JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
PALESTINIAN INTERIM SELF-GOVERNMENT AUTHORITY
MINISTRY OF PLANNING AND INTERNATIONAL COOPERATION (MOPIC)

THE STUDY ON SEWERAGE DEVELOPMENT PLAN IN THE AREA OF KHAN YUNIS IN PALESTINIAN INTERIM SELF-GOVERNMENT AUTHORITY

FINAL REPORT
MAIN REPORT

DECEMBER 1997

PACIFIC CONSULTANTS INTERNATIONAL CO., LTD., TOKYO
NIHON SUIDO CONSULTANTS CO., LTD., TOKYO

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In this report, the following exchange rate as of August 1997 was used for the cost estimation:

US$ 1.00 = NIS 3.3 = Yen 120

PREFACE

In response to the request from the Palestinian Interim Self-Government Authority, the Government of Japan decided to conduct the Study on Sewerage Development Plan in the Area of Khan Yunis in Palestinian Interim Self-Government Authority and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Palestine a study team headed by Dr. Norihiro Noda, and composed of members from Pacific Consultants International and Nihon Suido Consultants co., LTD, four times between September 1996 and October 1997.

The team held discussions with the officials concerned of the Palestinian Interim Self-Government Authority, and conducted field surveys. After the team returned to Japan, further studies were made and the present report was prepared.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two governments.

I wish to express my sincere appreciation to the officials concerned of the Palestinian Interim Self-Government Authority for their close cooperation extended to the team.

December 1997

Kimio Fujita
President
Japan International Cooperation Agency

THE STUDY ON SEWERAGE DEVELOPMENT PLAN IN THE AREA OF KHAN YUNIS IN PALESTINE INTERIM SELF-GOVERNMENT AUTHORITY

Mr. Kimio Fujita
President
Japan International Cooperation Agency

LETTER OF TRANSMITTAL

Dear Sir,

We are pleased to submit to you the final report entitled "THE STUDY ON SEWERAGE DEVELOPMENT PLAN IN THE AREA OF KHAN YUNIS IN PALESTINIAN INTERIM SELF-GOVERNMENT AUTHORITY". This report has been prepared by the Study Team in accordance with the contract signed on 11 September 1996 (changed 24 October 1996) and 12 May 1997 between the Japan International Cooperation Agency and the Joint Study Team of Pacific Consultants International and Nihon Suido Consultants.

The report examines the existing conditions of sewerage and urban drainage in the area of Khan Yunis, presents a master plan of drainage, sewerage development and the results of a feasibility study on sewerage and drainage development for the priority areas selected by the master plan.

The report consists of the Executive Summary, Main Report, Supporting Report and Drawings including the discs. The Executive Summary summarizes the results of all studies. The Main Report contains background conditions, sewerage development plan, urban drainage, conclusions and recommendations. The Supporting Report includes data and technical details. In addition, Drawings have been prepared and is submitted herewith.

All members of the Study Team wish to express grateful acknowledgement to the personnel of your Agency, Advisory Committee, Ministry of Foreign Affairs, Ministry of Construction and Embassy of Japan in Israel, and also to officials and individuals of the Palestinian Interim Self-Government Authority for their assistance extended to the Study Team. The Study Team sincerely hopes that the results of the study will contribute to the socio-economic development and the improvement of health and hygiene in the area of Khan Yunis and that friendly relations of both countries be promoted further by this occasion.

Yours faithfully,

Norihiro Noda

Dr. Norihiro Noda
Team Leader

Main Report

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ACRONYMS

Agencies and Programs

IBRD	International Bank for Reconstruction and Development
JICA	Japan International Cooperation Agency
MOPIC	Ministry of Planning and International Cooperation
NGO	Non-Governmental Organization
PLO	Palestinian Liberation Organization
PWA	Palestinian Water Authority
OECF	Overseas Economic Cooperation Fund
UNDP	United Nations Development Programme
UNEP	United Nations Environmental Programme
UNRWA	United Nations Relief and Works Agency for Palestine Refugees in the Near East
WHO	World Health Organization

Technical Terms

BOD_5	Biochemical oxygen demands, 5-day, 20℃
COD	Chemical oxygen demands
Cl	Chlorine ion
DO	Dissolved oxygen
MLSS	Mixed liquor suspended solids
MLVSS	Mixed liquor volatile suspended soids
MPN	Most probable number
NKj N	Kjeldahl nitrogen
pH	The reciprocal of the logarithm of the hydrogen-ion concentration
SS	Suspended solids
SRT	Sludge retention time
TS	Total solids
TSS	Total suspended solids
T-N	Total nitrogen
T-P	Total phosphorous
As	Arsenic
Cr6	Chromium, hexavalent
Cr	Chromium
Fe	Iron
Mn	Manganese
Pb	Lead
Cd	Cadmium
Hg	Mercury

Economics and Financial Terms

AIC	Average incremental cost
B/C	Benefit to cost ratio
CRF	Capital recovery factor
EIRR	Economic internal rate of return
FIRR	Financial internal rate of return
F.V.	Future value
NPV	Net present value
PW	Present worth
OCC	Opportunity cost of capital
p.a.	Per annum

UNITS

Units	
mm	millimeter
cm	centimeter
m	meter
km	kilometer
mm^2	square millimeter
cm^2	square centimeter
m^2	square meter
km^2	square kilometer
ha	hectare
d	dunom (= 0.1 ha)
ml	milliliter
l	liter
m^3	cubic meter
mg	milligram
g	gram
kg	kilogram
t	ton (1000kg)
W	watt
kW	kilowatt
kwh	kilowatt hour
m^3/d	cubic meters per day
m^3/h	cubic meters per hour
m^3/s	cubic meters per second
l/d	liters per day
l/s	liters per second
lpcd	liters per capita day
Pa	newtons per square meter
kPa(kN/m^2)	kilonewtons per square meter
kg/cm^2	kilograms per square centimeter
mg/l	milligrams per liter
$m^3/m^2/d$	cubic meters per square meter per day

CHAPTER 1 INTRODUCTION

CHAPTER 1 INTRODUCTION

1.1 Background

There has been a long history between Palestine and Israel: most of the time were not necessarily peaceful. Even since the end of WWII the two peoples had been fighting for their existence fiercely. However those days of war and hatred came to an end several years ago.

On September 13, 1993 the Israeli Government and PLO (Palestinian Liberation Organization) reached an official agreement for peace between Israel and Palestine. This was called as "Oslo I." It was followed by additional agreements for materialization up to "Oslo II" on September 18, 1995. Since then many donors, bilateral and multilateral, have expressed their wishes for contributions for peace. The Government of Japan has set up and aid package of US$200 million for two years, in coordination with other donors, to assist the Palestinian Authority develop itself. The Japanese assistance will be followed by different programs and schemes.

However this kind of peaceful progress was made by the Labor Party of Israel (late Prime Minister Rabin and former PM Peres) seeking the co-existence with Palestinians. When the conservative Likad coalition government came to power in May 1996, the peace process was reviewed and delayed by PM Netanyahu. They are stressing more on security than peace. The different approaches of both governments led to an incident in end-September 1997, claiming about 70 deaths. At the same time this study started in the field of Palestine.

The City of Khan Yunis is No. 2 City of Gaza Governorates following Gaza City. It is located in the southern part of Gaza Governorates, and expected to be a development center for the southern Gaza Governorates. It has at present an administrative area of ca. 25 km^2 with a total population of ca. 150,000, including ca. 50,000 residing in Al Qatatwa Refugee Camp. The City of Khan Yunis recently integrated four communities of Kiza Al Najar, Kizan Abu Humar, Ka'a Al Gorain and Wadi Saber, located south to the City. This area is basically an agricultural area and named as Kizan Area in the Study.

The City of Khan Yunis is surrounded with five villages of Bani Sohaila, Abasan Saghera, Abasan Kabera, Khuzaa and Qarrara, with an estimated population of ca. 50,000. They are also covered with the Study.

Palestine has been fighting and suffering from continuous wars and troubles with Israel since the end World War II up to the Peace Agreement. As a result basic infrastructures such as sewerage system were not made satisfactory to ever increasing demands of the people, especially in the area of Khan Yunis.

The residents are using cess pits or leaching pits for toilet wastewater and discharging other wastewater to streets or empty lands. Wastewater or its residuals finally reach the aquifer and contaminate it. A high concentration of nitrate is observed in ground water, causing a health problem.

In Gaza Governorates UNRWA, EU or bilateral donors like US are working to conduct feasibility studies on sewerage systems for other cities beside Khan Yunis. Therefore the Palestinian Interim Self-Government Authority made an official request to conduct a sewerage development study for the Area of Khan Yunis.

Responding to the request, the Government of Japan dispatched the Preparatory Study Team in March 1996 to discuss the Scope of Work for the full-scale Study. Both sides reached the agreement for this Study to be conducted by Japanese consultants.

1.2 Purpose of Master Plan

The Study is targeted at the following components to improve the environmental and hygienic conditions of the area of Khan Yunis:

(1) To formulate a Master Plan of sewerage system for the area of Khan Yunis for 20 years up to year 2015, and to conduct a Feasibility Study for the priority project selected from the Master Plan,
and

(2) To conduct technical transfer to the Palestinian counterpart members through the Study.

The wastewater to be targeted at will be domestic wastewater, nightsoil, industrial wastewater and stormwater.

The purpose of Master Plan is to formulate the sewerage/drainage plan for the Khan Yunis Area of about 44.6 Km^2, taking into account all the aspects related to the Study such as urban, industrial and agricultural developments.

1.3 Study Area

The Study Area is vastly varied with characteristic situations such as population density: from about 400 persons per ha in Al Qatatwa Camp to several persons per ha in the Kizan area consisting of Kiza Al Najar, Kizan Abu Humar, Ka'a Al Gorain and Wadi Saber. The population growth rate is as high as ca 5%, and is considered to be by and large at this level in the near future. Based on this projection, the total population of the Study Area will double in the target year 2015.

The total Study Area is estimated to be ca. 44, Km^2, with a total population of about 200,000, resulting in the average population density of 45 persons per ha.

The area and population is summarized in Table M.1.1.

Table M.1.1 Area and Population of the Study Area

Study Area	Area (ha)	Population	Remarks
Khan Yunis City	1,660	126,000	including Camp
Qarrara	443	10,000	
Bani Sohaila	404	24,000	
Abasing Saghera	128	6,000	
Abassan Kabera	424	17,000	
Khuzaa	129	8,000	
Kizan Area	1,270	5,000	
Total	4,458	196,000	

As the Study necessitates, other cities in Gaza Governorates and in Israel will be included in the Study.

1.4 Study Organization

The Preliminary Study Team reached the agreement of S/W to conduct the Study in March 1996. The Full-scale Study Team was selected in September 1996 by JICA. The counterpart organization of the Palestinian Government is Ministry of Planning and International Cooperation (MOPIC).

Japan International Cooperation Agency (JICA) has the overall responsibility for the Study, assisted by Advisory Committee. The committee is basically responsible for the technical aspects and is to give advices to JICA as requested.

The Palestinian National Authority (PNA) has organized the Steering Committee including MOPIC as the prime counterpart organization, supported by Palestinian Water Authority (PWA), Ministry of Agriculture (MOA), the Municipality/Village concerned, and others. The Steering Committee is the major committee of the Palestinian Government, in which the Study's major findings are to be reported and the decisions are to be made for essential matters like land acquisition.

The Study has been jointly conducted by both the JICA Study Team and the Palestinian counterpart team in close consultation with the Steering Committee as well as the JICA Advisory Committee. The study organization is shown below.

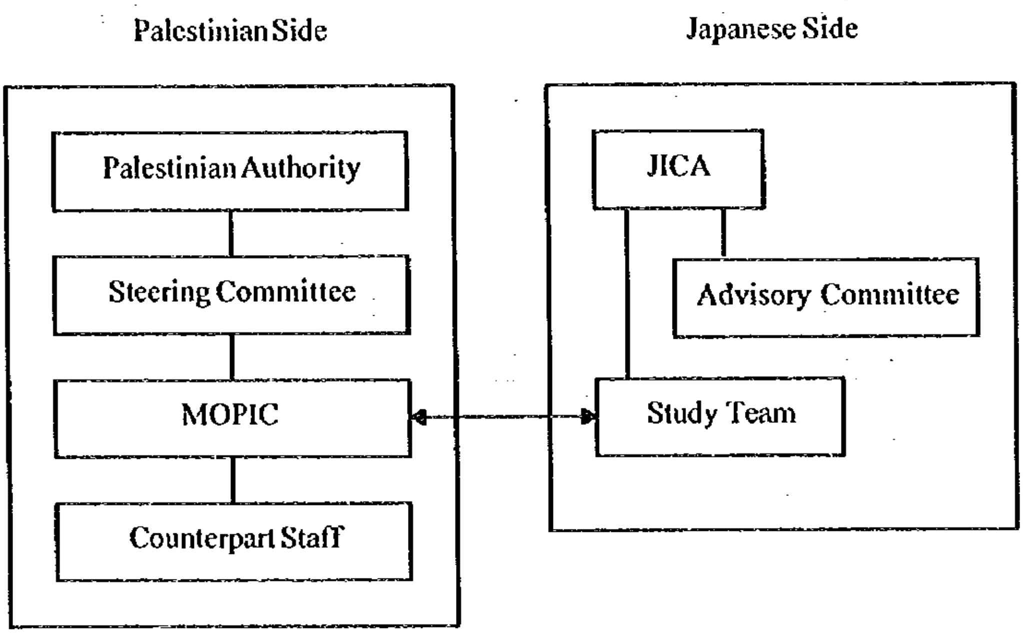

Fig. M.1.1 Study Organization

In Japan the Advisory Committee is held at the essential timing such as departure and return of the Study Team to be reported to and give guidance through JICA.

1.5 Study Reports

All the reports to be produced in the course of the Study are as follows:

- Inception Report to be submitted in September 1996
- Progress Report (1) to be submitted in December 1996
- Interim Report to be submitted in March 1997

These three reports were submitted to JICA and MOPIC at the designated timing. The Interim Report covers the main components of Master Plan, though some minor changes must be made in the Draft Final Report.

In the second year the following reports are to be submitted.

- Progress Report (2) to be submitted in July 1997
- Draft Final Report to be submitted in September 1997
- Final Report to be submitted in November 1997

The Final Report will be completed in Japan one month after the Study Team receives comments made by the Palestinian Side to the Draft Final Report.

The first field survey was conducted from September 20 to December 18, 1996. The first batch of the Study Team consisting of 5 members were accompanied by two members of the JICA Advisory Committee and one official of the JICA Headquarters. The IC/R was discussed with the Steering Committee from September 22 through 25, 1996, and agreed between both sides. The agreements were recorded on the M/M dated on September 25, 1996.

Since then, however, unhappy troubles occurred on September 25 in West Bank and September 26 in Gaza Governorates, followed by a couple of days' disturbances both in West Bank and Gaza Governorates. A total of about 70 people were killed in theses incidences. However fortunately this was ended up with a summit meeting held in Washington D.C. in USA. Since then continuous discussions are being held between Palestine and Israel. The present situation is calm and the Study can be continued.

However the second and third batches of the Study Team members were postponed until the end of the first field work. The original study schedule was largely changed: only five members had worked in the field by substituting the works of other members and subcontracting two additional surveys.

Though a large change was made to the original schedule, an additional mission to supplement the first field work as made possible at end of February 1997 for 18 days. This mission consisted of five members who mainly visited the site for the first time. The Interim Report was submitted as scheduled in March 1997.

CHAPTER 2 EXISTING CONDITIONS

CHAPTER 2 EXISTING CONDITIONS

2.1 Natural Conditions

2.1.1 Topography and Geography

The Study Area is located in the southwest of Gaza City, covering an area of 44.58 km^2. The Area comprises Khan Yunis City and its surrounding nine (9) villages and one refugee camp.

Khan Yunis City and its surrounding areas are the center of the Southern District of the Gaza Governorates, comprising mostly flat terrain and coastal dunes with the ground elevations ranging from 20 to 90 meters above sea water level (SWL).

Along the coastal shore line is a long sand hill with about 40 meters SWL, forming in the north-southern direction. The ground elevations fall to about 25 meters SWL at the center of Khan Yunis City, declining toward the north-eastern direction and going up to inland hills of about 80 to 100 meters SWL in the same direction.

Soils of the Area are mostly loessial soils, and the ridges consist of sandstone. Sand dunes are found along the coast to the south and west of the Area, and have high water infiltration capacities, thus forming suitable areas for recharge of the aquifer.

The Area is drained through small branches of wadies, and the rainwater runoffs flow down generally following the natural ground slopes or drains, either reaching nearby wadies, infiltrate into ground, or evaporate while they are flowing downward. Once it rains, the wadis are formed following the natural ground elevations, having relatively small tributary areas and flowing either toward the Mediterranean Sea or southeastern direction.

2.1.2 Hydrology

In and around the Study Area, aquifer is made up by sand, sand stone and pebbles with a thickness of 120 meters near the coast. A typical hydro-geological cross section of the narrow strip shows the aquifer decreases in thickness by 100 meters. Agriculture is the largest water consumers in the Area.

The rainfall is not sufficient for the cultivation of most crops, and that supplemental irrigation water is necessary. The ground water resources are being over-exploited, and the deficit in the fresh water budget would be in the order of 40 million m³/year, and if such abstraction and use continue at the present rate, all the available good-quality ground water may be deteriorated in 15 to 20 years. The aquifer in the east and south of the Area contains more saline, having chloride concentrations of over 1,000 mg/l. The chloride concentrations measured in 1995 in the Study Area are shown in Figures M.2.1 and M.2.2.

2.1.3 Meteorology

General meteorological data such as daily and monthly precipitation are available from the Meteorological Station in Gaza, but without short-duration rainfall intensity data. Long-term meteorological conditions have been observed at the Station, including temperature, humidity, evaporation, and wind directions and velocities for more than twenty years. The "Meteorological Data" of this report, and are summarized in the following paragraphs:

(1) Air Temperature

Table M.2.1 shows air temperature in Khan Yunis City. The average monthly temperature varied between the lowest 13.6℃ in January and the highest 26.2℃ in August, with the average annual temperature of 21℃. Mean annual cloudiness range 30-35 percent and mean annual number of days with maximum temperature of 35℃ or more was 0～10 days. Temperatures are generally low during the winter months having annually from 51 to 100 days with minimum temperature of 10℃. The seasonal temperature transition being smooth and uniform and following the regular progression of the seasons in the Mediterranean climate. Temperatures in Gaza City observed from 1980 through 1995 are also indicated as a reference in Tables in Appendix-K.

Table M.2.1 Average Monthly Temperatures in Khan Yunis City (in ℃)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Temperature	13.6	14.0	15.8	18.0	21.3	23.8	25.7	26.2	25.2	22.9	19.8	15.4	21.0

Source: Israel Meteorological Service; Atlas of Israel, 1985. Observed over 14 years.
At 45 meters above sea level, 31° 21íN, 34° 18íE.

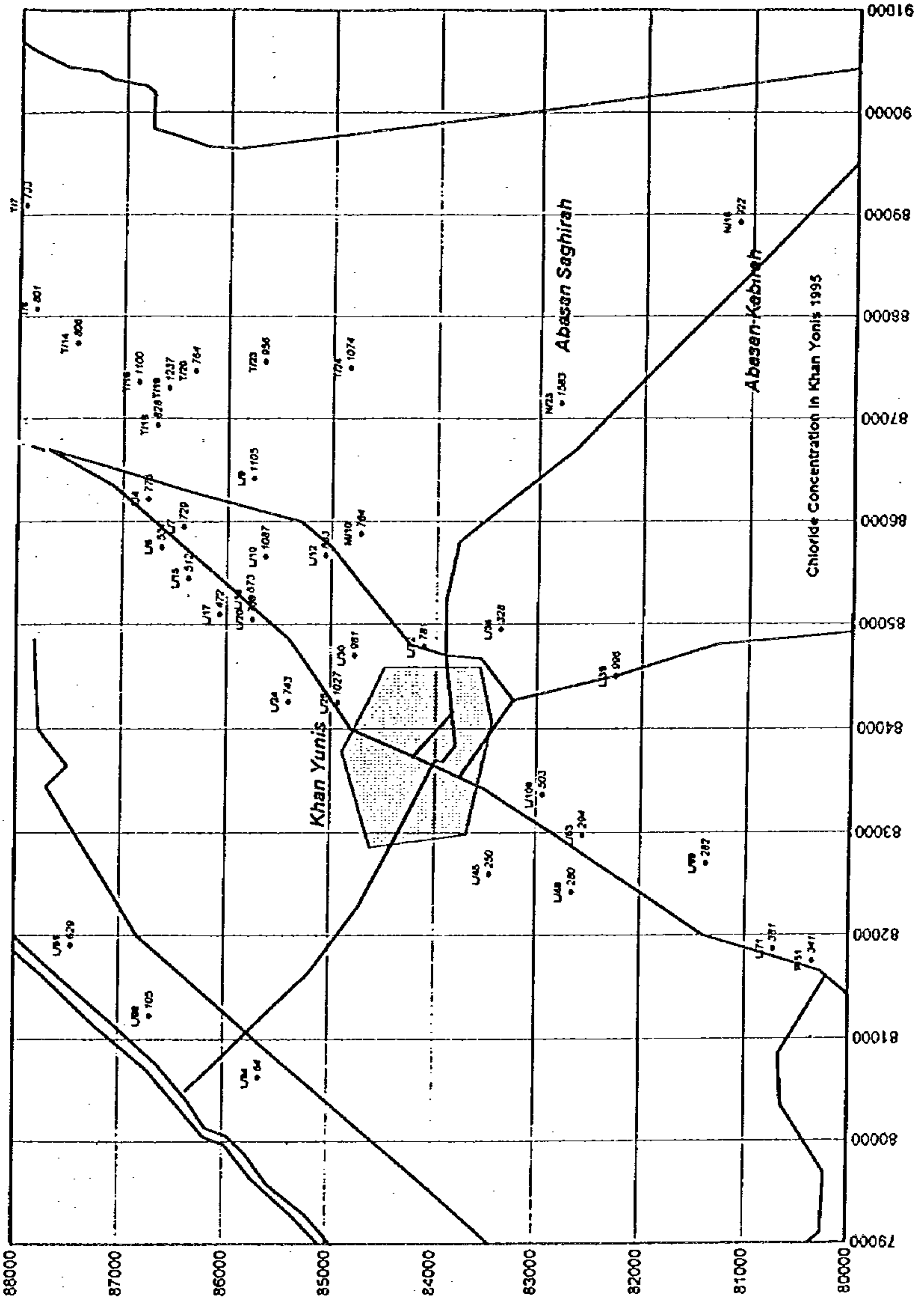

FIG.M.2.1	CHLORIDE CONCENTRATION IN KHAN YUNIS 1995 (1)

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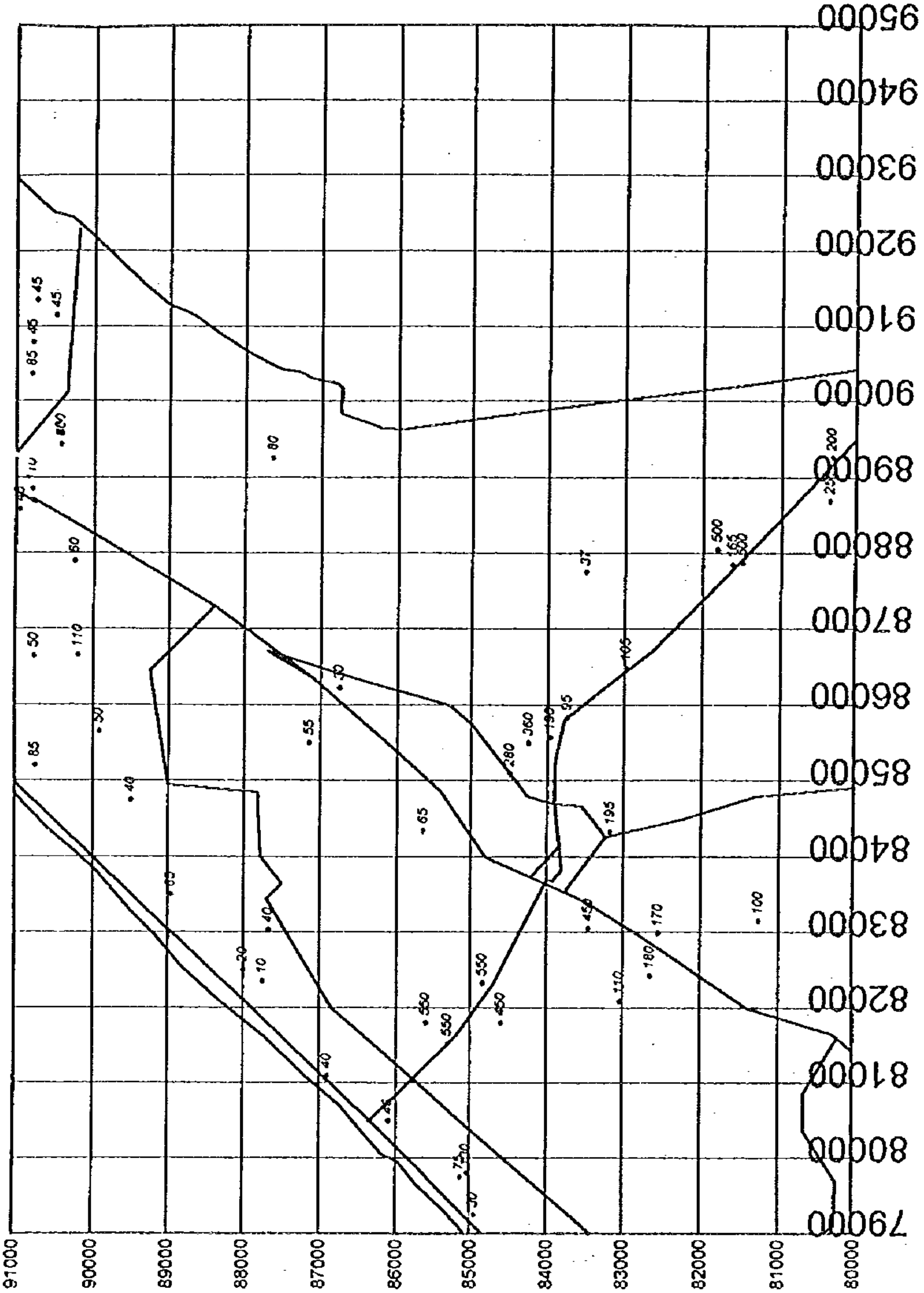

FIG.M.2.2	CHLORIDE CONCENTRATION IN KHAN YUNIS 1995 (2)

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JICA
AD 1997

(2) Precipitation

Table M.2.2 shows the monthly and yearly average precipitation in Gaza City observed by the Meteorological Station over a period of fourteen years from 1981 through 1994. The average monthly and annual precipitation in the area varied significantly, from the highest 546.5 mm in 1994 and the lowest 127.5 mm in 1981, with an average precipitation of 341.30 mm.

The driest months in the year are June through August with almost no precipitation. The wettest months are December and January with the average precipitation of 66 mm and 70.84mm respectively, as shown in Table M.2.2 below. There are two well defined seasons, the wet season starting in October and extending into April, and the dry season extending May to September.

The daily average precipitation also varied widely, the highest in the last eight years (1987 to 1994) being 75.5 mm occurred on November 30, 1991 and the second highest of 69 mm on November 22, 1994.

Table M.2.2 Monthly Precipitation (mm)

Year	Jan	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
1981	36.50	21.50	16.50	11.00	-	-	-	-	-	-	42.00	-	127.50
1982	47.00	151.50	55.20	-	-	-	-	-	-	-	138.30	78.80	470.80
1983	142.00	78.50	34.00	-	-	-	-	-	-	5.00	4.00	12.60	276.10
1984	53.00	0	35.10	5.00	-	-	-	-	-	6.00	17.00	28.00	144.10
1985	2.00	87.50	15.50	5.70	-	-	-	-	-	5.00	2.90	149.40	268.00
1986	13.50	21.90	2.70	96.50	10.20	-	-	-	4.70	36.00	280.40	40.80	506.70
1987	18.60	27.50	56.20	2.50	-	-	-	-	-	103.90	14.50	60.90	284.10
1988	104.10	97.00	19.70	4.70	-	-	-	-	-	7.00	37.50	54.50	324.50
1989	117.20	113.00	10.70	-	-	-	-	-	-	-	19.00	43.00	302.90
1990	76.20	38.00	69.00	12.50	-	-	-	-	-	-	11.00	18.00	224.70
1991	128.10	86.00	105.50	-	-	-	-	-	-	3.50	77.00	145.00	545.10
1992	123.80	171.50	18.20	-	2.00	1.00	-	-	-	-	43.50	135.00	495.00
1993	49.20	165.00	25.50	-	-	-	-	-	-	7.50	13.00	2.00	262.20
1994	80.50	22.50	15.00	-	-	-	-	-	-	7.00	265.50	156.00	546.50
Average	70.84	77.24	34.20	34.20	2.44	1.00	-	-	2.35	16.45	66.00	66.00	341.30

Source: Meteorological Station, Gaza, from 1981 to 1994.

(3) Evaporation

The monthly average evaporation over 25 years in Gaza varied between the maximum of 173.8 mm in July and the minimum of 63.4 mm in January, with the annual average evaporation of 1,299.8 mm. The average evaporation rates are generally higher when the temperatures are high and lower when the temperatures are low. The monthly average evaporation rates are shown in Table M.2.3 below.

Table M.2.3 Average Evaporation (mm)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Evaporation	63.4	73.1	94.1	116.4	133.4	135.5	173.8	137.8	124.9	113.7	91.0	78.7	1,299.8

Source: Israel Meteorological Service; Atlas of Israel, 1985.

(4) Wind

Wind directions and velocities vary depending on the season. The monthly average wind velocities in the last 16 years were in the range of 15 to 20 knots, the highest being 20.96 knots in 1992 and the lowest being 15.12 knots in 1987. The prevailing wind directions ranged in between 215 and 260 degrees from the north. Monthly average wind directions and velocities observed in the last 16 years from 1980 through 1995 are shown in Appendix-N of this report.

2.2 Socio-economy and Finance

2.2.1 Economy

(1) General Including Israeli Economy

As mentioned hereinafter, the economy in Palestine can not stand on its own feet without the relationship with Israel in terms of balance of payment in external trade. Therefore, the economic condition of Israel should be cleared firstly.

Israel is a nation consisting of immigrants, so that the economic growth relies on immigrants to come into the nation. Jewish residents abroad, especially who reside in the United States are an important factor for the Israeli economy too. A grant aid from the United States amounted at around US$ 3 billion per annum (US$ 1.8 billion thereof is the aid for military affairs)(1) is based on such background. as the Jewish residents in the United States mentioned above and that enormous amount of arms expenditure because of some countries around the nation and expenditure needed for maintaining the public peace with the Palestine. State owned enterprises and the Histadrut fill also the important role in the Israeli economy.

Gaza Governorates(1) : Information from the Japanese Embassy in Israel, January 1996.

The existing Government of Israel follows in the previous Government's policy principally consisting of domestic developments, especially development in socio-economic infrastructures, and liberalization and internationalization of economy.

The gross domestic products (GDP) as of 1995 was estimated at US$ 74.3 billion (equivalent to US$ 14,279 per capita) with a growth rate of 6.8 % as same rate as that in previous year of 1994. The consumer price index was calculated at 14.5 % in 1994 and estimated at 7.9 % in 1995.

There are unstable factors for improvement of international balance of payment because that the historically greatest deficit amount had estimated to be produced in 1995. Therefore, the Government of Israel has tried to improve international relationships as the agreement with Jordan for trading, and establishment of trading offices of the Sultanate of Oman and the State of Qatar in Israel following the peace process. The Government of Israel had started to negotiate on free trading agreement with the Government of Canada, the Republic of Turkey, and the United Mexican States too.

(2) Palestinian Economy

1) Gross Domestic Products in Palestine

Gross domestic product (GDP) in Palestine is shown in Appendix 1.1 by 1986 constant price level for last 6 years since 1987, and they are summarized in Table M.2.4.

Table M.2.4 Summary of GDP at Factor Cost in Palestine

As of 1992 (Million US$)

No.	Economic activity	GDP	Share rate (%)	Annual growth rate (%)
1	Agriculture, forestry and fishery	481.0	37.00%	8.77%
2	Industry	104.5	8.04%	-4.71%
3	Construction of buildings/public works	163.5	12.58%	-7.47%
4	Public services/community services	132.0	10.15%	-5.38%
5	Other service	419.0	32.23%	-5.05%
GDP at factor cost		1,300.0	100.00%	-1.57%
GNP per capita at 1986 constant price (US$)		1,008.5	-	-7.17%
GDP per capita at 1986 constant price (US$)		771.5	-	-5.52

Source: Economic Statistics in the West Bank and Gaza Governorates, Current Status Report Series (No.2) issued by the Palestinian Bureau of Statistics, January 1995.

(Note) Annual growth rate means the rate since 1987.

According to the above mentioned Table, an economic activity group of agriculture, forestry and fishery is the highest contribution factor to the GDP as 37.0 % in share rate as of 1992, while the second contribution factor is the group of other services as 32.3 %. In this case, the economic activity group of other services include transport, trade and others including ownership of dwelling, and errors and omissions.

2) External Trade and International Balance of Payment

In 1987 and 1991, the Palestinian trading amount amounted to US$. 1,163 million and US$ 1,042 million in export and, US$ 1,371 million and US$ 1,500 million in import respectively as shown in Appendix I.2. In Palestine, the balance of external trading was constantly minus side during these several years. It means that the amount of import was larger than that of export.

Detail of international balance of payment is shown in Appendix I.2 and summarized below:

Table M.2.5 International Balance of Payment in Palestine

(Million US$)

Item of account	1987	1988	1989	1990	1991	Annual growth rate(%)
Export	1,162.7	946.0	885.0	1,075.0	1,042.0	-2.70%
Import	1,370.7	1,005.0	946.0	1,205.0	1,500.0	2.28%
Balance of payment	-657.2	-472.0	-475.0	-612.0	-900.0	-7.56%
Net transfer payment	162.9	135.3	123.5	154.2	156.5	-1.00%
Current account	-45.1	-106.0	53.0	20.0	-307.0	-38.09%

Source : Economic Statistics in the West Bank and Gaza Governorates, Current Status Report Series (No.2) issued by the Palestinian Bureau of Statistics, January 1995.

External trade in Palestine has greatly relied on Israel to serve as shown in the following Table M.2.6:

Table M.2.6 Balance of Payment in Palestine by Destination

(Million US$)

Item of account	1987	1988	1989	1990	1991	1992	Annual growth rate(%)
With Israel	-237.3	-	-143.9	-193.4	-255.2	-264.7	-
Exports	143.2	n.a.	21.8	35.2	58.9	63.8	-19.92%
Imports	380.5	n.a.	165.7	228.6	314.1	328.5	-4.68%
With Jordan	68.8	42.9	31.9	22.9	29.2	28.0	-
Exports	78.2	52.4	40.4	32.2	38.4	37.5	-16.29%
Imports	9.4	9.5	8.5	9.3	9.2	9.5	-0.54%
With other countries	-77.2	-66.8	-98.5	-110.1	-125.2	-112.4	-
Exports	3.4	2.3	3.9	8.6	9.0	5.1	27.55%
Imports	80.6	69.1	102.4	118.7	134.2	117.5	13.59%
Total	-245.7	-	-210.5	-280.6	-351.3	-349.1	-
Exports	224.8	-	66.1	76.0	106.3	106.4	-
Imports	470.5	-	276.6	356.6	457.5	455.5	-

Source: Economic Statistics in the West Bank and Gaza Governorates, Current Status Report Series (No.2) issued by the Palestinian Bureau of Statistics, January 1995.

(Note) Trading amounts with Israel includes those for Gaza Governorates only, but exclude those for West Bank for both the export and import amounts because of lack of data.

As indicated in the above Table, the Palestinian trading amounts with Israel in 1987, 1989, 1990, 1991 and 1992 were 63.7 %, 33.0 %, 46.3 %, 55.4 % and 60.0 % respectively for exports and, 80.9 %, 59.9 %, 64.1 %, 68.7 % and 72.1 % respectively for imports even though the trading amounts for West Bank were not included. Thus the economy in Palestine can not stand on its own feet without the relationship with Israel in terms of trading situation.

Both the amounts of export and import were decreased since 1987 for the trading with Israel and Jordan. But decreasing rate for import was less than that of export. The import amounts from Jordan were almost flat during these years.

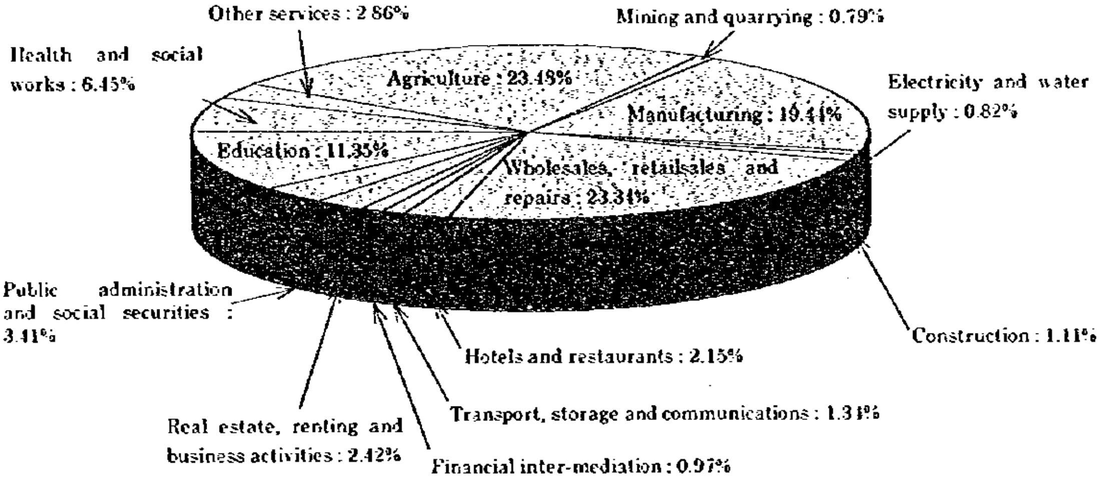
On the other hand, the amounts of export and import with the other countries were increased as 27.55 % and 13.59 % respectively since 1987. However, the amounts of imports exceeded those of exports in this case too.

3) Economic Activities

According to the available data(2), 23.5 % of economic active population are engaged in agriculture which was the highest share rate to the total economic

(2) : The Establishment Census 1994, Final Report, Palestinian Central Bureau of Statistics, August 1995.

active population as of 1994. Peoples who engaged in a business for wholesale, retailsales and repairs were the second one as 23.3 %, and the third : 19.4 % in the work group of manufacturing. This situation seems to reflect to GDP in Palestine as mentioned in previous sub-clause, namely the agriculture, forestry and fishery was shared at 37.00 % to the total GDP at factor cost, and the economic activity group of transport, trade and others was shared at 32.23 % to the same GDP. The economic activities in terms of persons engaged by industrial origin is illustrated in the following Fig. M.2.3.



Sources: Establishment Census 1994, Final Report, Palestinian Central
Bureau of Statistics, August, 1995.

(Note) Number of persons engaged in agriculture is excerpted from the Economic Statistics in the Wet Bank and Gaza Governorates, Current Status Report Series No.2, Palestinian Bureau of Statistics, January 1995.

Fig. M.2.3 Economic Activities in Terms of Persons Engaged

Appendix I.3 shows a detail of above mentioned situation by region of West Bank and Gaza Governorates, and by gender.

4) Agricultural Production

Cultivated area in Palestine are classified into 2 categories as (1) unirrigated area and (2) irrigated area. Unirrigated area is 167,410 ha consisting of 160,170 ha in West Bank and 7,240 ha in Gaza Governorates, while the irrigated area is 20,570 ha consisting of 9,570 ha in West Bank and 11,000 ha in Gaza Governorates as of 1991/92 as shown in Appendix I.4.

In the statistic data in Palestine[1], crops are classified as (1) field crops, (2) vegetables and potatoes, (3) melons, (4) citrus and (5) fruits.

Field crops include wheat, dry pulses, seasame, tobacco, and others. The crop group of vegetables and potatoes include potatoes, tomatoes, cucumbers and snake cucumbers, onion and garlics, egg plant, vegetable marrows, cauliflowers, cabbages, muchina and others. Melons include water melons and sugar-melons. Citrus includes oranges, lemons, clementines and mandarines, shamouti, lapes, grapefruits, and others. Fruits include grapes, olives, plums, figs, apricots, bananas, almonds, dates, and others. Among those crops in Palestine, the most valuable crops are olives.

Production of those crops is increased in the crop group of vegetables and potatoes, and fruits as 6.29 % per annum and 23.75 % per annum respectively during the period from 1987 to 1992, while decreased in the crop group of melons and citrus as -20.32 % and -9.04 % during the same period. Detail of these cultivated crop situation are shown in Appendix I.5 and summarized below:

Table M.2.7 Agricultural Production and Its Value in Palestine

	Production (1,000 tons)		Value (1,000 US$)		
	1987	1992	1987	1992	
Field crops*	40.9	33.5	13,503	15,970	-3.91
Vegetables and potatoes	301.3	408.8	117,597	127,367	6.29
Melons	73.5	23.6	19,126	4,476	-20.32
Citrus	279.8	174.2	51,767	33,176	-9.04
Fruits	96.3	279.5	79,680	166,905	23.75

Source: Economic Statistics in the West Bank and Gaza Governorates, Current Status Report Series (No.2), issued by the Palestinian Bureau of Statistics, January 1995.

(Note)* Field crops produced in Gaza Governorates is not included because of lack of data.

5) Livestock and Related Products

Main production livestock related products are meat from cattle, sheep, goats, and poultry, and milk from cow, sheep and goats, and eggs. Both the

[1] : Economic Statistics in the West Bank and Gaza Governorates, Current Status Report Series (No.2), Palestine
Bureau of Statistics, January 1995.

production of meats, milk and eggs in Palestine are increased at a rate of 9.71 %, 4.39 % and 23.49 % per annum during the period from 1987 to 1992. Detail of livestock related production situation is shown in Appendix G.5 too, and summarized as below:

Table M.2.8 Livestock Related Production and Its Value in Palestine

	Production		Value (1,000 US$)		
	1987	1992	1987	1992	
Meat (1,000 tons)	50.7	80.6	163,294	152,581	9.71
Milk (million liters)	62.2	77.1	66,728	55,086	4.39
Eggs (million pcs.)	134.0	384.8	17,767	35,666	23.49

Source: Economic Statistics in the West Bank and Gaza Governorates, Current Status Report Series (No.2), issued by the Palestinian Bureau of Statistics, January 1995.

Peoples living in Gaza Governorates engage in fishery too, but the production is negligible little according to the said statistic data.

6) General Economic Aspects as a Whole

As mentioned above, about 23.5 %, 23.3 % and 19.4 % of people living in Palestine are engaged in agriculture, wholesale and retailsales including repairs, and manufacturing respectively as of 1994. On the other hand, about 16.0 % of persons engaged in agriculture are working in Israel according to the data indicating in the Appendix I.4. It seems that the other industrial activities as wholesales and retailsale including repairs and manufacturing would be in the same situation too.

Nevertheless the agriculture and manufacture are shared rather high in persons engaged to the total work force, the amount of imports exceeded that of exports. And the trend of exports was tone down, but that of imports was increased more and more since 1987. It means that almost of the products are used domestically. Even thought, these domestically produced goods do not satisfy to demand of peoples living in Palestine. This situation reflects in the said external trade.

Aiming at the external trade, the export to Israel was greatly decreased with about 20 % per annum from 1987 to 1992. And, the import from Israel also decreased with about 5 % during the same period. The external trade with Jordan was in the same situation.

On the other hand, both of the exports and imports with other countries have been increased, but the handling amounts were still rather small comparing with those with Israel. Thus the external trade with other countries will be expected in the future for economic development in Palestine.

7) Consumer Price

Appendix I.6 (A) shows a consumer price index and inflation rates in Palestine since 1986 and summarized below:

Table M.2.9 Consumer Price Index of Palestine in General

Year	West Bank	Gaza Governorates	Israel
1986	100.0	100.0	100.0
1992	200.7	203.0	261.5
Average annual increasing rate (%)	12.31%	12.53%	17.38%

Source: Economic Statistics in the West Bank and Gaza Governorates, Current Status Report Series (No.2), Palestine Bureau of Statistics, January 1995.

The average annual growth rate of consumer price index was 12.31 % I West Bank and 12.53 % in Gaza Governorates since 1986 up to 1992 which were rather low comparing with that of Israel as 17.38 % during the same period according to the data in the above Table. but it should be said that these rates were still high, so that this situation should press people's livelihood.

8) Exchange Rate

The fluctuation of exchange rates with US Dollars during the period from 1986 to 1994 is shown in Appendix I.6 (B) and summarized below:

Table M.2.10 Exchange Rates with US Dollars

(NIS, middle rate)

Year	NIS/US$
1986(1)	1.5
1990(1)	2.0
1994(2)	3.0
Annual average decreasing ratio (%)	8.27%

Source(1):Economic Statistics in the West Bank and Gaza Governorates, Current Status Report Series (No.2), Palestinian Bureau of Statistics, January 1995.
Source(2):Statistics Quarterly -January-March 1995- for Gaza Governorates (Volume 1), Central Statistics Department, Ministry of Planning and International Cooperation, the Palestinian National Authority, May 1995.

(3) Economy of Gaza Governorates

1) External Trade and International Balance of Payment

In 1987 and 1991, the trading amount in Gaza Governorates amounted to US$. 493 million and US$ 378 million in export and, US$ 529 million and US$ 501 million in import respectively as shown in Appendix I.2. These amount were around 40 % in export and 35 % in import comparing with the total amount of Palestinian external trade. In Gaza Governorates too, the balance of external trading was constantly minus side during these several years.

The said Appendix I.2 are summarized as below:

Table M.2.11 International Balance of Payment in Gaza Governorates

(Million US$)

Item of account	1987	1988	1989	1990	1991	Annual growth rate(%)
Export	492.6	353.0	278.0	375.0	378.0	-6.41%
Import	528.8	343.0	302.0	389.0	501.0	-1.34%
Balance of payment	-252.1	-161.0	-168.0	-218.0	-296.0	-3.93%
Net transfer payment	76.8	80.1	79.8	81.7	81.8	1.59%
Current account	40.6	-84.0	50.0	66.0	-44.0	-67.12%

Source: Economic Statistics in the West Bank and Gaza Governorates, Current Status Report Series (No.2) issued by the Palestinian Bureau of Statistics, January 1995.

