumping stations are unable to handle maximum wastewater flows in the system. As a result, overflows of raw sewage onto the streets is a common problem throughout the city.

Wet wells in most of the stations are undersized and too shallow. Hence the displacement volume betwen the minimum wastewater level needed to maintain pump suction submergence and the maximum level possible without surcharging the sewers is inadequate to avoid excessive starting and stopping of the constant-speed pumps. To reduce frequency of starts and stops the operators commonly permit levels to rise every pump cycle to a point where sewers are surcharged. In addition, many sewers remain surcharged through at least a part of the day simply because pumps cannot keep up with maximum flows.

We have not been able to obtain rating curves for the auxiliary pumps nor to obtain any discharge readings. Judging, however, from the steep system head curves of the force mains into which they discharge, we doubt that the use of the auxiliary pumps adds appreciably to the pumpage at any of the stations except R-3.

During the WWFMP study, location and repair of a major leak in the potable water distribution system made water available on a 24 hr/d basis. This has increased the wastewater flow and caused backups and overflows in areas where they previously did not occur. At one station, which shares a common force main with a larger station, system head is frequently above the pump shutoff head so that delivery is zero.

The existing electrical systems in the stations are hazardous in several respects. Equipment in the wet and dry wells does not comply with hazardous area restrictions (explosive gas): lamps are not completely sealed, wiring is not properly insulated at terminals and many of the motors are of the open type. There are no lockout switches in the dry wells to prevent pumps from being started during maintenance work. Hazards also originate from bare isolating switches and fuseboards in the operator's rooms of stations that are fed from the municipal system.

The power loop, and the transformers at the stations served by the loop, the generator, switchgear, and transformers at Station No. 8 are all adequate for present loads. The 625 KVA generator at Station No. 8 provides sufficient standby capacity for these same loads, but could not handle any additional loads from stations not now connected to the loop. The electrical services from the municipal system are adequately sized for future loads at Stations R-1, R-2 and R-3.

Eleven of the pump stations built under the "Japanese Project" (excluding the Main Pumping Station No. 8 which is in good condition) and the four pump stations in the Reconstruction Zones suffer from the following critical problems:

1. Inadequate pumping capacity for peak flows.
2. Undersized wet well detention capacity for average flows.
3. Poor screening arrangement to remove larger solids from the wastewater. The wet wells are therefore filled with debris which clogs pumps.
4. Inadequate spare parts to keep the pumps running.
5. Existing electrical hazards and the lack of standby electrical power for the Reconstruction Zones' pump stations.
6. Undersized force mains.
7. Lack of tools and equipment to maintain the system.
8. High operating and maintenance costs.

To restore adequate wastewater collection in Port Said, these stations must be replaced.

The Kabbutti pumping station (R-4) should be retained until a new interceptor sewer is constructed in its area (see Section 8.6). Then it can be abandoned.

8.4 PROJECTS IN PROGRESS

Pumping Stations and Force Mains

Four wastewater pumping stations are under construction in Port Said. One station was just completed in Port Fouad. The four in Port Said include Station R-5 in the new

Kabbutti housing area (to the south of Station R-2), the relief station near existing station No. 12 (at the head of the Interior Canal), the Industrial Area station to the east of the Interior Canal (R-6 in Figure 8-A), and a small lift station near the stadium.

The first three are identical in design, consisting of a 4 m diameter concrete caisson approximately 5 m deep inside. GOPS officials indicate that these caissons are designed to serve as inlet screening wells which are to be connected to much larger future pumping stations to be constructed at these sites. As a temporary measure submersible pumps are to be installed directly in the caisson. Each station will then discharge through a 350 mm asbestos-cement force main.

The caisson and force main of the station in the new Kabbutti housing area are complete. The force main will discharge to a small settling tank near the training school, which will overflow to the Manzala Canal. This system should be put into service on a temporary basis until the permanent station in this area is completed in 1983 (future drainage area No. 8).

Work on the caisson for the relief station near existing station No. 12 started in May 1978. The force main from this station will run south along the Interior Canal to El Nasr Street, then westward in El Nasr and El Gehan Street to the wastewater treatment plant at Mazrah. A 400 m section of the force main near the station has already been completed. Work on this station should continue as planned. This site will be the location of a new pumping station to serve future drainage area No. 4.

For the Industrial Area pump station, the caisson is completed, but work has not started on the force main. Construction of collection sewers in this area is nearing completion. The force main was to discharge to a settling tank near the El Raswa bridge. The tank was to overflow to the Junction Canal. Construction has been delayed to ensure that the tank location is compatible with future projects. The 350 mm force main planned will be adequate for present flows but a parallel line will be needed by 1990 to accommodate future flows.

Construction should proceed on this line, but it should extend west to the same discharge point as Station R-4, at which location it would be intercepted under the Immediate Phase Program (Section 8.6). For the interim, construction of the proposed new settling tank does not appear warranted, but the flow could be passed through the same tank as the R-4 discharge. The force main route should cross the Interior Canal on the causeway near the Portex Factory, and should then follow roads south along the Interior Canal and west along the Junction Canal.

The lift station at the stadium is being constructed to serve a hotel and public facilities being built beneath the stadium stands. Completion is expected during 1979. The lift station will discharge to a sewer tributary to Main Pump Station No. 8.

The new station in Port Fouad serves a small cluster of new housing units in the southeastern corner of the city, too far east to be served by existing gravity sewers. The force main from this station discharges directly to the Suez Canal. When new interceptors are installed in this area, the flow can be collected by gravity and the station abandoned.

Local Sewers

Lateral and local trunk sewers are under construction in two drainage areas in conjunction with the pumping stations discussed above (the new Kabbutti area and an area immediately south of Shari 100 which is tributary to the relief station at PS 12). Extension

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of lateral sewers into the Kuwait housing area was completed in early 1978. These sewers will drain to existing P.S. 12 and the new relief station.

Minor extensions of lateral sewers are being carried out in Port Fouad, and along the beach in Port Said. The work in Port Fouad is associated with new SCA employee housing. Extensions in Port Said are being made to serve the new hotel, several public toilets along the beach and some new large residential structures to the west of area R-2.

8.5 HIGH PRIORITY MEASURES

Recommended below as high priority are those measures which will most directly address problems of sewage overflows in existing built-up areas.

Procurement of Services

Sewer System Cleaning, Inspection and Grouting

This is the essential starting point for any remedial work on the existing system. The program would include:

- Removal of material deposited in the system.
- Complete visual or televised inspection of sewers, manholes and pump station wet wells to determine structural condition, distribution and contribution of possible various infiltration sources, and hydraulic capacity of sewers. (This information is needed for final design of major reconstruction work described below.)
- Preparation of detailed sewer system maps.
- Grouting of leaking joints as located.

Immediate benefits of the cleaning will be 1) to increase sewer capacity, thereby decreasing overflows and ponded sewage in the low-lying areas, and 2) to reduce the level of noxious gases in the sewers and wet wells.

Televised inspection and grouting should proceed directly after cleaning without intervening attempts to isolate areas with high incidence of leaks. Reasons for this are:

- Leaks are not likely to be concentrated in just a few drainage areas.
- The structural condition of the sewers is of critical interest, and can be determined only by the TV inspection.
- New deposition and accumulations of materials in the sewers could make complete inspection difficult if time is given up to perform flow isolation studies.
- The cost of the flow isolation studies would be eliminated. Typically these require a large staff of experienced technicians and cost approximately 30 percent of the cost of TV inspections.
- Video tapes of the TV inspection will provide a valuable permanent record of the system for use by operating staff and by designers planning reinforcements.

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Reconstruction of the system of pumping stations and force mains will be necessary before surcharging and deposition of solids in the sewers can be fully controlled. Nevertheless, the cleaning program should proceed now, not after the reconstruction work. Reasons for this are:

- Cleaning the system is the quickest action that can be taken to help relieve the wastewater ponding in the streets.

- Removing the deposition in the sewers and manholes and wet wells will make it simpler and easier to operate the pumping stations. Present operation is severely hampered by the continuous need for unclogging pumps.

- The inspection, which depends on cleaning, will provide information needed for final planning of system reconstruction and measures to control infiltration.

For the reasons outlined below, we recommend that the cleaning and inspection program be carried out under contract with a U.S. firm experienced in this work:

- It does not appear practical for GOSSD or GOPS to provide the full staffing or to procure on a crash basis the equipment needed for the program.

- Local contractors lack experience in sewer cleaning.

- An experienced U.S. Contractor would have ready access to the necessary equipment and trained personnel.

- Local personnel could be integrated in the program to the extent available and trained in the latest sewer cleaning techniques and associated support functions. Such training should be an integral part of the field program.

The contract should provide for the local sewer department to retain sufficient cleaning equipment, support vehicles, spare parts and miscellaneous equipment to continue the cleaning program on a routine basis. Under GOSSD coordination, additional equipment needed in the original program could be utilized in other cities.

As detailed in Figure 11-A, program execution would be started within 8 months and completed within 14 months of the time engineering is authorized. Proposed staffing is shown in Figure 8-C. Estimated costs as detailed in Tables 8.4 and 8.5 are LE 591,000 for the cleaning program and LE 346,500 for inspection and grouting.

Solid Waste Study

The High Priority Program should also include a solid waste study following the scope in Appendix C. A key goal would be to develop a solid waste program that would eliminate disposal of trash and other unacceptable materials to the wastewater system. The study cost is estimated at LE 55,000.

Major Capital Projects

The problems of the existing system can be corrected only by reconstruction of major elements: pumping stations, force mains and interceptors. To simplify and reduce costs of future operations, the opportunity should be taken in this reconstruction to consolidate existing drainage areas. We recommend that the thirteen existing areas, 1 to 8, 11,

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12, R-1, R-2 and R-3 as shown in Figure 8-A, be reduced to seven areas (future Nos. 1 to 7) as shown in Figure 8-D and described below:

- A new drainage area 1 would be created by combining former areas 2 and 5. A new pump station located at the site of existing station 5 would serve the combined drainage areas. It would discharge via a new force main to the existing Main Station No. 8.

- A new drainage area 2 would be created by combining former areas 1, 3, 4 and 6 at the site of existing station 4. Flow from this drainage area would be pumped to new drainage area 4.

- New drainage area 4 would be created by combining former areas 7, 11 and 12. (A new pump station would be constructed near the site of existing Station 12 to serve this area and accept flow from new area 2).

- The Main Pump Station No. 8 would be retained unchanged, but with a greatly reduced load. This drainage area would be redesignated as new drainage area 3.

- Pump stations in existing Reconstruction Zones R-1, R-2 and R-3 would be rebuilt as submersible type stations. Each would discharge directly to Mazrah. These areas would be renumbered 5, 6 and 7, respectively.

Deep gravity interceptors would provide required interconnections of existing areas. Individual projects, project elements and costs are detailed in Appendix F. Pump station capacities and line sizes are shown on Plate 1, and typical layouts in Figures 8E, 8F and 8G. Figure 8D shows the overall collection system layout into which this reconstruction fits.

In the proposed system, all flows from existing sewered areas discharge to Mazrah through force mains. Normally, in collecting multiple drainage areas it is preferable to use gravity interceptors with successive lift stations. For collecting flows to Mazrah, however, a system using multiple parallel force mains is recommended because:

- The proposed system takes advantage of four separate existing lines running to Mazrah from existing drainage areas. Only two lines would be added to serve these areas.

- Substituting a gravity interceptor for these two lines would require two extra major lift stations.

- Available rights-of-way pass through congested areas which gravity interceptor construction would disrupt greatly.

- Force mains can be constructed more rapidly and lend themselves better to the staging.

As shown in Table 8.6 the High Priority major capital projects for reconstruction of the existing collection system are estimated to cost a total of LE 6,487,000 including contingencies and support services.

Equipment Procurement

Since roughly three years will elapse before replacement pump stations can be completed, the ability to make repairs to existing equipment quickly and adequately will be crucial in preventing further deterioration of the system. The maintenance staff has shown considerable skill and ingenuity in the repairs they make with the tools and equipment available. Provision of a well-equipped maintenance shop would put their expertise to its best use, improving the quality of repairs and reducing the likelihood of breakdowns.

In addition, the sewer department is lacking several items of major equipment which would greatly facilitate maintenance. These include: vehicles for transporting work crews and tools; vehicles for transporting equipment to and from the central shop; and equipment for cleaning accumulated grit from wet wells.

The wastewater laboratory at Mazrah should be put in operation as soon as possible so that regular monitoring of wastewater characteristics and receiving water quality can be initiated. Information obtained from such monitoring would be useful in final design and in performance checks of recommended treatment facilities. A laboratory building was recently completed at Mazrah and a chemist is employed on the staff. However, the lab has not been equipped due to lack of funds.

We recommend purchase of the equipment listed in Table 8.7 as part of the High Priority Works. The total cost of equipment, shipping and insurance is estimated at LE 298,000. Local costs for renovation of the shop building and installation of equipment are estimated at LE 65,000. Additional equipment will be purchased as part of the sewer cleaning program and turned over to GOPS upon the completion of that work.

Local Measures

All storm water inlets to the existing sewer system should be sealed over with concrete or asphalt. This work could be done by wastewater department forces. An allowance of LE 5,000 for materials is included in the High Priority Program.

Operational Measures

Although major capital construction of pump stations is required to eliminate surcharging, its extent can be reduced by modifying present pump station operating procedures. Even when pump capacity is sufficient to keep up with flows, the operators attempt to maximize the length of pump operating cycles by allowing the water surface in the wet wells to rise to within a meter of the ground surface before starting the pumps. Since the shallowest sewers have only one meter of cover, this means that all sewers in the drainage area are surcharged and their velocity reduced to zero once in every pump cycle.

We recommend the following procedures:

- Allow wet wells to fill only to the halfway point before starting pumps.

- During off-peak hours lengthen runs by operating pumps with two-speed drives on the low speed.

Operating in this manner would provide reasonably long pump running times while also lessening surcharging of the smallest diameter sewers which clog most easily. Keeping these sewers under gravity flow conditions would reduce the frequency of blockages

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and sewer overflows. Simple, locally fabricated, level indicators would help the operators carry out this recommendation.

To make the best use of available capacity, we recommend setting up a schedule of operation for each pump station. This schedule would specify 10 to 15 minute intervals during which each given pump station would or would not operate. Such a schedule would allow stations on common force mains to operate unopposed much of the day. However, since all stations have inadequate peak capacity, simultaneous operation would still be necessary during peak hours.

8.6 IMMEDIATE PHASE AND STAGED DEVELOPMENT PROGRAMS

Major Capital Projects

Projects in the Immediate Phase program involve:

- Extension of collection system to new drainage areas in southern Port Said with interceptors leading to a main collection point at the intersection of the Junction and Manzala canals.
- Interception of Port Fouad discharges and collection to a single point to the south.
- Rehabilitation of existing sewers identified from inspection program as needing repair.
- Construction of transport systems to convey flows from the above collection points to treatment sites under Alternatives 1-A, 2-A and 2-B as outlined in Chapter 7.

Staged Development projects involve:

- Extension of the Port Said system to further new drainage areas to the south.
- Reinforcement of the transport systems to carry high future flows.
- Collection and conveyance to treatment of flows from the fishing villages at El Gamil and from the recreational development west of Mazrah.

Collection Facilities

The collection system layout for Port Said and Port Fouad is shown in Figure 8-D. Projects, project elements and costs are detailed in Appendix F. Pump station capacities and line sizes are shown on Plate I, and typical layouts in Figure 8-E, 8-F and 8-G.

The collection facilities to serve the new fishing villages and the recreational development near the airport west of Mazrah are shown in Plate I. The latter area will discharge to Mazrah under both treatment and disposal alternatives. The fishing villages will discharge to Mazrah under Alternative 1, and directly to the southwest plant under Alternative 2. Design parameters under the two alternatives are given in Table 8.8.

The extension of the wastewater collection system into new areas must keep ahead of development needs. A review of Table 4.2 indicates that flows in new drainage areas will increase rapidly, reaching close to maximum within a few years. Thus staging pump

station capacities in the new drainage areas is not practical. The system as a whole may be staged, however, by initiating construction for different areas at appropriate times.

Under the Immediate Phase program, collection facilities must be provided for Port Fouad and for new drainage areas 8, 9, 10 and 11 in Port Said. Areas 8, 9 and 10 in particular will have a substantial residential population by the end of 1979. Area 11 includes the New Community Demonstration Project, which is currently scheduled for construction during the period 1982 to 1986. All of these areas will reach saturation between 1985 and 1990.

In the Staged Development program, construction must begin on facilities to serve drainage areas 12, 13 and 14 in the late 1980's. All three areas will be generating significant flows by 1990 and should reach saturation by 1995. Drainage area 16 will require facilities in place by the end of 1994 and will reach peak flow by the year 2000.

The boundary between drainage areas connected to Mazrah and those connected to the southern collection point (Figure 8-D) was set so that existing facilities at Mazrah would be fully utilized under Alternative 2-A. None of the presently developed drainage areas to the south (8, 9, 10) would be connected to Mazrah because of right-of-way restrictions near the head end of the Manzala Canal. Available rights-of-way there should be devoted to new lines connecting existing areas to Mazrah. Future drainage areas 13 and 14 west of the Manzala Canal would be connected to Mazrah along new rights-of-way. Depending on the layout of local collectors and on staging of development, flows from drainage areas 13 and 14 might better be collected by a large interceptor to a lift station near Mazrah or by discharge to the force main from the southern collection point (Alternative 1-A only).

As shown in Table 8.6, projects to collect flow from new drainage areas in southern Port Said will involve outlays of LE 4,547,000 in the Immediate Phase and 4,846,000 in the Staged Development. The project to intercept and collect Port Fouad flows to a single point will involve an outlay of LE 1,251,000, all in the Immediate Phase.

As shown in Table 8.10, costs of collection systems for new areas west of Mazrah would be LE 1,773,000 under Alternatives 1A and 1B and LE 744,000 under Alternatives 2A and 2B. These figures are used in the comparison of alternatives in Chapter 9. The outlay for the selected alternative will be made under the Staged Development Program.

As shown in Table 8.9, major additional outlays will be required for service connections and local collectors in individual drainage areas. These outlays will amount to LE 5,227,000 in the Immediate Phase and LE 34,455,000 in Staged Development (1983-2000). (Outlays calculated on basis given in Appendix B).

A local cost allowance of LE 500,000 is included in the Immediate Phase Program for rehabilitation of existing sewers.

Transport System

The layouts of transport facilities under the different treatment and disposal alternatives were shown in Figures 7-A and 7-B. Design parameters for the Immediate Phase and ultimate final stage facilities are given in Table 8.8. As shown in Table 8.11, transport system costs under different alternatives are as follows:

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Alternative	Cost in 1978 1000 LE Immediate Phase	Staged Development	Total
1A	4,200	1,408	5,608
2A	4,741	1,736	6,477
2B	9,659	2,751	12,410

The cost figures will be used in the comparison of alternatives in Chapter 9, and the outlays for the selected alternative will be included under the Immediate Phase and Staged Development in the final recommended program.

Equipment Procurement

Table 8.12 presents procurement costs and schedules for additions of vehicles and other major equipment needed for system operation and maintenance. Based on the scheduled additions, costs for equipment procurement (100 percent foreign) are estimated as follows:

	Cost in 1978 1000 LE
Immediate Phase (1982)	336
Staged Development (1983-2000)	
1983-1985	64
1986-1990	101
1991-1995	81
1996-2000	70

Procurement of Services

The Immediate Phase program should include a study of surface drainage problems as outlined in Appendix D. Estimated costs are LE 70,000 of which LE 52,000 would be foreign.

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TABLE 8.1

COMPARISON OF EXISTING SLOPES AND SURVEYED SLOPES
(Drainage Area No. 1)

Manhole Designation	Slope mm/m	
	Field Survey	Existing Map
55A-127		8
127-31	6	17
31-22	16	
22-10	2	7
10-27	41	22
27-9	25	9
19-7	13	9
22-23	15	5
10-11	14	6
27-28	19	11
19-29	21	14
23-11	19	6
11-28	14	10
28-29	18	8
23-14	15	11
39-38	4	
38-37	9	1
37-36	2	24
36-35	4	13
35-34	6	11
34-33	1	1
33-38	4	1
38-32A	4	1
32A-32	9	1
32-1	13	1
1-2	4	2
2-3	4	
38-48	11	2
37-47	12	2
36-46	13	2
35-45	9	6
34-44	9	2
38-43	4	2
32-8	7	7
1-24	24	2
2-25	27	1
3-4	9	

Slopes in the remainder of drainage area No. 1 were similar to those shown above.

TABLE 8.2

SEWER INVENTORY
(Length in m)

Existing Drainage Area No.	Sewer Diameter mm								
	150	175	220	300	400	450	525	600	Total
P.F.	2424	1728	1304	132					5588
R-1		3030	1087	516					4633
R-2		3949	2857	943					7749
R-3		6836	2926	930	263	265			11220
R-4		402	533						935
R-5(1)		5440	1982	1724	1116	450	30		10742
R-6(2)		2083	1233	504	630	556			5006
1		3423	3191						6614
2		1991	1100						3091
3		3450	2640						6090
4		1900	1430						3330
5		2200	1530						3730
6		2860	2400						5260
7		3560	2200						5760
8		1900	1300						3200
10		3520	3313	635					7468
11		5036	902	542				35	6515
12		4229	2130	1265	265	170	125	175	8359
Total Length m	2424	57537	34058	7191	2274	1441	155	210	105290

(1) New Kabbutti Pump Station
(2) Industrial Area Pump Station

TABLE 8.3

DATA ON EXISTING PUMP STATIONS
(Flow in cu m/hr)

	STATION NUMBER	1	2	3	4	5	6	7	8	11	12	R1	R2	R3	R4
	Tributary area (ha)	21.8	30.9	17.2	23.1	77.1	29.9	25.1	44.9	30.8	40.6	60.5	62.7	62.0	50.0
	Population(1)	6200	6100	9600	14,000	14,300	18,100	37,700	10,200	800	22,100	32,100	29,000	43,200	0
FLOW	Est. total sewage flow	80	80	110	150	210	150	160	180	50	210	230	260	360	140
	Flow from other stations	-	-	80	-	-	-	150	1,200	-	50	-	-	-	-
	Total average flow	80	80	190	150	210	150	310	1,380	50	260	230	260	360	140
	Total peak flow	170	195	410	330	495	320	670	2,680	120	590	520	620	860	360
VOL.	Non-surcharging - cm	3.7	3.7	3.7	3.7	3.7	3.7	3.7	25.8	3.7	3.7	25.8	25.8	25.8	25.8
	Det. time at avg. flow min.	4.0	4.2	1.6	2.0	1.5	2.2	1.0	1.7	-	1.9	10	9.6	5.9	11
	Length m	825	510	600	650	200	685	115	400	410	465	2,600	1,800	3,600	1,500
FORCE	Diameter mm	200	200	300	200	250	200	250	500	200	300	400	408	350	300
MAINS	Length m	-	1250(2)	660(2)	-	1,250(2)	660(2)	550(2)	2,400(2)	-	550(2)	-	-	-	-
	Diameter m	-	300	300	-	300	300	300	600	-	350	-	-	-	-
	Discharge to	PS 3	PS 8	PS 8	PS 7	PS 8	PS 8	PS 8	STP	PS 12	PS 8	STP	STP	STP/Lk	Lake
	Number	2	2	2	2	2	2	2	3	2	2	2	2	3	2
	Manufacturer	Flygt	KSB	KSB	Flygt	KSB	KSB	KSB	KSB	KSB	KSB	-	-	-	KSB
MAIN	Model	C53200	KWvzx	KWvzx	C53200	KWvzx	KWvzx	KWvzx	KWvzx	KWvzx	KWvzx	-	-	-	-
PUMPS			150-30	150-30		150-30	150-30	150-30	350-60	150-30	150-30	-	-	-	-
	Rated flow cu m/hr	210	144	250	210	144	144	250	900	Note(3)	250	290(3)	290(3)	360(3)	100(3)
	Rated head m	20	18.8	18.8	20	18.8	18.8	18.8	22	-	18.8	-	-	-	-
	Rated RPM	950	1,450	1,450	950	1,450	1,450	1,450	960	-	1,450	-	-	-	-
	Actual pump capacity single pump, single station	Note(4)	135	226.6	Note(4)	180	180	234	953	Note(4)	225	Note(4)	Note(4)	Note(4)	Note(4)
	Actual capacity, single pump two stations where common force main	-	108	185.3	-	135	148	175	-	-	167	-	-	-	-
	Deficient capacity	-	87	224	-	360	172	495	1620	-	423	-	-	-	-
	Force main velocity if adequate pumps provided m/sec	1.5	1.6	1.6	2.9	2.6	2.7	3.7	2.6	-	2.3	1.1	2.4	2.4	1.3

(1) Based on total population in drainage area connected to collection system. Purpose is to show that stations are inadequate to handle future flows. Actual estimated 80% of the residents are connected, except in R-3 where only 60% are connected.
(2) Common force main shared by stations 2 & 5, 3 & 6, 7 & 12.
(3) Reported capacities; no nameplates on pumps.
(4) Pump curve not available.

TABLE 8.4

SEWER CLEANING PROGRAM
PROCUREMENT OF SERVICES - HIGH PRIORITY PROGRAM

ESTIMATED PERSONNEL-EQUIPMENT COSTS(1)
(LE 1,000)

	Local	Foreign	Total
Personnel			
Contractor(2)			
Project Manager	6	45	51
Workshop Supervisor	5	35	40
2 Field Supervisors(3)	7	46	53
Governorate of Port Said(4)			
Assistant Project Manager	6	-	6
Workshop Foreman	3	-	3
2 Assistant Field Supervisors	4	-	4
2 Operators	12	-	12
Engineer(2)			
Resident Engineer	7	47	54
2 Inspectors	10	54	64
Local Labor Pool(5)			
3 Mechanics	5	-	5
12 Driver/Assistant Operators	13	-	13
30 Laborers (Semi-Skilled)	24	-	24
2 Clerk/Typists	4	-	4
2 Office Boys	1	-	1
Subtotal Personnel Costs	107	227	334
Field Equipment(6)			
Major Items			
10 Bucket Rigs (2 spare machines) with buckets and frames for loading into dumpsters at LE 7,000 ea.(7)	-	70	70
5 International Harvester Travelalls with heavy duty transmissions, suspension and trailer hitch at LE 7,000 ea.	-	38	38
2 Power Rodders at LE 4,000 ea.	-	8	8
2 Chevrolet Blazers at LE 6,250 ea.	-	25	25
2 Collection Trucks - Front Dumpster Loading Type at LE 19,500 ea.	-	39	39
24 Two cubic meter Dumpsters at LE 80 ea.	-	2	2
Support Equipment			
Tool set for 10 bucket rigs at LE 900 per rig	-	9	9
Spare parts for 9 vehicles at LE 2000 per vehicle	-	18	18
Spare parts for 10 bucket rigs at LE 600 per rig	-	6	6
Spare parts for 2 collection trucks at LE 3,000 per truck	-	6	6
Machine shop equipment (drill press, milling machine, etc.)	-	8	8
Machine shop tools - 4 complete sets of mechanics tools at LE 500 ea.	-	2	2
Office Furniture	5	-	5
Subtotal Field Equipment	5	231	236
Operating Expenses			
10 Bucket Rigs and five Travelalls at LE 10 per day per rig-vehicle	7	-	7
5 Chevrolet Blazers at LE 6 per day per vehicle	5	-	5
2 Collection Trucks at LE 8 per day per truck	2	-	2
Office supplies - allowance	4	-	4
Monthly expendables - workshop at LE 300 per month	2	-	2
Monthly expendables - office at LE 200 per month	1	-	1
Subtotal Operating Expenses	21	-	21
Totals	133	458	591

(1) Based on August 1978 costs. Includes contingencies and support allowance costs.
(2) Includes overhead and fee.
(3) Contractor may require more supervision due to time constraints.
(4) Assumed that Governorate of Port Said could not supply these people and the Contractor did.
(5) Governorate of Port Said, possibly able to supply some of the required personnel, which would reduce costs.
(6) Treated as equipment procurement for determining support allowance costs and contingencies.
(7) Purchase of previously owned equipment could be time saving and result in considerable savings due to market conditions in the U.S.

TABLE 8.5

PROCUREMENT OF SERVICES
INSPECTION AND GROUTING OF SEWERS
ESTIMATED PERSONNEL AND EQUIPMENT COSTS

	Estimated Costs(1) (Thousands of 1978 LE)		
	Local	Foreign	Total
Personnel			
Contractor(2)			
Project Manager	4	24	28
Field Supervisor	4	21	25
8 Operators/Technicians	33	114	147
Local			
10 Drivers	6	-	6
2 Clerk/Typists	4	-	4
Subtotal Personnel	51	159	210
Equipment & Material Costs(3)			
4 video tape TV and packer equipped step vans. Capital cost is LE 24,500. Cost of return shipment and depreciation estimated at 55% of capital costs.	-	54	54
Spare parts and expended equipment at LE 21 ea/d for 4 video tape rigs	-	10	10
4 bypass pumping rigs (to be retained by Governorate of Port Said at end of project) at LE 7,400 for pump, piping and generator	-	30	30
2 4-wheel drive utility vehicles at LE 7,300 per vehicle	-	15	15
Subtotal Equipment and Material	-	109	109
Operating Expenses			
Operating costs at LE 6 ea/d for 4 video tape rigs	6	-	6
Grout based on 1700 joints requiring 2 gallons of grout per joint at LE 5/gallon	-	17	17
Operating costs at LE 8 ea/day for 4 bypass pumping rigs (time used will be 75% of program)(4)	3	-	3
Operating costs at LE 6/d for 2 4-wheel drive utility vehicles(4)	1.5	-	1.5
Subtotal Operating Expenses	10.5	17	27.5
Total Operating Costs	61.5	285	346.5

(1) Based on August 1978 prices. Includes contingencies and support allowance costs.
(2) Includes contractors overhead and fee.
(3) Treated as equipment procurement for determing contingencies and support allowance costs.
(4) Based on 6-day, 20-week work period.

TABLE 8.6

SEWAGE COLLECTION SYSTEM
CAPITAL COSTS[1]
(Thousands of 1978 LE)

Project	Total Cost	Foreign Cost	Local Cost
PORT SAID			
High Priority Projects			
A	4,197	2,116	2,081
B	747	405	342
C	389	206	183
D	270	138	132
E	884	412	472
TOTAL	6,487	3,277	3,210
Immediate Phase Projects			
A	2,559	1,112	1,446
B	1,861	631	1,230
C	127	33	94
TOTAL	4,547	1,776	2,770
Staged Development			
A	362	193	169
B	2,571	1,371	1,200
C	950	396	554
D	963	405	558
TOTAL	4,846	2,365	2,481
TOTAL	15,880	7,418	8,461
PORT FOUAD			
Immediate Phase Projects			
	1,251	435	816

(1) See Appendix F for project estimates and foreign/local cost split.

TABLE 8.7

PROCUREMENT OF EQUIPMENT COSTS
HIGH PRIORITY PHASE

	Quantity	Function	Estimated Costs(1) Thousands of 1978 LE Local	Foreign(2)	Total
Maintenance Shop Equipment					
Lathe	1			14.6	
Milling Machine	1			14.6	
Drill Press	1			14.7	
Shear	1			5.0	
Power Hacksaw	1			1.5	
Shop Compressor	1			1.0	
Air Operated Tools	1			0.7	
Arc Welder	1			1.5	
Acetylene Torch & Gas Tanks	1			0.7	
Miscellaneous Hand Tools	1			14.7	
Subtotal Machine Shop			50(3)	69.0	119
Laboratory Equipment					
Balance	1			0.96	
Oven	1			0.60	
Furnace	1			0.72	
Autoclave	1			2.52	
Incubator	1			1.68	
Distilling Unit	1			0.72	
pH Meter	1			0.48	
Reagents	1			2.16	
Glassware and Other Supplies	1			2.16	
Subtotal Laboratory Equipment			5.0(4)	12.0	17.0
Sewer Maintenance Vehicles & Equipment					
Water Tight Dump Truck with Orange Peel Bucket	1	Wet well cleaning		28.0	
Flat Bed Truck with One Ton Hydraulic Knucle Boom Crane and Power Tailgate	1	Removal of equipment from below ground stations and transport to central maintenance facilities.		29.4	
Tractor with Front End Loader and Backhoe	1	Repair of major sewer leaks.		14.0	
Crew Cab Pickup Trucks	2	Transportation of sewer maintenance crews.		19.6	
Diesel Driven Portable Sewage Pumps (200 cu m/hr at 20 MJDH)	6	Replacement of oldest of existing portable units.		50.4	
Electric Motor Driven Submersible Sewage Pumps 150 cu m/hr at 20 m	6	Temporary installation in caissons under construction in Areas 8 and 9 and at relief station near existing PS 12.		33.6	
Six Inch - Eccentric Plug Valves	20	General replacement of existing		8.4	
Eight Inch - Eccentric Plug Valves	20	worn equipment and installation		11.2	
Six Inch - Flap Check Valves	20	with temporary pumps.		5.6	
Ten Meter Lengths of 150 mm Spiral Reinforced Rubber Hose	24	Suction and discharge hoses for temporary pumps.		7.0	
Dolly Type Hoisting Frames with One TM Chain Hoists	4	Moving equipment in stations with superstructures and and in shop.		7.8	
Portable Arc Welder with 61 Meters of Cables and Accessories	1	Shop and field repairs.		2.0	
Subtotal Sewer Maintenance Vehicles and Equipment			10(5)	217	227
Total High Priority Equipment Procurement			65	298	363

(1) Based on August 1978 costs Includes allowances for contingencies and support services.
(2) Includes delivery to Port Said.
(3) Rebuilding floor and new electrical system and lighting for existing machine shop building to install equipment.
(4) Local costs for installing laboratory equipment.
(5) Local costs for putting trucks into service and installing portable pumps.

TABLE 8.8

DESIGN PARAMETERS

ALTERNATIVE COLLECTION AND TRANSPORT SYSTEMS

	Ultimate Station Capacity cu m/hr	Type	No. Pumps I	No. Pumps F	TDH	Motor HP	Force Mains Diameter	Force Mains Length
Transport Systems								
Alternative IA								
Main Pump Station Southern	7400	DP	4	2	36	300	1 at 900 1 at 750	5450 I 3200 F
Alternative IIA								
Main Pump Station Southern	7400	DP	4	2	30	250	1 at 900 1 at 750	4400 I 4400 F
Alternative IIB								
Main Pump Station Southern	9250	DP	4	2	38	400	1 at 1000 1 at 750	4400 I 4400 F
Main Pump Station Port Fouad	1850	DP	4		16	60	2 at 600	5800 I
Alternatives IA and IIA								
Main Pump Station Port Fouad	1850	DP	4		22	75	1 at 600	2300 I
Collection System								
I Alternatives								
PS-17	655	Sub	3		45	100	350	2400
PS-18	475	Sub	2		41	100	300	1800
PS-18A (booster)	475	Sub	2		41	100	300	1800
II Alternatives								
PS-17	180	Sub	2		22	30	250	2400
PS-18	475	Sub	2		38	100	300	1600

Note: DP = Dry pit
Sub = Submersible
I = Indicates facilities installed during Immediate Phase
F = Indicates added facilities installed during Final Stage

TABLE 8.9

COST OF SERVICE CONNECTIONS AND LOCAL COLLECTORS(1)

	1978-1982	1983-1985	1986-1990	1991-1995	1996-2000	Total
Population Increase in Newly Developed Areas	61,300	54,700	135,800	116,700	118,700	487,200
New Hectares of Industrial Development	72	55	145	92	41	405
Cost of Local Collectors (LE)						
Residential and Institutional(2)	1,575,400	1,405,800	3,490,000	2,999,200	3,050,600	12,521,000
Industrial(3)	601,200	459,300	1,210,800	768,200	342,400	3,381,800
Subtotal - Collectors	2,176,600	1,865,100	4,700,800	3,767,400	3,393,000	15,902,800
Costs of Service Connections (LE)						
Residential(4)	2,194,500	1,958,300	4,861,600	4,177,900	4,249,500	17,441,800
Institutional(5)	147,100	131,300	325,900	280,100	284,900	1,169,300
Industrial(6)	107,300	82,000	216,100	137,100	61,100	603,500
Subtotal - Service Connections	2,448,900	2,171,600	5,403,600	4,595,100	4,495,500	19,214,600
Subtotal	4,625,500	4,038,700	10,104,400	8,362,500	7,988,500	35,117,000
Allowance for removal and replacement of surface clay(7)	601,300	525,000	1,313,600	1,087,100	1,038,500	4,565,200
TOTAL	5,226,800	4,563,700	11,418,000	9,449,600	9,027,000	39,682,200

Notes:

(1) In 1978 LE. Costs are 86% local and include allowance for contingencies and support.
(2) At 25.70 LE per person.
(3) At 8,350 LE per gross hectare of industrial use.
(4) At 35.80 LE per person.
(5) At 2.40 LE per person.
(6) At 1,490 LE per gross hectare of industrial use.
(7) At 13 percent of local collector and service connection subtotal.

