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No. 2

FEASIBILITY STUDY ON SHARQIYA SEWERAGE SYSTEM IN THE ARAB REPUBLIC OF EGYPT

FINAL REPORT

VOLUME ONE SUMMARY REPORT

SEP. 1988

JAPAN INTERNATIONAL COOPERATION AGENCY

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PREFACE

In response to the request of the Government of the Arab Republic of Egypt, the Japanese Government decided to conduct the Feasibility Study on Sharqiya Sewerage System in the Arab Republic of Egypt and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Egypt a survey team headed by Mr. Heiichiro MAKINO of Tokyo Engineering Consultants Co., Ltd., comprising members of Tokyo Engineering Consultants Co., Ltd. and Nihon Suido Consultants Co., Ltd. from July to September, 1987 and January to March, 1988.

The team had discussions with the officials concerned of the Government of Egypt and the Governorate of Sharqiya, and conducted a field survey. After the team returned to Japan, further studies were made and the present report has been prepared.

I hope that this report will serve for the development of the project and contribute to the promotion of friendly relations between our two countries.

I wish to express my deep appreciation to the officials concerned of the Government of Egypt and the Governorate of Sharqiya for their close cooperation extended to the team.

September, 1988

Kensuke Yanagiya

Kensuke Yanagiya
President
Japan International Cooperation Agency

September, 1988

Mr. Kensuke Yanagiya
President
Japan International Cooperation Agency
Tokyo, Japan

Dear Sir:

LETTER OF TRANSMITTAL

It is our pleasure to submit to you the Final Report of the Study on Sharqiya Sewerage System in the Arab Republic of Egypt.

The field survey and study have been conducted during the period from July 1987 to September 1988.

This Report consists of four volumes: VOLUME ONE - Summary Report, which provides the summary of the study and recommendations; VOLUME TWO - Main Report, which describes the results of survey and analysis; VOLUME THREE - Appendices, which contains the details regarding the technical, legal and socio-economic aspects; VOLUME FOUR - Drawings, which contains maps and drawings.

We hope that realization of the proposed schemes would greatly contribute to improve the sanitary and environmental conditions in the Sharqiya Governorate.

Finally, we take this opportunity to express our sincere gratitude to Japan International Cooperation Agency, Ministry of Foreign Affairs and Ministry of Construction of the Government of Japan, the Embassy of Japan in Egypt, Advisory Committee and the officials concerned of the Government of the Arab Republic of Egypt which gave useful advice to the Stduy Team during the study period.

Respectfully yours,

H. Makino

HEIICHIRO MAKINO
Team Leader
for the
Study on Sharqiya Sewerage System

FEASIBILITY STUDY

ON

SHARQIYA SEWERAGE SYSTEM

IN

THE ARAB REPUBLIC OF EGYPT

FINAL REPORT

CONSTITUENT VOLUMES

VOLUME ONE SUMMARY REPORT

VOLUME TWO MAIN REPORT

VOLUME THREE APPENDICES

VOLUME FOUR DRAWINGS

CONTENTS OF VOLUME ONE

Table of Contents

Table of Contents (Cont'd)

Table of Contents (Cont'd)

List of Tables

List of Figures

UNITS AND ACRONYMS

Agencies

ARWSS	Abbasa Regional Water Supply System
CAPMAS	Central Agency for Public Mobilization and Statistics
GOPP	General Organization for Physical Planning
GOSSD	General Organization for Sewerage and Sanitary Drainage
IBRD	International Bank for Reconstruction and Development
JICA	Japan International Cooperation Agency
MOIC	Ministry of International Cooperation
MOP	Ministry of Planning
NOPWASD	National Organization for Potable Water and Sanitary Drainage
U.N.	United Nations
UNDP	United Nations Development Program
WHO	World Health Organization

Technical Terms

AC	Asbestos Cement
BOD	Biochemical Oxygen Demands 5-day, at 20°C
Cl	Chloride Ion
CI	Cast Iron
COD	Chemical Oxygen Demands
CP	Clay Pipe
DO	Dissolved Oxygen
DWF	Dry Weather Flow
H_2S	Hydrogen Sulfide
MLSS	Mixed Liquor Suspended Solids
MPN	Most Probable Number
pH	The reciprocal of the logarithm of the hydrogen-ion concentration
P/S	Pumping Station
PVC	Polyvinyl Chloride
RCP	Reinforced Concrete Pipe
SRT	Sludge Retention Time
SS	Suspended Solids
STP	Sewage Treatment Plant
TS	Total Solids

Units

atm	Atmosphere
cm	Centimeter
dia.	Diameter
fd	Feddan (0.42 ha)
gcd	Grammes per capita per day
ha	Hectare
hr	Hour
in.	Inch
km	Kilometer
lcd	Liters per capita per day
l/sec	Liters per second

Units (cont'd)

m	Meter
m/s	Meters per second
mm	Milimeter
m2	Square meter
m3	Cubic meter
mg/l	Miligrammes per liter
m3/day	Cubic meters per day
m3/min	Cubic meters per minute
m3/m2/day	Cubic meters per square meter per day
kl/day	Kiloliters per day
KW	Kilowatt

Economic and Financial Terms

AIC	Average Incremental Cost
B/C	Benefit to Cost Ratio
EIRR	Economic Internal Rate of Return
FIRR	Financial Internal Rate of Return
LE	Egyptian Pounds
NPV	Net Present Value
OCC	Opportunity Cost of Capital
pts	Piasters (1/100 LE)
PW	Present Worth

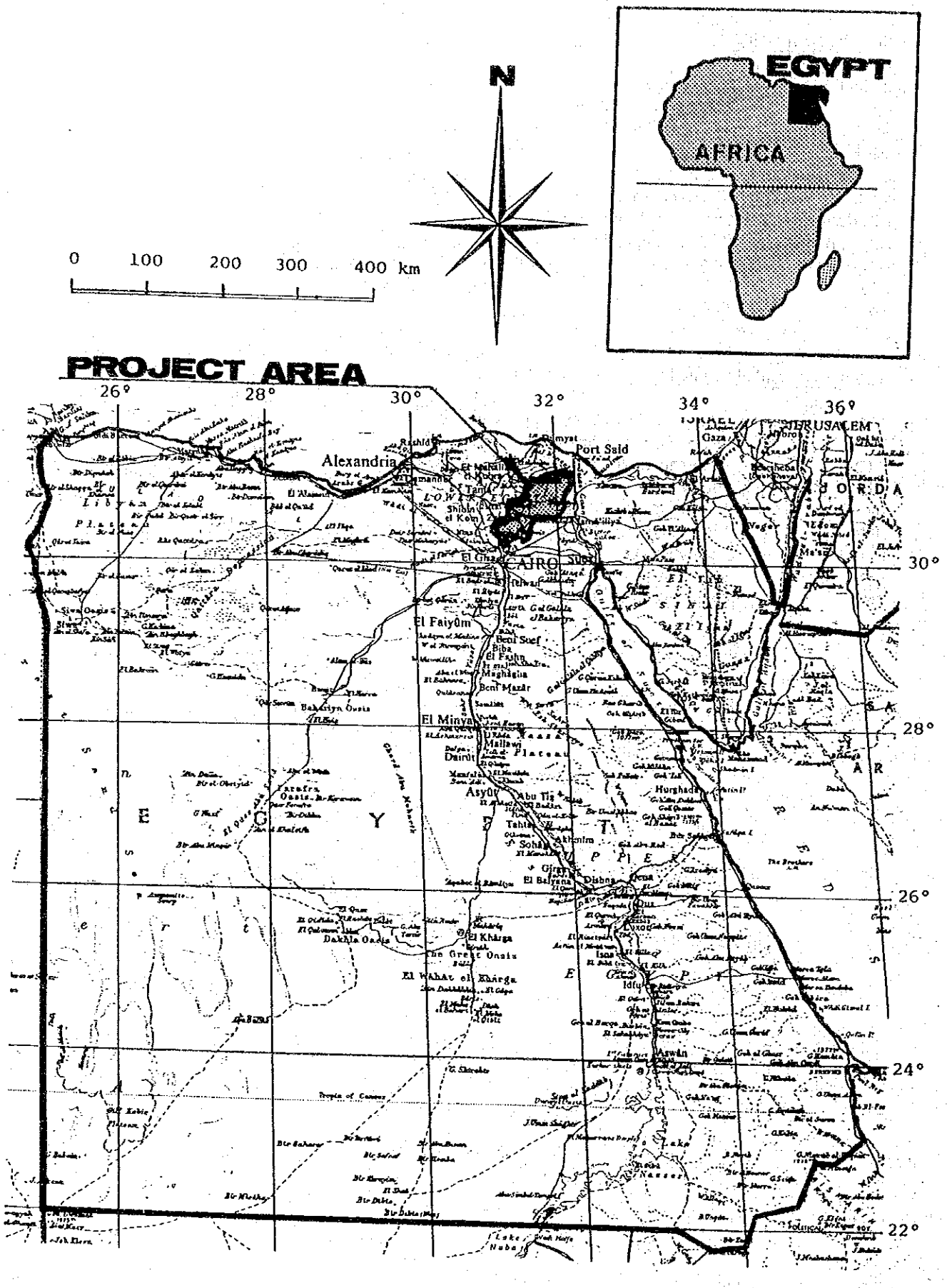

Fig. 1 Location of the Study Area

FEASIBILITY STUDY ON SHARQIYA SEWERAGE SYSTEM	DATE: SEP. 1980	JICA
SEWERAGE GENERAL PLAN AND INDEX MAP (G-1)	SCALE: 1:100,000	DRAWING NO.

I. INTRODUCTION

1.1 PROJECT BACKGROUND

In 1986 the Government of Egypt requested the Government of Japan to cooperate in developing a program to establish a comprehensive planning of sewerage systems for the Sharqiya Governorate, as a vital step toward the improvement in public health and environmental conditions with due considerations to the socioeconomic situation in the area as a whole.

In response to the request from the Government of Egypt, the Government of Japan decided to cooperate with the project and the Japan International Cooperation Agency (JICA), an agency responsible for implementation of technical cooperation programs of the Government of Japan, undertook the study in close coordination with the Egyptian government authorities concerned according to the Scope of Work signed on March 26th 1987.

The Governorate of Sharqiya (The Governorate) acts as counterpart agency to the Japanese study team and also as a coordinating body in relation to other organizations for smooth implementation of the study.

1.2 OBJECTIVES OF THE STUDY

The main purpose of the Study is to develop an appropriate sewerage plan up to the year 2005, including a feasibility study for the first phase program of sewerage for the year 1995. More specifically, the objectives are:

(a) To formulate a long-term program as basic concept for the sanitation improvement program by the Governorate up to the year 2005, and identify the first priority project to be provided by 1995 (Phase I study)

(b) To carry out a feasibility study for the 1st priority project identified in the long-term program (Phase II study).

(c) To transfer technology to the Egyptian counterpart from the study team throughout the course of the Study.

1.3 SCOPE OF THE STUDY

To carry out the Study, the following specific scope is identified:

(a) Study Area : The study area of the Phase I study covers the Sharqiya Governorate, but excludes the Tenth of Ramadan area. The study area of the Phase II study is to be selected from the results of the Phase I study.

(b) Target Years : The target years for the long-term program is 2005, and for the feasibility study 1995 is considered. For the planning of main sewers, conditions in 2040 shall be considered.