External trade in Gaza Governorates has greatly relied on Israel as shown in the following Table M.2.12:

Table M.2.12 Balance of Payment in Gaza Governorates by Destination

(Million US$)

Item of account	1989	1990	1991	1992	1993	1994	Annual growth rate(%)
With Israel	-143.9	-193.4	-255.2	-264.7	-263.5	-244.9	-11.40
Exports	21.8	35.2	58.9	63.8	48.0	52.3	17.10
Imports	165.7	228.6	314.1	328.5	311.5	297.2	13.46
With West Bank	0.0	0.0	0.0	0.0	0.0	3.7	-
Exports	0.0	0.0	0.0	0.0	0.0	24.4	-
Imports	0.0	0.0	0.0	0.0	0.0	20.7	-
With other countries	-24.7	-27.6	-29.5	-24.0	-27.0	-8.9	-1.76
Exports	9.6	12.4	11.8	13.4	14.6	6.6	8.75
Imports	34.3	40.0	41.3	37.4	41.6	15.5	3.93
Total	-168.6	-221.0	-284.7	-288.7	-290.5	-250.1	-10.31
Exports	31.4	47.6	70.7	77.2	62.6	83.3	14.80
Imports	200.0	268.6	355.4	365.9	353.1	333.4	12.04

Source: Economic Statistics in the West Bank and Gaza Governorates, Current Status Report Series (No.2) issued by the Palestinian Bureau of Statistics, January 1995, and Statistic Quarterly -January-March 1995 for Gaza Governorates, Central Statistics Department of Ministry of Planning and International Cooperation, The Palestinian National Authority, May 1995.

As indicated in the above Table, share rates of the trading amounts of Gaza Governorates with Israel to the total trading amounts in 1989, 1990, 1991, 1992 and 1993 were 69.4 %, 73.9 %, 83.3 %, 82.6 % and 76.7 % respectively for exports and, 82.9 %, 85.1 %, 88.4 %, 89.8 % and 88.2 % respectively for imports. Detail of this situation is shown in Appendix I.7. Dependency level of Gaza Governorates to Israel is higher than that of whole Palestine.

Both the amounts of export and import were increased since 1989 for the trading with Israel. But the balance of trade was decreased because that the handling amount of imports exceeded greater than that of exports.

The amounts of export and import with the other countries were also increased as 8.75 % in export and 3.93 % since 1989. However, the amounts of imports exceeded those of exports in this case too, so that the balance of trade was also decreased.

Appendix I.8 shows a trading situation aiming at commodities in 1994, and summarized below:

Table M.2.13 Trade in Gaza Governorates by Commodities in 1994

(Thousand NIS)

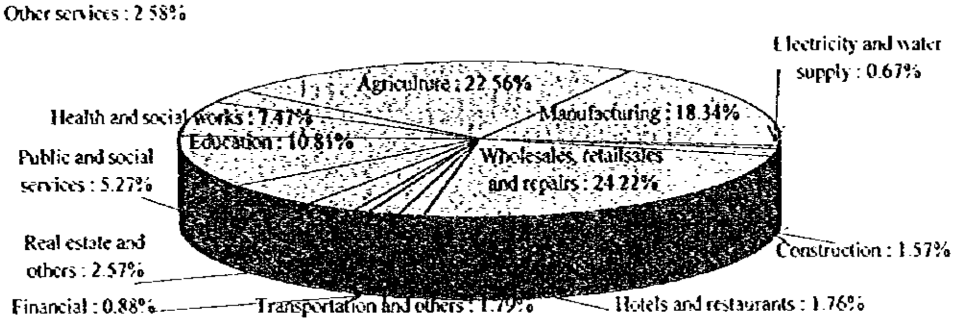
Commodities	Export	Import	Trade balance
Building materials	23,906	259,669	-235,763
Citrus	23,445	2,185	1,260
Fruits/vegetables	55,079	50,538	4,541
Livestock/products	2,892	105,307	-102,415
Household articles/furniture	15,275	27,954	-12,679
Electric materials	9,049	19,002	-9,953
Spare-parts	1,521	16,862	-15,341
Wood/products	1,737	17,544	-15,807
Foods	12,268	264,734	-252,466
Clothing/textile	95,796	80,875	14,921
Medical materials	77	11,371	-11,294
Others	8,946	83,634	-74,688
Petrol	0	34,313	-34,313
Water	0	1,360	-1,360
Electricity	0	27,799	-27,799
Total	249,991	1,003,147	-753,156

Source: Statistics Quarterly -April-December 1995- for Gaza Governorates, Central Statistics Department of Ministry of Planning and International Cooperation, the Palestinian National Authority, May 1995.

According to the above Table, the highest 3 commodities for import were building materials, livestock and related products, and foods, while the commodities of fruits and vegetables, and clothing and textile were almost same amount between exports and imports.

2) Economic Activities

The pattern of economic activities in persons engaged in Gaza Governorates is almost the same with that for the whole Palestine. But, ranking of agriculture and the economic activity group of wholesales and retailsales including repairs has reversed, namely highest one is the latter one with share rate of 24.22 % and former one is the second one with that of 22.56 % as shown in the following Fig. M.2.4.



Sources: Establishment Census 1994, Final Report, Palestinian Central Bureau of Statistics, August, 1995.
(Note) Number of persons engaged in agriculture is excerpted from the Economic Statistics in the Wet Bank and Gaza Governorates, Current Status Report Series No.2, Palestinian Bureau of Statistics, January 1995.

Fig. M.2.4 Economic Activities in Terms of Persons Engaged in Gaza Governorates

Appendix I.3 shows a detail of above mentioned situation by gender.

3) Agricultural Production

Cultivated areas in Gaza Governorates are also classified into 2 categories as (1) unirrigated area and (2) irrigated area. Unirrigated area is 7,240 ha, while the irrigated area is 11,000 ha as of 1991/92 as mentioned in previous clause.

Production of crops is increased in the crop group of vegetables and potatoes, and fruits as 1.20 % per annum, 8.90 % per annum respectively during the period from 1992 to 1994, while decreased in the crop group of field crops, melons, and citrus as -72.05 %, -11.24 % and -7.94 % during the same period. The increasing rate of fruits was highest, but actual produced volume was rather little comparing with vegetable and potatoes. Detail of these cultivated crop situation are shown in Appendix I.9 and summarized follow:

Table M.2.14 Agricultural Production and Its Value in Gaza Governorates

	Production (1,000 tons)		Value (1,000 NIS)		
	1992	1994	1992	1994	
Field crops	12.8	1.0	6,019	704	-72.05
Vegetables and potatoes	201.7	253.9	160,078	231,224	1.20
Melons	9.9	7.8	4,068	2,715	-11.24
Citrus	119.4	101.2	42,350	58,047	-7.94
Fruits	19.9	23.6	28,541	44,538	8.90

Source : Statistics Quarterly -April-December- for Gaza Governorates, Central Statistics Department of Ministry of
Planning and International Cooperation, the Palestinian National Authority, May 1995.

4) Livestock and Related Products

Main livestock related products in Gaza Governorates are also meat from cattle, sheep, goats, and poultry, and milk from cow, sheep and goats, and eggs as same as in the West Bank. But, the actual produced volume of them were ranging from 15 % to 25 % to the total production volume of Palestine except eggs. Detail of livestock related production situation is shown in Appendix G.9 too, and summarized below:

Table M.2.15 Livestock Related Production and Its Value in Gaza Governorates

Livestock related products	Production		Value (1,000 US$)		
	1992	1994	1992	1994	
Meat (1,000 tons)	18.3	18.0	73.991	84,770	-0.82
Milk (million liters)	10.4	17.0	19,589	27,000	27.85
Eggs (million pcs.)	145.0	150.0	31,900	30,000	1.71

Source: Statistics Quarterly -April-December- for Gaza Governorates, Central Statistics Department of Ministry of Planning and International Cooperation, the Palestinian National Authority, May 1995.

Peoples living in Gaza Governorates engage in fishery too, but the production is negligible little according to the said statistic data.

5) General Economic Aspects as a Whole

As mentioned above, about 22.6%, 24.2% and 18.3 % of people living in Gaza Governorates are engaged in agriculture, wholesale and retailsale including repairs, and manufacturing respectively as of 1994. On the other hand, about 30 % of persons engaged in agriculture are working in Israel according to the data indicating in the Appendix I.4. It seems that the other industrial activities as whole and retailsale including repairs and manufacturing would be in the same situation, and this trend would be more than that of West Bank..

Nevertheless the agriculture and manufacture are shared rather high in persons engaged to the total work force, the amount of imports exceeded that of exports. And the trend of exports was tone down, but that of imports was increased more and more since 1987. These situation are almost the same with the West Bank. It means that almost of the products are used domestically too. Even thought, these domestically produced goods do not satisfy to demand of peoples living in Gaza Governorates. This situation reflects in the said external trade.

Aiming at the external trade, the balance of trade with Israel was decreased with the rate of about 11 % per annum from 1989 to 1994, and that with other countries were also the same situation even though the handling amount of both the exports and imports were increased because that the mounts of imports were greatly exceeded the amounts of exports.

2.3 Institutions and Regulations

2.3.1 Governmental Organizations

(1) Ministry of Planning and International Cooperation

Ministry of Planning and International Cooperation (MOPIC) was established in 1994, and has today a staff number of around 250. The ministry aims at physical and strategic planning for rural and urban areas. It is working on national development plans for medium and long term and also with international cooperation and coordination. The Environmental Planning Directorate (EPD) within the Ministry is of importance in planning that will affect the environment.

The organizational chart of Ministry of Planning and International Cooperation is included as Fig. H.1 in the Appendix H. The organization distinguishes between Directorate, Department and Unit. Directorate is the largest unit, followed by Department and the smallest one is Unit. Center means a unit working within the whole Ministry.

The Environmental Planning Directorate (EPD) was established in 1994 as a Directorate General under the MOPIC. EPD is divided into three Departments, Planning and Policy Department, Monitoring and Environmental Impact Department and Information and Follow Up Department. The total number of staff of EPD is 22. Of them are 17 working in the Gaza Governorates and 5 in the West Bank. EPD has three staff members working on water and wastewater issues. They work within the Water Resources Protection Unit that is part of the Planning and Policy Department.

The Directorate of Urban and Rural Planning has three staff members working on water and wastewater issues in the Gaza Governorate.

The responsibility for MOPIC and the other Ministries as well as their interrelationship is shown in a draft Fig. H.2 in Appendix H in Volume III "Supporting Report."

(2) Palestinian Water Authority

Palestinian Water Authority (PWA) is a body established in April 1996. It operates in accordance with Law No 18, 1996 (see Appendix H, Text F. 3). The current PWA staff is managed by the Chairman. In addition to the permanent staff there are some professionals associated to the Water Resource Action Programme. The Water Resource Action Programme is supported by UNDP.

The staff numbers totally around 20 persons. The organizational chart of PWA is included as Chart H.4 in Appendix H in Volume III "Supporting Report."

The World Bank financed project "Water and Wastewater Management Contract" has started in September 1996 with PWA as the implementing agency. This project aims at organizing the water supply and wastewater service delivery into a utility, which eventually may be established as an autonomous body. The body may be organized within PWA or possibly as a private organization under PWA. The utility may be granted a concession to abstract water for delivery either directly to the consumers or in bulk to e.g. municipal distribution organizations.

PWA uses the word utility to describe an organization, covering the whole Gaza Governorates. The utility will aim to work with quality of water, to reduce the unaccounted for water, to improve the management systems and the promotion of proper institutional set up, all regarding water and wastewater for domestic and industrial use. PWA will work with strategic planning, licensing, monitoring et cetera.

As a guideline for the work of Palestinian Water Authority, the Authority has proclaimed fifteen principles regarding the water policy. These rules are collected in Palestinian Water Policy, dated January 1996. The rules affect all kinds of water, also treated sewage water for reuse. In Appendix H, Text H.5 is shown the Palestinian Water Policy.

(3) Ministry of Agriculture

The organizational chart of the Ministry of Agriculture is included as Fig. H.6 in Appendix H in Volume III "Supporting Report."

The main function of Ministry of Agriculture concerns the agriculture sector within the country. There are eight General Directorates working with polices, planning and development. Six Departments work with agricultural production, research, publicity, forestry, fisheries, veterinary services, plant protection, irrigation and administration/ finance.

The Irrigation Department is dealing with irrigation questions, need of water, quality demands et cetera.

The Ministry of Agriculture has since 1967 been the sole agency responsible for agricultural water resources, quotas licensing of wells, data collection and distribution of Mekorot water. The MOA has ongoing discussions and work with PWA in the water /wastewater sectors to facilitate the transfer of responsibility for water resources to the PWA.

MOA has a well developed water section and has just recently engaged a wastewater engineer to support the Ministry in questions regarding reuse of wastewater.

MOA has developed a number of project ideas for effluent reuse and are ready to develop these ideas further into detailed project proposals, if they have enough funds. The obstacle so far, however, has been that none of the wastewater treatment facilities in Gaza has been capable of producing effluent of a standard which would allow reasonable large-scale and consistent use in the agricultural sector.

(4) Ministry of Local Government

The organizational chart of the Ministry of Local Government is included as Chart H.7 in Appendix H in Volume III "Supporting Report."

MLG is assigned responsibility for the local government system and has been actively engaged in trying to define the structure of local government, the institutional arrangements and the key organizations at the various levels and the roles and functions at these levels.

The total staff of Ministry of Local Government is 134 persons.

(5) Municipality of Khan Yunis

The Municipality of Khan Yunis is located in the south part of Gaza Governorates. A camp named as Al Qatatwa is partly included in the municipality.

Table M.2.16 Area and population of the Study Area

District	Area (ha)	Population	Projected Population in 2015
Khan Yunis and Camp	1,660	126,000	299,000
Kizan Area	1,270	5,000	11,000
Bani Sohaila	404	24,000	51,000
Qarrara	443	10,000	21,000
Abassan Saghera	128	6,000	13,000
Abassan Kabera	424	17,000	36,000
Khuzaah	129	8,000	17,000
Total	4,458	196,000	448,000

Municipality Government

The organization of Municipality of Khan Yunis is shown in Fig. 5.2. Under the City Council the Mayor is in charge for the government, assisted by 10 divisions. However the number of officials is so small as under 200 to serve the population of about 126,000 in the Municipality.

The dominant entities in the local government system are the municipalities , which in many cases have under-established and limited service and regulatory functions. The service includes electricity, water supply, sanitation, solid waste management, local roads, libraries, parks and recreation, fire abatement, slaughter houses, markets, land use planning, development & building approvals, business & professional licensing.

The Municipality Council as well as the Mayor are appointed by Mr. Y. Arafat, Chairman of the Palestinian National Authority.

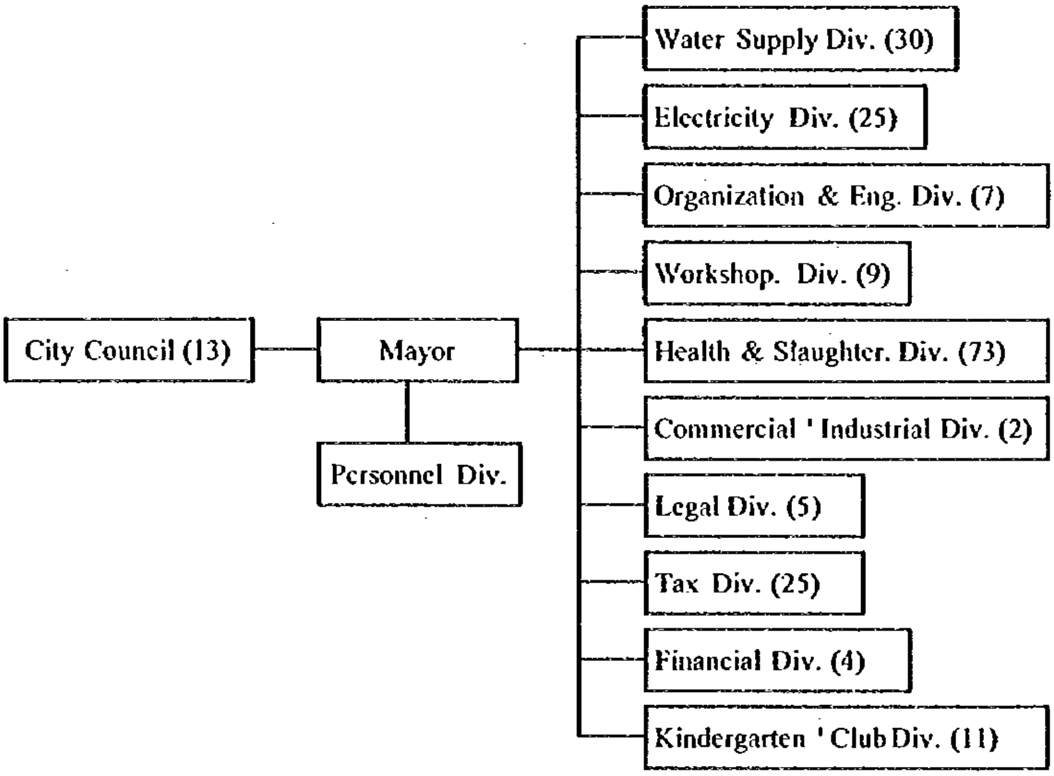


Fig. M.2.5 Organization Chart of Khan Yunis Municipality

All sewage which today is produced within Khan Yunis area is conveyed to septic tanks in the vicinity of the buildings. The sewage drains in the partly open septic tanks and a septic sludge remains. The sludge is collected by tankers, municipal or private, and emptied at an open area outside the settlement. The Municipality has five tankers operating each day, when necessary in shift. To that there are 15 private tankers working in the area.

Institution for management of these operations is the Health & Slaughter Division within Khan Yunis Municipality.

Municipality Budget

The 1995 budget of Municipality of Khan Yunis is shown in Table M.2.17 which is almost the same as the last year. This table indicates the following:

- Not detailed for sufficient service for the residents
- Tax revenues is quite limited
- Project revenues amount at about 85% of the total revenue
- No guarantee for normal function of the government

This can lead to a conclusion that the resident are accustomed to a vicious cycle: "No burden, No service". This is an irresponsible relationship between the government and resident. Concerning the sewerage service, this kind of situation is a serious problem: if no charge can be collected. no cost recovery is secured. Therefore institutional building, management and residential education are so important as to be discussed in the Study.

Table M.2.17 Budget of Municipality of Khan Yunis

(1995, unit: NIS)

Revenue		Expenditure	
Tax	315,000	Government cost	1,054,600
Local service	2,235,900	Local service	1,869,000
Government service	-	Government service	-
Subtotal (Routine)	2,550,900	Subtotal (Routine)	2,923,600
Water supply	2,141,500	Water supply	2,098,800
Electricity	11,880,000	Electricity	11,549,000
Sewerage	-	Sewerage	-
Subtotal (Project)	14,021,500	Subtotal (Project)	13,647,800
Total	16,572,400	Total	16,571,400

(6) Village Councils

The small Village Councils around Khan Yunis Municipality can be seen on previous Table 5.1. They have a population of around 70,000 people and an area of around 27 km^2.

Village Councils are the next level of local government compared to municipalities. They enjoy a representative government structure but lack the broad range of functions and revenue raising options of municipalities.

2.3.2 Community Organizations

(1) General

Over the last five years, relief agencies working in rural areas have adopted community participation as an element in programs to improve water supply and sanitation, increasingly, attention is being paid to applying participatory methods in urban and peri-urban communities as well.

In water, sanitation, and housing programs, community participation has typically meant requiring beneficiaries of a construction project to contribute labor and/or money and take responsibility for managing the facilities. The concept of community participation can also be taken a few steps further. Participation means involving community members in environmental problems. The concept also includes training community leaders and government officials to conduct a sustained dialogue with each other about environmental management. Community participation is viewed as a good component of making housing and infrastructure projects sustainable.

Regarding water and wastewater project it is increasingly being recognized that it is necessary to raise the knowledge of hygiene conditions and behavior are also required to reduce water and wastewater-related decease. Hygiene education addresses these changes and thus aims to provide the essential link between improved facilities and user practices.

(2) Community Participation

A simple but valuable form of community participation could be to arrange a series of small public meetings in local areas in which residents are presented with information and given ample opportunity to express their views. If such a procedure is found desirable it should above all take place within the planning phase, when possible views from the public still can affect the planning.

The subject community participation and public awareness seems to have been noticed in an increasing degree the latest years related to water and wastewater systems. By natural reasons this can be connected to ongoing extensions of existing networks and also construction of new ones. Through the years there has been a misuse of existing wastewater networks in Gaza Governorates from people putting solid wastes, dangerous liquids et cetera into the pipelines and the toilets.

To avoid this, a new awareness should be brought to the public in their use of the systems. There is also an economical aspect in the awareness. A wastewater system is a utility and the users must get aware of the necessity to pay for this utility.

As a few examples on project and institutes working in the field of environmental (health) related education and community participation can be mentioned the following:

- Palestinian Water Authority has engaged an Awareness Specialist for water and wastewater and they have also published reports on Public Awareness Campaigns executed in Gaza.
- GTZ (German Agency for International Cooperation) has funded a project called Gaza Governorates Central Region Solid Waste Management Project, which has included for instance Khan Yunis. In the project is a public awareness and community participation program integrated.

(3) Peoples Awareness

Means to access peoples awareness may include public meetings as shown above, formation of advisory groups, information leaflets, advertising, television, school programs et cetera.

For Khan Yunis Wastewater Project recently (within the project) a social survey has been made to investigate peoples awareness in an early stage of the planning. The result is not yet evaluated.

(4) NGO

Many Non Governmental Organizations are working in Khan Yunis area, most of them with health education. A table showing all these NGO's is included in Appendix F in Volume III "Supporting Report."

The only Non Governmental Organization that has a close relation to Khan Yunis Wastewater Project seems to be Save The Children Federation (SCF).

SCF has been established in Gaza since 1978, They are working with water and sewage projects and health education, normally with community participation in coordination with municipality or other NGO's, also Palestinian.

Peoples participation consists usually of labor in small projects, such as minor pipelines, house connections et cetera. They are funded from various donors. The number of staff is 22 and their regular budget is US$700,000.

(5) International Organizations

There are two wellknown international organizations established in Gaza , UNRWA and UNDP.

UNRWA (United Nations Relief and Works Agency) has by capacity and resources maintained a role in the Gaza Governorates for a long period within the sectors of water, wastewater and environmental protection. In order to strengthen the Agency's approach to the problems of water supply, sewerage, surface water drainage and solid waste disposal, UNRWA established in 1992 a Special Environmental Health Programme aimed at improving the over all health conditions in the refugee camps and their surroundings. The activities in SEHP have in the latest years turned from mainly feasibility studies to more design, planning and implementation. UNRWA is used by a number of donors for projects over the whole Gaza Governorates, mostly within the refugee camps.

SEHP has usually ongoing works in the camps, for instance in Khan Yunis camp, and it consists mostly of education and environmental health. UNRWA has totally around 5,000 staff members in Gaza Governorates. Of the them are 320 people working in the Special Environmental Health Programme including funds their budget for 1996 is US$12.8 Million (US$8.8 Million for projects and US$4.0 Million for normal budget.)

UNDP (United Nations Development Programme) has ongoing work in Khan Yunis Municipality with rehabilitation of water wells and the water network including also construction of new lines. They work with project management. The staff consist of 7 engineers and they normally use consultants. The total staff of UNDP in Gaza Governorates numbers 22 persons.

2.3.3 Legal System

The general election of the Palestinian Government was held in January 1996 and as the result the Palestinian National Council was founded for the first time as the legistrative body. At present British laws and Egyptian ones are applicable in Gaza Governorates, while Jordanian laws and others are applicable in West Bank. Such a legal system is sometimes disturbing the private activities.

Under Israeli occupation during 1967 to 1992 1389 military orders were issued in West Bank, while 1,060 ones were issued in Gaza Governorates. These are civil, criminal and commercial laws. About one third of the military laws are related to economic activities. Israeli settlers are protected by military orders at the same level of other Israeli. This kind of situation indicates that the Palestinian Government will have to issue its own legal system as it becomes more independent from Israel.

2.4 Sanitation and Environment

2.4.1 General

Main problems induced environmental degradation and pollution in Gaza Governorates are as follows:

1) Land and water resources are both extremely scarce.

2) Misplaced development and agricultural expansion in resent years by rapid increase of population.

3) Poor collection system of solid and liquid wastes in urban area.

4) Poor management of waste water treatment facilities

Given the fast rate of population growth and the increased consumption of water per capita resulting from economic growth, the problems will only increase in the near future.

(1) Groundwater Pollution

The pollution of groundwater with heavy metals, nitrate, pesticides and other organic compounds is also getting a problem , however, the situation is not known little of so far. Main groundwater pollution being clear are as follows:

1) Nitrate

The situation in Gaza Governorates is far more serious, as preliminary results from water quality tests have indicated the presence of nitrates that are above acceptable levels. The situation appears to be worst in Khan Yunis, where peak values of over 350 mg/l NO_3 are measured. This level exceeds far the quality standards for drinking water. Drinking this water may cause methaemoglobinaemia (called as blue baby disease) in babies and small children. It is not clear if the nitrates originated from fertilizers or wastewater discharged from house holds.

2) Others

Pollution is made between diffuse pollution sources in agriculture and households, and the point of sources such as waste disposal site. Diffuse pollution by agriculture appears to be largely a result of a lack of knowledge and awareness among farmers and extension workers as to the consequences of high doses of fertilizers (e.g. nitrates) and fumigants (e.g. methyl bromide).

Other cause is improper site selection of public water supply wells, the rapid expansion of city limits, the location of industrial zones, sewage pools and petrol stations near drinking water wells, and the absence of protection zones and similar land use planning mechanisms.

(2) Degradation of Landscape

The few remaining natural areas and beach are rapidly disappearing because of construction activities, intensive horticulture and indiscriminate sand quarrying, and are deteriorated by the large-scale practice of dumping domestic, construction and industrial wastes.

The coastal area are currently by far the most important and most frequented recreational sites of Gaza Governorates. The widespread dumping of solid waste and rubble on the beaches reduces further recreational development and further increases health problems.

Wadi Gaza can be seen as a unique landscape feature in Gaza Governorates, with picturesque cliffs and forested parts. The Wadi's outlet to the sea includes open spaces and views, salt marshes, forested parts and interesting landscape transitions from freshwater marsh to young dunes near the beach. The Wadi is heavy polluted by a central sludge and sewage drain from Gaza City, and sludge drains from the Middle Camps.

(3) Groundwater Salinization

Salinity is increasing in many parts of the territory. In some parts of the Gaza Governorates, conductivity exceeds the level of 4,000 micro-semen's. An increase in conductivity is directly related to an increase in salinity. Such water is too salty for irrigating most crops, let alone for drinking.

The increase in water salinity can be attributed to overpumping of the existing water resources. The water table is falling in many parts of the territory leading to an imbalance between fresh and brackish water in the center of the territory. In coastal areas, sea water is intruding into the coastal aquifer.

With regard to salinization, the primary cause is over-pumping. Extraction rates are higher than recharge rates. This is a direct result of the high population density. Following main causes play a role on different levels and scale.

1) At the farm level water use is sometimes excessive as a result of inefficient irrigation techniques.

2) At the municipal level there are excessive distribution losses.

(4) Fauna and Flora

The widespread pollution of soil and surface waters has almost wiped out wildlife. Natural habitats are rarely preserved or are used intensively. Pesticides and chemical wastes severely upset the ecological equilibrium, and the apparent lack of natural pest control mechanisms is a consequence of this.

The Gaza Governorates plays a role as a stop-over and flyway for large numbers of migratory birds. The impacts of pesticides and chemical pollution of the environment on bird reproductivity and survival may not be felt within the Gaza Governorates, but will certainly have a transitional dimension.

A number of endemic plant and mammal species, such as the Boxton's Gird Meriones sacramenti, need to be saved from extinction in the Strip. Protection of these highly valuable species should be incorporated into the new laws and land use planning exercises.

(5) Cultural heritage

Gaza has seen a glorious and eventful past, as it is one of the oldest cities in the world. Many of the important historical buildings are religious places, like mosques, madrases, churches and tombs.

Although many archaeological sites and historical monuments have been destroyed or damaged in the course of history, sufficient interesting and beautiful sites and monuments remain which reflect the great significance of the city and its surrounding area. Most of the sites were dug up during the British mandate. And another site is used for other purpose such as construction, agriculture and infrastructure because of the scarcity of land. Another reason for the rapid disappearance of sites is the absence of adequate legislation on preservation of antiquities and monumental buildings. The present law is very old (British Mandatory Antiquities Law from 1929) and largely inadequate. Under the situation, the remaining building is in poor condition and will disappear soon if no measures have already undergone the same fate and have disappeared completely. However, these archaeological heritages are worthwhile preserving for future generations.

(6) Water Borne Diseases

Epidemiological investigations directed at wastewater-contaminated drinking water supplies, use of raw or minimally-treated wastewater for food crop irrigation and health effects to farmworkers using undisinfected wastewater have all provided evidence of infectious disease transmission from such practices.

Some infectious diseases in Gaza are reported in the Table M.2.18. These figures suggest that water-borne disease are endemic to Gaza Governorates. According to the table, number of waterborne disease is increasing year by year.

Table M.2.18 Selected Reported Infectious Diseases in Gaza Governorates (all potentially waterborne)

Infectious Disease	1988	1989	1990	1991	1992
Conjunctivitis	-	7,672	-	11,964	13,143
Diarrhea Sis.					
-(0-3) Years	-	-	-	16,362	17,448
-(Over 3) Years	-	-	-	7,948	11,115
Dysentery	1,300	2,242	3,200	6,714	7,804
Hepatitis A & B	278	186	716	252	685
Typhoid	21	46	21	15	12
Salmonella	72	100	505	332	55

An epidemic of cholera occurred in Gaza in October and November of 1994. Approximately 90 cases were confirmed with one death. About 80 % of the cholera case were in Gaza City and the immediate surrounding region.

Operation and management practices, such as treatment reliability features and use area controls, play an important role in reducing estimated health risks. At the present time, no reclaimed water standards or guidelines in the country are based on risk assessment using microorganism infectivity models.

2.4.2 Environmental Law

Some ministries and governmental agencies have a direct relation with projects which focus on rehabilitation of the Palestinian infrastructure and environmental protection issues. Unfortunately, until today there is no clear laws and regulations that have been created by the Palestinian people to protect the fragile environment in Palestine, due to the long and harsh occupation since 1967.

As mentioned in 2.3.3, the Palestinian legal system is yet weak and needs to be strengthened. Therefore the environmental laws are far from satisfactory in comparison with the international laws. For example the water quality of effluent is not set up, as well as discharged wastewaters. The system of environmental assessment is not legally established. Therefore in this report a rational method is suggested for environmental impact assessment.

2.4.3 Environmental Organization

Along with the regulations and law of the environmental protection, a systematic organization has not been established in PA. The Environmental Planning Directorate (EPD) within the Ministry of Planning and International cooperation (MOPIC) is in charge for environmental planning with three (3) departments: Planning and Policy Department, Monitoring and Environmental Monitoring Department, and Information and Follow-up Department. However their capability of environmental monitoring is largely limited due to lack of necessary facilities and capacity.

2.5 Major Infrastructures

2.5.1 Transportation

In the Study Area, transportation facilities have been developed mainly by land transportation because of the unique and strategic location in the Gaza Governorates situated at the southern end of the Region. Khan Yunis also means that it acts as one of the main communications and transportation hubs toward which other parts of the Region are directed. The Mediterranean Sea has excellent natural conditions for port development, however, so far the port has not been provided yet and is now in preparation.

Currently, the transportation in the Gaza Region relies mostly on motor vehicles. Transportation statistics report was published by the Palestinian Bureau of Statistics, however, specific data and information indicating the situation Khan Yunis City and surrounding areas are not available. The statistics include such major items as stock of transportation equipment by type, number of drivers in the years from 1980 to 1992, as summarized in the following table:

Table M.2.19 Transportation by Type of Vehicles and Drivers

Type of vehicles	1980	1987	1990	1991	1992
Private cars	29,129	19,241	65,866	69,531	79,454
Trucks & Commercial Cars	2,353	11,810	19,654	21,039	22,820
Buses & Minibuses	422	581	761	801	809
Taxies	828(*)	1,682	1,861	1,880	1,987
Motorcycles & Scooters	309	1,196	834	746	735
Tractors	495	2,781	5,067	5,306	5,529
Special services & others vehicles	166	553	925	1,063	1,054
Vehicles Total	4,893(*)	37,884	94,988	100,366	111,788
Drivers	11,600	51,400	139,900	149,600	163,300

Source: "Economic Statistics in the West Bank and Gaza Governorates," January 1995, Palestinian Bureau of Statistics, Current Status Report Series (No.2), pp 6.5, Table 2.4.2.

2.5.2 Electricity

(1) Palestinian Electricity Sector

In 1967 when the Palestine was under Israel conquest, electric power in the occupied Palestinian Territory was generated and distributed to a limited number of communities through regional and local utility suppliers. The major suppliers of electricity to the Gaza Region was Municipality Electricity Department (GMED) supplying electricity to Gaza City and surrounding communities.

The development of the Palestinian energy sector, in general, and the electricity sector in particular, were impeded through preventing the existing utility suppliers from expanding or even sustaining their existing generating capacity. As the result of the Israel measures, the Jerusalem District Electricity Company (JDEC) was eventually forced to completely shut down its generating facilities, while the Nablus Municipality Electricity Undertaking (NMEU) continues to generate only about thirty percent of its installed capacity.

While the number of communities supplied with electricity has increased since 1967, the Palestinian electricity is characterized by severely curtailed national generation capacity, lack of a coherent national transmission grid, obsolescent distribution networks, absence of a Palestinian national institutional framework and total dependence on Israel for all energy inputs.

Current energy requirements for different types of energy sources indicate that approximately 54 percent of total energy demand is from oil products, 31 percent from electricity and 15 percent from gas.

In 1992, total electricity energy consumption in the Palestine was estimated to be about 160 MW. Of this, domestic consumption accounted for about 58 percent, commercial consumption about 17 percent, industrial consumption about 11 percent, agricultural consumption about 9 percent, and municipal consumption about 5 percent.

Of the served population, about 54 percent are supplied directly from the Israel Electric Corporation (IEC), 288 percent from IEC through JDEC, 10 percent from the local generators and 8 percent from NMEU.

The average per capita energy consumption was estimated at about 112kg oil equivalent, while the average per capita electricity consumption was estimated at approximately 437 kWh. The low values for Palestinian are mainly due to the absence of substantial industrial activities and relatively large number of communities without electricity.

(2) The Gaza Region

The Gaza Region's population in 1990 was about 773,000. The electricity was distributed among 13 urban, semi-urban and rural communities, and 8 refugee camps. All of the communities in the Gaza region are supplied directly by IEC through 22 kV transmission lines which distribute the region at 7-linking-up points across the entire northern and eastern boundaries of the Region, with an estimated contracted capacity of 50 to 60 MVA.

In 1992 the Region's total number of customers was estimated at around 70,000. The total annual consumption for the same year was estimated at about 320 gWh (320 million kWh). The major transmission lines in the Gaza Region in 1992 are shown in Figure M.2.6 and the populations served by the electricity supply in the Gaza Region are shown in Table M.2.20.

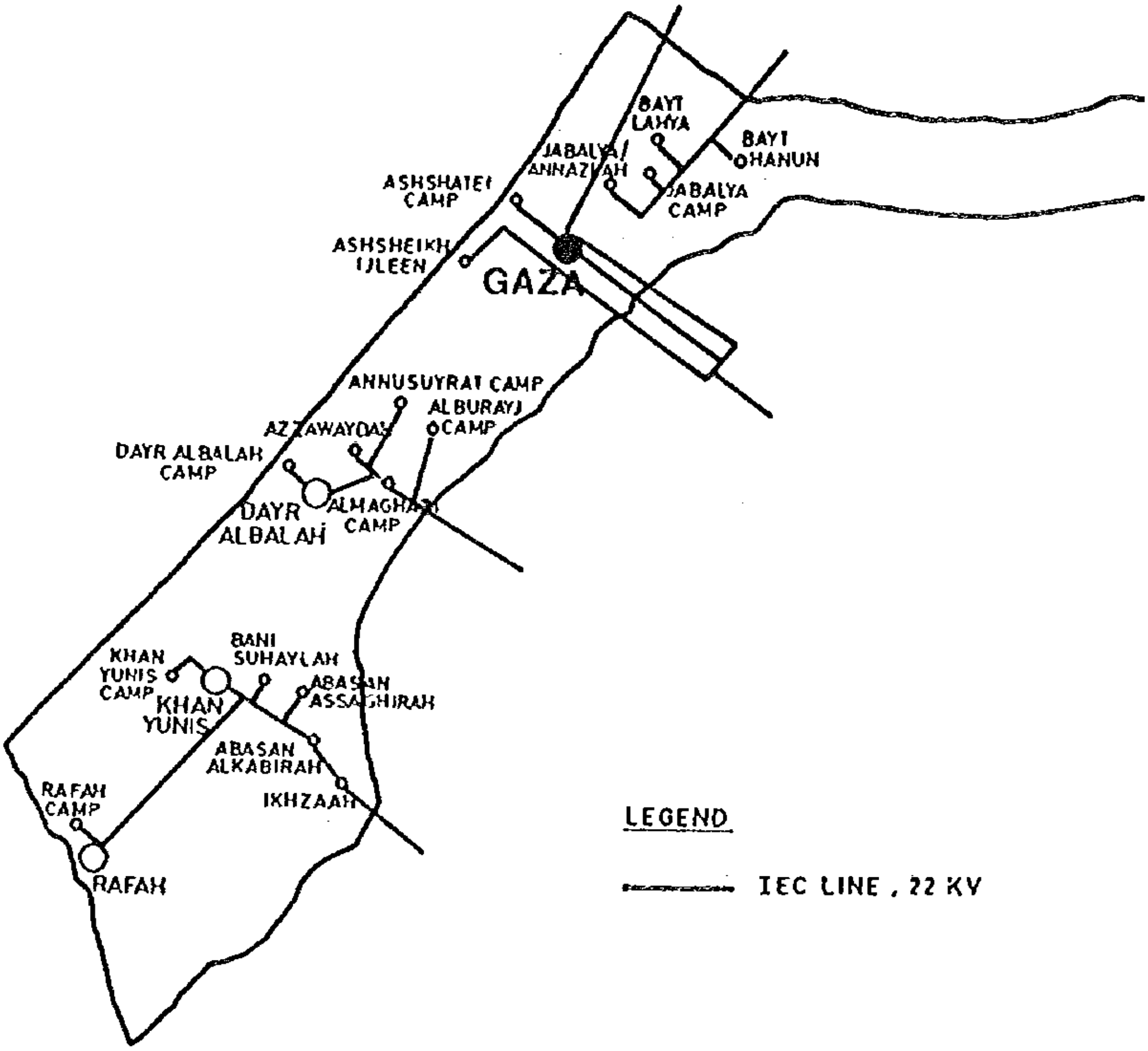


FIG.M.2.6 ELECTRIC TRANSMISSION LINES IN GAZA

THE STUDY ON SEWERAGE DEVELOPMENT PLAN IN THE AREA OF KHAN YUNIS
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Table M.2.20 Populations Served by Electricity in Gaza Region

Community Population size	1990		2000	
	Number of Communities	Percent of Population	Number of Communities	Percent of Population
More than 20,000	5	55.6	10	98.4
10,000-20,000	3	6.2	-	-
7,500-10,000	1	1.2	-	-
5,000-7,500	-	-	2	1.0
2,500-5,000	3	1.5	2	0.6
Less than 2,500	1	0.3	-	-
Refugee camps	8	35.2	-	-
Total	21	100.0	14	100.0

Source: "The Palestinian Electricity Sector, Guidelines for Reconstruction and Development," March 1993, Palestine Studies Project Center for Engineering and Planning.

None of the electric power stations in the Region are currently operational. The entire electricity supply for the Region is imported directly from IEC. However, most of the Region's communities have electric power distribution network which are generally obsolescent and require substantial upgrading and rehabilitation. The level of electrical energy imports from IEC during 1990 was estimated 32 MW for the Gaza Region. For the future electricity demands, the base year load in 1992 is estimated to be at around 178 MW.

2.5.3 Housing and Building Conditions

Currently data are lacking to indicate the conditions concerning housing and building, however, the recent building and housing constructions, particularly in urban areas, appear to be increasing. Most of the houses and buildings are permanent structure and constructed of reinforced concrete, bricks, and concrete blocks generally in acceptable quality. In the urban zones of Khan Yunis City, most of the houses are of multiple-story type, but in the peripheral areas of the City one story or two stories residences with yards are predominant.

Houses in the urban built-up zones are closely located each other, leaving either little or no yards but only narrow pathways. Street blocks are generally well provided, in some areas with sidewalk. In general, the housing conditions are not poor except in some areas wherein illegal people reside.

2.5.4 Roads and Streets

Although no data are available showing the exact percentage of asphalt paved roads, it appears that about 60 to 70 percent of the existing roads are either paved or reasonably maintained, in particular in the central portion of Khan Yunis urban area, remaining parts are left either unpaved or unrepaired. The unpaved roads and foot-paths consist of loose fine sand, creating problems during rainfalls. Sand is washed away and flowing into the existing drains or other depressed portion, blocking smooth flow of rainwater runoffs.

Currently, expansion and construction of major roads are underway or under planning, and are expected to be improved in the near future.

In the refugee camps, the roads conditions are worse than other part of the City with narrower streets either paved or unpaved. No sufficient drainage system to discharge the stagnated rainwater runoffs is provided if not at all, and once heavy rain falls the rain water runoffs would easily stagnate in low lying areas and causing inundation. Also, much of the black and gray waters coming from houses are disposed of into cesspits built in the public roads or right-of-ways, in view of the scarcity of available space for the proper disposition of the liquid wastes.

2.5.5 Existing Water Supply Facilities

(1) Khan Yunis City

The existing water supply system was planned and constructed in the 1950's and has been deteriorated because of many illegal connections and lacking of adequate operation and maintenance of the facilities.

The main water sources for water supply system is the existing six wells managed by the Municipality in the different parts of the City, and part of the supplying water purchased from the MEKOROT. Exact amount of the water supplied by theses wells can be hardly known because of the lack of good maintenance and mal-functioning of water measuring equipment of all the wells. The present quantity of the water supply is estimated by the Khan Yunis City and the Palestinian Hydrology Group to be 3.8 million m^3/year. Recently, a new well with a capacity of 150 to 200 m3/hour was dug and now the seven wells in total are being operated. Table M.2.21 shows the conditions of the existing seven wells.

Table M.2.21 Wells of Khan Yunis Water Supply System

Wells	Location (coordinates)	Ground elevation (+m)	Static water level (+m)	Depth of well (m)	Pump type & size	Discharge (m^3/hr)	Drive Power (hp)
1. Ayya L-43	8310/8545	58	50	89	6" vertical	65	115
2. El-Sa'ada L-87	08232/08484	52.7	54.75	92	6" vertical	80	75
3. Eastern L-41	8433/8317	60	61.34	99.5	6" vertical	60	60
4. Al-Amal L-159	08190/08562	43.5	60	100	6" vertical	160	100
5. Southern L-176	08208/08304	48.5	40	80	6" submers.	120	-
6. Al-Ahrash L-127	08275/08580	49	60	-	6" vertical	80-85	100
7. New well	-	21	-	-	-	-	-

Source: "Khan Younis, Rehabilitation and Upgrading of the Water Supply and Distribution System," January 1996, Center for Engineering and Planning prepared for United Nations Development Programme.

Water quality of the well water has high salinity (mg CLØ/l) and nitrate (mg NO_3/l)levels, as high as 880 mg/l and 350 mg/l respectively, far removed from international standards. This is considered mainly due to over-pumping, infiltration of wastewater into ground, and improper use of fertilizers.

The future water consumption rates are projected by the Khan Yunis Municipality as listed in the table blow:

Table M.2.22 Projected Water Consumption Rates in Khan Yunis

Year	Per capita Consumption (l/cap/day)	Served Population (persons)	Total Water Demand(m^3/day)
1995		123,000	14,760
2000		167,000	20,160
2005		213,000	25,680
2010		-	30,480
2015		-	36,000
2020	120	425,000	42,720
2025	120	505,000	50,640

Source: "Khan Yunis, Rehabilitation and Upgrading of the Water Supply and Distribution System," January 1996, Center for Engineering and Planning.

The water system were planned based on the following design criteria:

1) The future projected demands are estimated based on the saturated populations.

2) The daily average per capita water consumption is projected to be 120 lcpd.

3) The peak factor is 2 (hourly maximum rate).

4) Available head at demand nodes is 20 meters or higher.

Currently, the rehabilitation and upgrading of the water distribution network are underway to meet the increased water requirements in the year 2025. The planned distribution network will function efficiently when the required water sources and storage/regulator facilities are developed. The proposed water supply development plan for the year 2025 is shown in Figure M.2.7.

(2) Khuzaa, Abassan Kabera, Abassan Saghera, Bani Sohaila Other Villages

The drinking water to these areas is distributed through the MEKOROT water supply network system. The water is distributed to Khuzaa through a 4-inch water main of asbestos cement pipes from Abassan Kabera. In addition to the water supply system, each of the communities has independent wells but are used mainly for crop irrigation. Each of Khuzaa and Abassan Kabera villages has 2 and 3 wells for irrigation use, respectively.

According to the Water Authority, the supplied water quantities to Khan Yunis City and surrounding villages by supply sources are as follows:

Table M.2.23 Water Quantities by Administration (As of August 1996)

City and Villages	Sources and Quantities of Water Supply (m^3/yr.)			Total
	MEKOLOT Public Water System		Private Wells	
1. Khan Yunis City	1,042,280	3,611,9201	0	4,654,200
2. Abassan Kabera	450,460	112,000(summer only)	0	562,460
3. Al Qarrara	0	512,000 (1 well)	43,000	555,000
4. Bani Sohaila	474,550	415,000 (2 wells)	0	889,550
5. Kuzaa	309,610	0	0	309,610
6. Abassan Saghera	0	80,000	0	80,000
7. Other southern villages	0	1,314,000	0	1,314,000
Total	2,276,900	6,044,920	43,000	8,364,820

Source: The Palestine Water Authority.