TABLE 8.10

ALTERNATIVE COSTS OF COLLECTION SYSTEMS FOR AREAS WEST OF MAZRAH
(Thousands of 1978 LE)

	Pipelines	Equipment & Installation	Structures & Misc.	Total
Alternatives 1A, 1B				
PS-17	180	390	30	
Contingencies (20%)	36	78	6	
Support (31.5%)	57	123	10	
TOTAL	273	591	46	910
PS-18 & 18A	162	360	48	
Contingencies (20%)	32	72	10	
Support (31.5%)	51	113	15	
TOTAL	245	545	73	863
COMBINED TOTAL				1,773
Alternatives 2A, 2B				
PS-17	96	90	20	
Contingencies (20%)	19	18	4	
Support (31.5%)	30	28	6	
TOTAL	145	136	30	311
PS-18	81	180	24	
Contingencies (20%)	16	36	5	
Support (31.5%)	26	57	8	
TOTAL	123	273	37	433
COMBINED TOTAL				744

TABLE 8.11

TRANSPORT SYSTEM COSTS
(Thousands of 1978 LE)

	Pipeline Costs	Equipment & Installation	Structures & Misc.	Total
Alternative 1A				
Main Pump Station				
Southern Service Area				
Immediate Phase	1,363	1,129	280	
Contingencies (20%)	273	226	56	
Support (31.5%)	429	356	88	
TOTAL	2,065	1,711	424	4,200
Final Phase	608	321		
Contingencies (20%)	122	64		
Support (31.5%)	192	101		
TOTAL	992	486		1,408
Alternative 2A				
Main Pump Station				
Southern Service Area				
Immediate Phase	1,760	1,090	280	
Contingencies (20%)	352	218	56	
Support (31.5%)	544	343	88	
TOTAL	2,666	1,651	424	4,741
Final Phase	836	318		
Contingencies (20%)	167	62		
Support (31.5%)	263	98		
TOTAL	1,266	470		1,736
Alternative 2B				
Main Pump Station				
Southern Service Area				
Immediate Phase	1,954	1,320	330	
Contingencies (20%)	391	264	66	
Support (31.5%)	616	416	104	
TOTAL	2,961	2,000	500	5,461

TABLE 8.11 (Cont'd)

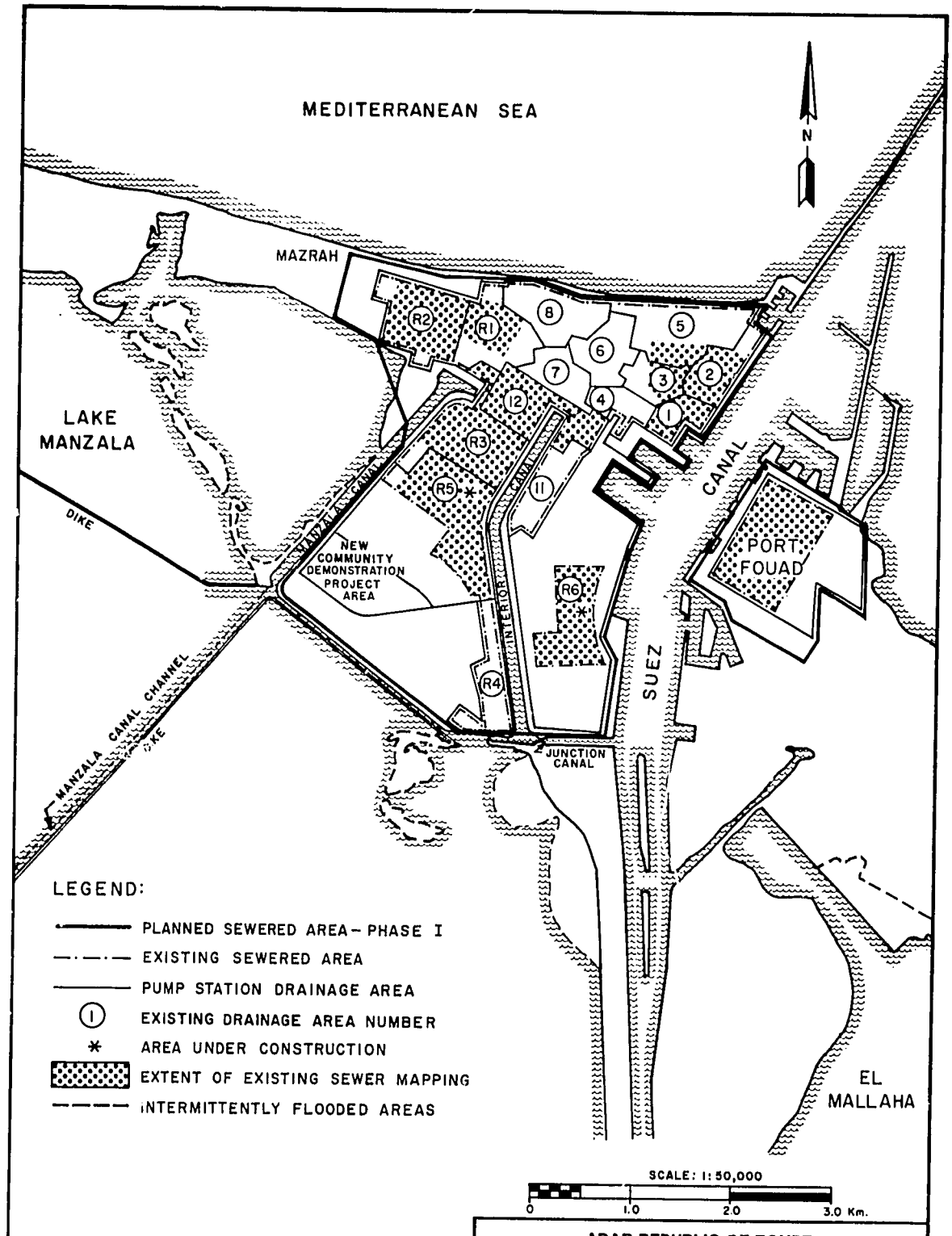
	Pipeline Costs	Equipment & Installation	Structures & Misc.	Total
Alternative 2B (Cont'd)				
Final Phase				
Contingencies (20%)	836	980		
Support (31.5%)	167	196		
	263	309		
TOTAL	1,266	1,485		2,751
Port Fouad Main P.S. and Siphon				
Immediate Phase				
Station		420	120	
Force Main	1,247			
Siphon	1,050			
Subtotal	2,297	420	120	
Contingencies (20%)	459	84	24	
Support (31.5%)	724	132	38	
TOTAL	3,480	636	182	4,298
Immediate Phase Total Southern Service Area and Port Fouad				9,659

TABLE 8.12

SCHEDULE OF VEHICLE PROCUREMENT AND ADDITION
(Thousands of 1978 LE)

Type of Vehicle	Unit Cost	Phase(1) High Priority Works 1979-1981 No.	Cost	Immediate 1982 No.	Cost	Staged Development 1983-1985 No.	Cost	1991-1995 No.	Cost	1996-1995 No.	Cost	1996-2000 No.	Cost	Total Per Type Cost
Car	7	-	-	3	21(2)									21
Utility Truck	12	4	48	8	96	-	-	2	24	-	-	1	12	180
Crew Cab	12	6	72	1	12	-	-	2	24	1	12	-	-	120
Sludge Hauling Trucks	20	-	-	3	60	1	20	-	-	1	20	1	20	120
Front End Loader	30	-	-	1	30	-	-	-	-	-	-	-	-	30
Dump Truck With Orange Peel	20	1	20	-	-	-	-	-	-	1	20	-	-	40
Sewer Cleaning Collection Trucks	20	2	40	-	-	-	-	1	20	-	-	1	20	80
Backhoes	15	1	15	3	45	1	15	1	15	1	15	-	-	105
Flat Bed With Crane	21	1	21	2	42	-	-	-	-	-	-	-	-	63
Dump Trucks	15	-	-	2	30	1	15	-	-	-	-	-	-	45
Bucket Machine	14	-	-	-	-	1	14	1	14	1	14	1	14	56
Power Rodder	4	-	-	-	-	-	-	1	4	-	-	1	4	8
TOTAL COST PER PHASE			216		336		64		101		81		70	868

(1) 100 percent foreign cost delivered to Port Said includes contingencies and support cost.
(2) Typical - 3 cars at LE 7,000 each totals LE 21,000.



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PORT SAID
WATER AND WASTEWATER FACILITIES MASTER PLAN

HAZEN AND SAWYER
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EXTENT OF SEWER MAPPING

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FIG. 8-A

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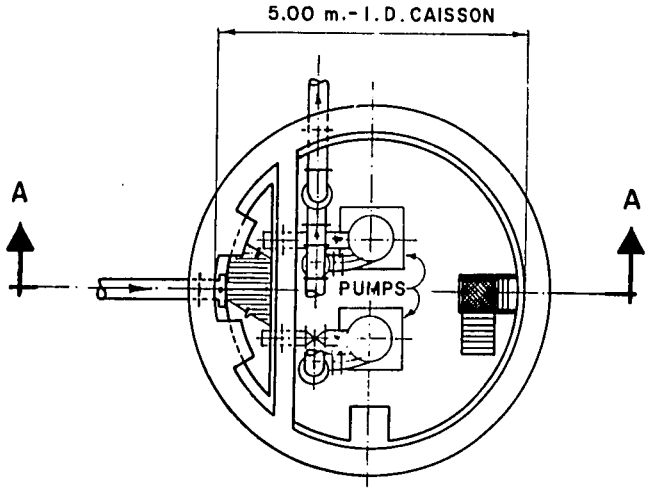
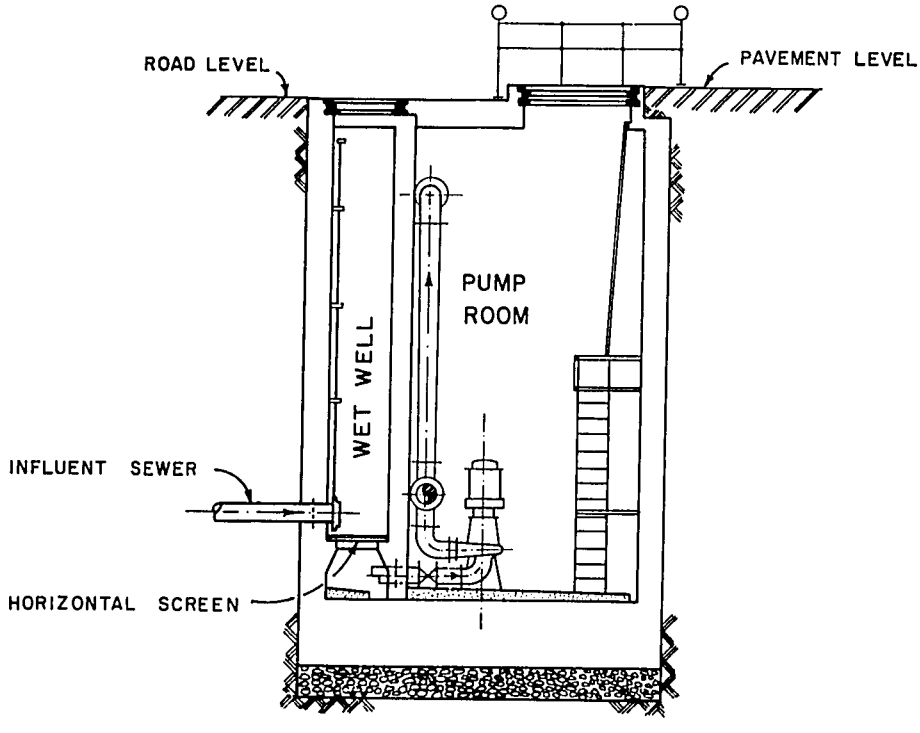


SECTIONAL PLAN



SECTION A - A

SCALE 1 : 100

NOTE:
TYPICAL FOR STATIONS 1 TO 7, 11 & 12. STATIONS 8, R-1, R-2, R-3 & R-4 HAVE SIMILAR SUBSTRUCTURE (6m. DIA.) AND SUPERSTRUCTURE TO HOUSE PUMP DRIVES.

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TYPICAL EXISTING SEWAGE PUMPING STATION

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FIG. 8-B

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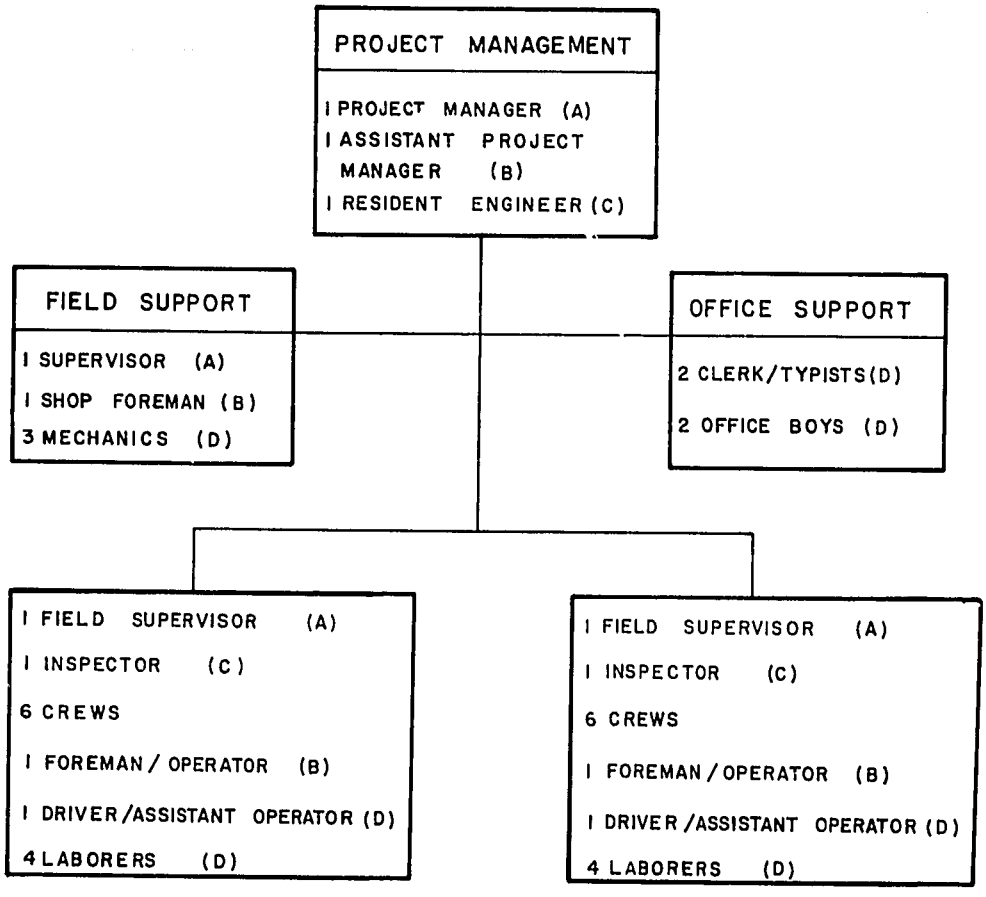

NOTES

(A) TO BE SUPPLIED BY CONTRACTOR
(B) TO BE SUPPLIED BY GOVERNORATE OF PORT SAID
(C) TO BE SUPPLIED BY CONSULTANT
(D) TO BE SUPPLIED BY GOVERNORATE OF PORT SAID IF AVAILABLE. IF NOT WILL BE PROCURED FROM LOCAL CONSTRUCTION LABOR FORCE.

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PROPOSED ORGANIZATION FOR SEWER CLEANING PROGRAM

VOL. 3
FIG.
8-C

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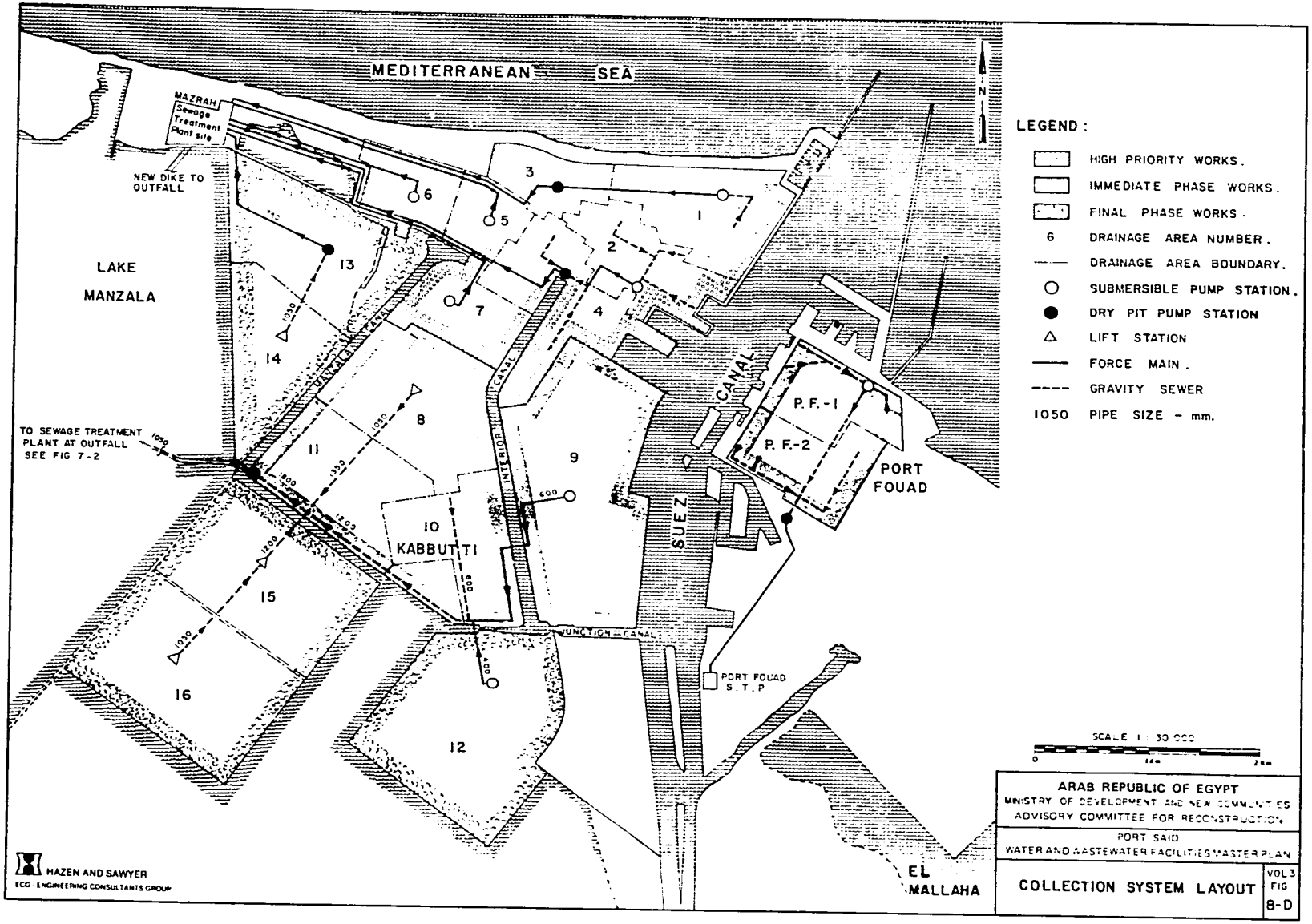
MEDITERRANEAN SEA
MAZRAH Sewage Treatment Plant site
NEW DIKE TO OUTFALL
LAKE MANZALA
TO SEWAGE TREATMENT PLANT AT OUTFALL SEE FIG 7-2
MANZALA CANAL
INTERIOR CANAL
KABBUTTI
JUNCTION CANAL
SUEZ CANAL
P. F.-1
P. F.-2
PORT FOUAD
PORT FOUAD S.T.P
EL MALLAHA
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
1050
1350
1500
1200
600
N
LEGEND :
HIGH PRIORITY WORKS.
IMMEDIATE PHASE WORKS.
FINAL PHASE WORKS.
6 DRAINAGE AREA NUMBER.
DRAINAGE AREA BOUNDARY.
SUBMERSIBLE PUMP STATION.
DRY PIT PUMP STATION
LIFT STATION
FORCE MAIN.
GRAVITY SEWER
1050 PIPE SIZE - mm.
SCALE 1 : 30 000
0
1km
2km
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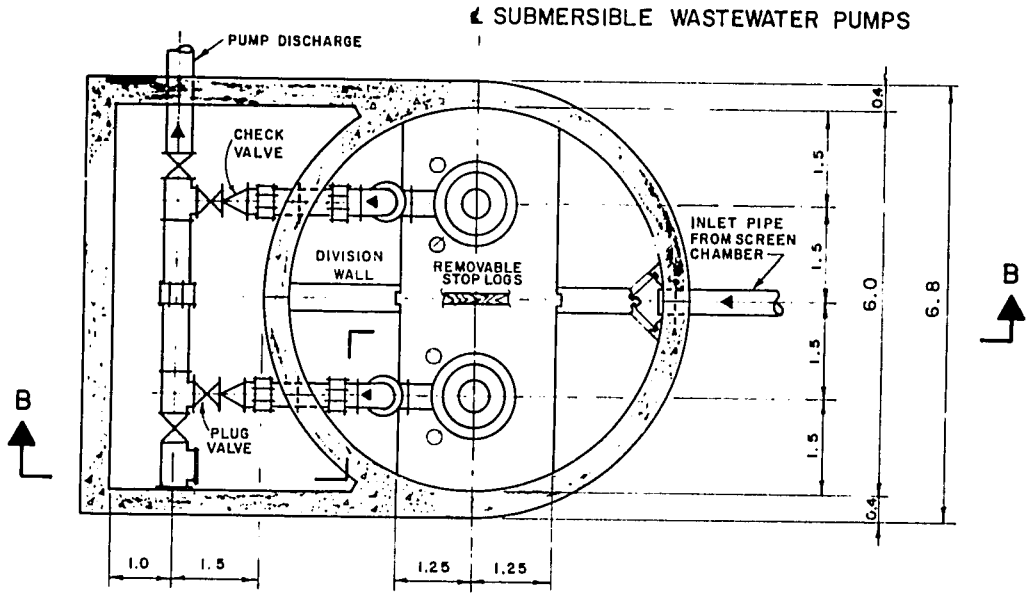
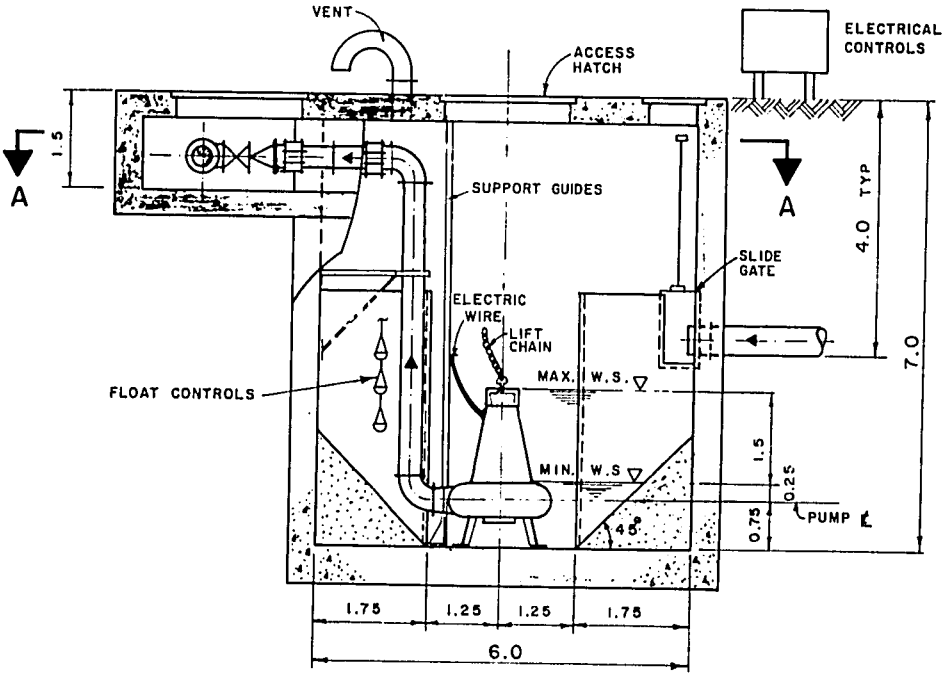
WATER AND WASTEWATER FACILITIES MASTER PLAN
COLLECTION SYSTEM LAYOUT
VOL 3
FIG
8-D



SECTION A-A



SECTION B-B

SCALE 1:100

ALL DIMENSIONS IN METERS

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

TYPICAL
SUBMERSIBLE PUMP STATION

VOL.3
FIG.
8-E

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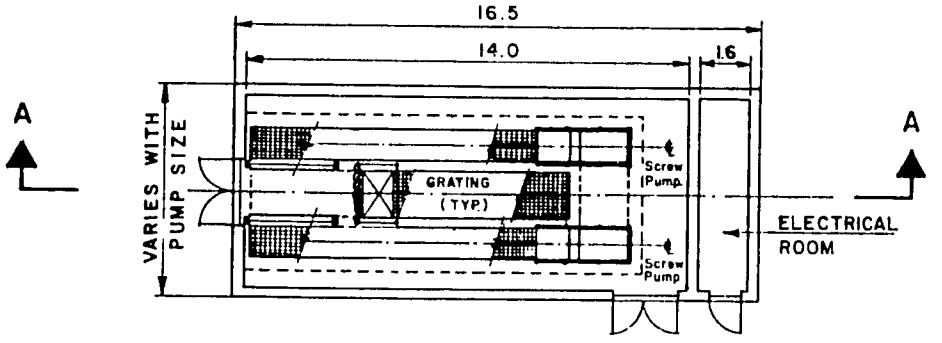
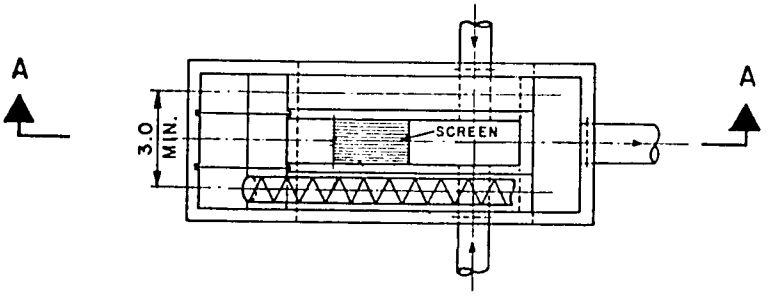
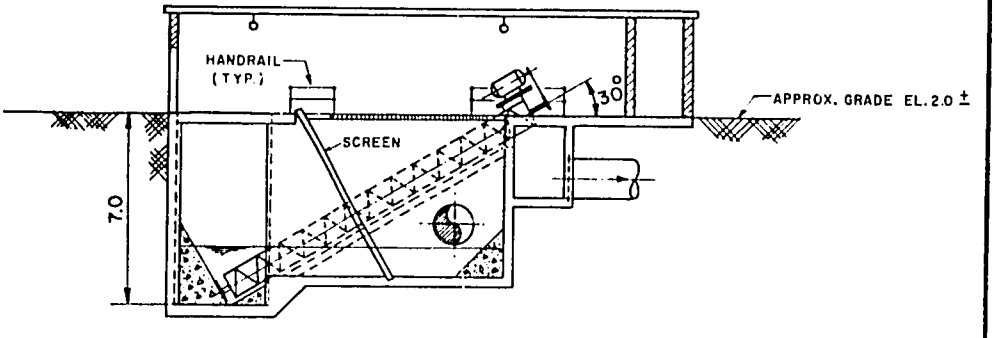


UPPER PLAN



LOWER PLAN



SECTION A - A

SCALE 1:200

ALL DIMENSIONS IN METERS.

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

TYPICAL HELICAL SCREW LIFT STATION

VOL.3
FIG.
8-F

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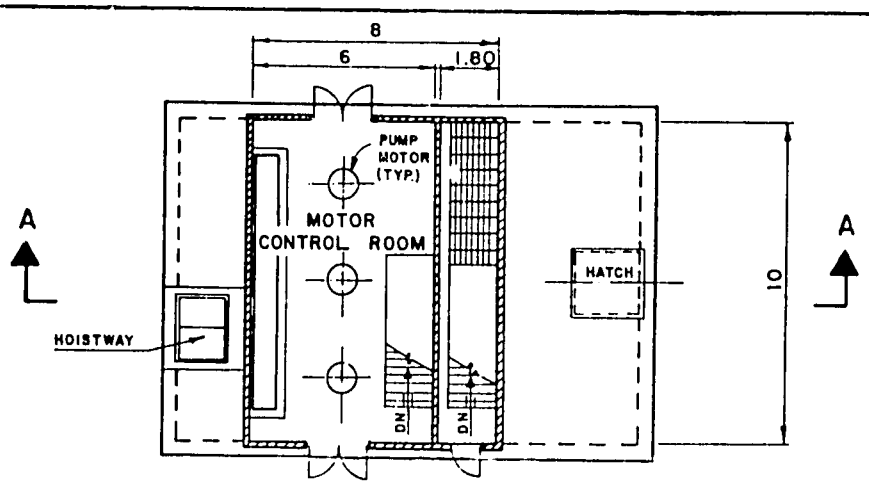
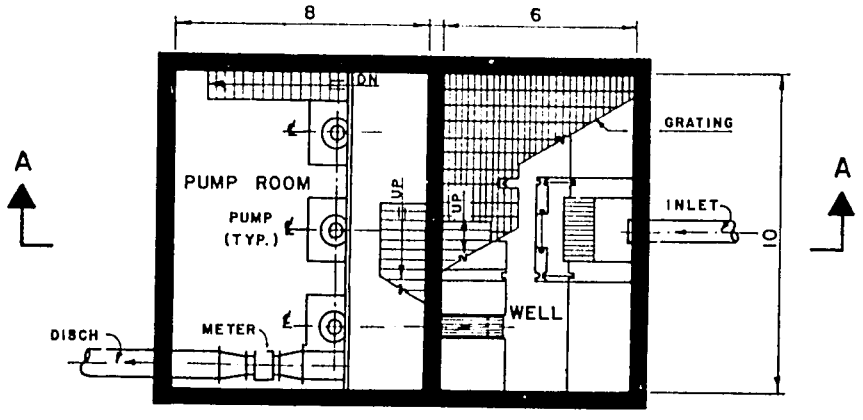
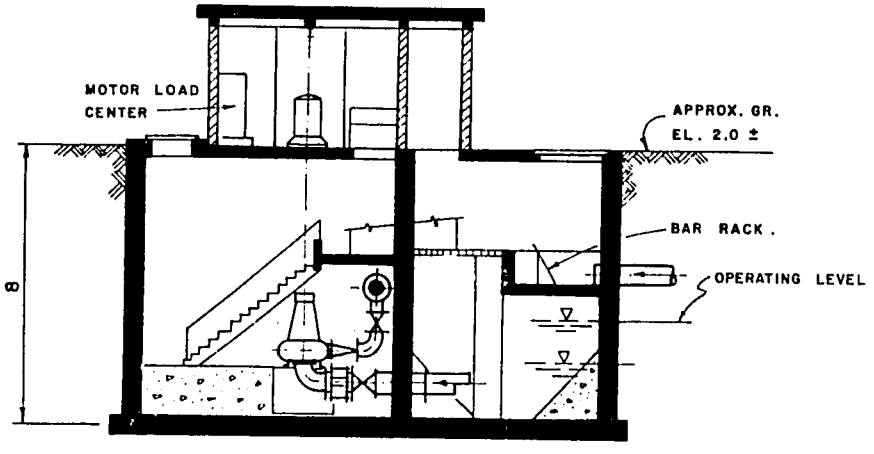


UPPER PLAN



LOWER PLAN



SECTION A-A

SCALE 1 : 200

ALL DIMENSIONS IN METERS.

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

TYPICAL DRY PIT PUMP STATION

VOL. 3
FIG. 8-G

CHAPTER 9

ANALYSIS AND COSTS OF RECOMMENDED PROGRAM

9.1 ANALYSIS

Four alternatives for collection, treatment and disposal of wastewater were developed in Chapters 6, 7 and 8 based on primary treatment with disposal to Lake Manzala or to the Suez Canal (the latter for Port Fouad only). Under all alternatives wastewater is collected to two locations in Port Said (Mazrah and a new main pump station at the confluence of the Manzala and Junction Canals) and to a single location in Port Fouad.

The alternatives differ as to treatment and discharge location as follows:

Alternative	Area Served	Treatment Location	Discharge 1000 cu m/d 1982	Discharge 1000 cu m/d 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

The alternatives also differ as to the layout of pipelines to transport wastewater from the main collection points to treatment locations.

Under all alternatives effluent would discharge to Lake Manzala through a 1.5 km outfall with a 1 km diffuser section. Discharge of Port Fouad effluent to the Suez Canal would be through a short outfall, extending only to reach maximum depth in the canal. No diffuser would be needed.

Capital and annual operating costs for three alternatives (1A, 2A and 2B) are summarized below:

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Alternative	Treatment Locations	Capital Cost (1000 LE)	Annual Operating Costs (LE)
1-A	Mazrah Port Fouad	45,412	434,000
2-A	Mazrah Southwest Port Fouad	41,691	402,000
2-B	Mazrah Southwest	46,035	409,000

The relative costs of these three alternatives show clearly that the fourth Alternative 1-B with all flows treated at Mazrah, would be more costly than any other. Hence, detailed costs were not developed for this alternative.

Alternative 2-A has a decided capital cost advantage over the other remaining alternatives. The extra treatment location in Alternative 2-A results in higher labor costs, but these are offset by power savings to give a decided operating cost advantage over Alternative 1-A, and slightly lower operating costs than Alternative 2-B.

Since the present worth of Alternative 2-A would be the lowest of the alternatives considered, regardless of discount rate, we have not made a full present worth analysis of the type indicated in Chapter 5. Application of shadow pricing to capital costs would affect all alternatives about the same since they have the same proportions of various types of construction and their relative costs would remain in proportion. Application of shadow pricing to electricity (ratio 3.4) would increase the advantage of Alternative 2-A, since it has the lowest power needs. Shadow pricing of skilled labor (ratio of up to 1.5) would reduce the advantage of Alternative 2-A, but the effect would be much less than for shadow pricing of electricity.

Tables 9.1, 9.2 and 9.3 show capital costs, connected horsepower, required operating staffs and estimated power and labor costs for the three alternatives compared.

9.2 OTHER CONSIDERATIONS

SCA Requirements

If the SCA objects to discharge of primary effluent to the Suez Canal, further consideration could be given to Alternative 2-B, which would eliminate any discharge to the Canal. Though technically feasible this alternative entails extra capital costs which should be financed other than by user charges.

Sludge and Odors

The recommended program would retain primary treatment at Mazrah, but remove sludge drying to the isolated site of the new Southwest treatment works. Land development under the PSMP is expected to encroach on the present buffer zone around Mazrah. The Mazrah site does not meet current Ministry of Health guidelines which require plants to be separated by 2 km from developed areas downwind. With sludge processing located elsewhere, however, we believe the Mazrah plant need have no negative impact on its surroundings. In detailed design, attention must be given to proper handling of residues in

order to minimize the effects of possible odor sources. There is little justification, however, for substantial extra outlays to replace Mazrah with facilities at a more remote location.

Flexibility

The capacity of the system as planned could be readily expanded to accommodate loads from additional population up to the PSMP target of 750,000 people. The added flow would average 18,000 cu m/d. Added growth would probably take place to the south of the city, from where wastewater could flow to the southern main pumping station, or to the west, in areas directly tributary to either the Mazrah or Southwest treatment plants.

The Mazrah plant site could accomodate needed additional primary treatment units, and the southwest site could easily be expanded. The additional flow could be carried in the planned force mains to the southwest site, using somewhat higher pumping heads in the southern main station.

9.3 RECOMMENDATION

In view of its significantly lower costs, Alternative 2-A is recommended as the basis for the wastewater collection treatment and disposal program. The recommended alternative is technically sound and based on accepted engineering standards and practices. It would raise water quality in Lake Manzala and the Suez Canal to acceptable levels.

Estimated capital costs of the High Priority, Immediate Phase and Staged Development programs under Alternative 2-A are shown in Table 9.4.

TABLE 9.1

WASTEWATER PRIMARY TREATMENT ALTERNATIVE I-A

COST SUMMARY

	Capital Costs - (Thousands of 1978 LE)		
	High Priority & Immediate Phase	Staged Development	TOTAL
PORT SAID			
Collection			
Port Said	11,034	4,846	15,880
Areas West of Mazrah	0	1,773	1,773
Transport	4,200	1,408	5,608
Treatment (Mazrah)	4,848	3,310	8,158
Effluent Disposal (Lake Manzala)	7,694	2,411	10,105
Subtotal	27,776	13,748	41,524
PORT FOUAD			
Collection	1,251	0	1,251
Transport	1,324	0	1,324
Treatment (Port Fouad)	995	0	995
Effluent Disposal (Suez Canal)	318	0	318
Subtotal	3,888	0	3,888
TOTAL CAPITAL COSTS	31,664	13,748	45,412

	Annual Operating Costs (LE)
Power(1)	193,000
Salaries(2)	241,000
TOTAL ANNUAL COSTS	434,000

(1) Total connected HP - 8,874
(2) Total operating staff - 229 persons

TABLE 9.2

WASTEWATER PRIMARY TREATMENT ALTERNATIVE 2-A

COST SUMMARY

	Capital Costs - (Thouands of 1978 LE)		
	High Priority & Immediate Phase	Staged Development	TOTAL
PORT SAID			
Collection			
Port Said	11,034	4,846	15,880
Areas West of Mazrah	0	744	744
Transport	4,741	1,736	6,477
Treatment (Mazrah and Southwestern)	6,347	1,896	8,243
Effluent Disposal (Lake Manzala)	6,459	0	6,459
Subtotal	28,581	9,222	37,803
PORT FOUAD - New Plant			
Collection	1,251	0	1,251
Transport	1,324	0	1,324
Treatment (Port Fouad)	995	0	995
Effluent Disposal (Suez Canal)	318	0	318
Subtotal	3,888	0	3,888
TOTAL CAPITAL COSTS	32,469	9,222	41,691

	Annual Operating Costs (LE)
Power(1)	152,000
Salaries(2)	255,000
TOTAL ANNUAL COSTS	407,000

(1) Total connected HP - 6,991
(2) Total operating staff - 244 persons

TABLE 9.3

WASTEWATER PRIMARY TREATMENT ALTERNATIVE 2-B[1]

COST SUMMARY

	Capital Costs - (Thousands of 1978 LE)		
	High Priority & Immediate Phase	Staged Development	TOTAL
PORT SAID - PORT FOUAD			
Collection			
Port Said	11,443	4,846	16,289
Areas West of Mazrah	0	744	744
Port Fouad	1,251	0	1,251
Transport			
Port Said	5,461	2,751	8,212
Port Fouad	4,298	0	4,298
Treatment (Mazrah and Southwestern)	6,816	1,966	8,782
Effluent Disposal (Lake Manzala)	6,459	0	6,459
TOTAL CAPITAL COSTS	35,728	10,307	46,035

	Annual Operating Costs (LE)
Power[2]	168,000
Salaries[3]	240,000
TOTAL ANNUAL COSTS	409,000

(1) Alternative IB eliminated since providing all treatment at Mazrah would not be cost effective.
(2) Total connected HP - 7,737.
(3) Total operating staff - 234 persons.