(c) Phase I Study : The study comprises field surveys and data collection in Egypt and analytical and design work both in Egypt and Japan. More specifically it includes : i) data collection and analysis, ii) study of present status of sewerage and sanitary conditions, iii) definition of planning criteria, iv) formulation of a long-term program, and v) identification of the first priority sewerage project up to 1995.

(d) Phase II Study : This study encompasses the feasibility study for the priority sewerage project, including i) identification of scope for proposed project, ii) water quality and topographic surveys, iii) facilities planning, iv) institutional and organizational planning, v) project evaluation, and vi) implementation program.

1.4 UNDERTAKING OF THE STUDY

The Government of Japan, through JICA, has taken necessary measures to despatch the study team to Egypt and effect technology transfer to the Egyptian counterpart personnel in the course of the Study. The study team commenced the work on 15th July 1987 and undertook surveys, discussions with the Governorate, field investigations, and analyses of collected data in Egypt until 30th September 1987. The work for the Phase I study was completed by 22nd December 1987, and the results of the Study are presented in the form of an Interim Report, which was submitted to the Governorate and other agencies concerned in January 1988.

The second on-site survey concentrated on the first phase program was conducted from 6 January to 19 March, 1988. The Draft Final Report, which contains both the long-term and the first phase programs, was completed in July, 1988. Discussions on the Draft Final Report were held in Sharqiya and Cairo in August, 1988. The Final Report was completed in September, 1988.

1.5 REPORTS AND DOCUMENTS PREPARED

A number of reports have been prepared and submitted to the Governorate during the period of the Study, either in the form of interim or draft, covering all the work performed under the Study. Results of the investigations and studies together with recommendations are presented in the following reports :

(a) Volume One	SUMMARY REPORT (Final)
(b) Volume Two	MAIN REPORT (Final)
(c) Volume Three	APPENDICES (Final)
(d) Volume Four	DRAWINGS (Final)

II. PRESENT CONDITIONS OF THE STUDY AREA

2.1 PHYSICAL CHARACTERISTICS OF THE AREA

(a) The Governorate is located in the northeastern part of the Nile Delta which lies over the Rosetta and Damietta Branches (see Figure 1). The study area for the sewerage feasibility study comprises the entire Governorate, but excludes the Tenth of Ramadan. The Governorate with the total area of about 4,200 km^2 extends approximately 100 km from northeast to southwest and 40 km from northwest to southeast.

(b) The agricultural land in the Governorate occupies about 2,868 km^2, that accounts for 68 percent of the Governorate's land, whereas residential and desert areas are 271 km^2 and 691 km^2, respectively. Elevations of the land range from 3 m in the northeast to 10 m in the southwest, as the flows of many canals and drains flow down southwest to northeast.

(c) The Pleistocene is recognized by the heavily rainy age in Egypt. The loose materials transported by the Nile River from Ethiopian and Sudan rocks were deposited forming the Delta aquifer. These strata are dominated by unconsolidated coarse sand and gravels with occassional clay lenses. The recent sediments were deposited at the end of the rainy age. The top boundary of the deltaic deposits is a formation belonging to the Holocene. This formation which acts as a cap of aquifers, is a semipervious clay and silt aquitard. The clay cap contains the subsoil water body in the Nile Delta. Its water is referred to as shallow or simply the water table. This water comes from infiltration and seepage from the irrigation network.

(d) The aquifer system consists of alluvial sediments. These sedimentary deposits contain two layers within which groundwater can occur. The lower layer is formed of highly permeable graded sand and gravel, and the upper one is formed by a clay-silt layer

of relatively low horizontal permeability and very low vertical permeability. The impermeable Pliocene clay constitutes the base of the system, sealing off any upward or downward flow through this aquiclude. The thickness of the aquifer ranges from 100 to 900 m. The thickness of the fresh water (up to 1000 mg/l salinity) bearing zone ranges from zero to 300 m. In the north and east directions, the thickness decreases because of the sea water edge intruding from the Mediterranean Sea and the Suez Canal.

(e) The climate of the Governorate is characterized as hot and dry weather in summer season from May to Septemeber, but with relatively mild weather in the rest of the year. The highest temperature ever recorded was 46.2°C in June, while the lowest temperature of 0.8°C was recorded in December. The annual average temperature is 21°C, with the average monthly maximum and minimum temperature of 35°C and 6.1°C, respectively. Although temperatures in a half of the year are higher than 30°C, the heat is not so oppressive due to the low humidity ranging between 50 and 60 percent.

(f) The precipitation in the region is low with an average annual rainfall of 29.3 mm which are mostly concentrated in the winter months. The maximum daily rainfall was 24 mm recorded in November 1932. Daily and monthly rainfall data are available, however, data showing short duration rainfall intensities are not available.

(g) The dominant wind directions are from northeast, north, northwest and southwest, with an annual average wind velocity of 2.8 knots. Velocities during February, March and April are higher than other months, having an average velocity of 3.2 knots.

(h) Humidities in the region are in general low, ranging between 30 percent and 85 percent, depending on the time and season. The highest evaporation rate of 6.3 mm/day occurred in May, while the lowest evaporation of 2 mm/day was observed in December.

2.2 SOCIO-ECONOMIC AND SOCIAL ASPECTS

(a) Sharqiya has the third largest population in Egypt after Cairo and Dakahlia. As of 1986, the total population of the Governorate was 3,254,000 which accounts for about 7 percent of the country's population. A majority of the population inhabit the rural area. In the last ten years from 1976 to 1986, the population of Sharqiya has grown at an average annual rate of 2.2 percent, that is slightly higher than the national average of 2.1 percent.

(b) Sharqiya is one of the leading agricultural governorates in the Nile Delta, having about 683,000 feddan of cultivated land area. It is envisaged that additional 400,000 feddan will be further reclaimed and become arable land for agricultural production. Major crops produced in the region are wheat, maize, rice, cotton and bean.

(c) The main industries in the Governorate are food, livestock, dairy products, animal feed, textile and garments, and building material industries. Numerous cottage-type industries also exist in such fields as engineering, machinery, furniture and soft drinks. The size of the existing industrial establishments varies from small to medium scale, which capitals range from LE 5,000 to 3 million.

(d) The Governorate is divided into twelve Marakaz and one city. Every Markaz has a Planning Department/Section to prepare physical planning, however, land use plans were not developed yet due mainly to the shortage of staff. The Regional Office of the General Organization for Physical Planning (GOPP) has been developing the land use plans of the cities. The land use study for Bilbeis was completed in 1985, and those for Zagazig and Abu Kebir are now underway by GOPP. Studies for other cities/Marakaz have not been started yet.

(e) Hospitals and clinics are provided in all the major cities in the Governorate. As of 1987, there are a total of 1,512 beds in public

and central hospitals, with 713 doctors now working. Though the Governorate has been exerting efforts to combat infections and epidemic diseases by extensive health services to the people, the incidence of disease is high. The prevalent causes of the mortality, more or less related to water-borne diseases, such as bilharzia, amoebic dysentry, ankylostomiasis, diarrhea, enteric fever, cholera, poliomiyelitis, infective hepatitis, and food poisoning, are attributable to inadequate sanitary facilities. The total number of bilharzia in 1980 was 127,077, which descreased almost 50 percent of 62,348 in 1986 (urban and rural area). On the other hand amoebic dysentry cases increased from 3,981 to 5,265 or 30% increase in the same period (urban area).

2.3 PUBLIC FACILITIES

(a) Canals traversing the Governorate originate in the Nile River. Major canals run north with exception of the Ismailiya Canal, eventually discharge to Manzala Lake. The canal system in the Governorate can be classified into two groups according to their water sources, one receiving from the Tawfiki Rayab Canal, and the other from the Ismailiya Canal. The El Hanut and El Wadi Canals receive wastewaters from drain pumping stations. Additional drain pumping station to the Wadi Canal has been under consideration.

(b) Wastewaters both from urban and rural areas are collected through a number of small branch drains and led to the major drains either by gravity or pumps and finally emptied into Manzala Lake. Most of the urban areas of the Governorate are tributaries to two major drains, the Bahr El Bakar and Bahr Haduas Drains.

(c) There are at present three categories of water supply system in the Governorate, namely i) City-owned system, ii) Housing Department system, and iii) Abbasa system. The water supply sources are the groundwater and/or canal water. At present, a total of 227,000 m^3/day of potable water is supplied to approximately 2.9 million

people, which accounts for about 91 percent of the total Governorate population. These three water supply systems have been operated and maintained by the Sharqiya Governorate in line with national policy of decentralization. The water is supplied to users either through house connections or standpipes. In addition, indirect water supply is practiced through private water vendors who deliver water to isolated communities in Huseiniya and Kafr Saqr Marakaz. In the urban areas, roughly 85 percent of the population obtain water through privately installed house connections and 12 percent through standpipes, whereas 80 percent of residents rely on standpipes and 9 percent on house connections in rural areas as of 1986.

(d) Presently, 12 cities have sanitary sewerage system, but no cities have sewage treatment plant except Zagazig city. The population and extension of the areas served by the sewer network are estimated to be about 409,300 or 57.5 percent of the total urban population and 1,658 ha respectively. The sewerage system is the separate system that carries only sanitary wastewaters by gravity. At the terminus of the sewer system, a sewage pumping station is generally provided to lift the sewage and transmit it to the final disposal site, which is in most cases a nearby drainage channel.

The sewerage system comprises of house connections with inspection chamebers, gravity sewer pipes, pumping stations, outfall pressure pipes, and in case of Zagazig, a sewage treatment plant. The sewage from houses and buildings is first led to the inspection chambers provided in front of the houses, and then flow down to the nearby manholes through the house connections. As the sewage flows down by gravity in the public sewer pipes, pumping stations need to be provided to lift the sewage wherever the sewer becomes deep to continue gravity flow to the sewage treatment plant.

The existing sewage treatment plant in Zagazig, constructed in 1938, provides secondary treatment by an oxidation ditch process and trickling filters before discharging the sewage to the drain.

The existing sewage treatment plant has been out of use except the sedimentation and desludging units and therefore, more than half the collected sewage bypasses the treatment units to the nearby drain. In order to improve the deteriorating conditions of the existing plant, a new treatment plant is under construction by NOPWASD near the old plant. The new plant of the conventional activated sludge process is designed to treat a total of 121,275 m^3/day sewage from 385,000 people by 2010, and 195,750 m^3/day sewage from 522,000 people by 2030.

The existing sewerage system have been operated and maintained by the cities, however, most of the cities have budgetary limitations and staff shortages. Most of the cities have plans to extend the existing sewerage systems, but without comprehensive sewerage planning.

(e) It is estimated that roughly 55 percent of the national population rely for their excreta disposal on either septic tank or soakaway, and a further 35 percent without appropriate wastewater disposal systems. In the Governorate where sanitary sewerage systems are not available, transh system is most commonly used. The transh generally receives excreta together with raw sewage. The wastewater leaches into the ground where the soil is permeable. In case of the septic tanks, solids settle and the supernatant partially treated is disposed of through transh or directly to drains.

(f) Roads in the Governorate are classified into two categories depending on the purpose and scale, viz. highway and intra-city roads. The highways are constructed by the Central Government, to connect the major cities, towns and villages, while the intra-city roads are to serve streets within cities, towns and villages. The highways can be classified into two classes, two-lane and four-lane roads, of which the four-lane roads are generally provided with a central separation zone and reserved land space at both sides, The intra-city road can also be classified into two types, two-lane and four-lane, with the widths ranging from 21 m to 25 m. Most of the major roads, both of highways and intra-city roads are paved by

asphalt and gravel foundation, but many portion of the minor roads are not paved yet.