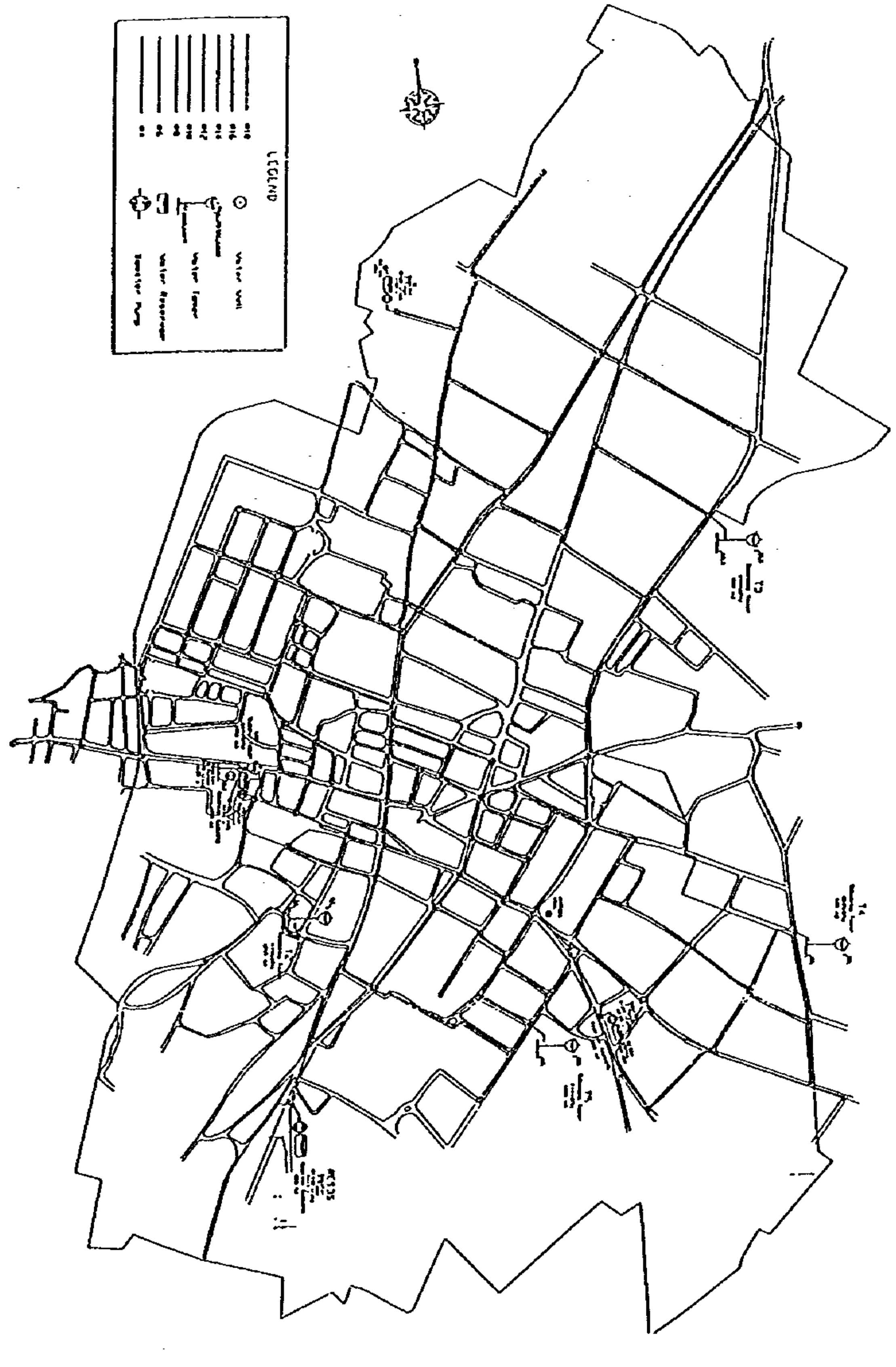

FIG.M.2.7	WATER SUPPLY DEVELOPMENT PLAN IN KHAN YUNIS

THE STUDY ON SEWERAGE DEVELOPMENT PLAN IN THE AREA OF KHAN YUNIS
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Per capita water supply quantities in the villages are generally low compared with those in Khan Yunis City, ranging between 77 and 80 l/cap/day. The supplied water has high salinity contents of almost 1,500 mg/l. The water uses of households are measured with water meters: however, because of the inadequate maintenance of water meters, illegal connections, and possible high rate of water leakage, the percentage of unaccounted-for water is high, reaching almost 50 percent according to the water authorities. The future water consumption projection data are not available for these villages. The water charge is NIS 18 up to the first 10 m³ and then NIS 2 for additional one m³ of water. In Gaza City, 50 percent of the water charge is added as sewer user charge.

2.5.6 Sewerage System

A separate sanitary sewer collection and disposal system was originally planned by Israeli Consultants TOSHIA in 1977, and part of the system was constructed in the and 1980is by Khan Yunis Municipality. The sewerage system was to collect the sewage from the central portion of the City and dispose of it to an aerated lagoon sewage treatment plant site in Garara via a pumping station. The planned sewerage system facilities are shown in Figures M.2.8 and M.2.9, and their capacities, sizes and major features are summarized below:

(1) Sewer network

Sewer pipe	:	Asbestos cement pipes (ACP)
Pipe size	:	6 to 16 inches (150 to 400 mm)
Total pipe length	:	35 km

(2) Pumping station

Mechanical screening	:	1 unit
Grit chamber	:	1 unit
Depth of pump well	:	10 meters
Pump capacity	:	200 m3 / hour
Number of pumps	:	3 sets
Electric generator	:	1 set

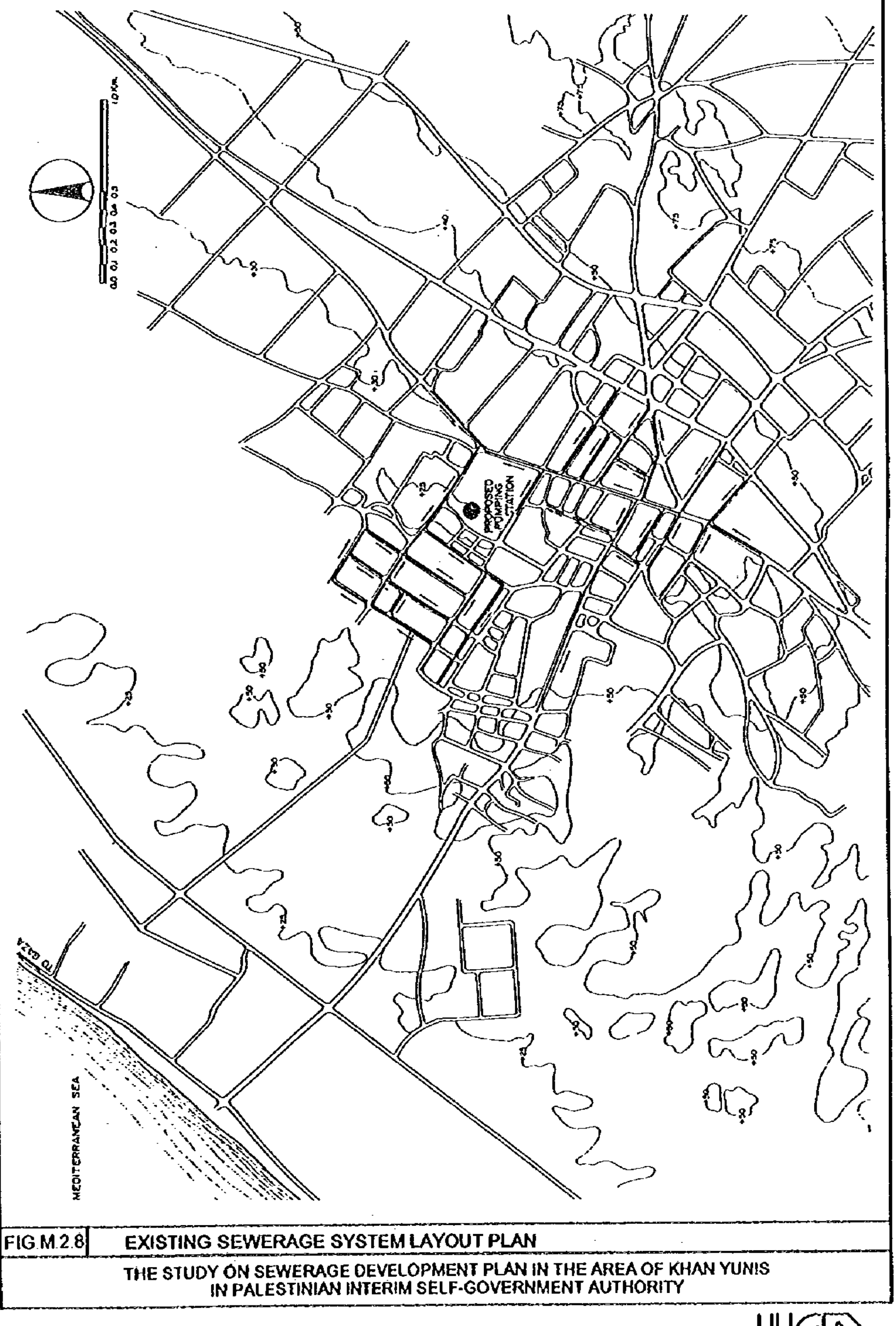

FIG.M.2.8 EXISTING SEWERAGE SYSTEM LAYOUT PLAN

THE STUDY ON SEWERAGE DEVELOPMENT PLAN IN THE AREA OF KHAN YUNIS IN PALESTINIAN INTERIM SELF-GOVERNMENT AUTHORITY

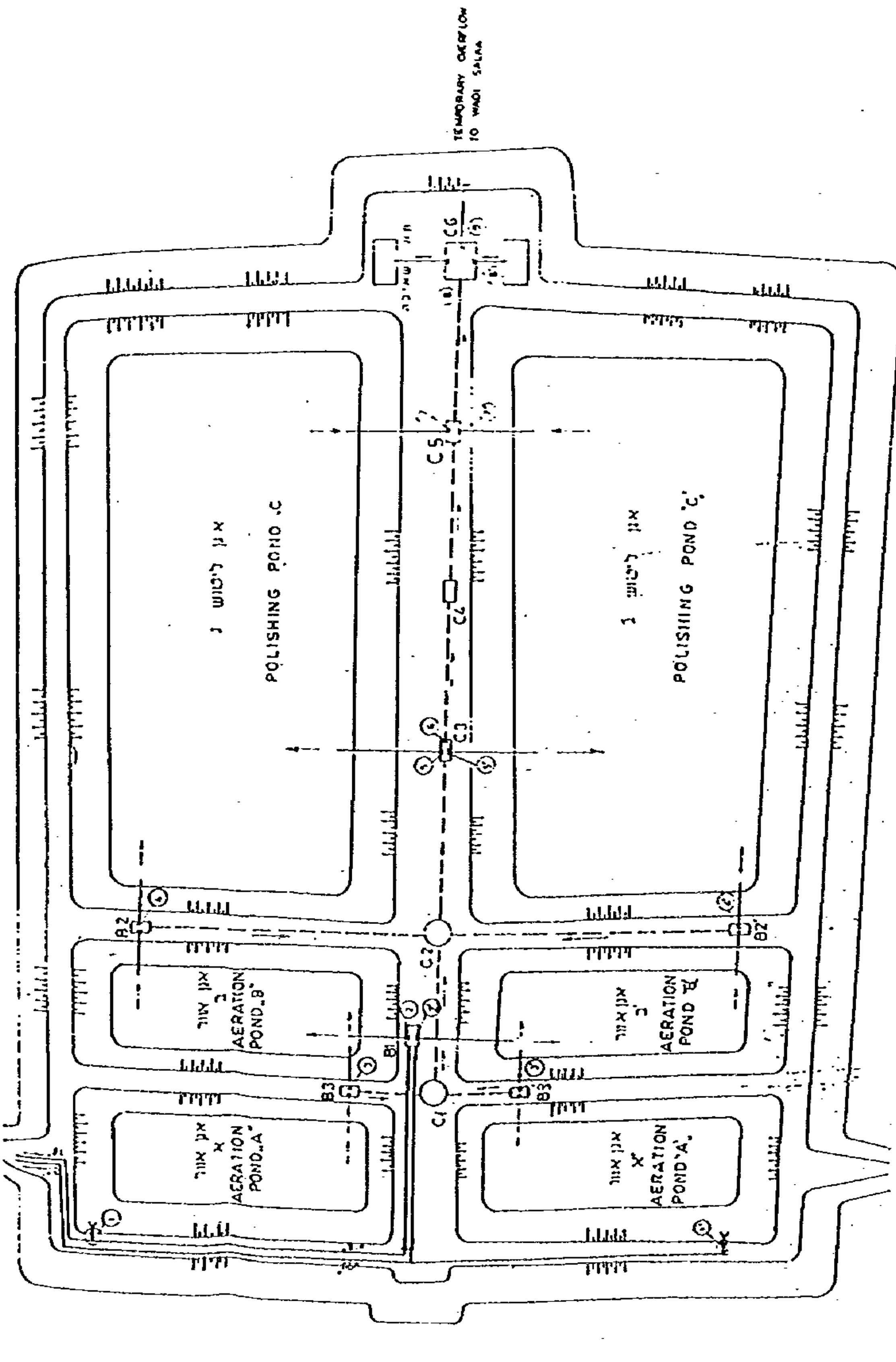

FIG.M.2.9	PLANNED SEWAGE TREATMENT PLAN FOR EXISTING SEWERAGE

THE STUDY ON SEWERAGE DEVELOPMENT PLAN IN THE AREA OF KHAN YUNIS IN PALESTINIAN INTERIM SELF-GOVERNMENT AUTHORITY

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(3) Sewage treatment works

Treatment process	:	Aerated lagoons
Aeration pond	:	4 units
Polishing ponds	:	2 units
Outfall	:	Temporary overflow to the Wadi Salka

The construction of sewers started in 1978 following the original design at the central and western parts of the Khan Yunis City area. The sewer network consists of 8" (200 mm), 12" (300 mm), 14"(350 mm), and 16" (400 mm) asbestos cement pipes, with the total length of about 7 km or about 20 percent of the total planned length.

The lift pump station was planned at a depressed point, from where the sewage would be sent through a force main to the sewage treatment plant at Qarrara. The pump station has, however, not been constructed yet.

After the part of the sewer network had been constructed, the works were suspended due to political, financial and land acquisition problems, and no further facility was constructed. The existing sewer manholes were allegedly filled in by sand by the City to prevent illegal house connections to the sewers. So far, sewer locations have been confirmed by a field survey, but no inventory is available as to the sewer invert elevations.

2.5.7 Individual Sanitation Facilities

Presently no sewerage system exists in the Study Area. All of the wastewater from households are either leached into ground through cesspits or septic tanks which are built in front of each house or apartment complex. In some areas with narrow streets, where space are not available in private land for the provision of such facilities, cesspits are built on the public roads.

Many of households dispose of the black water into cesspits or septic tanks, but sullage water is discharged directly onto the ground or public roads. The toilet system generally use flush tanks or water tanks, many cases with water faucets or showers to cleansing. Exereta is flushed and carried away to cesspits or septic tanks through pipes. The exereta solids mixed with the flush or cleansing water settle to the bottom of chamber and are digested anaerobically as they undergo in the chambers.

There are two different types of cesspits, one is deep cesspits with a diameter of 80 centimeters steel cylinder of 1 meter long welded to 12 to 15 meters deep. Another type is larger in size having 2 meters in diameter. Depth of pits is determined depending upon the soil characteristics. The top of the pit is covered by a concrete slab or manhole cover of cast iron. Although pits content are occasionally desludged, pit deposits tend infiltrate gradually into the surrounding soil and reducing the soil permeability. Thus, pits are abandoned in about three to seven years depending on the soil characteristics, and new pits are dug. The cost of a pit is approximately US$ 1,000.

Pits are frequently emptied by vacuum trucks. In Khan Yunis City, at present there are about 1,000 septic tanks are in operation. Tank desludging work is managed by 5 municipality's trucks and 15 private trucks. For desludging of average septic tanks, the city charges NIS 20 whereas private trucks charge NIS 25. All the collected sludge is dumped at several sites outskirts of the City. Structures of typical septic tank and leaching tank are shown in Figures M.2.10 and M.2.11.

Sanitary situation is worse in the central urban areas of the City where population densities are high, e.g. in the Khan Yunis refugee camp, about 380 persons per hectare reside. In such highly populated and low lying areas, the ground appears to be saturated with the wastewater and at many locations overflow to ground surface. The ground water contains high nitrates.

2.5.8 Stormwater Drainage System

Rainwater runoff is discharged by means of road surfaces and at certain locations of drainage ditches, but are in general not adequate to smoothly discharge the storm water runoffs. Much of the runoffs from households or yards are discharged directly to the streets and pathways, as spaces or vacant lots to retain the runoffs are limited.

The drainage situation in Khan Yunis is worse than other areas. The central district of the City near Municipal Office and along the Jamal Abd El Naser street is occasionally flooded once it heavy rain falls. Without gutters and side drains, all the rainwater runoffs find their way to the street, which functions as a storm water drain, and finally flows down to the lowest point where the pump station was proposed by a sewerage plan.

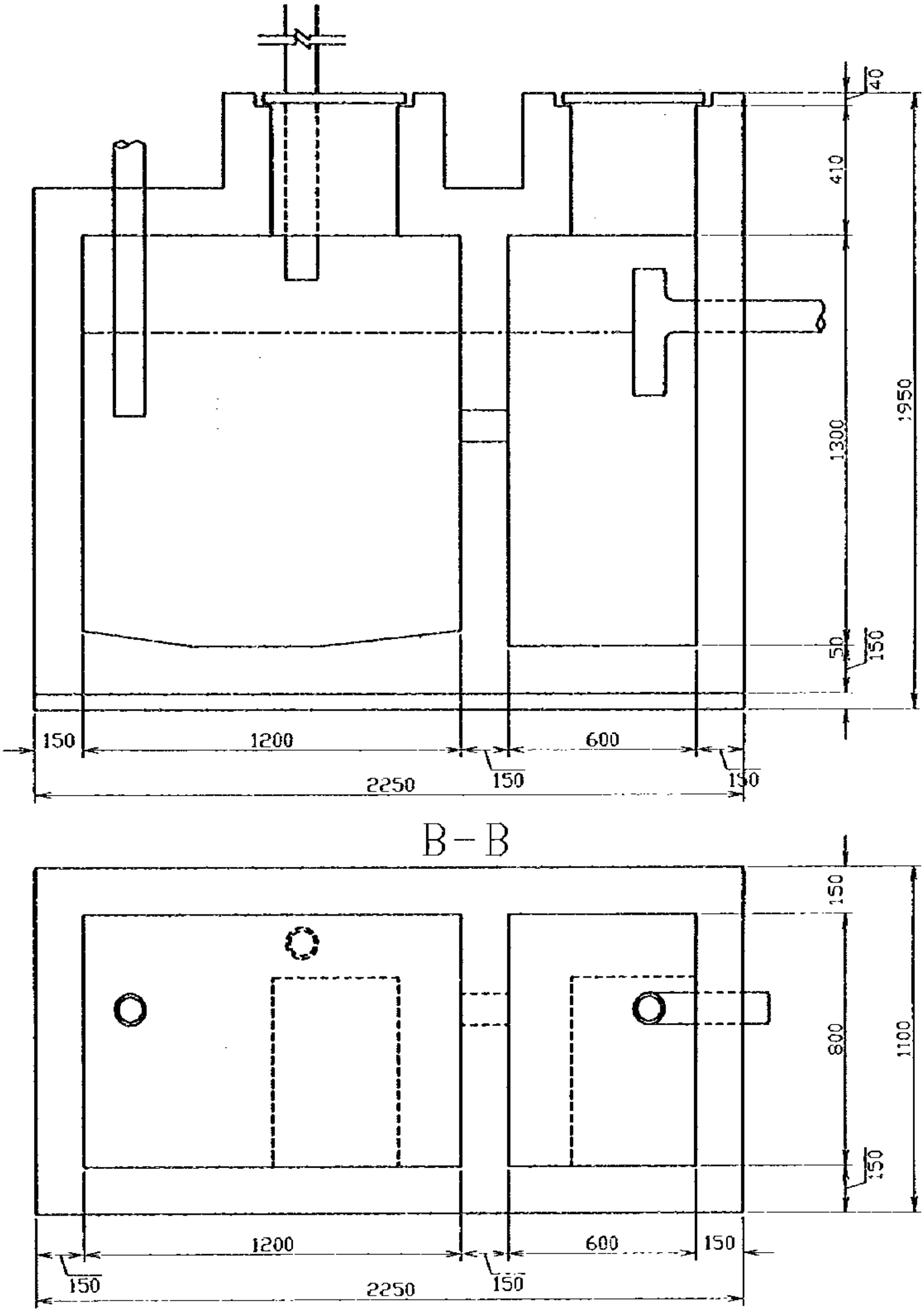


FIG. M.2.10 STANDARD SEPTIC TANK STRUCTURE

THE STUDY ON SEWERAGE DEVELOPMENT PLAN IN THE AREA OF KHAN YUNIS
IN PALESTINIAN INTERIM SELF-GOVERNMENT AUTHORITY

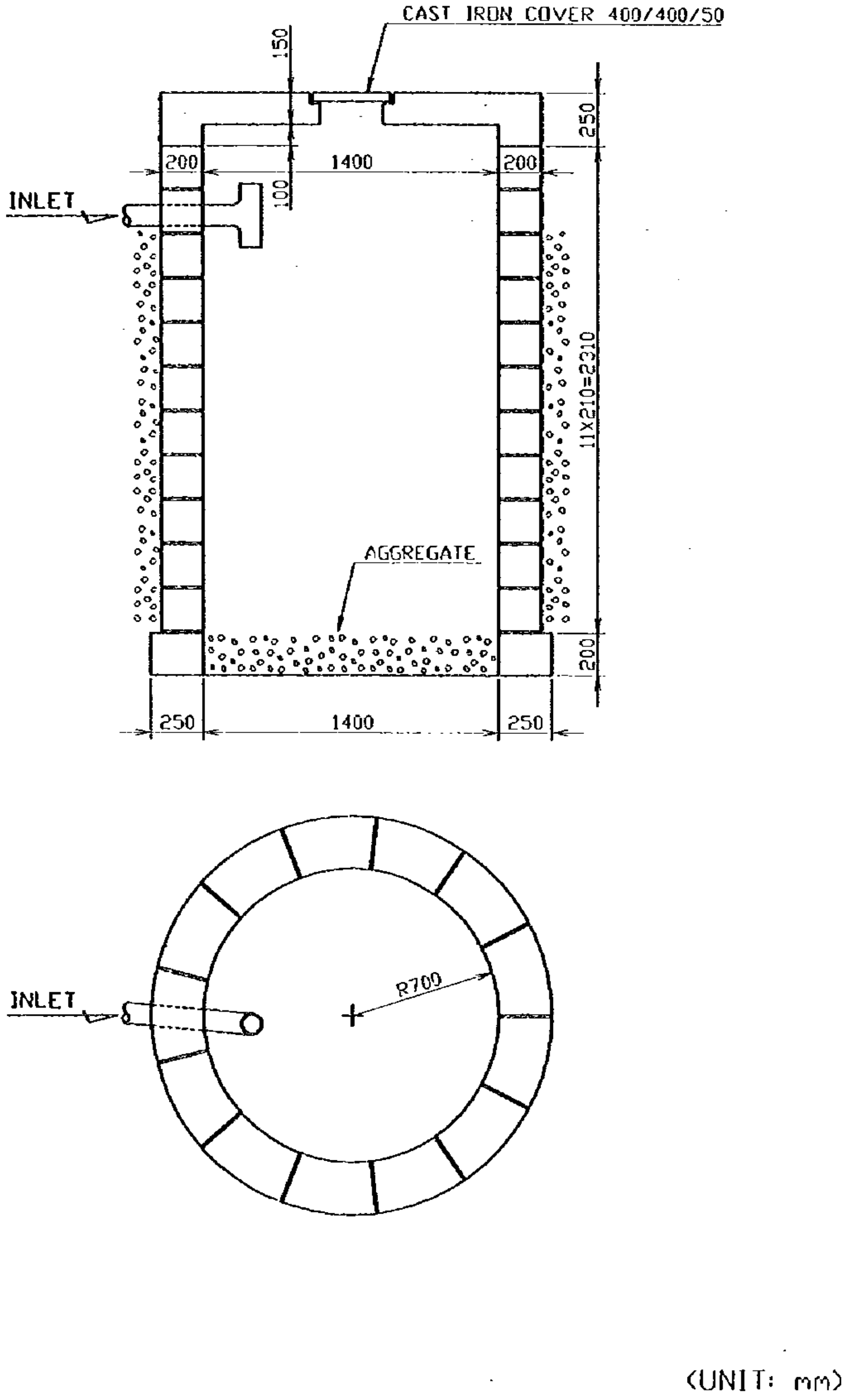


FIG. M.2.11 STANDARD LEACHING TANK STRUCTURE

THE STUDY ON SEWERAGE DEVELOPMENT PLAN IN THE AREA OF KHAN YUNIS
IN PALESTINIAN INTERIM SELF-GOVERNMENT AUTHORITY

In the area near the Municipality Office, there exists a wide depressed area where markets are located. Whenever heavy rain falls, the rainwater runoff from a catchment area of 60 hectares finds its way to this area. Currently, a 100 mm diameter drain pump is provided and managed by the City, but the pump capacity is not enough to discharge the heavy stormwater runoffs and caused inundation occasionally. The pumped water is conveyed through 100 mm steel discharge pipes to the Jamal Abd El Naser street near the City Office and emptied to the road surface.

At other few depressed locations scattering in the central part of the City, a small pump is provided and discharge the rain water to the nearby streets at higher locations to flow down on the road surface. Washed sand deposits on the existing drainage channel downstream and the sections are considerably narrowed, thus, obstructing smooth flow of the water. The water is finally discharged to the depressed lot at the pumping station site and stagnates until it is either evaporated or infiltrated into the ground.

In areas other than Khan Yunis City, the drainage situation appears to be not so serious. In Kizan area, the rainwater runoffs have either been directly used or stored for irrigation purpose, or recharged into ground. As most of the area is planned to remain as the agricultural zone in the future, and there would be no serious problem as to urban storm water drainage. Also, in southern villages of Khuzaa, Abassan Kabera, Abassan Saghera and Qarrara, the stormwater runoffs are generally flow down to the surrounding agricultural lands through road surfaces and used for irrigation purpose or recharged to the ground, thus, no severe flooding has so far been occurred in these areas.

CHAPTER 3 URBAN PLANNING AND LAND USE

CHAPTER 3 URBAN PLANNING AND LAND USE

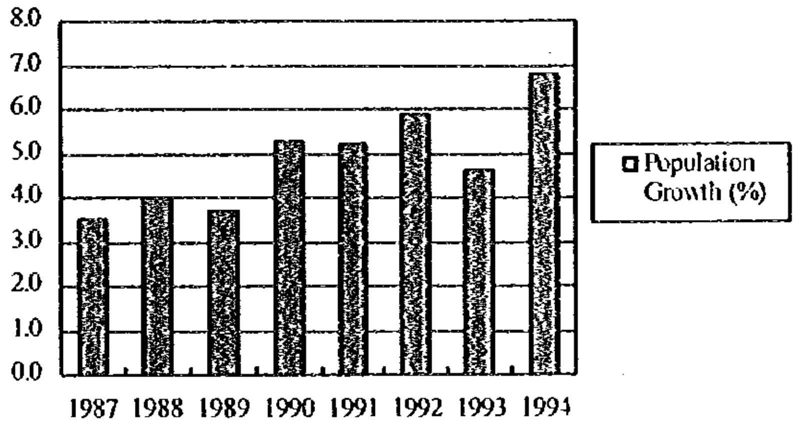
3.1 Population Projection

3.1.1 Population Trend

The Khan Yunis Area has experienced high population growth rates in the last decade as shown in Table M.3.1 due mainly to the high immigration of new families to the Region. For other villages than Khan Yunis City no detailed information showing the past population growth trends were not available to the study team.

Table M.3.1 Khan Yunis City Population Growth Rates

Year	Annual growth rate(%)
1987	3.5
1988	4.0
1989	3.7
1990	5.3
1991	5.2
1992	5.9
1993	4.6
1994	6.8



Source: MOPIC

As evident as shown in Fig M.3.1, there was an upward tend in population growth from 1987 to 1994. The average rate was 4.9 % during the period.

The study Team projected the future population growth based on a study conducted by MOPIC as follows:

- From 1997 to 2000: 6.5%
- From 2001 to 2005: 5.0%
- From 2006 to 2010: 3.5%
- From 2011 to 2015: 3.0%

This is a downward projection of the populations growth, which was agreed by MOPIC. In a further study of the population projection the Palestinian side suggested that a large number of returnees from abroad be calculated for the projection. The study Team accepted the MOPIC suggestion and made the following assumptions:

a. The central parts of the Study area will have the alone figures.

b. Swrownging areas, presently farm lands, will accept the home-cowing returnees in kizan Area and Qarrara.

The study Team therefore set the following two scenarios.

<Scenario I> : natural increase and returnees

<Scenario II> : natural increase only

After discussions with MOPIC the Study Team decided to use Scenario I as the hase projection of the population growth in Khan Yunis area, while Scenario II will be remained as reference.

3.1.2 Present Population

Present populations in Khan Yunis City and villages within the Study Area for the years 1995 and 1996 were estimated by MOPIC and Palestinian Central Bureau of Statistics as tabulated in the table below:

Table M.3.2 Present Population of the Study Area

	Administrative Units	(1) 1995	(1) 1996	(2) 1996
1.	Khan Yunis	88,300	90,400	-
2.	Khan Yunis Camp	41,300	42,300	-
3.	Bani Sohaila	16,500	16,900	23,478
4.	Qarrara	10,800	11,100	10,124
5.	Abassan Saghera	5,400	5,500	5,176
6.	Abassan Kabera	11,300	11,600	17,456
7.	Khuzaa	6,000	6,200	8,466
	Total	179,600	144,000	64,700

Note: (1) MOPIC ; Statistics Quarterly Gaza Governorates, April - June 1996.
(2) Palestinian Central Bureau of Statistics; Small Area Population, Revised Estimates for 1996.

Because sufficient data are not available to indicate the present population distribution throughout the Study Area, a demographic survey was conducted for the study from October through November 1996 at the selected representative blocks in the inhabited zones, to investigate the present population distributions, living patterns, housing numbers, and family members. For the survey, the entire Study Area was divided into 210 blocks as shown in Figure M.3.1.

As summarized in Table M.3.3, the average population density of the surveyed area was 44 persons per hectare (For more details refer to Appendix A, Urban Planning and General"). The population estimates based on the survey results indicate a good agreement with the projection by the MOPIC.

Table M.3.3 Population Distribution in Each Administrative Unit

District	Area (ha)	Estimated Population
Khan Yunis and Camp	1,737.884	125,519
Bani Sohaila	463.509	24,432
Abassan Kabera	422.787	17,274
Abassan Saghera	128.133	6,389
Qarrara	358.248	10,171
Khuzaa	128.590	7,605
Kizan	1,199.939	4,717
Total	4,439.000	195,407

The present population distribution within the Study Area thus contemplated is illustrated in Figure M.3.1.

3.1.3 Population Projection

The future population for the Khan Yunis and other villages were projected by the MOPIC and Palestinian Central Bureau of Statistics up to the year 2010. The MOPIC projected the future populations applying varied growth rates by stage, at 6.5 percent per year from 1995 to 2000, 5.0 percent from 2000 to 2005, and 3.5 % for 2005 to 2010, whereas the Palestinian Central Bureau of Statistics projected with COHORT.

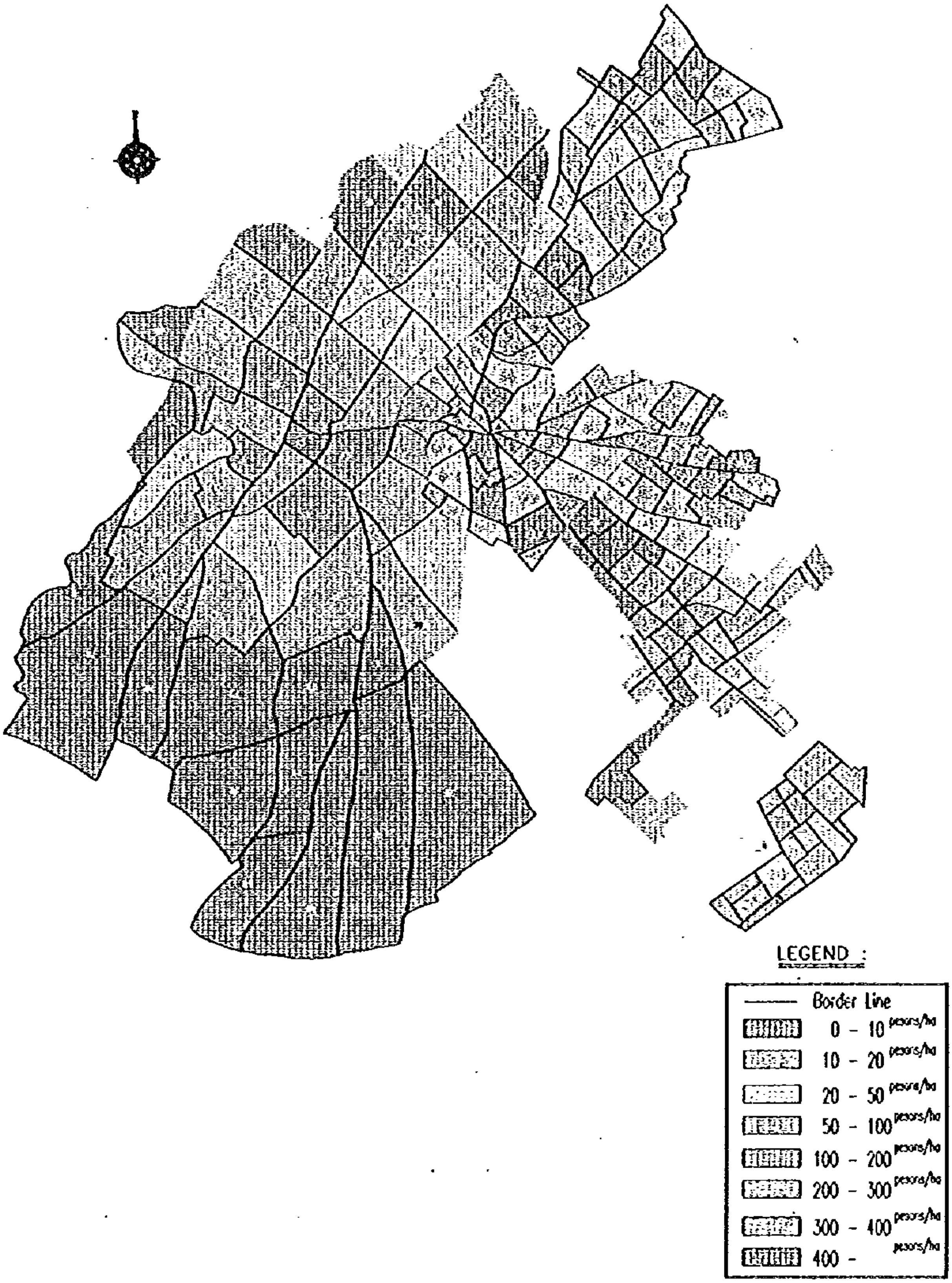


FIG. M.3.1 POPULATION DENSITY IN 1996

THE STUDY ON SEWERAGE DEVELOPMENT PLAN IN THE AREA OF KHAN YUNIS
IN PALESTINIAN INTERIM SELF-GOVERNMENT AUTHORITY

AD 1997

There are significant differences in both present and future projections among the agencies, therefore, the government's recent development plans have been taken into account to reach realistic population projections. As the governments' projections have involved various social, political and international situations, these have been rectified with due considerations on the possible population settlements in the near future into the present agricultural zones in Kizan and Qarara. The population growth rates in these areas have thus been adjusted on the basis of the MOPIC's returnees settlement plans. The projected population growths for each of the administrative boundaries from 1996 through 2015 are tabulated in Table M.3.4 and Table M.3.5.

The population distribution in 2015 was also projected based on the present population distribution survey results (See Section 3.5) and the land use plan for 2015 (See Section 3.4.3). The population densities and populations by land use pattern for each of the administrative units estimated from 1996 through 2015 are shown in Table M.3.4 and Table M.3.5 and are illustrated in Figure M.3.2.

Table M.3.4 Population Projection for STUDY Area by MOPIC

Year	Khan Yunis		Kizan Area		Bani Sohaila		Qarrara		Abassan Saghera		Abassan Kabera		Khuzaa		TOTAL
	Growth rate %	Popula-tion	Growth rate %	Popula-tion	Growth rate %	Popula-tion	Growth rate %	Popula-tion	Growth rate %	Popula-tion	Growth rate %	Popula-tion	Growth rate %	Popula-tion	
1996		132,700		4,700		16,900		11,100		5,500		11,600		6,200	188,700
1997	6.5	141,326	14.574	5,385	6.5	17,999	6.101	11,777	6.5	5,858	6.5	12,354	6.5	6,603	201,302
1998	6.5	150,512	14.574	6,170	6.5	19,168	6.101	12,496	6.5	6,238	6.5	13,157	6.5	7,032	214,773
1999	6.5	160,295	14.574	7,069	6.5	20,414	6.101	13,258	6.5	6,644	6.5	14,012	6.5	7,489	229,181
2000	6.5	170,714	14.574	8,099	6.5	21,741	6.101	14,067	6.5	7,076	6.5	14,923	6.5	7,976	244,596
2001	5.0	179,250	14.574	9,280	5.0	22,828	6.101	14,925	5.0	7,429	5.0	15,669	5.0	8,375	257,756
2002	5.0	188,212	14.574	10,632	5.0	23,970	6.101	15,836	5.0	7,801	5.0	16,453	5.0	8,794	271,698
2003	5.0	197,623	14.574	12,181	5.0	25,168	6.101	16,802	5.0	8,191	5.0	17,275	5.0	9,233	286,473
2004	5.0	207,504	14.574	13,957	5.0	26,427	6.101	17,827	5.0	8,600	5.0	18,139	5.0	9,695	302,149
2005	5.0	217,879	14.574	15,991	5.0	27,748	6.101	18,915	5.0	9,030	5.0	19,046	5.0	10,180	318,789
2006	3.5	225,505	14.574	18,321	3.5	28,719	6.101	20,069	3.5	9,346	3.5	19,713	3.5	10,536	332,209
2007	3.5	233,398	14.574	20,992	3.5	29,724	6.101	21,293	3.5	9,674	3.5	20,403	3.5	10,905	346,389
2008	3.5	241,567	14.574	24,051	3.5	30,765	6.101	22,592	3.5	10,012	3.5	21,117	3.5	11,286	361,390
2009	3.5	250,021	14.574	27,556	3.5	31,841	6.101	23,970	3.5	10,363	3.5	21,856	3.5	11,681	377,288
2010	3.5	258,772	14.574	31,572	3.5	32,956	6.101	25,433	3.5	10,725	3.5	22,621	3.5	12,090	394,169
2011	3.0	266,535	14.574	36,173	3.0	33,945	6.101	26,985	3.0	11,047	3.0	23,299	3.0	12,453	410,437
2012	3.0	274,531	14.574	41,445	3.0	34,963	6.101	28,631	3.0	11,378	3.0	23,998	3.0	12,827	427,773
2013	3.0	282,767	14.574	47,486	3.0	36,012	6.101	30,378	3.0	11,720	3.0	24,718	3.0	13,211	446,292
2014	3.0	291,250	14.574	54,406	3.0	37,092	6.101	32,231	3.0	12,071	3.0	25,460	3.0	13,608	466,118
2015	3.0	299,988	14.574	62,335	3.0	38,205	6.101	34,197	3.0	12,434	3.0	26,224	3.0	14,016	487,399

Table M.3.5 Population Projection for Study Area by MOPIC
Natural Increase Only <Scenario II>

Year	Khan Yunis		Kizan Area		Bani Sohaila		Qarrara		Ab. Saghera		Ab. Kabera		Khuzaa		Total
	Growth %	Population	Growth %	Population	Growth %	Population	Growth %	Population	Growth %	Population	Growth %	Population	Growth %	Population	
1996		132,700		4,700		16,900		11,100		5,500		11,600		6,200	188,700
1997	6.5	141,326	6.5	5,006	6.5	17,999	6.5	11,822	6.5	5,858	6.5	12,354	6.5	6,603	200,966
1998	6.5	150,512	6.5	5,331	6.5	19,168	6.5	12,590	6.5	6,238	6.5	13,157	6.5	7,032	214,028
1999	6.5	160,295	6.5	5,677	6.5	20,414	6.5	13,408	6.5	6,644	6.5	14,012	6.5	7,489	227,940
2000	6.5	170,714	6.5	6,046	6.5	21,741	6.5	14,280	6.5	7,076	6.5	14,923	6.5	7,976	242,756
2001	5.0	179,250	5.0	6,349	5.0	22,828	5.0	14,994	5.0	7,429	5.0	15,669	5.0	8,375	254,894
2002	5.0	188,212	5.0	6,666	5.0	23,970	5.0	15,743	5.0	7,801	5.0	16,453	5.0	8,794	267,639
2003	5.0	197,623	5.0	6,999	5.0	25,168	5.0	16,531	5.0	8,191	5.0	17,275	5.0	9,233	281,021
2004	5.0	207,504	5.0	7,349	5.0	26,427	5.0	17,357	5.0	8,600	5.0	18,139	5.0	9,695	295,072
2005	5.0	217,879	5.0	7,717	5.0	27,748	5.0	18,225	5.0	9,030	5.0	19,046	5.0	10,180	309,825
2006	3.5	225,505	3.5	7,987	3.5	28,719	3.5	18,863	3.5	9,346	3.5	19,713	3.5	10,536	320,669
2007	3.5	233,398	3.5	8,267	3.5	29,724	3.5	19,523	3.5	9,674	3.5	20,403	3.5	10,905	331,893
2008	3.5	241,567	3.5	8,556	3.5	30,765	3.5	20,206	3.5	10,012	3.5	21,117	3.5	11,286	343,509
2009	3.5	250,021	3.5	8,855	3.5	31,841	3.5	20,914	3.5	10,363	3.5	21,856	3.5	11,681	355,532
2010	3.5	258,772	3.5	9,165	3.5	32,956	3.5	21,646	3.5	10,725	3.5	22,621	3.5	12,090	367,975
2011	3.0	266,535	3.0	9,440	3.0	33,945	3.0	22,295	3.0	11,047	3.0	23,299	3.0	12,453	379,014
2012	3.0	274,531	3.0	9,723	3.0	34,963	3.0	22,964	3.0	11,378	3.0	23,998	3.0	12,827	390,385
2013	3.0	282,767	3.0	10,015	3.0	36,012	3.0	23,653	3.0	11,720	3.0	24,718	3.0	13,211	402,096
2014	3.0	291,250	3.0	10,316	3.0	37,092	3.0	24,362	3.0	12,071	3.0	25,460	3.0	13,608	414,159
2015	3.0	299,988	3.0	10,625	3.0	38,205	3.0	25,093	3.0	12,434	3.0	26,224	3.0	14,016	426,584

Table M.3.6 (1/4) Population Distribution in 2015

Khan Yunis

Year	Land Use	Camp 1	Camp 2	C.O.	H, BSC	H, A	Agri & O	Planning	Pop Proj	Difference
	ha	104	57	138	550	608	187	1644		
1996	p/ha	400	257	270	60	7	10			
	persons	41600	14649	37260	33000	4321	1870	132700	132700	0
1997	p/ha	405	259	279	64	15	10			
	persons	42091	14769	38458	35015	9093	1870	141326	141326	0
1998	p/ha	410	261	288	68	23	10			
	persons	42589	14890	39757	37153	14054	1870	150312	150312	0
1999	p/ha	414	263	298	72	33	10			
	persons	43092	15011	41067	39421	19834	1870	160295	160295	0
2000	p/ha	419	266	307	76	42	10			
	persons	43601	15134	42421	41828	25320	1870	170174	170174	0
2001	p/ha	424	268	318	81	49	10			
	persons	44116	15258	43819	44382	29805	1870	179250	179250	0
2002	p/ha	429	270	328	86	56	10			
	persons	44637	15382	45264	47091	33967	1870	188212	188212	0
2003	p/ha	434	272	339	91	63	10			
	persons	45164	15508	46756	49967	38358	1870	197623	197623	0
2004	p/ha	439	274	350	96	71	10			
	persons	45698	15635	48297	53017	42987	1870	207504	207504	0
2005	p/ha	445	277	362	102	79	10			
	persons	45238	15763	49689	56254	47865	1870	217879	217879	0
2006	p/ha	450	279	373	109	82	10			
	persons	46784	15892	51533	59669	49737	1870	225505	225505	0
2007	p/ha	455	281	386	115	85	10			
	persons	47337	16022	53232	63333	51604	1870	233398	233398	0
2008	p/ha	461	283	398	122	88	10			
	persons	47896	16153	54987	67200	53462	1870	241567	241567	0
2009	p/ha	466	286	412	130	91	10			
	persons	48462	16285	56799	71303	55302	1870	250021	250021	0
2010	p/ha	471	288	425	138	94	10			
	persons	49034	16418	58671	75656	57122	1870	258772	258772	0
2011	p/ha	477	290	439	146	95	10			
	persons	49614	16552	60605	80275	57619	1870	266535	266535	0
2012	p/ha	483	293	454	155	95	10			
	persons	50200	16687	62603	85177	57994	1870	274531	274531	0
2013	p/ha	488	295	469	164	96	10			
	persons	50793	16824	64667	90377	58237	1870	282768	282768	0
2014	p/ha	494	298	484	174	96	10			
	persons	51393	16961	66798	95895	58333	1870	291250	291250	0
2015	p/ha	500	300	500	185	96	10			
	persons	52000	17100	69000	101750	58268	1870	299988	299988	0