TABLE 9.4

COST SUMMARY OF RECOMMENDED
WASTEWATER FACILITIES PROGRAM - ALTERNATIVE 2-A[1]

	Estimated Capital Costs[2] (Thousands of 1978 LE)		
	Local	Foreign	Total
High Priority			
Equipment Procurement & Local Measures[4]	70	298	368
Procurement of Services[3]			
Sewer Cleaning Program[5]	133	458	591
Sewer Inspection & Grouting Program[6]	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[1]	7,365	5,440	12,805
Port Fouad Treatment & Disposal[1]	658	655	1,313
Sewer Rehabilitation	500	-	500
Secondary Collection System 1979-1982[8]	4,495	732	5,227
Equipment Procurement[3]			
Vehicle & Maintenance Equipment	-	336	336
Procurement of Services[3]			
Surface Drainage Study	18	52	70
Subtotal Immediate Phase	19,160	12,954	32,114
Staged Development			
1983-1985			
Secondary Collection[8]	3,924	639	4,563
PS-12, PS-13	950	1,252	2,202
Additional Vehicles & Equipment[3]	-	64	64
1986-1990			
Secondary Collection System[8]	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	999	897	1,896
Additional Vehicles & Equipment[3]	0	101	101
1991-1994			
Secondary Collection System[8]	8,127	1,320	9,447
LS-15	573	381	954
Additional Vehicles & Equipment[3]	0	81	81
1995-2000			
Secondary Collection System[8]	7,758	1,265	9,023
LS-16	573	392	965
Additional Vehicle & Equipment[3]	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

(1) For Port Said - modified Mazrah and new Southwest Treatment Plant. For Port Fouad - new treatment plant.
(2) Based on August 1978 prices including contingencies and support allowance costs.
(3) Recommended projects common to all alternatives; therefore do not appear in Tables 9.1, 9.2 and 9.3 that compare alternatives.
(4) For details see Table 8.7.
(5) For details see Table 8.4.
(6) For details see Table 8.5.
(7) Including local measures for sealing storm water inlets.
(8) Service connections and local collector sewers in individual drainage areas.

The wastewater system for Port Said is under the Wastewater Department of the Governorate of Port Said as a division within the Governorate Engineering Department. The present staff is to be commended for its efforts in restoring service after the 1967-73 shutdown and keeping the system running in spite of inadequate facilities and shortages of tools, maintenance equipment and spare parts. The department is, however, overstaffed with unskilled labor while critically short of skilled technicians and supervisory personnel. Improving this situation will require both specialized training to upgrade individual qualifications, and more competitive compensation to attract and retain key staff.

Specific measures recommended to overcome present deficiencies include:

- Provision of adequate tools and replacement parts.
- Improvement of record keeping.
- Training programs to increase skills.
- Strengthening of supervision.

This chapter considers in detail:

- Overall and functional organization and staffing for wastewater system operations for both near and long term operation in Port Said, including integration with water operations.
- Personnel qualifications, training and salary.

10.1 ORGANIZATIONAL STRUCTURE

Overall Structure

The wastewater system operates within the overall Governorate organizational structure. The head of the Wastewater Department reports to the Governorate Director of Engineering. The department staff handles all the normal operations and maintenance functions of a typical municipal wastewater department. Other Governorate offices provide support functions such as personnel, materials procurement and accounting. Major improvements are the responsibility of the Government. Except for service connections, no charges are assessed against system users.

A portion of Port Fouad, consisting of housing built by the SCA for its employees, is served by sewers built and presently operated by the SCA. This area drains to a pump station in the shipyard which discharges to the Mediterranean. Once the Immediate Phase Works are completed, this station will be abandoned and operation and maintenance of all facilities in Port Fouad should be put under the control of the Governorate of Port Said.

Several alternative organizational structures are being considered for the water and utilities in the canal cities:

- The consultants for the national Management and Tariff Studies Relative to Water/Sewerage recommended (December 1978) a combined regional water and sewerage company, or general organization, to serve the canal cities.

- An alternative recommendation in the report was formation by the SCA of a regional water company and separate formation of a regional sewerage utility, either as a public company or as a general organization. (A general organization would, of course, be appropriate if the wastewater utilities for the canal cities were to be integrated into GOSSD at the national level.) The ultimate goal would be eventually to combine the two organizations.

- On the other hand, we understand that present national policy favors giving governorates increasing responsibility for public services.

Integrating water and wastewater operations at the local or regional level would:

- Simplify levying user charges for water and wastewater service. (The charges would be based on metered water use in any case).

- Avoid unnecessary duplication of equipment and staff for basically similar activities, including:

  - Pipeline construction and maintenance
  - Treatment plant operation and maintenance
  - Pumping station operation and maintenance
  - Shops
  - Laboratories
  - Engineering and construction management
  - Customer services contacts
  - Procurements
  - Financial management
  - Personnel and training
  - Coordination of service extensions and street openings

A major effort would be needed to establish a basis for such integration, taking into account the interest of all present parties concerned. We believe that the potential benefits would justify the effort.

Whatever the organizational structures selected to provide water and sewer service to Port Said in the years ahead, the choice is likely to be made in a wider context than that of Port Said alone. The selection of overall structure should take these factors into account:

- The local organization in Port Said necessarily has the "line" responsibility for providing service there.

- The overall structure should be judged by how well it supports the local organization in carrying out this responsibility.

- The organization responsible for service must have the authority and independence to discharge this responsibility.

- The present overall structure is functional and should not be altered until a demonstrably better alternative is developed.

Departmental Structure

The departmental organization shown on Figure 10-A would fit readily into the different overall structures supplying support reviews. A completely autonomous organization, whether at the governorate or regional level, would have separate departments to handle such functions as finances, personnel, engineering, and procurement. In such a structure, the wastewater organization shown would serve as the operations and maintenance department, or the local branch of each department in a regional structure.

At present the department is organized into Civil, Mechanical, and Treatment Divisions, and an Administrative Section, with the following responsibilities:

- Administrative Section - reports, records, correspondence, accounts and budgets.

- Civil Division - sewer and wet well cleaning, sewer repairs, new projects, installation of new house connections.

- Mechanical Division - operation and maintenance of pumping stations; operation of central maintenance shop.

- Treatment Division - operation and maintenance of the Mazrah STP and a laboratory.

To transform the present departmental organization to that shown on Figure 10-A, the following specific revisions are recommended:

- Establish a New Project/Facility Records Division to inspect new work and to develop and maintain record drawings of facilities. The division staff would work closely with consultants supervising major projects.

- Redesignate the Civil Division as the Pipeline Division, better emphasizing its function of installing and maintaining sewers and force mains.

- Replace the Mechanical and Treatment Divisions with an Operations Divison, responsible for normal running of the wastewater system; and a Maintenance Division, responsible for major overhaul work, upkeep of buildings and grounds, and operation of shops and stores.

The recommended local level wastewater organization could be readily adapted to a combined water-wastewater utility. We would suggest the following:

- The Pipeline Division would be responsible for installation and repair of all types of lines.

- The Operations Division would be responsible for all treatment and pumping facilities.

- Maintenance of all plants and pumping stations would be centralized in one division, including sections for stores and equipment.

- The New Projects/Facilities Records Division would remain as shown, but would also include water projects and records.

- Customer services would be handled by a new Customer Services Division, responsible for customer accounting and collection, as well as water meter installation, reading and repair.

10.2 ADMINISTRATION

The Wastewater Department currently has an engineer/manager (titled General Inspector), an assistant manager (also an engineer), and an Administrative Section. The recommended organization would not have an assistant manager position. The head of the Operations Division would be recognized as the second ranking professional in the department and would act as director when necessary.

The Administrative Section would be retained to prepare reports, correspondence and budgets. Staff of the Administrative Section would include an administrative assistant at the supervisory level, a clerk-typist and a clerk to handle budgets and accounts.

10.3 NEW PROJECTS/FACILITIES RECORDS DIVISION

This division would be headed by an engineer experienced in construction supervision and preparation of record drawings. An assistant engineer would directly oversee field measurements and preparation of record drawings. Six technicians with qualifications in surveying, drafting and inspection of construction, would be assigned permanently. Foremen, operators, mechanics and craftsmen from other divisions would supplement this staff as needed.

The division would work with the contractors and engineering consultants responsible for major new construction, contributing special knowledge of local problems and conditions, and receiving training in inspection and preparation of utility record drawings. A major task during the High Priority Program would be to assist consultants in preparing record drawings of existing system elements. Ultimately, the division would assume full responsibility for recording all extensions.

10.4 OPERATIONS DIVISION

Professional Supervisory Staff

Overall responsibility for operations should be exercised by a chief engineer with strong management capabilities and a technical background in the application of electrical and mechanical equipment. The chief engineer should be assisted by five shift managers - engineers with similar but likely less extensive backgrounds - who would provide high level technical supervision on a round-the-clock basis.

Collection and Treatment Section - Shift Operations

The need to staff every pumping station with two operators 24 hours a day is questionable. This schedule probably will be necessary for the immediate future; however, at a later point, it should be possible to automate the smaller stations. Two of the conditions which will determine when such automation is possible are: (1) reliability of the power supply; (2) availability of technicians capable of maintaining the control equipment.

Although the Mazrah STP is currently inoperative, the Treatment Division maintains a staff of approximately 70 people to clear sludge from the bypass channel and perform minor maintenance tasks. A laboratory building has been completed and a chemist employed, but the lab has not been equipped or used for testing.

Recommended staffing for shift operations is based on provision of full time staffing only at treatment facilities and at the larger pumping stations. Smaller stations would use screw pumps, requiring no controls, or submersibles for which simple, reliable float controls are available. Anticipating a more reliable power supply, we believe the smaller stations would operate satisfactorily with only intermittent attendance by roving crews as outlined below. The assignment of full time attendants can be phased out gradually as the reliability of new stations is demonstrated.

Staffing for pump station operation and for clearing blocked sewers would be far below present levels. This reduction reflects in part the improved pumping stations, the elimination of surcharged operation and the benefits of a regular sewer cleaning program. It also reflects more efficient utilization of operating labor than at present, which depends on the improvements in transportation and communication described in Section 10.8 below.

In each shift, foreman, operators and laborers would be assigned on the following basis:

- Foreman:

  Port Fouad (1)
  Treatment (1)
  Mazrah Collection Area (1)
  Southern Port Said Collection Area (1)

- Operators:

  Mazrah - Effluent Pumping (1)
  Southwest - Treatment (1)
  Mazrah - Treatment (1)
  Port Fouad - Treatment (1)
  Southern Main P.S. (1)
  Port Fouad P.S. (1)
  P.S. 4 (1)
  P.S. 13 (1)
  Roving Crews (4)

- Laborers:

  Mazrah - Preliminary Treatment (2)
  Southwest - Preliminary Treatment (2)
  Port Fouad - Treatment (1)

Port Fouad - Pumping (2)
P.S. 4 (1)
P.S. 13 (1)
Southern Main P.S. (1)
Roving Crews (4)
Blockage Removal (4)

Four roving crews, each consisting of one operator and one laborer, would cover the unmanned pumping stations, visiting each station twice per shift to check and service equipment, and to remove screenings. Four additional laborers, assigned to assist the roving crews, would be available to clear reported sewer blockages. These laborers and the roving crews would be under the direction of the Mazrah or Southern collection area foreman, who would dispatch them where most needed.

An extra laborer would be assigned to the Port Fouad system to assure sufficient staff to cover all operations there including removal of blockages. The Port Fouad foreman would dispatch his entire staff of operators and laborers where most needed.

Because of the hazards of working in the sewers and around treatment and pumping facilities, staffing is planned so men can be assigned or dispatched to hazardous areas in pairs.

Based on a six-day, 48-hour work week with allowances for vacations, holidays, leave and sick time, round-the-clock staffing would take five men per position staffed. On this basis the shift operation of the Collection and Treatment Section would require a total staff of 20 foremen, 76 operators (55 pump station and 21 treatment plant) and 85 laborers. For most efficient use of personnel, assignments should be flexible and individuals prepared to work at different locations in the system as the need arises. Operators should be encouraged to become familiar with the full range of equipment at different installations.

Solids Disposal

This section would be responsible for removing dried sludge from the drying beds, loading it on trucks and hauling to final disposal locations. The year 2000 staffing would include a foreman, 35 laborers, 17 truck drivers and three loader operators. Work on the beds would normally be confined to the day shift, sludge hauling trucks would work two shifts. Laborers would break up dried cake on the beds to permit it to be handled by the loader. The loader would transfer it to stockpiles and also load it from these to trucks. For reasons indicated in Chapter 6, operating costs are based on the wastewater utility itself hauling the sludge to agricultural areas 40 km away. Proceeds from sale of the sludge at LE 1.00/cu m would more than offset the haul costs.

Two drivers with specially equipped trucks would be assigned to collect grit and screenings from treatment works and pumping stations.

Operations Division Records

The operations division should maintain daily operating records on each pumping station and maintenance records on each piece of equipment.

Operating records should be in the form of a daily log maintained by each operator. It should include the number of hours each pump operates, the quantity pumped (estimated

if the station is not equipped with a flowmeter) and any comments concerning the condition of the equipment and maintenance performed.

Maintenance records on equipment should be in the form of a card file. A card should be prepared for each item of equipment and should list the following information:

Type of equipment		Identifying No:
Manufacturer:		Location:
Serial No:		
Date of installation:		
Capacity:		
Interchangeable with units:		
Similar to units:		
Date:	Hours of operation:	Maintenance performed:

These cards shold be updated from the operators' logs on a weekly basis and reviewed to ensure that routine maintenance is performed at the necessary intervals. A file including shop drawings and manufacturers' literature on all equipment should also be maintained.

The Operations Division should also maintain records on treatment plant operation and maintenance with a log book and card file system similar to that proposed for the pump stations. Records should include influent flow, sludge flows, pump operating hours, power consumed, chemicals consumed (if any), dewatered sludge volumes, etc.

Laboratory samples should be taken of the plant influent, the various sludge streams and at any intermediate points in the process where testing is required to ensure proper adjustment.

Laboratory

Operating control of primary treatment requires very little laboratory work. The major concern of the laboratory should be monitoring of industrial contributors (for excessive solids loads and toxic materials) and of receiving water quality (for dissolved oxygen, BOD and coliforms). Sampling frequency and the volume of analyses need not be high. Estimated staffing needs are one chemist and a laborer for cleanup and sample collection. Laboratory space at Mazrah is adequate. The immediate phase recommended program includes an allowance for needed equipment.

10.5 PIPELINE DIVISION

Until recently the Pipeline Division employed 150+ men who worked in one and two-man crews to clear obstructions from the sewers using metal sectional rods. These crews respond to complaints and are not used in a regularly scheduled cleaning program. These men were recently transferred out of the wastewater depatment and put under the direct control of Port Said's three district supervisors in hopes of providing faster response to complaints. However, some confusion has resulted since many of the drainage areas are split by the district boundaries. Often an overflow in one area is caused by a blockage in an adjacent district, making the responsibility for cleaning it unclear.

The Division still operates a truck mounted jet rodder in a regular sewer cleaning program. Another crew works regularly on manually removing accumulated grit and sludge from pump station wet wells. Normally this crew spends two to three weeks per station cleaning each station at least once per year. However, several more troublesome stations require more frequent cleaning.

The Division requires the 150 men to maintain the approximately 105 km of sewer or about 1.5 men/km of sewer. Once the new pump stations are in operaton and the sewers flow freely, blockages should be much less frequent, and fewer men should be required.

A regular program should be instituted to clean the entire system approximately once every two years. The actual schedule should be developed as experience dictates as some reaches may require more or less frequent cleaning.

One bucket machine with a 6-man crew should be able to clean 30 km of sewer per year.

The separation of pumping and treatment operations between the present Mechanical and Treatment Divisions ignores the basic similarity of their work. This work involves monitoring and servicing pumps and other mechanical equipment, whether in a collection system pumping station or at the treatment plant. Keeping this separation in the future would result in a rigid and wasteful utilization of staff in the expanded system. Treatment and pumping operations are closely related functionally. Both must be kept running on a 24-hr basis. Combining them in a single division will assure the most responsible round-the-clock direction.

The Division would be headed by a Chief Engineer who should be experienced in utility line design, construction, and maintenance. The division would be made up of three sections as described below. The basis for estimated staffing requirements in these sections is given below. Blockage crews, formerly part of the civil division would be transferred to the operations division to provide better round-the-clock supervision of their work.

Pipeline Maintenance

This section would be responsible for repair of force main leaks, and of broken sewers and manholes. They would also handle minor extensions of the secondary collection system as the repair work load permits. Major extensions are assumed to be done by outside contract.

In the year 2000, the section would consist of a supervisor, four sewer repair crews and two manhole inspection crews. Each crew would include a foreman, a mason or pipefitter and three laborers; the four sewer repair crews would be supported by two backhoe operators.

Sewer and Force Main Cleaning

This Division presently owns 2 bucket machines which cannot be used due to a lack of certain key parts. These parts could be easily fabricated once the maintenance shop is re-equipped. In addition 10 bucket machines and 2 power rodders will be turned over to GOPS upon completion of the recommended sewer cleaning program (see Chapter 8). This is more equipment than will be required for a regular cleaning program in Port Said. Therefore some of the equipment could be made available to other municipalities.

Wet well cleaning should be required on a much less frequent basis once the High Priority Works are completed. It could easily be accomplished by a two man crew operating a dump truck with an orange peel bucket (see Chapter 8).

Once the regular cleaning program is operating, it should be possible to reduce the manpower requirements for clearing blockages from 1.5 men/km of sewer to 1 man per

drainage area per shift. However, for safety's sake they should operate in pairs covering two drainage areas.

This section would clean pipelines on a regular basis, using bucket machines and hydraulic rodding equipment in the sewers and pipeline "pigs" in the force mains. The year 2000 staff would consist of: a supervisor, seven bucket machine crews each with a foreman, two machine operators and five laborers; and five crews to handle hydraulic rodding and force main cleaning, each crew with an operator and three laborers.

Sewer Connections

This section would install new building connections and repair existing ones. From 1982 on, the volume of new connctions is expected to require a section consisting of a supervisor, two backhoe operators to open trenches, and six crews each with a foreman and four laborers.

Pipeline Division Records

The Pipeline Division should be responsible for maintaining an accurate set of sewer maps and providing information to the New Project/Facilities Records Division. Updating of the maps as new connections are made and recording of major repairs should be a continuing function of the Pipeline Division.

It is assumed that accurate maps of the existing system can be prepared during the sewer cleaning and inspection program and turned over to the Governorate. Maps should be prepared at several scales, organized by service and drainage area. Detailed maps should be at a scale to show adjacent utilities clearly in both plan and profile. Regular procedures should be established for exchanging information with SCA, the EEA and the Ministry of Telecommunications regarding the location of underground utilities, and for notifying one another when excavation is required.

Records should be kept at the Pipeline Division level of all major repairs and the approximate volume of material removed. This will enable modification of the cleaning schedule to focus on the sewer reaches accumulating the most solids.

To facilitate record-keeping a numbering system should be devised which would identify each manhole and sewer reach.

10.6 MAINTENANCE DIVISION

The Maintenance Division would likewise centralize responsibility for major upkeep of buildings and equipment throughout the system. The present organization requires a needless duplication of maintenance functions between the Treatment and Mechanical divisions.

The division would be headed by a mechanical engineer experienced in application and maintenance of pumping and electrical equipment.

The division staff would normally work on the day shift only, but individual mechanics would rotate, being "on-call" at their homes in case of emergency breakdown maintenance beyond the capabilities of the shift operators. The division would be made up of three sections as follows:

Field Maintenance/Transport

This section would be responsible for:

- maintaining vehicles and construction equipment used in the system
- carrying out field repairs on installed equipment
- transporting equipment for shop repair
- moving portable pumps and generators as needed

Staffing would consist of one foreman, six mechanics or electricians, six laborers and three drivers. One flat bed truck with hydraulic crane and two pick-up trucks would be assigned to the section.

Building and Grounds

This section, consisting of a foreman, four craftsmen and six laborers would handle building painting and repairs and upkeep of facility grounds.

Shops and Stores

Major work on equipment is carried out in a centralized shop and repair facility. Although shop equipment is limited, the staff includes accomplished machinists who manage to fabricate almost all replacement parts needed for pump maintenance.

The shop is located in a building which served as the central compressor station of the now abandoned ejector system. The building is equipped with a large traveling bridge crane, and is generally of adequate size. Some renovation work is required, particularly replacement of the concrete floor which still contains the anchors for the old compressors, and a new lighting and power system to allow the installation of machine tools.

The central shops would be staffed by a foreman, nine mechanics or electricians and nine laborers. The central warehouse would be staffed by a storekeeper and three clerks.

As part of its responsibility, this section would:

- inventory, safeguard, order and record use of supplies and materials in operation and maintenance of the system;
- compile and analyze equipment operation and maintenance records to determine needed stocks of spare parts, and to identify equipment that should be replaced because of excessive repair costs.

10.7 CUSTOMER SERVICE

We recommend the Customer Services Division of the Water utility be designated to collect charges for sewer service, with proceeds turned over to the wastewater system. This would avoid duplication of effort by the utility organizations and save customers of these related utility services the trouble of dealing with two separate customer service organizations.

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- The New Projects/Facilities Records Division would remain as shown.

- Customer services would be handled by the division shown for the water utility organization in Volume 2 of this report.

10.8 STAFF QUALIFICATIONS

All staff should be able to understand oral and written instructions, be safety-conscious and know the basics of materials and tools used in their work. All except those with strictly desk or light workbench duties must be physically fit for climbing, lifting and walking. All but ordinary laborers should be able to fill out written reports of work activities.

Operators and maintenance technicians must fully understand the functioning of the processes, equipment and controls for which they are responsible. This should extend to recognizing fault conditions and knowing appropriate responses including totaly manual operation where necessary.

All staff should receive appropriate training to help them best use ther skills in the wastewater system. At a minimum this should include basic orientation to work practices and safety, pluse on-the-job training. In many cases formal training programs should be provided to expand employees' skills - both to do their present jobs better and to help them advance to higher positions.

Table 10.1 shows desirable education backgrounds for various positions in the organization.

Supervisors in the wastewater system must provide both the leadership and major portions of the specialized technical know-how to keep the system functioning properly. A program of incentives and of technical and managerial training is needed in order to attract, develop and retain supervisory staff for future needs, and for replacing present staff who retire.

Training

To benefit fully from the recommended improvements to physical facilities, it is necessary to increase the operating and maintenance skills of the staff. The required upgrading of skills can be accomplished most effectively through formal training programs organized by specialists in such work - drawing upon materials available from professional associations such as the Water Pollution Control Federation.

Development costs of good programs are high, and once developed they should be used to the maximum. For this reason we suggest that the programs be developed by a national agency such as GOSSD, which would present them to as many local systems as possible. Presentations should include instructing local supervisors in techniques for on-the-job training to supplement the formal program.

Compensation

In 1978 the amount projected to be spent for Wastewater Department salaries was LE 110,000. We understand that the staff this covers excludes 150 low paid sewer maintenance workers recently transferred out of the control of the department. Based on the remaining staff of 347, the average salary per employee amounts to only LE 318/yr.

The average total compensation presently offered to Wastewater Department employees is far below what is needed to attact and retain fully qualified staff.

Labor costs were estimated for five year invervals, based on the projected staffing shown in Table 10.2. For intervening years, labor costs were interpolated on a straight-line basis.

Staffing needs for solids disposal and for pipeline maintenance were estimated as follows:

Solids Disposal

One laborer for each four beds

Pipeline Maintenance

One crew per 100 km of sewer

Manhole Maintenance

One crew per 230 km of sewer

Sewer Cleaning

One bucket machine crew per 60 km of sewer
One power rodder crew for 100 km of sewer
One hydraulic rodder crew for the entire system

For the projection of labor costs, we have grouped the staff positions shown on the organization chart (Figure 10.A) into categories according to required training, skill and level of responsibility. Table 10.3 shows this grouping and projects numbers of employees in each staff position through the year 2000, with estimates of compensation for different categories as follows:

Average Category	Compensation 1978 LE/yr
Professional	*
Supervisory/Senior Technician	1800
Technician/Operator	1200
Clerical	1000
Laborer	780

*Average not meaningful since compensation would vary widely with experience and responsiblity. For lower level professional positions we have assumed compensation equivalent to that for supervisors.

We believe that compensation at these levels will be necessary to attract and retain individuals with the requisite skills to properly operate the system.

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10.9 COMMUNICATIONS AND PERSONNEL TRANSPORT

To permit more effective utilization of operating staff, this chapter recommends increasing use of roving crews to cover collection system operations including the smaller pumping stations which would not be attended full time.

This will require better communications and personnel transport. We recommend that:

1) A two way radio system be installed to link all facilities having full time staffing, and

2) radio equipped vehicles be provided to permit rapid dispatch of operating and maintenance crews to locations where needed.

We have allowed for a total of 21 vehicles by the year 2000, providing one for each operation foreman position (per shift) and one for each maintenance crew foreman. Shift managers and division chiefs should also be assigned radio equipped vehicles.

Arrangements should be made, through the public telephone system if possible, to a central dispatch point serving the entire wastewater utility. The radio system base station should be located at this point.

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TABLE 10.1

DESIRABLE EDUCATIONAL BACKGROUNDS FOR WASTEWATER SYSTEM STAFF

Position	Education Level	Major or Specialty Subjects
Clerk Typist	Secondary	Office skills - typing
Storekeeper	Secondary	Office skills - bookkeeping
Clerk		
Surveyor		
Draftsman		
Mechanic		
Electrician		
Lab. Technician	Secondary	Technical school training in appropriate specialized area
Operator (Treatment, Pumping)		
Pipeline Crew Chief		
Equipment Operator		
Operations Foreman	Secondary	Technical school training in appropriate areas for all staff supervised
Maintenance Chief		
Chief Engineer Pipeline		
Division Engineer	University	Civil Engineering
New Projects		
Chief Engineer Maintenance	University	Mechanical Engineering
Chief Engineer Operations	University	Sanitary Engineering
Shift Manager - Operations		
Director	University	Sanitary Engineering

TABLE 10.2

STAFFING BASIS FOR LABOR COSTS

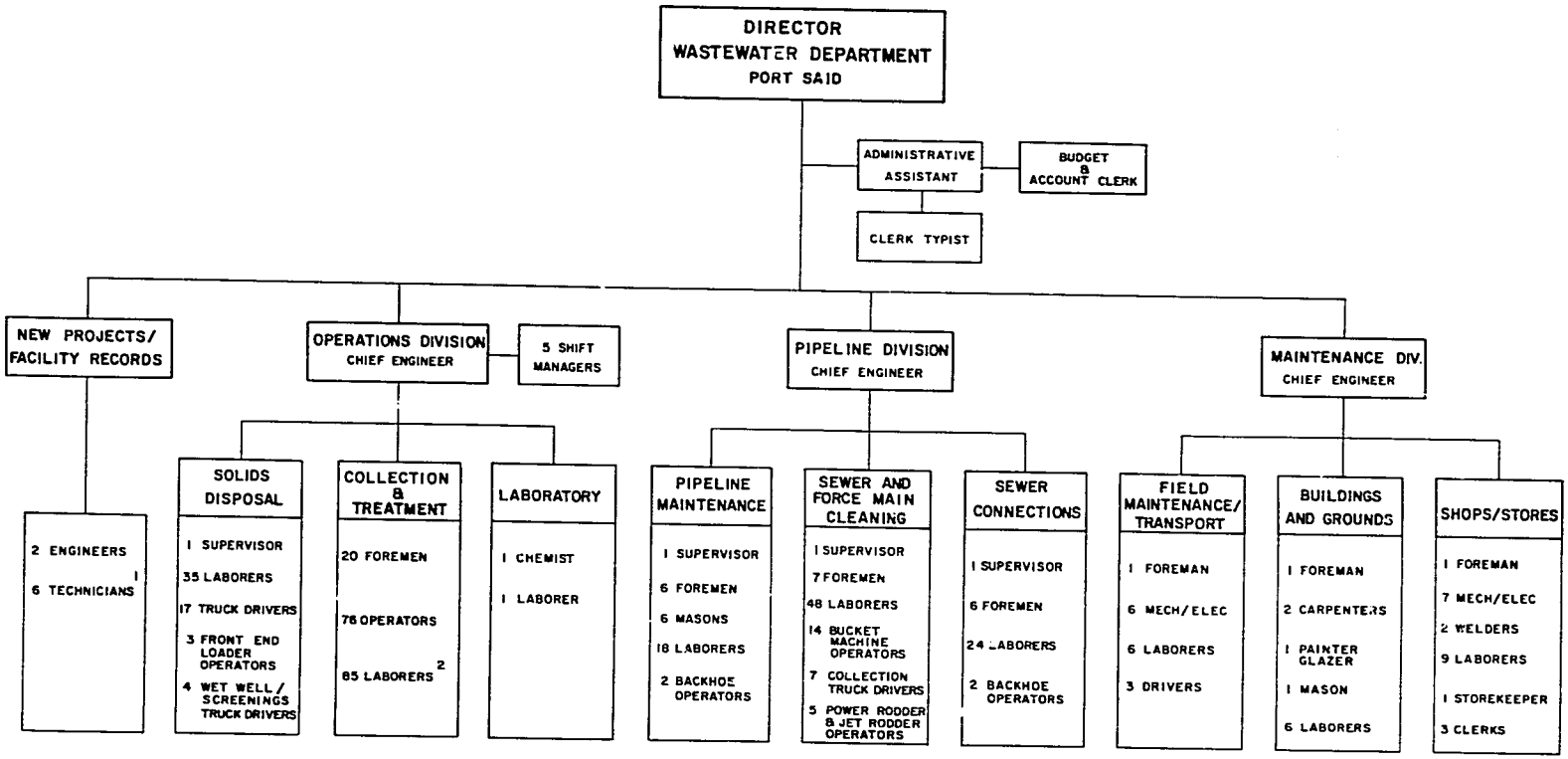
Position	1983	1985	1990	1995	2000
Professional					
Director of Department	1	1	1	1	1
Chief Engineer - Operations	1	1	1	1	1
Chief Engineer - Pipelines	1	1	1	1	1
Chief Engineer - Maintenance	1	1	1	1	1
Operations Shift Manager	5	5	5	5	5
Chemist	1	1	1	1	1
Engineer Records	1	1	1	1	1
Engineer New Projects	1	1	1	1	1
Subtotal	12	12	12	12	12
Supervisor & Senior Technician					
Service Area Supervisor	10	10	10	10	10
Treatment Plant Supervisor	10	10	10	10	10
Sludge Handling Supervisor	1	1	1	1	1
Pipeline Maintenance Supervisor	1	1	1	1	1
Sewer Cleaning Supervisor	1	1	1	1	1
Sewer Connections Supervisor*	1	1	1	1	1
Maintenance Shop Supervisor	1	1	1	1	1
Field Maintenance Foreman	1	1	1	1	1
Buildings & Grounds Foreman	1	1	1	1	1
Sewer Cleaning Crew Chief	3	4	5	6	7
Sewer Repair Crew Chief	3	3	5	6	6
Sewer Connection Crew Chiefs*	4	6	6	6	6
Senior Mechanic	3	3	3	3	3
Senior Electrician	3	3	3	3	3
Subtotal	43	46	49	51	52
Technician & Operators					
Pump Station Operator	35	35	50	53	55
Treatment Plant Operator	15	15	15	15	15
Sludge Pump Station Operator	1	1	1	1	1
Effluent P.S. Operator	5	5	5	5	5
Storekeeper	1	1	1	1	1
Bucket Machine Operator	6	8	10	12	14
Power Rodder Operator	2	2	3	3	4
Jet Rodder Operator	1	1	1	1	1
Sewer & Manhole Mason	3	3	5	6	6
Maintenance Mechanic	4	4	4	4	4
Maintenance Electrician	3	3	3	3	3
Welder	2	2	2	2	2
Carpenter	2	2	2	2	2
Painter/Glazer	1	1	1	1	1
Mason	1	1	1	1	1
Surveyor	2	2	2	2	2
Inspector	2	2	2	2	2
Draftsmen	2	2	2	2	2
Subtotal	88	90	110	116	121
Equipment Operator					
Sludge Truck Driver	8	11	11	14	17
Wet Well & Screenings Truck Driver	2	2	2	4	4
Front End Loader Operator	3	3	3	3	3
Sewer Cleaning Collection Truck Driver	3	4	5	6	7
Backhoe Operator (Repair)	1	1	1	2	2
Backhoe Operator (New Connections)*	1	1	2	2	2
Field Maintenance/Transport Driver	3	3	3	3	3
Subtotal	21	25	27	34	38
Laborer					
Pump Stations	40	40	55	58	60
Treatment Plants	25	25	25	25	25
Sludge Beds	17	20	25	29	35
Laboratory	1	1	1	1	1
Bucket Machine Crews	15	20	25	30	35
Power & Jet Rodder Crews	7	7	10	10	13
Sewer & MH Repair Crews	9	9	15	18	18
Field Maintenance	6	6	6	6	6
Buildings & Grounds	6	6	6	6	6
Shops & Stores	9	9	9	9	9
Service Connection Crews	16	24	24	24	24
Subtotal	151	167	201	216	232
Clerical					
Administrative Section	3	3	3	3	3
Shops & Stores	3	3	3	3	3
Subtotal	6	6	6	6	6
TOTAL STAFF	321	346	405	435	461

*All labor costs of new connections are included in Capital Cost of New Service Connections in Table 8.9.

TABLE 10.3

WASTEWATER FACILITIES STAFFING COST CHART

Position	Compensation LE/Person/yr	1983 No. of Personnel	1983 Cost (LE)	1985 No. of Personnel	1985 Cost (LE)	1990 No. of Personnel	1990 Cost (LE)	1995 No. of Personnel	1995 Cost (LE)	2000 No. of Personnel	2000 Cost (LE)
Professional	Varies	12	31,600	12	31,600	12	31,600	12	31,600	12	31,600
Supervisors & Senior Technicians	1800	38	68,400	39	70,200	42	75,600	44	79,200	45	81,000
Technicians & Operators	1200	88	105,600	90	108,000	110	132,000	116	139,200	121	145,200
Equipment Operators	1200	20	24,000	24	28,800	25	30,000	32	38,400	36	43,200
Laborers	780	135	105,300	143	111,500	177	138,100	192	149,800	208	162,200
Clerical	1000	6	6,000	6	6,000	6	6,000	6	6,000	6	6,000
Subtotal			340,900		356,100		413,300		444,200		469,200
Administrative Support and Supplies 30%			102,300		106,800		124,000		133,300		140,700
TOTAL			443,200		462,900		537,300		577,500		609,900



NOTES:

1- SURVEYORS, INSPECTORS AND DRAFTSMEN.

2- INCLUDES BLOCKAGE REMOVAL CREWS.

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MINISTRY OF DEVELOPMENT AND NEW COMMUNITIES
ADVISORY COMMITTEE FOR RECONSTRUCTION

PORT SAID
WATER AND WASTEWATER FACILITIES MASTER PLAN

RECOMMENDED WASTEWATER ORGANIZATION YEAR 2000

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FIG. 10-A

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CHAPTER II

PROGRAM EXECUTION

This chapter outlines procedures for the overall wastewater facilities program execution, with specific emphasis on implementing the High Priority Projects. Included are schedules for program execution, annual capital outlays and operation and maintenance costs. The chapter also considers contractor capabilities and the availability of labor, equipment and materials for the proposed work.

II.1 FRAMEWORK AND PROCEDURES

Under present plans, GOSSD would execute the High Priority Projects with financing from USAID, and would contract for engineering services from a consortium of Consultants. Negotiations for Consultant services are underway with a joint U.S. venture called the Canal Cities Consultants (Hazen and Sawyer, Metcalf and Eddy International Inc. and Pirnie Harris International) in association with the Egyptian Canal City Consultants (Engineering Consultants Group, Middle East Consulting Office and I. Gaafar and Partners). These firms prepared the facilities master plans for the three canal cities.

We propose that in so far as practical, a single person (Project Director) should be designated within GOSSD to direct the overall High Priority Projects program for the three cities with project managers assigned to specific projects. For continuity, the same project managers should see the work through from preliminary design to final acceptance of newly constructed facilities. The managers would be responsible for coordinating all in-house project activities and would be the liaison between GOSSD headquarters and the Consultants, the construction contractors and the staff of the New Projects Division in the local wastewater system organization.

Procedures established for execution of the High Priority Projects are outlined below:

Negotiations of Consultant's Services

Negotiations for Consultant services for the High Priority Projects would define a scope of work to include the following phases:

- Inception Report
- Rehabilitation
- Training
- Design Report
- Design and Construction

Services would be performed on a cost plus fixed fee basis.

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Project Authorization

Based on review of the design reports, GOSSD would select specific projects to be executed, conclude financial arrangements and authorize detailed design and supervision of construction by work orders.

Detailed Design

The Consultants would prepare plans and specifications for tendering both for construction and for direct procurement of materials and equipment by GOSSD. The design would be submitted for GOSSD review at appropriate stages.

Bidding, Review and Award

Tenders would be received by GOSSD. The Consultants would analyze all bids to assure their compliance with the tender documents and then make a recommendation for contract award to GOSSD.

Services During Construction

These services, to be contracted for by work order, would include review of contractor schedules and work plans, review of submittals on materials and equipment to be supplied by the contractor, interpretation of the intent of the design documents, decisions on suggested changes, witnessing shop tests on major equipment, certification of compliance with contract requirements, and processing of change orders for approval by GOSSD.