(g) The Electric Company for Suez and Sharqiya is responsible for development and operation of electric power generation, transmission and maintenance in the Governorate. As of 1987, there are a total of 432,033 electricity connections within the Governorate, of which 427,055 are connected with the public nets, but a total of 129,295 buildings are not connected yet. The Company's development plans have been carried out under the Master Plan 1982/87 to meet all the needs for the reliable electricity supply in the Governorate.

2.4 WASTEWATER QUANTITIES AND QUALITIES

(a) The drain waters were sampled at five selected points where the wastewaters are discharged from Zagazig, Bilbeis, Minyet El Qamh, Abu Kebir and Faqus. The drain waters contain much suspended materials that are not colloidal in form. The suspended materials are mostly organic and black in color. Appearance of the suspended materials indicate that digestion occurs during the prolonged anaerobic conditions subjected to the water. The average BOD and SS concentrations are 193 and 130 mg/l, respectively, which are almost of the same order of the raw sewage itself. Nutrient level in terms of ammonia nitrogen and total phosphorus is also high indicating a heavy organic contamination by the wastewaters from urban areas.

(b) The analyses of the raw sewage sampled from the existing sewerage systems indicate that the suspended and colloidal materials concentrations are high. The average SS concentration of the four samples was 426 mg/l. In addition to the suspended materials, large quantities of scum and garbage were observed at the sampling points, especially at the inlet chambers of pumping stations in Abu Kebir and Faqus cities. BOD concentrations ranged from 350 to 900 mg/l, with an average value of 501 mg/l. The total phosphorus was relatively high compared with BOD and ammonia nitrogen.

(c) The effluent of Zagazig sewage treatment plant contained less SS, BOD, COD and ammonia nitrogen than other raw sewage, however, overall effluent quality indicated that the treatment plant did not function as the secondary treatment plant. BOD concentration of 82 mg/l is still high and does not meet the requirements by the Law No. 48/1982.

(d) At three shallow wells, waters were sampled and analysed. All of the sampled waters were odorless, colorless and very clear by observations, however, had high conductivity which indicate that the waters contained high dissolved solids. Chloride ion, that is sometimes a good indicator for the contamination by domestic sewage, was also high in concentration. Also, the analysis indicated existence of fecal coliform, which means that these shallow well waters are contaminated by the wastewaters from the nearby transhes or other sewage disposal systems.

(e) The water consumption patterns were identified and classified into three categories, namely : i) urban domestic, ii) rural domestic, and iii) non-domestic waters. In addition to the domestic water consumptions, 10 lcd is considered as the commercial water demand for all cities. Industrial water demand is taken as 10 percent of the domestic and commercial water demand for Zagazig and Bilbeis, and 10 percent of the domestic use for other cities. Institutional water demand, 15 percent of the domestic and commercial water demand is added for Zagazig, but for other cities, 10 percent is considered.

In estimating the sewage quantities, it is estimated that 90 percent of all the water consumption will reach the sewers. Thus, the overall average sewage quantity as of 1986 is estimated to be 219,700 m^3/day. Of the total sewage produced, 89,991 m^3/day or 41 percent is assumed to originate from urban areas while 129,674 m^3/day or 59 percent from rural areas.

2.5 ORGANIZATION

(a) National Organization for Potable Water and Sanitary Drainage (NOPWASD) was established in 1981 merging the former General Organization for Potable Water (GOPW) and General Organization for Sewerage and Sanitary Drainage (GOSD) to undertake identification, planning studies, research and overseeing project implementation of water supply and sewerage system development projects. This organization is also responsible for establishing national standards, technical specifications, and their control; development of training programs to upgrade the quality of design, construction, as well as operation and maintenance of the systems; and engineering consulting services as required by governorates.

(b) Ministry of Housing and Public Utilities is a key central agency which administers the whole major construction works in Egypt including sewerage construction and administratively oversees NOPWASD and functions as a decision making body of public sector construction projects.

(c) Ministry of Planning plays a key role to select the priority projects including sewerage development projects in the light of the national development plan in the whole country as proclaimed by the national five-year plan. The final decision of the Ministry of Housing and Public Utilities to implement a concerned project is made based on the priority project selected and ratified by the Ministry of Planning.

(d) Ministry of International Cooperation is a coordinating body related to major public sector projects which require the foreign technical and/or financial assistance. All foreign agencies or technical cooperation agencies are required to keep in touch with this agency to engage in their concerned projects.

(e) Ministry of Finance provides the funds for the operation and maintenance, minor rehabilitation and extension works of public utility systems, including sewerage and sanitary drainage system of

the Governorates. Ministry of Irrigation is concerned with sewerage development projects because irrigation canals should be protected from wastewater discharges to the irrigation waters. Ministry of Health is concerned in the safeguarding the public health by regulating the quality standards of wastewaters to be discharged.

(f) The Governorate of Sharqiya is a local government agency responsible for operation and maintenance of sewerage system. The Governorate is divided into 12 district areas called Markaz (city-center status) and one city. The offices of each Markaz and city house the sewerage control unit. In the Governorate office in Zagazig, the Section of Cities and Village Sewerage and Drainage controls the sewerage and drainage and drainage systems all over the administrative areas of the Governorate. This section is under the control of the Water Supply and Sewerage Division, Housing Department, which is directly controlled by the Ministry of Housing and Public Utilities.

(g) Every city and Markaz has a unit related to sewerage works which is responsible for operation and maintenance of the facilities. The staffing for the sewerage works in the cities and Markaz is, in general, insufficient in terms of number and qualification. Due to the apparent shortage of skilled laborers, preventive maintenance of the facilities cannot be performed, and these units are not capable of managing all the necessary work except those for emergency works.

2.6 NEED FOR PROJECT

At present, twelve cities have sanitary sewerage system; however, none of these except Zagazig have an appropriate sewage treatment system. Even in Zagazig sewerage system, only a small portion of the inflowing sewage is receiving sedimentation, and almost all the sewage is bypassed directly into the nearby drain. Though a new treatment plant is under construction by NOPWASD, it may take a few years to complete.

The ever-increasing population and the improvement of the living conditions in the area, together with urban development has rapidly increased water use. Pollution of canals, drains and groundwater by uncontrolled wastewater discharges has reached deplorable level, and requires immediate action to prevent further degradation of the region's water sources and disruption of the environment. Further surface and ground water contamination in the area will no doubt cause more serious damage to the environment and development of the region, especially for agriculture and public sanitation.

The study on the existing sanitary situations of the region indicates that a comprehensive sewerage and sanitation improvement program be immediately implemented. If no actions are taken immediately to improve the existing sewerage and sanitation systems, the water pollution and sanitary conditions, which have already reached deplorable level, will become progressively worse. When the sewerage projects are completed and put into operation, the sewage effluent will no doubt contribute to improving the quality of the irrigation water downstream. If the project is not implemented at this time, the cost escalation might hamper the project implementation at a later stage.

III. PLANNING CONSIDERATIONS

3.1 GENERAL

The planning and design basis for the sewerage component facilities have been developed and various alternative plans for possible sanitary systems have been considered so that the most appropriate system planning can be worked out for the project. Following a review of the alternative technolgies, the best solution for each of the components has been selected.

3.2 DEFINITION OF STUDY AREA

The sewerage project implementation areas for the master plan (up to 2005) and the first phase program (up to 1995) have been selected on the basis of field surveys, review of existing physical and development conditions, and various future development schemes.

(a) On the basis of the studies and investigations to select the priority urban areas where sanitary conditions have been deteriorated and wastewater discharge to drains are causing serious environmental problems, the thirteen cities have been defined as the sewerage implementation areas up to the year 2005. Other areas like small towns and villages are not included in the present master plan. Areas other than the sewerage implementation areas are expected to be covered under different schemes in parallel with the sewerage implementation program.

(b) Based on the strategic sewerage planning up to 2005, a staged construction program has been worked out to determine the desirable priority of the sewerage construction, taking into account such important elements as water pollution, population density, and various development schemes. The feasibility study area (the first phase program area) thus selected covers the urban builtup districts of the four major cities, namely i) Zagazig ii) Beilbeis iii) Faqus and iv) Minyet El Qamh.

3.3 POPULATION ESTIMATES

The future population for urban and rural areas in each Markaz for years 1990, 1995, 2000, 2005, have been estimated taking into account previous projections made by various agencies, including IBRD, CAMAS, GOPP, JICA, as well as the latest population census data in 1986. Population growth rates for urban and rural areas have been estimated for four different categories, i.e. high, medium, low and lowest, for the different stages, according to the type of the cities, and the population for each of 13 Marakaz projected. The total populations projected for the different years are as follows :

Type of area	1986	1990	1995	2000	2005
Urban area	711.5	798	914	1,039	1,180
Rural area	2,542.8	2,832	3,146	3,534	3,974
Total	3,253.3	2,621	4,060	4,573	5154

(unit : 1,000 persons)

Population in 2040 was also estimated to be 13,555,000 by CAPMAS, of which urban and rural populations are 2,970,000 and 10,585,000 respectively.

3.4 WASTEWATER QUANTITIES AND QUALITIES

(a) Per capita sewage flow rates in the years 1990, 1995, 2000 and 2005 for each city have been estimated as shown in the following :

City	1990	1995	2000	2005
Zagazig City	144	150	157.5	162
Bilbeis, Faqus and Abu Kebir Cities	127.4	130.7	136.1	140.4
Minyet El Qamh City	116.8	119.8	124.7	140.9
Other cities	104.9	106.9	108.9	110.9

(unit lcd)

(b) In addition to the sewage flows, an average infiltration of 10 m^3/ha/day is considered for sewer planning and design purposes.

(c) The ratios of the peak flow and daily maximum flow to average daily flow are estimated to be 1.4 and 2.0 respectively. Design flow rates, for sewer and treatment plant design, in the year 2005 are summarized in the following table :

Table 3.1 Design Flow Rates in 2005

(m3/day)

City	(1) Daily average	(2) Daily maximum 1.4x(1)	(3) Peak flow 2.0 x (1)	(4) Infiltration	(5) Design flow for treatment (2) + (4)	(6) Design flow for pipes (3) + (4)
Zagazig	58,644	82,102	117,288	27,260	109,362	144,548
Huseiniya	3,216	4,502	6,432	2,530	7,032	8,962
Kafr Saqr	3,882	5,435	7,764	2,480	7,915	10,244
Faqus	10,951	15,331	21,902	5,150	20,481	27,052
Abu Kebir	16,006	22,408	32,012	4,440	26,848	36,452
Abu Hammad	4,880	6,832	9,760	3,100	9,932	12,860
Ibrahimiya	4,880	6,832	9,760	1,700	8,532	11,460
Hihya	5,434	7,608	10,868	2,650	10,258	13,518
Diarb Nigm	6,765	9,471	13,530	2,590	12,061	16,120
Bilbeis	27,097	37,936	54,194	6,670	44,606	60,864
Minyet El Qamh	11,513	16,118	23,026	3,000	19,118	26,026
Hashtul El Soak	5,101	7,141	10,202	2,540	9,681	12,742
Qenayat	5,878	8,229	11,756	2,280	10,509	14,036
Total	164,247	229,945	328,494	66,390	296,335	394,884

Note: Design flows for Bilbeis include flows from army camp.