Kizan Area

Year	Land Use	Camp 1	Camp 2	C.O.	H, BSC	H, A	Agri & O	Total	Check	Difference
	ha					519	751	1270		1270
1996	p/ha					4	4			
	persons					1920	2780	4700	4700	0
1997	p/ha					4	4			
	persons					2284	3101	5385	5385	0
1998	p/ha					5	5			
	persons					2717	3453	6170	6170	0
1999	p/ha					6	5			
	persons					3232	3837	7069	7069	0
2000	p/ha					7	6			
	persons					3844	4255	8099	8099	0
2001	p/ha					9	6			
	persons					4573	4707	9280	9280	0
2002	p/ha					10	7			
	persons					5439	5193	10632	10632	0
2003	p/ha					12	8			
	persons					6470	5711	12181	12181	0
2004	p/ha					15	8			
	persons					7695	6262	13957	13957	0
2005	p/ha					18	9			
	persons					9154	6837	15991	15991	0
2006	p/ha					21	10			
	persons					10888	7433	18321	18321	0
2007	p/ha					25	11			
	persons					12951	8041	20992	20992	0
2008	p/ha					30	12			
	persons					15405	8646	24051	24051	0
2009	p/ha					35	12			
	persons					18324	9232	27556	27556	0
2010	p/ha					42	13			
	persons					21796	9776	31572	31572	0
2011	p/ha					50	14			
	persons					25926	10247	36173	36173	0
2012	p/ha					59	14			
	persons					30839	10606	41445	41445	0
2013	p/ha					71	14			
	persons					36682	10804	47486	47486	0
2014	p/ha					84	14			
	persons					43632	10774	54406	54406	0
2015	p/ha					100	14			
	persons					51900	10435	62335	62335	0

Table M.3.6 (2/4) Population Distribution in 2015

Qarrara

Year	Land Use	Camp 1	Camp 2	C.O.	H, B&C	H, A	Agri & O	Total	Check	Difference
	ha				136	95	211	443		443
1995	p/ha				55	12	12			
	persons				7416	1152	2532	11100	11100	0
1997	p/ha				57	13	13			
	persons				7757	1264	2756	11777	11777	0
1998	p/ha				60	14	14			
	persons				8110	1397	2939	12496	12496	0
1999	p/ha				62	16	15			
	persons				8472	1522	3265	13258	13258	0
2000	p/ha				65	17	17			
	persons				8844	1670	3553	14067	14067	0
2001	p/ha				68	19	18			
	persons				9225	1832	3867	14925	14925	0
2002	p/ha				71	21	20			
	persons				9616	2011	4209	15836	15836	0
2003	p/ha				74	23	22			
	persons				10015	2206	4591	16802	16802	0
2004	p/ha				77	25	24			
	persons				10420	2421	4986	17827	17827	0
2005	p/ha				80	28	26			
	persons				10832	2656	5427	18915	18915	0
2006	p/ha				83	30	28			
	persons				11248	2915	5907	20069	20069	0
2007	p/ha				86	33	30			
	persons				11666	3199	6429	21293	21293	0
2008	p/ha				89	37	33			
	persons				12086	3509	6997	22592	22592	0
2009	p/ha				92	40	36			
	persons				12504	3850	7616	23970	23970	0
2010	p/ha				95	44	39			
	persons				12919	4225	8289	25433	25433	0
2011	p/ha				99	48	43			
	persons				13328	4536	9022	26985	26985	0
2012	p/ha				101	53	47			
	persons				13725	5087	9819	28631	28631	0
2013	p/ha				104	58	51			
	persons				14110	5581	10687	30378	30378	0
2014	p/ha				106	64	55			
	persons				14475	6124	11632	32231	32231	0
2015	p/ha				109	70	60			
	persons				14817	6720	12660	34197	34197	0

Bani Suhaila

Year	Land Use	Camp 1	Camp 2	C.O.	H, B&C	H, A	Agri & O	Total	Check	Difference
	ha			128	200	59	17	404		404
1995	p/ha			58	47	1	0			
	persons			7424	9400	76	0	16900	16900	0
1997	p/ha			60	49	8	5			
	persons			7660	9771	494	85	17939	17939	0
1998	p/ha			62	51	17	5			
	persons			7903	10156	1024	85	19168	19168	0
1999	p/ha			64	53	27	5			
	persons			8153	10556	1619	85	20414	20414	0
2000	p/ha			66	55	37	10			
	persons			8412	10973	2186	170	21741	21741	0
2001	p/ha			68	57	44	10			
	persons			8679	11405	2574	170	22828	22828	0
2002	p/ha			70	59	51	10			
	persons			8954	11855	2991	170	23970	23970	0
2003	p/ha			72	62	55	21			
	persons			9239	12323	3250	357	25168	25168	0
2004	p/ha			74	64	62	24			
	persons			9532	12808	3679	408	26427	26427	0
2005	p/ha			77	67	67	38			
	persons			9834	13314	3954	646	27748	27748	0
2006	p/ha			79	69	69	38			
	persons			10146	13839	4088	646	28719	28719	0
2007	p/ha			82	72	72	38			
	persons			10468	14384	4226	646	29724	29724	0
2008	p/ha			84	75	74	38			
	persons			10800	14951	4367	646	30765	30765	0
2009	p/ha			87	78	76	38			
	persons			11143	15541	4511	646	31841	31841	0
2010	p/ha			90	81	79	38			
	persons			11497	16154	4660	646	32956	32956	0
2011	p/ha			93	84	79	38			
	persons			11861	16791	4647	646	33945	33945	0
2012	p/ha			96	87	79	38			
	persons			12238	17453	4661	646	34998	34963	35
2013	p/ha			99	91	79	38			
	persons			12626	18141	4661	646	36074	36012	62
2014	p/ha			102	94	79	38			
	persons			13027	18856	4661	646	37190	37092	98
2015	p/ha			105	98	79	38			
	persons			13440	19600	4661	646	38347	38205	142

Table M.3.6 (3/4) Population Distribution in 2015

Abassan Saghera

Year	Land Use	Camp 1	Camp 2	C.D.	R. B&C	R. A	Agri & O	Total	Check	Difference
	ha				61	14	53	128		128
1996	p/ha				70	50	10			
	persons				4270	700	530	5500	5500	0
1997	p/ha				73	61	10			
	persons				4467	851	530	5858	5558	0
1998	p/ha				77	74	10			
	persons				4673	1035	530	6238	6238	0
1999	p/ha				80	80	12			
	persons				4889	1119	636	6644	6644	0
2000	p/ha				84	83	15			
	persons				5115	1166	735	7076	7076	0
2001	p/ha				88	92	15			
	persons				5351	1283	795	7429	7429	0
2002	p/ha				92	101	15			
	persons				5593	1408	795	7801	7801	0
2003	p/ha				96	102	17			
	persons				5856	1434	901	8191	8191	0
2004	p/ha				100	105	19			
	persons				6127	1456	1007	8600	8500	0
2005	p/ha				105	108	21			
	persons				6409	1508	1113	9030	9030	0
2006	p/ha				110	109	21			
	persons				6705	1529	1113	9345	9346	0
2007	p/ha				115	110	21			
	persons				7015	1546	1113	9674	9674	0
2008	p/ha				120	111	21			
	persons				7339	1560	1113	10012	10012	0
2009	p/ha				126	112	21			
	persons				7677	1573	1113	10363	10363	0
2010	p/ha				132	113	21			
	persons				8032	1580	1113	10725	10725	0
2011	p/ha				138	113	21			
	persons				8403	1582	1113	11098	10725	373
2012	p/ha				144	113	21			
	persons				8791	1582	1113	11486	11047	439
2013	p/ha				151	113	21			
	persons				9195	1582	1113	11891	11378	513
2014	p/ha				159	113	21			
	persons				9621	1582	1113	12316	11720	596
2015	p/ha				165	113	21			
	persons				10065	1582	1113	12760	12434	326

Abassan Kabera

Year	Land Use	Camp 1	Camp 2	C.D.	R. B&C	R. A	Agri & O	Total	Check	Difference
	ha				309	17	98	424		424
1996	p/ha				36	22	1			
	persons				11124	378	98	11600	11600	0
1997	p/ha				37	35	2			
	persons				11562	596	196	12354	12354	0
1998	p/ha				39	39	5			
	persons				12018	649	490	13157	13157	0
1999	p/ha				40	38	9			
	persons				12491	639	882	14012	14012	0
2000	p/ha				42	39	13			
	persons				12983	666	1274	14923	14923	0
2001	p/ha				44	41	15			
	persons				13494	705	1470	15669	15569	0
2002	p/ha				45	45	17			
	persons				14026	761	1666	16453	16453	0
2003	p/ha				47	45	20			
	persons				14578	765	1960	17303	17275	28
2004	p/ha				49	49	22			
	persons				15152	831	2156	18139	18133	0
2005	p/ha				51	50	25			
	persons				15749	847	2450	19046	19046	0
2006	p/ha				53	53	25			
	persons				16369	894	2450	19713	19713	0
2007	p/ha				55	55	25			
	persons				17014	939	2450	20403	20403	0
2008	p/ha				57	55	26			
	persons				17684	935	2548	21167	21117	50
2009	p/ha				59	55	26			
	persons				18381	927	2548	21856	21856	0
2010	p/ha				62	57	26			
	persons				19105	968	2548	22621	22621	0
2011	p/ha				64	57	26			
	persons				19857	969	2548	23374	23299	75
2012	p/ha				67	59	26			
	persons				20639	1003	2548	24190	23939	192
2013	p/ha				69	60	26			
	persons				21452	1020	2545	25020	24718	302
2014	p/ha				72	60	26			
	persons				22237	1020	2548	25865	25450	405
2015	p/ha				75	60	26			
	persons				23175	1020	2548	26743	26224	519

Table M.3.6 (4/4) Population Distribution in 2015

Khuzaa

Year	Land Use	Camp 1	Camp 2	C.D.	H. B&C	H. A	Agri & C	Total	Check	Difference
	ha				102		27	129		129
1996	p/ha				56		19			
	persons				5687		513	6200	6200	0
1997	p/ha				60		19			
	persons				6090		513	6603	6603	0
1998	p/ha				64		19			
	persons				6519		513	7032	7032	0
1999	p/ha				68		19			
	persons				6976		513	7489	7489	0
2000	p/ha				73		19			
	persons				7463		513	7976	7976	0
2001	p/ha				77		19			
	persons				7862		513	8375	8375	0
2002	p/ha				81		19			
	persons				8281		513	8794	8794	0
2003	p/ha				85		19			
	persons				8720		513	9233	9233	0
2004	p/ha				90		19			
	persons				9182		513	9695	9695	0
2005	p/ha				95		19			
	persons				9667		513	10180	10180	0
2006	p/ha				98		19			
	persons				10023		513	10536	10536	0
2007	p/ha				102		19			
	persons				10392		513	10905	10905	0
2008	p/ha				106		19			
	persons				10773		513	11286	11286	0
2009	p/ha				109		19			
	persons				11168		513	11681	11681	0
2010	p/ha				114		19			
	persons				11577		513	12090	12090	0
2011	p/ha				117		19			
	persons				11940		513	12453	12453	0
2012	p/ha				121		19			
	persons				12314		513	12827	12827	0
2013	p/ha				124		19			
	persons				12698		513	13211	13211	0
2014	p/ha				128		19			
	persons				13095		513	13608	13608	0
2015	p/ha				132		19			
	persons				13503		513	14016	14016	0

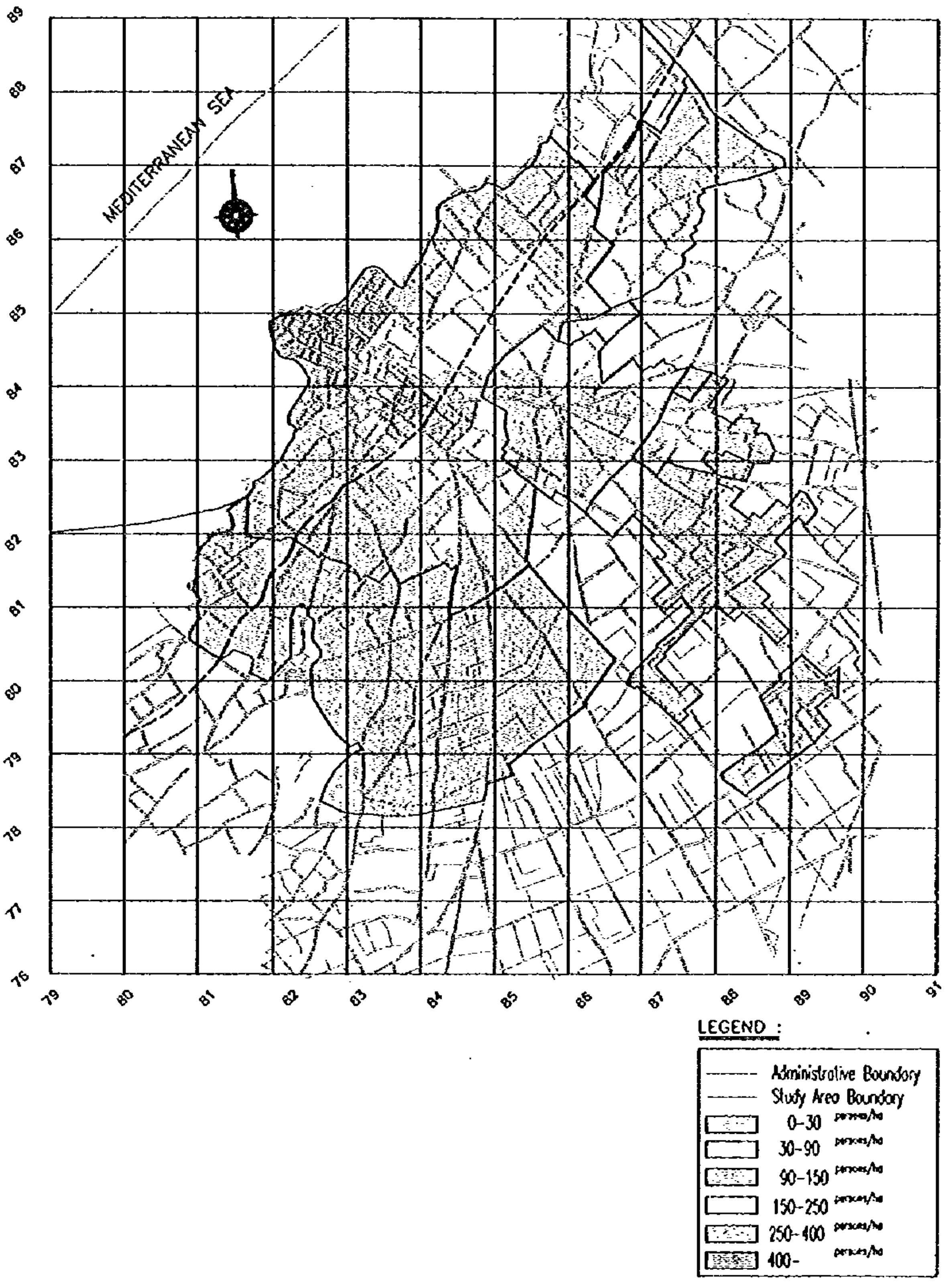


FIG. M.3.2 POPULATION DENSITY IN 1996 (ESTIMATED)

THE STUDY ON SEWERAGE DEVELOPMENT PLAN IN THE AREA OF KHAN YUNIS
IN PALESTINIAN INTERIM SELF-GOVERNMENT AUTHORITY

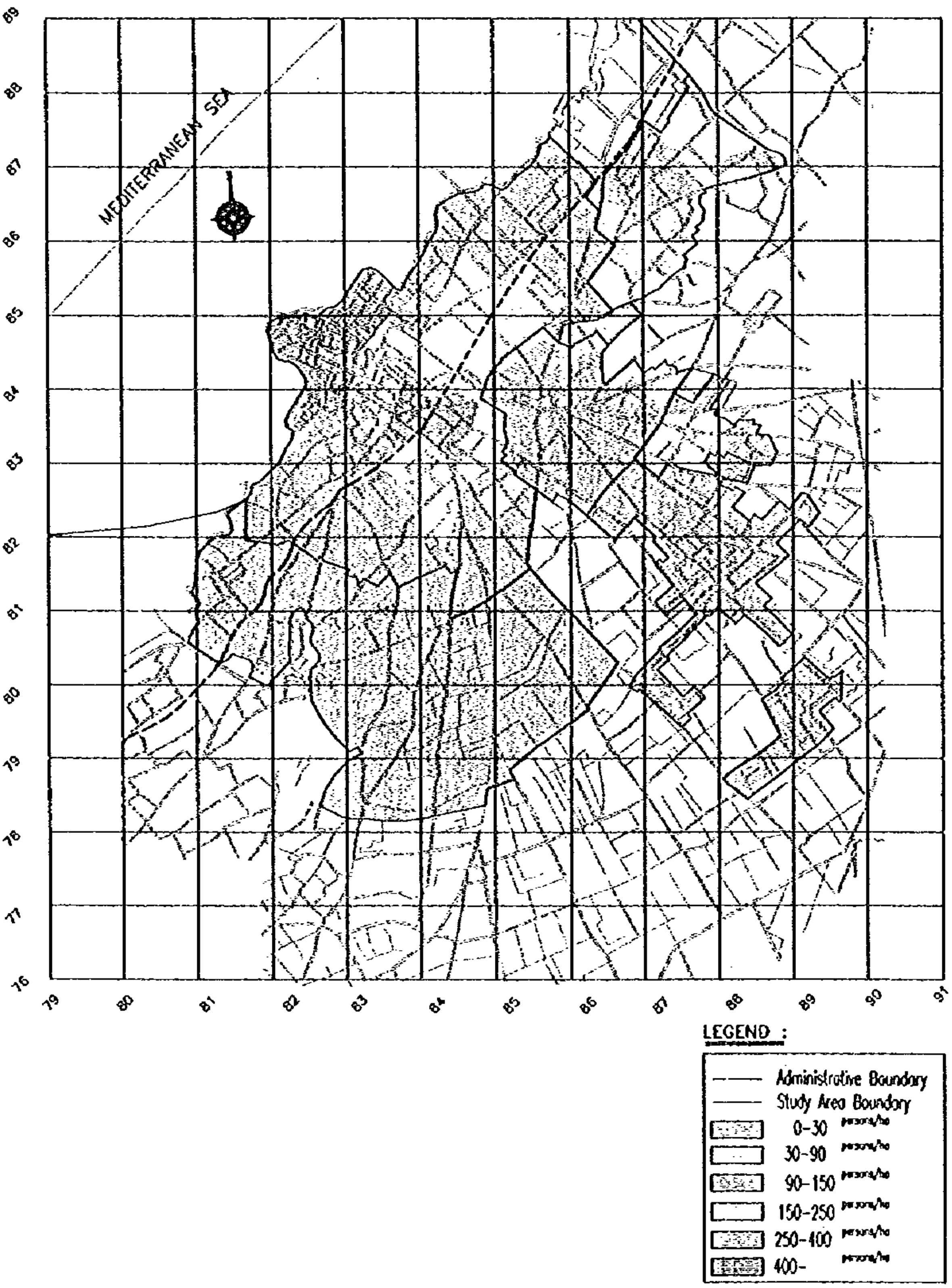


FIG M.3.3 POPULATION DENSITY IN 2005 (PROJECTED)

THE STUDY ON SEWERAGE DEVELOPMENT PLAN IN THE AREA OF KHAN YUNIS
IN PALESTINIAN INTERIM SELF-GOVERNMENT AUTHORITY

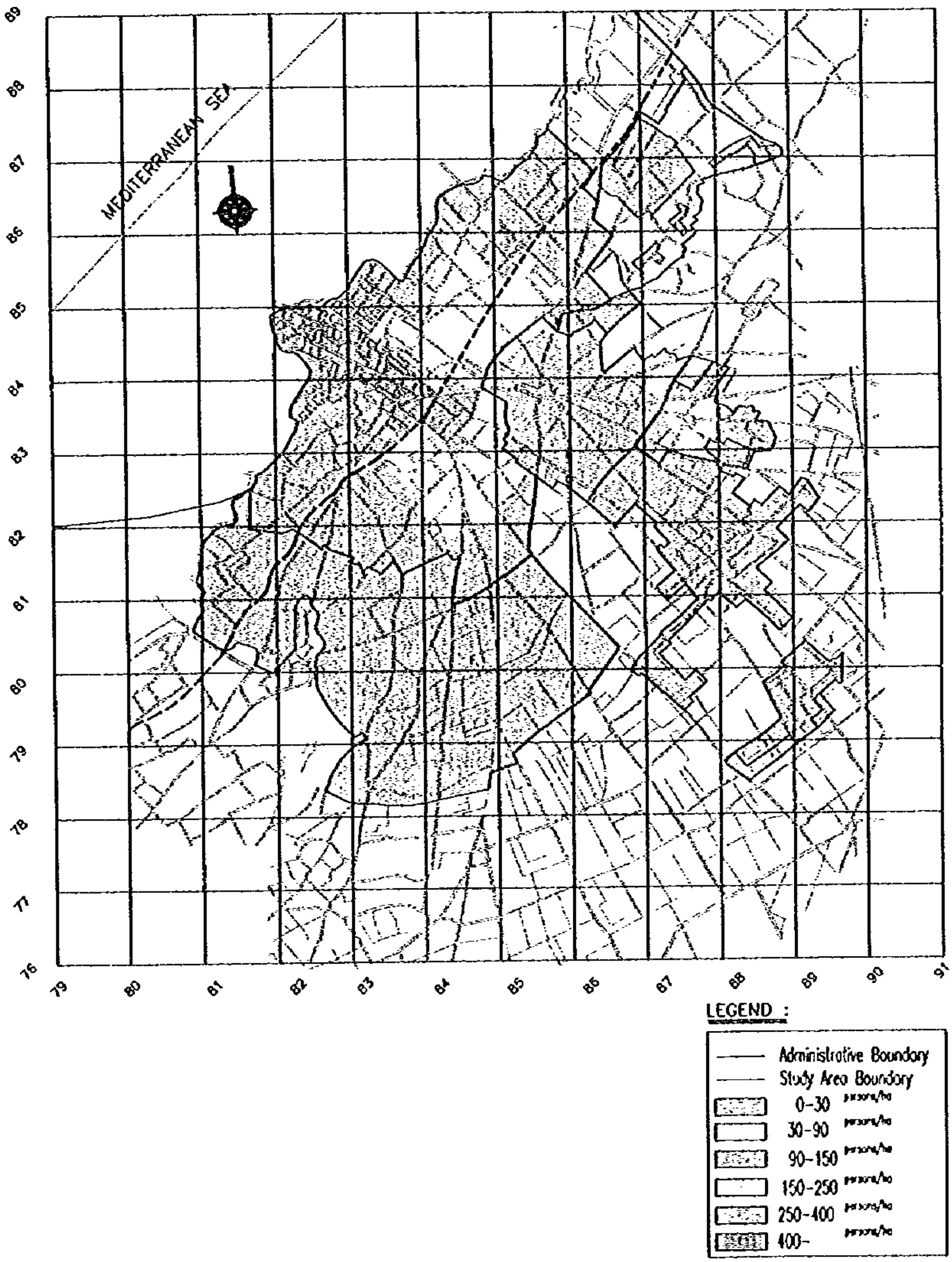


FIG. M.3.4 POPULATION DENSITY IN 2015 (PROJECTED)

THE STUDY ON SEWERAGE DEVELOPMENT PLAN IN THE AREA OF KHAN YUNIS
IN PALESTINIAN INTERIM SELF-GOVERNMENT AUTHORITY

JICA
AD 1997

3.2 Future Land Use

3.2.1 General

Khan Yunis City and its surrounding areas are undergoing a remarkable rate of growth. Between 1996 and 2015, Khan Yunis City's population is expected to become more than doubled to almost half million including a lot of returnees The rapid urbanization has brought problems to the area, and urban utility systems have failed to develop to serve the ever-expanding area.

Nonetheless, the area is expected to continue its growth, chiefly because of its primal position in a rapidly growing region. The pattern of growth, characterized by relatively uncontrolled suburban expansion appears to have generally crystallized within the Study Area, and areas of residential, commercial and agricultural expansion are defined.

The Ministry of Local Government, Khan Yunis City, and other villages in the Study Area have formulated long-term plans to establish development programs for their own administrative areas. The plans called for the improvement of the general physical conditions of the Area, including proper land uses.

The land use plan for each of the councils indicates the future land use pattern: however, such major features as target year for which the plan was elaborated, population forecast, and population distribution, have not necessarily been made clear.

The future land use patterns contemplated is applied as a basis for the succeeding sewerage/sanitation system planning with minor adjustment or addition in the light of the recent conditions of the area. The land use plan comprises zones not being used yet, and semi-urbanized districts in the neighboring communities for the future urbanization. These were further discussed with MOPIC, Khan Yunis City and village officials and confirmed its appropriateness for the future conditions.

3.2.2 Land Use Plans

The future land use plan for each of the councils has been worked out either by the Ministry of Local Government, or city and villages. The future plan for Khan Yunis and its surrounding villages classify the whole area into five (5) different zones; namely, i) Housing A ii) Housing B and C, iii) Agricultural and Open Area, iv) Commercial, and v) Refugee Camp, considering the type of future development of the area, as explained in the following:

(1) Housing Area-A

The residential area type A includes single and multiple family dwellings of all types, buildings of mixed use, and all other types of inhabited structures. The lot size is to be 500 m^2 or larger, and only 30 percent of the lot area is permitted to construct residential buildings of three-story high.

(2) Housing Area-B

The residential zone under this category is the UNRWA administered refugee camp areas of 0.55 km^2 with high population densities.

(3) Housing Area-C

The lot size in this zone is to be 400 m^2 or smaller. The percentage of the lot area to be used for residential buildings construction of four-story high is limited to 40 percent.

(4) Commercial Area

Included in the commercial districts are such commercial buildings as markets, shopping centers, office buildings, warehouses, retail establishments, and the like.

(5) Agricultural and Open Area

Agricultural and open land areas comprise about 38.9 percent of the whole planned area. The ever-growing population would probably find their way to the surrounding agricultural lands, thus the agricultural lands would tend to gradually decrease.

3.2.3 Land Use in 2015

Based on the demographic survey conducted by JICA Study Team three patterns of population density were produced by then:

- Population Density in 1996 (Estimated)
- Population Density in 2005 (projected)
- Population Density in 2015 (projected)

They are shown in Figure M.3.5, M.3.6 and M.3.7.

For the effective planning of the sewerage/sanitation system, a compilation is made of the area and location of existing residential, howsing, industrial, and public land use, which is the basis for projecting land use throughout the planning period.

For the review of the present conditions in the Area, a topographic map of 1:20,000, covering the entire Study Area with the contour lines at 10-meter intervals.

Also two sheets of map in a scale of 1:5,000 (1986) with one meter interval contour lines, and 1:10,000 topographic maps, a set of aero-photographs in the scale of 1:5,000 (1995) obtained from Israel were used for checking the present developing conditions in the areas.

Based on these maps and other information, the future land use patterns up to the year 2015 has been developed by the following manners:

(1) Identify the non-habitable areas, such as agricultural areas and wasteland.

(2) Identify the industrial area.

(3) Identify the residential and commercial areas in urbanized areas in Khan Yunis and villages according to the land use plans.

(4) Identify administration boundaries which are at present not so clear.

(5) Identify the development plans of housing complexes in the outskirts of the urbanized zones.

According to the plan, the Study Area would be essentially urbanized by 2015, however, much of the portion of the agricultural lands in Kizan area would still remain as an agricultural zone in the foreseeable future. The Study Area land use pattern in 2015 thus contemplated is shown in Figure M.3.5, and component land uses are summarized in the following table:

Table M.3.7 Land Use Composition in Study Area

Land Use	Percentage	Area (ha.)
Agricultural/Open	30.51	1,360
Commercial	5.97	266
Residential (A)	29.45	1,313
Residential (B) and (C)	30.46	1,358
Camp (Low density)	1.28	57
Camp (High density)	2.33	104
Total	100.00	4,458

Note: Estimated by the JICA Study Team and agreed by MOPIC

Table M.3.8 shows the land use areas identified by municipality and villages. The refugee camp is divided into two categories: high density and low density. However the density itself is not a category of land use in urban planning. The refugee camp has been administered by UNRWA. It is possible that the refugee camps will be integrated and developed in Khan Yunis municipality, as the Study assumes. Than the refugee camp will be identified as a urban planning category such as residential area. By that time the camp is categorized as high / low density.

Table M.3.8 Land Use by Municipality / Villagees

	Camp		H.A	H.B&C.	C.D	Agri	Total	Grnd	Ratio
(ha)	High	Low				&Op		Tot	%
Camp	104	57					161	161	100.0%
Khan Yunis			508	450	110	415	1483	1499	98.9%
Kizan Area						519	519	1270	40.9%
Qararra			70	100		273	443	443	100.0%
Bani Sohalia			50	140	90	124	404	404	100.0%
Ab Saghera			9	41		39	89	128	69.5%
Ab Kebera			12	209		183	404	424	95.3%
Khuzaa				52		77	129	129	100.0%
Total	104	57	649	992	200	1630	3632	4458	81.5%

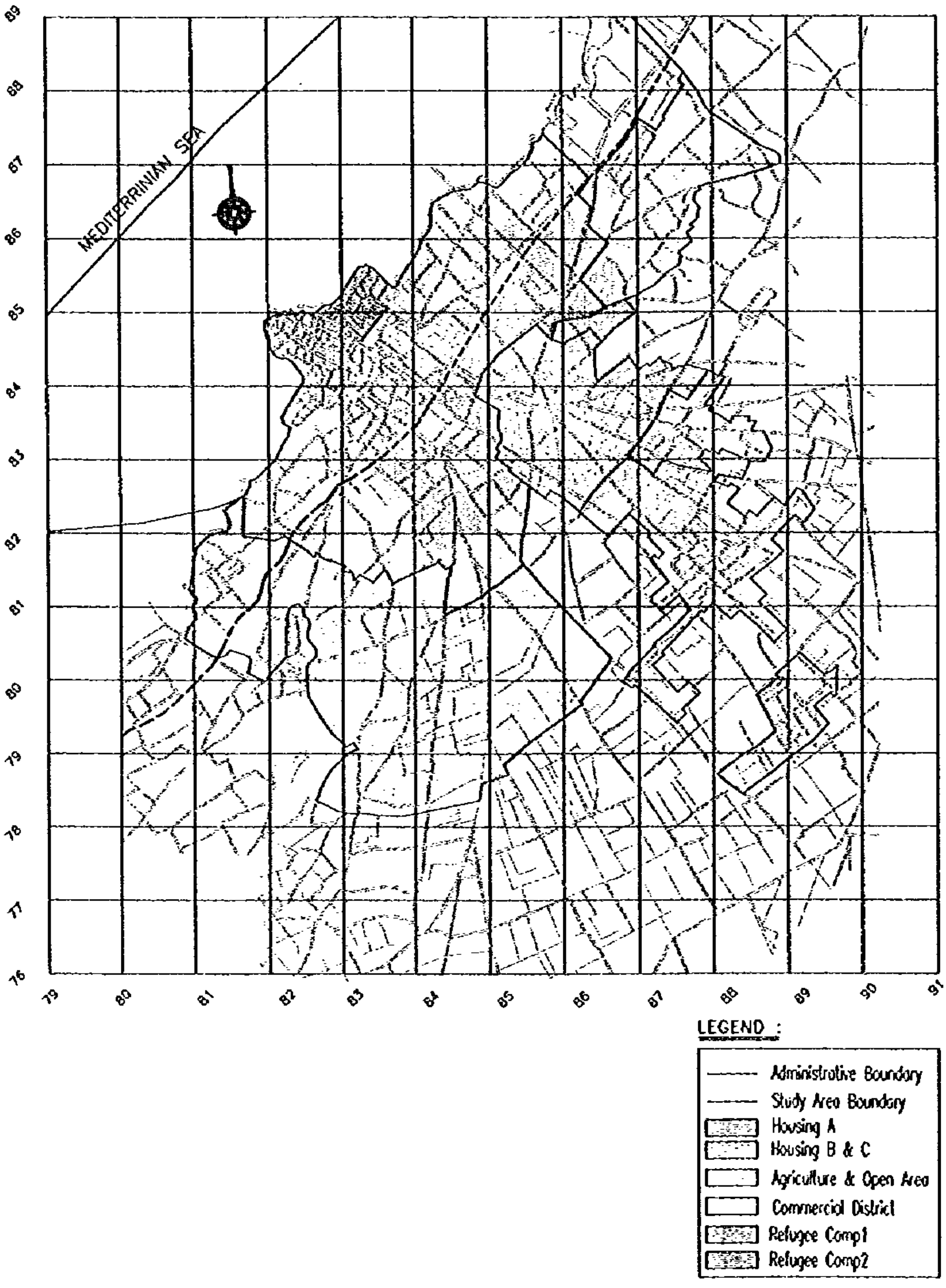


FIG. M.3.5 | LAND USE MAP IN 1996 (ESTIMATED)

THE STUDY ON SEWERAGE DEVELOPMENT PLAN IN THE AREA OF KHAN YUNIS
IN PALESTINIAN INTERIM SELF-GOVERNMENT AUTHORITY

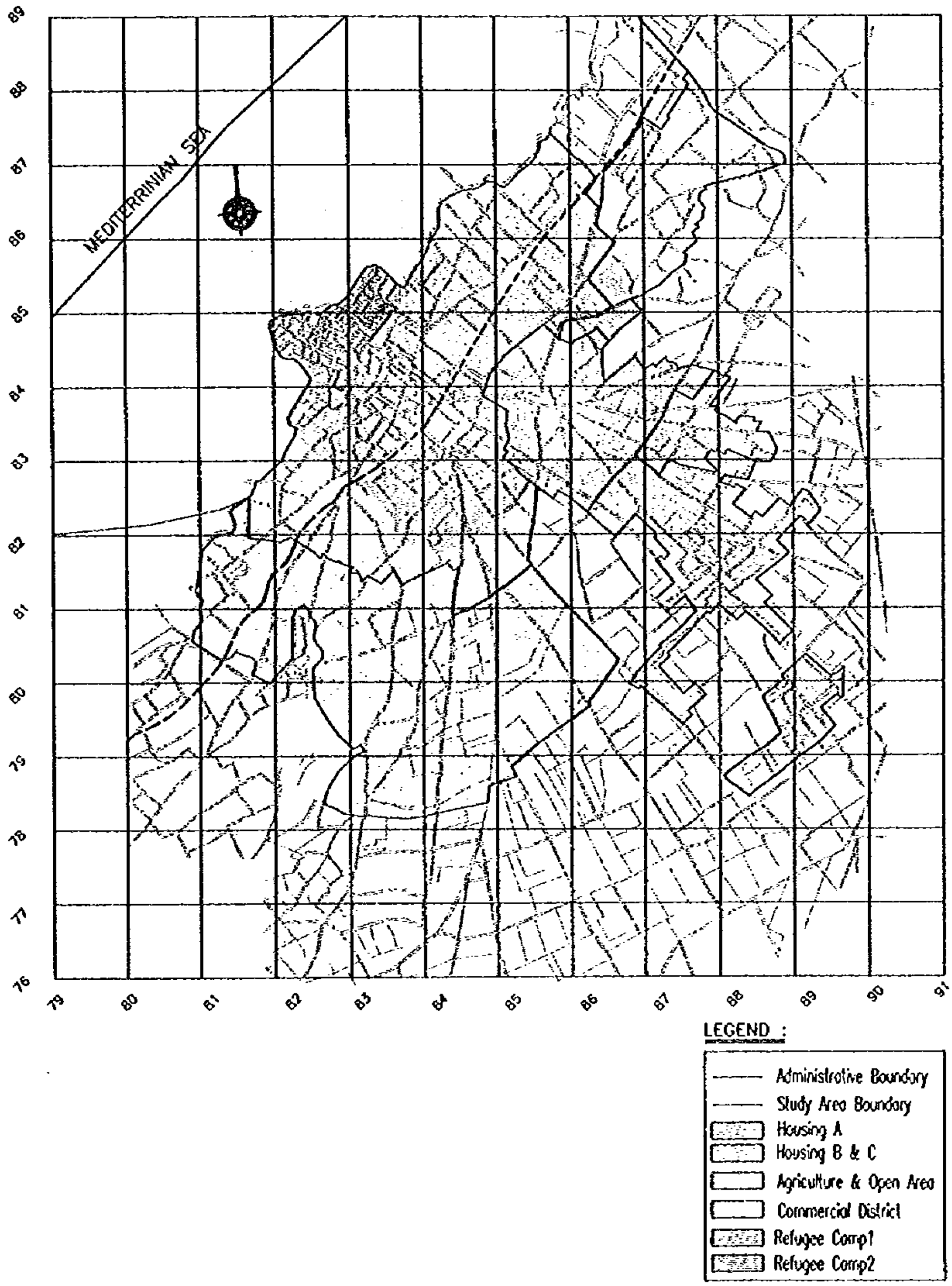


FIG. M.3.6	LAND USE MAP IN 2005 (PROJECTED)
THE STUDY ON SEWERAGE DEVELOPMENT PLAN IN THE AREA OF KHAN YUNIS IN PALESTINIAN INTERIM SELF-GOVERNMENT AUTHORITY	

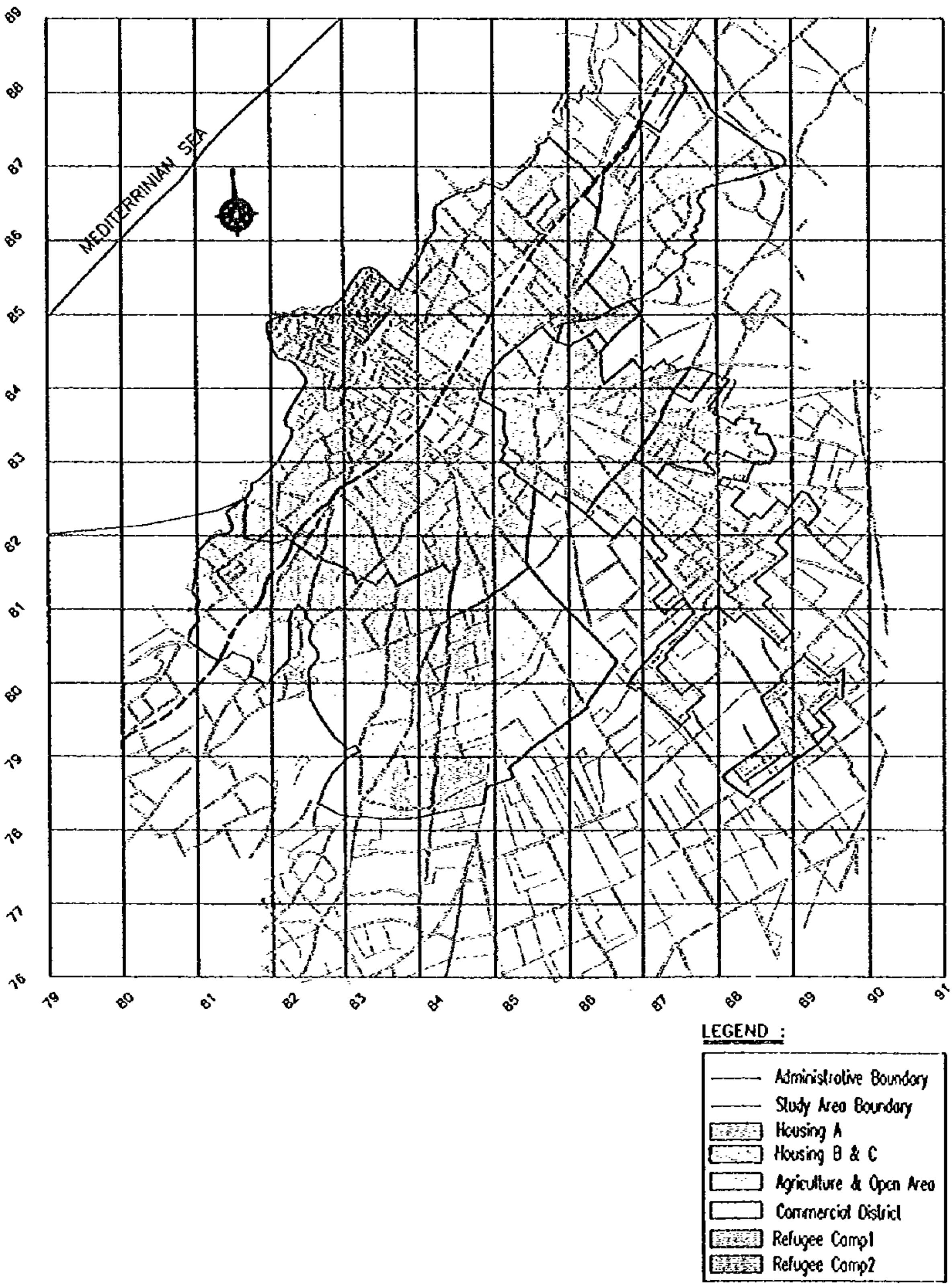


FIG. M.3.7 LAND USE MAP IN 2015 (PROJECTED)

THE STUDY ON SEWERAGE DEVELOPMENT PLAN IN THE AREA OF KHAN YUNIS
IN PALESTINIAN INTERIM SELF-GOVERNMENT AUTHORITY

The future land use projection above appears to be reasonable within the central urbanized area but are rather conjectural in the periphery; however, as the peripheral areas that will be last sewered, the necessary revision in the forecast may be made in the future prior to the final design.

Khan Yunis City will expand not only into agricultural land but onto the surrounding hillside dune areas. Urbanized areas have increased and will increase rapidly, and within the City urban zones, theoretically no rural area will exist in the future. It is evident that the increasing population finds its way to the sparsely inhabited outskirts of the City.

Because the urban development plans are still underway, it is hard to forecast precisely the Area's future development patterns, however, during the forth- coming period up to the year 2015, the residents' income may increase, and the economic growth and population increase are expected, thus the urban development would further continue in the foreseeable future, keeping with the present development pace.

3.3 Prospect of Economy and Finance

The Palestinian Authority has a vision about development of its territory named as the "Focus on Environment in Palestine". The "Gaza Land Resources -Land Use Planning and Resources Protection-" is one of the study report in the framework of the Gaza Environmental Profile Project for formulating the development vision for Gaza Governorates.

In this report, they present three development scenarios such as the "Status Quo scenario (the Scenario 1)", the "Autonomous Growth scenario (the Scenario 2)" and the "Social Welfare scenario (the Scenario 3)" with target including not only for land use, but also for population, for economic activities and so on in 2010.

In this sub-clause, an economic and financial prospect of Gaza Governorates may be presented as discussed hereunder along the motif of the Scenario 2 with prolongation up to 2015 because that is the most realistic scenario according to relationships between Palestinian Authority (the PA) and Israel and, the international situations concerning the PA at the present time.

The Scenario 2 assumes that Gaza develops its own economy with little interaction and cooperation with Israel, but the relations with Israel remain tense. There is a direct cooperation with neighboring Arab countries. Policies are based on export oriented growth and are successfully mobilizing domestic and foreign capital for an ambitious (productive) investment program.

Due to the remaining tension in relation with Israel, Gaza's economic development will be still made much in isolation in 2015. However, links may be established with other Arab countries and the rest of the world by means of a new airport in Rafah area. The Gross Domestic Products (GDP) will have rather high growth rate and, despite a still high population growth, the report said that income per capita will be increase by the rate of around 3 % per year up to the end of scenario and this may be realized in 2015 even if the development pace will be slow down. The high level of investment will be financed from increased domestic savings and from the influx of foreign capital. This will apply to private as well as public funds. On the labour front, despite effort to stimulate labour-intensive development, the economy will be unable to fully absorb the growing labour force and a considerable number of workers will be still employed in Israel. Competition for land will push up its prices, leading to higher costs of agriculture, housing and other activities.

Agriculture will shift in cropping pattern from low value citrus and rainfed field crops to high value irrigated vegetables, strawberries, cut flowers, flower bulbs and other high value produce. Industry will be grown as competitive and export-oriented one, especially in manufacturing field. The employment rate will be lagging behind as a result of increasing labour productivity. New industries may be exclusively located in newly established industrial zones, outside the urban areas. Existing enterprises will find it difficult to operate and may expand in the city areas and many of them will also be moved to these new zones.

With the high population growth experienced, demand of housing should be high in the construction aspect. Output will be further enlarged as a result of the on average good housing standards achieved. In addition, high investments in infrastructure, industry and other sectors will be stretching the construction and building supply sectors to their limits. Employment may grow in proportion to output.

Tourism development will be limited as a result of the reduced appeal of the coast. Most of the sea front will be developed with prestigious housing and offices.

The report said that the domestic water demand will be doubled from 46 MCM per year in 1995 to 110 MCM per year at the end of the scenario in whole of the Gaza Governorates. Even in the case of development would be more slow pace than that mentioned in the report, it might be realized up to the year 2015 with no doubt. In this connection, there is another analysis in PWA for the Municipality of Khan Yunis. According to a result of this analysis, the Municipality of Khan Yunis has domestic water demand of around 19 MCM with shortage of 9 MCM in 1995, and they have projected that this water demand will become 30 MCM with shortage of 20 MCM in 2015. It means that they will face to serious water shortage in the future.

Total water demand could no longer be met from groundwater resources only. So, the report said that some desalination plant using sea water will be necessary to establish for helping to reduce depletion of the aquifers in Gaza Governorates. Reduced distribution losses in municipal networks also contribute to this as well as the infiltration of effluent from the waste water treatment plant.

They visualized in addition to intensive development within the 1995 boundaries of the Municipalities of Gaza, Khan Yunis and Rafah that new residential districts will be established, exclusively in the eastern part of Gaza. New self-contained satellite towns may be established in Beit Hanoun and West of Abassan Kabera.

CHAPTER 4 ECONOMIC AND FINANCIAL FRAMEWORK UP TO 2015

CHAPTER 4 ECONOMIC AND FINANCIAL FRAMEWORK UP TO 2015

4.1 General Economic Situation Including Israeli Economy

The Palestinian economy has a chronically weak basis. The main reasons of this are an ability on the industrial activity and trade, inadequate infrastructure, and exodus of Palestinian expatriates. Furthermore, the Palestinian economy has been so closely inter-related with the Israeli economy and it is dominated by service industries and agriculture. The under development of the industrial sector particularly production of exportable quality goods, and the large share services and sectors reflects the current imbalance of trading. Another contributing factor to the poor economic situation is the high unemployment rate.

In the past, much of national income was derived from economic interactions of Palestinians in Israel, and it is said that was representing about one third of the total GNP. However, this situation is restricted too at this moment caused by fluctuations in the political and security situation.

As mentioned hereinafter, the economy in Palestine can not stand on its own feet without the relationship with Israel in terms of balance of payment in external trade. Therefore, the economic condition of Israel should be cleared firstly.

The Israel is a nation consisting of immigrants, so that the economic growth relies on immigrants to come into the nation. Jewish residents abroad, especially who reside in the United States are an important factor for the Israeli economy too. A grant aid from the United States amounted at around US$ 3 billion per annum (US$ 1.8 billion thereof is the aid for military affairs)[1] is based on such background. as the Jewish residents in the United States mentioned above and that enormous amount of arms expenditure because of some countries around the nation and expenditure needed for maintaining the public peace with the Palestine. State owned enterprises and the Histadrut fill also the important role in the Israeli economy.