Project Director's Authority

To discharge his responsibilities, the Project Director from GOSSD should have authority to:

- Act as liaison with the Consultants;
- Coordinate design review by GOSSD;
- Issue tender documents;
- Receive bids from tenderers, review the tender analysis prepared by the Consultants and recommend award to GOSSD;
- Approve contractors' submittals, invoices, and, within prescribed limits, change orders; and
- Recommend final acceptance of work.

The Consultants would support the GOSSD Project Director in his work. Appropriate higher management levels in GOSSD would approve final tender documents, sign contracts, approve change orders (beyond the limits for which the Project Director has authority) and accept completed activities.

During the High Priority Projects, procedures should be adopted to rely more on in-house capabilities and less on outside consultants for implementation of the immediate and final stage programs. Specifically this would involve:

- Ongoing, in-house review of the facilities Master Plans to define projects to be considered for authorization. The Consultant may be authorized to update the Master Plans at the conclusion of the High Priority design stage.

- Establish procedures for selection of projects to be authorized.

- In-house preparation of preliminary designs to serve as a basis for decision making by GOSSD and, where necessary, form negotiations with outside consultants.

Presently, GOSSD is understaffed and finds difficulty in prompt review of project reports and design documents. To help eliminate this situation, it is recommended that GOSSD recruit local qualified personnel who would receive on-the-job training during the High Priority Projects as assistant project managers. Upon completion of their training, the new assistant managers can help to expeditiously implement the Immediate and Staged Development Phases of the work.

11.2 SCHEDULE

Figure 11-A shows a detailed CPM for the High Priority/Immediate Phase Projects; Figure 11-B shows an overall schedule for execution of wastewater system improvements by staged development to keep pace with needs through the year 2000. Chapters 7 and 8 detail when required new capacity must be on line to meet increasing demands. The collection system needs in Chapter 8 also reflect the expanded physical growth of the urban area.

The High Priority Projects and the remaining Immediate Phase Projects, were classified in four categories (local measures, equipment procurement, major capital construction and procurement of services), according to the nature of the work and how it was to be executed. A summary of the work is as follows:

Local Measures

The recommended local measures include limited inspection, rodding and flushing of sewers and manholes, blocking of catch basins, (to prevent solid waste entering the wastewater collection system) storm water data collection, and expediting construction of the wastewater treatment plant facilities. The measurements are within the capabilities of GOPS and GOSSD's own forces and should start immediately.

Equipment Procurement

The recommended wastewater system High Priority equipment procurement projects include laboratory equipment, special trucks for cleaning manholes and catch basins, emergency wastewater pumps, spare parts and miscellaneous tools. The Consultant will prepare specifications, coordinate purchase, delivery and supervise installation and start-up of the equipment. A local contractor or GOPS/GOSSD can perform the equipment installation. Sufficient skilled manpower is available in Port Said to install this equipment.

Major Capital Construction

The High Priority major capital construction projects include new collector interceptors, pump stations, force mains and modifications to the Mazrah Treatment Plant. Immediate Phase projects consist of new primary treatment facilities for southwestern Port Said and Port Fouad. Included also are the collectors, force mains and pump stations

needed to transport the sewage from expanded and new service areas to the treatment plants. Construction of a separate storm water system shall also be initiated.

Staged Development programs include ongoing construction of secondary collector systems, the building of new pump stations and force mains and expansion of the Mazrah and Southwest Wastewater Treatment Plants capacities. The schedule for collection system improvements and additions is based on spreading work needed by each target year uniformly over the period since the previous target year. Actual schedules may vary depending on needs at the time and on the general construction market.

Procurement of Service

As part of the High Priority Projects, services not locally available are required to carry out the sewer cleaning program, the sewer grouting and inspection program and a solid waste study. None of the above programs have yet to be carried out in Egypt on the scale required to bring about the needed improvements to the Port Said wastewater collection system. The sewer cleaning, grouting and inspection work should be conducted by a qualified foreign firm with experience in this work. The method of sewer cleaning including type of equipment would be selected after a trial program to evaluate the various methods available. The firm would provide equipment and manpower to carry out the job as well as train local personnel in the methods and operations for carrying on the program in the future. It is preferred to accomplish the sewer cleaning program with foreign equipment and labor, rather than build up a large local labor force for a one time only operation. Sewer cleaning equipment used in the project should be turned over the GOPS for use in an ongoing maintenance program.

The solid waste study and report should be performed by the Consultant as a High Priority Project. As an Immediate Phase Project, the Consultant should initiate a storm water data collection and analysis procedure for use in the design of a future storm water collection system.

The execution schedule, Figure 11-A, shows time allowances for engineering design, purchase of equipment, land acquisition where needed, construction periods and the start-up and testing of new facilities. The availability of competent local contractors and suitable construction materials is discussed in Appendix B. For scheduling of major civil works, such as treatment plants and major pump sations, time factors for modern mechanized construction practices are adopted. For labor-intensive projects such as installation of pipelines, manpower requirements to meet schedules must reflect local productivity per man hour.

11.3 COST SCHEDULES

For allocating cost for engineering, design, and construction, the following guidance were utilized:

Local Collectors and Service Connections

The construction of local collectors and service connections was estimated directly for each year.

Pumping Stations, Force Mains, Major Interceptors and Outfalls

For work under the High Priority and Immediate Phase programs, engineering was scheduled in 1980 with construction over the next two years split as follows:

	Percent	
	1981	1982
Civil Works	67	33
Pipelines	50	50
Equipment	0	100

The effluent pumping stations, force mains and outfall were scheduled for construction during the same period with costs split between years as above. Other pump stations and pipelines were scheduled to be constructed in a single year, according to when needed, with engineering scheduled in the year prior to construction.

Treatment Works

Initial construction and latter additions were scheduled for two-year construction periods as shown in Figure 11-A. Engineering was scheduled prior to the first year of construction. Construction was split between the two years as follows:

	Percent	
	First Year	Second Year
Piping	33	67
Equipment	0	100
Civil Works	67	33

Table 11.1 lists annual outlays for capital improvements based on the execution schedule in Figure 11-B. Outlays are broken down by collection system (sewers, force mains, pumping stations), treatment works and effluent disposal (diffusors, outfalls). The work is also classified according to expected useful life as follows:

Work Classification	Useful Life
Civil Works/Pipelines	40 yr
Mechanical/Electrical Equipment	20 yr
Vehicles, Construction Equipment and Tools	10 yr

Appendix B details physical, economic and construction factors that affect these costs. If regulations require U.S. origin for reinforcing steel and cement, costs for structural work will increase by about 30% of the total in-place cost for structures. This has only a slight overall effect on the total project costs. For the High Priority wastewater system program, costs would be increased by about LE 350,000 were cement and steel purchased from the USA.

Table 11.2 shows annual capital outlays broken down into local and foreign exchange costs.

Table 11.3 shows expected annual operation and maintenance costs for the system through the year 2000. Details for calculation of these costs are presented in Chapter 5. Labor costs are based on the recommended organization and salary levels presented in Chapter 10.

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11.4 CONSTRUCTION MANPOWER AND EQUIPMENT REQUIREMENT

Table 11.4 shows the manpower both skilled and unskilled, which we estimate will be needed to build the recommended facilities.

Manpower

The average local manpower requirement for the implementation of the recommended wastewater facilities improvements is estimated at 150 skilled and 400 unskilled laborers per year. During the period of intensive construction work, through 1982 needs will run as high as 600 skilled laborers and 1,100 unskilled laborers. No less than about 30 skilled and 180 unskilled laborers per year will be needed in any period, assuming the construction schedule as shown in Figure 11-8.

The amount of labor needed and the ratio of skilled to unskilled labor is influenced by the type of construction method employed (intensive hand work versus mechanized) and the production rate needed within the allowable construction period time frame.

Manpower requirements were estimated based on the following assumptions:

- 270 working days per year (6 day work week with minimal allowances for vacation, holidays and sick time).
- Six productive work hours per day.
- Labor rates of LE 7 per day for skilled labor (pipe layer, equipment operator) and LE 3 per day for unskilled. (These reflect 1978 contractor costs for labor in Port Said.)
- Appropriate mixes of skilled and unskilled labor for different types of work.
- Mechanized construction practices for the erection of pump stations and treatment units, with labor cost representing an estimated 40 percent of total construction costs.
- Intensive hand work for installing sewer lines, manholes and force mains, with labor representing the bulk of the total construction costs.

In future years, much of the pipeline work in new areas may be mechanized because of the high cost of hand labor. This would increase skilled labor needs and accordingly reduce unskilled labor needs.

The supply of unskilled labor is abundant and should remain so, as agricultural workers continue to be attracted by higher and more regular wages in the construction industry.

There is, however, a shortage of skilled and semi-skilled labor, supervisory personnel and technicians, many of whom have been drawn to other Arab countries where higher paying jobs are available. This situation is not expected to change and is likely to result in continuing escalation of construction costs.

Current standards of workmanship vary widely in Egypt. High standards are needed to assure properly operating water facilities with low maintenance costs. To recruit

workmen who can meet such standards, labor rates beyond average market levels must be allowed for.

To get high quality work completed on time, the supply of skilled labor must be increased. We concur with the conclusion of the Greater Cairo Waterworks Master Plan[1] that a formal and permanent national training program is needed for skilled construction workers. Otherwise it could prove necessary to import labor and/or to contract with foreign construction firms. The first of these plans would raise local contractor costs; the second would raise initial bid prices for work reflecting both higher mobilization and labor costs.

Construction Equipment

General construction equipment needed to carry out the recommended program would include:

a) Three (3) concrete transit mix trucks, 6 cu m capacity.

b) Two (2) diesel hydraulic crawler backhoes; one 0.50 cu m and one 0.75 cu m capacity.

c) One flatbed truck and trailer.

d) Two (2) wheeled tractor loaders - 1.2 cu m capacity.

e) One (1) water truck - 20 cu m capacity.

f) Two (2) backhoes, loader wheeled type - 60 H.P.

g) Five (5) dump trucks - 12 cu m capacity.

h) Two (2) air compressors - 7 cu m/min capacity with jack hammers, hose, vibratory pile driving hammer, etc.

i) One (1) hydraulic truck mounted crane - 18 tonne capacity - 30 m boom.

j) Twelve (12) gas water pumps - six 50 mm and six 100 mm discharge with hoses, etc.

k) One (1) tractor dozer - 140 H.P.

l) One (1) towed vibrating roller - 1.8 tonne.

m) Five (5) trench compactors vibratory plate.

n) Two (2) welders - 200 amp capacity each.

o) One (1) pavement breaker.

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(1) Draft Final Report, Part II, Staged Development, ES-Parsons in Association with ECG, page 22-8.

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Equipment of the types above generally is already in the hands of Egyptian contractors who are able to amortize it over a number of projects. If there is any doubt of equipment availability, the government agencies responsible for the major utility programs now being planned could themselves procure needed equipment and make it available to contractors working on the programs. The volume of work in these programs is certainly sufficient to assure continued utilization of the equipment during its amortization period.

Well point equipment for dewatering trenches will be one type of special equipment needed for construction in Port Said. The details as to the type, capacity, etc. of this equipment will be determined during the design phase of the project.

11.5 SPECIAL CONSTRUCTION PROBLEMS

Installation of large pipelines in existing areas of Port Said presents special problems. Streets are narrow, closely lined with structures, laced with existing utilities and filled daily with traffic or street markets.

The most difficult problem will be to protect adjacent structures and existing utilities during deep sewer construction. In all cases trenches must be supported by timber or steel sheeting. Dewatering plans should be carefully developed based on tested soil permeability. Where dewatering by well points poses any danger to foundations of adjacent structures, other techniques must be used. Two possible approaches are outlined below.

One approach would be to install tight steel sheeting, then to excavate within the sheeting using a clamshell, and finally to seal the bottom of the trench with tremie concrete. Before sheeting is driven, existing utility lines should be located by hand excavation. With the concrete plug in place, pumps could directly dewater the trench permitting sewer installation in the dry. To permit this approach, street width must allow working room for a crane to drive tight sheeting, excavate, and place tremie concrete. The routes shown in Plate I have been selected to minimize utility conflicts and maximize working room for equipment.

The second approach is a local technique described in the Greater Cairo Wastewater Project.(1) Excavation, installation and removal of timber trench supports, pipe laying and concrete placment are all carried out by divers working without gear. Apparently, specialized groups of divers are available who can produce acceptable quality work under these conditions.

Similar but less difficult construction problems may arise where it is necessary to remove the clay layer under new force mains and replace it with select material. Excavation depths to remove the clay generally will be much less than for installing deep sewers, and placement of select fill may be possible without dewatering.

To minimize disruption along narrow streets used as pipeline routes, excavated material must be stored in a manner that does not block off access. This could require either temporary retaining structures or off-site storage.

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(1) Special Report No. 2, Volume 3, "Construction Methods and Costs", John Taylor & Sons/Binnie and Partners in Association with Dr. A. Abdel-Warith, June 1977.

TABLE 11.1

ANNUAL CAPITAL OUTLAYS
RECOMMENDED WASTEWATER SYSTEM IMPROVEMENTS
(Thousands of 1978 LE)

Line No.		1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	CAPITAL IMPROVEMENTS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	TREATMENT WORKS AND DISPOSAL																						
3	Civil Works	-	394	3,377	1,663	-	-	-	-	-	-	52	669	-	-	-	-	-	-	-	-	-	-
4	Mechanical	-	631	1,358	6,695	-	-	-	-	-	-	86	1,089	-	-	-	-	-	-	-	-	-	-
5	TRANSPORT SYSTEM																						
6	Civil Works	-	114	838	611	-	31	176	211	-	-	5	62	8	104	-	-	6	78	-	-	-	-
7	Mechanical	-	439	-	5,605	-	109	154	1,237	-	-	64	815	27	347	-	-	29	370	-	-	-	-
8	COLLECTION (1)																						
9	Major Sewers and Force Mains - Civil	-	780	3,504	6,459	-	74	111	830	-	-	111	1,423	34	430	-	-	35	445	-	-	-	-
10	Local Collectors - Civil	615	615	615	618	703	703	703	1,062	1,062	1,062	1,062	1,062	851	851	851	851	851	766	766	766	766	766
11	CAPITAL IMPROVEMENTS SUBTOTALS																						
12	Civil Works	615	1,903	8,334	9,351	703	808	990	2,103	1,062	1,062	1,230	3,216	893	1,385	851	851	892	1,289	766	766	766	766
13	Mechanical	-	1,070	1,358	12,300	-	109	154	1,237	-	-	150	1,904	27	347	-	-	29	370	-	-	-	-
14	Vehicles & Maintenance Equipment	-	368	-	336	-	64	-	-	-	-	101	-	-	-	-	81	-	-	-	-	70	-
15	Service Connections	691	691	691	691	818	818	818	1,222	1,222	1,222	1,222	1,222	1,038	1,039	1,038	1,039	1,038	1,039	1,038	1,039	10,38	1,039
16	TOTAL CAPITAL IMPROVEMENTS	1,306	4,032	10,383	22,678	1,521	1,799	1,962	4,562	2,284	2,284	2,703	6,342	1,958	2,771	1,889	1,971	1,959	2,698	1,804	1,805	1,874	1,805
17	Rehabilitation (2)	-	1,454	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

(1) Excluding Service Connections

(2) Not considered as capital addition.
Entered as cost in Table 11.3.

TABLE 11.2

ANNUAL CAPITAL OUTLAYS FOR WASTEWATER SYSTEM IMPROVEMENTS

FOREIGN AND LOCAL CURRENCY
(Thousands of 1978 LE)

Line No.		1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	FOREIGN CURRENCY OUTLAYS																						
2	Collection System	183	183	183	183	213	213	213	320	320	320	320	320	264	264	264	264	264	253	253	253	253	253
3	Transportation		1332	1410	6273		214	178	1173			180	1334	69	310			70	321				
4	Treatment & Disposal		1026	1536	3534							138	760										
5	Vehicles & Maintenance Equipment		298		336		64					101					81					70	
6	Procurement of Services		743																				
7	SUB-TOTAL FOREIGN CURRENCY	183	3582	3129	10,326	213	491	391	1493	320	320	739	2414	333	574	264	345	334	574	253	253	323	253
8	LOCAL CURRENCY OUTLAYS																						
9	Collection System	1123	1623	1123	1126	1308	1308	1308	1964	1964	1964	1964	1964	1625	1626	1625	1626	1625	1552	1551	1552	1551	1552
10	Transportation			2247	7088			263	1105				966		571				572				
11	Treatment & Disposal			3884	4138								988										
12	Procurement of Services (1)		265																				
13	SUB-TOTAL LOCAL CURRENCY	1123	1888	7254	12,352	1308	1308	1571	3069	1964	1964	1964	3928	1625	2197	1625	1626	1625	2124	1551	1552	1551	1552
14	TOTAL	1306	5470	10,383	22,678	1521	1799	1962	4562	2284	2284	2703	6342	1958	2771	1889	1971	1959	2698	1804	1805	1874	1805

(1) Includes Sewer Cleaning & Inspection Programs

TABLE 11.3

OPERATION MAINTENANCE AND REHABILITATION COSTS FOR WASTEWATER SYSTEM(1)

(Thousands of 1978 L.E.)

Line No.		1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	MAINTENANCE MATERIAL SERVICES																						
2	Civil Works	9	9	39	55	55	55	56	58	58	58	58	63	63	64	64	64	64	65	65	65	65	65
3	Mechanical Equip.	35	35	74	424	424	424	428	463	463	463	463	517	517	527	527	527	527	538	538	538	538	538
4	Force Mains and Major Collection Sewers	4	4	22	56	56	56	57	61	61	61	61	61	69	71	71	71	71	74	74	74	74	74
5	Secondary Collection System	8	9	9	10	10	11	11	12	12	13	14	14	15	15	16	16	17	17	17	18	18	19
6	Service Connection	-	1	1	2	2	3	3	4	5	5	6	7	7	8	8	9	10	10	11	11	12	13
7	Vehicle O & M	-	6	6	6	60	60	68	68	68	68	68	76	76	76	76	76	85	85	85	85	85	92
8	Pumping station power and STP power	73	79	85	90	96	101	106	112	117	122	127	130	134	138	141	144	146	149	151	152	152	153
9	Sewer Cleaning O & M	-	6	6	6	6	6	7	7	7	7	7	9	9	9	9	9	10	10	10	10	110	12
10	Overall annual labor costs	229	282	336	389	443	449	463	487	503	516	527	536	547	556	565	573	578	586	591	598	605	609
11	Rehabilitation(2)	-	1454	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12	TOTAL	358	1886	578	1039	1152	1166	1199	1273	1295	1313	1332	1422	1437	1465	1477	1489	1509	1534	1543	1551	1559	1575

(1) See Chapter 5 for derivation of O & M costs.

(2) From High Priority Program

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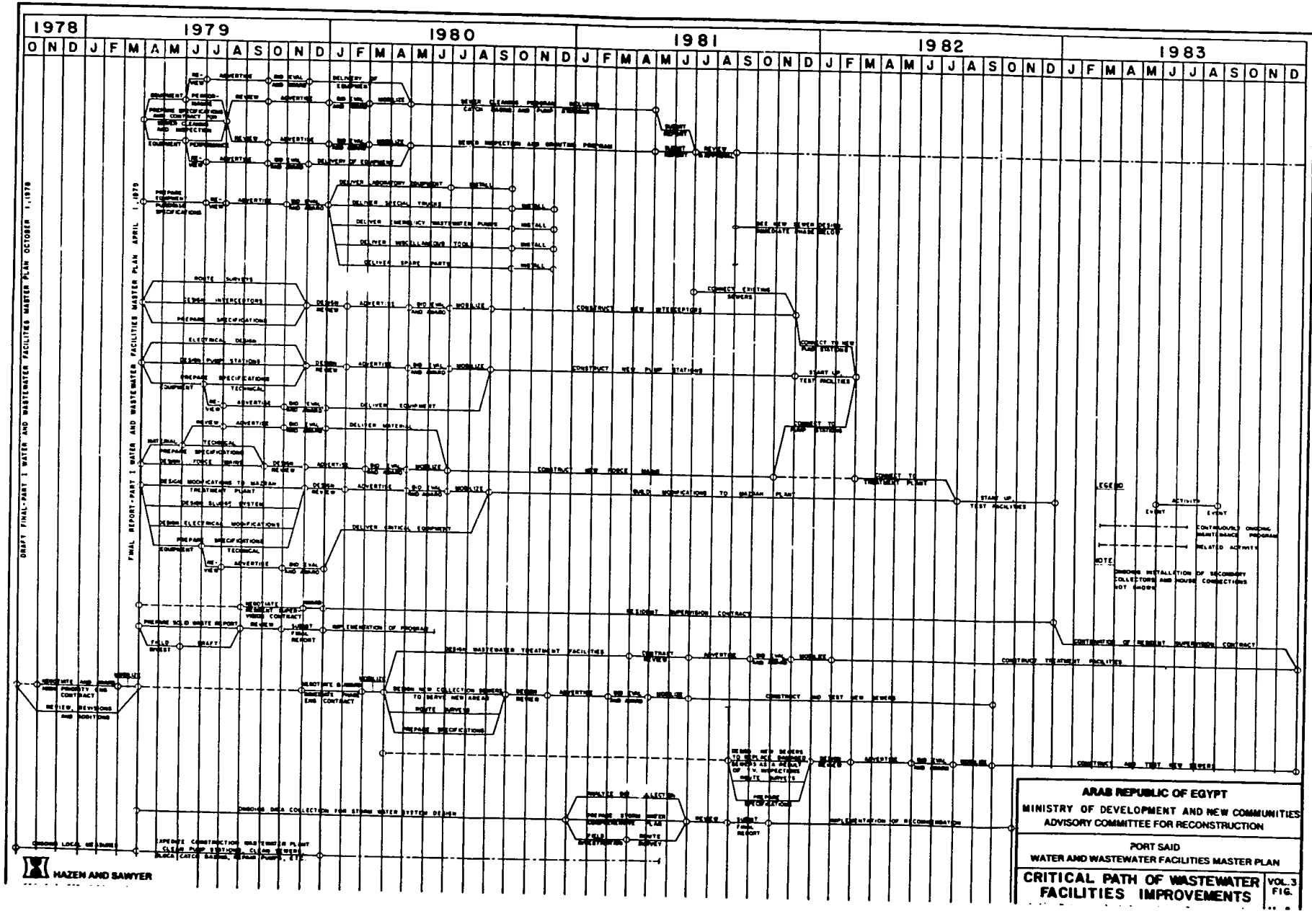
TABLE 11.4

CONSTRUCTION MANPOWER REQUIRED

		Manpower per Year	
	Year(s)	Skilled	Unskilled
Sewer Cleaning and Inspection Program	1980	30	50
Rehabilitate Existing Collection Sewers	1981	50	270
Rebuild Pump Station Interceptors and Force Mains	1981-82	320	760
Renovate Mazrah STP	1981	90	70
Expand Mazrah STP	1990	20	20
Build Southwest STP	1981-82	70	50
Expand Southwest STP	1990	30	20
Build Port Fouad STP	1981	30	20
New Pump Stations/Lift Stations, Interceptors & Force Mains	1985	30	90
	1986	30	90
	1990	30	90
	1992	30	90
	1996	30	90
Expansion of Secondary Collection System	1979-2000	30	180
Storm Water Study	1980	10	5
Solid Waste Study	1980	6	4



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

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WATER AND WASTEWATER FACILITIES MASTER PLAN

CRITICAL PATH OF WASTEWATER FACILITIES IMPROVEMENTS

VOL. 3
FIG.

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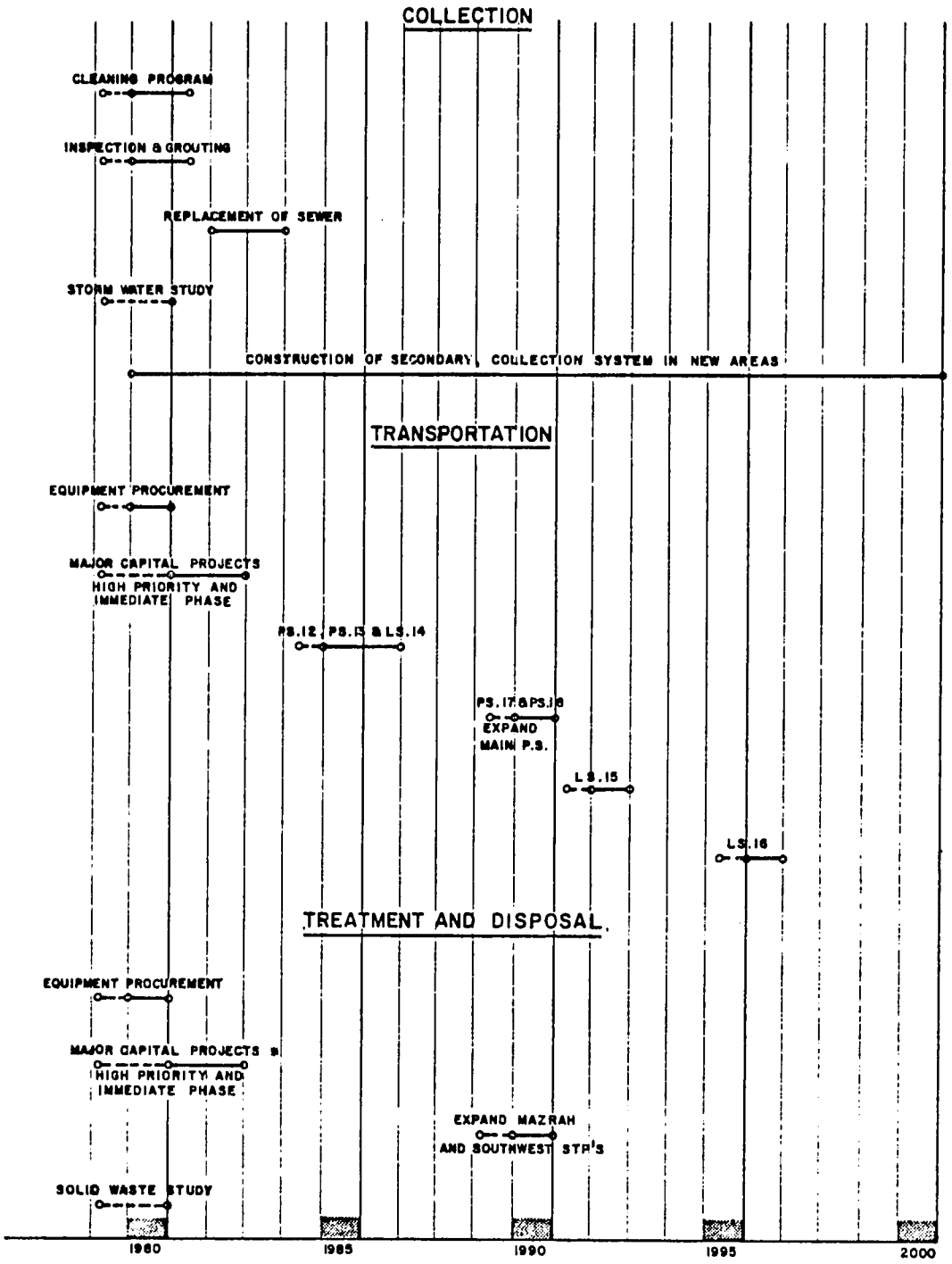

LEGEND :

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

HAZEN AND SAWYER
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JANUARY 1979

ARAB REPUBLIC OF EGYPT

MINISTRY OF DEVELOPMENT AND NEW COMMUNITIES
ADVISORY COMMITTEE FOR RECONSTRUCTION

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WATER AND WASTEWATER FACILITIES MASTER PLAN

WASTEWATER FACILITIES PROGRAM EXECUTION

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FIG.
II-B

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CHAPTER 12

FINANCING

12.1 SUMMARY OF ALTERNATIVES

Three approaches to financing the recommended program were examined:

- Self sustaining user charge financing - utility basis
- Self sustaining user charge financing - debt service basis
- Deficit financing

These alternatives differ significantly in the extent to which current users would pay for present and future service.

Under the utility basis alternative, 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 (O&M) expenses plus depreciation, and to yield a return on investment of at least six percent (as called for in the WWFMP scope). (Cash flow must be checked to see that it covers debt service i.e., interest and amortization on loans obtained for new construction). In later years, as debt service declines, funds could be accumulated to pay in part for replacement of facilities as they wear out.

With financing on a debt service basis, present users would pay just for system O&M plus debt service on loans covering new facilities. Customers would have "free" use of existing facilities until the facilities were replaced.

Under deficit financing, no user charges would be instituted and operating revenues would be limited as indicated in Section 12.4

Cost Escalation

To permit year-to-year comparisons of financial condition, the analysis of utility basis financing was made entirely in 1978 LE. The resulting rates were used in assessing the economic impact of projected charges on wastewater system users (Section 13.2).

The analyses of debt service basis and deficit financing included cost escalation in order to anticipate expected effects of inflation on loan requirements or on levels of government support in deficit financing.

The effect of inflation on rates required for self-financing is less critical since customer income presumably will rise with costs. For local costs, escalation is likely to be especially steep during the High Priority and Immediate Phase of the recommended program. This is due to the substantial increases in construction investment occurring in many sections of the Egyptian economy, including utilities. From review of other reports and from discussions with persons familiar with construction costs in Egypt, we believe it reasonable to allow for escalation rates as follows:

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Year	Annual Rate of Cost Escalation (Percent) Domestic Goods and Services (Local)	Foreign Equipment and Supplies (Imports)
1978	20	7
1979	20	7
1980	19	7
1981	18	7
1982	16	7
1983	14	7
1984	12	7
1985	10	7
1986	8	7
1987-2000	7	7

12.2 UTILITY BASIS FINANCING

The analysis of utility basis financing is summarized in tables projecting asset values, depreciation, operating revenues and costs, cash flow, and balance sheets. Capital outlays for recommended projects and estimated future system operating costs were used from Tables 11.1, 11.2 and 11.3. Revenues were assumed to include wastewater charges based on water delivered to customers, plus direct charges for new wastewater service connections at cost. Based on projections of water sold, average charges per cu m were calculated to meet revenue needs. The basis for individual projections is detailed below.

Assets

The value of existing facilities and those being added under projects-in-process is presented in Tables 12.1 and 12.2. Applicable accumulated depreciation is shown as a percent of asset value. Assets were valued on a replacement cost basis, using the same unit prices as for recommended new works but without allowances for contingencies and support services. For simplicity, inventory values were neglected. The present status of depreciation was based on our estimates of remaining useful life.

Additions to fixed assets and cumulative depreciable values of fixed assets are scheduled in Table 12.3. Assets are separated in categories according to applicable depreciation rates. Added and cumulative values of service connections in the system are also shown in Table 12.3. Since these connections are paid for directly by building owners, we have not treated them as assets of the utility. We recommend, however, that the utility assume responsibility for maintaining service connections and for replacing them when necessary. The utility, not the customer, has an incentive to repair or replace poor service connections which may admit infiltration, adding to operating costs. Funds to cover maintenance and eventual replacement of service connections are included in the financial analysis below.

Depreciation

Annual and accumulated depreciation for fixed assets of the wastewater utility is projected in Table 12.4, calculated on a straight line basis with the following service lives:

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Type of Fixed Asset	Service Life
Civil Works/Pipe lines	40 yr
Mechanical*	20 yr
Vehicles & Maintenance Equipment	10 yr

(* Mechanical refers to installed mechanical or electrical equipment such as pumps, motors and controls. Maintenance equipment is largely for pipeline excavation.)

Also shown in Table 12.4 are annual and cumulative service connection replacement allowances. Annual figures are calculated in the same manner as depreciation, using a 40 year life.

A small fraction of assets (10 year service life) will be fully depreciated during the study period. Depreciation calculations assume these assets will be replaced at original cost when fully depreciated.

Since many of these assets are likely to serve beyond their nominal useful life, the small capital outlays for their replacement have not been scheduled in the financial tables for the sake of simplicity.

Operating Statement

The utility basis for determining required wastewater revenues and charges is shown in Table 12.5.

Wastewater charges are based on the amount of water sold annually (see Volume 2, Chapter 12). Flow-related operating costs are based on sewage flows projected on the basis outlined in Chapter 4 of this volume.

The return on investment for each year is calculated on a rate base equal to accumulated capital investment in fixed assets less accumulated depreciation.

Annual depreciation and added allowance for service connection replacement are taken from Table 12.4.

Revenue sources in the analysis are limited to (1) charges for service connections at cost, (2) sale of sludge at LE 1.00/cu m, and (3) wastewater charges based on quanitity of water sold. For utility basis financing, average annual wastewater charges required to balance revenues against operating costs, depreciation and return on investment would rise to a maximum of LE 0.126/cu m in 1983. Thereafter, as the fixed assets depreciate and costs are spread over more customers, the average charge would decline gradually to LE 0.068 by the Year 2000, with one intermediate jump from LE 0.069 to LE 0.097 from 1990 to 1991, when final stage construction of major facilities is scheduled.

Cash Flow and Balance Sheets

Table 12.6 presents a pro-forma cash flow analysis, showing whether interest and amortization of long term loans would be covered if the rates were as shown in Table 12.5.

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In this analysis the entire program of recommended improvements is assumed to be financed by long term loans covering both foreign exchange and local cost. Currently, the A.R.E. finances major wastewater improvements under the GOSSD budget.

Loan proceeds were treated as received and the corresponding capital outlays were treated as made at year end. (Interest during construction is allowed for under the costs of facilities). At the direction of the ACR, interest and amortization were based on the following terms for both foreign and local currency loans.

Interest	6%
Grace Period for Principal Payment	3 years
Payoff Period	20 years

Table 12.6 shows that the "utility" basis of determining revenues provides inadequate cash flow to meet operating and debt service needs after 1985. Based on these revenues, the pro forma balance sheets in Table 12.7 show cash deficits reaching LE 12,400,000 by the year 2000, with a corresponding negative net worth of LE 22,837,000.

Hence we have recalculated revenues needed to maintain a positive cash position over the study period. Since fluctuating unit charges are really undesirable in an actual tariff schedule, we determined revenues based on a "level charge" assuming full debt financing of capital improvements as in Table 12.6. The required level charge amounted to LE 0.10/cu m of water sold.

We then calculated an adjusted cash flow schedule and balance sheets based on this charge, but with borrowings set at the minimum needed to maintain cash reserves equal to two months' outlays for operation and maintenance expenses plus debt service.

Table 12.8 shows the adjusted cash flow schedule. Table 12.9 shows resulting balance sheets. In the year 2000 the system shows a small positive net worth. If level rates are maintained after 2000, both net worth and cash holdings should increase rapidly as initial loans are paid off. This would provide funds for replacement of fixed assets as they are retired.

12.3 DEBT SERVICE BASIS

Self-sustaining financing of the recommended program on a debt service basis is summarized in Table 12.10, with escalation applied to capital and operating costs as shown in Table 12.11. The escalated costs of capital improvements each year are assumed to be loan-financed on the same terms as shown in Section 12.2, above. Charges for service connections are assumed equal to the escalated cost of these connections.

Unit wastewater charges are determined for each year to provide revenue to cover O&M plus debt service costs. These charges represent the minimum for financing on a self-sustaining basis, providing no accumulation of funds to meet future needs.

12.4 DEFICIT FINANCING

Wastewater system deficits based on escalated capital and operating costs are projected in Table 12.11, assuming that operating revenue are limited to service connection charges at cost and the sale of sludge at 1 LE/cu m.

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In this case, the government must make up the deficits from other sources or defer system improvements and expansion.

The indicated annual deficits range as high as LE 41,813,000 (1982) but generally range well below half this amount. The accumulated deficit through the year 2000 would total almost LE 256,000,000.

12.5 APPROPRIATE USER CHARGES

The level wastewater charge of LE 0.10/cu m of water sold is appropriate to use in assessing the economic impact on customers of self-sustaining, user charge financing (Section 13.2).

Water rates will need to be adjusted periodically to offset the effects of cost escalation. The rates calculated in Table 12.10 illustrate how much rates may have to be increased to keep the system self-financing.

TABLE 12.1

ESTIMATED REPLACEMENT VALUE OF EXISTING WASTEWATER FACILITIES
(Thousands of 1978 LE)

Line No.	Item	Existing	Depreciation %	Depreciation on Existing Amount
1	Treatment Works			
2	Old Primary Sedimentation Tanks(1)	-	-	-
3	System 2 Primary Sedimentation Tanks	100	50	50
4	System 2 Aeration Basin	280	50	140
5	System 3 Primary Sedimentation Tanks	240	0	0
6	New Generator and Blowers	500	0	0
7	Subtotal Civil Works	620		190
8	Subtotal Mechanical(2)	500		0
9	Transport System			
10	Force Mains - Civil			
11	600 mm PS-3 to Mazrah	-	-	-
12	400 mm PS-5 to Mazrah	170	25	43
13	350 mm PS-6&7 to Mazrah	338	25	85
14	Pumping Stations			
15	Numbers 1,2,3,6,7,R-4(1)	-		-
16	Numbers 4 and 5 - Structures(3)	50	46	23
17	Number 8 - equipment	225	90	202
18	- structures	100	45	45
19	- electrical	160	90	144
20	Numbers R-1,2,3 - Structures(4)	114	25	28
21	Subtotal Civil Works	772		224
22	Subtotal Mechanical(2)	885		346
23	Collection System			
24	Major Sewers & Local Collectors(5)	8,210	58	4,788
25	Subtotal			
26	Civil Works	9,602		5,202
27	Mechanical	885		346
28	TOTAL - Treatment, Transport and Collection	10,487		5,548
29	Land	1,200		
30	Service Connections	645	50	323

(1) To be abandoned.
(2) Includes electrical.
(3) To be kept as screen chambers.
(4) Cassion will be utilized.
(5) See Table 12.2.