(d) The characteristics of the raw sewage in 2005 are determined on the basis of the field results and comparison with those in similar cities of Egypt and other countries, and are summarized below :

BOD	450 mg/l
SS	460 mg/l
COD	170 mg/l
NH_4-N	30 mg/l
Total-P	13 mg/l

3.5 BASIC CONCEPT OF SANITATION IMPROVEMENT

(a) Investigations and studies on the sanitation improvement both in urban and rural areas have led to the conclusion that additional toilet and local excreta disposal facilities are necessary where the sewer will not be provided for a prolonged period. Also, the existing transh and septic tank facilities are to be improved by appropriate means, and periodic cleansing should be made.

(b) Results of the water quality analyses and observation of shallow wells indicated that the wells were contaminated. Some of the wells, employing manual pumps and buckets scooping, were not properly constructed and were without appropriate covers at the top. Areas surrounding wells are often near toilets, latrines, transhes, and other wastewater sources, in some cases, resulting in ponding of wastewater in the immediate vicinity. In order to prevent these contaminations, transhes and septic tanks shall not be located too close to the wells, and at the same time, these should be inspected and cleaned periodically. Where the groundwater elevation is high and transh or septic tank effluent cannot be leached into the ground, some improvement measures should be considered including chlorination, provision of biological filter, pump installation, and improvement of tank structures.

3.6 ENGINEERING CONSIDERATIONS FOR SYSTEM PLANNING

(a) To select the most appropriate wastewater system for the area, all the feasible alternative wastewater collection and disposal systems have been analysed from technical, environmental and economic viewpoints.

The study was made on the three alternative systems, namely i)on-site sanitation system, ii) small-bore sewer system and iii) conventional sewer system.

The on-site sanitation system is in principle similar to the existing transh system but with additional septic tank and other auxiliary facilities, and cannot contribute to the improvement of groundwater contamination and sanitary conditions in the area. For these reasons this alternative was screened out.

The small-bore sewer system is less costly than the conventional sewerage system because of the reduced size of the sewer pipes, however, as experiences shown in many locations in the existing conventional sewerage systems, sewers are clogged by sand and other solids, and frequent cleanings are required to properly maintain the function of the facilities. The small size sewers will no doubt necessitate much more frequent cleansing of pipes than the present conventional sewers, and, will thus create significant difficulties in proper operation and maintenance. Furthermore, the existing systems in the region have long been planned and constructed as the conventional gravity sewer system, and there is no persuasive reason to change the present system to a new system without much experience in the region. In the light of these, the conventional sewerage system is selected as the most appropriate system for area.

(b) For the sewage treatment plan, there are essentially two major alternatives, i) discharge of sewage effluent into a drain with a high level of treatment (secondary process), and ii) discharge through an outfall to desert or farmland for land reclamation, with a level of treatment as needed to supplement the purifying action of the land.

Under the Law No. 48/1982, the effluent from a sewage treatment shall be 60 mg/l or less in terms of BOD_5, and consequently, the level of treatment should be secondary treatment at the final stage. Therefore, as possible alternative wastewater management techniques, biological treatment processes have been studied, including conventional activated sludge, oxidation ditch, oxidation pond, aerated lagoon, and extended aeration. Each of the alternative processes has been evaluated from technical and economic viewpoints. The evaluation indicated that the conventional activated sludge process be applied for the five medium size cities, and oxidation ditch process for the seven small size cities.

The discharge of sewage to desert or other waste land has been studied taking into account such factors as competing land uses, public health impact, energy requirements, aesthetics, and biological effects. In the Nile Delta region, the water resources situation is better than other regions, and the demand for such water is quite low and hence, sewage reuse is not attractive at present. Also, cost estimates for the system, including pumping stations and pressure outfall pipelines, are prohibitively high for the expected benefits, hence, it is evident that this method is inferior to the disposal to drains.

The best construction staging will be to construct the primary treatment facilities under the First Phase Program and later to add secondary treatment process to achieve the final goal of 60 mg/l BOD effluent quality.

3.7 DESIGN CRITERIA

(a) The sewer system shall be the separate gravity system. For planning and design of the sewers, the Manning equation shall be used.

(b) No public sewer shall be less than 200 mm in diameter, but for house connections, 150 mm or larger pipes shall be used.

(c) Gravity sewers shall be designed to have mean velocities of flow when flowing full or half-full of no less than 60 cm/sec for clay and PVC pipes, and 75 cm/sec for cement-bonded pipes, based on the Manning's formula using roughness coefficients of 0.012 and 0.013, respectively. All sewers shall be designed not to exceed a velocity of 3 m/sec to protect against sewer erosion.

(d) For sanitary sewer design, full capacity of the design peak flow rate is provided. When the smaller sewer joins a larger sewer, the crown of both sewers are to be placed at the same elevation.

(e) Earth covering of sewer pipe is not to be less than 1 m unless special protection measures against the expected loads are provided.

(f) The sewage pumping stations shall be designed based on the peak flow rates. All piping and conduits are to be designed to carry the expected peak flow rates. Substructures are designed generally to be circular in plan. Two types of pumps are considered appropriate for use, submersible and centrifugal types.

(g) Conventional activated sludge is recommended for five medium size cities, while for seven other small cities, oxidation ditch process is adopted.

(h) The sewage treatment plant units are designed based on the daily maximum rate of sewage flow per 24 hours. All pipings and conduits are designed for the peak flow rate.

(i) The design qualities of influent and effluent of the sewage treatment plant are set as follows :

Items	Influent	Effluent	Legal Requirements
BOD (mg/l)	450	30	60
SS (mg/l)	460	30	50
NO_3-N(mg/l)			50

3.8 MATERIALS AND METHODS OF CONSTRUCTION

Presently most of the construction materials for the sewerage and sanitation programs are available at Sharqiya except certain equipment required for pumping stations and sewage treatment plants. The construction methods applied for the sewers, pumping stations and sewage treatment works in Zagazig and other cities are practical, and the local construction industry will play a major role in the construction of the sewage facilities.

3.9 COST ESTIMATES

In estimating construction costs of the facilties, unit costs for domestic items such as labor, materials to be purchased in Egypt, power, equipment and transportation, and materials and equipment to be imported were collected and checked. For master plan purposes, all costs are estimated on the basis of mid-1987 price levels at Sharqiya Governorate.

The sewer construction costs are estimated based on the local materials, but electrical and mechanical works are assumed to be imported. Shipping and importation allowances have been added to imported items. Foreign currency portion of the costs required for the imported items are indicated in Egyptian Pounds converted from foreign currency by official exchange rate in mid-1987. The exchange rates used in the estimates are as follows :

1 U.S.Dollar	2.225 Egyptian Pound
100 Yen	1.523 Egyptian Pound

IV. LONG TERM PLAN (UP TO 2005)

4.1 STRATEGIC PLAN FOR SEWERAGE TO THE YEAR 2005

(a) The long term sewerage plan covers the projected urban areas of the thirteen cities in 2005. All the urban areas where sewer pipes have already been provided are encompassed in the strategic planning area. Thus, the sewerage implementation area is classified into two categories, the existing service areas and those to be sewered by 2005. The existing sewers and pumping stations are considered to be continuously usable with necessary improvement and rehabilitation.

(b) Under the long term plan, trunk sewers, pumping stations and sewage treatment works have been designed for the presently unsewered areas to accomodate all the wastewater flows produced in all the urban areas covering both the existing sewered areas and unsewered areas.

(c) The construction costs estimated include those for new facilities and existing systems' improvement and rehabilitation. On the basis of the estimated costs for the facilities and evaluation of the priority of sewerage construction, the sewerage implementation program up to the year 2005 has been developed. The plan proposes to implement the sewerage program in the four high priority cities, namely i) Zagazig, ii) Bilbeis, iii) Faquis, and iv) Minyet El Qamh, during the First Phase Program (up to 1995) for the feasibility study.

(d) Organizational setup, including staffing requirements and operation and maintenance of the proposed system have been developed and recommended. Financial and economic analysis considering the long term span up to 2005, was made and the feasibility of the sewerage construction confirmed.

4.2 PROPOSED SEWERAGE SYSTEM

(a) Possible integration of individual city sewerage system has been studied to select the most appropriate sewerage systems combination, particularly among Zagazig, Qenayat and Hihya, located closely each other. The study results indicate that in case of Qenayat city, the combination with that of Zagazig city is more economical than individual sewerage system whereas the individual sewerage system is more advantageous for Hihya city. Therefore, only Qenayat city sewerage system is to be connected to Zagazig city sewerage for the final treatment of the sewage, but for other eleven cities, the individual sewerage systems are proposed.

(b) The recommended sewerage system of physical facilities encompasses i) systems of trunk sewers, submains, branch and lateral sewers, ii) sewage pumping stations and force mains, iii) sewage treatment works, the conventional activated sludge process for the five medium size cities, and the oxidation ditch process for the remaining small scale cities.

(c) Hydraulic computations have been made for all trunk sewers of the thirteen cities based on the conditions in 2040. Pumping stations, force mains and sewage treatment plants are designed based on the conditions in 2005.

(d) The collected sewage flow will be transported eventually to the sewage treatment works at the terminus of the sewers, either by gravity or in case the sewer depth becomes 5 m or more, by means of pumping stations. Two different types of pumps are recommended submersible for smaller stations and centrifugal pumps for larger stations. A total of 26 new sewage pumping stations are proposed for the new sewerage systems in the thirteen cities.

(e) The conventional activated sludge process is proposed for treatment works in five medium cities namely, i) Zagazig, ii) Faqus, iii) Abu Kebir, iv) Bilbeis, and v) Minyet El Qamh. For the other seven cities, the oxidation ditch process is recommended. The Zagazig sewage treatment plant which is now under construction is justified to be of sufficient capacity to treat the combined sewage flows from Zagazig and Qenayat cities in 2005. As such, the costs of treatment works for these two cities are not included in the master plan.

(f) Although the existing sewers are generally in good conditions, improvements and rehabilitations will be required by 2005, because of the expected increase in wastewater productions. From the investegation and evaluation of the existing sewer systems, it is assumed that 15 percent of the branch and lateral sewer construction cost will be required for the rehabilitation and improvement.

(g) All pumping units in the existing pumping stations are considered to require replacement by the year 2005, and the costs thereof are included in the overall rehabilitation cost estimation.

The proposed sewer pipes and sewage pumping stations are shown in Table 4.1 and 4.2 respectively.

4.3 COST ESTIMATES

Construction costs are estimated based on the preliminary design of each facility using unit costs developed for each item. Land acquisition costs for pumping stations and sewage treatment plants are estimated on the basis of the estimated land space requirement for each system.

Table 4.1 Sewer Pipes Planned

City	Served Population	Service Area (ha)			Number of House Connections	Total Length of Branch and Lateral (km)	Trunk Sewer	
		Existing	New	Total			Diameter*(mm)	Length (km)
Zagazig	362,000	794	1,932	2,726	12,070	1,090	250 - 900	27.99
Huseiniya	29,000	-	253	253	970	101	200 - 600	6.55
Kafr Saqr	35,000	98	150	248	1,170	99	200 - 900	6.38
Faqus	78,000	-	515	515	2,600	206	200 - 1,000	14.62
Abu Kebir	114,000	103	341	444	3,800	178	200 - 900	14.91
Abu Hammad	44,000	144	166	310	1,470	124	250 - 900	7.44
Ibrahimiya	44,000	16	154	170	1,460	68	250 - 900	4.04
Hihya	49,000	30	235	265	1,630	106	200 - 900	6.33
Diarb Nigm	61,000	65	194	259	2,030	104	400 - 1,000	4.14
Bilbeis	183,000	227	440	667	6,100	267	200 - 900	11.07
Minyet El Qamh	82,000	150	150	300	2,740	120	250 - 750	8.10
Mashtul El Soak	46,000	26	228	254	1,540	102	200 - 900	6.86
Qenayat	53,000	5	223	228	1,760	91	250 - 900	6.68
Total	1,180,000	1,658	4,981	6,639	39,340	2,656		125.11

Note: * Diameters are only for gravity sewers.