The existing Government of Israel follows in the previous Government's policy principally consisting of domestic developments, especially development in socio-economic infrastructures, and liberalization and internationalization of economy.

[1] : Information from the Japanese Embassy in Israel, January 1996.

The gross domestic products (GDP) as of 1995 was estimated at US$ 74.3 billion (equivalent to US$ 14,279 per capita) with a growth rate of 6.8 % as same rate as that in previous year of 1994. The consumer price index was calculated at 14.5 % in 1994 and estimated at 7.9 % in 1995.

There are unstable factors for improvement of international balance of payment because that the historically greatest deficit amount had estimated to be produced in 1995. Therefore, the Government of Israel has tried to improve international relationships as the agreement with Jordan for trading, and establishment of trading offices of the Sultanate of Oman and the State of Qatar in Israel following the peace process. The Government of Israel had started to negotiate on free trading agreement with the Government of Canada, the Republic of Turkey, and the United Mexican States too.

4.2 Palestinian Economy

4.2.1 Gross Domestic Products in Palestine

Gross domestic product (GDP) in Palestine is shown in Table 1 in Appendix-I by 1986 constant price level for last 6 years since 1987, and they are summarized in the following Table M.4.1.

Table M.4.1 Summary of GDP at Factor Cost in Palestine

As of 1992 (Million US$)

No.	Economic activity	GDP	Share rate (%)	Annual growth rate(%)
1	Agriculture, forestry and fishery	481.0	37.00%	8.77%
2	Industry	104.5	8.04%	-4.71%
3	Construction of buildings/public works	163.5	12.58%	-7.47%
4	Public services/community services	132.0	10.15%	-5.38%
5	Other service	419.0	32.23%	-5.05%
GDP at factor cost		1,300.0	100.00%	-1.57%
GNP per capita at 1986 constant price (US$)		1,008.5	-	-7.17%
GDP per capita at 1986 constant price (US$)		771.5	-	-5.52

Source: Economic Statistics in the West Bank and Gaza Governorates, Current Status Report Series (No.2) issued by the Palestinian Bureau of Statistics, January 1995.

(Note) Annual growth rate means the rate since 1987.

According to the above mentioned Table, an economic activity group of agriculture, forestry and fishery is the highest contribution factor to the GDP as 37.0 % in share rate as of 1992, while the second contribution factor is the group of other services as 32.3 %. In this case, the economic activity group of other services include transport, trade and others including ownership of dwelling, and errors and omissions.

4.2.2 External Trade and International Balance of Payment

In 1987 and 1991, the Palestinian trading amount amounted to US$. 1,163 million and US$ 1,042 million in export and, US$ 1,371 million and US$ 1,500 million in import respectively as shown in Table 2 in Appendix-I. In Palestine, the balance of external trading was constantly minus side during these several years. It means that the amount of import was larger than that of export.

Detail of international balance of payment is shown in Table 2 in Appendix-I in Volume III "Supporting Report" and summarized below:

Table M.4.2 International Balance of Payment in Palestine

(Million US$)

Item of account	1987	1988	1989	1990	1991	Annual growth rate(%)
Export	1,162.7	946.0	885.0	1,075.0	1,042.0	-2.70%
Import	1,370.7	1,005.0	946.0	1,205.0	1,500.0	2.28%
Balance of payment	-657.2	-472.0	-475.0	-612.0	-900.0	-7.56%
Net transfer payment	162.9	135.3	123.5	154.2	156.5	-1.00%
Current account	-45.1	-106.0	53.0	20.0	-307.0	-38.09%

Source : Economic Statistics in the West Bank and Gaza Governorates, Current Status Report Series (No.2) issued by the Palestinian Bureau of Statistics, January 1995.

External trade in Palestine has greatly relied on Israel to serve as shown in the following Table M.4.3:

Table M.4.3 Balance of Payment in Palestine by Destination

(Million US$)

Item of account	1987	1988	1989	1990	1991	1992	Annual growth rate(%)
With Israel	-237.3	-	-143.9	-193.4	-255.2	-264.7	-
Exports	143.2	n.a.	21.8	35.2	58.9	63.8	-19.92%
Imports	380.5	n.a.	165.7	228.6	314.1	328.5	-4.68%
With Jordan	68.8	42.9	31.9	22.9	29.2	28.0	-
Exports	78.2	52.4	40.4	32.2	38.4	37.5	-16.29%
Imports	9.4	9.5	8.5	9.3	9.2	9.5	-0.54%
With other countries	-77.2	-66.8	-98.5	-110.1	-125.2	-112.4	-
Exports	3.4	2.3	3.9	8.6	9.0	5.1	27.55%
Imports	80.6	69.1	102.4	118.7	134.2	117.5	13.59%
Total	-245.7	-	-210.5	-280.6	-351.3	-349.1	-
Exports	224.8	-	66.1	76.0	106.3	106.4	-
Imports	470.5	-	276.6	356.6	457.5	455.5	-

Source : Economic Statistics in the West Bank and Gaza Governorates, Current Status Report Series (No.2) issued by the Palestinian Bureau of Statistics, January 1995.

(Note) Trading amounts with Israel includes those for Gaza Governorates only, but exclude those for West Bank for both the export and import amounts because of lack of data.

As indicated in the above Table, the Palestinian trading amounts with Israel in 1987, 1989, 1990, 1991 and 1992 were 63.7 %, 33.0 %, 46.3 %, 55.4 % and 60.0 % respectively for exports and, 80.9 %, 59.9 %, 64.1 %, 68.7 % and 72.1 % respectively for imports even though the trading amounts for West Bank were not included. Thus the economy in Palestine can not stand on its own feet without the relationship with Israel in terms of trading situation.

Both the amounts of export and import were decreased since 1987 for the trading with Israel and Jordan. But decreasing rate for import was less than that of export. The import amounts from Jordan were almost flat during these years.

On the other hand, the amounts of export and import with the other countries were increased as 27.55 % and 13.59 % respectively since 1987. However, the amounts of imports exceeded those of exports in this case too.

4.2.3 Economic Activities

According to a data(2), 23.5 % of economic active population are engaged in agriculture which was the highest share rate to the total economic active population as of 1994. Peoples who engaged in a business for wholesale, retailsales and repairs were the second one as 23.3 %, and the third : 19.4 % in the work group of manufacturing. This situation seems to reflect to GDP in Palestine as mentioned in previous sub-clause, namely the agriculture, forestry and fishery was shared at 37.00 % to the total GDP at factor cost, and the economic activity group of transport, trade and others was shared at 32.23 % to the same GDP. The economic activities in terms of persons engaged by industrial origin is illustrated in Fig. M.4.1 in the next page.

Table-3 in Appendix-I shows a detail of above mentioned situation by the region of West Bank and Gaza Governorates, and by gender.

4.2.4 Agricultural Production

Cultivated area in Palestine are classified into 2 categories as (1) unirrigated area and (2) irrigated area. Unirrigated area is 167,410 ha consisting of 160,170 ha in West Bank and 7,240 ha in Gaza Governorates, while the irrigated area is 20,570 ha consisting of 9,570 ha in West Bank and 11,000 ha in Gaza Governorates as of 1991/92 as shown in Table 4 in Appendix-I in Volume III "Supporting Report."

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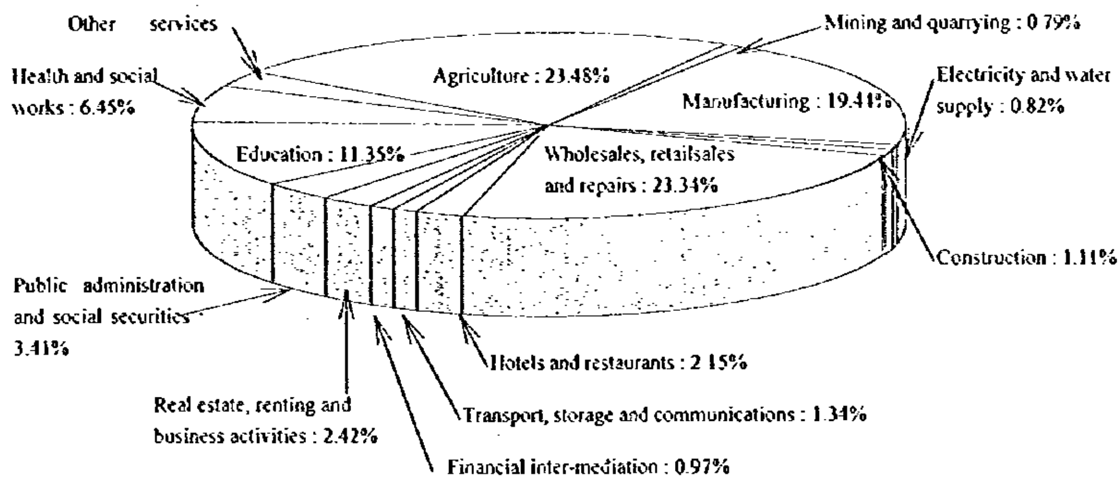
(2) : The Establishment Census 1994, Final Report, Palestinian Central Bureau of Statistics, August 1995.



Sources Establishment Census 1994, Final Report, Palestinian Central Bureau of Statistics, August, 1995.

(Note) Number of persons engaged in agriculture is excerpted from the Economic Statistics in the Wet Bank and Gaza Governorates, Current Status Report Series No.2, Palestinian Bureau of Statistics, January 1995.

Fig. M.4.1 Economic Activities in Terms of Persons Engaged

In the statistic data in Palestine(3), crops are classified as (1) field crops, (2) vegetables and potatoes, (3) melons, (4) citrus and (5) fruits.

Field crops include wheat, dry pulses, seasame, tobacco, and others. The crop group of vegetables and potatoes include potatoes, tomatoes, cucumbers and snake cucumbers, onion and garlics, egg plant, vegetable marrows, cauliflowers, cabbages, muchina and others. Melons include water melons and sugar-melons. Citrus includes oranges, lemons, clementines and mandarines, shamouti, lapes, grapefruits, and others. Fruits include grapes, olives, plums, figs, apricots, bananas, almonds, dates, and others. Among those crops in Palestine, the most valuable crops are olives.

Production of those crops is increased in the crop group of vegetables and potatoes, and fruits as 6.29 % per annum and 23.75 % per annum respectively during the period from 1987 to 1992, while decreased in the crop group of melons and citrus as -20.32 % and -9.04 % during the same period. Detail of these cultivated crop situation are shown in Table 5 in Appendix-IAppendix G.5 and summarized below:

(3): Economic Statistics in the West Bank and Gaza Govemorates, Current Status Report Series (No.2), Palestine Bureau of Statistics, January 1995.

Table M.4.4 Agricultural Production and Its Value in Palestine

Crops	Production (1,000 tons)		Value (1,000 US$)		Annual growth rate in production (%)
	1987	1992	1987	1992	
Field crops*	40.9	33.5	13,503	15,970	-3.91
Vegetables and potatoes	301.3	408.8	117,597	127,367	6.29
Melons	73.5	23.6	19,126	4,476	-20.32
Citrus	279.8	174.2	51,767	33,176	-9.04
Fruits	96.3	279.5	79,680	166,905	23.75

Source : Economic Statistics in the West Bank and Gaza Governorates, Current Status Report Series (No.2), issued by the Palestinian Bureau of Statistics, January 1995.
(Note) * Field crops produced in Gaza Governorates is not included because of lack of data.

4.2.5 Livestock and Related Products

Main production livestock related products are meat from cattle, sheep, goats, and poultry, and milk from cow, sheep and goats, and eggs. Both the production of meats, milk and eggs in Palestine are increased at a rate of 9.71 %, 4.39 % and 23.49 % per annum during the period from 1987 to 1992. Detail of livestock related production situation is shown in Table 5 in Appendix-I too, and summarized as below:

Table M.4.5 Livestock Related Production and Its Value in Palestine

Livestock related products	Production		Value (1,000 US$)		Annual growth rate in production (%)
	1987	1992	1987	1992	
Meat (1,000 tons)	50.7	80.6	163,294	152,581	9.71
Milk (million liters)	62.2	77.1	66,728	55,086	4.39
Eggs (million pcs.)	134.0	384.8	17,767	35,666	23.49

Source : Economic Statistics in the West Bank and Gaza Governorates, Current Status Report Series (No.2), issued by the Palestinian Bureau of Statistics, January 1995.

Peoples living in Gaza Governorates engage in fishery too, but the production is negligible little according to the said statistic data.

4.2.6 General Economic Aspects as a Whole

As mentioned above, about 23.5 %, 23.3 % and 19.4 % of people living in Palestine are engaged in agriculture, wholesale and retailsales including repairs, and manufacturing respectively as of 1994. On the other hand, about 16.0 % of persons engaged in agriculture are working in Israel according to the data indicating in the Table 4 in Appendix-I. It seems that the other industrial activities as wholesales and retailsale including repairs and manufacturing would be in the same situation too.

Nevertheless the agriculture and manufacture are shared rather high in persons engaged to the total work force, the amount of imports exceeded that of exports. And the trend of exports was tone down, but that of imports was increased more and more since 1987. It means that almost of the products are used domestically. Even thought, these domestically produced goods do not satisfy to demand of peoples living in Palestine. This situation reflects in the said external trade.

Aiming at the external trade, the export to Israel was greatly decreased with about 20 % per annum from 1987 to 1992. And, the import from Israel also decreased with about 5 % during the same period. The external trade with Jordan was in the same situation.

On the other hand, both of the exports and imports with other countries have been increased, but the handling amounts were still rather small comparing with those with Israel. Thus the external trade with other countries will be expected in the future for economic development in Palestine.

4.2.7 Consumer Price

Table 6 (A) in Appendix-I shows a consumer price index and inflation rates in Palestine since 1986 and summarized below:

Table M.4.6 Consumer Price Index of Palestine in General

Year	West Bank	Gaza Governorates	Israel
1986	100.0	100.0	100.0
1992	200.7	203.0	261.5
Average annual increasing rate (%)	12.31%	12.53%	17.38%

Source: Economic Statistics in the West Bank and Gaza Governorates, Current Status Report Series (No.2), Palestine Bureau of Statistics, January 1995.

The average annual growth rate of consumer price index was 12.31 % I West Bank and 12.53 % in Gaza Governorates since 1986 up to 1992 which were rather low comparing with that of Israel as 17.38 % during the same period according to the data in the above Table. but it should be said that these rates were still high, so that this situation should press people's livelihood.

4.2.8 Exchange Rate

The fluctuation of exchange rates with US Dollars during the period from 1986 to 1994 is shown in Table 6 (B) in Appendix-Iand summarized below:

Table M.4.7 Exchange Rates with US Dollars

(NIS, middle rate)

Year	NIS/US$
1986(1)	1.5
1990(1)	2.0
1994(2)	3.0
Annual average decreasing ratio (%)	8.27%

Source(1): Economic Statistics in the West Bank and Gaza Governorates, Current Status Report Series (No.2), Palestinian Bureau of Statistics, January 1995.

Source(2): Statistics Quarterly -January-March 1995- for Gaza Governorates (Volume 1), Central Statistics Department, Ministry of Planning and International Cooperation, the Palestinian National Authority, May 1995.

4.3 Economy of Gaza Governorates

4.3.1 External Trade and International Balance of Payment

In 1987 and 1991, the trading amount in Gaza Governorates amounted to US$. 493 million and US$ 378 million in export and, US$ 529 million and US$ 501 million in import respectively as shown in table 2 in Appendix-I . These amount were around 40 % in export and 35 % in import comparing with the total amount of Palestinian external trade. In Gaza Governorates too, the balance of external trading was constantly minus side during these several years.

The said Table 2 in Appendix-I are summarized as shown in Table M.4.8 in the next page. And, External trade in Gaza Governorates has greatly relied on Israel as shown in M.4.9.

Table M.4.8 International Balance of Payment in Gaza Governorates

(Million US$)

Item of account	1987	1988	1989	1990	1991	Annual growth rate(%)
Export	492.6	353.0	278.0	375.0	378.0	-6.41%
Import	528.8	343.0	302.0	389.0	501.0	-1.34%
Balance of payment	-252.1	-161.0	-168.0	-218.0	-296.0	-3.93%
Net transfer payment	76.8	80.1	79.8	81.7	81.8	1.59%
Current account	40.6	-84.0	50.0	66.0	-44.0	-67.12%

Source : Economic Statistics in the West Bank and Gaza Governorates, Current Status Report Series (No.2) issued by the Palestinian Bureau of Statistics, January 1995.

Table M.4.9 Balance of Payment in Gaza Governorates by Destination

(Million US$)

Item of account	1989	1990	1991	1992	1993	1994	Annual growth rate(%)
With Israel	-143.9	-193.4	-255.2	-264.7	-263.5	-244.9	-11.40
Exports	21.8	35.2	58.9	63.8	48.0	52.3	17.10
Imports	165.7	228.6	314.1	328.5	311.5	297.2	13.46
With West Bank	0.0	0.0	0.0	0.0	0.0	3.7	-
Exports	0.0	0.0	0.0	0.0	0.0	24.4	-
Imports	0.0	0.0	0.0	0.0	0.0	20.7	-
With other countries	-24.7	-27.6	-29.5	-24.0	-27.0	-8.9	-1.76
Exports	9.6	12.4	11.8	13.4	14.6	6.6	8.75
Imports	34.3	40.0	41.3	37.4	41.6	15.5	3.93
Total	-168.6	-221.0	-284.7	-288.7	-290.5	-250.1	-10.31
Exports	31.4	47.6	70.7	77.2	62.6	83.3	14.80
Imports	200.0	268.6	355.4	365.9	353.1	333.4	12.04

Source : Economic Statistics in the West Bank and Gaza Governorates, Current Status Report Series (No.2) issued by the Palestinian Bureau of Statistics, January 1995, and Statistic Quarterly - January-March 1995- for Gaza Governorates, Central Statistics Department of Ministry of Planning and International Cooperation, The Palestinian National Authority, May 1995.

As indicated in the above Table, share rates of the trading amounts of Gaza Governorates with Israel to the total trading amounts in 1989, 1990, 1991, 1992 and 1993 were 69.4 %, 73.9 %, 83.3 %, 82.6 % and 76.7 % respectively for exports and, 82.9 %, 85.1 %, 88.4 %, 89.8 % and 88.2 % respectively for imports. Detail of this situation is shown in Table 7 in Appendix-I. Dependency level of Gaza Governorates to Israel is higher than that of whole Palestine.

Both the amounts of export and import were increased since 1989 for the trading with Israel. But the balance of trade was decreased because that the handling amount of imports exceeded greater than that of exports.

The amounts of export and import with the other countries were also increased as 8.75 % in export and 3.93 % since 1989. However, the amounts of imports exceeded those of exports in this case too, so that the balance of trade was also decreased.

Table 8 in Appendix-I shows a trading situation aiming at commodities in 1994, and summarized below:

Table M.4.10 Trade in Gaza Governorates by Commodities in 1994

(Thousand NIS)

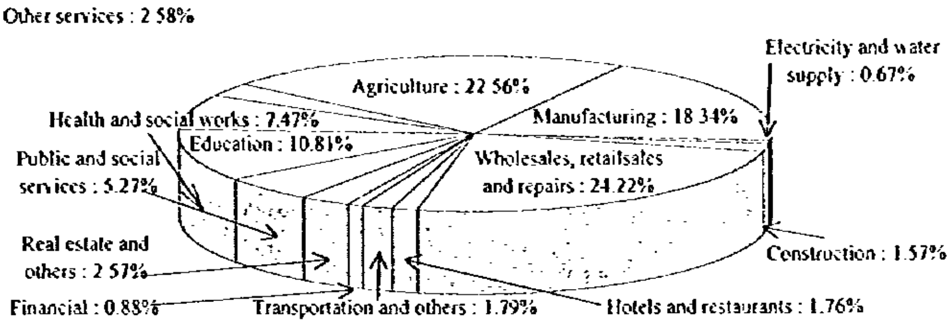
Commodities	Export	Import	Trade balance
Building materials	23,906	259,669	-235,763
Citrus	23,445	2,185	1,260
Fruits/vegetables	55,079	50,538	4,541
Livestock/products	2,892	105,307	-102,415
Household articles/furniture	15,275	27,954	-12,679
Electric materials	9,049	19,002	-9,953
Spare-parts	1,521	16,862	-15,341
Wood/products	1,737	17,544	-15,807
Foods	12,268	264,734	-252,466
Clothing/textile	95,796	80,875	14,921
Medical materials	77	11,371	-11,294
Others	8,946	83,634	-74,688
Petrol	0	34,313	-34,313
Water	0	1,360	-1,360
Electricity	0	27,799	-27,799
Total	249,991	1,003,147	-753,156

Source : Statistics Quarterly -April-December 1995- for Gaza Governorates, Central Statistics Department of Ministry of Planning and International Cooperation, the Palestinian National Authority, May 1995.

According to the above Table, the highest 3 commodities for import were building materials, livestock and related products, and foods, while the commodities of fruits and vegetables, and clothing and textile were almost same amount between exports and imports.

4.3.2 Economic Activities

The pattern of economic activities in persons engaged in Gaza Governorates is almost the same with that for the whole Palestine. But, ranking of agriculture and the economic activity group of wholeales and retailsales including repairs has reversed, namely highest one is the latter one with share rate of 24.22 % and former one is the second one with that of 22.56 % as shown in the following Fig. M.4.2.



Sources Establishment Census 1994, Final Report, Palestinian Central Bureau of Statistics, August, 1995.
(Note) Number of persons engaged in agriculture is excerpted from the Economic Statistics in the Wet Bank and Gaza Governorates, Current Status Report Series No.2. Palestinian Bureau of Statistics, January 1995.

Fig. M.4.2 Economic Activities in Terms of Persons Engaged in Gaza Governorates

Table 3 in Appendix-I shows a detail of above mentioned situation by gender.

4.3.3 Agricultural Production

Cultivated areas in Gaza Governorates are also classified into 2 categories as (1) unirrigated area and (2) irrigated area. Unirrigated area is 7,240 ha, while the irrigated area is 11,000 ha as of 1991/92 as mentioned in previous clause.

Production of crops is increased in the crop group of vegetables and potatoes, and fruits as 1.20 % per annum, 8.90 % per annum respectively during the period from 1992 to 1994, while decreased in the crop group of field crops, melons, and citrus as -72.05 %, -11.24 % and -7.94 % during the same period. The increasing rate of fruits was highest, but actual produced volume was rather little comparing with vegetable and potaytoes. Detail of these cultivated crop situation are shown in Table 9 in Appendix-I and summarized as shown in Table M.4.11 in the next page.

4.3.4 Livestock and Related Products

Main livestock related products in Gaza Governorates are also meat from cattle, sheep, goats, and poultry, and milk from cow, sheep and goats, and eggs as same as in the West Bank. But, the actual produced volume of them were ranging from 15 % to 25 % to the total production volume of Palestine except eggs. Detail of livestock related production situation is shown in Table 9 in Appendix-I too, and summarized as shown in Table M.4.12.

Table M.4.11 Agricultural Production and Its Value in Gaza Governorates

Crops	Production (1,000 tons)		Value (1,000 NIS)		Annual growth rate in production (%)
	1992	1994	1992	1994	
Field crops	12.8	1.0	6,019	704	-72.05
Vegetables and potatoes	201.7	253.9	160,078	231,224	1.20
Melons	9.9	7.8	4,068	2,715	-11.24
Citrus	119.4	101.2	42,350	58,047	-7.94
Fruits	19.9	23.6	28,541	44,538	8.90

Source : Statistics Quarterly -April-December- for Gaza Governorates, Central Statistics Department of Ministry of Planning and International Cooperation, the Palestinian National Authority, May 1995.

Table M.4.12 Livestock Related Production and Its Value in Gaza Governorates

Livestock related products	Production		Value (1,000 US$)		Annual growth rate in production (%)
	1992	1994	1992	1994	
Meat (1,000 tons)	18.3	18.0	73.991	84,770	-0.82
Milk (million liters)	10.4	17.0	19,589	27,000	27.85
Eggs (million pcs.)	145.0	150.0	31,900	30,000	1.71

Source : Statistics Quarterly -April-December- for Gaza Governorates, Central Statistics Department of Ministry of Planning and International Cooperation, the Palestinian National Authority, May 1995.

Peoples living in Gaza Governorates engage in fishery too, but the production is negligible little according to the said statistic data.

4.3.5 General Economic Aspects as a Whole

As mentioned above, about 22.6%, 24.2% and 18.3 % of people living in Gaza Governorates are engaged in agriculture, wholesale and retailsale including repairs, and manufacturing respectively as of 1994. On the other hand, about 30 % of persons engaged in agriculture are working in Israel according to the data indicating in the Table 4 in Appendix-I. It seems that the other industrial activities as whole and retailsale including repairs and manufacturing would be in the same situation, and this trend would be more than that of West Bank..

Nevertheless the agriculture and manufacture are shared rather high in persons engaged to the total work force, the amount of imports exceeded that of exports. And the trend of exports was tone down, but that of imports was increased more and more since 1987. These situation are almost the same with the West Bank. It means that almost of the products are used domestically too. Even thought, these domestically produced goods do not satisfy to demand of peoples living in Gaza Governorates. This situation reflects in the said external trade.

Aiming at the external trade, the balance of trade with Israel was decreased with the rate of about 11 % per annum from 1989 to 1994, and that with other countries were also the same situation even though the handling amount of both the exports and imports were increased because that the mounts of imports were greatly exceeded the amounts of exports.

4.4 Public Finance

The public sector in Palestine consists of the civil administration and the municipalities. The budget for the civil administration (central Government of Palestine) does not include expenditur on security or expenditures on Israeli settlers in the occupied territories (Palestinian territories). The budget is prepared on n annual basis and has to be approved by the Israeli Kenneset. At the time the budget is being prepared, forecasts are made for revenues and expenditures in each of the West Bank and Gaza Governorates, and the two forecasting amounts are then combined into one budget. The municipalities and village councils are also required to prepare annual budgets. Since 1992, the fiscal year coincided with the calendar year; prior to that, the fiscal year ended March 31. Therefore, an interim budget was prepared for the period April - December 1991.

4.4.1 Central Government

In 1987/88 and 1990/91, the Government finances of Palestine amounted to NIS 938 million and NIS 546 million in revenue and NIS 372 million and NIS 546 million in expenditure with their rise rates of 16.54 % and 13.64 % per annum respectively as shown in Table 10 in Appendix-I, and summarized in Table M.4.13 hereunder.

4.4.2 Municipal Government

In 1987/88 and 1990/91, the municipal Government finances of Palestine amounted to NIS 127 million and NIS 134546 million in revenue and NIS 162 million and NIS 158 million in expenditure with their rise rates of 1.80 % and -0.83 % per annum respectively as shown in Table 11 in Appendix-I, and summarized in Table M.4.14 hereunder.

Table M.4.13 Government Finance

(Million NIS)

Revenue/expenditure	1987/88	1990/91	Average annual growth rate (%)
Revenue	345.0	546.0	16.54
Expenditure	372.0	546.0	13.64
Surplus/deficit	-27.0	0.0	-

Source : Developing the Occupied Territories -An Investment in Peace-, Volume 2: The Economy, the World Bank in Washington, D.C., September 1993.

Table M.4.14 Government Finance

(Million NIS)

Revenue/expenditure	1987/88	1990/91	Average annual growth rate (%)
Revenue	127.0	134.0	1.80
Expenditure	162.0	158.0	-0.83
Surplus/deficit	-35.0	-24.0	-

Source : Developing the Occupied Territories -An Investment in Peace-, Volume 2: The Economy, the World Bank in Washington, D.C., September 1993.

Comparing with the budget of the Central Government, the budget of municipal Government is small scale. As shown in the above Table, the actual outcome for the municipal Government generated deficits in 1987/88 and in 1990/91. As indicating in Table 11 in Appendix-I, the actual outcome of expenditures exceeded that of revenues in 1988/89 and in 1989/90 too. These deficits were financed by the Central Government for large part, and financed by external financing and self-financing for the other part according to the same Table in the said Appendix.

4.5 Financial Positions of Entities

4.5.1 Central Government

According to the available information[4], revenues are broken into receipts from the income tax, the value added tax (VAT), customs and excise duties and purchase taxes, health fees, other fees and charges, as well as receipts from the "deduction fund".

The income tax consists of a tax on individuals and a tax on corporations. The individual income tax is progressive with the highest rate being 45 %. The income tax

[4] : Developing the Occupied Territories -An Investment in Peace-, Volume 2:The Economy, the World Bank in Washington, D.C., September, 1993.

brackets are adjusted upwards twice a year according to the inflation rate. The corporation tax rate is 38 %.

The VAT is applied at the same rate as Israel (currently, the 17 % as of 1993). Sales of agricultural products by producers is not subject to the VAT, nor are the services provided in touristic establishments. A zero rate is applicable to exports.

Customs duties are the same as those applicable in Israel, and so are the excise duties on domestic production (mainly tobacco and beverages) and the purchase taxes (applicable to a number of domestically-produced and imported goods).

Regarding non-tax revenue, receipts are broken into health fees and other fees and charges. The health fees represent fees paid by employees of the civil administration (the Central Government) as well as whoever wants to join on a voluntary basis the health plan of the civil administration. The fee is currently NIS 64 per month. Other fees and charges comprise a large variety of levies on things such as bridge crossings, car registration, departure fees and so on. Some of those fees are in fact in the nature of taxes such as the motor vehicle taxes.

Receipts from the "deduction fund" are related to the social securities payments made in connection with the Palestinian workers working in Israel and the benefits they are entitles to. The total employer and employee social security contribution is 12.7 % of salary, broken down into 7.4 % for the employer and 5.3 % for the employee. The Palestinian workers working in Israel are entitled to benefits worth 0.9 % of salary, and th remainder 11.8 that he is not entitled to is remitted back to the civil administration. These amounts remitted back constitute the receipts of the "deduction fund".

Expenditures are classified into 2 main categories as current and development. Current expenditures are broken separately into expenditures on health, education and welfare, and other current expenditure. There is no economic classification available of current expenditure (e.g. wages and salaries, transfers, etc.), but the only separate category provided under development expenditures to transfers to the budgets of the municipal Government.

Intifadah has started since 1987. Following the Intifadah, the Palestine National Council proclaimed the occupied territories consisting of the West Bank and Gaza Governorates a nation of Palestine. However, there are no economic boundaries between Israel and Palestine. Goods produced in Israel and purchased by residents of Palestine are subject to tax in Israel, while goods produced in Palestine and purchased by residents of Israel are subject to tax in Palestine. Goods exported out of Israel and Palestine to the other countries are zero-rated, while those imported to them from the other countries are taxed at the same rates at the point of entry.

4.5.2 Municipal Government

The budgets for the municipal Governments include the revenues and expenditures of the electricity and water utilities. The consolidated budget for the municipal Governments is broken into ordinary and extraordinary budgets,

The ordinary budget consists of current revenue and expenditures, while the extraordinary budget covers mainly development expenditures and their sources of financing.

Current revenues can be divided into such 3 main categories s (1) taxes (property tax and fuel tax), (2) water charges and (3) electricity chatges.

Similarly, current expenditures consist of expenditures on general services as well as expenditures by the water and electricity utilities.

The main source of financing for the development expenditures are loans and grants from the civil administration, while financing from external sources is small.

4.6 Economic and Financial Framework up to 2015

4.6.1 General

At the present time, the Government of the Palestine Authority (the PA) has no any system to show its Governmental budget in public except a particular report for donor countries according to an information from the Ministry of Finance of the PA.

However, it is sure that the central Government of the PA has a system to collect taxes including customs and duties directly from its people, and the local Government like municipalities has its own budget systems independently from the central Government. The central Government gives subsidies to local Governments when such local Governments face to produce deficit from their actual revenues and expenditures.

Therefore, it can not be expected any financial support from the central Government to the Municipality of Khan Yunis for operation and maintenance of new waste water treatment system to be established which is now under planning by this study. The

Project should be operated and maintained by the Municipality of Khan Yunis itself and the cost for such operation and maintenance including (1) cost of electric power for pumping system, (2) cost for chemical materials for treatment of waste water, (3) wages and salaries for labour and staffs, (4) cost for other necessary equipment and materials, (5) renewal or replacement cost for civil works and other mechanical/electrical equipment should be borne by beneficiaries living in the areas where the system is to be established.

4.6.2 Palestine

According to the information from the Ministry of Finance of the PA, the overall Government budget and recurrent accounts are as briefly shown Table hereunder.

The revenues indicating in this Table mainly include (1) income taxes, (2) property taxes, (3) value added taxes (VAT) and (4) customs and duties from import of goods and services.

Table M.4.15 Budget of Central Government of Palestine

(US$ million)

Revenue/Expenditure	Budget for 1997	Recurrent account in 1996	Recurrent account in 1995
Revenue	680.0	670.0	424.5
Expenditure	780.0	782.0	525.0
Surplus/Deficit	100.0	112.0	100.5

Source : Ministry of Finance, PA.

The expenditures shown in the above Table include (1) wages and salaries for official labour and staffs, (2) expenses for stationary, (3) expenses for capital assets and (4) subsidies for local Governments. Details of these expenditures are not available this time too.

As mentioned above, almost of all revenue are spent for their own use in the central Government except some amount of subsidies to the local Governments, and as shown in the above Table, the amount of their expenditures exceed the amount of their revenue. The Ministry of Finance of the PA said that they will make effort to reduce the amount of deficit for the future continuously, but there will be no any rooms for financial support to any projects made by the local Governments.

Accordingly, the planned sewage treatment system should be operated and maintained by the Municipality of Khan Yunis itself and the cost for such operation and maintenance as (1) cost of electric power for pumping system, (2) cost for chemical materials for treatment of waste water, (3) wages and salaries for labour and staffs, (4) cost for other necessary equipment and materials, (5) renewal or replacement cost for civil works and other mechanical/electrical equipment should be borne by beneficiaries living in the areas where the system is to be established as mentioned above, and it might not be able to establish such economic and financial supporting frame works up to the year 2015 from the view point of finance of the central Government of the PA.

Even the expenditure for development cost in other field as education, medical facilities, social infrastructure, power plant and so on, they have no their own fund, the Ministry of Finance said. These developments are executed by using foreign aids from the several donor countries.

4.6.3 Khan Yunis

Formerly, Gaza Governorates had formed one Governorate as called the Gaza Governorat. But, the PA divided this former Gaza Governorate into five Governorates as the North Governorate, the Gaza Governorate, the Middle Governorate, the Khan Yunis Governorate, the South Governorate since November 1996. The Municipality of Khan Yunis is now belonging to the Khan Yunis Governorate since then.

The budget of the Municipality of Khan Yunis is limited with o any subsidies from the Central Government. As ready mentioned in the previous report, (1) the budget is not detailed for sufficient services for its residents, (2) the tax revenue is quite limited, (3) therefore, the project revenue amounts at about 85 % of the total revenue, and (4) there is no guarantee for normal function of the Government of the PA.

As an example, a revenue and an expenditure, and their actual situations are shown in the following Table.

Table M.4.16 Budget of Municipality of Khan Yunis

As of 1995 (unit : NIS)

Revenue			Expenditure		
Item	Budget	Actual	Item	Budget	Actual
Routine revenue	2,549,900	2,291,768	Routine expenditure	2,923,600	2,793,747
Tax	315,000	357,955	Administration	1,054,600	1,014,941
Local service	2,234,900	1,933,813	Local services	1,869,000	1,778,806
Project revenue	14,021,500	14,070,495	Project expenditure	13,647,800	14,108,998
Water supply	2,141500	2,545,829	Water supply	2,098800	1,959,557
Electricity	11,880,000	11,524,666	Electricity	11,549,000	12,149,441
Total	16,571,400	16,362,263	Total	16,571,400	16,902,745

Source : The Municipality of Khan Yunis.

According to the information from the Municipality, this situation has shown almost the same pattern in these several years. For expecting the wealthy self-finance of the Municipality, the routine revenue should be strengthened, but for this purpose, family economy and industrial situation should be analyzed first.

In the above Table, the project revenue mainly consists of charges of water and electricity supply. It means that the average per capita expenditure is around NIS.110 per annum which was more than 10 % of residents' income when their income assumed at around NIS.1,200 per month as shown in Table 12 in Appendix-I in Volume III "Supporting Report." Here, a result of the social survey made by JICA In 1996 shows that the residents' average monthly income in urban and rural areas, and for farmers were NIS.1,137, NIS.976 and NIS.960 per household respectively as of 1996, and the weighted average income for whole study area may be estimated at NIS.1,059 per household based on the said social survey as shown in Table 13 in Appendix-I in Volume III "Supporting Report."

Generally speaking, residents usually bear at 4 or 5 % for water and electricity against their total income in maximum rate. From this viewpoint, the share rate of expenses for water and electricity to their income is quite high comparing with their income. On the other hand, the charges for sewerage treatment services were not appeared officially in the Municipality of Khan Yunis in the above Table because that there is no any official regulation about sewerage treatment systems at present. Anyhow, there might be no any room to pay for charges for sewerage treatment services when the systems would be established according only to the said data mentioned above.

However, for establishing the economie and financial framework up to 2015, the budget structure should be analyzed in more detail, and another Municipalities' budget should be studied as in Gaza or Rafah both in Gaza Governorates as a reference.

4.6.4 Water Sector

As mentioned in previous chapter, the PA will face a huge amount of water shortage in the near future, for example such amount of water shortage will be 20 MCM per year in the Municipality of Khan Yunis only.

For solving this problem, the PA has a plan named "the Water Resources Action Program". The Water Resources Action Program is a partnership of Palestinian individuals and institutions active in the water sector, which seeks to identify and resolve issues constraining the sustainable development of Palestinian water resources and, at the same time, to build Palestinian capability in water resources management. The Water Resources Action Program comprises (1) a Steering Committee of senior professionals, representing eight Palestinian institutions and the three donors as UNDP, CIDA (Canadian International Development Agency, Canada), and ODA (Overseas Development Administration, UK) supporting the Program, (2) a multidisciplinary Task Force of six sector professionals and three support staff, charged with coordinating the implementation of the Program's work plan, and (3) a growing network of other institutions contributing to the Program activities.

The said Water Resources Action Program are involving a lot of agencies as (1) the Governmental institutions including the Water Department and the Palestinian Environmental Protection Agency, (2) 5 Palestinian NGOs, (3) 5 universities in the PA, (4) 2 UN organizations including United Nations Relief Works Agency (UNRW) and UNDP and (5) 4 external organization including the American Near East Refugee Aid (ANERA), Save the Children Federation (SCF), Catholic Relief Services (CRS) and Deutsche Gesellschaft fur Technische zusammenarbeit (GTZ).

The said Water Resources Action Program covers the whole Palestine consisting of the Gaza Governorates and the West Bank. On the Municipality of Khan Yunis, projects shown in Table M.4.17 below are under going targeted to 2010.

The already cleared total budget of projects shown in the said Table is around US$ 7 million. And there are several projects which are under negotiated and the budgets of these projects are not decided yet. Therefore, for establishing the economic and financial framework up to 2015 in the field of water sector, a more information on the said pending projects will be necessary to take, and a more detail analysis should be necessary about the annual allocation of the budget of the projects shown in the Table.

Table M.4.17 List of Under Going/ Proposed Projects in the Municipality of Khan Yunis

Name of project	Objective area	Finance/implemented by:	Budget(US$)	Progress
Rehabilitation and Upgrading of Khan Yunis Network Phase I	Zone 1	Japan/UNDP	1.7 million	Finish at the end of December, '96.
Rehabilitation and Upgrading of Khan Yunis Network	Al Satar, Zone 3	EC/Pecdar	0.45 million	Under going. Started on the 1st of August, '96.
Rehabilitation and Upgrading of Khan Yunis Network	Gazan/Al Najar, Gazan/Abu Homar, Zone 4	EC/Pecdar	0.75 - 1 million	Under going. Started on the 1st of February, 96 and will finish on the 1st of August, '97.
Rehabilitation and Upgrading of Khan Yunis network	Main lines to wells and reservoirs	World Bank /Pecdar	1.0 million	Under going. Started on the 1st of September, '96 and will finish on the 1st of April, '97.
Rehabilitation and Upgrading of Khan Yunis Phase II	Zone 1	Japan/UNDP	Not decided yet	Under negotiating.
Construction of New 2 Wells		EC/Pecdar	Not decided yet	Under negotiating.
Water Wells Rehabilitation		UNDP	Not decided yet	Under negotiating.
Construction of House Connection and Installment of Water Meters for 2,000 Consumers	Ma'en area	EC/Pecdar	Approximately 1.0 million	Under going the Feasibility Study and Design.
Construction of 2 Desalination Units of 70 m^3/hr Each		Italian NGO (GISS), Al Azhar University	1.9 million	Under going. Started on the 1st of September, '96 and will finish on 30th of May, '97.

Source : The Municipality of Khan Yunis.

CHAPTER 5 SOCIAL AND INSTITUTIONAL FRAMEWORK UP TO 2015

CHAPTER 5 SOCIAL AND INSTITUTIONAL FRAMEWORK UP TO 2015

5.1 General

Palestine is an old society and also a new country. She is so old that she appeared in the history more than 3000 years ago, named as Canaan. The Palestinian society is now an arabic one, which historically underwent through Egyptian, Turkish and British influences as well as Israeli ones. She is a "new" country which was internationally recognized only a couple years ago in 1993 after the peace agreement called as Oslo I and II was reached with Israel. In this content the institutions of the Palestinian society are old, but not well established to deal with recently emerging issues such as environmental protection.

There is at present no legal frame work established for environmental impact assessment: which organization approves the process of EIA, what are the environmental standards, what are the legal steps if adverse effects seem to be serious against benefits, etc.

During the occupation by the Israeli government its military orders were the legal system for Palestine. There are also still many Israeli settlements within Gaza and West Bank, which are completely out of control of Palestine, though they are located within the Palestinian territory. As the central government the Palestinian National Authority (PNA) was established under the leadership of PLO Chairman Mr. Y. Arafat. In January 1996 the first general election was held and Mr. Y. Arafat was elected as the leader of PNA, and the members of Palestinian National Council (legistrative body) were elected at the same time.

Until November 1996 the governmental organization basically consisted of two levels: central and local levels. In November 1996 a new intermediate level was introduced as Governorate, so that three levels of the government were established: central, regional and local governments (see Fig. M.5.1). The former Gaza Governorate was then divided into five governorates in Gaza Governorates: Northern, Gaza, Middle, Khan Yunis and Rafah Governorates. Khan Yunis Municipality is included in Khan Yunis Governorate with surrounding villages.

5.2 Governmental Organizations

5.2.1 Palestinian Authority (PA)

The first election was held in January 1996 and Chairman of PLO, Mr. Y. Arafat, was elected as President of Palestinian Authority (PA). The new legislation organization was established as Palestinian National Council (PNC) on March 2, 1996, as shown in Fig. M.5.2. The naming of ministers is almost self-explanatory. Of these ministries the ministries closely related with the Study are marked with *.

There are 22 ministries at present as follows:

- Ministry of Housing
- Ministry of Public Works*
- Ministry of Telecommunications
- Ministry of Transportation
- Ministry of Interior
- Ministry of Planning & International Cooperation*
- Ministry of Local government*
- Ministry of Justice
- Ministry of Finance
- Ministry of Labour
- Ministry of Industry
- Ministry of Economy & Trade
- Ministry of Agriculture*
- Ministry of Tourism & Archeology
- Ministry of Health*
- Ministry of Education
- Ministry of Higher Education
- Ministry of Culture & Arts
- Ministry of Information
- Ministry of Sports & Youth
- Ministry of Social Affairs
- Ministry of Waqf & Religious Affairs

These ministries were just established within PNA, and some of them are lacking essential officials to fulfill the duties assigned for them. They will need to be strengthened substantially by proper staffing and trainings for officials. MOPIC is the counterpart of the JICA Study responsible to organize the Steering Committee.

The revenue of 1995 amounted to US$216 million, while the expenditure were US$435 million. The gap was filled with foreign donations of US$367 million, though the financial shortage was about US$150 million, as shown in Table M.5.1. In other works the deficit of US$513 million were equal to the amounts of foreign aids and shortage.

Table M.5.1 Financial Status of PA

(1995, unit: US million)

Revenue	216	Expenditure	435
• Tax	85	• Services	189
• Others	31	• Security	100
• Return from Israel	100	• Capital investment	294
Balance			-513
• Foreign aids	367		
• Shortage	146		

5.2.2 Ministry of Planning and International Cooperation

Ministry of Planning and International Cooperation (MOPIC) was established in 1994, and has today the total staff number of about 250. The Ministry aims at physical and strategic planning for rural and urban areas. It also aims at international cooperation. It is involved in national development plans for medium and long term and also with international cooperation and coordination.

The organizational chart of Ministry of Planning and International Cooperation is shown in Fig. M.5.3. The organization distinguishes between Directorate, Department and Unit. Directorate is the largest unit, followed by Department and the smallest one is Unit. Center is equivalent to a unit working within the whole ministry.

The Environmental Planning Directorate (EPD) within the Planning Sector is in charge and responsible with all the projects in planning that will affect the environment. EPD is divided into three Departments:

(1) Planning and Policy Department
(2) Monitoring and Environmental Impact Department
(3) Information and Follow-up Department

The total staff number of EPD is 22:17 working in the Gaza Governorates and 5 working in the West Bank. They are also working in a close relationship with the Water Resources Protection Unit that is part of the Planning and Policy Department.

In the Urban and Rural Planning Directorate (URPD) there are three staff members working on water and wastewater issues in the Gaza Governorate. This Directorate is in charge with planning both in urban and rural developments of major infrastructures.

5.2.3 Palestinian Water Authority

Palestinian Water Authority (PWA) is a body established by law No. 18, 196 (see Appendix II, Reference 2) in April 1996. The current PWA staff is managed by the Chairman (commissioner).

Water Resources Auction Programme (WRAP) was established in 1994 to deal with water resources and to be the core of the PWA. WRAP was supported by UNDP. Upon the establishment of PWA, the staff of WRAP was merged into PWA. There are still some professionals associated to the WRAP are assisting the PWA staff in technical issues.

The total staff number is about 20 persons. The organizational chart of PWA is shown in Fig. M.5.4.

The World Bank-financed project "Water and Wastewater Management Contract" has started in September 1996 with PWA as the implementing agency. This project aims at organizing the water supply and wastewater service delivery into a utility, which eventually may be established as an autonomous body. The body may be organized within PWA or possibly as a private organization under PWA. The utility may be granted a concession to abstract water for delivery either directly to the consumers or in bulk to e.g. municipal distribution organizations.