TABLE 12.2

EVALUATION OF EXISTING WASTEWATER COLLECTION SYSTEM

Size mm	Length m	Avg. Depth m	Unit Cost LE/m	Replacement Cost LE
150	2,423	1.5	25	60,600
175	60,938	2	40	2,437,500
220	35,114	3	65	2,282,400
300	7,908	3.3	80	632,600
400	2,274	3.5	120	272,900
450	1,651	3.6	135	222,900
525	155	3.7	150	23,300
600	210	3.8	170	35,700
	110,675			5,967,900
Manholes(1)			750	2,242,500
			TOTAL	8,210,400

(1) No. of Manholes - 2,990
Avg. Spacing - 37 m

TABLE 12.3

SCHEDULE OF ADDITIONS TO FIXED ASSETS AND SERVICE CONNECTION VALUES
WASTEWATER SYSTEM
(Thousands of 1978 LE)

Line No.		1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	ADDED ASSETS (1)																							
2	Civil Works	9602	615	1903	8341	9342	703	808	990	2103	1062	1062	1230	3216	893	1385	851	851	892	1289	766	766	766	766
3	Mechanical (2)	885	-	1069	1358	12301	-	109	154	1237	-	-	150	1904	27	347	-	-	29	370	-	-	-	-
4	Vehicles and Maintenance Equipment	-	-	308	-	336	-	64	-	-	-	-	101	-	-	-	-	81	-	-	-	-	70	-
5	Land	1200	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6	TOTAL	11687	615	3280	9699	21979	703	981	1144	3340	1062	1062	1481	5120	920	1732	851	932	921	1659	766	766	836	766
7	DEPRECIABLE VALUES																							
8	Civil Works	9602	10217	12120	20461	29803	30506	31314	32304	34407	35469	36531	37761	40977	41870	43255	44106	44957	45849	47138	47904	48670	49436	50202
9	Mechanical	885	885	1954	3312	15613	15613	15722	15876	17113	17113	17113	17263	19167	19194	19541	19541	19541	19570	19940	19940	19940	19940	19940
10	Vehicles and Maintenance Equipment	-	-	308	308	644	644	708	708	708	708	708	809	809	809	809	809	890	890	890	890	890	960	960
11	TOTAL	10487	11102	14382	24081	46060	46763	47744	48888	52228	53290	54352	55833	69953	61873	63605	64456	65388	66309	67968	68734	69500	70336	71102
12	ADDED VALUE OF SERVICE CONNECTIONS	-	691	692	691	692	818	818	818	1222	1222	1222	1222	1222	1038	1039	1038	1039	1038	1039	1038	1039	1038	1039
13	VALUE OF SERVICE CONNECTIONS	645	1336	2028	2719	3411	4229	5047	5865	7087	8309	9531	10753	11975	13013	14052	15090	16129	17167	18206	19244	20283	21321	22360

(1) 1978 assets represent existing facilities, (see Table 12.1).
(2) Includes electrical work.

TABLE 12.3 (Cont.)

BASIS FOR PREPARING TABLE 12.3

Schedule of Additions to Fixed Assets and Service Connection Values

Line	
1	Added Assets. Heading for lines 2 to 6.
2	Civil Works. From line 12 of Table 11.1. 1978 from line 26 of Table 12.1.
3	Mechanical. From line 13 of Table 11.1. 1978 from line 27 of Table 12.1.
4	Vehicles and Maintenance Equipment. From line 14 of Table 11.1.
5	Land. From line 29 of Table 12.1.
6	Total. Sum of lines 2 to 5 above.
7	Depreciable Values. Heading for lines 8 to 11.
8	Civil Works. Cumulative sum of values in line 2 above.
9	Mechanical. Cumulative sum of values in line 3 above.
10	Vehicles and Maintenance Equipment. Cumulative sum of values in line 4 above.
11	Total. Sum of lines 8 to 10 above.
12	Added Value of Service Connections. From line 20 of Table 11.1; 1978 value from line 30 in Table 12.1.
13	Value of Service Connections. Cumulative sum of values in line 12 above.

TABLE 12.4

SCHEDULE OF DEPRECIATION COSTS
WASTEWATER SYSTEM
(Thousands of 1978 LE)

Line No.		Per-Cent	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
1.	ACTUAL DEPRECIATION COST ON FIXED ASSETS														
2.	Civil Works	2.5	-	240	255	303	512	745	763	783	808	860	887	913	944
3.	Mechanical (1)	5		44	44	98	166	781	781	786	794	856	856	856	863
4.	Vehicle and Maintenance Equipment	10				31	31	64	64	71	71	71	71	71	81
5.	TOTAL			284	299	432	709	1,590	1,608	1,640	1,673	1,787	1,814	1,840	1,888
6.	ACCUMULATED DEPRECIATION ON FIXED ASSETS		5,548	5,832	6,131	6,563	7,272	8,862	10,470	12,110	13,783	15,570	17,384	19,224	21,112
7.	ANNUAL DEPRECIATION ON SERVICE CONNECTIONS	2.5		16	33	51	68	85	106	126	147	177	208	238	269
8.	ACCUMULATED DEPRECIATION ON SERVICE CONNECTIONS		323	339	372	423	491	576	682	808	955	1,132	1,340	1,578	1,847

Line No.		1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1.	ACTUAL DEPRECIATION COST ON FIXED ASSETS										
2.	Civil Works	1,024	1,047	1,081	1,103	1,124	1,146	1,178	1,198	1,217	1,236
3.	Mechanical (1)	958	960	977	977	977	979	997	997	997	997
4.	Vehicle and Maintenance Equipment	81	81	81	81	89	89	89	89	89	96
5.	TOTAL	2,063	2,088	2,139	2,161	2,190	2,214	2,264	2,284	2,303	2,329
6.	ACCUMULATED DEPRECIATION ON FIXED ASSETS	23,175	25,263	27,402	29,563	31,753	33,967	36,231	38,515	40,818	43,147
7.	ANNUAL DEPRECIATION ON SERVICE CONNECTIONS	299	325	351	377	403	429	455	481	507	533
8.	ACCUMULATED DEPRECIATION ON SERVICE CONNECTIONS	2,146	2,471	2,822	3,199	3,602	4,031	4,486	4,967	5,474	6,007

(1) Includes electrical work.

TABLE 12.4 (Cont.)

BASIS FOR PREPARING TABLE 12.4

Schedule of Depreciation Costs

Line

1 Annual Depreciation on Fixed Assets. Heading for lines 2 to 5. No 1978 values are shown. Depreciation on existing facilities is picked up in lines 7 to 9 below.

2 Civil Works. 2.5 percent of asset value shown on line 8 of Table 12.3 for previous year.

3 Mechanical. 5 percent of asset value shown on line 9 of Table 12.3 for previous year.

4 Vehicles and Maintenance Equipment. 10 percent of asset value shown on line 10 of Table 12.3 for previous year.

5 Total. Sum of lines 2 to 4.

6 Accumulated Depreciation on Fixed Assets. The 1978 value is based on existing assets times the applicable weighted percent of accumulated depreciation (Table 12.1, line 28). Values for succeeding years are cumulative sums of 1978 value and values shown in line 5 above.

7 Annual Added Allowance for Service Connection Replacement. 2.5 percent of value shown on line 13 of Table 12.3 for previous year.

8 Accumulated Allowance for Service Connection Replacement. The 1978 value is from line 30 of Table 12.1. Other years' values are cumulative sums of 1978 value and values shown in line 7 above.

TABLE 12.5

PRO FORMA OPERATING STATEMENTS 1979-2000
WASTEWATER SYSTEM
(Thousands of 1978 LE)

Line No.	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1. FLOWS									FLOWS (cu m)													
2. Water Produced (cu m x 10^6)	36.5	38.0	40.0	41.8	44.0	46.5	49.4	52.0	55.0	58.0	61.0	64.0	67.5	70.5	73.5	76.5	79.1	82.5	86.0	90.0	92.0	95.2
3. Water Sold (cu m x 10^6)	27.0	29.0	31.0	32.7	34.6	36.5	38.9	41.0	43.5	46.0	48.5	51.5	53.5	56.0	58.5	60.8	63.0	66.0	68.5	71.0	73.4	75.8
4. Sludge Sold (cu m x 10^3)					35	39	42	44	47	49	52	54	56	58	61	63	65	67	69	72	74	76
5. ANNUAL COSTS(1)									COSTS (1978 LE 1,000)													
6. Operation and Maintenance	358	432	578	1,039	1,152	1,166	1,199	1,273	1,295	1,313	1,332	1,422	1,437	1,465	1,477	1,489	1,509	1,534	1,534	1,551	1,559	1,575
7. Depreciation on Fixed Assets	284	299	432	709	1,590	1,608	1,640	1,673	1,787	1,814	1,840	1,888	2,063	2,088	2,139	2,161	2,190	2,214	2,264	2,284	2,303	2,329
8. Depreciation on Service Connections	16	33	51	68	85	106	126	147	177	208	238	269	299	325	351	377	403	429	455	481	507	533
9. Return on Investments	368	388	567	1,123	2,399	2,346	2,308	2,279	2,379	2,335	2,290	2,269	2,462	2,394	2,373	2,295	2,222	2,145	2,112	2,022	1,931	1,843
10. TOTAL ANNUAL COSTS	1,026	1,152	1,628	2,939	5,226	5,226	5,273	5,372	5,638	5,670	5,700	5,848	6,261	6,272	6,340	6,322	6,324	6,322	6,374	6,338	6,300	6,280
11. REQUIRED REVENUES																						
12. Wastewater Charges	335	460	937	2,247	4,373	4,369	4,413	4,106	4,369	4,399	4,426	4,572	5,167	5,175	5,241	5,220	5,221	5,216	5,267	5,227	5,188	5,165
13. Connection Charges	691	692	691	692	818	818	818	1,222	1,222	1,222	1,222	1,222	1,038	1,039	1,038	1,039	1,038	1,039	1,038	1,039	1,038	1,039
13a. Sludge Sales					35	39	42	44	47	49	52	54	56	58	61	63	65	67	69	72	74	76
14. TOTAL ANNUAL REVENUE	1,026	1,152	1,628	2,939	5,226	5,226	5,273	5,372	5,638	5,670	5,700	5,848	6,261	6,272	6,340	6,322	6,324	6,322	6,374	6,338	6,200	6,280
15. Required avg. cost of Wastewater Collected (milliemes/cu m water sold)	12	16	30	69	126	120	113	100	(Milliemes/cu m) 100	96	91	89	97	92	90	86	83	79	77	74	71	68

(1) Does not include rehabilitation.

TABLE 12.5 (Cont.)

BASIS FOR PREPARING TABLE 12.5

Pro Forma Operating Statements 1978-2000

Line	
1	Flows. Annual flows expressed in millions of cu m/d. Used for operating cost estimates and estimates of average charges to provide needed revenues.
2	Water Produced. The quantity of water treated annually at the WTP. Based on average daily flow in Table _____.
3	Water Sold. The amount of water paid for, whether metered or estimated. It is assumed equal to 90 percent of the water delivered to customers, which in turn is calculated as average water produced less leakage, both as given in Table _____.
4	Sludge Sold. Amount of dried sludge cake sold.
5	Annual Costs. Heading for lines 6 to 10.
6	Operation and Maintenance. From Table 11.3, line 12, deducting the cost of rehabilitation (1979 to 1982) from Table 11.1.
7	Depreciation on Fixed Assets. From Table 12.4, line 5.
8	Depreciation on Service Connections. From Table 12.4, line 7.
9	Return on Investment. 6 percent of the depreciated fixed assets for previous year end, as shown in line 6 of Table 12.7.
10	Total Annual Costs. Sum of lines 6 to 9.
11	Required Revenues. Heading for lines 12 to 14.
12	Wastewater Charge. The money required from water sales to generate required total annual wastewater revenues. Line 14 less line 13 and 13a.
13	Connection Charge. Estimated revenue from installing service connections at cost. The cost of service connections is derived from line 20 in Table 11.1. For 1979, add line 30 in Table 12.1.
13a	Sludge Disposal Charge. Estimated revenue from sludge sold at LE 1.00/cu m.
14	Required Total Annual Revenues. Set equal to total annual costs to make system self-financing.
15	Required Annual Cost of Water Sold. The average cost per cu m to the customer to generate required revenues.

TABLE 12.6

PRO FORMA CASH FLOW SCHEDULES 1979-2000
WASTEWATER SYSTEM
(Thousands of 1978 LE)

LINE NO.	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1. SOURCE OF FUNDS																						
2. Loans	1306	5426	10390	22671	1521	1799	1962	4562	2284	2284	2703	6342	1958	2771	1889	1971	1959	2698	1804	1805	1874	1805
3. Revenues	1026	1152	1628	2939	5226	5226	5273	5372	5638	5670	5700	5848	6261	6272	6340	6322	6324	6322	6374	6338	6300	6280
4. TOTAL	2332	6578	12018	25610	6747	7025	7235	9934	7922	7954	8403	12190	8219	9043	8229	8293	8283	9020	8178	8143	8174	8085
5. APPLICATION OF FUNDS																						
6. Capital Additions	1306	3972	10390	22671	1521	1799	1962	4562	2284	2284	2703	6342	1958	2771	1889	1971	1959	2698	1804	1805	1874	1805
7. Interest	-	78	404	1027	2384	2455	2511	2510	2659	2667	2669	2682	2907	2861	2858	2781	2704	2617	2570	2462	2349	2232
8. Amortization	-	-	-	65	337	856	1990	2066	2156	2254	2482	2596	2710	2845	3163	3261	3399	3494	3592	3690	3825	3915
9. Operation, Maint. and Rehab.	358	1886	578	1039	1152	1166	1199	1273	1295	1313	1332	1422	1437	1465	1477	1489	1509	1534	1543	1551	1559	1575
10. TOTAL	1664	5936	11372	24802	5394	6276	7662	10411	8394	8518	9186	13042	9012	9943	9387	9502	9571	10343	9509	9508	9607	9527
11. NET SURPLUS (DEFICIT)	668	642	646	808	1353	749	(427)	(477)	(472)	(564)	(783)	(852)	(793)	(901)	(1158)	(1209)	(1288)	(1323)	(1331)	(1365)	(1433)	(1442)
12. Balance (Cash & Receivables Less Accounts Payable)																						
at beginning of year	-	668	1310	1956	2764	4117	4866	4439	3962	3490	2926	2143	1291	491	(402)	(1560)	(2769)	(4057)	(5380)	(6711)	(8076)	(9509)
at end of year	668	1310	1956	2764	4117	4866	4439	3962	3490	2926	2143	1291	498	(401)	(1560)	(2769)	(4057)	(5380)	(6711)	(8076)	(9509)	(10951)
13. OUTSTANDING LONG TERM DEBT																						
Accumulated Loans	1306	6732	17122	39793	41314	43113	45075	49637	51921	54205	56908	63256	65214	67985	69874	71845	73804	76502	78306	80111	81985	83790
Less Accumulated Amortization	-	-	-	(65)	(402)	(1258)	(3248)	(5314)	(7470)	(9724)	(12206)	(14802)	(17512)	(20357)	(23520)	(26781)	(30180)	(33674)	(37266)	(40956)	(44781)	(48696)
Net Outstanding Debt	1306	6732	17122	39728	40912	41855	41827	44323	44451	44481	44702	48454	47702	47626	46354	45064	43624	42828	41040	39155	37204	35094

TABLE 12.6 (Cont.)

BASIS FOR PREPARING TABLE 12.6

Pro Forma Cash Flow Schedules 1978-2000

Line	
1	Source of Funds. Heading for the anticipated sources of required money. (Lines 2 to 4).
2	Loans. The annual capital requirement to finance the recommended programs.
3	Revenue. Money to be collected from the customers for water service and connection. Line 14 of Table 12.5.
4	Total. Sum of lines 2 and 3.
5	Application of Funds. Heading for the anticipated annual expenditures. (Lines 6 to 10).
6	Capital Additions. The amount of money invested in capital facilities. Table 12.3, line 6 plus line 12.
7	Interest. The required annual interest payment based on assumed terms for foreign and local loans. (Apply to outstanding loan balance at end of previous year.)
8	Amortization. The required annual amortization based on assumed terms for foreign and local loans.
9	Operation, Maintenance and Rehabilitation. Total from Table 11.3, line 12.
10	Total. Sum of lines 5 to 9.
11	Net Surplus (Deficit). The total funds (line 4) less the total application of funds.
12	Balance. The cumulative total of the surplus indicated at the beginning and end of each year. The build-up will be less than indicated since funds will be used for renewal of facilities and likely also for extensions of the system.
13	Outstanding Long-Term Debt. A schedule summarizing the accumulated long-term debt and amortization to be used for comparing the net outstanding debt with the Balance.

TABLE 12.7

PRO FORMA BALANCE SHEETS 1979-2000 (END OF YEAR) WASTEWATER SYSTEM (Thousands of 1978 LE)

LINE NO.	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1. ASSETS																							
2. Existing and Recommended Facilities	10,487	11,102	14,382	24,081	46,060	46,763	47,744	48,888	52,228	53,290	54,352	55,833	60,953	61,873	63,605	64,456	65,388	66,309	67,968	68,734	69,500	70,336	71,102
3. Less Accumulated Depreciation	(5,548)	(5,832)	(6,131)	(6,563)	(7,272)	(8,862)	(10,470)	(12,110)	(13,783)	(15,570)	(17,384)	(19,224)	(21,112)	(23,175)	(25,263)	(27,402)	(29,563)	(31,753)	(33,967)	(36,231)	(36,515)	(40,818)	(43,147)
4. SUBTOTAL DEPRECIATED FACILITIES	4,939	5,270	8,251	17,518	38,788	37,901	37,274	36,778	38,445	37,720	36,968	36,609	39,841	38,698	38,342	37,054	35,825	34,556	34,001	32,503	30,985	29,518	27,955
5. Land	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200
6. SUBTOTAL - DEPRECIATED FIXED ASSETS	6,139	6,470	9,451	18,718	39,988	39,101	38,474	37,978	39,645	38,920	38,168	37,809	41,041	39,898	39,542	38,254	37,025	35,756	35,201	33,703	32,185	30,718	29,155
7. Cash	--	427	1,222	1,579	2,110	2,899	3,649	3,213	2,717	2,179	1,608	819	(60)	(956)	(1,856)	(3,031)	(4,235)	(5,522)	(6,842)	(8,186)	(9,542)	(10,965)	(12,400)
8. Accounts Receivable	--	257	288	407	735	1,307	1,307	1,318	1,343	1,410	1,418	1,425	1,462	1,565	1,568	1,585	1,581	1,581	1,581	1,594	1,585	1,575	1,570
9. TOTAL ASSETS	6,139	7,154	10,961	20,704	42,833	43,307	43,430	42,509	43,705	42,509	41,194	40,053	42,443	40,507	39,254	36,808	34,371	31,815	29,940	27,111	24,228	21,328	18,325
10. LIABILITIES AND NET WORTH																							
11. Accounts Payable	--	16	200	30	81	89	90	92	98	99	100	101	111	111	114	114	115	116	119	119	119	119	121
12. Long Term Loans	--	1,306	6,732	17,122	39,728	40,912	41,855	41,827	44,323	44,451	44,481	44,702	48,454	47,702	47,628	46,354	45,064	43,624	42,828	41,040	39,155	37,204	35,094
13. Allowance for Depreciation of Customer Services	323	339	372	423	491	576	682	808	955	1,132	1,340	1,578	1,847	2,146	2,471	2,822	- 3,199	3,602	4,031	4,486	4,967	5,474	6,007
14. TOTAL LIABILITIES	323	1,661	7,304	17,575	40,300	41,577	42,627	42,727	45,376	45,682	45,921	46,381	30,412	49,959	50,213	49,290	49,378	47,342	46,978	45,645	44,241	42,797	41,222
15. Capital Contributions	6,139	6,139	6,139	6,139	6,139	6,139	6,139	6,139	6,139	6,139	6,139	6,139	6,139	6,139	6,139	6,139	6,139	6,139	6,139	6,139	6,139	6,139	6,139
16. Earned Surplus (Deficit)	(323)	(646)	(2,482)	(3,010)	(3,606)	(4,409)	(5,336)	(6,357)	(7,810)	(9,312)	(10,866)	(12,467)	(14,108)	(15,591)	(17,098)	(18,621)	(20,146)	(21,666)	(23,177)	(24,671)	(26,152)	(27,608)	(29,036)
17. Net Worth	5,816	5,493	3,657	3,129	2,533	1,730	803	(218)	(1,671)	(3,173)	(4,727)	(6,328)	(7,969)	(9,452)	(10,959)	(12,482)	(14,007)	(15,527)	(17,038)	(18,538)	(20,013)	(21,469)	(22,837)
18. TOTAL LIABILITIES AND NET WORTH	6,139	7,154	10,961	20,704	42,833	43,307	43,430	42,509	43,705	42,509	41,194	40,053	42,443	40,507	39,254	36,808	34,371	31,815	29,940	27,111	24,228	21,328	18,325

TABLE 12.7 (Cont.)

BASIS FOR PREPARING TABLE 12.7

Pro Forma Balance Sheets 1978-2000

Line	
1	Assets. Heading for lines 2 to 9.
2	Existing and Recommended Facilities. From line 11, Table 12.3.
3	Less Accumulated Depreciation. The accumulated depreciation from Table 12.4. (Entered as negative figure.)
4	Sub-Total Depreciated Facilities. Line 2 less line 3.
5	Land. Cumulative sum of values on line 5 of Table 12.3.
6	Sub-Total Fixed Assets. Sum of lines 4 and 5.
7	Cash. The surplus year-end balance indicated on line 12 of Table 12.6, less line 8 below, plus line 11 below.
8	Accounts Receivable. Estimated at 25 percent of total revenues.
9	Total Assets. Sum of lines 6 to 8.
10	Liabilities and Net Worth. Heading for lines 11 to 18.
11	Accounts Payable. Estimated at 1-1/2 month's cost less salaries (0.125 times the sum of line 12 less line 10 of Table 11.3).
12	Long-Term Loans. The net outstanding debt from line 13 of Table 12.6.
13	Accumulated Depreciation on Customer Services. From line 8, Table 12.4. This represents a fund for replacement of services as needed.
14	Total Liabilities. Sum of lines 11 to 13.
15	Capital Contribution. The depreciated value of the existing facilities as of 1978. Value includes facilities and land minus depreciation on these facilities (not including service connections) from Table 12.1.
16	Earned Surplus (Deficit). Line 17 less line 15 (balancing factor).
17	Net Worth. Line 9 less line 14.
18	Total Liabilities and Net Worth. Sum of lines 14 and 17.

TABLE 12.8

ADJUSTED CASH FLOW SCHEDULE 1979-2000
(Thousands of 1978 LE)

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Sources of Funds																						
Loans	-	2,213	8,396	22,513	-	-	799	4,606	5,529	1,249	2,283	6,577	1,108	2,638	1,607	1,555	1,370	1,956	537	348	125	-
Revenues	3,391	3,592	3,791	3,962	4,313	4,507	4,750	5,366	5,619	5,871	6,124	6,426	6,444	6,697	6,949	7,182	7,403	7,706	7,957	8,211	8,452	8,695
Total	3,391	5,805	12,187	26,475	4,313	4,507	5,529	9,972	11,148	7,120	8,407	13,003	7,552	9,315	8,556	8,737	8,773	9,662	8,494	8,559	8,577	8,695
Application of Funds																						
Capital Additions	1,306	3,972	10,390	22,671	1,521	1,799	1,962	4,562	2,284	2,284	2,703	6,342	1,958	2,771	1,889	1,971	1,959	2,698	1,804	1,805	1,874	1,805
Interest	-	-	133	637	1,987	1,981	1,949	1,896	5,609	2,306	2,279	2,300	2,563	2,493	2,508	2,442	2,349	2,258	2,197	2,047	1,882	1,697
Amortization	-	-	-	-	111	530	1,656	1,656	1,656	1,695	1,925	2,202	2,264	2,378	2,707	2,763	2,894	2,974	3,035	3,104	3,201	3,228
Operation & Maintenance	358	1,836	578	1,039	1,152	1,166	1,199	1,273	1,295	1,313	1,332	1,422	1,437	1,465	1,477	1,489	1,509	1,534	1,543	1,551	1,559	1,575
Total																						
Net Surplus (Deficit)	1,727	(53)	1,086	2,128	(458)	(969)	(1,237)	585	304	(478)	168	737	(670)	208	(25)	72	62	198	(85)	52	61	390
Balance																						
At beginning of year	-	1,727	1,674	2,760	4,888	4,430	3,461	2,224	2,809	3,113	2,635	2,803	3,540	2,870	3,078	3,053	3,125	3,187	3,385	3,300	3,352	3,413
At end of year	1,727	1,674	2,760	4,888	4,430	3,461	2,222	2,809	3,113	2,635	2,803	3,540	2,870	3,078	3,053	3,125	3,187	3,385	3,300	3,352	3,413	3,803
Outstanding Long-Term Debt																						
Accumulated Loans	-	2,213	10,609	33,122	33,122	33,122	33,901	38,507	44,036	45,285	47,568	54,145	55,253	57,871	59,478	60,700	62,070	64,026	64,563	64,911	65,036	65,036
Less Accum. Amortization	-	-	-	-	111	641	2,297	3,593	5,609	7,304	9,229	11,431	13,695	16,073	18,780	21,543	24,437	27,411	30,446	33,550	36,751	39,979
Net Outstanding debt	-	2,213	10,609	33,122	33,011	32,481	31,604	34,554	38,427	37,981	38,339	42,714	41,558	41,798	40;698	39,157	37,633	36,615	34,117	31,361	28,285	25,057

Prepared on the same basis as Table 12.6, except that loan is the minimum amount required so that Surplus is adequate to maintain a cash level no less than two months of total expenses (capital, operating and maintenance, and debt service).

TABLE 12.9

ADJUSTED BALANCE SHEETS 1979-2000
(Thousands of 1978 LE)

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
ASSETS																						
Existing & Recom. Facilities	11,102	14,382	24,081	46,060	46,763	47,744	48,888	52,228	53,290	54,352	55,833	60,953	61,873	63,605	64,456	65,388	66,309	67,968	68,736	69,500	70,336	71,102
Less Accum. Depreciation	(5,832)	(6,131)	(6,563)	(7,272)	(8,862)	(10,470)	(12,110)	(13,783)	(15,570)	(17,384)	(19,224)	(21,112)	(23,175)	(25,263)	(27,402)	(29,563)	(31,753)	(33,967)	(36,231)	(38,515)	(40,818)	(43,167)
SUBTOTAL DEPRECIATED FACILITIES	5,270	8,251	17,518	38,788	7,901	37,274	36,778	38,445	37,720	36,968	36,609	39,841	38,698	38,342	37,054	35,825	34,556	34,001	32,503	30,965	29,518	27,955
Land	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200
SUBTOTAL DEPREC. FIXED ASSETS	6,470	9,451	18,718	39,988	39,101	38,474	37,978	39,645	38,920	38,168	37,809	41,041	39,898	39,542	38,254	37,025	35,756	35,201	33,703	32,165	30,718	29,155
Cash	895	976	1,850	4,058	3,441	2,424	1,128	1,565	1,807	1,266	1,373	2,044	1,370	1,518	1,430	1,444	1,452	1,577	1,430	1,418	1,419	1,750
Accounts Receivable	848	898	948	991	1,078	1,127	1,188	1,342	1,405	1,469	1,531	1,169	1,611	1,674	1,737	1,796	1,851	1,927	1,989	2,053	2,113	2,174
TOTAL ASSETS	8,213	11,325	21,516	45,037	43,620	42,025	40,294	42,552	42,132	40,903	40,713	44,254	42,879	42,734	41,421	40,265	38,504	38,705	37,122	35,656	34,250	33,079
LIABILITIES & NET WORTH																						
Accounts Payable	16	200	30	81	89	90	92	98	99	100	101	111	111	114	114	115	116	119	119	119	119	121
Long Term Loans	-	2,213	10,609	33,122	33,011	32,481	31,604	34,554	38,427	37,981	38,339	42,714	41,558	41,798	40,698	39,157	37,633	36,615	34,117	31,361	28,285	25,057
Allowance for Depreciation of Customer Services	339	372	423	491	576	682	808	955	1,132	1,340	1,578	1,847	2,146	2,471	2,822	3,199	3,602	4,031	4,486	4,967	5,474	6,007
TOTAL LIABILITIES	355	2,785	11,062	33,694	33,676	33,253	32,494	35,607	39,658	39,421	40,018	44,672	43,815	44,383	43,634	42,471	41,351	40,765	38,722	36,447	33,878	31,185
Capital Contributions	6,139	6,139	6,139	6,139	6,139	6,139	6,139	6,139	6,139	6,139	6,139	6,139	6,139	6,139	6,139	6,139	6,139	6,139	6,139	6,139	6,139	6,139
Earned Surplus (Deficit)	1,719	2,401	4,315	5,204	3,805	2,633	1,661	806	(3,665)	(4,657)	(5,444)	(6,557)	(7,075)	(7,788)	(8,352)	(8,345)	(8,986)	(8,199)	(7,739)	(6,930)	(5,767)	(4,245)
Net Worth	7,858	8,540	10,454	11,343	9,944	8,772	7,800	6,945	2,474	1,482	695	(418)	(936)	(1,649)	(2,213)	(2,206)	(2,847)	(2,060)	(1,600)	(791)	372	1,894
TOTAL LIABILITIES & NET WORTH	8,213	11,325	21,516	45,037	43,620	42,025	40,294	42,552	42,132	40,903	40,713	44,254	42,879	42,734	41,421	40,265	38,504	38,705	37,122	35,656	34,250	33,079

Prepared on the same basis as Table 12.7

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TABLE 12.10

DEBT SERVICE FINANCING
(All Values in Thousands of LE)

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Amount of Loan(1)	1,544	6,797	16,056	37,679	3,214	4,001	4,941	11,664	6,819	7,296	8,688	20,703
Amortization(2)	-	-	-	-	77	417	1,220	3,104	3,265	3,465	3,712	4,295
Interest(3)	-	93	500	1,464	3,720	3,888	4,055	4,165	4,669	4,857	5,072	5,335
Total Debt Service(4)	-	93	500	1,464	3,797	4,305	5,275	7,269	7,934	8,322	8,784	9,630
Operation & Maintenance Cost(5)	425	2,683	936	1,746	2,202	2,468	2,781	3,168	3,460	3,764	4,096	4,641
TOTAL EXPENSES	425	2,776	1,436	3,210	5,999	6,773	8,056	10,437	11,354	12,086	12,880	14,271
Required Cash(6)	71	463	239	535	1,000	1,129	1,343	1,740	1,899	2,014	2,147	2,379
Additions to Cash	71	392	(112)	184	465	129	214	397	317	115	133	232
Revenues(7)	829	987	1,166	1,351	1,858	2,081	2,287	3,667	3,923	4,196	4,490	4,803
Req. Revenue from Sewer Charge	-	1,348	158	2,043	4,606	4,781	5,983	7,167	7,788	8,005	8,523	9,700
Water Sold, 10^6 x cu m	27.0	29.0	31.0	32.7	34.6	36.5	38.9	41.0	43.5	46.0	48.5	51.5
Req. Rate, LE/cu m	-	.046	.005	.062	.133	.131	.154	.175	.179	.174	.176	.188

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Amount of Loan(1)	7,559	11,186	8,465	9,301	9,913	14,328	10,594	11,342	12,418	12,986
Amortization(2)	4,636	5,001	5,435	6,470	6,848	7,407	7,831	8,596	8,791	9,508
Interest(3)	6,299	6,453	6,798	6,918	7,065	7,215	7,605	7,743	7,896	8,071
Total Debt Service(4)	10,935	11,454	12,233	13,388	13,913	14,622	15,436	16,339	16,687	17,579
Operation & Maintenance Cost(5)	5,030	5,483	5,927	6,398	6,950	7,558	8,138	8,764	9,436	10,215
TOTAL EXPENSES	15,965	16,937	18,160	19,786	20,863	22,180	23,574	25,103	26,123	27,794
Required Cash(6)	2,661	2,823	3,027	3,298	3,477	3,697	3,929	4,184	4,354	4,632
Additions to Cash	282	162	204	271	179	220	232	255	170	278
Revenues(7)	4,372	4,681	5,003	5,356	5,723	6,126	6,547	7,009	7,491	8,019
Req. Revenue from Sewer Charge	11,875	12,418	13,361	14,701	15,319	16,274	17,259	18,349	18,802	20,053
Water Sold, 10^6 x cu m	53.5	56.0	58.5	60.8	63.0	66.0	68.5	71.0	73.4	75.8
Req. Rate, LE/cu m	.222	.222	.228	.242	.243	.247	.252	.258	.256	.265

(1) Total capital cost, including inflation, from Table 12.11
(2) 5% of cum. loans, 4-23 yrs.
(3) 6% of outstanding balance
(4) Interest plus amortization
(5) From Table 12.11
(6) Two months of total expenses
(7) Service connections and sale of sludge, from Table 12.11

TABLE 12.11

OPERATING STATEMENTS 1979-2000
DEFICIT FINANCING BASIS
(Thousands of LE)

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Rate of Inflation																						
Local	20%	19%	18%	16%	14%	12%	10%	8%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%
Foreign	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%
Capital Outlays(1)																						
Local 1978 LE	1,123	1,888	7,254	12,352	1,308	1,308	1,571	3,069	1,964	1,964	1,964	3,928	1,625	2,197	1,625	1,626	1,625	2,124	1,551	1,552	1,551	1,552
Inflated	1,348	2,696	12,223	24,144	2,915	3,264	4,313	9,099	6,231	6,667	7,133	15,266	6,757	9,776	7,737	8,283	8,858	12,388	9,679	10,363	11,082	11,865
Foreign 1978 LE	183	3,582	3,129	10,326	213	491	391	1,493	320	320	739	2,414	333	547	264	345	334	574	253	253	323	253
Inflated	196	4,101	3,833	13,535	299	737	628	2,565	588	629	1,555	5,437	802	1,410	728	1,018	1,055	1,940	915	979	1,337	1,121
Operations & Maintenance(2)																						
Local 1978 LE	320	1,847	495	596	709	722	751	788	810	828	846	880	895	912	924	935	954	968	976	984	992	1,007
Inflated	384	2,638	834	1,165	1,580	1,802	2,062	2,336	2,569	2,810	3,073	3,420	3,721	4,057	4,399	4,763	5,200	5,645	6,091	6,570	7,088	7,699
Foreign 1978 LE	38	39	63	443	443	444	448	484	485	485	486	542	543	553	554	554	554	566	566	567	567	568
Inflated	41	45	102	581	622	666	719	832	891	954	1,023	1,221	1,309	1,426	1,528	1,635	1,750	1,913	2,047	2,194	2,348	2,516
TOTAL EXPENSES (w/inflation)	1,969	9,480	16,992	39,425	5,416	6,469	7,722	14,832	10,279	11,060	12,784	25,344	12,589	16,669	14,392	15,699	16,863	21,886	18,732	20,106	21,855	23,201
Required Cash(3)	328	1,580	2,832	6,571	902	1,078	1,287	2,472	1,713	1,843	2,131	4,224	2,098	2,778	2,399	2,617	2,811	3,648	3,122	3,351	3,643	3,867
Additions to Cash	328	1,252	1,252	3,739	(1,417)	(1,359)	(1,254)	(69)	(759)	130	288	2,093	(2,126)	680	(379)	218	194	837	(526)	229	292	224
Revenues																						
Service Conn.(4)	829	987	1,166	1,351	1,823	2,052	2,245	3,623	3,976	4,147	4,438	4,749	4,316	4,623	4,942	5,293	5,658	6,059	6,478	6,937	7,417	7,943
Sludge Sale(5)	-	-	-	-	35	39	42	44	47	49	52	54	56	58	61	63	65	67	69	72	74	76
TOTAL REVENUES	829	987	1,166	1,351	1,585	2,011	2,287	3,667	3,923	4,196	4,490	4,803	4,372	4,681	5,003	5,356	5,723	6,126	6,547	7,009	7,491	8,019
DEFICIT	1,468	9,745	17,078	41,813	2,141	3,029	4,181	11,096	5,597	6,994	8,582	22,634	6,091	12,667	9,010	10,561	11,334	16,597	11,659	13,326	14,656	15,406

(1) From Table 11.2
(2) From Table 11.3. O&M costs on mechanical equipment considered foreign. Foreign/local split on collection system O&M based on foreign/local split for capital cost of collection/transportation system, Table 11.2.
(3) Two months of total expenses.
(4) At cost incl. inflation.
(5) At 1 LE/cu m

CHAPTER 13

ECONOMIC AND ENVIRONMENTAL CONSIDERATIONS

13.1 INVESTMENT PERSPECTIVE

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 substantial investment.

Investment in new infrastructure has not kept pace with social and economic needs. Funds for regular maintenance work have been totally inadequate for upkeep of existing systems. An additional problem for the canal cities is the damage still remaining from the 1967 and 1973 wars.

Water and wastewater projects must compete nationally with projects which address other infrastructure needs. Moreover, the needs of Port Said must compete with those of other cities and regions. This section summarizes surveys of infrastructure needs in Egypt reported by others.

Five Year Plan

A five year plan for 1978-82 was prepared by the Ministry of Planning. The plan calls for a total public investment of LE 10 billion, or about LE 2 billion per year. As shown in Table 13.1, about six percent, or LE 125 million, is allocated annually to utilities, presumably water and sewerage. By comparison, 1976 utilities investments (also calculated at 1977 price levels) amounted to LE 45 million.(1) During the previous decade (1966-75), annual public investment in utilities ranged from LE 2.5 to LE 16.4 million.(2)

WHO/World Bank Needs Projection

Projections by the WHO/World Bank Cooperative Program of annual water and sewerage financing needs through the year 2000 are presented in Table 13.2.

The level of investment need identified for the 1978-82 period is only LE 85 million per year, significantly below that in the Five Year Plan.

Table 13.3 presents a breakdown of these utility needs by location; Cairo is allocated 36 percent, rural projects 17 percent, Alexandria 11 percent, and all other cities together 36 percent.