Table 4.2 Design Outline of Pumping Stations

City	P/S No.	Design Peak Flow (m3/sec)	Inlet Depth (m)	Diameter (mm)	Q'ty	Remarks
Zagazig	No.1	0.083	9.3	150	3	
	No.2	0.271	6.2	250	4	
	No.3	0.305	4.3	250	4	
	No.4	0.239	3.8	200	4	
	No.5	0.206	5.9	200	4	
	Main	0.488	4.0	300	4	Existing
Huseiniya	No.1	0.025	5.6	100	2	
	No.2	0.020	4.0	100	2	
Kafr Saqr	No.1	0.011	3.9	100	2	
	No.2	0.015	3.6	100	2	
Faqus	No.1	0.145	6.6	200	3	
	No.2	0.060	3.0	150	3	
	No.3	0.313	4.4	300	3	
Abu Kebir	No.1	0.272	5.4	250	3	
	No.2	0.067	4.0	150	3	
Abu Hammad	No.1	0.102	5.2	200	3	
Ibrahimiya	No.1	0.017	4.3	100	2	
Hihya	No.1	0.033	4.0	150	2	
Diarb Nigm		- None -				
Bilbeis	No.1	0.212	5.3	250	3	
	No.2	0.041	3.0	150	2	
	No.3	0.080	3.0	150	3	Existing
	No.4	0.098	3.0	200	3	Existing
	No.5	0.042	3.0	150	2	
	No.6	0.029	3.0	150	2	Existing
	No.7	0.056	3.0	200	2	Existing
	No.8	0.049	3.0	200	2	
	No.9	0.066	3.0	200	2	
Minyet El Qamh	No.1	0.090	4.3	150	3	Existing
	No.2	0.030	3.0	150	2	Existing
	No.3	0.068	3.1	150	3	Existing
Mashtul El Soak	No.1	0.064	4.4	150	3	
	No.2	0.028	4.4	150	2	
	No.3	0.023	4.6	100	2	
Qenayat	No.1	0.163	5.9	250	3	

Note: Number of pumps includes one standby unit

Engineering costs are estimated to be 10 percent of the construction and rehabilitation costs. Contingencies both for cost escalation and physical contingencies are assumed to be 20 percent of the construction and rehabilitation costs.

The total project cost is estimated to be LE 446.226 million, of which LE 369.751 million or 83 percent is the local currency component and LE 76.475 million or 17 percent is the foreign currency component, as shown in Table 4.3. Operation and maintenance cost for all the sewerage systems in the Governorate is estimated to be LE 3.6 million per year when the proposed sewerage systems are completed and put into operation. The operation and maintenance costs are tabulated in Table 4.4

4.4 STAGED CONSTRUCTION PROGRAM

(a) A staged construction program for the sewerage facilities has been developed, considering the budgetary provisions in the New Five Year Plan and other constraints. All the sewerage systems to be provided in the urban areas of the thirteen cities are planned to incorporate complete secondary treatment by the year 2005.

(b) Each of the thirteen cities has been evaluated from the viewpoints of environment, engineering and finance, so as to select the priority project. The results of the evaluation has led to the conclusion that four cities, namely i) Zagazig, ii) Faqus, iii) Bilbeis, and iv) Minyet El Qamh require higher priority as far as the provision of sewerage among the thirteen cities is concerned.

(c) Construction in the remaining nine cities, is scheduled to commence after 1995.

The proposed sewerage implementation schedule is shown in Figure 4.1

Table 4.3 Total Project Costs

(LE 1.000)

City		B/L Sewer	Trunk Sewer	P/S	STP	Sub-total	Land Purchasing Cost	Rehabili. Cost	Contingency	Engineering Cost	TOTAL COST
Zagazig	T	57.960	10.549	4.319	-	72.828	375	5.841	15.734	7.868	102.646
	L/C	57.960	8.967	2.425	-	69.352	375	2.561	14.382	7.192	93.862
	F/C	-	1.582	1.894	-	3.476	-	3.280	1.352	676	8.784
Huseiniya	T	7.590	724	392	5.097	13.803	2.040	-	2.761	1.381	19.985
	L/C	7.590	615	203	2.580	10.988	2.040	-	2.198	1.099	16.325
	F/C	-	109	189	2.517	2.815	-	-	563	282	3.660
Kafr Saqr	T	4.500	899	382	5.594	11.375	2.240	596	2.394	1.197	17.802
	L/C	4.500	764	202	2.831	8.297	2.240	252	1.710	855	13.354
	F/C	-	135	180	2.763	3.078	-	344	684	342	4.448
Faqus	T	15.450	4.153	1.936	12.051	33.590	4.665	592	6.836	3.418	49.101
	L/C	15.450	3.530	1.136	8.580	28.696	4.665	420	5.823	2.912	42.516
	F/C	-	623	800	3.471	4.894	-	172	1.013	506	6.585
Abu Kebir	T	10.230	3.093	1.029	14.070	28.422	5.560	552	5.795	2.898	43.227
	L/C	10.230	2.629	441	9.286	22.586	5.560	294	4.576	2.288	35.304
	F/C	-	464	588	4.784	5.836	-	258	1.219	610	7.923
Abu Hammad	T	4.980	1.405	490	6.690	13.565	2.730	388	2.791	1.396	20.870
	L/C	4.980	1.194	199	3.386	9.759	2.730	130	1.978	989	15.586
	F/C	-	211	291	3.304	3.806	-	258	813	407	5.284
Ibrahimiya	T	4.620	709	194	5.935	11.458	2.320	343	2.360	1.180	17.661
	L/C	4.620	603	101	3.003	8.327	2.320	86	1.683	842	13.258
	F/C	-	106	93	2.932	3.131	-	257	677	338	4.403
Hihya	T	7.050	1.458	296	6.863	15.667	2.720	424	3.218	1.609	23.638
	L/C	7.050	1.239	165	3.473	11.927	2.720	110	2.407	1.204	18.368
	F/C	-	219	131	3.390	3.740	-	314	811	405	5.270
Diarb Nigm	T	5.820	2.349	-	7.797	15.966	3.200	112	3.216	1.608	24.102
	L/C	5.820	1.997	-	3.945	11.762	3.200	112	2.375	1.188	18.637
	F/C	-	352	-	3.852	4.204	-	-	841	420	5.465
Bilbeis	T	11.820	2.716	3.501	22.293	40.330	8.285	942	8.255	4.128	61.940
	L/C	11.820	2.309	1.665	15.556	31.350	8.285	426	6.355	3.178	49.594
	F/C	-	407	1.836	6.737	8.980	-	516	1.900	950	12.346
Minyet El Qamh	T	4.500	1.614	700	12.697	19.511	4.500	930	4.088	2.044	31.073
	L/C	4.500	1.372	140	9.162	15.174	4.500	244	3.083	1.542	24.543
	F/C	-	242	560	3.535	4.337	-	686	1.005	502	6.530
Mashtul El Soak	T	6.840	1.284	931	6.557	15.612	2.670	33	3.129	1.565	23.009
	L/C	6.840	1.091	463	3.318	11.712	2.670	33	2.349	1.175	17.939
	F/C	-	193	468	3.239	3.900	-	-	780	390	5.070
Qenayat	T	6.690	1.270	600	-	8.560	30	11	1.714	857	11.172
	L/C	6.690	1.080	246	-	8.016	30	11	1.605	803	10.465
	F/C	-	190	354	-	544	-	-	109	54	707
TOTAL	T	148.050	32.223	14.770	105.644	300.687	41.335	10.764	62.291	31.149	446.226
	L/C	148.050	27.390	7.386	65.120	247.946	41.335	4.679	50.524	25.267	369.751
	F/C	-	4.833	7.384	40.524	52.741	-	6.085	11.767	5.882	76.475

Note: B/L: Branch and lateral
P/S: Pumping station
STP: Sewage treatment plant
T : Total

L/C: Local currency portion
F/C: Foreign currency portion

Table 4.4 Operation and Maintenance Costs

(LE 1,000/year)

City	Service Area (ha)	Sewer Length (km)	Wastewater Flow (m3/day)	Treatment Process	Operation and Maintenance Costs			Total
					Sewer	P/S	STP	
Zagazig	2,726	1,090	94,062	AS	528	365	395	1,288
Huseiniya	253	101	5,746	OD	48	6	56	110
Kafr Saqr	248	99	6,362	OD	47	26	61	134
Faqus	515	206	16,101	AS	100	130	85	315
Abu Kebir	444	178	20,446	AS	86	95	105	286
Abu Hammad	310	124	7,980	OD	60	35	74	169
Ibrahimiya	170	68	6,580	OD	32	3	63	98
Hihya	265	106	8,084	OD	52	26	75	153
Diarb Nigm	259	104	9,355	OD	50	-	85	135
Bilbeis	667	267	33,767	AS	130	180	162	472
Minyet El Qamh	300	120	14,513	AS	58	45	78	181
Mashtul El Soak	254	102	7,641	OD	50	22	71	143
Qenayat*	228	91	-	-	44	69	-	113
Total	6,639	2,656	230,637	-	1,276	1,002	1,310	3,597

Note: Wastewater flow of Qenayat is included that of Zagazig.
Wastewater flow of Bilbeis includes from army camp.
AS: Conventional Activated sludge process
OD: Oxidation ditch process

Figure 4.1 Implementation Schedule

City	Work	Second Five-Year Plan				Third Five-Year Plan					Fourth Five-Year Plan					Fifth Five-Year Plan			
		1987	88	89	90	91	92	93	94	95	96	97	98	99	2000	01	02	03	04	05
Zagazig	1. Sewer/Pumping Station																			
	2. Sewage Treatment Plant	(by NOPWASD)																		
	3. Rehabilitation																			
	4. Land Acquisition/Engineering																			
Huseiniya	1. Sewer/Pumping Station																			
	2. Sewage Treatment Plant																			
	3. Rehabilitation																			
	4. Land Acquisition/Engineering																			
Kafr Saqr	1. Sewer/Pumping Station																			
	2. Sewage Treatment Plant																			
	3. Rehabilitation																			
	4. Land Acquisition/Engineering																			
Faqus	1. Sewer/Pumping Station																			
	2. Sewage Treatment Plant																			
	3. Rehabilitation																			
	4. Land Acquisition/Engineering																			
Abu Kebir	1. Sewer/Pumping Station																			
	2. Sewage Treatment Plant																			
	3. Rehabilitation																			
	4. Land Acquisition/Engineering																			
Abu Hammad	1. Sewer/Pumping Station																			
	2. Sewage Treatment Plant																			
	3. Rehabilitation																			
	4. Land Acquisition/Engineering																			
Ibrahimiya	1. Sewer/Pumping Station																			
	2. Sewage Treatment Plant																			
	3. Rehabilitation																			
	4. Land Acquisition/Engineering																			
Hihya	1. Sewer/Pumping Station																			
	2. Sewage Treatment Plant																			
	3. Rehabilitation																			
	4. Land Acquisition/Engineering																			
Diarb Nigm	1. Sewer/																			
	2. Sewage Treatment Plant																			
	3. Rehabilitation																			
	4. Land Acquisition/Engineering																			
Bilbeis	1. Sewer/Pumping Station																			
	2. Sewage Treatment Plant																			
	3. Rehabilitation																			
	4. Land Acquisition/Engineering																			
Minyet El Qamh	1. Sewer/Pumping Station																			
	2. Sewage Treatment Plant																			
	3. Rehabilitation																			
	4. Land Acquisition/Engineering																			
Mashtul El Soak	1. Sewer/Pumping Station																			
	2. Sewage Treatment Plant																			
	3. Rehabilitation																			
	4. Land Acquisition/Engineering																			
Qenayat	1. Sewer/Pumping Station																			
	2.																			
	3. Rehabilitation																			
	4. Land Acquisition/Engineering																			

4.5 ORGANIZATION

(a) Two alternative organizational setups are considered to achieve essential objectives; creation of a Public Water and Wastewater Company, and expansion and modification of the existing organization in the Sharqiya Governorate. The concept of the former alternative was already recommended in the water supply study by JICA in 1984, and is considered adequate to amalgamate the functions for sewerage with the Water Company. By unifying water supply and sewerage works into such an organization, the sewer charge collection can be effected as a surcharge on water charge.