PWA uses the word utility to describe an organization, covering the whole Gaza Governorates. The utility will aim to work with quality of water, to reduce the unaccounted for water, to improve the management systems and the promotion of proper institutional set up, all regarding water and wastewater for domestic and industrial use. PWA will work with strategic planning, licensing, monitoring et cetera.

As a guideline for the work of Palestinian Water Authority, the Authority has proclaimed fifteen principles regarding the water policy. These rules are collected in Palestinian Water Policy, dated January 1996. The rules affect all kinds of water, also treated sewage water for reuse.

5.2.4 Ministry of Agriculture (MOA)

The organizational chart of the Ministry of Agriculture is shown in Fig. M.5.5.

The main function of Ministry Agriculture concerns the agriculture sector within the country. There is one General Directorate comprising five departments and one unit working with polices, planning and development. Another eight General Directorates work with agricultural production research, publicity, forestry, fisheries, veterinary services, plant protection, irrigation and administration/finance.

The Irrigation Department is dealing with irrigation questions, need of water, quality demands et cetera.

Since 1967 the Ministry of Agriculture has been the sole agency responsible for agricultural water resources, quotas licensing of wells, data collection and distribution of Mekorot water. The MOA has ongoing discussions and work with PWA in the water/wastewater sectors to facilitate the transfer of responsibility for water resources to PWA.

MOA has a well developed water section and has just recently engaged a wastewater engineer to support the Ministry in questions regarding reuse of wastewater.

MOA has developed a number of project ideas for effluent reuse and are ready to develop these ideas further into detailed project proposals, based on the available funds. The obstacle so far, however, has been that none of the wastewater treatment facilities in Gaza has been capable of producing effluent of a standard, which would allow reasonable large-scale and consistent use in the agricultural sector.

5.2.5 Ministry of Local Government

The organizational chart of the Ministry of Local Government (MLG) is shown in Fig. M.5.6.

MLG is assigned responsibility for the local government system and has been actively engaged in defining the structure of local government, the institutional arrangements and the key organizations at the various levels and the roles and functions at these levels. In November 1996 a new intermediate organization was introduced to coordinate the central government with municipalities and villages. This is called as Governorate. Now there are five Governorates in Gaza Governorates: Northern, Gaza, Middle, Khan Yunis and Rafah.

The total staff number of Ministry of Local Government is 134 persons.

5.2.6 Municipality of Khan Yunis

The Municipality of Khan Yunis is located in the south part of Gaza Governorates. A camp named as Al Qatatwa is partly included in the municipality.

Table M.5.2 Area and population of the Study Area

District	Area (ha)	Population in 1996	Projected Population in 2015
Khan Yunis and Camp	1,660	132,700	299,988
Kizan Area	1,270	4,700	62,335
Bani Sohaila	404	16,900	38,205
Qarrara	443	11,100	34,197
Abassan Kabera	424	11,600	26,224
Abassan Saghera	128	5,500	12,434
Khuzaa	129	6,200	14,016
Total	4,458	188,700	487,399

Source: JICA Study Team and MOPIC 1997

(1) Municipality Government

The organization of Municipality of Khan Yunis is shown in Fig. M.5.7. Under the City Council the Mayor is in charge for the government, assisted by 10 divisions. However the number of officials is so small as under 200 to serve the population of about 132,700 in the administrative boundaries of the Municipality. The Refugee Camp is jointly administered by UNRWA.

The dominant entities in the local government system are the municipalities, which in many cases have under-established and limited service and regulatory functions. The service includes electricity, water supply, sanitation, solid waste management, local roads, libraries, parks and recreation, slaughter houses, markets, land use planning, development & building approvals, business & professional licensing.

The members of Municipality Council as well as the Mayor are appointed by Mr. Y. Arafat, President of the Palestinian Authority.

Almost all waste waters which today are generated within Khan Yunis area are conveyed to cesspits constructed in the vicinity of the buildings or houses. The sludge is collected by vacuum tankers, municipal or private, and emptied at an open area outside the built-up areas. The Municipality has five vacuum tankers operating each day, when necessary in shift. Additionally there are 17 private tankers working in the area.

The Health & Slaughter Division is responsible for the management of these operations within Khan Yunis Municipality.

(2) Municipality Budget

The 1995 budget of Municipality of Khan Yunis is shown in Table M.5.3 which is almost the same as the last year. This table indicates the following:

- Not detailed for sufficient service for the residents
- Tax revenues is quite limited
- Project revenues amount at about 85% of the total revenue
- No guarantee for normal function of the government

This can lead to a conclusion that the residents are accustomed to a vicious cycle: "No burden, No service". This is an irresponsible relationship between the government and residents. Concerning the sewerage service, this kind of situation will cause a serious problem: if no or little charge is collected, no cost recovery is secured sustainable operation and development. Therefore institutional building, management and residential education are so important as to be discussed in the Study.

Table M.5.3 Budget of Muncipality of Khan Yunis

(1995, unit; NIS)

Revenue		Expenditure	
Tax	315,000	Government cost	1,054,600
Local service	2,235,900	Local service	1,869,000
Government service	-	Government service	-
Subtotal (Routine)	2,550,900	Subtotal (Routine)	2,923,600
Water supply	2,141,500	Water supply	2,098,800
Electricity	11,880,000	Electricity	11,549,000
Sewerage	-	Sewerage	-
Subtotal (Project)	14,021,500	Subtotal (Project)	13,647,800
Total	16,572,400	Total	16,571,400

5.2.7 Village Councils

The small village councils around Khan Yunis Municipality can be seen on previous Table M.5.2: Bani Sohaila, Qarrara, Abassan Saghera, Abassan Kabera and Khuzaa. Their present population is around 51,300 people with a total area of around 27 km^2.

Since village councils are the next level of local government compared to municipalities, they are the broad range of functions and revenue raising options of municipalities, though they have a representative governmental entity.

5.3 Community Organizations

5.3.1 General

Over the last five years, relief agencies working in rural areas have adopted community participation as an element in programs to improve water supply and sanitation, increasingly, attention is being paid to applying participatory methods in urban and peri-urban communities as well.

In water, sanitation, and housing programs, community participation has typically meant requiring beneficiaries of a construction project to contribute labor and/or money and take responsibility for managing the facilities. The concept of community participation can also be taken a few steps further. Participation means involving community members in environmental problems. The concept also includes training community leaders and government officials to conduct a sustained dialogue with each other about environmental management. Community participation is viewed as a good component of making housing and infrastructure projects sustainable.

Regarding water and wastewater project it is increasingly being recognized that it is necessary to raise the knowledge of hygienic conditions and behavior are also required to reduce water and wastewater-related deceases. Hygiene education addresses these changes and thus aims to provide the essential link between improved facilities and user practices.

5.3.2 Community Participation

A simple but valuable form of community participation could be to arrange a series of small public meetings in local areas in which residents are presented with information and given ample opportunity to express their views. If such a procedure is found as desirable, it should above all take place within the planning phase, when possible views from the public still can affect the planning.

The subject community participation and public awareness seems to have been noticed in an increasing degree the latest years related to water and wastewater systems. By natural reasons this can be connected to ongoing extensions of existing networks and also construction of new ones. Through the recent years there has been a misuse of existing wastewater networks in Gaza Governorates by discharging solid wastes, dangerous liquids et cetera into the pipelines and the toilets. To avoid this, a new awareness should be brought to the public in their use of the systems. There is also an economical aspect in the awareness. A wastewater system is a utility and the users must get aware of the necessity to pay for this utility.

As a few examples on project and institutes working in the field of environmental (health) related education and community participation can be mentioned the following:

- Palestinian Water Authority has engaged an Awareness Specialist for water and wastewater and they have also published reports on Public Awareness Campaigns executed in Gaza.
- GTZ (German Agency for International Cooperation) has funded a project called "Gaza Governorates Central Region Solid Waste Management Project", which has included for instance Khan Yunis. In the project a public awareness and community participation program are integrated.

5.3.3 Peoples Awareness

Means to access peoples awareness may include public meetings as shown above, formation of advisory groups, information leaflets, advertising, television, school programs et cetera.

For Khan Yunis Wastewater Project recently (within the project) a social survey has been made to investigate peoples awareness in an early stage of the planning. The result is not yet evaluated.

5.3.4 NGO

Many Non Governmental Organizations are working in Khan Yunis area, most of them with health education. A table showing all these NGO's is included.

The only Non Governmental Organization that has a close relation to Khan Yunis Wastewater Projects seems to be Save The Children Federation (SCF).

SCF has been established in Gaza since 1978, they are working with water and sewage projects and health education, normally with community participation in coordination with municipality or other NGO's, also Palestinian.

Peoples participation consists usually of labor in small projects, such as minor pipelines, house connections et cetera. They are funded from various donors. The number of staff is 22 and their regular budget is US$700,000.

5.3.5 International Organizations

There are two well-known international organizations established in Gaza: UNRWA and UNDP.

UNRWA (United Nations Relief and Works Agency) has by capacity and resources maintained a role in the Gaza Governorates for a long period within the sectors of water, wastewater and environmental protection. In order to strengthen the Agency's approach to the problems of water supply, sewerage, surface water drainage and solid waste disposal, UNRWA established in 1992 a Special Environmental Health Programme (SEHP) aimed at improving the over all health conditions in the refugee camps and their surroundings. The activities in SEHP have in the latest years turned from mainly feasibility studies to more design, planning and implementation. UNRWA is used by a number of donors for projects over the whole Gaza Governorates, mostly within the refugee camps.

SEHP has usually ongoing works in the camps, for instance in Khan Yunis camp, and it consists mostly of education and environmental health. UNRWA has totally around 5,000 staff members in Gaza Governorates. Of the them are 320 people working in the Special Environmental Health Programme including funds their budget for 1996 is US$12.8 million. (US$8.8 million for projects and US$4.0 million for normal budget).

UNDP (United Nations Development Programme) has ongoing work in Khan Yunis Municipality with rehabilitation of water wells and the water network including also construction of new lines. They work with project management. The staff consist of 7 engineers and they normally use consultants. The total staff of UNDP in Gaza Governorates numbers 22 persons.

5.4 Laws and Regulations

5.4.1 General

As mentioned before Palestine has historically undergone different legal systems: Egyptian, Turkish Jordanian and Israel. So there are a large size of mixtures in its legal system, and some of them are contradictory. Palestine is in a meaning a new-borne country which can not afford to review those laws and revise them for their new system.

The same situation can be seen concerning the environmental protection. At present there is no established system for environmental protection nor for environmental impact assessment. In order to justify a project from environmental point of view, the international practice shall be consulted such as WHO Guidelines.

5.4.2 Sewerage Law

Now the people in Khan Yunis area are using on-site systems for their waste water management. The cess pits and septic tanks are penetrating waste water into the ground water to cause serious contamination. However there is no law to regulate this kind of practice. Therefore the sewerage/sanitation law should be introduced to protect the fragile environment of Palestine. The sewerage law would obligate the house connection within a certain time frame. Otherwise though a sewerage system is constructed, it would not be used properly.

5.5 Institutional Frame up to 2015

5.5.1 Institutional Building for Master Plan

The Master Plan for sewerage development in Khan Yunis area has been identified by the Study Team to cover a total area of 3,632 ha, or 81.5% of the Study Area (4,458 ha). Considering the financial capacity and technical complexity the Study Team has divided the Master Plan of sewerage development into three stages:

(1) First Stage: 1998 to 2002
to cover market an area of 848 ha to serve ca. 166,000 people.

(2) Second Stage: 2003 to 2008
to cover an area of about 1,451 ha to serve ca. 188,000 people.

(3) Third Stage: 2009 to 2015
to cover an area of 1,333 ha to serve ca. 122,000 people.

Those residents out of sewerage service areas will be served for their sanitation by public or private vacuum trucks for desludging..

The Master Plan for drainage has been identified by Study Team to be divided into two stages:

(1) First Stage: 1998 to 2002
to cover market and central zones with a total area of 350 ha.

(2) Second Stage: 2003 to 2008
to cover an area of about 63 ha surrounding the market and central zones.

5.5.2 Operation and Maintenance

The O/M works for sewerage are as follows:

- Sewers (including house connections)
- Pumping stations
- Treatment plant

There are some O/M works required for sanitation for vacuum trucks. The O/M works for drainage are as follows:

- Pumps
- Retention basins
- Drains and pipes

Of these three services a major part of O/M works will be given to sewerage.

The staff required for O/M are as follows:

- Sewers
- Pumping stations
- Treatment plant
- Drains
- Sanitation
- Administration

The Study Team has estimated the requirements for O/M staffing in each stage as follows:

Table M.5.4 Staff Requirement for O/M

	Staffing for						
Stage	Sewers	P/S	WWTP	Sanitation	Drainage	Administration	Total
First	32	30	25	30	5	20	142
Second	80	60	36	30	5	25	236
Third	122	90	48	30	5	30	325

As the system develops, the staff number will increase in each stage from 142 to 325.

The organization for administration, WWTP and P/S are proposed as in Fig. M.5.8.

5.5.3 Institutional Development

The sewerage/drainage investment is heavy at the initial stage, while there is only one revenue which comes from the users' charges at a low level. This is why the cost recovery for sewerage/drainage is usually quite difficult.

The cost for drainage can be expected from the governmental expenditure (tax), because the government is responsible for the minimum welfare to protect flooding for the residents.

The Study Team recommends that a gradual institutional development should be considered, because the sewerage/drainage system is new in Khan Yunis. A stepwise development can be processed as follows:

(1) Municipality based Management

In case a village is integrated with a large system, the village shall take a due cost sharing.

(2) Regional Management

After some experiences are accumulated, the management can be expanded to integrate the surrounding areas.

(3) Gaza-based Management

Once the governments have experienced the sewerage/drainage management, a single management within Gaza Governorates can be possible. However without proper experience the overall integration would be too early.

The institutional development is shown in Fig. M.5.9.

It shall be noted that prior to each management staff training will be required as well as the legal modification will be required.

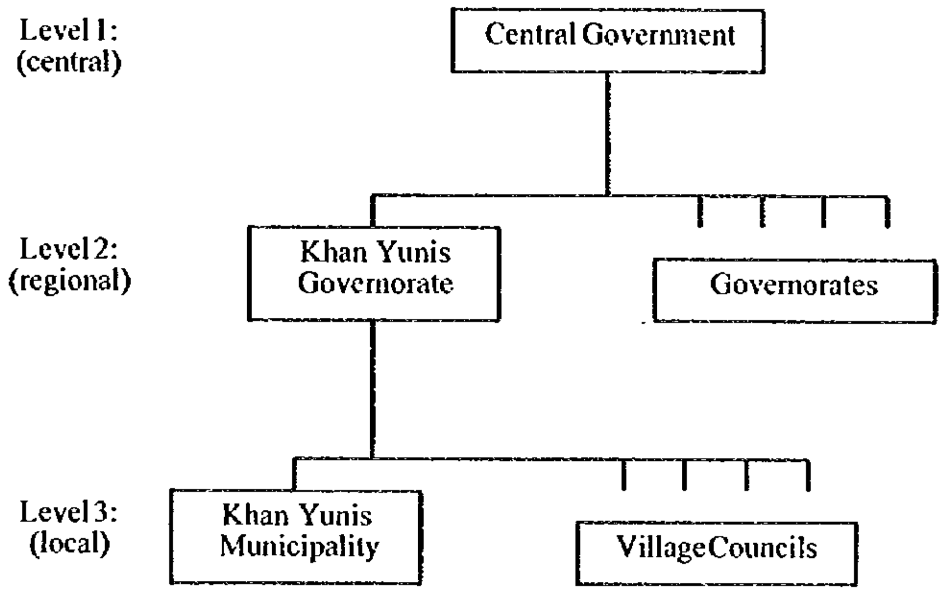


FIG.M.5.1 GOVERNMENTAL STRUCTURE OF PNA

THE STUDY OF SEWERAGE DEVELOPMENT PLAN IN THE AREA OF KHAN YUNIS IN PALESTINIAN INTERIM SELF-GOVERNMENT AUTHORITY

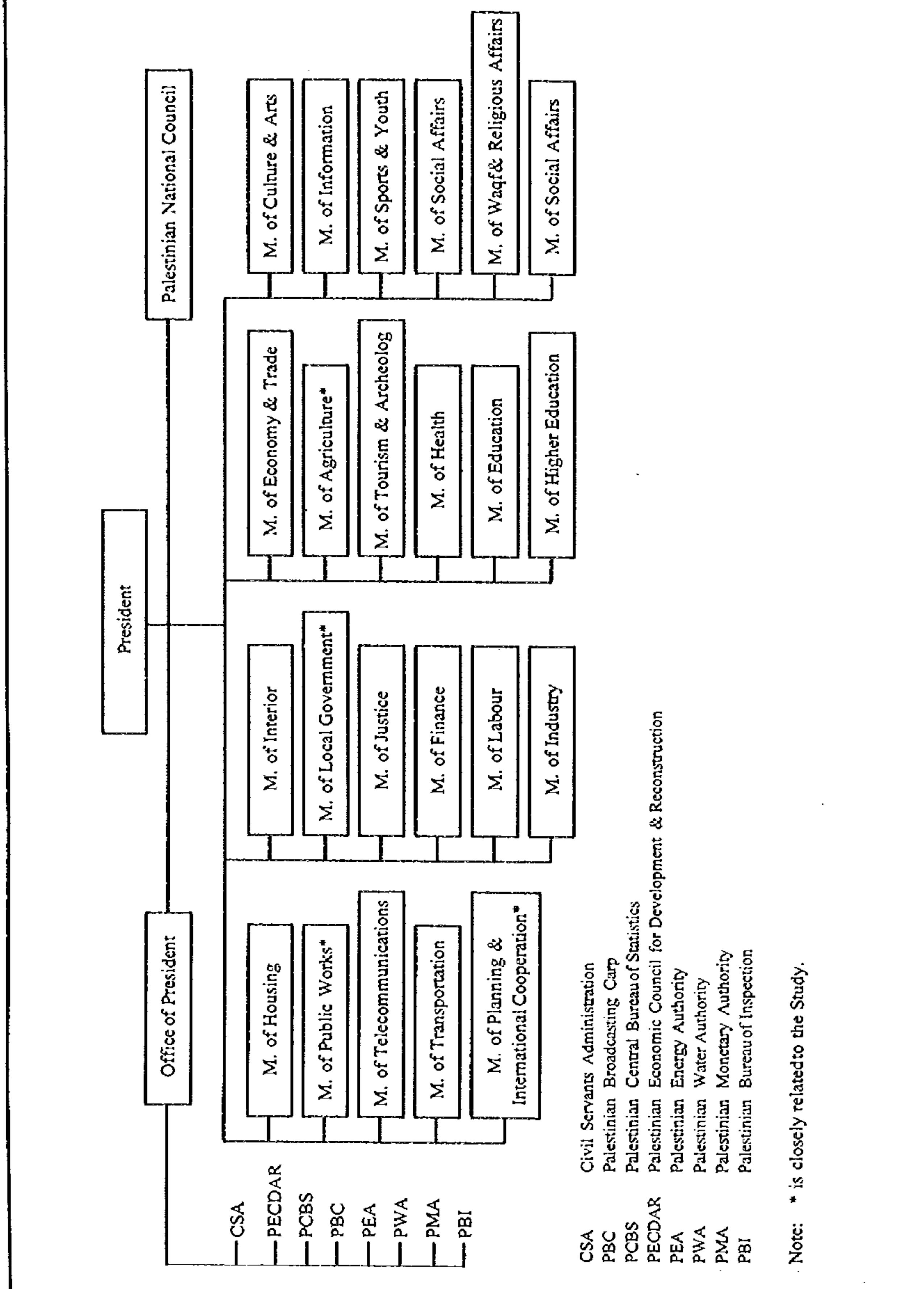


FIG.M.5 2 ORGANIZATION CHART OF PALESTINIAN AUTHORITY

THE STUDY OF SEWERAGE DEVELOPMENT PLAN IN THE AREA OF KHAN YUNIS IN PALESTINIAN INTERIM SELF-GOVERNMENT AUTHORITY

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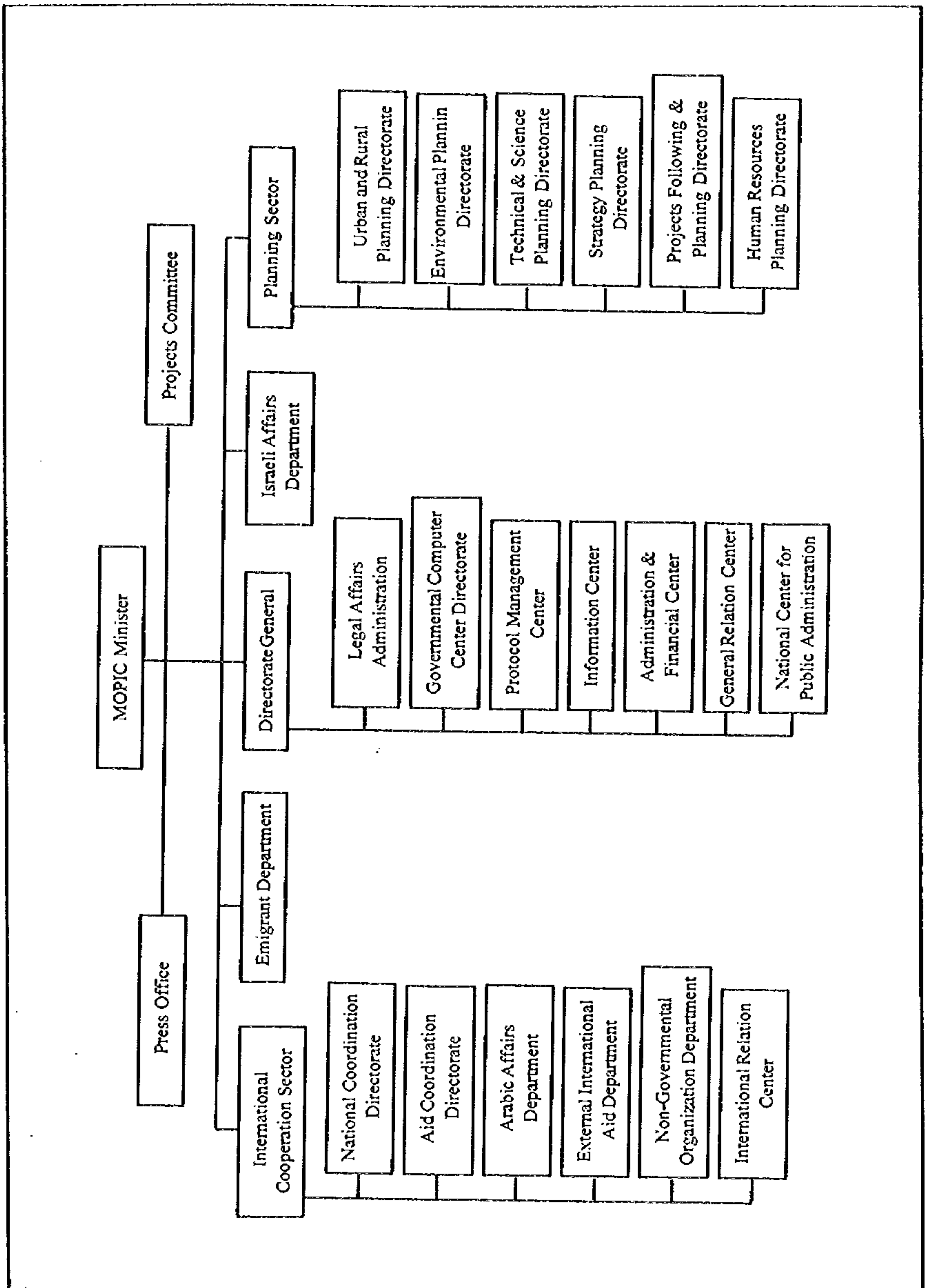

FIG.M.5.3 MINISTRY OF PLANNING AND INTERNATIONAL COOPERATION (MOPIC) ORGANIZATION CHART

THE STUDY OF SEWERAGE DEVELOPMENT PLAN IN THE AREA OF KHAN YUNIS IN PALESTINIAN INTERIM SELF-GOVERNMENT AUTHORITY

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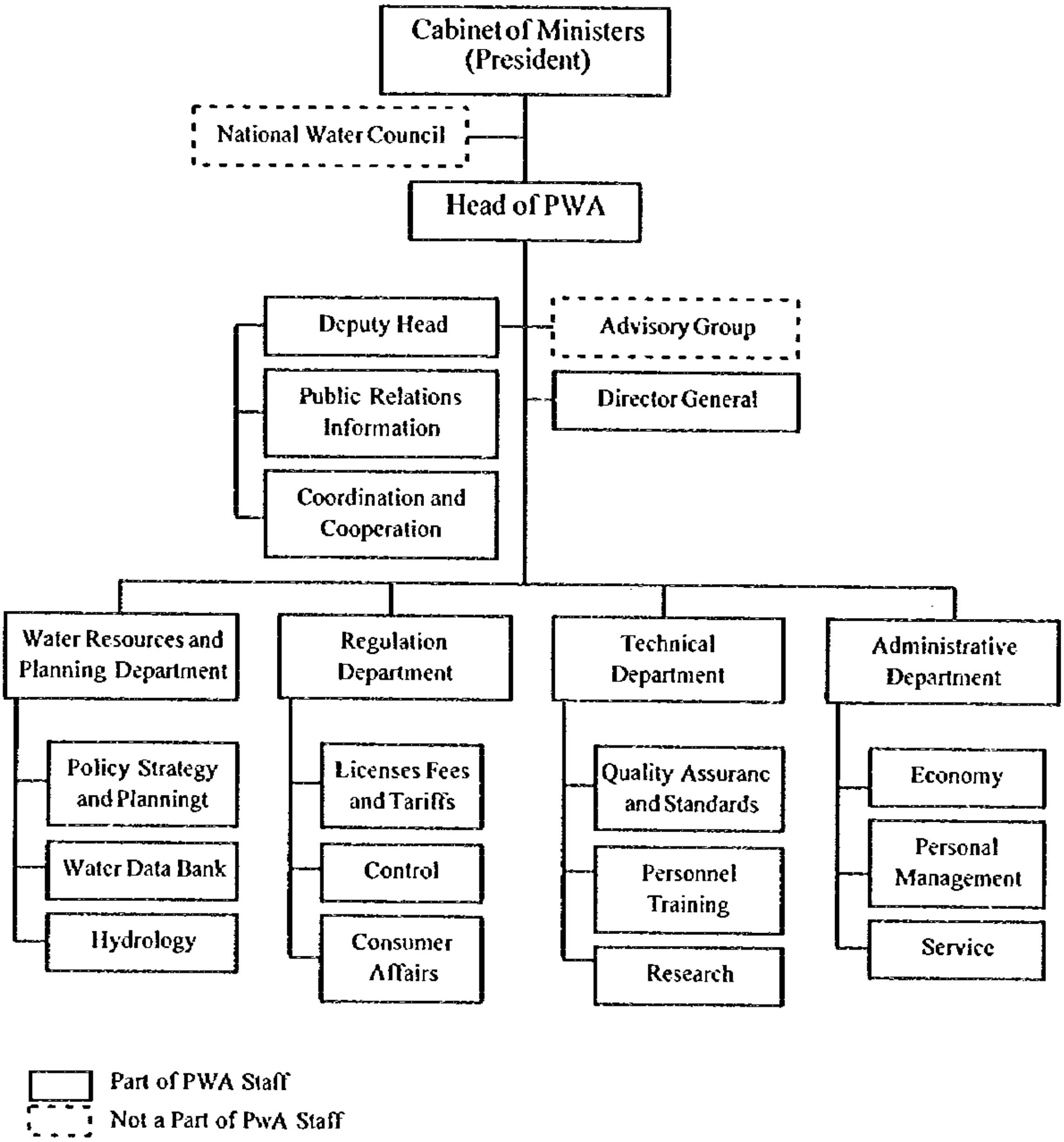


FIG.M.5.4 PALESTINIAN WATER AUTHORITY (PWA) ORGANIZATION CHART

THE STUDY OF SEWERAGE DEVELOPMENT PLAN IN THE AREA OF KHAN YUNIS IN PALESTINIAN INTERIM SELF-GOVERNMENT AUTHORITY

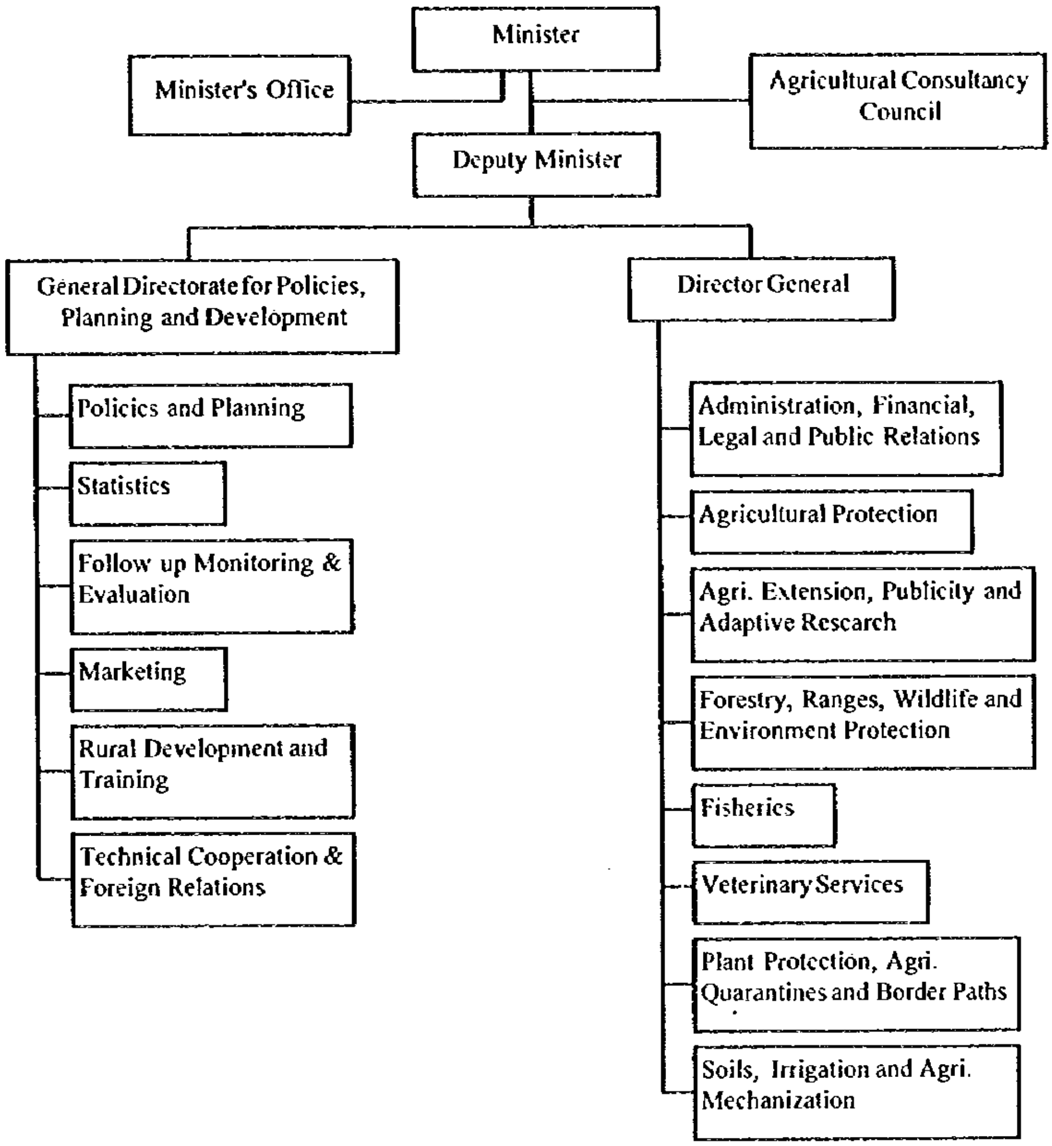


FIG.M.5.5 MINISTRY OF AGRICULTURE ORGANIZATION CHART

THE STUDY OF SEWERAGE DEVELOPMENT PLAN IN THE AREA OF KHAN YUNIS IN PALESTINIAN INTERIM SELF-GOVERNMENT AUTHORITY

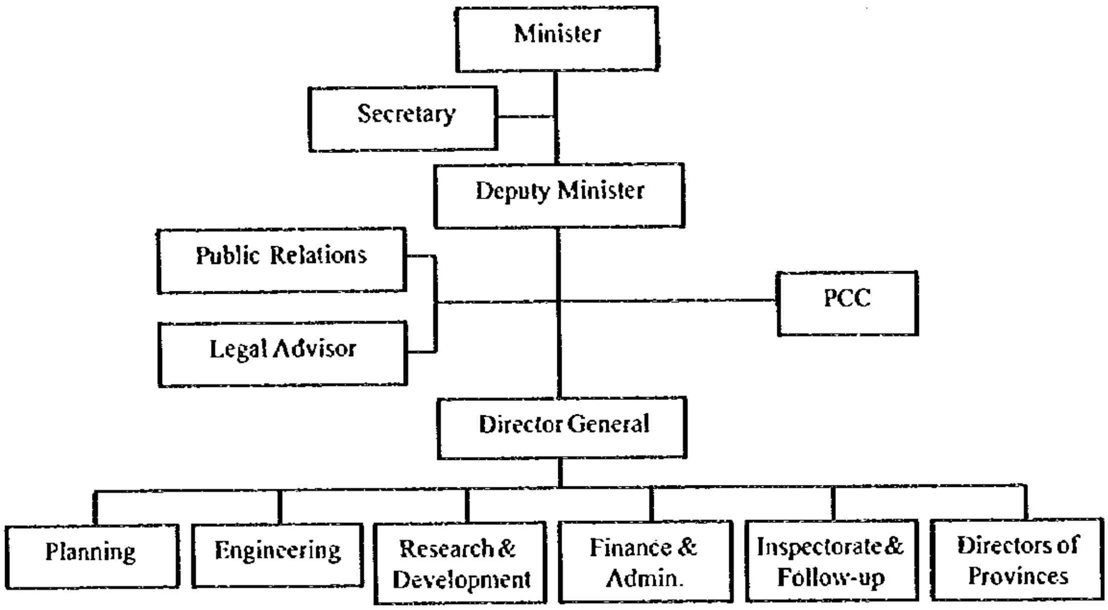


FIG.M.5.6 MINISTRY OF LOCAL GOVERNMENT (MLG) ORGANIZATION CHART

THE STUDY OF SEWERAGE DEVELOPMENT PLAN IN THE AREA OF KHAN YUNIS IN PALESTINIAN INTERIM SELF-GOVERNMENT AUTHORITY

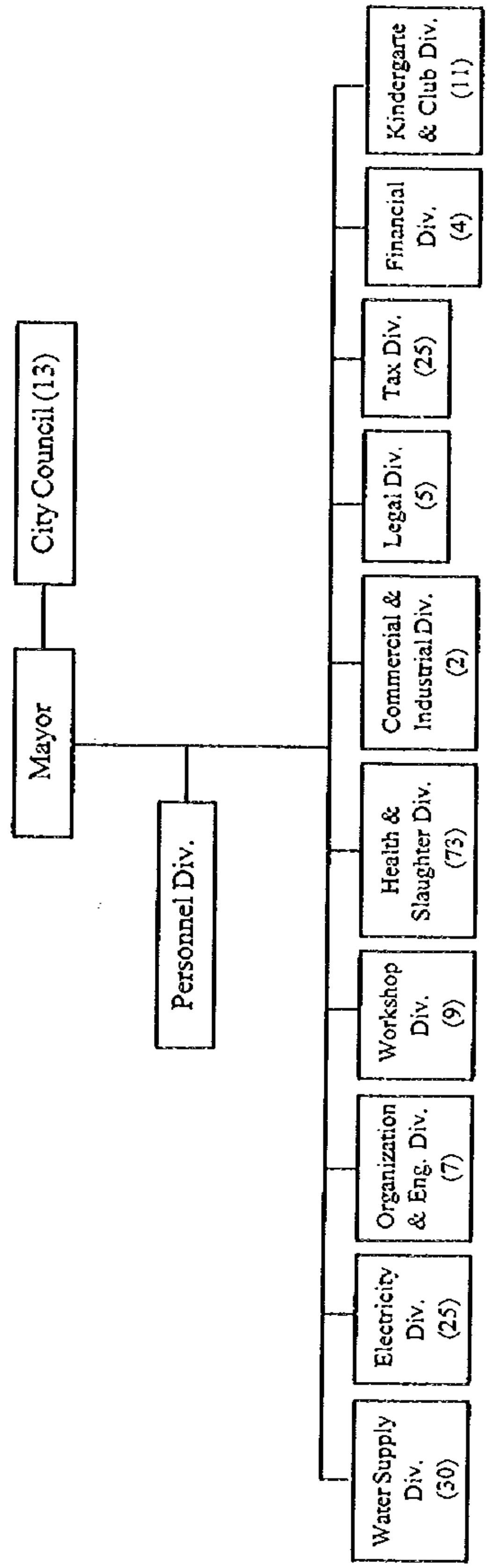
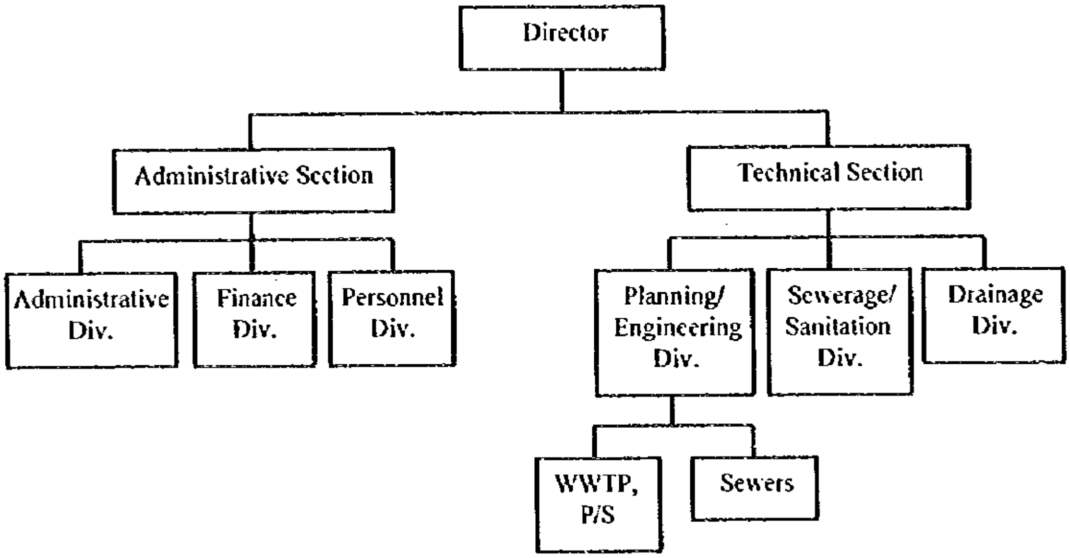
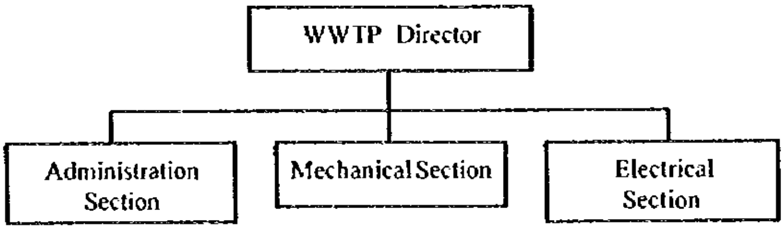


FIG.M.5.7	ORGANIZATION CHART OF KHAN YUNIS MUNICIPALITY

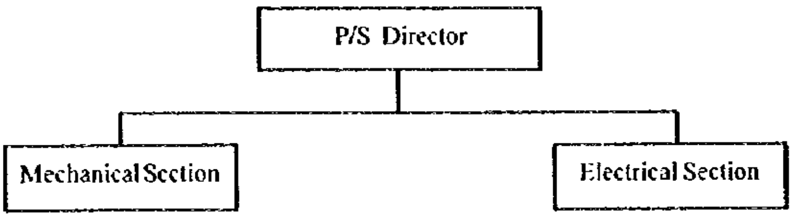
THE STUDY OF SEWERAGE DEVELOPMENT PLAN IN THE AREA OF KHAN YUNIS
IN PALESTINIAN INTERIM SELF-GOVERNMENT AUTHORITY



(1) Administration



(2) Wastewater Treatment Plant



(3) Pumping Station

FIG.M.5.8	SEWERAGE ORGANIZATION

THE STUDY OF SEWERAGE DEVELOPMENT PLAN IN THE AREA OF KHAN YUNIS
IN PALESTINIAN INTERIM SELF-GOVERNMENT AUTHORITY

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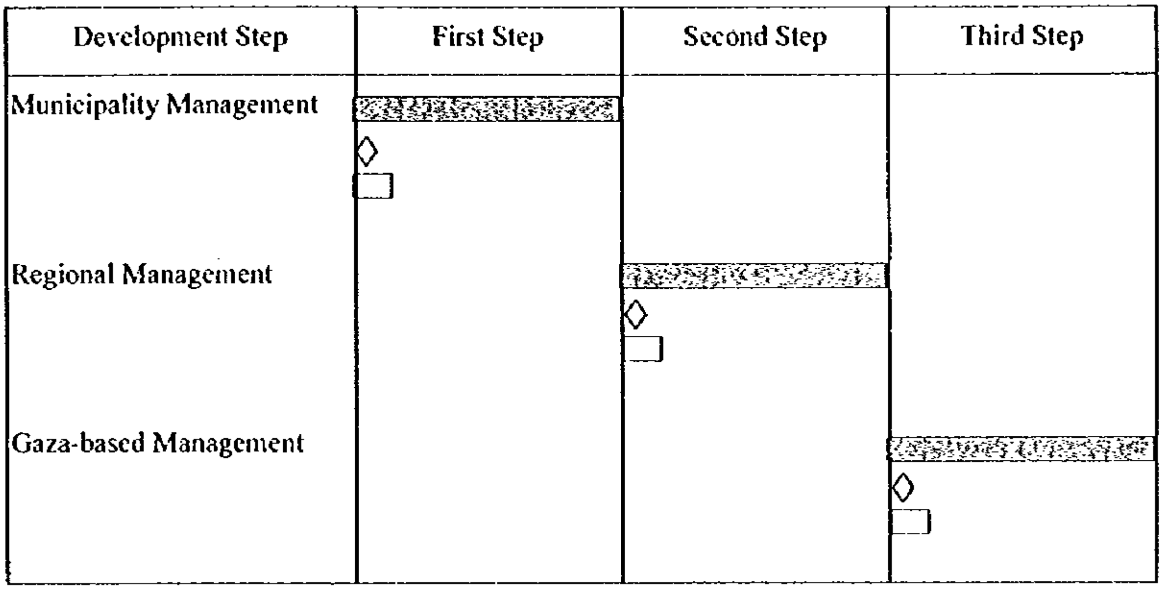

Note) ◇ : Staff Recruitment

□ : Training

Fig. M.5.9 Institutional Development

CHAPTER 6 BASIC PRINCIPLES AND TARGETS

CHAPTER 6 BASIC PRINCIPLES AND TARGETS

6.1 Basic Principles of Master Plan

6.1.1 Clear Objective

A sewerage system will require a huge investment as the capital cost, and the on-going operation and maintenance will also require a careful management to keep the system function within the cost recovery level.

Clear objectives shall be identified for each stage in the master Plan. For clear objectives, residents will support the sewerage management and pay their bills.

Since the central district of Khan Yunis City is situated lower than the surroundings; wastewater and stormwater are concentrated in the city center. Therefore this district will have to be entitled as the highest priority. Though the city center is congested as well as the near refugee camp, the cost performance is expected to be the highest, because the area is densely populated and the pipe length per each resident will be shorter than other districts.

It is expected that the cost performance will decrease as the service area expands toward outside. Longer pipes will be required to cover sparsely populated areas with a sewerage system.

6.1.2 Staged Implementation

Because the Master Plan is formulated for a period of about 20 years, the period will need to be decided into several stages. There are a lot of uncertainties to project the future frame for Master Plan : social conditions, economic situations, technical development, or human resources and trainings.

The staging should not be rigid, but rather flexible reflecting the changing situations. When one stage is approaching toward its end, the next stage should be renewed based on the previous achievements.

6.1.3 Technical Soundness

There are relatively many options for technological alternatives of the sewerage system. Some of them are relatively primitive, while others are highly advanced even with computerized systems. It is a general trend for developing countries to seek more advanced technologies than their capacity, just ignoring their own situations.

Though high-rank officials of the government are excellent, they are not in the position to operate the sewerage system. So qualified know the situations very well operators should be recruited to operate the system properly.

6.1.4 Cost Recovery

The sewerage system will require a heavy capital investment. On the other hand people's awareness to pay the cost is generally low. Therefore the cost recovery is very difficult. The following are the possible cases of coast recovery.

- Case I
  - Construction cost (or Repayment)
  - Depreciation of capital cost
  - O/M cost

- Case II
  - Depreciation of capital cost
  - O/M cost

- Case III
  - O/M cost

Case I is the most difficult to be realized, while Case III is the easiest. If the users can not pay even for O/M cost, the system itself would be meaningless, because other people will have to pay their expenses maybe through tax. However this kind of situation will happen in the sewerage system, because illegal connections and delayed payment of the tariff will deteriorate easily the financial position of the system. If the ignorance lasts longer, the situation will become too serious to recover any more. This is why a good management is quite importance for the sewerage system.

It is the principle that users who are benefiting from the service will have to pay for it. This is a relationship of "Give and Take". In water supply those who are receiving water must pay according to their water consumption. In the same content those who are receiving the sewerage service must pay for it.

However the drainage system is rather difficult to identify the clear benefit. Therefore the cost of construction and O/M would be better covered by the local government. The cost recovery can be basically summarized as follows in Table M.6.1.

Table M.6.1 Cost Recovery

Category / Cost recovery	Sewerage		Sanitation		Drainage	
	Construction	O/M	Construction	O/M	Construction	O/M
Public	○	×	×	×	○	○
Private	△	○	○	○	×	△

Note) ○= Main cost sharing
△= Partly cost sharing
×= No cost sharing

6.1.5 Prioritization

It is true that many people want a piped sewerage system for their houses, regardless of the cost required. It is a general trend to require an extension of the service area to their residential area, if a new system is planned to cover the neighborhood. Commonly political involvements are happening to influence the technical judgment. It is quite importance to recognize that the inclusion of a small area with low priority will largely deteriorate the financial position. It is of great importance that the prioritization must be done just on the basis of technical judgment.