Adequacy of Needs Projections

The Port Said share of the above need projections may be inferred on a population basis. Table 13.4 compares Port Said population and growth figures from this report with

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(1) World Bank. Economic Management in a Period of Transition, Vol. 5, Table 17-1.
(2) WHO/World Bank Cooperative Program, Water Supply and Sewage Sector Study, Vol. 2, pages 78-79, June 1977.

projected figures for total Egypt, total urban, and total urban less Greater Cairo and Alexandria.

Based on its proportion of urban population growth for 1980-85, the Port Said share of the 1978/82 Five Year Plan projected investment in utilities (Table 13.1) would amount to LE 10.0 million, or LE 2.0 million per year. This covers a bit over half of the costs for the High Priority and Immediate Phase water programs. It would be totally inadequate for both water and wastewater.

Based on its population growth for the period 1986-2000, the Port Said share of the WHO/World Bank water needs projection in Table 13.2 would be 0.83 million/yr.

At 1978 cost levels, the recommended wastewater program involves capital outlays totaling LE 40,062,000 between now and 1982, and capital outlays totaling 43,996,000 (averaging LE 2,450,000 per yr) from 1983 through the year 2000. Even if adjusted to 1978 cost levels, the Five Year Plan and WHO/World Bank projections appear very low in relation to these Port Said needs. A new national needs projection, based on current water and wastewater master plans, should be prepared.

Priority Assessment

In making public capital investment decisions, the central government is faced with competing demands between various sectors and local areas. Priority may be expected for projects which can be financed by their own revenues or those which provide sufficient general benefits to the overall economy. In developing countries, utility charges are often set too low to provide adequate revenues, reflecting a judgment that charges high enough to provide self-financing would impose an undue burden on much of the population. Applying this judgment often results in under financing and inferior service.

In Section 13.2, below, an assessment is made of whether or not the Port Said water utilities can be financed from user charges. General economic benefits, as a basis for justifying any portion of the recommended program, are assessed in Section 13.3. Section 13.4 includes a number of environmental benefits which cannot be assessed in quantitative economic terms. This latter section also considers adverse effects of the program and defines required commitments of resources.

The assessment is made for the program as a whole, including proper treatment and disposal. It should be noted that the major portion of proposed wastewater charges (even excluding connection charges) goes to pay for collection, i.e., just for removal of sewage from the immediate urban areas. Even if sewage were discharged to the nearest available waters without treatment or dispersion, the reduction in wastewater charges required for self-financing of the system would be less than 40 percent. It is questionable whether this difference would warrant continued gross pollution of the city's aquatic surroundings.

13.2 COSTS TO SYSTEM USERS

A breakdown of projected water use by consumer category is shown in Table 13.5. As would be expected, the largest category is domestic, representing over 60 percent of water use from 1982 through 2000. Industry accounts for up to 22 percent; institutional (government) about 10 percent; and public taps and gardens 5 to 6 percent.

As noted in Chapter 12, an average charge of LE .100/cu m of water sold (1978 LE) could provide adequate financing for the wastewater system through the year 2000. The

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details of any future rate structure fall under the scope of the National Management and Tariff Study, now being carried out for the ACR. We propose here to assess the impact of the average charge above on different consumer categories, particularly domestic users.

In this analysis we assume that the high water users correspond to the highest income group; the medium water users to the middle income group; and the low water users to the lowest income group. Such a correspondence can reasonably be expected where water is sold at true cost, and individual consumers see their water use reflected in the bill they receive. If any subsidy is provided to users, it should apply only to a limited quantity of water representing basic needs. Otherwise any relation between water use and income level would break down.

Demand forecasts for the WWFMP are based on increasing water consumption within each domestic water use class, and on an increasing proportion of the population in the higher use classes. Individual figures are as follows:

	Percent of Population		Per Capita Use lcd	
Use Class	1977	2000	1977	2000
High	20	30	250	275
Medium	40	40	170	195
Low	40	30	85	110

Table 13.5 shows that by the year 2000 the high water use class - presumably the group best able to pay - will account for the largest single portion of total water consumption: 26 percent.

Figure 13-A shows present and projected year 2000 income distributions based on estimates in the PSMP, updated to 1978 LE. Income ranges corresponding to high, medium and low water use are identified, based on the assumption that water use varies with income. Presumably the PSMP income projections relate to the employment forecast in the PSMP. Under better economic conditions, where structural unemployment is reduced or eliminated, it would be reasonable to expect average incomes to be even higher. If its urban economy prospers, incomes in Port Said should average higher than in other cities in Egypt simply because Port Said has no rural fringe areas where people growing their own food could subsist on very low incomes.

For each water use class, typical household annual wastewater charges are projected in Table 13.6 and related to income. Household wastewater costs were based on a unit charge of LE 0.10/cu m of water sold. Incomes were based on PSMP projections, assuming the relation of water use to income outlined above. Average household size was taken to be 4.6 in 1978 and 4.4 in the year 2000, following PSMP projections.

At 1978 consumption and income levels, annual wastewater charges for the low water use class would range from 2.6 to 5.6 percent of household income. Ranges for the higher water use classes would be from 1.0 to 4.4 percent. Since household income is expected to increase more rapidly than household water consumption during the period 1978-2000, the proportion of income represented by wastewater charges is expected to decrease. By the year 2000, wastewater charges would range between 0.8 and 4.2% of household income.

A substantial portion of water consumption (32% at the lowest water use level) is attributable to wastage (e.g. leaks in customers plumbing system after the water meter). If such wastage were reduced, wastewater charges would decrease even further. The

wastewater charge based on water actually used, excluding wastage, amounts to 3.8% of household income for the lowest income group in 1978, decreasing to 3.0% by 2000.

Based on figures for water systems in other developing countries, we judge that the proposed unit charge for wastewater is reasonable and within the ability of Port Said residents to pay.

Among bases for this judgment we note the following:

- Recently planned water improvements for a number of Middle Eastern and African cities are to be self-financed at rates equivalent to more than U.S. $0.30/cu m, for water service alone:

	U.S. $/cu m (1978)
Amman, Jordan	0.76(1)
Mombasa, Kenya	0.55(1)
Mogadishu, Somalia	0.48(1)
Taiz, Yemen	0.44(2)
Nairobi, Kenya	0.33(1)
Blantyre, Malawi	0.29(1)

Most of these rates far exceed the combined total of the water and wastewater charges proposed for Port Said (LE 0.10 + LE 0.10 = US $0.29).

- At present rates, water bills in the Taiz system amount to 2 to 4 percent of income. The proposed rate will increase this range to from 3 to 6 percent of income. Wastewater charges will be additional (65 to 85 percent of water charges).

- Information from the World Bank indicates that 5 percent of household income is commonly regarded by funding agencies as a reasonable maximum for water bills of the lowest income group in developing countries.

Proper wastewater collection and disposal is an essential service, fully as imported to public health as proper water supply. Failure to levy adequate charges is likely to result in a level of service below what the public wants and would willingly support.

Table 13.7 shows the impact of the proposed average wastewater charge on several existing industrial establishments in Port Said. Annual wastewater costs, based on present water consumption are compared with estimated current salary costs based on compensation figures in Table 13.8. (These figures are results of a survey of private sector business primarily in Cairo. No comparable results are available for Port Said in particular but the figures are likely to be applicable.) For almost all of the industries, wastewater bills would represent only a small fraction of operating costs. The exceptions are slaughtering and food processing operations with high water use and very small staffs.

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(1) DeAnne Julius, Project Economist, Department of Energy, Water and Telecommunication, IBRD, personal communication.

(2) Water and Wastewater Tariff Study, Taiz, Yemen, prepared for USAID, by Deloitte, Haskins and Sells, September 1977.

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13.3 ECONOMIC BENEFITS

For many types of infrastructure investment, particularly in transportation, economic benefits are both identifiable enough and sufficiently quantifiable so that user charges may be reduced or eliminated. This is not the case in Port Said. Reliance on general economic benefits to justify the investment and eventual recurrent costs would risk under-financing the water and wastewater systems.

The major types of general economic benefits which might be assigned to the WWFMP are enhancement of real estate values, increases in health-related industrial productivity and additional tourist earnings. Each of these benefits will be considered in the context of Port Said.

Real estate values are enhanced by location as well as by improvement in any aspect of the infrastructure (water and wastewater, electricity, transportation) and by environmental considerations such as clean air, quiet, or an attractive view and setting. A building supplied with water and wastewater services obviously has a higher value than a building without these advantages. In Port Said, where the WWFMP applies to the entire city, there is no relative advantage. Rent will be determined by the play of supply and demand for different types of real estate.

An additional consideration is that utilities are only one aspect of an infrastructure which is being upgraded in its entirety. Attributing a specific amount of increase in value to improved wastewater services, or to improved electrical supply, is not possible. Benefits which accrue to real estate values from utilities are "captured" by the utilities in the form of appropriate user charges on domestic and industrial users. To add economic benefits to user charges would therefore be double counting.

Improvement in utilities may lead to a reduction of work days lost due to water-related sickness. If the resulting increase in productivity were defined, it could possibly be captured by higher industrial user charges. However, a large share of the work force in Port Said is either self-employed in the formal sector or employed in service industries where productivity cannot be measured. Any effort, therefore, to ascribe economic benefits to increased output resulting from an improved wastewater system would be theoretical.

Additional tourist earnings would depend on many factors, of which proper wastewater disposal is only one. Again, attributing portions of benefits to specific infrastructure improvements would be quite arbitrary. There would also be major questions as to how the benefits should be "captured" for the support of specific infrastructure.

In sum, there appear to be no general benefits to the Egyptian economy which, in the absence of adequate user charges, would justify the proposed investment. By the same token, it is not likely that such general economic benefits could be found to justify priority investment in utilities for any other cities in Egypt.

13.4 ENVIRONMENTAL CONSIDERATIONS

General

Adequate wastewater collection and disposal is important in promoting industrial, commercial, and tourism activity.

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Benefits of expanding such activity presumably will be reflected in user charges. This section considers the more general environmental and health benefits of the recommended program of water system improvements, together with whatever adverse effects may be expected.

Benefits

Public Health - Records for Port Said show that the majority of parasitic diseases endemic to the study area are helminthic (parasitic worms). This indicates a strong relationship to improper sewage disposal. The most frequently reported reported parasitic disease are ascariasis and oxyuriasis. The infective stages occur in moist, humic, sandy soil. In Port Said this environment results where the inadequate collection system allows sewage to pond. By eliminating this environment, the proposed collection system will significantly reduce the potential for transmission of the parasites.

High rates of gastro-intestinal disorders exist in Port Said. Reported cases in 1977 were 2337. Implementation of the wastewater projects is expected to eliminate transmission of these diseases by preventing direct contact with sewage contaminated recreational waters.

Receiving Water Quality - Implementation of the proposed wastewater master plan would initiate long-term recovery of Lake Manzala and the Suez Canal from the adverse effects of the untreated discharges. Excessive bacterial levels in Lake Manzala, the Junction Canal and the Suez Canal would be eliminated.

Productivity

Nutrients associated with sewage (carbon, phosphorus and nitrogen) are now lost to Lake Manzala's biological community. The septic zone near the Mazrah discharge acts as a nutrient trap. Dissolved oxygen levels of near zero do not allow fish to take advantage of the high (cell counts of 77×10^6 per cubic meter) phytoplankton production. The proposed wastewater disposal facilities, discharging to waters with adequate dissolved oxygen, could increase production significantly in the fishery. The water quality and fishery impacts are discussed in detail in Volume 4, Receiving Water Studies.

Adverse Effects

Direct adverse effects of the wastewater system will be limited to the period of construction. For the land based construction these consist of disruption of traffic and possible temporary relocation of some commercial activities, as well as noise and dust associated with construction activities. These effects are temporary, and the city will return to normal following completion of the projects.

In addition there will be a localized degradation of water quality during construction of the outfall structures in Lake Manzala and the Suez Canal. This would have no significant effect on the fishery, since fish would merely avoid the areas during the period of construction and return at the completion of the activities.

Long-term indirect environmental effects must be expected from the development which the wastewater facilities would permit. Industrial development may be expected to bring air pollution problems and wastewater discharges which require specific controls. Development within the framework of the Port Said Master Plan should minimize potential long-term adverse effects.

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Compatability with Long Range Planning

Evaluation of the wastewater projects took into account long-term goals as presented in the PSMP including:

- development of a tourism zone;
- protection of existing recreational uses and resources;
- protection of the fisheries in Lake Manzala and the Mediterranean.

Of special interest to the development of the wastewater facilities is the planned expansion of tourist facilities. Construction of the proposed wastewater facilities is essential for the tourism plan to proceed. Without wastewater disposal, promoting use of new tourist facilities in Port Said would be extremely difficult.

The Receiving Water Studies, included as Volume 4 of this report, found that the proposed wastewater facilities would protect the recreational use of the Mediterranean beaches and would have no significant adverse effects on the fisheries. With the implementation of proper fishery management techniques, the productivity of the Lake Manzala fishery could increase substantially.

Other Environmental Considerations

The recommended projects require a considerable and irretrievable outlay of funds which will not be available for other potential beneficial projects. Other commitments of resources are primarily limited to construction materials, energy and a minor land commitment. The year 2000 energy requirements of the wastewater facilities would be 26,000 kilowatt hours per day. Collection system construction will be in existing streets, in existing rights-of-way, or in proposed land reclamation areas. Approximately 15 hectares of land will be reclaimed from Lake Manzala for sludge drying beds. Other treatment facilities are located in existing sites.

Sewage sludge as a soils builder or low grade fertilizer is a valuable commodity. Presently this resource is being lost. By the year 2000 the wastewater treatment facilities will recover up to 48 tons/day of sludge for agricultural utilization or for use in fish culture operations.

13.5 CONCLUSION

Although the benefits cannot be quantified, the necessity for proper wastewater collection and disposal is beyond question. The benefits accrue locally rather than to the country as a whole. Hence the system costs should ultimately be borne locally. The benefits can be "captured" for support of the system through a system of user charges. The charges required for proper support of the system would be over five times those presently imposed for water service.

Users of the system should be made aware of the impact of water use on wastewater costs and should be discouraged from waste. There are major obstacles to such awareness in a system where most households do not pay individually metered water bills. Metering individual dwelling units appears neither practical nor cost effective, but adequate

rates for water and wastewater service would at least impress the need for water conservation on those responsible for paying the bills for particular connections. These people in turn could be expected to promote proper maintenance of fixtures and wiser use by the ultimate consumers.

TABLE 13.1

PLANNED PUBLIC INVESTMENT 1978 - 1982

(LE Million)

	Total Investment	Annual Average	%
Total	10,175(1)	2,035	100
Agriculture	396	79	4
Irrigation & Drainage	483	96	5
Industry	2,413	483	24
Petroleum	562	112	5
Electricity	924	185	9
Construction	214	43	2
Transportation & Communication	2,307	461	23
Suez Canal	475	95	5
Commerce & Finance	226	45	2
Housing	585	117	6
Utilities	623(2)	125	6
Services	978	195	9

(1) Foreign exchange component calculated at incentive rate would add LE 3,057 million to total cost.

(2) LE 902 million if adjusted to 1978 price levels with foreign exchange component calculated at the incentive rate.

Source: World Bank, Economic Management in a Period of Transition, Vol. 1, Table 5-4. At 1977 prices.

TABLE 13.2

WATER AND WASTEWATER EXPENDITURE REQUIREMENTS FORECAST
(Millions of 1976 LE)

Annual Expenditure	Total	Water	Sewerage
1976	81	52	29
1977	83	49	34
1978	78	46	32
1979	72	38	34
1980	53	31	22
1981-1985	109	59	50
1986-2000	127	63	64

Source: WHO/World Bank Cooperative Program, Water Supply and Sewerage Sector Study, June 1977, Vol. 2, p. 77. (Assumed 1977 purchasing power)

TABLE 13.3

TOTAL WATER AND WASTEWATER EXPENDITURE REQUIREMENTS FORECAST, 1976-2000
(Millions of 1976 LE)

	Total	%	Water	Sewerage
Total	2,824	100	1,461	1,363
Rural Projects	455	17	455	-
Cairo	1,030	36	308	722
Alexandria	314	11	237	77
Other Cities	1,025	36	461	564

Source: WHO/World Bank, Vol. 2, p. 77. Error in original text corrected.

TABLE 13.4

PORT SAID POPULATION AND GROWTH COMPARED TO NATIONAL TRENDS

	Year		
	1980	1985	2000
Port Said Population as Percentage of:			
Total National Population	0.7%	0.8%	1.0%
Total National Urban Population	1.5%	1.6%	1.7%
Total National Urban Population excluding Cairo and Alexandria	3.5%	4.0%	4.1%

	Period	
	1980-1985	1986-2000
Port Said Population Growth as Percentage of:		
Total National Population	1.6%	1.5%
Total National Urban Population	1.8%	1.8%
Total National Urban Population excluding Cairo and Alexandria	4.2%	4.2%

TABLE 13.5

WATER CONSUMPTION FORECAST, PORT SAID

Consumer Category	1977 Million cu m/yr	1977 % Consumption	1982 Million cu m/yr	1982 % Consumption	2000 Million cu m/yr	2000 % Consumption
Domestic	17.7	68	23.1	64	52.3	62
High Water Use	5.8	22	7.8	22	21.9	26
Medium Water Use	7.8	30	10.2	28	20.8	25
Low Water Use	4.1	16	5.1	14	9.6	11
Industry/Tourism	4.4	16	7.2	21	18.5	22
General Industry	2.3	9	4.5	12	12.9	15
Shipyard	1.1	4	1.3	4	2.8	4
Tourism	0.3	1	0.5	2	1.2	1
Ships	0.4	1	0.5	2	1.1	1
Port	0.3	1	0.4	1	0.5	1
Institutional	2.8	11	3.5	9	8.9	11
Taps and Gardens	1.3	5	2.3	6	4.6	5
TOTAL*	26.2	100	36.1	100	84.3	100

*Metered consumption including wastage.

TABLE 13.6

PROJECTED WASTEWATER CHARGES(1) AS PERCENT OF ESTIMATED HOUSEHOLD INCOME

Domestic Water Use Class	1978			2000		
	Annual Income(2)	Annual Wastewater Charges		Annual Income(2)	Annual Wastewater Charges	
	LE (1978)	LE (1978)	% of Income	LE (1978)	LE (1978)	% of Income
Low	376-800	21	2.6-5.6	580-1150	24	2.1-4.2
Medium	800-1150	35	3.1-4.4	1150-1560	38	2.4-3.3
High	1150-4980	49	1.0-4.2	1560-6620	51	0.8-3.2

(1) Per household, based on unit charge of LE .100/cu m, water use as shown in Section 13.2, wastage of 40 lpcd, and average household size as given in PSMP, Vol. 3, p. 37.
(2) See Figure 13-A.

TABLE 13.7

INDUSTRY WASTEWATER COST AS PERCENT OF SALARY COST

	Water Use		Employees		Water Cost as % of Salary Cost
	cu m(1)	Cost (LE)(2)	No.	Salary (LE)(3)	
Portex/Thick Cover	84,376	8,438	1,400	2,353,000	X
Slaughterhouse	52,252	5,225	27	45,360	12
El Nasr Dehydration	44,507	4,451	150	252,000	2
Egyptian Milling	21,422	2,142	70	117,600	2
Canal Rope Co.	21,110	2,111	600	1,008,000	X
Edfina	17,904	1,790	140	235,000	1
El Nasr Salines	9,963	996	300	504,000	X
Ice Company	9,591	959	45	75,600	1
Defres "Fina"	9,092	909	200	336,000	X
Gereco Freezing Co.	9,076	908	15	25,200	4
Egyptian Tea Co.	7,773	777	250	420,000	X

(1) See Table 4.1.
(2) At rate of LE 0.100/cu m.
(3) LE 1,680/yr average salary, based on private industry compensation (Table 13.8).
X Less than 1%.

TABLE 13.8

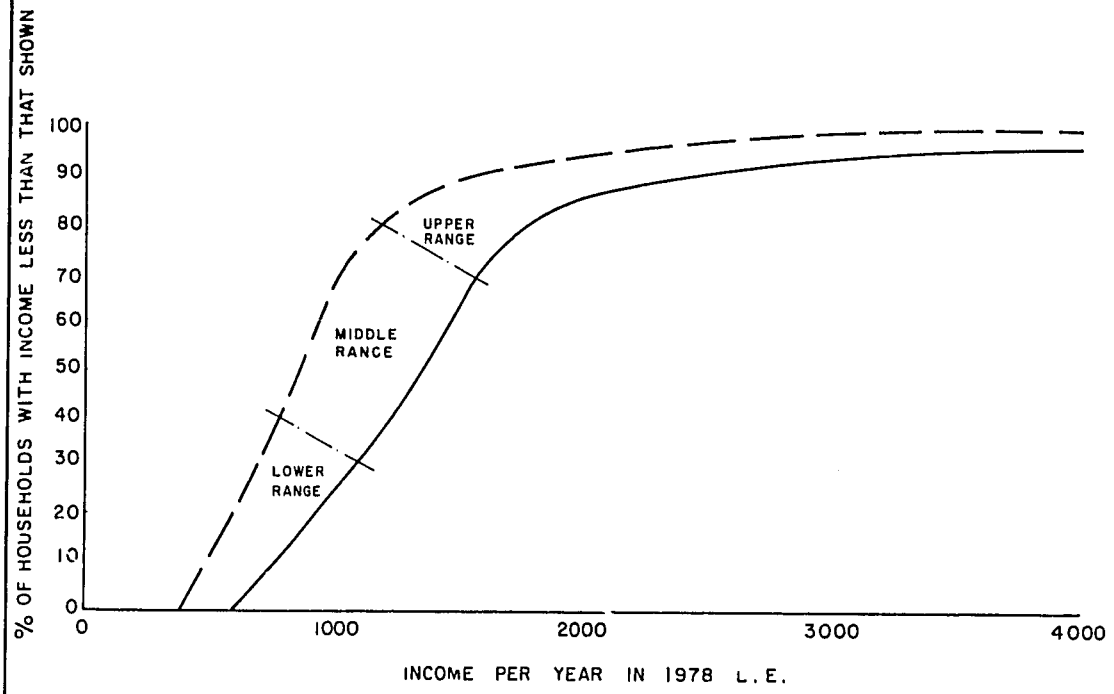
AVERAGE ANNUAL COMPENSATION IN PRIVATE SECTOR

CAIRO AREA

(LE)

	Salary	Plus Bonuses & Overtime	Plus Company Benefits
Categories			
Managers	4,416	5,244	6,636
Professionals	2,220	2,544	3,300
Skilled Clerical	3,156	3,648	4,644
Skilled Technical	1,716	2,160	2,688
Semi-Skilled Clerical	1,308	1,608	2,112
Semi-Skilled Technical	1,140	1,644	2,256
Unskilled	660	972	1,608
Positions			
Financial Mgr/Controller	5,214	5,542	7,397
Administration Manager	4,644	5,459	6,645
Sales Manager	6,342	6,905	7,833
Economist	3,970	4,269	4,510
Mechanical Engineer	3,078	4,147	5,374
Chemist	1,974	2,065	3,600
Accountant	2,232	2,533	2,905
Secretary	2,146	2,433	2,709
Skilled Draftsman	2,436	2,555	3,017
Skilled Electrician	1,770	2,332	3,097
Skilled Mechanic	1,236	1,359	2,695
Senior Salesperson	2,127	2,315	3,823
Clerk, General	1,413	1,513	1,990
Typist	1,378	1,531	1,863
Semi-Skilled Mechanic	882	1,600	2,356
Semi-Skilled Electrician	768	1,425	2,181
Factory/Lab Worker	576	665	1,394

Source: Copyright Middle East Advisory Group, Survey of Personnel Policies and Salary Levels, December 1978. Used by permission.



INCOME RANGE	1978		2000	
	% OF HOUSEHOLDS	INCOME LE / yr	% OF HOUSEHOLDS	INCOME LE / yr
UPPER	20	1150 - 4980	30	1560 - 6690
MIDDLE	40	800 - 1150	40	1150 - 1560
LOWER	40	376 - 800	30	580 - 1150

* ASSUMING UPPER INCOME RANGE DEFINED BY HIGH WATER USE LEVEL MIDDLE RANGE BY MEDIUM USE, ETC (PERCENT OF HOUSEHOLDS AT EACH WATER USE LEVEL IS THAT ASSUMED IN FORECASTING WATER DEMAND).

LEGEND:

— — — YEAR 1978

——— YEAR 2000

SOURCE : ADAPTED FROM PSMP VOL.4 TABLE 8, P 155.

ARAB REPUBLIC OF EGYPT

MINSTRY OF DEVELOPMENT AND NEW COMMUNITIES
ADVISORY COMMITTEE FOR RECONSTRUCTION

PORT SAID
WATER AND WASTEWATER FACILITIES MASTER PLAN

HAZEN AND SAWYER
ECG · ENGINEERING CONSULTANTS GROUP

INCOME DISTRIBUTION

VOL.3
FIG.
13-A

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APPENDIX A

DESIGN CRITERIA AND STANDARDS

A. SEWAGE COLLECTION SYSTEM

1. Sewers

Peak Flow Factors	See Chapter 4
Local Drainage Areas; Combined Force Mains Discharges from such areas.	3 times average daily flow for domestic, institutional and industrial flows
Gravity Interceptors serving Multiple Drainage Areas; Main Pump Stations fed by such interceptors.	2 times average daily flow for domestic, institutional and industrial flows
All Areas	Leakage, wastage and infiltration are considered base flows with a peaking factor of one
Minimum Diameter	175 mm (7 in)
Minimum Slope	To provide velocity of 0.6 m/s at minimum flows
Depth of Flow	0.8 of diameter at peak flow
Material of Construction	Up to 1000 mm diameter, vitrified clay pipe with hemp/mortar joints, concrete encased.* Greater than 1000 mm diameter, cast in place concrete pipe with brick lining.
Structural Loading	Safety factor of 2.5
Infiltration Allowance	
Existing Sewers	3000 lpd/cm (dia) - km (approx. 12 cu m/d/ha at present sewer density)
New Sewers	5000 lpd/cm (dia) - km (approx. .5 cu m/d/ha at proposed sewer density

*This is the present GOSSD standard practice. Acceptable, locally manufactured vitrified clay pipe with rubber gasket joints, if available at time of construction, would be preferable. At present the roundness tolerances of locally manufactured vitrified clay pipe are not adequate to insure tight sealing of gasket joints.

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Drop-type Manholes	Use where inlet sewer invert is 0.60 m or greater above manhole invert
Manholes	Located wherever a change of gradient, diameter or direction occurs and wherever a connection is made.
Manhole Spacing	
175 mm - 225 mm dia	30 m max. spacing
300 mm - 450 mm	45 m max. spacing
600 mm - 1000 mm	60 m max. spacing
larger than 1000 mm	90 m max. spacing
House Connections	100 mm dia, vitrified clay running from the edge of the building, where a concrete inspection chamber will be built, to the main collector sewer on the street.
Slope of House Connection	1-2% (preferably 2%)
Toxic & Deleterious Materials	Prohibit strong acids or bases, oils, grease and flammables from the sewer system

2. Pumping Stations

a) Capacity: The peak flow with the largest pump out of service. Stations of 600 cu m/hr capacity or higher have at least three pumps.

b) Wet Wells with side slopes to avoid depositions (45° side slope), 10 minutes detention at daily average flow and with maximum water surface below the influent sewer invert. Duplicate sets of screens, gates and grit traps. Detention time of 5 minutes at average daily flow is possible in screw lift stations due to inherent variable capacity of helical screw pumps.

c) Pumps: Constant speed: above 50 HP - dry pit type with motors housed in an above-ground superstructure. 50 HP and smaller - submersible. (Submersible pumps over 50 HP are not recommended because they are too large to discharge through flexible hoses and too heavy to be supported from discharge piping by quick-release couplings in the wet well. See Chapter 8 and Figure 8-E for design details.) Explosion-proof motors for helical screw pumps; electrical equipment located in separate room with no direct access to wet well/pump room.

d) Controls: Start/stop - manual or float actuated with manual alternation. Provide for portable flow measurement.

e) Manifolding: Individual suctions with shutoff valves and a common discharge manifold with check and shutoff valves in each manifold connection. Valved connection to the force main for portable emergency pumps. Valved-off insert point for portable flow meter on discharge force main of all stations not equipped with installed meter. Slide gates or stop logs in screw lift stations to isolate each pump.

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f) Emergency Power: Two independent sources of power plus a receptacle for connecting a portable generator.

g) Safety: Forced wet well ventilation, actuated upon operator entry, sized for 30 air changes per hour, and continuous ventilation in dry wells and motor rooms sized for 6 air changes per hour.

Provide access stairs and emergency exit ladders to both wet and dry wells (no stairs in small stations with submersible pumps). Locate completely separate emergency stop buttons at pumps, pump motors and screening stations, and lockouts on all pump controls.

3. Force Mains

a) Minimum Velocity - 1.0 m/sec

b) Maximum Friction Loss - 4 m/1000 m of pipe

c) Appurtenances - air releases at all high points, drains at all low points, and valved-off insert and removal points for pipeline pigs. The radius of all bends shall permit the use of pigs for line cleaning.

d) Materials of Construction

Mains 150 - 300 mm diameter	Locally manufactured asbestos cement
400 mm and above	Ductile iron, polyethylene lined, asphalt coated, imported from USA

e) Depth of Cover - 1.0 m minimum

B. SEWAGE TREATMENT

1. Degree of Treatment

Primary, determined from assessment of impact of alternative degrees of treatment, as shown in Chapter 6.

2. Plant Location Considerations

Existing facilities
Economy of collection and conveyance to disposal
Residential areas near the site
Topography of the site
Flooding, drainage
Prevailing winds
Access roads
Power facilities

3. Treatment Selection Considerations

Degree of treatment
Waste characteristics

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Utilization of existing facilities
Cost effectiveness
Operation and maintenance requirements

4. Design Flows and Loads

Domestic, industrial, commercial, institutional flows and loads (BOD and suspended solids) plus infiltration. Stage works up to those needed for year 2000 or 750,000 population where applicable.

a) Design Flows: For process detentions or hydraulic loadings: average daily flows.

For maximum hydraulic capacity: calculated peak flow as for sewers.

Any recirculation is to be added to the above flows.

b) Design Organic Loads: Average daily loads

5. Screening

a) Bar Screen Location: Ahead of grit chamber

b) Clear Openings Between Bars: Manually cleaned - 2.5 cm; mechanically cleaned - 2.0 cm.

c) Bar Size: 1.0 cm minimum

d) Velocity of Approach: Limit to 0.45 m/s @ peak, 0.15 m/s @ avg.

e) Velocity Through Screens: Calculate on the basis of the projected vertical opening of the screen relative to the flow cross sectional area.

Non-Mechanical Screens: Limit approximately 0.30 m/s
Mechanical Screens: Limit velocity to 0.75 m/s

f) Minimum Invert Drop at Screens: 0.1 m

g) Slope: Hand-cleaned screens - 30 to 45 degrees with the horizontal.

h) Drainage Area: Perforated slab at the top of the rack.

6. Grit Chambers

Design to remove 90 percent of all particles 0.15 mm in diameter (100 mesh) or larger.

Maximum overflow rate: 720 m/day at peak flow
Design velocity: 0.30 m/sec

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7. Primary Settling Tanks - Design flow

a) Overflow rates at design flow: 24 to 40 m/day

b) Minimum Depth: 2.5 m

c) Outlet Weirs: Adjustable; maximum hydraulic loading at design flow: 1000 cu m/day/m of weir.

d) Scum: Discharged with the sludge. Provide scum baffles ahead of the outlet weirs.

e) Sludge Hoppers: Minimum Wall Slopes

Mechanically cleaned: 1.7 vertical to 1.0 horizontal

Pyramidal: 1.7 horizontal to 1.0 vertical

Conical: 1.5 horizontal to 1.0 vertical

f) Total Suspended Solids Removal: Based on overflow rates. For estimating sludge production assume 60 percent removal at 25 m/day.

g) BOD Removal: Based on overflow rates. Assume 35 percent removal at 25 m/day.

h) Minimum Number of Tanks: 2

8. Drying Beds

a) Drying Bed Area Basis: Total daily sludge volume produced.

	Digested Sludge	Raw Sludge
Sludge application depth:	0.3 m	0.6 m*
Bed applications per year:	30	10
Equivalent application rate:	.0247 m/d	.0165 m/d

b) Embankments: Minimum height 0.3 m. Construction: concrete block, stone masonry or earth sodded with grass.

c) Underdrains: Minimum size: 100 mm
Minimum slope: 0.5 percent
Spacing: not more than 6.5 meters on centers

d) Gravel: Depth 25 cm minimum. Size: lower 15 cm, 35 to 40 mm; top 10 cm graded to support sand.

e) Sand: Depth - 0.3 to 0.4 m. Effective size (D_{10}) - 0.3 to 0.75 mm. Uniformity coefficient (D_{60}/D_{10}) - below 4.0.

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*0.2 m applied at four day intervals, left on bed about 30 days after last application.

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9. Sludge Conveyance

a) Minimum pipe size

Gravity:	200 mm
Pump Suction:	150 mm
Pump Discharge:	100 mm

b) Slope: Gravity discharge - 3.0 percent

c) Velocity: Minimum - 0.6 m/sec

C. ELECTRICAL

1. Reliability

a) Two independent sources of power for pumping stations critical to maintaining water supply.

b) Transfer switches or circuit breakers as required to avoid paralleling supply sources.

2. System Voltages

New Primary Feeders	11 KV
Feeders from SCA system	5.5 KV
Secondary	3.3 KV or 380V/220V

3. Motor and Lighting Voltages

Motors over 200 HP	3.3 KV
Motors up to 200 HP	380 V
Lighting, motors less than 2 HP	220 V (single phase)

4. Capacity

Adequate to limit voltage dips due to motor starting requirements, so that the motors will properly accelerate the driven machines and connected loads to rated speed.

System voltage dips and their time duration during start-up of large motors limited to acceptable values so as to prevent tripping of control relays, etc., and to avoid shutting off mercury lighting and other equipment susceptible to voltage dips of long time duration.

Capacity adequate to provide power for future requirements as described in the report.

5. Codes and Standards

Conform to the following codes and standards:

IEEE	Institute of Electrical and Electronic Engineers
IPCEA	International Power Cable Engineers Association
ANSI	American National Standards Institute

NEC	National Electrical Code (USA)
NEMA	National Electrical Manufacturers Association (USA)
IES	Illuminating Engineers Society

Operate at 50 hz and an ambient temperature of 44°C.

6. Power Distribution

11-KV, 3-phase, 3-wire underground electrical service cables will be used for high voltage distribution.

7. Branch Circuiting

a) 220-V single phase branch circuits for 2 HP and smaller.

b) 380-V, 3-phase circuits for 200 HP and smaller.

c) Lighting and general purpose convenience receptacles - 220-volts, 1-phase service.

d) Copper conductors for all installations except for underground 11-KV primary circuits which shall be aluminum.

e) Rigid galvanized steel conduits except conduits in hazardous and corrosive areas, which shall be rigid galvanized steel with extruded plastic covering.

8. Lighting

Fluorescent lighting fixtures for all interior building locations.

Mercury vapor lighting fixtures for all exterior lighting fixtures. Explosion proof construction and fixtures, complying with established standards, in hazardous and chlorine areas.

D. SOILS AND FOUNDATIONS

1. Footings

Structures can be found on spread footings or rafts bearing on the sand stratum beneath the surface clay. Foundation designs should limit differential settlement due to consolidation of the lower clay as follows:

Within structures	
Steel framed	2.5 cm
Concrete	1.25 cm
Between pipes and structures	5.0 cm

(Use flexible pipe connections into buildings to accommodate expected differential settlement.)

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2. Bearing Pressures

For the WWFMP - 1.0 kg/sq cm. In final design bearing pressure for each structure should be determined individually based on expected settlement in the lower clay. Adjacent structures should be adequately spaced so that resulting soil pressures from their overlapping loadings do not cause the structures to tilt excessively.

3. Pipelines in Reclamation Areas

Pipelines may be directly bedded in the sand fill provided at least 30 cm (or one quarter of the trench width if trench exceeds 1.2 m) of sand fill remain between the bottom of the pipe and top of the surface clay layer. Otherwise, the surface clay layer should be removed to its full depth within the trench limits, and replaced with clean compacted sand, in which the pipe can be bedded. If the surface clay layer is not removed, allowance must be made for expected settlement due to surface clay consolidation under the sand fill. This consolidation will be rapid but not uniform. Sewer lines should not be installed in the sand fill until this consolidation is 90 percent complete, as determined by on-site testing conducted by the engineer. See Table A-1 for estimated consolidation time. If scheduling requires earlier sewer construction, the underlying clay layer must be removed.

4. Dikes

Dikes to form lagoons or storage basins, or to provide access and pipeline corridors in areas of Lake Manzala, will be based on removal of the soft surface clay and end dumping of sand fill. Design will include conservative side slopes (1 on 2.5), rip rap protection against wave action, and allowance for settlement in the lower clay layer.

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TABLE A-1

ESTIMATED TIME FOR PRIMARY CONSOLIDATION OF SURFACE CLAY

Reclamation* Area	Approximate Mean Time for 90% Consolidation
8	2 mo
6	3 mo
1	1-1/4 yr
9	2 yr
3	1-3/4 yr
7	2-1/2 yr

*See Figure 1-B for locations.

Source: Golder Associates, Port Said Urban Land Reclamation Design Study, Final Report, Volume 4, p. 104.

APPENDIX B

BASIS FOR CAPITAL COST ESTIMATES

A. INTRODUCTION

This Appendix establishes the basis for estimating capital costs of wastewater projects in the WWFMP. Included are basic labor and material costs, unit construction costs, and cost curves for certain project elements. Costs are based on design approaches, materials, and construction methods considered most appropriate, practical and economical under local conditions.