(b) Sharqiya Governorate is legally empowered to undertake the development as well as operation and maintenance of the sewerage and drainage disposal systems and all other sanitary systems within the Governorate's boundary, and the adminstrative authority has recently been strengthened by the national decentralization policy. The latter alternative is to expand the existing units responsible for the sewerage works to satisfy the function required for the sewerage system development.

(c) The creation of Public Water and Wastewater Company has a significant advantage because it is deviced so as to achieve full autonomy, but sewerage service activity is public in nature and not so financially beneficial in comparison with the water supply operation. The involvement of the sewerage service management in the benefit oriented public sector water company will impose a financial burden on the company. Further possible disadvantage is that it may require time consuming efforts for legislative and administrative procedures. Such disadvantages are so overwhelming that the latter alternative is considered to be more appropriate. The present organizational proposal is therefore based on the framework of the expansion and modification of the existing organization in Sharqiya Governorate.

(d) The proposed organizational units will be responsible for the planning, design, construction, operation and maintenance of the entire sewerage and drainage systems in the Governorate, with the objectives of collection, treatment and ultimate disposal of domestic and industrial wastewaters. In order to achieve these objectives, the proposed organizational units should include the units and functions of i) Administration, ii) Design, and iii) Operation/Maintenance.

(e) In order to meet the needs of the sewerage system development project up to 2005, the present organization should be functionally developed. The present functional units should be expanded and new units should be added according to the sewerage systems development plan and the basic functional units. The existing sections of 'Cities and Villages Sewerage and Drainage' in the Governorate office is required to be functionally reshuffled providing for sub-sections of planning and design, construction, central laboratory and operation and maintenance.

(f) The existing Sewerage Units which are responsible mainly for the operation and maintenance of the sewerage facilities in each Markaz are required to be expanded in accordance with the long term development plan of sewerage facilities.

(g) The personnel requirements for the proposed sewerage development plan up to 2005 has been made as shown in Table 4.5. It is emphasized that sufficient number of skilled engineers and technicians to manage the construction, operation and maintenance of the facilities should be provided. Concerted efforts should be made to develop a long term training program to meet the immediate and future manpower requirements in the progress of the proposed project.

Note: During the draft final report meeting, it was informed that the Ministry of Housing and the NOPWASD considered to establish new public sector companies of water supply and sewerage services in July 1989 in

order to provide higher level of the services to the consumers and to ensure more financially sound status of the entities.

The basic concept of the public companies is similar to the one which is discussed as one of alternative organizational setups in this report. Yet, the major differences are that 1) the presently proposed public companies would be established not at individual governorate level, but at the Development Region level, 2) they would be responsible for mainly operation and maintenance, and house connection works, while the planning, design and construction of the new projects, research and training would be undertaken by the NOPWASD and 3) they are, in principle, self-financed public entities in covering necessary operation and maintenance costs by their revenues from tariffs and connection charges.

Due to short notice, in-depth examination on the recently proposed public companies is not available in this study. However if the tariff rates are substantially raised to ensure the self-financed operation of the companies and the necessary legal procedures for their creation are completed as planned, it seems that the new companies idea appears to be a very appropriate and constructive proposal to the present problematic system.

4.6 FINANCIAL ANALYSIS

Egypt has been in a difficult position financially, following the worsening in the general economic conditions. The budget deficit for 1986/1987 reached almost a quarter of the total annual budget. The percentage of the central governments' subsidy to the Sharqiya Governorate accounts for about 70 percent, which means that the Governorate relies on the central government heavily.

The expenditures for the sewerage projects in Egypt are as follows :

Table 4.5 Estimated Staffing of All Sewerage Works Units in 2005

Job Title / Section	Engineer	Technician	Operator	Foreman	Laborer	Driver	Total
Sharqiya Governorate							
Cities & Village							
Sewerage Drainage							
Plans & Design	2	4					6
Constructions	2	4					6
Operation & Maintenance	2	4					6
Central Laboratory	1(chemical)	3			5		9
Zagazig							
Sewer	1	50		4	90	4	149
Pumping Station	1	39	26	6	130		202
Treatment Plant	1	15	10	2	30		58
Huseiniya							
Sewer	1	10		4	90		105
Treatment Plant	1	5	3	1	15		25
Transh System		1			10	5	16
Kafr Saqr							
Sewer	1	10		3	70		84
Pumping Station	1	15	10	2	50		78
Treatment Plant	1	5	3	1	15		25
Transh System		1			4	2	7
Fagus							
Sewer	1	10		5	110		126
Pumping Station	1	18	12	3	60		94
Treatment Plant	1	5	3	1	15		25
Transh System		1			10	5	16
Abu Kebir							
Sewer	1	12		7	150		170
Pumping Station	1	12	8	2	40		63
Treatment Plant	1	5	3	1	15		25
Transh System		1			8	4	13
Abu Hammad							
Sewer	1	7		3	70		81
Pumping Station	1	9	6	2	30		48
Treatment Plant	1	5	3	1	15		25
Transh System		1			10	5	16
Ibrahimiya							
Sewer	1	5		3	60		69
Pumping Station	1	6	4	1	20		32
Treatment Plant	1	5	3	1	15		25
Mihya							
Sewer	1	9		4	90		104
Pumping Station	1	12	8	2	40		63
Treatment Plant	1	5	3	1	15		25
Transh System		1			10	5	16
Diarb Nigm							
Sewer	1	7		3	70		81
Pumping Station	1	9	6	2	30		48
Treatment Plant	1	5	3	1	15		25
Transh System		1			8	4	13
Bilbeis							
Sewer	1	7		3	70		81
Pumping Station	1	15	10	2	50		78
Treatment Plant	1	5	3	1	15		25
Minyet El Qamh							
Sewer	1	10		5	100		116
Pumping Station	1	9	6	2	30		48
Treatment Plant	1	5	3	1	15		25
Transh System		1			10	5	16
Mashtul El Soak							
Sewer	1	10		5	100		116
Pumping Station	1	9	6	2	30		48
Treatment Plant	1	5	3	1	15		25
Transh System		1			6	3	10
Qenayat							
Sewer	1	9		4	90		104
Pumping Station	1	6	4	1	20		32
Treatment Plant	1	5	3	1	15		25
Transh System		1			6	3	10
Total	45	415	152	94	1,987	45	2,738

Table 4.6 Changes in National Budget for Sewerage Section (LE1,000)

Year	National Budget	Public Invest.	Sewerage Sector	Sharqiya
1977-1981/82	18,200	1,135	460	
1982/83-86/87	36,400	2,894	1,520	7.0
1987/88-91/92	46,500	4,017	2,296	21.5

Source : Ministry of Planning

The increase rate of the budgets for sewerage sector from 1977 to 1991 is 9.4 percent per annum. The central government plans to allocate the shares of LE 3.5 million from 1985 and under the New Five-Year Plan LE 8 million for the construction of sewage treatment plant in Zagazig, through NOPWASD. On the other hand, the Sharqiya Governorate invested LE 700,000 to all Marakaz in 1984/85 and 1985/86, and LE 500,000 during 1986/87.

The Governorate started to collect since July 1985, 10 percent of the water surcharge as the sewer charge, but only a quarter of the annual required costs were collected. In addition, the Governorate has been collecting LE 5 to 50 per installation as the sewer connection charge from each house. The Government undertook a study on the sewer charge and recommended to increase the charge until 1991 so that all the expenditures required for the systems' operation and maintenance can be secured.

The total investment required for the sewerage system by 2005 amounts to LE 446.2 million. If the investment for the sewerage sector is continuously secured in the national budget, and particular considerations are given to the Sharqiya's sewerage construction program, the project is expected to be efficiently implemented.

Sufficient revenue for the sewerage service is essential to meet the financial requirements of current outlay for operation and maintenance activities. It is expected that significant increases in the sewerage tariff would be made to generate sufficient incomes and to sustain a long-term investment program for the Sharqiya Governorate. Yet, it is the responsibility of the Central Government to revise the tariff level.

It is proposed for the Central Government to raise the tariff rate to strengthen the financial capability of the Governorate and to reduce the increasing financial burden of subsidy in the sewerage sector. Under the present tariff rate, a financial revenue for sewerage services has been projected at current prices for the period 1986/87 - 2005/06, then the projected difference between the revenue and operation and maintenance expenditures for the same period is computed to become negative in the future and lead to cumulative deficits by 2005.

The financial gap is expected to further widen and amount to LE 0.7 million in 2005/06. Therefore, unless there is substantial increase in sewerage tariff charges, necessary funds for operation and maintenance costs would be deficient and it would be imperative to encourage internal fund raising so that independent operation and sewerage services is viable.

4.7 ECONOMIC ANALYSIS

When the proposed sewerage systems are completed, significant improvements in the environmental and public health conditions can be expected. The systems would benefit to about 1.2 million people by 2005. The system would also contribute to institutional development and formation of appropriate financial policies and practices to achieve financial viability of the sewerage services.

The economic and social benefits accruing from the provision of sewerage systems may be summarized as follows :

(a) The sewered population will increase from the present 409,000 to 535,000 and 1.2 million by the years 1995 and 2005, respectively, with the service ratios from the present 57.5 percent to 58.5 and 100 percent of the total urban population.

(b) The water-borne diseases as well as health hazards due to inadequate sanitary services could be reduced.

(c) The present contamination of shallow well waters could be reduced.

(d) The irrigation water pollution could be prevented and this would indirectly enhance agricultural productivity and its utilization for potable water purposes.

(e) The financial position of executing entity, in terms of its pricing policy, financial management, internal fund generation and above all, viable operation and maintenance would be consolidated.

V. FIRST PHASE PROGRAM (UP TO 1995)

5.1 SCOPE OF THE FIRST PHASE PROGRAM

(a) Four cities, Zagazig, Faqus, Bilbeis and Minyet El Qamh, were selected for the first phase program up to the year 1995, as a result of priority evaluation. Feasibility study was conducted according to the Scope of Work agreed on.

(b) The second on-site survey was carried out in the project area to conduct field surveys, such as leveling survey, water quality analysis and socio-economic survey, and to obtain complementary data and information.