6.2 Targets of Master Plan

6.2.1 Target Area

The Master Plan has the following target areas in the southern part of Gaza Governorates :

- Khan Yunis City (1,660 ha)
- Kizan Area (1,270 ha)
  including Kizan Abu Humar, Kizan Al Najar, Ka'a Al Gorain and Wadi Saber
- Bani Sohaila (404 ha)
- Abasan Kahera (424 ha)
- Abasan Saghera (128 ha)
- Qarara (443 ha)
- Khuzaa (129 ha)

A total area of 4,458 ha is a huge area for a new sewerage system. The area has not been served with sewerage system though planed once by Israel in 1970's. A completely new system will need to be established from the beginning not only physical facilities, but also the responsible institution with financial viability. This task has been requiring great efforts from the Study Team.

6.2.2 Target Components

The Master Plan will deal with the following wasters of the target area :

- Domestic Wastewater
- Industrial Wastewater
- Stormwater

The present population of about 200,000 are using cess pits or septic tanks, through which raw wastewaters are penetrating into underground to cause a large area pollution. The groundwater is a important water resource for living and agriculture, though the salinity level is very high in some parts of the area. in order to improve the environment conditions the Study Team has formulated the Master Plan with the following components :

- Centralized sewerage system
- Improved sanitation system
- Stormwater drainage system

After detailed surveys with institution and financial reviews a separate system was proposed by the Study Team with consultation with MOPIC. This system will require less capital investment than the combined system to deal with both wastewater and stormwater.

6.2.3 Target Year of Master Plan

There will be more uncertainties for planning as the target year is set for a longer period. On the other hand if the target year is too short, the master planning would become meaningless. This is why the target year of the Study is to be set for 20 years at year 2015.

The Palestinian society has been chaning rapidly. During the wars and following conflicts with Israel, many Palestinians were forced to go out of the country, mainly in the Arabic world of middle East. Now the agreement between both countries was reached for peace 2 to 3 years ago. Though there are still some problems, the fundamental point is that both sides have recognized the co-existence of another side. It is expected that many of those Palestinians living abroad are coming home or will come home soon. The small area of Gaza is expected to welcome those returnees by preparing the basic infrastructures for their livings. The sewerage system is also one of the fundamental infrastructures. Because of the limited human and financial resources, the whole projects formulated in the Master Plan are to be divided into three stages as follows :

- First Stage: for year 1998 to 2002
- Second Stage: for year 2003 to 2008
- Third Stage: for year 2009 to 2015

6.2.4 Target of Sewerage / Sanitation

The Master Plan identifies the areas to be sewered within the target years and those to be served with sanitation systems. The former is a densely populated area with higher affordability, while the latter is a sparsely populated area with less influence of pollution.

The Master Plan has identified of the study are of 4,458 ha :

- Sewerage Development are : 3,632 ha (81%)
- Sanitation area : 826 ha (18.5%)

The area development can be summarized as follows :

Table M.6.2 Sewerage / Sanitation Development of Master Plan (Area)

(ha)

Stage	First Stage	Second Stage	Third Stage
Sewerage	848 (23.3%)	2,299 (63.2%) (+ 1,451)	3,632 (100%) (+ 1,333)
Sanitation	3,610	2,159	826
Total	4,458	4,458	4,458

note : Figures in parenthesis are the additional areas.

Table M.6.3 Sewerage Development of Master Plan (Population)

Stage	First Stage	Second Stage	Third Stage
Sewerage	37.6%	81.8%	100%

After completion of First Stage 23.3% of the planned area of 3,632 ha will enjoy the sewerage service, and after completion of Second Stage the figure will increase to 63.2% (see Table M.6.2). The high-priority area is a densely populated area. Accounting the beneficiary population, 37.6% of the population planned to be sewered will enjoy the sewerage service, and after completion of Second Stage the figure will in crease to 81.8% (see Table M.6.3).

The Study Team estimated the development of sewerage/sanitation levels by the population in Table M.6.4.

Table M.6.4 Sewerage/Sanitation Served Population

	Present (1997)	First Stage (2003)	Second Stage (2009)	Third Stage (2016)
Sewerage	0	166,339	354,147	476,612
Sanitation	188,700	120,134	23,141	10,787
Total	188,700	286,473	377,288	487,399

6.2.5 Target of Drainage

Khan Yunis is situated in arid area, and the flooding appears to be not necessarily so serious as in other areas, However a low precipitation is concentrated only in winter period of four months.

If the common methodology is applied to calculate the drainage facilities, a huge investment would be required, though the facilities would be used only in winter period. The cost performance is very bad. Therefore the Study Team has identified the most sensitive area prone to flooding for the First Stage. The area is 350 ha, which will be installed with inexpensive facilities to deal with occasional floodings. A drainage simulation will be developed to identify the minimum facilities sequined for Second Stage as shown in Table M.6.5. The areas to be simulated on dynamic model will be about 1,000 ha.

Table M.6.5 Drainage Development of Master Plan (Area)

(ha)

Stage	First Stage	Second Stage	Third Stage
Required Area	350 (23.2%)	848 (56.2%) (+ 498)	1,509 (100%) (+ 661)
Other Area	4,108	3,610	2,949
Total	4,458	4,458	4,458

Note: Figures in parenthesis are the additional areas.

The present status of sanitation is shown in Figure M.6.1. Since there is no sewerage system in Khan Yunis area, all the on-site systems, cess pits or leaching pits, are dependent upon occasional desludging as required. At present all the sludges emptied from cess pits and others are dumped near the refugee camp. The sludge dumping site is only about 200 m from the nearest residential area. This is only a temporary site, where all the wastewaters are penetrating into ground to contaminate the groundwater. After the First Stage is constructed, this sludge dumping site will be eliminated as shown in Figure M.6.2. The sludges emptied from on-site systems will be discharged into the sewerage system through a pumping station or treatment plant. After completion of Second Stage there will be more sludge discharging points, as shown in Figure M.6.3. Finally after completion of the Master Plan systems only a minor population will be dependent upon sanitation service, as shown in Figure M.6.4.

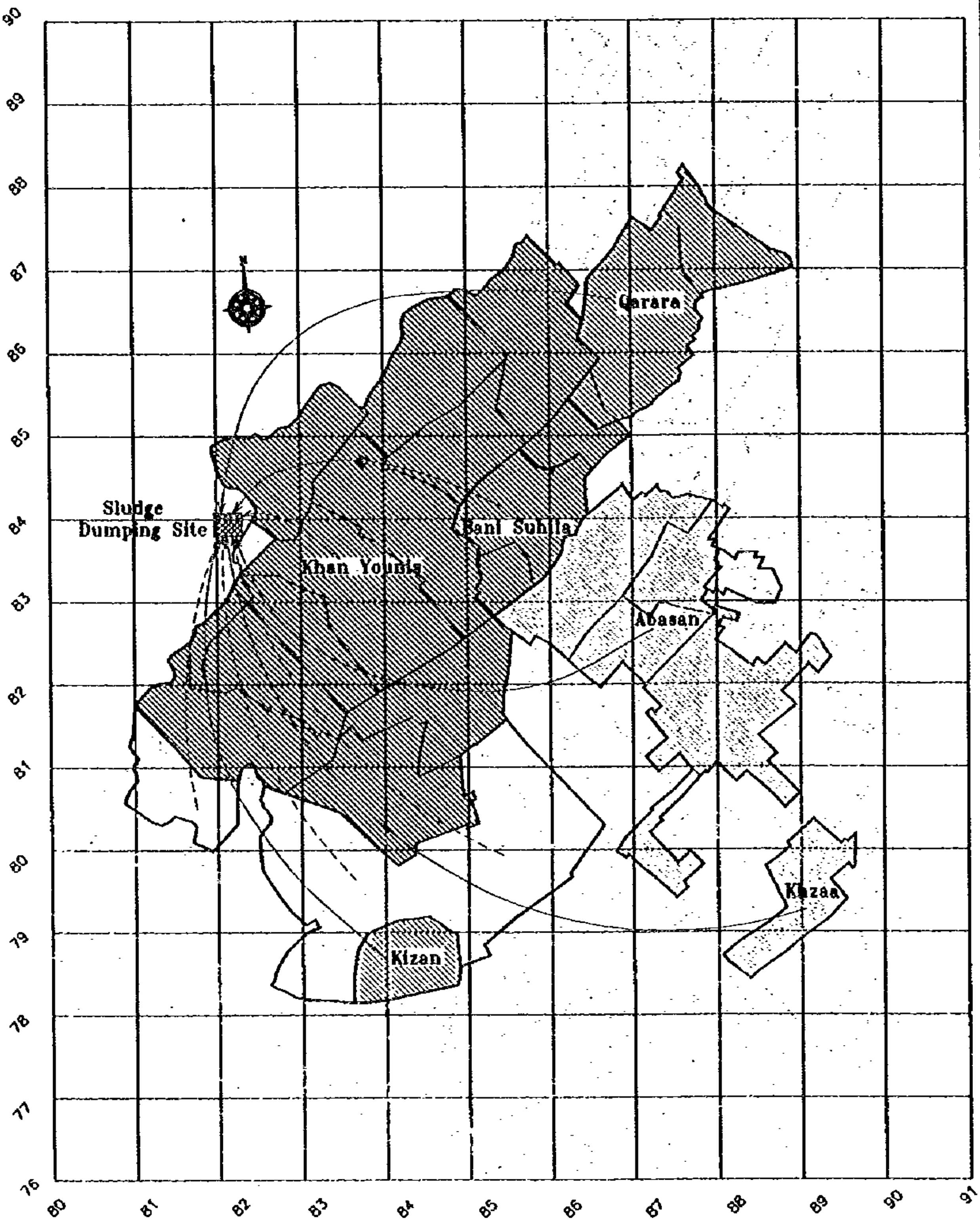

FIG. M.6.1	PRESENT STATUS OF SANITATION

THE STUDY ON SEWERAGE DEVELOPMENT PLAN IN THE AREA OF KHAN YUNIS
IN PALESTINIAN INTERIM SELF-GOVERNMENT AUTHORITY

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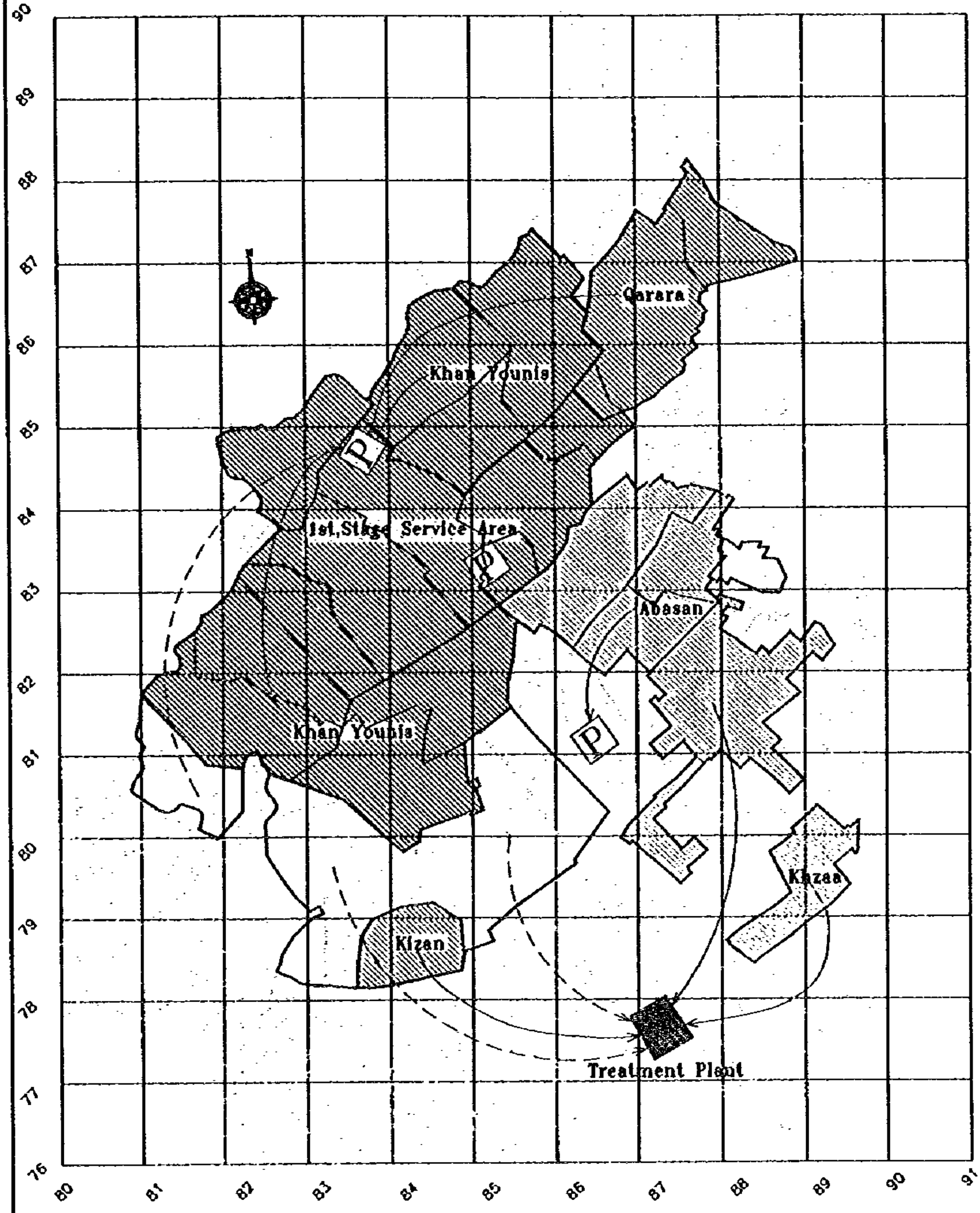

FIG. M.6.2	SANITATION CONDITION OF 1ST SATEGE COMPLETION

THE STUDY ON SEWERAGE DEVELOPMENT PLAN IN THE AREA OF KHAN YUNIS
IN PALESTINIAN INTERIM SELF-GOVERNMENT AUTHORITY

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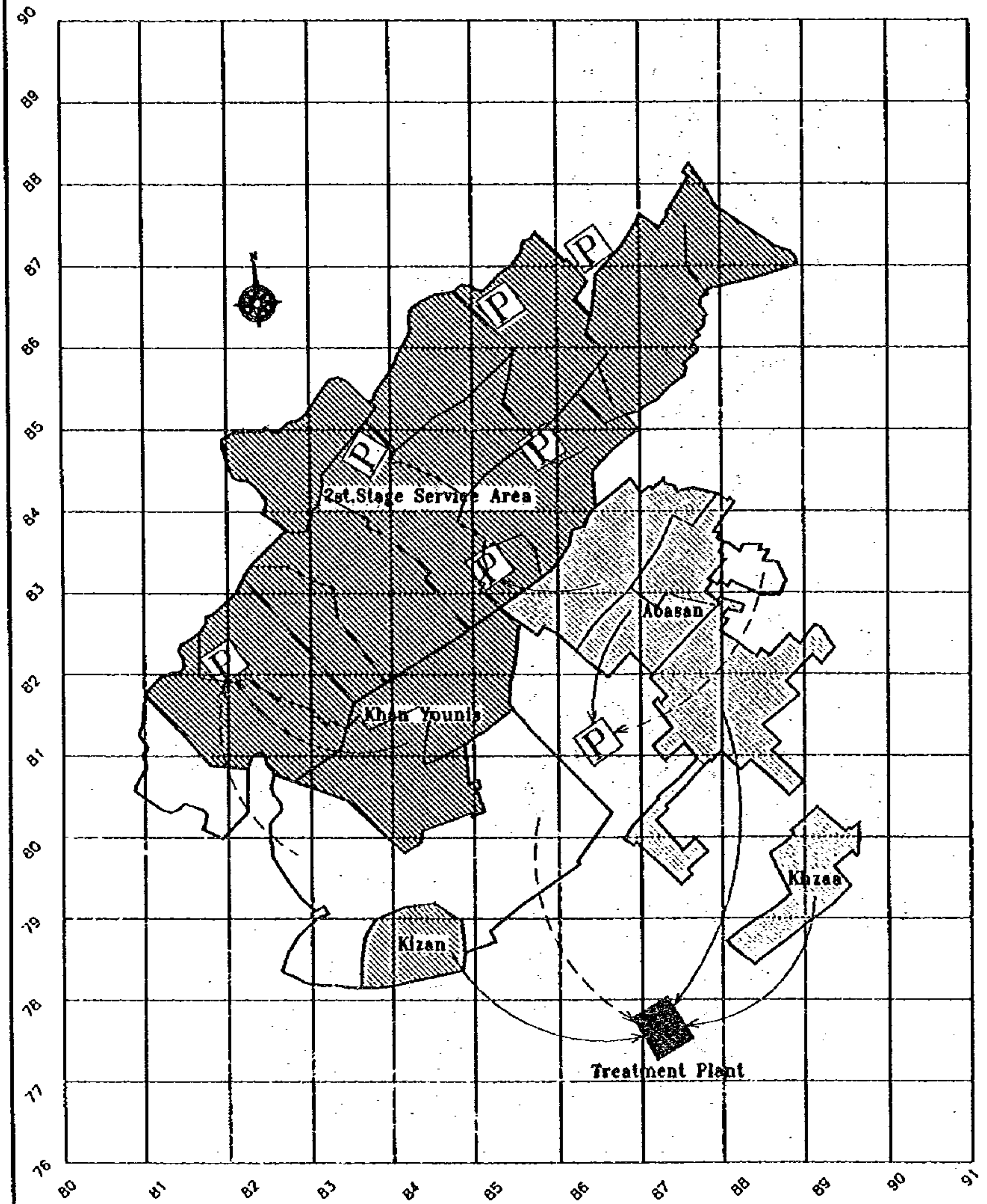

FIG M.6.3	Sanitation Condition of 2nd Stage Completion

THE STUDY ON SEWERAGE DEVELOPMENT PLAN IN THE AREA OF KHAN YUNIS
IN PALESTINIAN INTERIM SELF-GOVERNMENT AUTHORITY

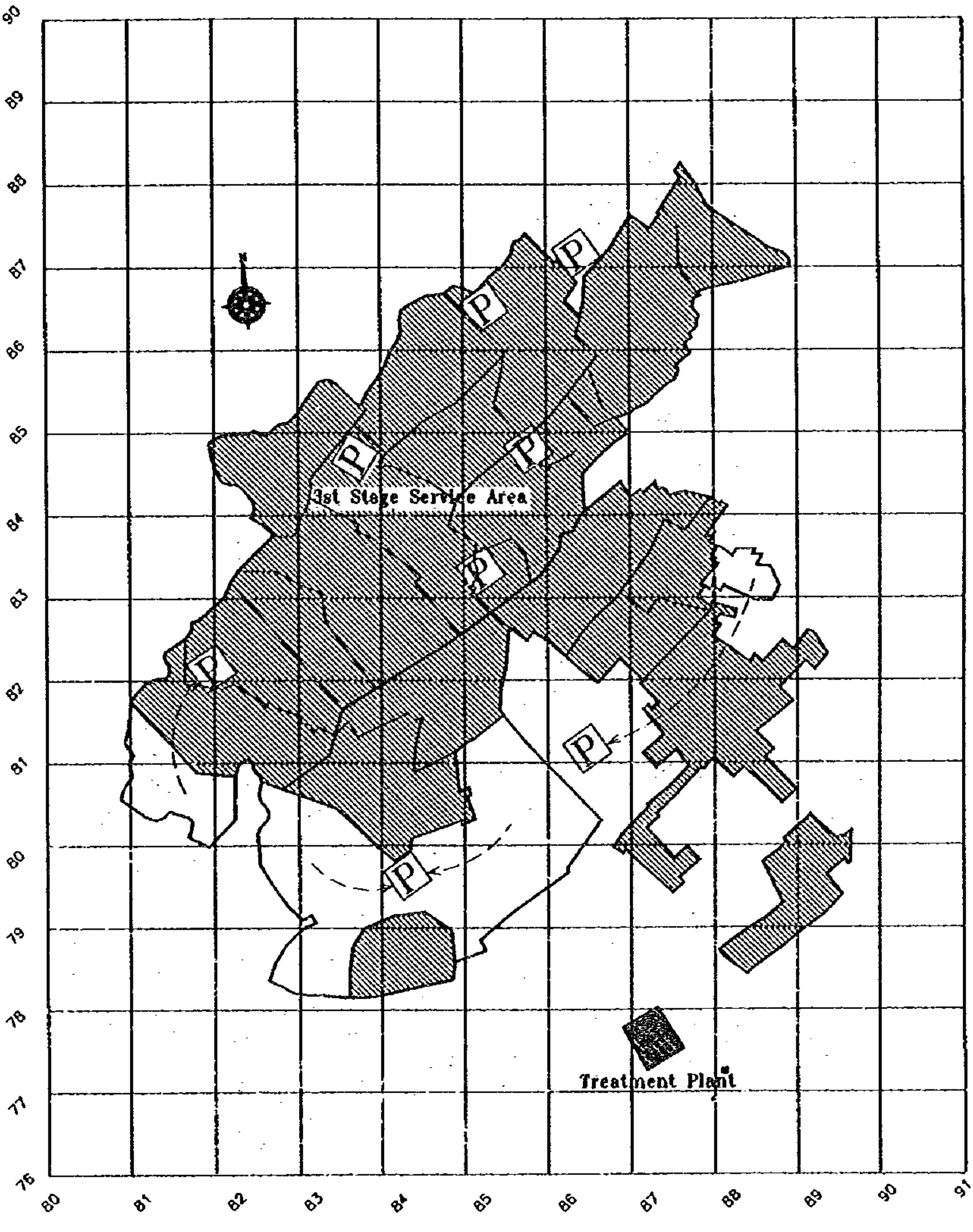

FIG. M.6.4 | SANITATION CONDITION OF 3RD STAGE COMPLETION

THE STUDY ON SEWERAGE DEVELOPMENT PLAN IN THE AREA OF KHAN YUNIS
IN PALESTINIAN INTERIM SELF-GOVERNMENT AUTHORITY

CHAPTER 7 WASTEWATERS

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7.1 Water and Wastewater Survey

7.1.1 Field Survey and Analyses

The quality and quantity of groundwater, wastewater and sanitary sludge were surveyed at the selected representative locations in Khan Yunis Area from October 1st through November 6th, 1996, in cooperation with the Khan Yunis Municipality and Center for Environmental Health Services. The samples were taken at the locations in the refugee camp; business zones; and high-income, middle-income and low-income areas, as illustrated in Figure M.7.1, and the analyses were performed on the wastewater, groundwater and sludge as presented in Table M.7.1 below:

Table M.7.1 Water and Sludge Quality Analysis Items

Wastewater	Ground water	Sludge
Ambient Temperature	Ambient Temperature	Specific Gravity
Sample Temperature	Sample Temperature	Water Content
Ph	pH	Volatic Solids
BOD_5	Total Coliform Group	BOD_5
COD_{cr}	Fecal Coliform Group	COD_{cr}
SS	Chloride (Cl^-)	Total Nitrogen (T-N)
Total Nitrogen (T-N)	Nitrate (NO_3^-)	Total Phosphorus (T-P)
Total Phosphorus (T-P)	Electronic Conductivity	Potassium (K)
Total Coliform Group	Sodium (Na)	Copper (Cu)
Fecal Coliform Group	Calcium (Ca)	Zinc (Zn)
Chloride (Cl^-)	Magnesium (Mg)	Cadmium (Cd)
Sulfate (SO_4^{2-})		Lead (Pb)
Total Dissolved Solids		Iron (Fe)
Electronic Conductivity		Manganese (Mn)
Sodium (Na)		Chromium (Cr)
Calcium (Ca)		Arsenic (As)
Magnesium (Mg)		Total Mercury (Hg)

More details of the field survey results are described in Appendix-L of this report.

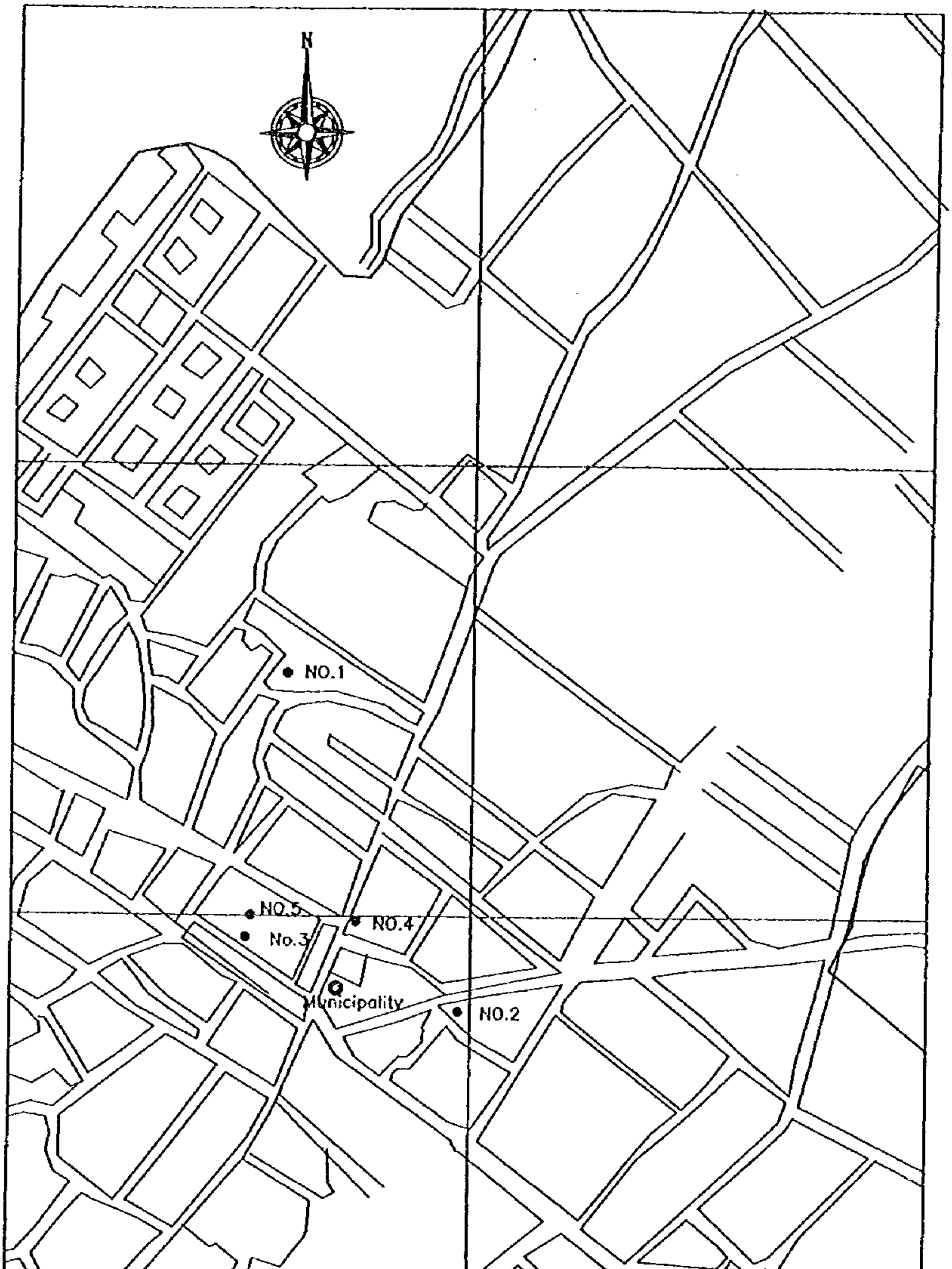


FIG.M.7.1 SKETCH MAP OF SAMPLING LOCATIONS FOR DOMESTIC WASTEWATER

THE STUDY ON SEWERAGE DEVELOPMENT PLAN IN THE AREA OF KHAN YUNIS
IN PALESTINIAN INTERIM SELF-GOVERNMENT AUTHORITY

7.1.2 Domestic Wastewater and Septic Tank Effluent

The results of the field survey revealed that the quantities of domestic wastewater (composed of black water and grey water) ranged from 51 liters per capita per day to 91 liters per capita per day, with an average value of 71 liters per capita per day. The characteristics of domestic wastewater and septic tank effluent at the selected representative locations are summarized in Table M.7.2.

Table M.7.2 Composition of Domestic Wastewater and Septic Tank Effluent

Parameter	Domestic Wastewater (Average Value)	Septic Tank Effluent (Average Value)
BOD (mg/l)	279	274
COD_{cr} (mg/l)	580	548
PH	7.6	7.0
SS (mg/l)	566	1499
T-N (mg/l)	111.0	157.5
T-P (mg/l)	20.6	24.2
TDS (mg/l)	2792	2609
Cl^- (mg/l)	1042	1048
SO_4^{2-} (mg/l)	303	161

Note: Results of Field Survey by JICA Study Team 1996.

The results of wastewater quality analyses are summarized as follows:

(1) The average BOD and COD concentrations of domestic wastewater were 279 mg/l and 580 mg/l, respectively, indicating relatively low values compared with those in Gaza, Rafa and Jabalia. The differences can be explained for the following three reasons:

i) Difference in the sampling conditions. The samples contained large size suspended solids, and that much of the suspended solids were removed before they were analyzed for BOD and COD. This means that the obtained values of BOD and COD presented only those of the dissolved BOD and COD concentrations,

ii) Difference in the sampling seasons. In the Gaza Region, BOD and COD concentrations of the wastewater during winter months are in general lower than those during the summer months. The results of the wastewater quality analyses at the existing wastewater treatment plants at Rafa and Gaza also support this, and

iii) Difference in sampling time. The survey was undertaken in relatively short period, consequently, these values may need to be adjusted for the purpose of the wastewater system planning.

(2) The variations of BOD, COD and wastewater production followed the living patterns of the selected families. A peak wastewater flow in each family occurred in the morning at around 5:00 to 7:00, with a simultaneous peak waste load concentration. Another obvious peak flow occurred in the evening at around 20:00 to 23:00.

(3) The variations of T-N and T-P were similar to the variation patterns of BOD and COD. The ratio of BOD: N: P was approximately 1:0.4: 0.08. From nutrient balance viewpoint, T-N and T-P contents seem to be somewhat higher than those of BOD.

(4) The average chloride (Cl^-) concentration was 1,042 mg/l. It appears to be slightly higher than those surveyed in Rafa and Gaza with the average chloride (Cl^-) concentrations of 726 mg/l and 651 mg/l, respectively.

(5) No apparent differences in the characteristics were observed between the domestic wastewaters and septic tank effluents except for sulfate (SO_4^{2-}) concentrations.

7.1.3 Existing Wastewater Treatment Plants

Table M.7.3 shows the surveyed influent and effluent wastewater qualities of the existing treatment plants at Rafa and Gaza. As can be seen from the table, BOD and COD concentrations were relatively low compared with the data by other organizations during summer season (BOD, 500-800 mg/l; COD, 900-1,600 mg/l). It was observed, however, that the BOD and COD removal rates surveyed at the Rafa Treatment Plant were 25% and 31%, and those at the Gaza Treatment Plant were 27% and 21%, respectively.

Table M.7.3 Treatment Capability of Existing Wastewater Treatment Plants

Parameter	Rafa WWTP		Gaza WWTP	
	Influent (Average)	Effluent (Average)	Influent (Average)	Effluent (Average)
BOD (mg/l)	279	210	326	239
COD_{cr} (mg/l)	362	251	501	398
PH	7.2	7.2	7.3	7.5
SS (mg/l)	397	580	607	192
T-N (mg/l)	71.6	74.0	72.2	61.0
T-P (mg/l)	7.4	6.5	8.0	7.7
TDS (mg/l)	1653	1555	2000	2155
Cl^- (mg/l)	726	693	651	632
SO_4^{2-} (mg/l)	175	98	182	81

Note: Results of Field Survey by JICA Study Team n1996.

7.1.4 Ground Water

In addition to the survey of domestic and treatment plant wastewaters, ground water qualities were measured. The survey results indicated that the average chloride (Cl^-) and nitrate (NO_3^-) concentrations were 981 mg/l and 309 mg/l, respectively, showing that both of chloride and nitrate concentrations were still high. The fact explains the reason why the chloride (Cl^-) concentrations of the wastewater in Khan Yunis area are higher than those in Gaza and Rafa.

7.1.5 Per Capita Organic Waste Loading

Based on the wastewater survey results, the per capita BOD loads were estimated to be in the range of 14 to 32 g BOD/capita/day, with an average of 20 g BOD/capita/day, as shown in Table M.7.4. Other per capita waste loads at each location are also summarized in the same table.

Table M.7.4 Per Capita Waste Loads in Khan Yunis City

Location	Unit Waste Load (g /capita/day)				
	BOD	COD_{cr}	SS	T-N	T-P
No.1 (Refugee Camp)	18	38	38	4.6	1.8
No.2 (Middle-income Area)	19	38	31	8.0	1.9
No.3 (Low-income Area)	17	26	55	6.2	1.1
No.4 (High-income Area)	32	80	67	17.2	2.8
No.5 (Low-income Area)	14	30	16	5.4	0.3
Average	20	43	41	8.3	1.6

Note: Results of Field Survey by JICA Study Team 1996.

7.1.6 Sludge

The wastewater sludge collected from the Rafa and Gaza sewage treatment plants were sampled and analyzed. As shown in Appendix L in Volume III "Supporting Report", the sludge from the both treatment plants contained no abnormal values of heavy metals.

7.1.7 Industrial Wastewater

The industrial wastewater contribution to the sewage flow obviously depends on the size and activities of the industries. Table M.7.5 shows a summary of industrial activities in Khan Yunis City. These industrial activities are small in scale using small amount of process water. It was observed that no wastewater was generated from clothing manufacturers as well as woodwork factories during production process.

The quantities of wastewater generated from food and beverage factories as well as metal processing factories are estimated to be in the range of 0.5 m^3 to 10 m^3 per day. In fact, the wastewaters generated from these factories were firstly collected into septic tanks and then discharged into the ground without any treatment. Since no information were readily available with regard to the industrial wastewater qualities, it is considered necessary to sample and analyze during the feasibility study stage the industrial wastewater characteristics from the existing industries.

Table M.7.5 Types of Industry in Khan Yunis City

Type	Number of factories	Workers	Percentage of workers (%)
Food	3	60	5.1
Cloth	54	800	67.4
Woodwork	42	180	15.2
Base Metal, Metalwork	36	120	10.1
Chemical Factory	1	26	2.2
Total	136	1,186	100.0

Source: Khan Yunis Municipality

7.2 Projection of Wastewater Quantities

7.2.1 Daily Average Wastewater Flow

As discussed in the foregoing Sections, neither large scale water-consuming industries nor commercial developments exist in Khan Yunis and its surrounding areas, majority of the water consumption being domestic uses.

An average per capita sewage flow rate could be estimated based on the water consumed by inhabitants, restaurants and other commercial activities: however, no conclusive data showing the actual wastewater flow rates exist. Because of the deficiency and mal-functioning of water meters, water leakage, and illegal connections to the City water system, the total unaccounted-for water ratio was assumed to be 50 percent or higher according to the information of the Municipality.

With respect to the water consumption rates in the future, Khan Yunis City initially estimated that it would increase to 120 lpcd by the year 2025. However, this estimation was later revised to 140 lpcd in view of the expected rapid development of the Area in the near future and the accompanying increase of the water demands. The estimated total water demands in Khan Yunis Water Supply System are summarized in the following table:

Table M.7.6 Projected Water Demand for Khan Yunis Water Supply System

Year	Water Demands (m^3/day)
1995	14,760
2000	20,160
2005	25,680
2010	30,480
2015	36,000
2020	42,720
2025	50,640

Source: "Khan Yunis, Rehabilitation and Upgrading of the Water Supply and Distribution System," January 1996, Center for Engineering and Planning, pp.25 Table 3.3.

Although no reliable data are available at present as to the accurate estimation of the wastewater generation in the Area, it is assumed that the rate of wastewater productions to water consumptions is generally at around 80 percent, from the experience obtained elsewhere in the sewerage plans in the Gaza Region and other locations under similar conditions.

The water consumption rates projected for municipalities and villages in the Region by Netherlands group shows that the average water consumption rates projected for the municipalities in the Gaza Governorates, Khan Yunis City's in 2000 and 2010 are 125 lpcd and 135 lpcd, respectively, assuming that the expected improved services will result in higher per capita consumption rates. These estimations show close agreement to those estimated in the Khan Yunis Water Supply Rehabilitation Project.

The average daily per capita sewage flow rate in 2015 for Khan Yunis City and its surrounding villages is then projected assuming that 80 percent of the consumed water will become the wastewater. Thus, the daily average wastewater production was estimated to be:

$$140 \text{ lpcd} \times 80\,\% = 112 \text{ lpcd}$$

The water consumption rate in Khan Yunis in 1995 is estimated to be 14,760/123,000 = 120 lpcd, and hence, the per capita sewage flow rate is obtained to be 96 lpcd. The per capita sewage flow rates are expected to increase at the rate of water consumption increase.

The wastewater production survey conducted at the representative families (Refer to Appendix-L, "Water Quality Survey in Khan Yunis") showed that per capita waste-water generations ranged between 65 and 51 liters, whereas the unit water consumption rates were 90 and 77 liters, respectively. These indicate that the present ratios of the wastewater generation to water consumption were at around 70 percent.

From the above studies and the water survey under the Project, together with data obtained from other similar cities and villages in the Gaza Region, the average daily per capita sewage flow rate of 112 lpcd appears to be reasonable for the conditions in 2015 . For the sewerage system master planning, it is assumed that the present sewage flow rate of 90 lpcd will increase gradually and reach at the level of 112 lpcd.

7.2.2 Peak Wastewater Flow

The peak wastewater flow is estimated on the basis of peak water supply rate as applied for the Khan Yunis Water Supply System Plan. The field investigation conducted at the selected representative zones in the Area also revealed that the ratio of the hourly maximum sewage flow to the daily average sewage flow was about 3.3. In the sewer-age system serving more population than those in the investigated site, the ratio or peak factor will be lower than this value. Hence, the factor of 2.5 (as applied for the water supply system) can be used for the sewerage system planning and design.

The daily average and peak sewage flow rates projected for every five years up to 2015 are shown in the following table:

Table M.7.7 Projected Per Capita Sewage Flows (lpcd)

Year	Daily average flow rate	Peak flow rate
1996	90	225
2000	94.6	236.6
2005	100.4	251.1
2010	106.2	265.5
2015	112	280

Note: Daily average x 2.5 = Peak flow

7.2.3 Infiltration

Ground water elevations in the Area are generally low, except in some low-lying areas. Because the Area is semi-arid zone having low precipitations, ground water infiltration to the sewers seems to be not significant. Only during rainy seasons, storm runoff water infiltrates into the ground and possibly into sewer pipes through loose joints or manholes.

Although the groundwater infiltration data have not be obtained in Khan Yunis City and other parts of the Gaza Region, data in other areas under similar conditions may be instructive for the planning.

In El-Arish City, Sinai, Egypt, about 30 km south of Khan Yunis, the total amount of the ground water infiltration to sewer pipes at the coastal low-lying area was estimated to be 71 m^3/day/km of pipe, having about 2 percent of the daily average sewage flow rate. Other Egyptian cities, such as Port Said, Ismailia, Suez, Helwan, and Alexandria, with daily average flows rates of about 150 lpcd, the estimated infiltration rates range from 8 to 12 m^3/ha/day, which account for 5 to 10 percent of the daily average flow rates.

Because at present no sewerage system exists in Khan Yunis, no accurate groundwater infiltration data can be obtained, those representing conditions similar to Khan Yunis could be reasonably applied. In view of this, 5 percent of the daily average sewage flow rate may be applied for the sewer planning in addition to the design wastewater flow rates where justified necessary.

7.2.4 Industrial Wastewater

As discussed in the previous sections there exists no large scale water-consuming industries producing toxic and hazardous waste materials. According to the new land use plan developed by the MOPIC, the originally proposed industrial zone in Qarrara and Khan Yunis is now planned to be shifted to a newly designated industrial area in the south of Kizan area. Hence, no additional industrial wastewaters need to be considered in the sewerage planning. If in the future any particular type of water consuming industries were established within the sewerage planning area, such industries will be required to treat the wastewaters by themselves to the level acceptable to the public sewerage system.

7.3 Wastewater Quality

7.3.1 Present Daily Per Capita BOD and Other Loads

To estimate the wastewater qualities for both present and future conditions, the results of the wastewater survey were analyzed, as described in Appendix-L, "Water Quality and Quality Survey."

Per capita BOD and other pollutant loads estimated based on the field survey results are as follows:

Items	:	Per capita loads	Concentration
BOD_5	:	30 g	500 mg/l
COD_{cr}	:	60 g	1,000 mg/l
SS	:	42 g	700 mg/l
T-N	:	7.5 g	125 mg/l
T-P	:	1.5 g	25 mg/l

BOD : N : P = 1: 0.25 : 0.05

As can be seen from Table M.7.4, the average per capita BOD_5 sampled from the selected five different families was 20 g, which appears to be rather low side compared with data in other cities and villages under similar conditions. This can be explained for the reasons as mentioned in the item (1) of Section 7.1.2.

In view of these, it is prudent to consider that the average daily per capita BOD_5 of 20g was contributed with only the soluble BOD, and that the additional 10g BOD_5 considered to be contributed with solids should be included to project the total daily per capita BOD_5. Thus, the present daily average per capita BOD_5 load was estimated at 30 g.

7.3.2 Future Per Capita Daily BOD Loads

In estimating the future per capita BOD_5 loads, some assumptions were made by comparing data of other cities in similar nature. Per capita BOD_5 contributions by various studies are as follows:

(1)	South East Asia	43 g	(Duncan Mara)
(2)	India	30 - 45 g	(Duncan Mara)
(3)	Rural France	24 - 34 g	(Duncan Mara)
(4)	UK	50 - 59 g	(Duncan Mara)
(5)	US	45 -100g	(Ministry of Construction, Japan)
(6)	Germany	54 g	(K. Imhoff)
(7)	Japan	57 g	(Ministry of Construction)

The breakdowns of BOD_5 (Duncan Mara) loads are as follows:

Water Use	USA	Warm/Tropical Area
Personal washing	9	5
Dish washing	6	8
Garbage disposal	31	-
Laundry	9	5
Toilet faeces	11	11
urine	10	10
paper	2	1
Total (average adult)	78	40

The above assumption suggests that the present average per capita BOD_5 load of 45 gpcd appears to be reasonable, and this may increase annually at a rate of 0.5g, reaching at the level of 55 g by the year 2015. The daily average per capita sewage flow rate in the year 2015 is estimated to be 112 lpcd, therefore, the BOD concentration of the sewage is projected to be:

$$55 \text{ gpcd} \times 10^3/112 \text{ liters} = 500 \text{ mg/l}$$

In the same manner, per capita and concentrations of other waste loads are projected as follows:

Table M.7.8 Projected Waste Loads (2015)

	Items	Daily per capita loads (g)	Concentration in wastewater (mg/l)
1)	BOD	55	500
2)	SS	70	620
3)	COD	100	900
4)	T-N	14	130
5)	T-P	3	30

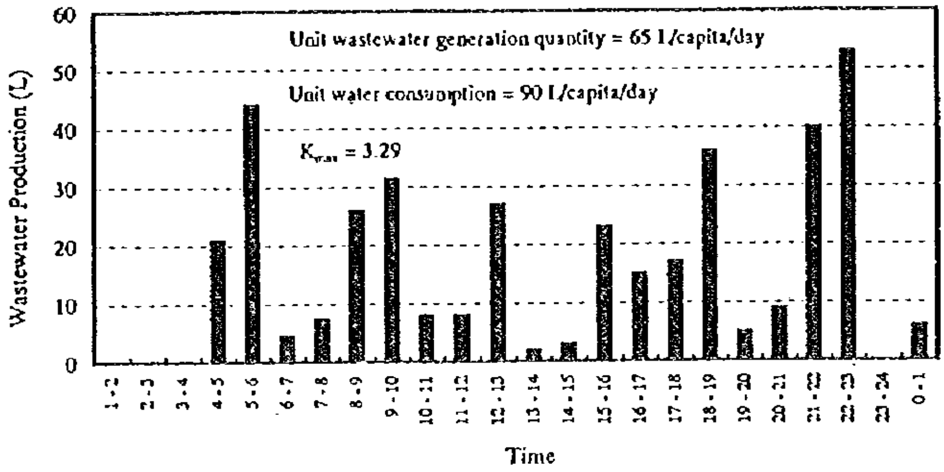


Fig. M.7.2 Daily Variations of Wastewater Production at Location No. 3

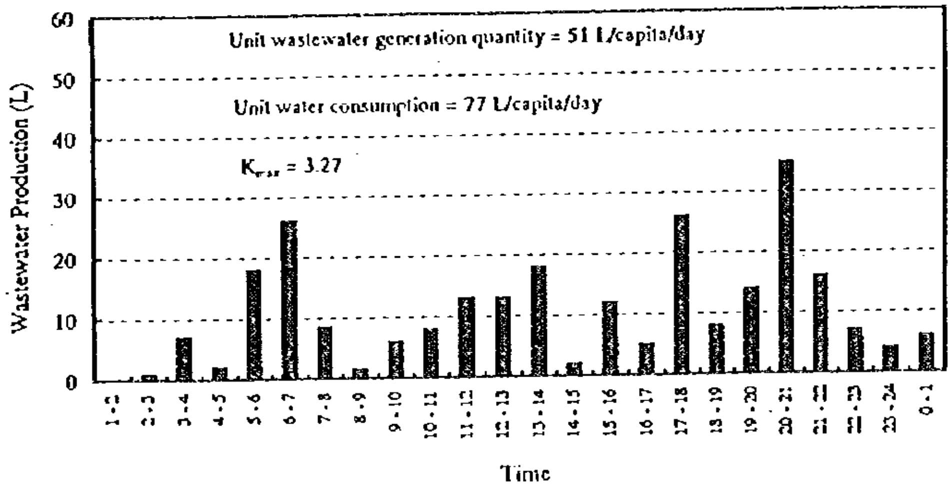


Fig. M.7.3 Daily Variations of Wastewater Production at Location No. 5

CHAPTER 8 STORMWATER QUANTITY

CHAPTER 8 STORMWATER QUANTITY

8.1 Rainfall Intensity

8.1.1 Rainfall Characteristics in the Area

Sufficient rainfall data in the Khan Yunis Area are lacking to develop stormwater drainage planning criteria. In the Meteorological Station in Gaza, such basic data as daily precipitation, humidity, air temperature, and wind direction and velocity are available for over 20 years, as shown in tables in Section 2.1 "Natural Conditions."