Costs presented reflect anticipated commercial prices without import duties. The foreign exchange portion of costs identified herein refers to direct foreign expenses which are limited to:

1. Items directly imported for use in the project whether by governmental agencies or by contractors working for these agencies.

2. Expenditures outside Egypt of foreign contractor and consultant, including:

   a) salaries of expatriate personnel paid in foreign currency

   b) home office overhead, profit and financial charges

B. FACTORS AFFECTING COSTS

The physical and economic factors reviewed below must be taken into account in design, selection of materials and choice of construction methods and equipment.

1. Physical Factors

   - Climate - The coastal location requires above ground structures resistant to corrosive effects of sea spray. Warm climate, flat slopes and saline infiltration contribute to sulphide buildup in sewers, requiring use of acid resistant materials.

   - Soils - The soft layer of surface clay should be completely removed and replaced with sand where pipe inverts are in or closely above this layer (see Section D, "Soils and Foundations", in Appendix A). Foundations for all but the lightest structures must extend through the clay layer to the firm sand below.

   - Groundwater - The high water table (1 m depth) will require sheeting and pumping for all but the most shallow excavations. Well point costs should be allowed, but in detailed design other dewatering alternatives should be considered (see Chapter 11). Groundwater is mildly corrosive (200-800 mg/l sulphates) at depths where wastewater force mains will be installed. Hence pipes should be of corrosion resistant material completely and heavily coated. Acid resistant cement should be used for structures. Deeper groundwater may be severely corrosive (2000 mg/l sulphates), making it essential to use acid resistant sewer piping, such as vitrified clay.

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- Congestion - Pipeline costs must allow for difficulties of working in narrow, heavily traveled streets while also minimizing disruption to the city. Where space does not permit conventional stockpiling, pipe and excavated material will have to be kept in special retaining structures or stored off-site.

- Existing Utilities - Maps of buried water, sewer, electric and telephone lines are often inaccurate or unavailable. Construction costs must allow for hand excavation at locations and depths where existing utilities are likely to be found.

2. Economic Factors

- Contractor Capability - The large nationalized Egyptian contracting firms have the experience to carry out almost all aspects of possible projects. In addition, smaller firms are available for water and sewer line work. Planning will be based on likely need for foreign contractors to install automated electric controls and specialized process equipment.

- Labor - Many of Egypt's skilled and semi-skilled laborers, supervising personnel and technicians have been drawn to other Arab countries by high wages, leaving a shortage at home. On the other hand, unskilled construction labor is readily available. Escalating costs for needed skilled labor are expected to continue, giving incentive to construction methods intensive in use of unskilled labor.

- Quality of Work - Standards vary widely in Egypt. Cost premium likely to be needed to assure compliance with quality specifications.

- Customs Regulation - Exemption of project components from import duties is anticipated. Needless customs tie-ups must be avoided (see Section 5.6, "Capital Cost Estimates", in Chapter 5).

C. CONSTRUCTION MATERIAL SOURCES

Many of the basic materials required for civil works construction of water and wastewater facilities are manufactured in Egypt, but items such as cement, reinforcing bars and structural steel are in chronically short supply. Almost all mechanical and electrical equipment will have to be imported.

Table B-1 summarizes information on material sources and indicates those upon which facilities planning and costs were based. Prices for imported materials were based on U.S. sources except in the case of cement, reinforcing and structural steel, where current local market prices for imported materials were used. It is normal A.R.E. practice to supplement local production of these items with imports to meet current construction needs. The costing in the report allows for the possible need for the project to obtain these materials from the supplemental sources. Chapter 11 indicates the bulk portion of foreign exchange costs related to procurement of these materials and the added cost if they have to be procured from the U.S.

In view of the major sewerage programs being undertaken in almost all cities in Egypt, it is essential that local production of vitrified clay pipe be increased or that production of suitable substitute pipe be introduced to fill the gap in meeting needs.

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At the same time manufacturing tolerances should be reduced so that clay pipe can be supplied with tight sealing rubber or plastic joints. This would eliminate the need for encasing sewer lines in concrete, a costly present practice to minimize infiltration. Cost allowances cover continuation of this practice, but savings are possible if tolerances for local pipe can be narrowed (see Chapter 11).

D. DEVELOPMENT AND APPLICATION OF COST DATA

1. General

Cost data are presented in three forms: basic labor and material prices, unit costs for particular construction, and cost curves for major project elements related to size or capacity. Sources or derivations of all data are given below. Finally, allowances are stated on project cost components not covered by unit prices or cost curves. All prices contained in this Appendix are August, 1978 levels. U.S. Dollar costs have been converted to Egyptian Pounds at a rate of U.S. $1.00 = LE 0.70.

2. Basis for Cost Curves

a) Civil Works

1. All civil works were assumed to be constructed by Egyptian contractors.

2. The basic cost inputs of labor, materials and equipment were assembled to form unit construction rates, i.e., for trench excavation and reinforced concrete. Unit costs include an allowance of 40% for contractor's overhead and profit.

3. Derived unit rates were then integrated to calculate cost of major project components such as pipe lines and civil works for pumping stations.

b) Mechanical and Electrical Equipment

1. All mechanical and electrical equipment was assumed to be imported from the U.S.

2. Prices of imported equipment were obtained directly from U.S. suppliers through recent quotations.

3. Fifty percent of equipment costs was added to the supplier's quote for costs of shipping, insurance and export/import charges to Port Said. Customs duties and local taxes were not included.

4. Mechanical and electrical equipment contained in sewage pumping stations, except for electronic sensors, was assumed to be installed by an Egyptian contractor with supervision by the U.S. supplier.

5. Installation of mechanical and electrical equipment contained in treatment process units was assumed to be by a U.S. contractor with direct support by the U.S. supplier.

6. Installation cost of pumping station and process equipment was estimated at 50 percent of equipment price.

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c) None of the cost curves include engineering design, construction supervision, legal and administrative costs nor contingencies. Allowances for these are applied separately as shown in Table B-5.

3. Labor

Table B-2 indicates average wage rates for various types of construction workers. The rates include social security and reflect the contractor's cost of labor per eight-hour day.

4. Materials

a) Local: Prices of local construction materials were obtained from factory list prices, discussions with contractors, private and government engineers. These prices are shown in Table B-3 and include delivery from point of manufacture to Port Said.

b) Imported: Prices of imported materials shown in Table B-3 were obtained from a review of past tenders, generally from European sources. Customs duties and local taxes are not included.

5. Unit Costs

Table B-4 presents unit costs for appropriate items of work associated with proposed wastewater facility construction. These unit costs have been derived by applying a realistic productivity rate of local labor and equipment to their basic cost. These rates include contractor's overhead and profit of 40 percent.

The Foreign Exchange Component of gravity sewers is presented in Table B-6. This includes imported cement and reinforcing steel used in the encasement and in cast in place pipes. The percentage of Foreign Exchange is higher for shallow pipes, where little excavation is involved, and for large cast in place lines. Generally, this cost component decreases with depth, as excavation costs become a larger percentage of the unit price.

6. Construction Cost Curves

Wastewater facility construction envisioned by the Master Plan includes sewer lines, pumping stations and wastewater treatment plants. For purposes of economic evaluations and budget estimates, cost curves derived from unit cost data for each major component have been prepared. Derivation of the various curves is outlined below. It should be noted that allowances must be added to cover engineering design, construction supervision, legal, administrative and interest costs and contingencies.

a) Gravity Sewers: Figure B-1 shows total in-place cost per linear meter for depths to 7 m and sizes of sewer up to 1,500 mm diameter. For sewers above 1,000 mm diameter, in place cost is based on cast-in-place concrete with acid resistant brick lining. Total installed cost includes the following:

- trench excavation by hand
- furnishing, installing and removing wood sheeting
- dewatering by wellpoints

- laying, joining and testing pipe
- cost of local manufactured pipe delivered to construction site, or cast-in-place concrete pipe with brick lining
- pipe bedding and concrete encasement
- backfill and compaction with in situ material
- disposal of surplus excavated material
- contractor's overhead and profit.

Pavement resurfacing and select backfill are not included. Where necessary, the cost of these items should be added to the curve value. Common practice for gravity sewer construction in Port Said is to completely encase vitrified clay pipe in plain concrete. If this practice is discontinued, encasement cost should be deducted.

Costs of new building connections and new collector sewers in local drainage areas were calculated based on our estimates of the costs of systems shown for the New Community(1) and Industrial Estates(2) in the Port Said Demonstration Projects. Sewer depths were revised based on slope criteria in the WWFMP. The figures we developed are:

	Building Connections (LE)	Local Collectors (LE)
Residential/Institutional cost per added person in newly developed area	38.20	25.96
Industrial cost per gross hectare of new industrial area	1486	8354

These costs include project allowances, as outlined in Table B-5 and Section 8 below. The cost of removing soft surface clay and replacing with select backfill is not included.

b) Sewer Manholes: Standard drawings for manhole construction were obtained from GOSSD. The manholes are cast-in-place concrete of four basic shapes which vary in size according to depth. A construction cost curve is shown on Figure B-1. The curve is based upon the in-place cost of manholes versus depth to sewer invert and includes all work except dewatering, which is accounted for in trench excavation.

c) Sewer Force Mains: Applicable cost curves for various diameter force mains are shown in Figure B-3. Force mains receiving sewage from pumping stations are assumed to be locally manufactured asbestos cement for 150 to 300 mm

(1) Shankland Cox Partnership et al, Port Said Demonstration Projects, Draft Final Report, New Community Project, February 1978.
(2) Ibid, Industrial Estate Project, February 1978.

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dia, and ductile iron pipe polyethylene lined and asphaltic coated for dia of 400 mm and greater. It is further assumed that sheeting and dewatering (except small amounts by some pumps) will not be necessary for pipe sizes up to 300 mm. For sizes greater than 300 mm, similar items of work to that indicated for gravity sewers (except concrete encasement) are included in the installed cost. The cost of ductile iron pipe including fittings is based upon US prices including freight, insurance and handling delivered to Port Said. Cost of asbestos cement pipe up to 300 mm diameter is the local manufacturer's price plus delivery cost to Port Said. An allowance of 10 percent per meter was assumed for fittings, valves and related appurtenances. The cost of removing soft surface clay is allowed for pipes greater than 400 mm dia. Smaller lines are assumed to be high enough above clay to avoid any problems.

d) Pumping Stations: Cost estimates for civil works of sewage pumping stations are based on design criteria in Appendix A and typical sections indicated on Figures 8-E, 8-F, 8-G, and B-2. Two types of pumping stations are considered. Stations up to 1,200 cu m/hr will be equipped with submersible pumps. Stations above 1,200 cu m/hr are the wet well/dry well type with centrifugal pumps or the screw pump type. All stations are designed to handle the peak flow with the largest pump out of service. No standby generating capacity has been included. Cost curves of pumping stations are shown on Figure B-2, which includes civil works construction cost versus capacity and the cost of mechanical and electrical equipment, including installation, versus both head and capacity. Installation costs are assumed as 50 percent of the U.S. equipment price.

e) Wastewater Treatment Facilities: Cost curves for various treatment process units are shown in Figure B-4. These curves show civil works and equipment plus installation costs.

All equipment is assumed to be imported from the US and installed by a US contractor. Civil works are assumed to be constructed by Egyptian contractors. Site preparation costs including demolition, earth moving and yard piping have not been included, nor has land acquisition costs. Appropriate values, depending on the site location and selection of process units, should be added to obtain the total cost of the treatment plant.

Cost-capacity relationships have been derived from our previous studies for other projects and from the following U.S. government publications:

- "Construction Costs for Municipal Wastewater Treatment Plants" 1973-77 EPA 430/9-/7-013 MCD 37.

- Water Pollution Abatement Technology: "Capabilities and Costs - Publicly Owned Treatment Works" PB250-690-03.

- "A Guide to the Selection of Cost-Effective Wastewater Treatment Systems" EPA 430/9-75-002 July 1975.

7. Land Costs

Construction cost estimates contained in this Appendix do not include acquisition of land or easement rights.

Most pipeline easements were assumed to be in public land or streets, involving no cost to projects. The costs of dikes specifically constructed to carry pipelines and the cost of project facility sites were based on the unit costs of creating new land, as given in the Golder Associates Report. These include the cost of mobilization and demobilization of dredges (LE 40,000 for a 12-inch dredge), disposal of surface clay (1.0 LE/cu m) and dredging and placement of sand fill. Where the sand fill is to be end dumped for dikes a cost of 3.5 LE/cu m was used. For land reclamation entirely with dredged sand (without removing the surface clay), an overall cost of 32,600 LE/ha was used.

8. Project Allowances

Table B-5 presents the estimated percentage allowances for contingencies, support and design related costs. These percentages are to be applied to the foreign plus local components of estimated costs for each project category. The total cost of project, therefore, will include the estimated local plus foreign costs and project allowance costs where applicable. The project allowance percentages were based on review of reports for other locations and on discussion with contractors.

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TABLE B-1

MATERIAL SOURCES

Item	Produced in Egypt	Comments	Source for Planning
Cement	X	Egyptian production does not meet present demands.	I
Sand & Aggregate	X	Most significant cost is for transportation.	E
Reinf. & Structural Steel	X	50% of finished and high tension steel is imported. Raw material is imported.	I
Pipe			
Clay - up to 1200 mm	X	Not suitable for tight sealing rubber or plastic joints; 6 to 7 mo predelivery notice required.	E
Asbestos Cement - up to 400 mm	X	Epoxy coating and lining not presently available but may be so in future if demand warrants.	E
Cast Iron - up to 400 mm	X	Imported pig iron; 6 mo predelivery notice required.	N
Ductile Iron	-		I
Valves - 200 mm	X	Quality reported uncertain.	E
200 mm	X		I
Small Pumps	X	Quality reported uncertain.	N
Machinery, Equip. & Electric	-		I

E = Egyptian
I = Imported
N = Not used in planning

TABLE B-2

LABOR COSTS

DAILY RATE (LE) AT PORT SAID[1]

August, 1978

Unskilled Laborer	2.5
Skilled Laborer	4.8
Carpenter	6.0
Brick Layer	7.2
Iron Worker	6.0
Plasterer	6.0
Concrete Finisher	7.8
Painter	5.6
Pipe Layer	7.2
Sheet Metal Worker	6.0
Electrician	7.2
Equipment Operator (Light)	6.0
Equipment Operator (Medium)	7.2
Equipment Operator (Heavy)	10.8
Truck Driver	7.2
Mechanic	6.2
Foreman	6.0
Guard	2.0

(1) Reflects contractor's cost of labor.

TABLE B-3

CONSTRUCTION MATERIAL COSTS

PORT SAID

August, 1978

Item	Unit	Price per Unit (LE)[1]
Sand	cu m	4
Aggregate	cu m	6
Bricks, Acid Resistant	1000	125
Plywood, Imported	cu m	200
Cement, Imported	ton	50
Reinforcing Steel, Imported	ton	265
Structural Steel, Imported	ton	330
Timber, Imported	cu m	180
Clay Pipe, Local Manufacturer		
Diameter, inch (mm)	1m (for all pipe below)	
7 (175)		1.9
9 (225)		2.2
10 (250)		2.9
12 (300)		4.3
15 (375)		6.6
18 (450)		12
20 (500)		14
24 (600)		19
30 (750)		43
36 (900)		63
40 (1000)		94
Ductile Iron Pipe[2] (Pressure, Imported)		
Diameter, mm		
200		-
300		-
400		57
600		101
900		193
1050		252
Asbestos Cement Pipe (Pressure, Local)		
Diameter, mm		
150		6
200		8
300		18

(1) Includes handling and transportation charges for delivery from place of manufacture to Port Said. Sewer pressure pipe prices include cost of couplings, fittings and related appurtenances.

(2) Polyethylene lined and asphaltic coated.

TABLE B-4

CONSTRUCTION UNIT COSTS

PORT SAID

August, 1978

	Unit	Price per Unit (LE)
Trench Excavation by hand		
Depth of trench, meters		
0-2	cu m	2.2
2-3	cu m	3.8
3-4	cu m	4.8
4-5	cu m	6.0
5-6	cu m	7.2
6-7	cu m	8.0
Trench Excavation by machine		
Depth of trench, meters		
0-2	cu m	1.8
2-3	cu m	3.0
3-4	cu m	4.0
4-5	cu m	5.0
5-6	cu m	6.0
Rock Excavation	cu m	12.0
Dewater trench by wellpoint	cu m	9.0
Dewater trench by sump pump	cu m	1.1
Furnish, install & remove wood sheeting	sq m	1.0
Bedding material	cu m	5.0
Trench, backfill & compaction	cu m	1.0
Pavement removal & replacement	sq m	7.5
Dispose of surplus excavation to 10 km	cu m	3.0
Sewer pipe laying & testing	1m/ 100 mm dia	0.8
Reinforced concrete walls, beams and floors above grade	cu m	135
Reinforced concrete foundations	cu m	90
Plain concrete, no formwork	cu m	30
Hydraulic fill by dredging, up to 3 km	cu m	1.80
Rock slope protection	cu m	13
Filter blanket	cu m	11

TABLE B-5

PROJECT COST ALLOWANCES

1. Contingencies

Percentages applied to total cost estimates by category:

	Percent
a) Capital Construction Projects	20
b) Equipment Procurement	5
c) Procurement of Services	-
d) Local Measures	-

2. Other Cost Allowances

Percentages applied to total cost estimates (without contingencies) to cover support and design related categories shown below:

	Capital Construction Projects %	Equipment Procurement %	Procurement of Services %
a) Engineering	9	5	5
b) Legal and Administrative	5	8	8
c) Construction Supervision	10	4	-
d) Cost of Money	7.5	-	-
TOTAL	31.5	17	13

No allowance is needed for "local measures" projects.

3. Foreign/Local Division of Cost Allowances

	Capital Construction Projects %		Secondary Distribution & Service Connections %		Equipment Procurement %		Procurement of Services %	
	Foreign	Local	Foreign	Local	Foreign	Local	Foreign	Local
a) Engineering	5	4	2	4	4	1	4	1
b) Legal and Administrative	-	5	-	3.5	-	8	-	8
c) Construction Supervision	6	4	3	4	2	2	-	-
d) Cost of Money	-	7.5	-	7.5	-	-	-	-
Percent of Total Cost	11	20.5	5	19	6	11	4	9

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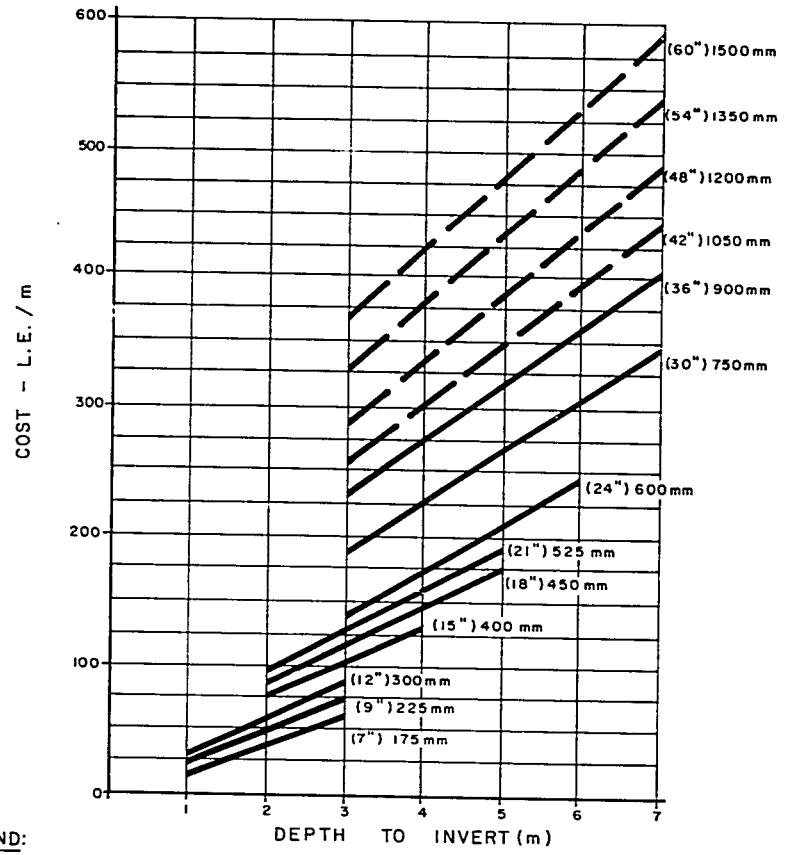
TABLE B-6

FOREIGN EXCHANGE COMPONENT

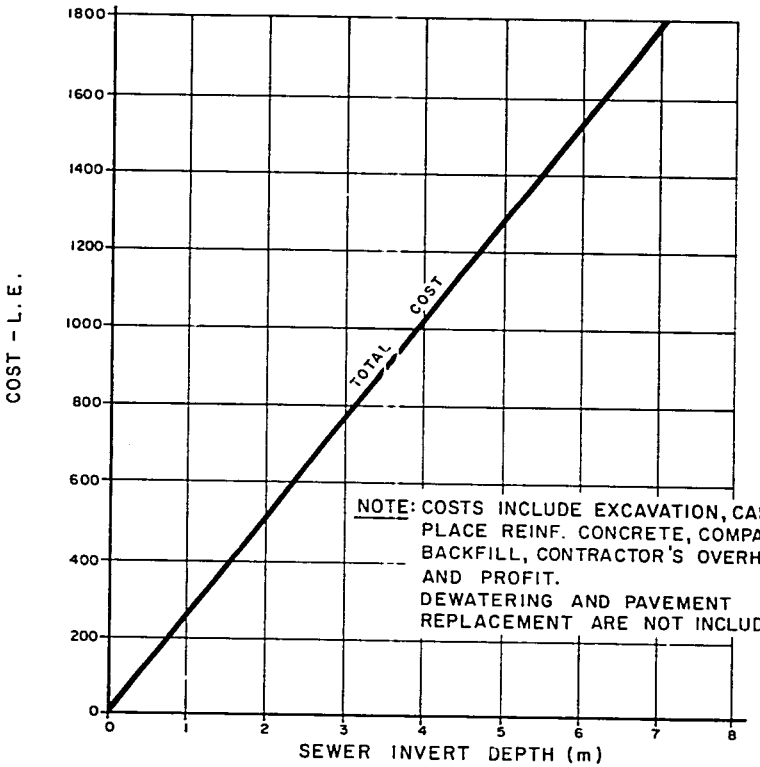
GRAVITY SEWER (FIG. B-1)

Pipe Size (mm)	Invert Depth (m) 1	2	3	4	5	6	7
	Foreign Exchange Component Percent of Total Cost						
225	27	17	8	-	-	-	-
300	27	18	9	-	-	-	-
375	13	10	7	-	-	-	-
450	-	14	12	10	7	-	-
525	-	15	13	10	8	-	-
600	-	-	13	11	9	7	-
750	-	-	12	11	10	9	7
900	-	-	12	11	10	8	6
1050	-	-	25	23	20	17	14
1200	-	-	26	24	21	18	15
1350	-	-	27	25	22	19	16
1500	-	-	27	25	23	20	17

GRAVITY SEWER



SEWER MANHOLE



NOTE: COSTS INCLUDE EXCAVATION, CAST IN PLACE REINF. CONCRETE, COMPACTED BACKFILL, CONTRACTOR'S OVERHEAD AND PROFIT.
DEWATERING AND PAVEMENT REPLACEMENT ARE NOT INCLUDED.

LEGEND:

- CAST IN PLACE CONCRETE WITH ACID RESISTANT BRICK LINING.
- VITRIFIED CLAY PIPE LOCAL MANUFACTURE.

NOTE: COSTS INCLUDE EXCAVATION, DEWATERING, SHEETING, INSTALLATION, MATERIALS, BACKFILL, CONTRACTOR'S OVERHEAD AND PROFIT. DOES NOT INCLUDE PAVEMENT REMOVAL AND REPLACEMENT NOR OVEREXCAVATION OF UNSUITABLE MATERIAL AND IMPORTED BACKFILL.

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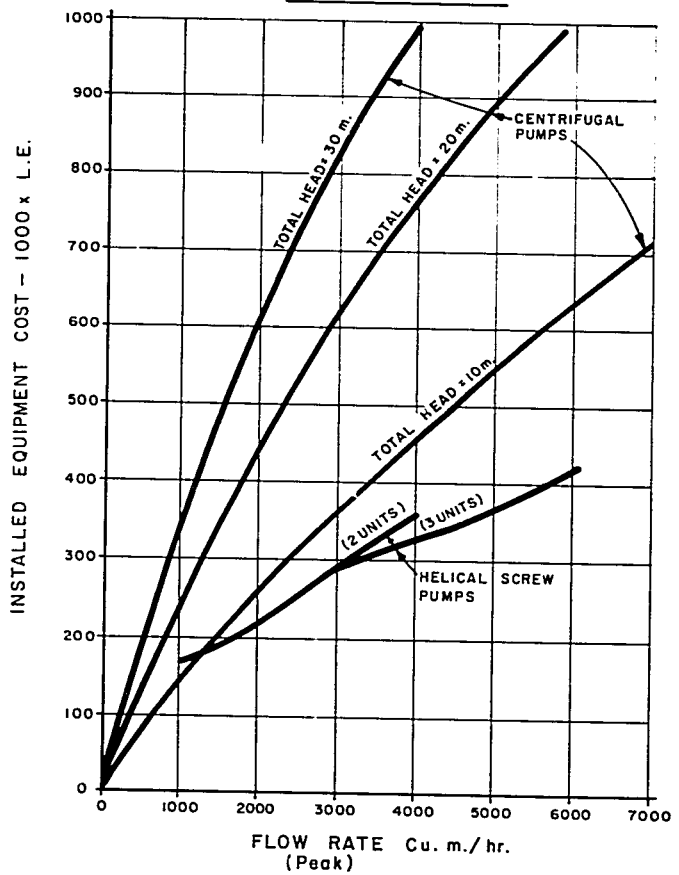
PORT SAID
WATER AND WASTEWATER FACILITIES MASTER PLAN

GRAVITY SEWER AND SEWER MANHOLE

VOL.3 FIG. B-1

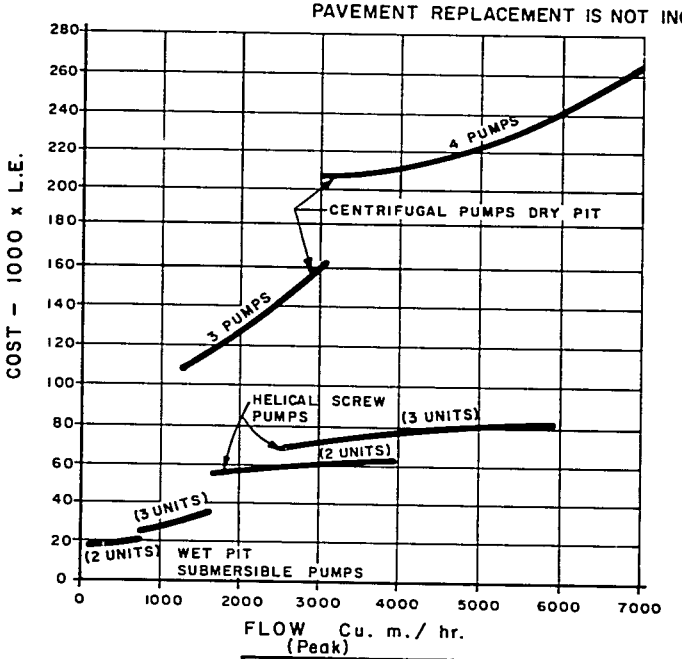
EQUIPMENT COST



NOTE: TOTAL COSTS INCLUDE OPERATING PLUS STANDBY PUMPS, PIPING, VALVES, HOISTING EQUIPMENT, ELECTRICAL AND INSTRUMENTATION EQUIPMENT, SCREENS, INCLUDING INSTALLATION COSTS AND CONTRACTORS OVERHEAD AND PROFIT.

CIVIL WORKS

NOTE: COSTS INCLUDE DEWATERING, EXCAVATION, REINF. CONCRETE METAL WORK, COMPACTED BACKFILL, CONTRACTORS OVERHEAD AND PROFIT.
PAVEMENT REPLACEMENT IS NOT INCLUDED.



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EQUIPMENT COST AND CIVIL WORKS SEWAGE PUMPING STATION

VOL.3 FIG. B-2

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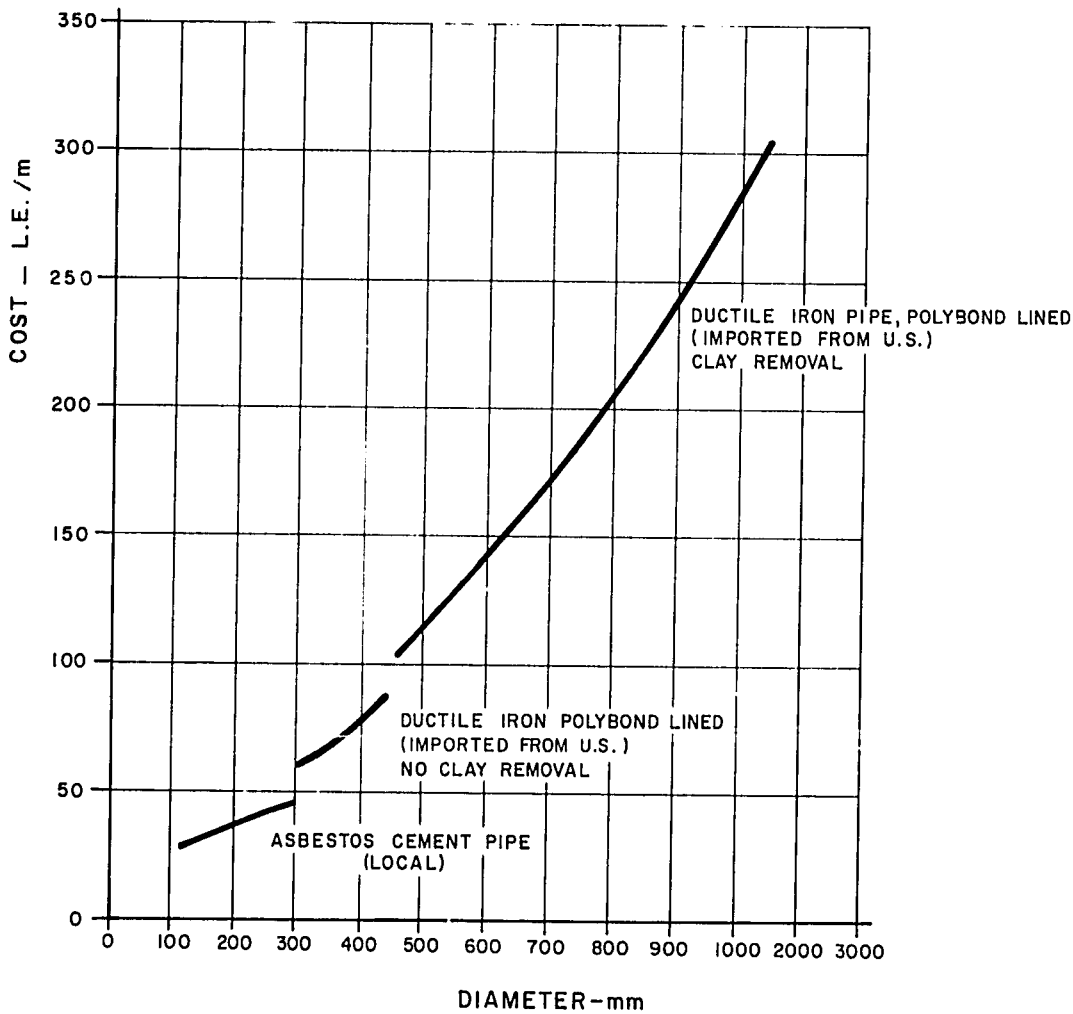
NOTE: COSTS INCLUDE HAND EXCAVATION, PIPE, RELATED FITTINGS, VALVES, AND OTHER APPURTENANCES, LAYING AND TESTING, COMPACTED BACKFILL, DISPOSAL OF EXCESS MATERIAL, CONTRACTOR'S OVERHEAD AND PROFIT. REMOVAL OF SURFACE CLAY AND REPLACEMENT WITH SELECT FILL FOR DIAMETERS GREATER THAN 400mm. WOODEN SHEETING & DEWATERING FOR PIPES GREATER THAN 300mm. PAVEMENT REPLACEMENT IS NOT INCLUDED.



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PORT SAID
WATER AND WASTEWATER FACILITIES MASTER PLAN

SEWER FORCE MAIN COSTS

VOL.3
FIG.
B-3

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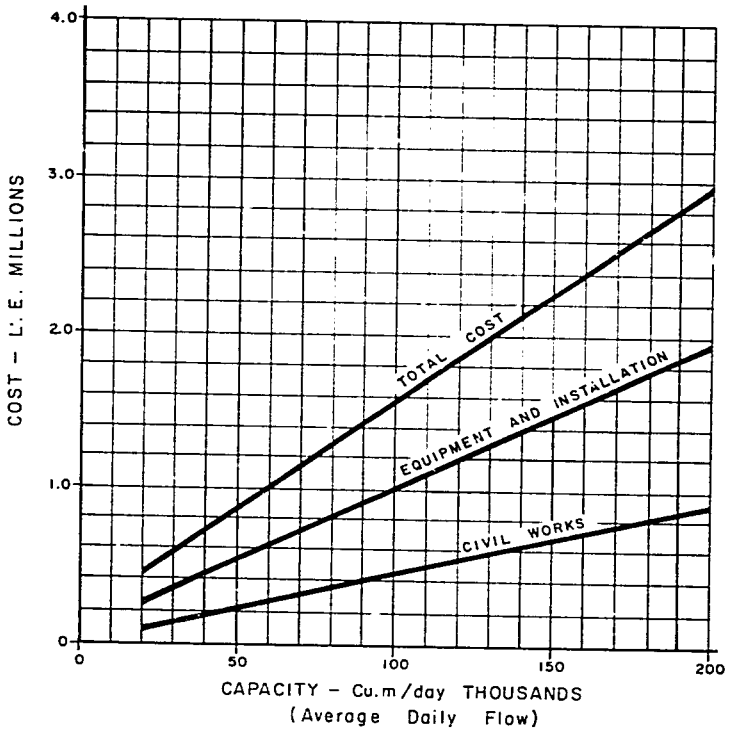
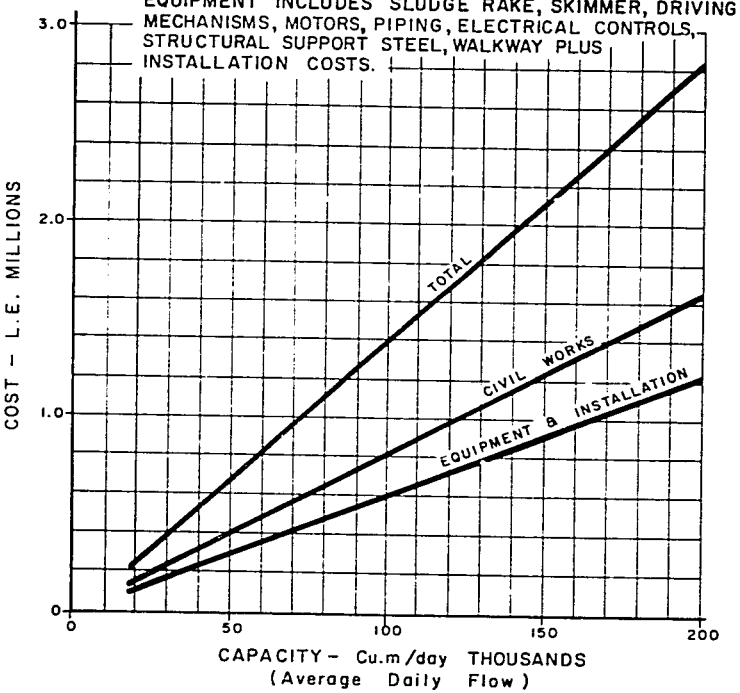
PRELIMINARY TREATMENT
SCREENING AND DEGRITTING



NOTE: CIVIL WORKS INCLUDE DEWATERING, EXCAVATING, BACKFILL, REINFORCED CONCRETE, MISC. METALWORK AND CONTRACTOR'S OVERHEAD AND PROFIT.
EQUIPMENT INCLUDES MECHANICALLY RAKED SCREENS, MOTORS, ELECTRICAL CONTROLS, PIPING, DEGRITTING UNIT PLUS INSTALLATION COSTS.

PRIMARY SEDIMENTATION

NOTE: CIVIL WORK INCLUDES SITE PREPARATION, FOUNDATION EXCAVATION, BACKFILL, REINFORCED CONCRETE TANK, MISC. METALWORK AND CONTRACTOR'S OVERHEAD AND PROFIT.
EQUIPMENT INCLUDES SLUDGE RAKE, SKIMMER, DRIVING MECHANISMS, MOTORS, PIPING, ELECTRICAL CONTROLS, STRUCTURAL SUPPORT STEEL, WALKWAY PLUS INSTALLATION COSTS.



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PRELIMINARY TREATMENT SCREENING AND DEGRITTING AND PRIMARY SEDIMENTATION

VOL.3 FIG. B-4

APPENDIX C

SOLID WASTE COLLECTION AND DISPOSAL

A. EXISTING SITUATION

Recognizing solid waste collection and disposal as a major problem in Port Said, the GOPS commissioned Promoservice International to review current practices and make recommendations. The study considered current collection, disposal practices, waste composition and production, as summarized in this section.

1. Collection

Port Said is divided into eight zones for refuse collection. In the El Shark (Orient) and El Arab zones, collection is door-to-door by private collectors with donkey carts. Costs for collection are paid by the individual customer. The remaining six zones (El Manak, Horyea El Nasr, El Chaff (beach), Kuwait, Port Fouad, and the Market Area) are subdivided into 25 sections. Refuse from these areas is collected and dumped at intermediate sites for transport to the landfills. Pickup at the intermediate sites often takes several days, creating conditions suitable for propagation of insect disease vectors such as flies and mosquitoes. Approximately 342 people are employed in solid waste collection in Port Said and 43 in Port Fouad.