5.2 ALTERNATIVE STUDY FOR THE FOUR CITIES

(a) In order to work out the most appropriate sewerage systems for the four cities, various alternative sewerage systems are developed and evaluated from technical and economic view points.

(b) Construction and operation and maintenance costs of the alternative sewerage systems for the four cities were estimated. These costs were compared each other and were taken into account with other important factors, such as ease of implementation, magnitude of initial investment and its effects, to select the most suitable systems.

5.3 PRELIMINARY ENGINEERING DESIGN

(a) Preliminary engineering design of the major sewerage facilities, such as trunk sewers, pumping stations and treatment plants was carried out based on the selected alternative systems. Leveling survey was conducted to obtain necessary information about topography in the four cities. Temporary bench marks, which are to be used for sewerage planning were established in the four cities. Calculations and drawings are attached to the report in separate volumes. Outline of the new facilities in the four cities are shown in Table 5.1.

Table 5.1 Outline of Sewerage Facilities up to 1995

City	Service Area (ha) Exis.	New	Total	Population	New Facilities: Branch and Lateral Sewer (km) Exis.	New	Total	Trunk Sewer & Force Main Dia.(mm)	Length (m)	Pumping Station	Dia.xNos.	Treatment Plant: Wastewater Flow Rate	Treatment Capacity*
Zagazig	794	832	1,626	297,000	318	333	651	250-900	10,760	No.3 No.5	250x4 200x4	---	---
Faqus	-	424	424	61,000	-	170	170	200-1000	13,830	No.1 No.2 No.3	200x3 150x3 300x3	12,213**	10,241 (1/2)
Bilbeis	227	129	356	133,000	91	52	143	200-900	6,140	No.1	250x3	20,983**	22,303 (1/2)
Minyet El Qamh	150	100	250	61,000	60	40	100	200-750	7,270	-		9,800**	9,559 (1/2)

Note: * Parentheses under treatment capacity indicate a portion of major treatment units to be completed by 1995.

** Daily average flow

(b) A new treatment plant, which is under construction in Zagazig, is not included in preliminary engineering design. However, it was confirmed that the capacity of the present construction is sufficient to accomodate combined sewage flows from Zagazig and Qenayat in 1995, and even that in 2005. The three other treatment plants were designed as conventional activated sludge process. Staged construction program is recommended, and one of two sets of primary, secondary and sludge treatment process units are to be constructed by 1995. Goals of the treatment is set at 30/30 mg/l for BOD and SS, which are well below the legal requirements of 60/50 mg/l. Treated effluent will be discharged into nearby drains. Sludges are treated by sludge drying beds, and reuse for agricultural purpose is recommended for final disposal of sludge.

5.4 COST ESTIMATION

(a) Project costs necessary for implementation of the first phase program were estimated in the same manner as mentioned in Section 4.3. Breakdown of the project costs by work items and by local and foreign components are shown in Table 5.2. A total of approximately LE 144 million is required for the construction of sewerage systems in the four cities. Of the total project costs, LE 120 million, or 84 percent is the local currency component and LE 24 million, or 16 percent is the foreign currency component. Project costs for each city are LE 48.5 million for Zagazig, LE 39.2 million for Faqus, LE 33.9 million for Bilbeis and LE 22.5 million for Minyet El Qamh.

(b) Implementation schedule for the four cities up to 1995 was developed, taking into account order and required time of each work item, which is shown in Table 5.3. Sewage treatment plant in Zagazig is considered to be completed by the end of fiscal 1990/91, and three other treatment plants by the end of 1994/95.

Table 5.2 Total Project Costs (1995)

(LE 1,000)

City		B/L Sewer	Trunk Sewer	P/S	STP	Sub-total	Land Purchasing Cost	Rehabilitation Cost	Contingency	Engineering Cost	Total Cost
Zagazig	T	24,960	4,274	2,121	-	31,355	150	5,841	7,439	3,720	48,505
	L/C	24,960	3,633	1,082	-	29,675	150	2,561	6,447	3,224	42,057
	F/C	-	641	1,039	-	1,680	-	3,280	992	496	6,448
Faqus	T	12,720	4,102	1,936	7,230	25,988	4,665	592	5,316	2,658	39,219
	L/C	12,720	3,487	1,136	5,148	22,491	4,665	420	4,582	2,291	34,449
	F/C	-	615	800	2,082	3,497	-	172	734	367	4,770
Bilbeis	T	2,040	1,821	1,711	13,370	18,942	8,075	942	3,977	1,989	33,925
	L/C	2,040	1,548	616	9,334	13,538	8,075	426	2,793	1,397	26,229
	F/C	-	273	1,095	4,036	5,404	-	516	1,184	592	7,696
Minyet El Qamh	T	3,000	1,530	700	7,650	12,880	4,500	930	2,762	1,381	22,453
	L/C	3,000	1,301	140	5,497	9,938	4,500	244	2,036	1,018	17,736
	F/C	-	229	560	2,153	2,942	-	686	726	363	4,717
TOTAL	T	42,720	11,727	6,468	28,250	89,165	17,390	8,305	19,494	9,748	144,102
	L/C	42,720	9,969	2,974	19,979	75,642	17,390	3,651	15,858	7,930	120,471
	F/C	-	1,758	3,494	8,271	13,523	-	4,654	3,636	1,818	23,631

Note - B/L: Branch and Lateral
P/S: Pumping Station
STP: Sewage Treatment Plant
T : Total
L/C: Local Currency Portion
F/C: Foreign Currency Portion

Table 5.3 Implementation Schedule

(LE 1,000)

City	Work Item	1989/90	1990/91	1991/92	1992/93	1993/94	1994/95	Sub-total
Zagazig	1. Sewer Pipes	-	-	7,309	7,309	7,309	7,307	29,234
	2. Pumping Station	-	-	530	530	530	531	2,121
	3. Treatment Plant	-	-	-	-	-	-	-
	4. Rehabilitation	1,460	1,460	1,460	1,461	-	-	5,841
	5. Land Acquisition	150	-	-	-	-	-	150
	6. Engineering	930	930	930	930	-	-	3,720
	7. Contingency	1,860	1,860	1,860	1,859	-	-	7,439
	Sub-total	4,400	4,250	12,089	12,089	7,839	7,838	48,505
Faqus	1. Sewer Pipes	-	-	4,206	4,206	4,206	4,204	16,822
	2. Pumping Station	-	-	484	484	484	484	1,936
	3. Treatment Plant	-	-	1,808	1,808	1,808	1,806	7,230
	4. Rehabilitation	296	296	-	-	-	-	592
	5. Land Acquisition	2,333	2,332	-	-	-	-	4,665
	6. Engineering	665	665	665	663	-	-	2,658
	7. Contingency	1,329	1,329	1,329	1,329	-	-	5,316
	Sub-total	4,623	4,622	8,492	8,490	6,498	6,494	39,219
Bilbeis	1. Sewer Pipes	-	-	965	965	965	966	3,861
	2. Pumping Station	-	-	428	428	428	427	1,711
	3. Treatment Plant	-	-	3,343	3,343	3,343	3,341	13,370
	4. Rehabilitation	471	471	-	-	-	-	942
	5. Land Acquisition	4,038	4,037	-	-	-	-	8,075
	6. Engineering	497	497	497	498	-	-	1,989
	7. Contingency	994	994	994	995	-	-	3,977
	Sub-total	6,000	5,999	6,227	6,229	4,736	4,734	33,925
Minyet El Qamh	1. Sewer Pipes	-	-	1,133	1,133	1,133	1,131	4,530
	2. Pumping Station	-	-	175	175	175	175	700
	3. Treatment Plant	-	-	1,913	1,913	1,913	1,911	7,650
	4. Rehabilitation	465	465	-	-	-	-	930
	5. Land Acquisition	2,250	2,250	-	-	-	-	4,500
	6. Engineering	345	345	345	346	-	-	1,381
	7. Contingency	691	691	691	689	-	-	2,762
	Sub-total	3,751	3,751	4,257	4,256	3,221	3,217	22,453
Total	1. Sewer Pipes	-	-	13,613	13,613	13,613	13,608	54,447
	2. Pumping Station	-	-	1,617	1,617	1,617	1,617	6,468
	3. Treatment Plant	-	-	7,064	7,064	7,064	7,058	28,250
	4. Rehabilitation	2,692	2,692	1,460	1,461	-	-	8,305
	5. Land Acquisition	8,771	8,619	-	-	-	-	17,390
	6. Engineering	2,437	2,437	2,437	2,437	-	-	9,748
	7. Contingency	4,874	4,874	4,874	4,872	-	-	19,494
	Total	18,774	18,622	31,065	31,064	22,294	22,283	144,102

5.5 REHABILITATION OF THE EXISTING FACILITIES

Rehabilitation of the existing sewerage facilities in the four cities is included in the first phase program. Improvement of the existing sewer pipes and replacement of the pumping units are main work items for rehabilitation. For improvement of the sewer pipes, 15 percent of construction cost for new facilities is assumed to be required. For replacement of pumping units, costs for supply and erection of pumps and motors are estimated. These costs are included in the total project costs.

5.6 PROCUREMENT OF EQUIPMENT AND MATERIALS

Most of the construction materials for the sewerage facilities are readily available locally in the Governorate. Construction should be undertaken by local contractors. However, some mechanical and electrical equipment shall be imported from foreign countries. Under the present circumstances in Egypt, and considering the nature of the project, it is suggested that NOPWASD procures these equipment in advance of the initiation of construction.

5.7 INSTITUTIONAL ARRANGEMENT

In pursuance of the long-term program up to the year 2005, institutional arrangement for the first phase program up to 1995 is identified and recommended.

(a) For the implementation of the first phase program, NOPWASD is proposed as the central agency to perform the leading role from the initiation of the program to the completion of the system construction, undertaking the responsibility to construct the major facilities as sewage treatment plants, pumping stations and trunk sewers. At the preparatory stage of the program, NOPWASD is required to keep in close contact with other key central agencies such as Ministry of Housing and Public Utilities, and the Ministry of Planning to obtain the necessary support in funding and administrative arrangements. The Ministry of International Cooperation is also required to be involved in arranging foreign aid and in

coordination among foreign agencies and national agencies concerned. NOPWASD is required to provide the task force comprising of key personnel of i) project manager/assistant project manager, ii) project design engineer, iii) project cost engineer, iv) project construction engineer, v) project accountant, vi) project treasurer, and vii) other supporting staff, for project implementation.

(b) While NOPWASD would be responsible for the construction of major sewerage facilities, Sharqiya Governorate would be responsible for the works of small size branch and lateral sewers, minor rehabilitation and installment of the house connections under the technical assistance and cooperation of NOPWASD.

(c) The four cities would be required to take part in some parts of the first phase construction work, such as construction of branch and lateral sewers. It is desirable that the personnel of the sewerage units related to the project cooperate or assist to the extent possible, NOPWASD and the Governorate during the construction period so that practical on-the-job training can be achieved.

(d) After the completion of the major facilities in all four cities by NOPWASD, the completed systems are to be transferred to the governorate, so that the governorate would undertake full responsibility for the operation and maintenance of the transferred systems. The governorate should strengthen the organization and staffing to cope with construction and particularly with operation and maintenance of the seweage systems, providing the new units and/or expanding the existing units. Proposed organizational setup related to the first phase program is shown in Figure 5.1, and a detailed staffing schedule is shown in Table 5.4

Figure 5.1 Proposed Organization Chart related to First Phase Sewerage Development Project

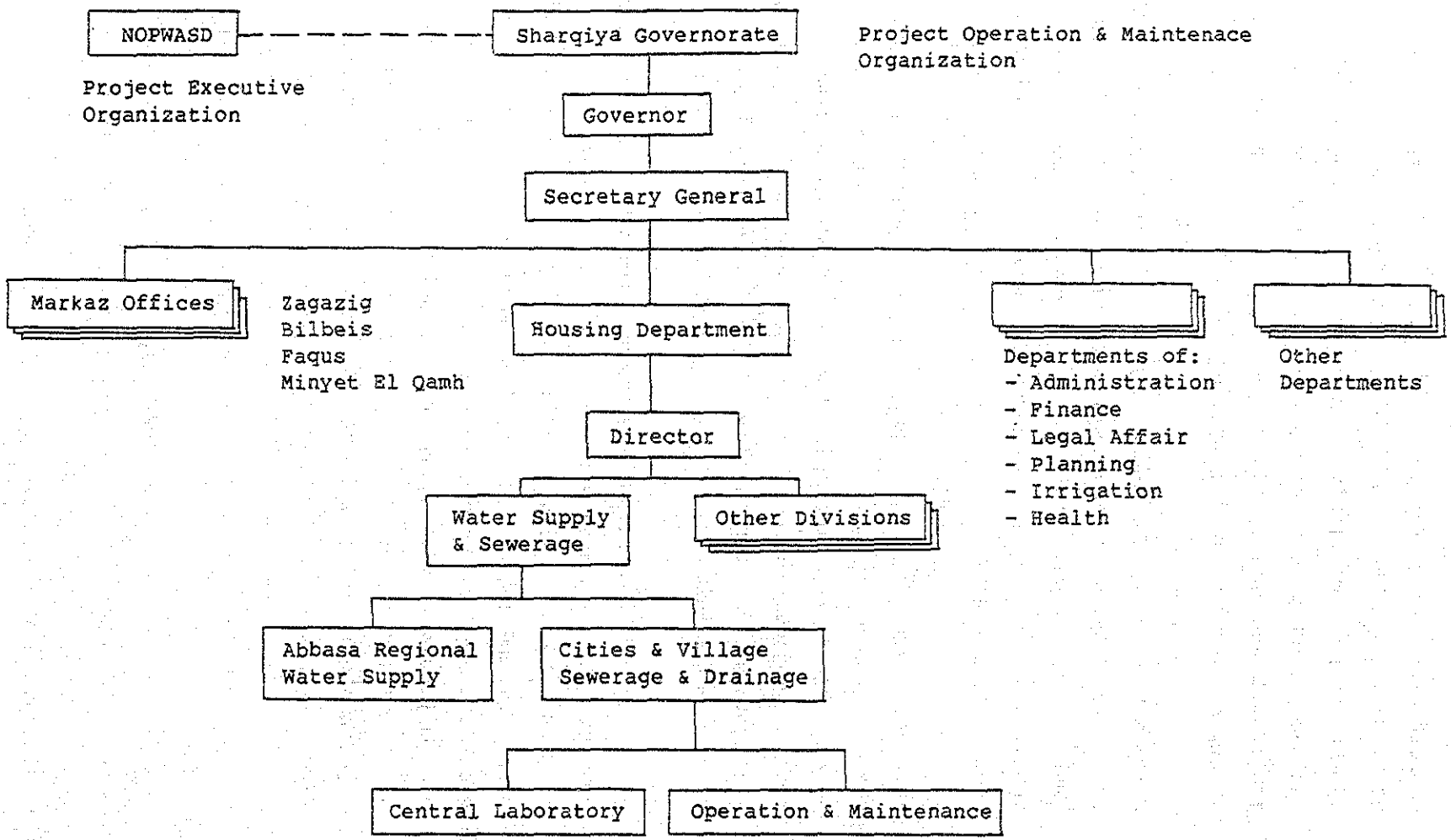

Table 5.4 Schedule of Estimated Staff Requirements for the First Phase Program

	1990/91	91/92	92/93	93/94	94/95	95/96	96/97	97/98	98/99	99/2000
Governorate Office:										
Cities & Village										
Sewerage & Drainage										
Operation & Maintenance	2	4	4	4	4	4	6	6	6	6
Central Laboratory	0	1	3	3	3	3	4	4	4	4
Markaz of Zagazig:										
Treatment Plant Unit	1	20	20	20	20	20	20	20	20	20
Pumping Station Unit	1	1	1	1	46	46	46	46	46	46
Sewer Unit	1	51	51	51	73	95	117	117	117	117
Markaz of Bilbeis:										
Treatment Plant Unit	1	1	1	1	1	20	20	20	20	20
Pumping Station Unit	1	1	1	1	1	61	61	61	61	61
Sewer Unit	1	6	6	6	6	21	21	21	21	21
Markaz of Faqus:										
Treatment Plant Unit	1	1	1	1	1	20	20	20	20	20
Pumping Station Unit	1	1	1	1	1	46	46	46	46	46
Sewer Unit	1	26	26	26	26	60	60	60	60	60
Markaz of Minyet El Qamh:										
Treatment Plant Unit	1	1	1	1	1	20	20	20	20	20
Pumping Station Unit	1	1	1	1	1	46	46	46	46	46
Sewer Unit	1	7	7	7	7	21	21	21	21	21
Total	14	122	124	124	191	483	508	508	508	508

5.8 FINANCIAL ANALYSIS

(a) The tariff rates used are unitary. The billing and collection systems are more or less the same in Sharqiya. The faulty meters are a serious problem, however there is no immediate solution. The consumers are responsible for the individual house connection. The use of vacuum cars to dispose of sewage is also commonly practiced in the project area. The private vacuum car system is available, yet it costs much more than the public system.

(b) The 160 families were sampled for a household income study. The average family size is 5.7 persons. The mean income level ranges between LE 180.1 and LE 233.6 per month among the five cities and the aggregate average is LE 210.9 in the project area. The average monthly payment for water supply is LE 1.2 per family of which sewage payment is LE 0.12 on average. The analysis shows that the proportion of the water charges including sewerage charges is 1.5% of the monthly income. If the private sewerage collector costs are also included, the affordability of the consumers would become significantly higher than the current tariff level.

(c) In view of the affordable limit of the consumers, it is suggested that the present tariff should be raised over time to meet the increasing operation and maintenance expenses.

(d) The proposed project requires large capital investment (LE 144.1 million). Of this, the foreign currency component is 16.4% while the local currency component is 83.6%. For financing this, various sources of funding must be sought out to reduce the financial burden of the Government. In this connection, the grant assistance scheme would be most appropriate to finance the foreign currency portion and a part of local currency portion of the project costs as the social sector project normally shows low rate of investment return. For the local portion, the subsidy and equity contribution from the central Government would be essential.

(e) The financial projection is carried out on the basis of the project revenues assuming substantial increases in tariff rates and sludge sales as a by-product from sewerage treatment plants. The analysis shows that the forthcoming operation and maintenance costs can be covered by the above revenues. Nevertheless, if the loan component is involved in the project financing plan, the debt service repayment would be extremely difficult under the estimated financial projection.

(f) Before computation of financial internal rate of return (FIRR), the long-run average incremental cost (AIC) at market prices was estimated. The results indicate that the AIC is considerably higher than the present tariff level. With the tariff increases proposed, the FIRR was calculated on five alternative cases: the highest FIRR (+2.4%) was obtained in case of the foreign portion of the total costs to be financed on grant basis and substantial tariff growth to be implemented. The lowest FIRR(-2.2%) was given in case of all the costs to be financed by the central Government and moderate tariff growth to be practiced. In view of this sensitivity test results, it is suggested that the proposed project should be implemented under the grant assistance scheme rather than the conventional loan scheme from foreign countries.

5.9 ECONOMIC ANALYSIS

(a) The AIC at economic prices was estimated. The result shows that the AIC was between 52 pts/m3 at a discount rate of 13% and 66 pts/m3 at a discount rate of 17%. The tariff rates which were proposed in our report were found within this AIC. The affordability of the consumers were also checked with the new tariff rates. The outcome was found that the proposed rates were within reasonable proportional limits of the monthly income level of the consumers.

(b) There are numerous economic benefits that the proposed project would generate. However the most of them are unquantifiable. The economic benefits that accrue from the project could be summarized as follows:

(i) reduced expenses for health care,
(ii) higher productivity of children in school,
(iii) improved welfare of the population,
(iv) higher land value,
(v) increased employment opportunities, and
(vi) transfer of technology.

The proposed project would help to increase wastewater treatment to the levels required in the year 2005 in the project area. The project would benefit some 480,000 people in 2000 and 520,000 people in 2005 living in the project area. In light of the need for improving the urban sewerage service in medium-sized cities in Egypt and the expansion of piped potable water to dwellings, coupled with high population density in the project area, it is economically justifiable for the Government to immediately implement the proposed sewerage system in Sharqiya.

5.10 ENVIRONMENTAL AND SOCIAL EVALUATION

(a) Many pollution control laws and decrees have been enacted in Egypt recently. The importance of carrying out environmental evaluation prior to the commencement of development project has been widely recognized. However, no law covering the environmental evaluation method has been actually decreed for various development projects. For enviornmental

evaluation of the sewerage system development project in the Sharqiya Governorate, technical alternatives for treatment and disposal of sewage and phasing alternatives were evaluated.

(b) There are some adverse effects on the environment caused by construction and operation of the sewerage system. However, these effects can be maintained at minimum levels if the system is constructed and maintained properly. Moreover, provision of a new sewerage system and treatment of sewage will significantly relieve present water pollution problems in surface water as well as groundwater, together with improvements in public health conditions. In view of environmental and social evaluation, overall effects expected by implementation of the sewerage projects in the project area are considered to be positive.

VI. CONCLUSION AND RECOMMENDATION

6.1 CONCLUSION

The need for improving urban sewerage service in medium size cities throughout Egypt is evident from the existing widespread severe environmental problems. Due to the expansion of piped potable water supply, coupled with high population density, inadequate sanitation system appears to be the leading cause of infectious diseases in urban areas. Benefits derived from the sewerage projects, although most of them are difficult to evaluate in a quantitative manner, are significant from environmental and public health points of view. Furthermore, through the implementation of the sewerage projects, other intangible benefits, such as institutional developments, opportunity of participation in the training program, can be realized. Therefore, implementation of the sewerge projects is justified in all respects.

6.2 RECOMMENDATION

A number of recommendations are made throughout the current report for the efficient and successful implmentation of the projects. These are summarized as follows:

- Preparation of topographic maps with relevant scales
- Carrying out sound engineering design for all construction work
- Immediate acquisition of land necessary for major sewerage facilities
- Utilization of local contractors and materials
- Provision of secondary treatment by conventional activated sludge process for medium size cities and by oxidation ditch process for small size cities
- Measurement and recording of sewerage flow at certain important points
- Monitoring of water quality in raw sewage and treated effluent
- Preparation and maintenance of as-built drawings
- Reuse of dried sludge for agricultural purpose
- Reuse of treated effluent for agricultural purpose
- Implementation of the first phase program in the four cities by NOPWASD
- Responsibility of the Sharqiya Governorate for the first phase program and for the long-term program

- Operation and maintenance of the sewerage systems by individual Markaz
- Establishment and fulfilment of efficient and practical training programs
- Raising of sewerage tariff to assure positive FIRR
- Need for foreign grant aid for viable operation of the projects