2. Characteristics of Solid Waste

The estimated daily production of solid waste in Port Said totals approximately 173 t, tabulated as follows:

Zone	t/d	cu m/d
El Shark	31.5	105
El Arab	36.0	120
El Manakh	18.0	60
Horyea El Nasr	18.9	63
El Chaff (beach)	5	16
Kuwait	4	14
Port Fouad	18.6	60
Market Area	17	80
Misc.	24	80
TOTAL	173	598

The collected waste is primarily fermentable material (62 percent). The remainder is: 9 percent fines (sand mixed with refuse), 19 percent inflammables and 10 percent inert substances. The average density of the collected wastes is 0.31 t/cu m.

The high percentage of fermentables is significant in terms of potential leaching from the disposal sites to Lake Manzala and resulting water quality degradation.

3. Disposal

Disposal of solid waste occurs generally at three landfill sites: (1) on the western shore of the Interior Canal; 2) near the Kabbutti fishing village on the northern shore of Lake Manzala; 3) in Port Fouad. Use of vacant lots as interim and sometimes permanent disposal sites also appears to be common practice.

4. Observations

From the Promoservice report and our own observations, current solid waste collection and disposal practices are inefficient and adversely affect general urban environmental quality in Port Said.

B. RECOMMENDATIONS

If considerable resources are to be committed to removing the public health hazards of pooled sewage in the streets and raw discharge to Lake Manzala, it seems inappropriate to allow the public health hazards of improper solid waste disposal to continue.

In addition, the question of the potential use of solid waste in sludge processing (composting) should be addressed, particularly because of the anticipated value of the processed sludge to agricultural concerns (see Section 6.3).

We therefore propose that a further solid waste study be authorized in connection with design of High Priority wastewater facilities. Objectives of this study would be:

1. Review Promoservice International study and recommendations.

2. Recommend modifications to insure compatibility with water and wastewater planning.

3. Establish costs, resource requirements, organizational and staffing needs for suggested modifications.

4. Prepare preliminary plans for recommended modifications.

5. Determine the public health and water quality impacts of current and future solid waste collection and disposal practices as related to goals of the wastewater planning effort.

6. Define what public health problems in Port Said and water quality problems in northern Lake Manzala are attributable to solid waste disposal practices.

The study should be budgeted for an added engineering effort of 12 man-months and would be completed in 4 months from the time authorized. Total cost is estimated at LE 55,000, of which LE 40,000 would be foreign cost and LE 15,000 local cost.

APPENDIX D

SURFACE WATER DRAINAGE

A. ANALYSIS OF EXISTING CONDITIONS

Observations of existing arrangements for storm water removal indicate that drainage is inadequate for the runoff from winter rains which occur in Port Said. Storm water entering sewers through storm drain connections overwhelms the wastewater collection system during rainy periods, while surface drainage tends to collect in many areas of the city. These problems require corrective measures to reduce instances of flooding in low lying areas and sewage overflows due to debris/runoff entering through storm water inlets.

Sealing of storm water inlets is recommended to limit overflows of wastewater. This will in turn increase rainwater quantities to be removed, but will eliminate hazards from flooding of streets with raw sewage. Collection of information necessary for storm drainage design is required as an initial program, including rainfall data collection for at least two years duration. Following this period, detailed planning and design of the storm drainage system can take place.

Available rainfall statistics for the Port Said area are shown in Table I.I. These data, limited to observed daily amounts over a relatively short period of record, do not adequately describe historic rainfall events. Rainfall intensity and duration data are needed to provide a sound basis for technical and economic evaluation of any proposed drainage system.

The PSMP consultants, in a preliminary evaluation of a drainage system for the New Community Demonstration Project, transposed rainfall statistics from other similar climatalogical regions. This is a well-established method which involved modifying selected hydrometeorological data to account for area differences such as elevation, latitude, distance from moisture source, storm shape and direction. However, without any local data to corroborate these transpositions, this method may not produce reasonable drainage design criteria.

The PSMP consultant has suggested that a surface drainage system for the proposed New Community Area should be incorporated in community infrastructure planning. For proposed rehabilitated areas such as El Arab, they suggest that existing storm water inlets be blocked so that the existing combined system be converted to handle only sewage flow.

We agree with both concepts. The construction cost of a separate underground system for storm water, requiring collection lines and pumping stations similar to sewers, would be prohibitive. For example, an average cost in proposed residential areas for sewers (including pumping stations) is about LE 30,000/ha. An underground drainage system, even if designed for relatively frequent run-off (mean annual), would have to be capable of conveying peak flows 5 to 10 times that of sewage peak flows. The cost of piping and pump stations required to handle peak storm water flows would be considerably higher than the cost of sewers.

In existing development, provisions for carrying and pumping storm flows, in connection with retention of existing storm drain connections to the sanitary system, again

would be cost-prohibitive because of costs imposed for larger sewer lines, pumping stations, treatment facilities, and/or by-passes. Except for certain critical areas which may be subject to property damage, all existing storm water inlet and catch basins should be blocked to allow the existing system to function solely for sewage transport. Drainage of critical areas, along with its cost effect on the sewerage system, would be evaluated during the field and rainfall data collection phase of the comprehensive drainage plan.

The lack of detailed data on storm characteristics suggests an immediate need for establishment of a network of recording rainfall gauges placed at representative locations throughout the city. Detailed drainage system design should be deferred until at least a few years of necessary rainfall data can be collected.

This is not to suggest that nothing be done until supporting rainfall data is collected and evaluated. Preparation of a comprehensive drainage plan can be undertaken simultaneously with data collection. For example, in conjunction with the on-going photogrammetric mapping of Port Said, additional field topographic surveys will be necessary to locate existing drainage inlets; identify areas subject to flooding; and define drainage patterns. Tasks necessary for preparation of a comprehensive drainage plan are outlined in Section B of this Appendix.

Until implementation of a drainage plan, it is recognized that there may be occasional inconveniences to residents if inlets are blocked. But it is believed that these potential inconveniences would be largely overcome by such factors as:

- Considerable reduction of sand, debris, trash from entering the sewage system which impedes sewage flow and increases maintenance costs;
- Elimination of sewage backups and overflows during periods of storm runoff which pose a critical health hazard;
- Overloading of treatment process units whereby short-circuiting may occur.

In summary we recommend that the following actions be implemented immediately:

- Install continuous recording rain gauges;
- Initiate a program designed to convert the existing combined underground drainage system to handle sewage flow only;
- Prepare a comprehensive stormwater drainage plan as generally outlined on the following pages.

B. GENERAL OUTLINE OF SCOPE OF WORK FOR COMPREHENSIVE STORM WATER DRAINAGE PLAN

The objective of the Drainage Plan is to establish a program for staged development of Port Said's drainage facilities within the Project Area through the year 2000.

Planning should be undertaken in two phases:

Phase I

This phase consists of all surveys, data collection, investigation and studies necessary to achieve a firm basis for drainage facility evaluations and design. Such tasks include, but are not limited to, the following:

1. Install continuous recording rain gauges at:

   - Water treatment plant
   - Sewage treatment plant
   - Selected site in Port Fouad
   - Port Said weather station

2. Prepare detailed maps of project area.

   a) Prepare drainage topographic sheets in conjunction with on-going photogrammetric mapping of Port Said.

   b) Conduct field topographic surveys to:

      - Determine location and elevation of existing drainage inlets and other drainage improvements.
      - Define drainage patterns and flow directions.
      - Delineate critical areas likely to incur damage and/or unacceptable inconvenience during periods of storm runoff.

   c) Obtain existing and future land use information to combine with topographic maps.

   d) Estimate runoff coefficients for various selected drainage sub-areas relative to soil type (infiltration), surface cover and surface storage.

3. Compile available rainfall and runoff information from:

   - Port Said weather station records
   - newspaper accounts
   - interviews with long time residents
   - other regions which are climatalogically similar to Port Said.

4. Investigate and make preliminary evaluations of:

   - known rainfall events relative to flooded areas

- actual or probable inconveniences and/or damages associated with past periods of runoff

- condition of existing storm water drainage inlets with respect to their rehabilitation in critical areas found in items 2b above.

Phase II

This phase consists of tasks necessary to develop, evaluate and compare alternative solutions and programs for immediate and long-term development of a storm drainage system within the Project Area. Typical tasks include, but are not limited to, the following:

1. Analyze recorded rainfall data obtained during Phase I in conjunction with past records and transposed data for preparation of depth-duration-frequency curves.

2. Conduct economic evaluations of damage caused by storms of varying severity.

3. Evaluate design storm frequencies for best level of protection versus drainage system cost. Select appropriate storm frequency.

4. Prepare comprehensive drainage plan:

   a) Perform hydrological calculations to determine design flows at selected locations.

   b) Evaluate alternative land and street grading, surface channel, pondage areas and other schemes to determine cost-effective solution of conveying and disposing of storm runoff in both existing and proposed developed areas.

   c) Conduct feasibility studies of the technical, financial and economic aspects of alternative schemes sufficient to permit a definite appraisal of the merits of a storm water drainage system relative to benefits and costs.

   d) Identify conceptual designs of selected drainage improvements in detail suitable for community development guidance and for renovation of drainage in existing development.

   e) Prepare reasonably accurate estimates of selected project quantities and associated costs.

   f) Prepare schedules showing staged drainage project construction according to area priorities.

   g) Describe methods of project implementation and sources of funding including organizational aspects.

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APPENDIX E

PRELIMINARY ANALYSIS OF SEWER SYSTEM REHABILITATION PROGRAM

A. EVALUATION OF EXISTING COLLECTION SYSTEM - GRAVITY COLLECTORS

1. Basic Information

Length of sewers - 105 km

Average diameter - 8 in

Pipe material - vitrified clay pipe

Joint type - rope and mortar

Age of sewer - 20 to greater than 50 years

Average depth of sewer - 1.5 m

Type of service connection - knock out to manhole

Manhole type - cast in place - circular

Manhole top - round cast iron, heavy

Average distance between manholes - 30 m

Pipe laid on concrete saddles and joints encased in mortar.

2. Observed Conditions

Surcharged - varies depending on pumping station activity and proximity to pumping station.

Large quantities of deposition varying between 1/4 to 1/2 of pipe dia based on probings of 150 manholes.

Continual clearing of blockages necessary.

Manhole steps are dangerous due to accumulation of sludge and corrosion.

Manholes inspected to the surcharge level were tight.

Inability of pumps to draw sewage levels below crown of sewer is related to pumping station design and capacity as much as or more than hydraulic capacity of sewers.

Soil conditions in most areas excavated near sewers showed sewers are either laid in a clayey sand or muck layer.

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B. POTENTIAL INFILTRATION SOURCES

1. Potential Infiltration Sources

Average length of sewer pipe = 1.5 m
105,000 m divide by 1.5 m/joint = 70,000 joints

Manholes spaced every 30 m
105,000 m divide by 30 m/manhole 3,500 manholes

Service connections = 12,000

Potential major breaks and deteriorated materials cannot be determined on a length basis.

2. Estimate of Percentage of Infiltration by Source

No physical inspection of sewers was possible nor was the quantity of infiltration under free flowing conditions determined due to the surcharged condition of the sewers. Therefore, all estimates are based on general experience with other systems.

Leaky joints - 40% of infiltration

Non-groutable leaks (crushed pipe, major longitudinal cracks, major offsets and manhole connection shears) - 20%

House connections - 15%

Faulty construction or deteriorated materials - 15%

Leaky manholes - 10%

3. Leakage Rates by Source

Rates are based on assumed average sewer depth of 1.5 m and groundwater depth of 1.0 m. Size of leaks is assumed to be that commonly found in old vitrified clay collection systems with similar soil conditions.

Leaky joints - 50% of joints at 7 lpm (liters per minute)
50% of joints at 4 lpm

Non-groutable leaks - 75% of leaks at 15 lpm
25% of leaks at 10 lpm

House connections - all at 4 lpm

Faulty construction or deteriorated materials at 15 lpm

Leaky manholes - 50% of manholes at 10 lpm
50% of manholes at 5 lpm

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4. Total Quantity of Infiltration to be Considered

Based on results of infiltration studies of similar systems in the U.S.:

An extremely high value would be twice the base flow.

A more probable value is 100% of the base flow.

Only about 80% of infiltration is expected to be identified by recommended inspection procedures. The remaining 20% consists of leaks too small to detect or in areas where access by television camera is impossible. These constitute the 3000 lpd/cm-dia-km allowance of infiltration allowed for in design.

40,000 cu m/d was therefore considered the largest quantity of infiltration that could enter the sewers once they are restored. Hence, 32,000 cu m/d is the highest amount of infiltration that could possible by removed.

5. Presumed Quantity of Infiltration by Source

a) Leaky joints: 40% of 32,000 = 12,000 cu m/d

High range 6,400 divide by 10 cu m/d =	640
Low range 6,400 divide by 5.7 cu m/d =	1120
Total number of leaky joints	1760

b) Non-groutable leaks: 20% of 32,000 = 6,400 cu m/d

High range 4,800 divide by 21 cu m/d =	220
Low range 1.600 divide by 14 cu m/d =	110
Total number of major sources	330

c) Service connections: 15% of 32,000 = 4,800 cu m/d

4,800 divide by 6 =	800
Total number of leaky service connections =	800

d) Faulty construction or deteriorated materials: 15% of 32,000 = 4,800 cu m/d

4,800 divide by 21 cu m/d =	220
Total number of occurrences =	220

e) Leaky manholes: 10% of 32,000 = 3,200 cu m/d

High range 1,600 divide by 14 =	110
Low Range 1,600 divide by 7 =	230
Total number of leaky manholes	340

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C. ESTIMATED COSTS OF REHABILITATION

1. Leaky Joints

Since cleaning and inspection is necessary to restore fully the hydraulic capacity of the collection system and to establish its physical condition, the costs associated with this normal component of rehabilitation program are not chargeable to joint repair. Therefore, the only costs considered here for repair of leaky joints are for the additional time and materials necessary to carry out actual grouting.

a) Estimated additional time necessary to grout joints:

Of the approximately 70,000 joints, an estimated 1,760 (or one out of 40) joints leak. On the average, a leaky joint will be repaired every 60 meters.

The time necessary to grout a joint can vary considerably. An estimated 45 minutes per joint will be necessary.

In estimating the time required to perform the inspection work, 100 meters per day was anticipated. Therefore, for estimating purposes, 2 joints per day will be encountered. To repair the joints will require approximately 20% more time required.

b) Estimated grouting costs:

The costs for internal inspection have been estimated at LE 327,000 (80% U.S. $).

These costs will be increased by 20% since all are time-related. Thus, the additional equipment and manpower costs are estimated at LE 61,000 (8% U.S.).

The cost of grout can vary considerably depending on the size of the joint leak and backfill material. The cost per joint has been estimated at LE 10/joint. Therefore, the cost of grout is LE 17,000 (100% U.S.).

Total cost of grouting is therefore LE 78,000 (85% U.S.).

c) Unit costs of grouting:

Cost per joint is LE 46 (85% U.S.).

Cost per cu m/d removed is LE 6.

2. Non-Groutable Leaks

It is anticipated that major leaks will be corrected by replacement of pipe and by repair of manhole connections.

For replacement of pipe, minimum number of meters to be replaced = 4.5 (three pipe sections). Maximum number of meters to be replaced = 9.

Costs of replacing pipe estimated at 1.5 times cost of installing new pipe. Based on cost of 8" pipe, this is LE 48/m.

Average cost of replacement = LE 300.

The cost of repairing manhole connections is extremely difficult to estimate due to the variety of conditions which can be encountered. It is assumed that the repair will consist of relaying the incoming and outgoing line since the source will be caused by a differential settlement between the manhole and sewer pipe. This will require the relaying of an estimated three lengths of sewer on each side of the manhole. The cost of this is LE 430.

The average cost of repairing a major leak is LE 375.

The unit cost of repairing a major leak is LE 19 per cu m/d removed.

3. Service Connections

If a service connection is found to leak by temporarily shutting off water to the building and observing flow from the connection, the entire service connection will be replaced.

The cost of replacing the service connection is based on a cost of LE 20/m and an average length of 10 m. The cost per connection is LE 200.

The unit cost of service connection replacement is LE 33 per cu m/d.

4. Faulty Construction or Deteriorated Materials

Limited to replacement of manholes or three lengths of sewer pipe.

Manhole replacement based on 2 m depth = LE 600 (1.5 times new construction cost).

Pipe replacement LE 430.

An average cost of LE 500 per source was used.

The unit cost for repairing leaks due to faulty construction or deteriorated materials is LE 23 per cu m/d.

5. Leaky Manholes

Repair limited to external grouting and internal plastering.

Grouting LE 50/vertical m (85% U.S.)

Plastering LE 20/vertical m

Assuming an average depth of 2 m, the cost will be LE 140/manhole.

The average limit cost of removing leaks from manholes = LE 15 per cu m/d.

6. Ranking and Magnitude of Rehabilitation Projects

To establish the priority for removing sources, the sources were ranked by cost per cu m of infiltration removed.

Leaky joints: LE 6 per cu m/d removed.

Leaky manholes: LE 15 per cu m/d removed.

Non-groutable leaks: LE 19 per cu m/d removed.

Faulty construction or deteriorated materials: LE 23 per cu m/d removed.

Service connections: LE 33 per cu m/d removed.

The overall costs of the potential rehabilitation program are as follows:

Source	Estimated Quantity(1) of Infiltration cu m/d	Cost to Remove (1978 LE)
Leaky joints	12,800	76,000
Leaky manholes	3,200	48,000
Non-groutable leaks(2)	6,400	122,000
Faulty construction or deteriorated materials	4,800	110,000
Service connections	4,800	160,000
TOTAL	32,000	516,000

(1) Detectable quantity only.
(2) Forecasting the occurrence and contribution of non-groutable sources is extremely tenuous.

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APPENDIX F

PROPOSED COLLECTION SYSTEM PROJECTS

A. GENERAL

This appendix details projects for improving and extending the collection systems in Port Said and Port Fouad. Projects do not include transport facilities to carry flow from major central collection points to treatment sites, nor local collector sewers and service connections in individual drainage areas.

B. PORT SAID

The recommended collection system (Chapter 4, Figure 4-D) includes projects under the High Priority, Immediate Phase and Staged Development Programs. All sewage flow in the southern portions of Port Said would be directed to a collection point located at the intersection of the Manzala and Junction Canals. A main pumping station would be constructed at this point to pump sewage to the treatment facilities. The size of this station and the routing of its force main depends on the treatment alternative selected.

Sewage from the two drainage areas west of the Manzala Canal would be pumped directly to Mazrah.

The recommended collection system in new areas makes extensive use of lift stations and large gravity sewers in the reclamation areas. It was determined in a preliminary evaluation of seven collection system alternatives that such a system was 20 to 25 percent less expensive to construct than one utilizing pump stations and long force mains. The major savings was in pumping equipment. Helical screw lift pumps were considered due to their many advantages in low head situations. These include mechanical simplicity, low operating speed, no valving, no wear rings or packing, wide operating range and the ability to run dry without damage.

Due to their simplicity of construction and equipment capital costs for lift stations are much lower than for pump stations. Lower power requirements and lack of piping and valving also reduce operating costs.

Savings were also realized in pipeline costs since only one or two large sewers would converge on the collection point rather than 6 or 8 force mains. The amount of parallel piping is greatly reduced, since gravity interceptors can serve several lift stations without causing the problems that common force mains produce for pump stations.

Since large interceptors can be built with capacity for future areas, the route of the main sewer needs only be disrupted by construction once. With parallel force mains following the same route, the area would be disrupted several times.

The work on the collection system is divided into three phases: High Priority, Immediate Phase and Staged Development. Each phases includes several projects which divide the work into logical segments by drainage area or major interceptor components. Most projects in the High Priority Phase involve major construction for which it will be difficult to complete design and bidding until 1980. Construction would run at least through 1981. In view of this extended schedule many of the Immediate Phase projects

will have to be constructed simultaneously with the High Priority Works. The Final Staged Development can be sequenced as required by urban development.

The project elements of the recommended collection system are outlined below and preliminary cost estimates summarized in the accompanying tables. Dates by which projects should be complete are shown in parentheses.

High Priority Works (see Table F-1)

Project A

1. Abandon existing pumping stations 1, 3, 4, and 6 and construct deep gravity sewers to convey sewage from these drainage areas to the site of existing pump station No. 4. The consolidated drainage area will now be known as area 2.

2. At the site of existing pump station No. 4 construct a new station to serve the consolidated drainage area 2. This station will consist of a 6-m diameter cassion approximately 8-m deep inside, equipped with 3 submersible pumps. It will discharge via a force main and gravity sewer to a new booster station located at the head of the Interior Canal near existing pump station No. 12.

3. Abandon existing pump stations 7, 11 and 12 and construct gravity sewers to convey the sewage from these areas to the new booster station. The consolidated drainage area will be known as area 4.

4. Construct a new booster pumping station at the head of the Interior Canal (at the site of the relief station now under construction). Due to the high capacity and head of this station it will be of the wet/dry well type, equipped with long shaft vertical pumps, and motors installed in a grade level motor room. The station will discharge via a 4.0 km long force main direct to the Mazrah treatment plant.

Project B

1. Rebuild existing station R-3 by converting the entire caisson into a wet well, installing submersible pumps, construction of a new electrical control building and installing a new screen chamber on the influent sewer. The new station would be known as No. 7.

2. Parallel the existing 350 mm force main with a second line the same size, consisting of new line plus usable sections of the line already installed to serve the relief station now under construction near existing station No. 12.

3. At the extreme western end of Kessra Street (intersection with Shari El Zafer) connect the two 350 mm lines to a new 500 mm line running west to the treatment plant. The abandoned portion of the 350 mm line will be utilized in Project C below.

Project C

1. Rebuild Station R-2 in the same manner as Station R-3 in Project B. The rebuilt station will be known as No. 6.

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2. Install a new 350 mm line north to Kessra Street and west to Shari El Zafer and connect it to the 350 mm line abandoned under Project B above. This line will operate in parallel with the existing 300 mm force main from this station to Mazrah.

Project D

1. Rebuild Station R-1 in the same manner as stations R-2 and R-3. The existing force main appears to be adequate. The rebuilt station will be known as No. 5.

Project E

1. Abandon existing pump station No. 2 and construct a gravity sewer to convey the sewage from this drainage area to the site of existing pump station No. 5. The consolidated drainage area will be known as area 1.

2. Replace existing station No. 5 with a new station consisting of a 6-m diameter caisson approximately 8-m deep, equipped with 3 submersible pumps. Convert the existing structure to serve as a screen chamber. This station will discharge via a new force main to the existing main pump station.

3. The greatly reduced load on the main pump station will allow it to be retained unchanged. The existing pumps may have to be throttled to operate properly under the reduced load. However, they are in good condition and should serve well for many years. This station and its drainage area will be known as No. 3.

Immediate Phase Works (see Table F-2)

Project A (1980)

1. Construct a new submersible type pump station in drainage area 9. The station would discharge via a force main crossing the Interior Canal in the existing causeway and then running south to the Junction Canal. This force main is to be built by GOSSD as part of a project now in progress.

2. Construct a gravity interceptor to serve drainage area 10. The sewer would start at a point west of the Portex factory and flow south to the Junction Canal.

3. Construct a 1200 mm dia. main sewer flowing westwards along the Junction Canal. This sewer would originate at the junction of the drainage area 10 sewer and the force main from Pumping Station No. 9 and flow west to the junction with the interceptor sewer from drainage areas 8 and 11.

Project B (1980)

1. Construct a new lift station in drainage area No. 8 (LS-8). The station would utilize helical screw pumps to lift sewage into a large interceptor.

2. Construct a 1050 mm sewer running south from LS-8 into drainage area 11. At the center of drainage area 11 provision would be made for the connection of two 750 mm collector sewers and the diameter of the interceptor increased to 1350 mm. This interceptor would flow south to the Junction Canal where it would joint the 1200 mm sewer from drainage areas 9, 10 and 12.

3. Construct an 1800 mm diameter sewer from the above junction to a main pumping station at the mouth of the Manzala Canal. The diameter of this sewer would allow for future flow from drainage areas 15 and 16.

Staged Development Phase Works (see Table F-3)

Project A (1985)

1. Construct a submersible type pump station in drainage area 12 to serve the Industrial Estate Demonstration Project.

2. Construct a 400 mm force main from this pump station to the 1200 mm interceptor sewer running along the Junction Canal.

Project B (1985)

1. Construct a helical screw lift station in drainage area 14. The station will discharge via a 1050 mm diameter sewer to Pumping Station No. 13.

2. Construct a wet/dry well type pumping station in drainage area 13. This station will serve area 13 and accept flow from area 14 and pump it to the Mazrah treatment site via a 750 mm force main.

Project C (1992)

1. Construct a helical screw lift station in drainage area 15. This station will discharge via a 1200 mm diameter sewer and a siphon under the Junction Canal to the 1800 mm diameter main sewer constructed under the Immediate Phase Works (Project B 3). This sewer would be capable of accepting future flows from drainage area 16.

Project D (1995)

1. Construct a helical screw lift station in drainage area 16. This station would discharge via a 1050 mm diameter sewer to LS-15. A siphon would be required under the canal separating drainage areas 15 and 16.

2. Install a third pump in lift station 15.

C. PORT FOUAD (see Table F-4)

Four alternative collection system layouts were evaluated for Port Fouad and the most economical layout chosen. All possible treatment and disposal alternatives for Port Fouad, would use this collection system layout.

As shown in Figure 4-D the Port Fouad collection system is divided into two drainage areas. Sewers are provided to intercept the five existing outfalls and convey the sewage to one of the two pumping stations.

Drainage area PF-1 would consist of the northern half of Port Fouad, including the SCA housing and the areas served by three of the existing outfalls. The pumping station would be located at the northern end of Main Street No. 15. It would consist of a 6-m diameter caisson, equipped with 3 submersible pumps. The station would discharge via a

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450 mm force main to a main sewer laid in Main Street No. 15 and flowing south to the second pumping station.

The southern half of Port Fouad, including the new housing areas in the southeast portion of the city would comprise Drainage Area PF-2. A main sewer laid in Main Street No. 15 and a major collector laid in a parallel street to the east would serve the presently unsewered areas and the new housing.

The pumping station serving PF-2 would also accept flow from PF-1 and would discharge to the treatment facility.

This pumping station and its force main would be considered a part of the transport system for Port Fouad.

Costs of these collection system improvements for Port Fouad were included under the Immediate Phase program.

D. DETERMINATION OF FOREIGN AND LOCAL COSTS

Total costs were divided into three categories: pipelines, equipment and structures. The method of estimating the foreign cost varied in each category.

Pipelines

The foreign cost of force mains was considered to include the cost of imported pipe and imported cement and reinforcing steel for encasements where required. The foreign cost of gravity sewers includes only the cost of imported cement and reinforcing for pipe encasement. This cost varies with the depth and size of pipe as tabulated in Appendix B.

Equipment

All equipment is imported and its cost is therefore foreign. Equipment installation estimated at 50% of purchase cost is considered entirely local.

Structures

The foreign cost of structures includes imported cement, reinforcing steel, structural steel, miscellaneous metal, fabricated doors and hatches, etc. The percentages vary from 10 percent for modification of existing structures up to 40 percent for new stations of the largest size (dry pit type).

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TABLE F-1

CONSTRUCTION COST - PORT SAID COLLECTION SYSTEM

HIGH PRIORITY WORKS
(Thousands of 1978 LE)

	Pipeline Costs	Equipment & Installation	Structures & Misc.	Total
Project A				
New PS-4	776	720	175	1,671
New PS-2	56	240	60	356
Interceptor Sewers from old areas 1	114	-	-	114
3	155	-	-	155
6	172	-	-	172
7	92	-	-	92
11	210	-	-	210
Subtotal				2,770
Contingencies (20%)				554
Support (31.5%)				873
TOTAL A				4,197
Project B				
Rebuild Station 7 (old R-3)	235	220	38	493
Contingencies (20%)				99
Support (31.5%)				155
TOTAL B				747
Project C				
Rebuild Station 6 (old R-2)	34	185	38	257
Contingencies (20%)				51
Support (31.5%)				81
TOTAL C				389
Project D				
Rebuild Station 5 (old R-1)	-	140	38	178
Contingencies (20%)				36
Support (31.5%)				56
TOTAL D				270
Project E				
New PS-1 (replaces old 5)	158	195	58	411
Interceptor Sewer	172	-	-	172
Subtotal				583
Contingencies (20%)				117
Support (31.5%)				184
TOTAL E				884
TOTAL CONSTRUCTION COST HIGH PRIORITY WORKS				6,487

TABLE F-2

CONSTRUCTION COST - PORT SAID COLLECTION SYSTEM

IMMEDIATE PHASE WORKS
(Thousands of 1978 LE)

Projects	Pipeline Costs	Equipment & Installation	Structures & Misc.	TOTAL
Project A (1980)				
PS-9	488	400	100	988
Interceptor Area 10	152	-	-	152
Main Sewer along Junction Canal	549	-	-	549
Subtotal				1,689
Contingencies (20%)				338
Support (31.5%)				532
TOTAL A				2,559
Project B (1980)				
LS-8	285	230	58	573
Interceptor Area 11	220	-	-	220
Main Sewer to Collection Point	435	-	-	435
Subtotal				1,288
Contingencies (20%)				246
Support (31.5%)				387
TOTAL B				1,861
Project C				
Kabbutti Public wc's	64	-	20	84
Contingencies (20%)				17
Support (31.5%)				26
TOTAL C				127
TOTAL CONSTRUCTION COST IMMEDIATE PHASE				4,547

TABLE F-3

CONSTRUCTION COST - PORT SAID COLLECTION SYSTEM

STAGED DEVELOPMENT PHASE WORKS
(Thousands of 1978 LE)

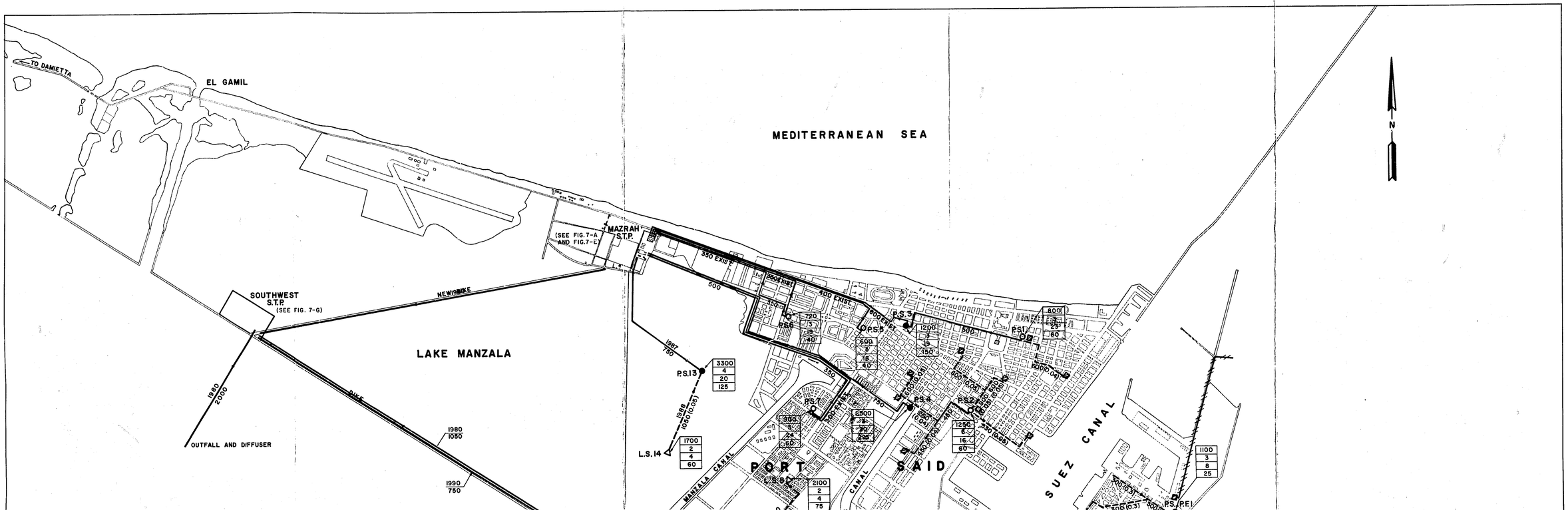
	Pipeline Costs	Equipment & Installation	Structures & Misc.	Total
Project A (1985)				
PS-12	79	110	50	239
Contingencies (20%)				48
Support (31.5%)				75
TOTAL A				362
Project B (1985)				
LS-15	221	205	56	482
PS-13	370	675	170	1,215
Subtotal				1,697
Contingencies (20%)				339
Support (31.5%)				535
TOTAL B				2,571
Project C (1992)				
LS-15	306	247	74	627
Contingencies (20%)				125
Support (31.5%)				198
TOTAL C				950
Project D (1995)				
LS-16	317	205	56	578
Install additional	-	58	-	58
Subtotal				636
Contingencies (20%)				127
Support (31.5%)				200
TOTAL D				963
TOTAL CONSTRUCTION COST FINAL PHASE				4,846

TABLE F-4

CONSTRUCTION COST - PORT FOUAD COLLECTION SYSTEM

IMMEDIATE PHASE WORKS
(Thousands of 1978 LE)

Project	Pipeline Costs	Equipment & Installation	Structures & Misc.	Total
Interceptor from NW outfall	14	-	-	14
Interceptor from west central outfall	107	-	-	107
Interceptor from SCA housing	6	-	-	6
Pump Station	39	150	45	234
Main Interceptor	208	-	-	208
Southwest Interceptor	83	-	-	83
Southeast Interceptor	174	-	-	174
Subtotal				826
Contingencies (20%)				165
Support (31.5%)				260
TOTAL IMMEDIATE PHASE PORT FOUAD				1,251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MEDITERRANEAN SEA
N
MAZRAH S.T.P.
(SEE FIG. 7-A AND FIG. 7-E)
350 EXIST.
400 EXIST.
500
SOUTHWEST S.T.P.
(SEE FIG. 7-G)
NEW 1980
LAKE MANZALA
1980 2000
OUTFALL AND DIFFUSER
1980 1050
1990 750
1987 700
P.S.13
3300
4
20
125
1988 1050 (0.05)
L.S.14
1700
2
4
60
MANZALA CANAL
PORT SAID
SUEZ CANAL
P.S.5
P.S.6
P.S.7
P.S.8
P.S.9
P.S.1
P.S.2
P.S.3
P.S.4
P.S.10
P.S.11
P.S.12
P.S.F.1
1100
3
8
25
2100
2
4
75
2500
2900
1250
16
60
800
23
60
1200
3
15
150
600
5
16
40
720
5
19
40
350
24
60

LEGEND

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

1987 — DATE CONSTRUCTED
750 — DIAMETER mm
FORCE MAIN

1988 — DATE CONSTRUCTED
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

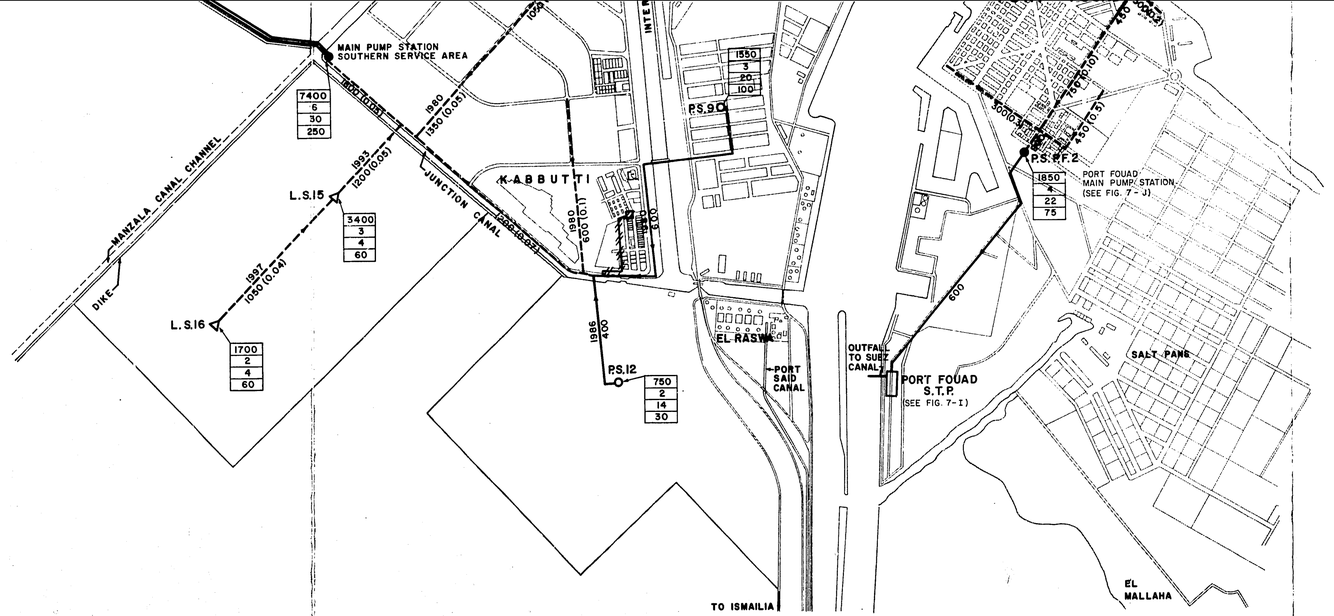
TO BE ABANDONED

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.



SCALE 1: 20,000
500 0 500 1000 METERS

PN-AAU 850
4074

Arab Republic of Egypt
MINISTRY OF DEVELOPMENT AND NEW COMMUNITIES
ADVISORY COMMITTEE FOR RECONSTRUCTION

PORT SAID
WATER AND WASTEWATER FACILITIES MASTER PLAN

STAGED DEVELOPMENT WASTEWATER COLLECTION SYSTEM ADDITIONS

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