The available rainfall data are those for daily, monthly and yearly precipitation, but no rainfall data of short duration such as 10-minute and 30-minute intensities have been observed so far. For the drainage plan in the Gaza Region, rainfall intensity-duration curves and formulae developed for the different frequencies in Dorot Meteoro-logical Station in Israel have been widely used. In view of these, for the drainage planning under this project these curves will in principle be used. Since the precipitation of Khan Yunis is less than that of Tel Aviv, the use of Israeli data is considered to be safe side.

8.1.2 Rainfall Intensity-Duration Relationships

The rainfall intensity-duration relationships for the different frequencies of recurrence are shown in Figure M.8.1 and summarized as follows:

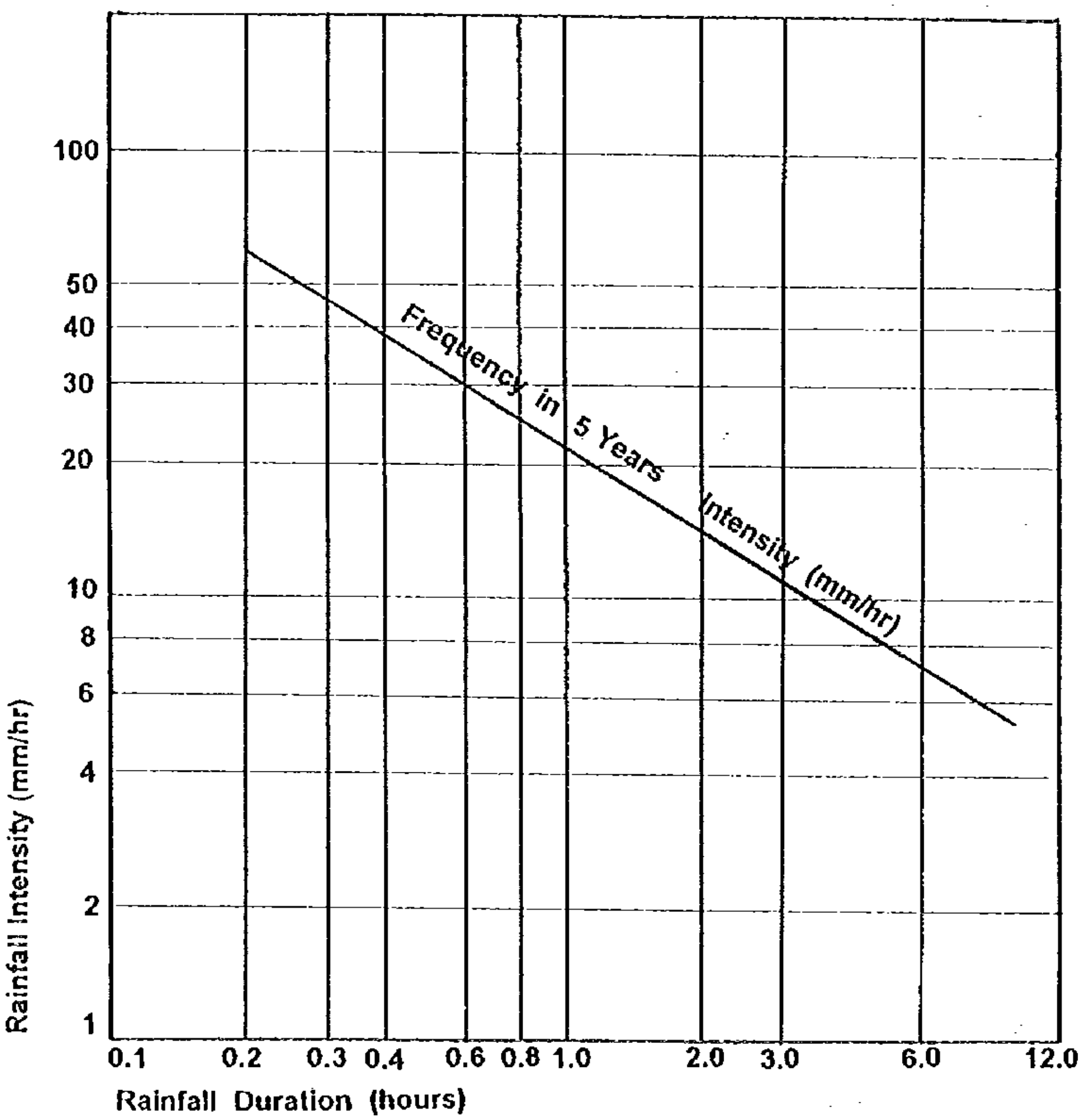
Frequencies of Recurrence (Once in years)	Intensities (mm/hr)
2	15
5	22
20	33

8.2 Runoff Quantity

8.2.1 Runoff Formula

For the master planning purpose, the rainfall discharge is to be calculated with the Rational Method as applicable. This takes the following form:

$$Q = 1/360\ CIA$$



Source: Dorot Meteorological Station

FIG.M.8.1	RAINFALL INTENSITY-DURATION CURVE

THE STUDY ON SEWERAGE DEVELOPMENT PLAN IN THE AREA OF KHAN YUNIS
IN PALESTINIAN INTERIM SELF-GOVERNMENT AUTHORITY

AD 1997

where

Q = peak discharge of the watershed above the point in question due to the maximum storm assumed (m^3 /sec)

C = runoff coefficient, which is the ratio of the runoff amount to the respective rainfall (-)

I = rainfall intensity based upon time concentration (mm)

A = area of the watershed (ha)

8.2.2 Rainfall Frequency for Planning

The average frequency of rainfall occurrence to be used for design determines the degree of protection afforded by a given storm drainage system. The rainfall characteristics and ground surface conditions peculiar to the Khan Yunis Area are as follows:

i) low rainfall precipitation,
ii) low rainfall intensity, and
iii) high permeability of soil.

Because of these conditions, there have been no severe large scale flood damage area except in certain low-lying districts. The rainwater runoffs in urban areas generally find their ways to disappear on the roads, or either evaporate or infiltrate into ground, and the remaining runoffs flow down toward the lower areas to a lesser degree.

In the central market of Khan Yunis City, stormwater runoffs overrun on main streets and stagnates occasionally for over several hours, reaching as deep as 2 meter at certain locations only during the winter period. This area is an important commercial centers in the City and that the flood damage is significant. According to Khan Yunis Municipality, such rain water shall be drained at least within one hour to maintain such normal urban activities, but the existing pump capacity is not capable of immediately pumping such inflowing water.

Which frequency of recurrence of storm to adopt in the master plan is basically to be determined by economic considerations. Practice is generally to plan storm drains on storm intensities expected as once every year or two years, although the basis of once every five years have been applied in many cases without much inconvenience. The inundation have occurred frequently in the central commercial zones, where markets, small shops, restaurants, and other various other commercial houses are located, thus causing significant damage to the commercial activities. In view of these, the frequency of five years is used for the drainage system planning.

8.2.3 Runoff Coefficients

Runoff coefficients are determined by taking into account the soil conditions, soil permeability and ground surface type. For each drainage district, a composite runoff coefficient are developed based on the percentage of the different type of surface in the drainage district. For the calculation, all the drainage areas have been classified into four different types of surface as shown below:

Table M.8.1 Basic Runoff Coefficients by Surface Type

Surface Type	Coefficient	Remarks
Roofs	0.85	Mainly flat roofs
Pavement	0.80	Sandy
Unpaved road	0.10	Mostly sandy soil
Open land	0.10	Mostly sandy soil

8.2.4 Time of Concentration

Time of concentration consists of the inlet time plus the time of flow in the drain from the most remote inlet to the point under consideration. Inlet time of 10 minutes are used for drainage plan. Values of time of concentration generally used in stormwater drainage design are shown in the following table:

Table M.8.2 Time of Concentrations (in minutes)

	Generally used in Japan	ASCE Standards
High population density area	5	-
Low population density area	10	-
Trunk drains	5	-
Branch and laterals	7 - 10	-
Average in Japan	7	-
All paved, densely populated completely sewered area	-	5
Relatively flat developing area	-	10 - 15
Average housing area	-	20 - 30

Source: Guideline for sewerage planning, Japan Sewage Works Association.

8.3 Unit Hydrographs

8.3.1 General

The unit hydrograph principle is widely used in flood estimation and prediction. It has what is sometimes a decided advantage over statistical and other methods of flood estimation, in that it gives the complete flood hydrograph, not just the peak value; which means it can be used wherever storage is involved. For example, in routing foods through reservoirs or through the lower reaches of drain where there may be the possibility of over-topping the flood control reservoirs.

The unit hydrograph method of assessment is most reliable when based on measurements of rainfall and streamflow, but it can be usefully employed where streams are too small to warrant measurement and where few rainfall observations, if any, have been made in the locality.

8.3.2 Retention Basin

A retention basin may be defined as a basin or impoundment within the stormwater drainage system, having a controlled or uncontrolled outlet, wherein water is stored for a relatively brief period of time, until the system can safely carry the ordinary flow plus the released water. The basic relationship expressing the functioning of a stormwater retention basin is:

$$V = \int_0^{t_1} (q_1 - q_0)dt$$

where

V = required capacity of basin (m^3)

t_1 = the time from commencement of storage until water surface elevation goes down (second)

q_1 = inflow rate to basin (m^3/sec)

q_0 = outflow rate from basin (m^3/sec)

In the above equation, q_1 is a function of the time which may be expressed by a hydrograph, developed by using the rainfall equation for a selected rainfall frequency. The relationship between rainfall duration and corresponding rainfall intensity may be illustrated as shown in Figure M.8.2.

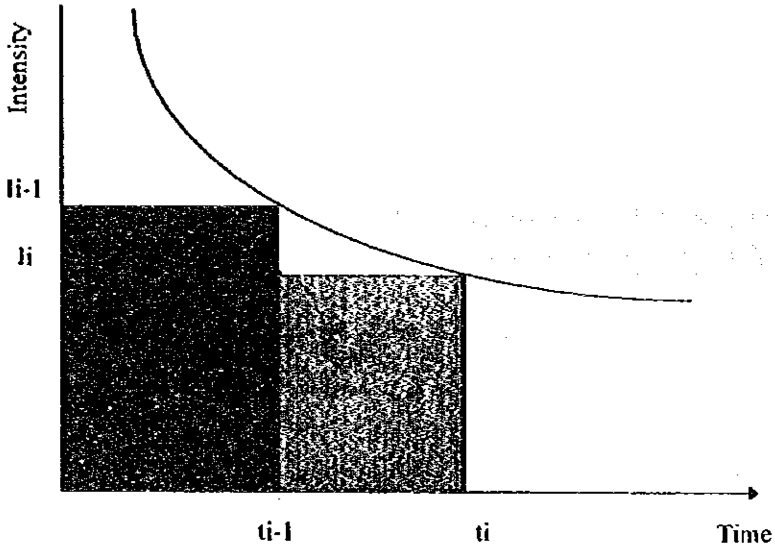


Figure M.8.2 Hydrograph of Runoff

Storage or impoundment will be governed by the characteristics of the outlet structure, usually a conduit through the pond at the bottom of the basin or pumping system through which normal discharge from the drainage area is discharged without impoundment. For this master plan study, it was assumed that the outflow is kept constant by a pump station, then the outflow rate can be expressed:

$$q_0 = CI_0A \quad \text{or} \quad I_0 = q_0/CA$$

Then, the previous equation may be rewritten:

$$V = \int_0^{t1} (CI_iA - CI_0A)dt$$

$$= CA\int_{t0}^{t1} (I_i - I_0)dt$$

While I_i and I_0 are constant, the above equation becomes;

$$V = CA(I_i - I_0)ti$$

In the above equation I_i corresponds to the time ti, therefore, even for a single rainfall, substantial numbers of the rectangular hydrographs could be developed. For this reason, the capacity of the basin should be determined on the basis of the value of ti which gives the maximum rate of retention. The above equation is proposed to determine the necessary capacity of retention basins to be used where the topographic conditions is suitable.

CHAPTER 9 BASIC CONSIDERATIONS FOR SYSTEM PLANNING

CHAPTER 9 BASIC CONSIDERATIONS FOR SYSTEM PLANNING

9.1 Division of the Area for Sewerage/Sanitation Planning

In dividing the study area into several sewerage/sanitation districts for master planning purpose, such basic elements as land use pattern, population distribution, administrative boundaries and developmental trends have been envisaged. Based on the land use maps developed for 2015 as discussed in Section 3.2.3, the land use patterns for the system planning were further elaborated to appropriately divide the area into sewerage/sanitation districts.

The whole study area is divided into seven independent sewerage/sanitation districts mainly following the present and future administrative boundaries as shown in the following table and illustrated in Figure M.9.1.

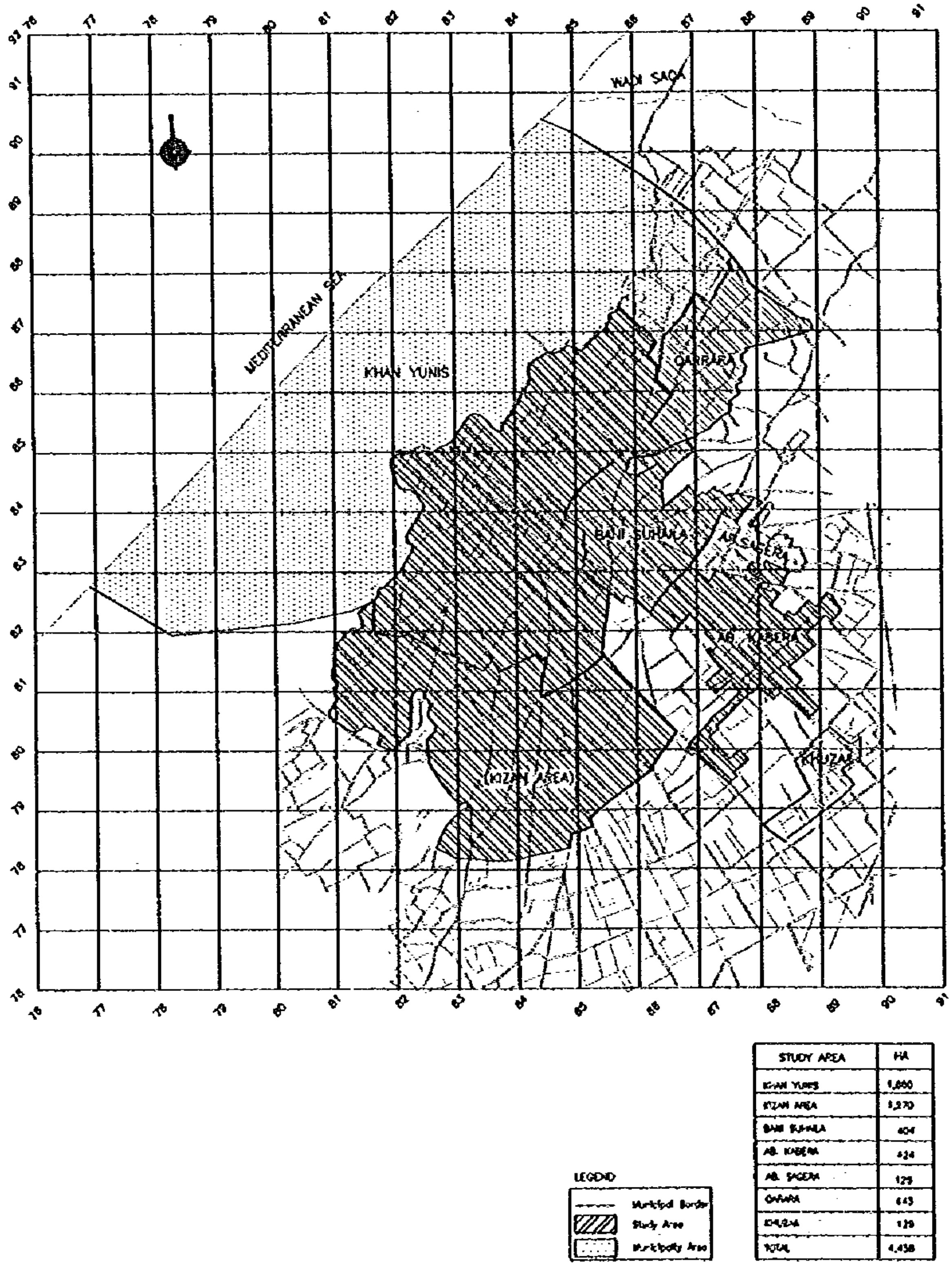
Table M.9.1 Sewerage/Sanitation Districts

District Name	Municipality/Villages Comprised	Area (ha)
(1) Khan Yunis	Khan Yunis	1,660
(2) Kizan	Kizan Abu Humar, Kizan Al Najar, Ka'a Al Goran, Wadi Saber	1,270
(3) Bani Sohaila	Bani Sohaila	404
(4) Qarrara	Qarrara	443
(5) Abassan Saghera	Abassan Saghera	128
(6) Abassan Kabera	Abassan Kabera	424
(7) Khuzaa	Khuzaa	129
Total		4,458

9.2 Wastewater System Planning

There are two distinctive types of the wastewater management systems; namely, on-site and off-site sanitation systems, the former being those to treat or dispose of the excreta at the site of the source and the latter to transport the excreta and other wastewater from the sources for treatment.

In the Study Area, most of the households have already been served by either septic tanks or cesspits with flush water toilets, the wastes from there have either been leached into ground or, in case of cesspits, periodically desludged with vacuum trucks for disposal.



STUDY AREA	HA
KHAN YUNIS	1,660
KIZAN AREA	1,270
BANI SUHAILA	404
AB. KABERA	424
AB. SAGERA	129
QARARA	643
KHUZAA	129
TOTAL	4,438

FIG. M.9.1 STUDY AREA MAP

THE STUDY ON SEWERAGE DEVELOPMENT PLAN IN THE AREA OF KHAN YUNIS
IN PALESTINIAN INTERIM SELF-GOVERNMENT AUTHORITY

After preliminary screening of various sanitation system options, two most appropriate sanitation alternative systems have been selected for further analysis. The alternatives include:

(1) On-site Sanitation System

Either cesspit, septic tank alone or combination with leaching pit. In the flush toilet system, excreta enters either the cesspit or septic tank and thence flows to the leaching pit or bed. The flow then leaches into soil.

(2) Off-site System

Conventional sewerage system, comprising house connections, public sewers, pumping stations, and sewage treatment works. Also, small-bore sewers comprising household toilet, influent pipe to an interceptor tank, a tank effluent pipe, street laterals and mains, pumping stations as required, and treatment works at the terminal of the conveyance system.

Each of the above alternative wastewater systems is described and evaluated for the selection of a system in the following paragraphs:

9.2.1 On-Site System

Flush toilet or aquaprivies of existing system will be used without modification but only a portion of the existing sewer pipes connecting the toilets to the cesspits. A septic tank is to be installed within the plot in between the flush toilet and the cesspit or leaching bed. During 1 to 3 days retention period, solids settle to the bottom of the tank where they are digested anaerobically. The supernatant will then inflow to the leaching bed or pit.

A septic tank is a watertight tank to which wastes are carried by water flushing down to a short sewer. A septic tank does not dispose of wastes; it helps to separate and digest the solid matter. The liquid effluent flowing out of the tank remains to be disposed of and the sludge accumulating in the tank must be periodically removed.

The effluent from septic tanks is, from the viewpoint of health, as dangerous as raw sewage so is ordinarily discharged to soakaways or leaching fields; it should not be discharged to surface drains or water courses without further treatment. Although septic tanks are most commonly used to treat the sewage from individual house-holds, they can also be used as a communal facility for populations up to about 300.

A two-compartment septic tank is now generally preferred to that with only a single compartment because the concentration of suspended solids in its effluent is considerably lower.

9.2.2 Off-Site System

(1) Small-Bore Sewers

This system requires the provision of interceptor tank to retain settleable solids within households. Removal of settled solids in the interceptor tank allows the effluent to flow by gravity and does not require the self-cleansing velocities necessary in conventional sewers. No large solids being discharged into the small bore sewer system are allowed for reduction of pipe diameters.

Other variances from the conventional sewerage design contribute to substantial savings, including reduced pipe slopes and depths and minimal requirements for manholes and pumping stations under normal conditions.

The interceptor tank will be about 1.5 meters in diameter and 2 meters deep, providing a minimum of 40 liters per capita per year of sludge storage volume, and two days retention period to ensure adequate removal of settleable solids. All interceptor tank effluent pipes may be as small as 50 mm in diameter, but for branch and lateral sewers, the diameters will be from 100 mm and most of the sewer pipe diameters will be smaller than those for the conventional sewerage system. No manholes are necessary for small bore system, either for cleansing out or at junctions of sewers or at changes in grades.

A comparison of the system with the conventional sewerage system indicates that the small bore systems are estimated at roughly 60 percent of the conventional system. The major costs of the conventional sewer systems are the street laterals and manholes. Small bore system is more cost effective than the conventional sewerage system. Under normal conditions, operation and maintenance costs will be lower than the conventional sewers because of the less solids content in the sewage flow thus eliminating to a great extent the necessity of sewer cleansing.

Although the small bore sewer system has many advantages as mentioned above, there is a grave constraint for the adoption of small bore sewer system to the Khan Yunis Area. As observed at many locations in the existing pipe systems or ditches, considerable amount of sand entering the pipes or conduits, and once it rains sand from road surface, footpaths, or lands is washed away and finds its way into the pipes. At many locations, these small size pipes can be completely clogged, thus requiring frequent cleansing of sand if the system is to be properly operated and maintained.

Small bore sewer pipes of 50 mm to 100 mm diameter will no doubt necessitate much more frequent pipe cleansing than conventional system. There will be a great possibility of choking of sewer pipes, making the operation and maintenance costs of this system tremendously higher than other alternatives and requiring more difficult works for the system maintenance.

In considerations of these conditions, small bore sewer system appears to be less advantageous to apply to the Khan Yunis Region than other alternatives.

(2) Conventional Sewerage System

This system is a most reliable modern sewerage system with a long experience in construction, operation and maintenance, and is most widely used throughout the world, but in general most costly among the alternative sanitation systems. The effluent from the system could be reused for various purposes including ground recharge and crop irrigation.

In the area there is a high demand for the reuse of the treated sewage effluent and prevention of further groundwater contamination. The effective reuse of the treated sewage effluent will therefore bring about a high level of benefits even though the construction, operation and maintenance costs may be higher than other alternative systems.

A study by the World Bank indicated that the costs of conventional and small bore sewerage systems planned for about 73 hectares districts serving a population of 39,420 residents are in the ratio of 1.581 to 1.013, or comparable costs for small bore sewers are at roughly 60 percent of the conventional sewers.

The major costs of the conventional sewer system are the street laterals and manholes. Conventional sewers and street laterals are sized to facilitate solids cleansing and are therefore larger than peak flows would require. The submains of conventional sewers are to be designed to accommodate peak flow factors of from 2 to 4. The overall length of pipe between houses and street laterals are somewhat longer in the case of conventional sewerage system than small bore sewers due to inefficiencies of conventional sewerage hook-up as compared to the small bore sewers' shared use of pits and tanks.

Conventional sewer system has many merits: they provide the greatest user convenience of all the waste disposal systems, for they permit the discharge of large amount of water; they do not pose any risks to health when functioning properly; their maintenance is assumed by the municipality, and they generally operate with few service interruptions or emergencies.

Yet sewer systems also have disadvantages; they are, first of all, expensive to construct; they require skilled contractors for the construction, a municipal organization for operation and maintenance, and a substantial amount of flushing water, which adds to the operating costs.

Given the high convenience level of sanitary sewerage, this system of excreta disposal has been the one of the choice almost to the exclusion of other alternatives.

(3) Conclusions

The foregoing discussions have led to the conclusions that the conventional sewerage system is as a whole superior to other alternative plans because its expected various advantages will surely overcome the disadvantages, and is evidently the most appropriate system among the options available particularly in considerations of the long term benefits derived from the system.

The congested areas with a high population density in Khan Yunis City and urbanized areas in other villages should be provided with the conventional sewerage system. However, in the districts where population densities are expected to remain low in the future, an improvement measure of the present sanitary conditions should be considered as a transitional means to the ultimate conventional sewerage system until some time beyond 2015.

9.3 Sewerage System Planning

9.3.1 Planning Concept

The concept for the wastewater collection and final disposal is based on fundamental engineering design criteria. The wastewater is to be collected through separate main, submain, branch and lateral sewers. Initially, sewage treatment facilities will be minimal as appropriate but will be capable of expansion and upgrading, as dictated by the population increase or environmental quality requirements.

The concept for sewage collection and treatment proposed under this project is the immediate collection of partially treated (septic tank or other sanitary facilities effluents) or untreated sewage from the most populated zones of Khan Yunis City and other villages.

The concept proposed in this master plan suggests phasing the construction of the sewerage and sewage treatment facilities. The result will be an immediate benefit to a significant portion of the Master Plan Area population, commensurate with economic limitations. The benefits derived from the new systems would be an improvement in the environment, which in turn, would result in a significant improvement in the health of the people and economics in the area.

The population and land use previously discussed are utilized in economic and technical analyses and computations, with the necessary adjustments to fit the recommended concept. Other pertinent factors considered in design include the ground surface gradients, effects of existing sewers, no river flows in the dry season, housing congestion, groundwater contamination, availability of suitable wastewater treatment plant site, and possible use of the treated sewage effluent for crop irrigation.

In certain areas, outside the Study Area, that can reasonably be expected to contribute to the sewerage system, sewers will be sized to include these additional flows wherever considered necessary. Any additional tributary areas should not be permitted without proper planning.

By the year 2015, it is assumed that the bulk of the Khan Yunis City and its surrounding areas will have separate sewers collecting and conveying the sewage to the sewage treatment plant, whereas in the sparsely populated villages, such as some portion within Kizan area, excreta would be treated with the private on-site sanitary systems.

It will be necessary to dispose of the collected sewage after the sewers and treatment plant are in operation. Initial disposal of the treated effluent would be made by direct discharge into the ground, or to agricultural lands, with coarse and fine screens, unaerobic ponds, oxidation ditches, final settling tanks and chlorinators. These treatment facilities would require periodic expansion so that, by 2015, the treatment plant will be provided with a sufficient treatment capacity to meet the increased quantity of the sewage inflow.

While details were examined as exhaustively as practicable, it must be emphasized that the master plan report recommendations are in order of magnitude. The passage of time, with a changed situation or variance in present assumptions, can reduce, eliminate or amplify any of the recommendations. For example, it was found that some information was not available on many important fields of basic statistics and existing facilities.

9.3.2 Sewerage Implementation Areas

For the purpose of sewerage and sanitation master planning, the whole Khan Yunis City and other surrounding villages of 4,458 hectares is defined as the "Study Area." The Study Area encompasses such non-habitable zones as cemetery, agricultural and green which would not be fully developed by 2015, and no sewerage/sanitation facilities would be required in such areas until later date. These areas are not required for the implementation of the complete plan immediately and hence excluded from the master planning.

The Project Area is divided into seven sewerage districts, each having a different trend in population growth rate, according to its land use characteristics. The sewerage systems will be constructed within the districts wherein the sewerage system provision is urgently required is defined as "Sewerage Implementation Area." The implementation area was selected considering the population densities, the future development programs, and the present sanitary conditions, in consultation with the MOPIC and villages. The implementation areas finally elaborated is illustrated in Figure M.9.2.

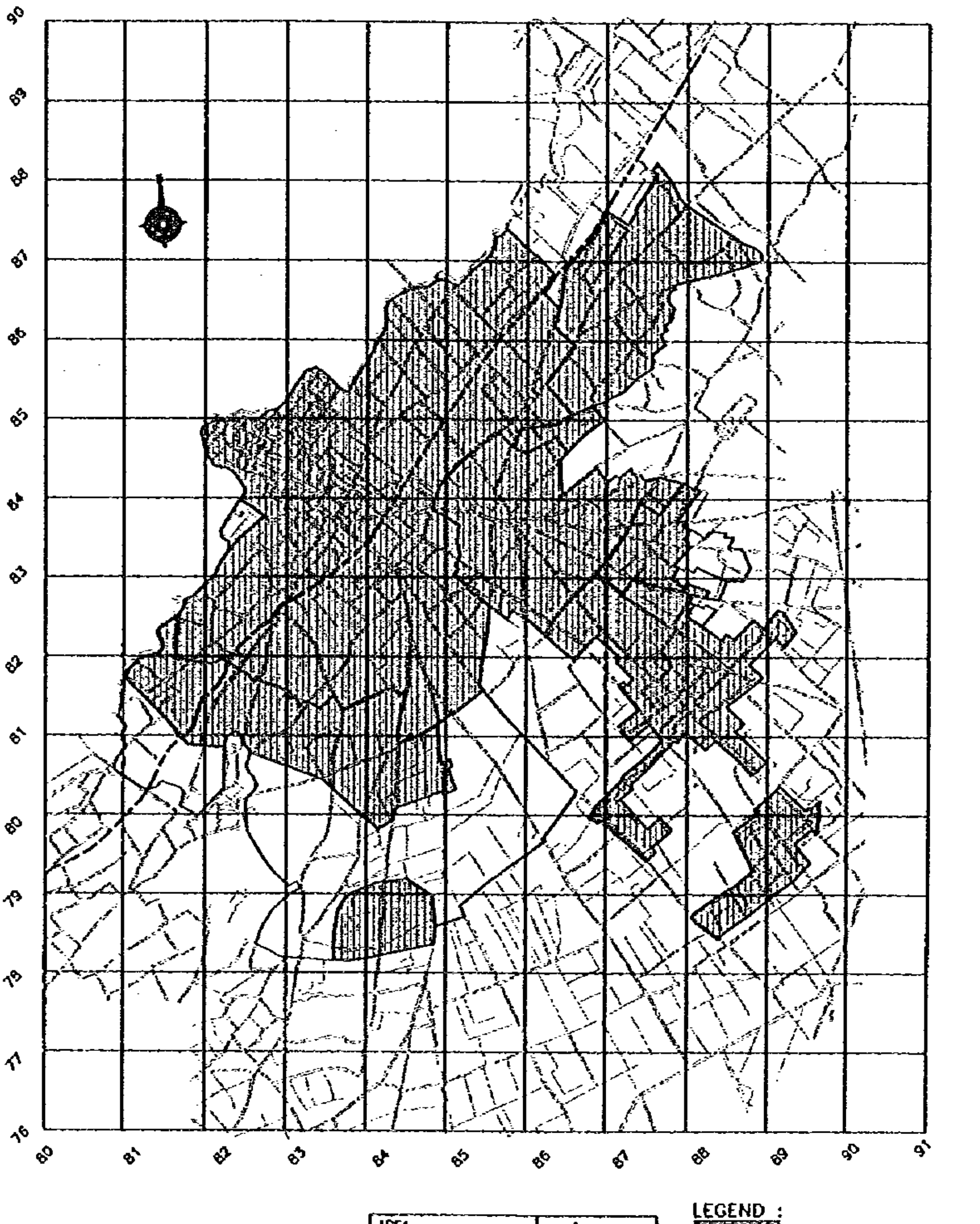
9.3.3 Served Population

The planned populations and wastewater generation in the districts are summarized in Table M.9.2 and sewerage implementation area thus estimated is shown in Figure M.9.2.

Table M.9.2 Population and Wastewater Production by District (2015)

District	Served Population	Sewage (m^3/d)	Sewage (m^3/s)
Khan Yunis	300,000	33,600	0.3889
Kizan	52,000	5,824	0.0674
BaniSohaila	38,000	4,256	0.0493
Qarrara	34,000	3,808	0.0441
AbassanSaghera	2,000	1,344	0.0156
AbassanKabera	26,000	2,912	0.0337
Khuzaa	14,000	1,568	0.0181
Total	476,000	53,312	0.6170

Source: JICA Study Team 1997



AREA	ha
Study	4,458
Sewerage	3,632

FIG. M.9.2 SEWERAGE IMPLEMENTATION AREA

THE STUDY ON SEWERAGE DEVELOPMENT PLAN IN THE AREA OF KHAN YUNIS
IN PALESTINIAN INTERIM SELF-GOVERNMENT AUTHORITY

JICA AD 1997

9.3.4 Wastewater Generation

To delineate the methodology involves in establishing wastewater flow rates, the following major factors have been dealt with:

(1) Classification of wastewater districts.

(2) Water consumption.

(3) Wastewater flow rates

As already discussed in Section 7.1 of this report, the dry weather wastewater generations were estimated based on the city water consumption rates for residences and commercial uses projected for 2015, plus 5 percent of the wastewater flows as an extraneous infiltration.

The wastewater flow variations during a day have been assumed based on the data obtained from the field surveys and the existing water supply system. Ratios of the daily average flow rate: daily maximum flow rate: hourly maximum flow rate are assumed at; 1.00 : 1.50 : 2.50.

9.3.5 Wastewater Quality

The wastewater quality, in terms of BOD_5, for planning of sewer collection, waste-water treatment, and sanitation systems, have been estimated based on the results of the water quality survey conducted on the existing sewerage facilities of the region, and household sanitation facilities. For the planning purpose, the wastewater BOD_5 concentration is estimated to be 500 mg/l as described in detail in the attached Appendix-L, "Water Quality Analysis" in Volume III "Supporting Report."

9.3.6 Wastewater Collection System

The main and submain sewers receive the wastewaters through separate sewer reticulations consisting of branch and lateral sewers. The sewers then transport the wastewater to the final disposal place by gravity and/or pressure flows. The main sewers to be built under the Master Plan range from 200 mm to 1,600 mm in diameter.

The topography of the Area is such that the sewers should follow the major drainage basin pattern. To do otherwise would require excessively deep excavation and structures for the mains, which in turn, would affect the necessary submains, branch and other sewers.

The recommended system is based on construction of open-cut sewers. The wastewater is conveyed by gravity and pressure flows to the point for discharge. The main sewer profiles are carefully examined and determined so that lift pumping stations are minimized to raise the wastewater on the way to the treatment plants.

Sewer construction, particularly in the Khan Yunis District, by the open-cut method would encounter problems of sheeting of trenches, narrow, winding streets, and costly. For these reasons, the open-cut method is considered for sewers to be constructed generally not over 6 meters below grade.

9.3.7 Combined Versus Separate System

In general combined system is less costly than separate system if both sanitary and stormwater drainage conduits are simultaneously constructed because the combined system needs only a single barrel to convey the mixture of rainstorm runoffs and wastewaters, whereas the separate system requires two barrels separately for sanitary sewage and storm runoffs.

The combined system needs to spare a large space in sewers that would possibly be used only several times in the year under the conditions, and the rest of the year only a small portion of sewer capacity would be used and never flow full. Also, much of the ground surface areas are sandy soil, and that considerable amount of sand or grit would inflow to the sewer system, easily choking the pipes and causing more operation and maintenance problems. The mixture of rainwater and sanitary sewage will definitely require a treatment to produce the mixture to the extent acceptable for the safe use of water if the water is to be utilized directly for crop irrigation. The treatment of the mixed wastewater requires additional costs.

In arid or semi-arid regions like Khan Yunis Area, where precipitation is quite low and soil permeability is high, a large capacity stormwater drains are definitely not required. In the Area, like other parts of the Region, road surface drain systems are efficiently used for stormwater runoff discharge. It appears that this system has various advantages, and is one of the best means to discharge the urban storm-water from the economical and technical viewpoints.

For the above reasons, it is evident that the separate system is more advantageous than the combined system to adapt to the wastewater management system under this Project.

9.3.8 Single Versus Double Pipes

The wastewater collection system may be constructed by stages up to the year 2015 following the priority for construction. Wide choices are available for the selection of the first-stage facility capacity-design period. Short design periods minimize excess capacity in the early years, conserve initial capital and give a chance to correct any errors made in predicting the future demands, whereas long design periods avoid the need for early duplication or relief.

Careful analysis was made of factors which should govern the selection of design period for the sewer system components so that the selections would be made on rational bases rather than by intuition. The factors considered included:

(1) the need to provide service to meet the demand.

(2) the need to minimize the present value of the immediate and future costs, taking into account the economic discounting rate, the relationship between capacity and cost and the expected pattern of demand growth.

(3) the need to limit the initial capital outlay.

(4) the need to avoid excessive disruption to traffic and other normal activities during construction, and to take account of difficulties which may affect second stage construction.

(5) the need to allow for possible erroneous prediction of demand growth in the absence of existing system experience to serve as a guide.

The sewer system would be constructed in general with the capacity sufficient to cater for the estimated 2015 wastewater flows: however, where conditions allow sewers may be constructed in double pipes, initially with the smaller capacity to handle the wastewater for certain period, say, first 10 years, then furnish an additional parallel sewer pipe to meet the ultimate wastewater flow rates, thus enabling to save construction costs.

At the initial construction stage of sewerage system the shortage of fund is expected, a cost comparison should be made for large main sewers, when exact construction schedules and other pertinent conditions are fixed, between single and double pipe sewer construction plans. Since the size of such small sewers as branch and laterals is generally governed by the minimum sewer size (200 mm), having allowance in capacity, and are generally laid along narrow streets and congested areas, the double barrel system was not considered for the secondary and tertiary sewers.

It is assumed that a soft loan may be made available for the sewer construction, and hence the single pipe system would generally be considered in detailed design unless conditions do not change substantially. Also, in order to avoid unnecessary traffic congestion by the double pipe construction in the heavily trafficked and densely populated zones in the first stage implementation area, design period (2015) capacity has been adopted for all secondary and tertiary sewers to be constructed under the project. However, during the feasibility study when more information are available, design periods for large main sewers are to be reviewed in detail on a case-by-case basis to justify whether the double barrel system is economically viable.

9.4 Wastewater Treatment System

9.4.1 Need of Wastewater Treatment System

As previously discussed, it is mandatory that ultimately all the wastewater districts be provided with the secondary treatment so that the treated sewage effluent could meet the internationally acceptable water quality requirements (at present no water quality standards are set forth yet by the Palestinian Government) and for the possible effluent reuse for crop irrigation. Because of its relatively low energy requirements, low construction and O/M costs, ease of O/M, and high cost performance, the oxidation ditch process has been selected to be the most suitable treatment method for the regional sewerage system program.

The basic plant operation will hydraulically handle dry weather sewage flow received at the plant. All flow received at the treatment facility will be mechanically screened, passed through grit removal facilities, receive unaerobic treatment, and aerated by oxidation ditches and disposed of either directly to the ground or to the nearby farm lands.

9.4.2 Potential Sites for Treatment Plant

(1) Alternative Sites

In selecting the most viable site for the sewage treatment plant construction, several possible alternative sites were first reviewed as to their suitability for the provision of treatment facility, evaluating such elements as technical appropriateness; economy of the system; residential, commercial, industrial and agricultural developments; and environmental impact aspects. After each of the candidate sites was evaluated, less viable alternative sites have been screened out from further scrutiny, and finally the following six sites were selected for detailed comparison (See Figure M.9.3):

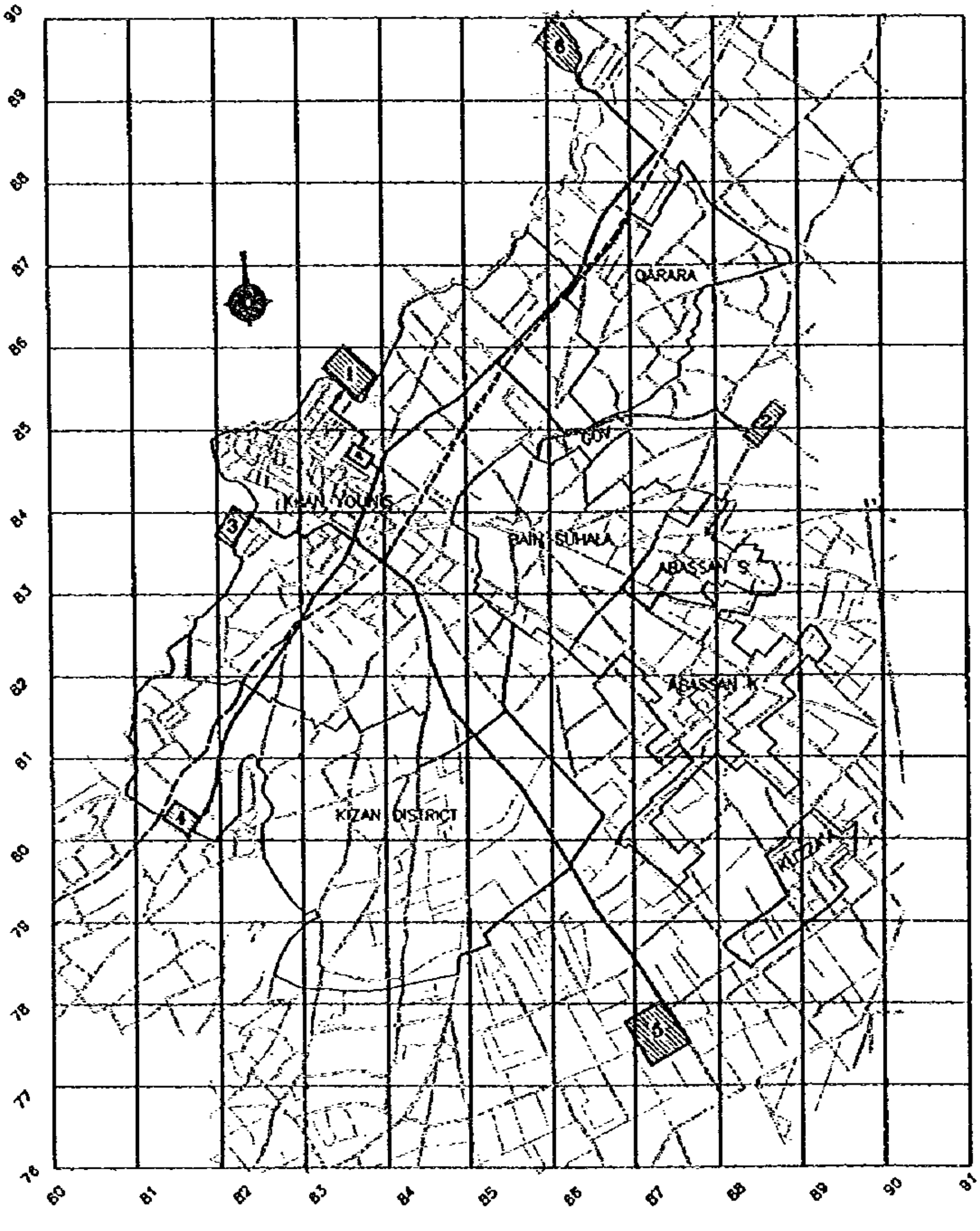


FIG. M.9.3	LOCATION OF ALTERNATIVE SEWERAGE TREATMENT PLANT SITES

THE STUDY ON SEWERAGE DEVELOPMENT PLAN IN THE AREA OF KHAN YUNIS
IN PALESTINIAN INTERIM SELF-GOVERNMENT AUTHORITY

1) Alternative Site No.1 : About 50 ha land located near the security road at the north-western boundary of Khan Yunis City (at Local coordinate N-S 86.0, E-W 89.5).

2) Alternative Site No.2 :Located at about 2 km east of Qarrara (at Local coordinate N-S 88.5, E-W 85.0).

3) Alternative Site No.3: Located at the edge of the Khan Yunis's south-west boundary close to the settlement zone, between refugee camp and cemetery (at Local coordinate N-S 82.5, E-W 84.0).

4) Alternative Site No.4: About 100 ha area land area stretching between the southern boundary of Kizan Abu Humar and Kizan Al Najar, about 5 km south of Khan Yunis (at Local coordinate N-S 81.5, E-W 80.5).

5) Alternative Site No.5: Located about 10 km southeast of Khan Yunis City and close to the delimiting line (at Local coordinate N-S 87.0, E-W 78.0).

6) Alternative Site No.6: Located about 6 km north of Khan Yunis City and about 2 km from the present northern City boundary (at Local coordinate N-S 86.0, E-W 89.5).

(2) Conditions of Sites

1) No.1 Alternative Site

This candidate site is located near the Al Qatatwa Camp close to the north-western boundary of the Khan Yunis City. The available area is more than 20 hectares arable land with ground elevations ranging from 30 to 40 meters above sea water level and is fully owned by the Government.

No wide agricultural lands exist near the site for the possible crop irrigation, but housing complexes are located close to the site. If the treated wastewater effluent cannot be used for crop irrigation, the effluent would be discharged to the sea only if an outfall pipeline were laid passing through the security zone. Otherwise the effluent will have to be disposed of into the nearby depressed dunes as a means of groundwater recharge, but the effluent disposal to the ground would not be permitted because of the stringent water quality requirements to protect the groundwater in this part of the Region.

2) No.2 Alternative Site

This land is located about 7 km east of Khan Yunis City and was once designated as the sewage treatment plant site under the Khan Yunis sewerage system plan by Israel, and a portion of sewer pipes and sewage treatment plant was constructed. However, this project was later canceled and the facilities were completely abandoned, and the treatment plant structures were demolished by the land owner, and the land was restored to the original shape.

The land is surrounded by the arable lands, and is used for agricultural purposes. As no access road exists connecting the site to the major public road, additional land acquisition of the access road will be necessary. Further, the land owner allegedly objects to siting of the wastewater treatment plant in his land. Thus, land acquisition may involve social problems.

The ground elevation of the site is at about 85 meters above sea water level, thus this alternative site is less practicable than other alternative locations, because of high energy requirements for transmitting the wastewaters from the Khan Yunis District.

Currently, there exists no residence adjacent to the site, but only several families of farmers reside about 1 km from the site. The land cost in this part of the area is about US$ 10 to 15 per square meter.

3) No.3 Alternative Site

This land of about 20 hectares is currently being used as a dumping site for garbage, waste materials, and septic tank sludge. The land owned by the Government is located at the edge of the City's southwestern boundary close to the settlement zone, at the ground elevations ranging from 50 to 60 meters above sea water level.

This site is located on the edge of the designated "Water Catchment 2" and "Agriculture 2," zones, according to the Emergency Resources Protection Plan contemplated by the Gaza Governorate. Within this zone, construction of large scale structures and discharging of wastewaters in any form to the ground are strictly prohibited. If a sewage treatment is to be constructed in this location, a high degree of the treatment level will be required to guarantee that the sewage treatment does not give any adverse impact to the surrounding environment.

Even if the construction of the sewage treatment system is permitted, the construction at such an elevated hilly terrain could hardly be justified economically and technically feasible because of its high energy requirements for lifting the sewage from the lower areas.

4) No.4 Alternative Site

This land of about 30 hectares stretches between the present southern boundary of Kizan Abu Humar and Kizan Al Najar at the ground elevation of about 60 meters above sea water level. The land faces a major road and has a good access to the site.

The site is located within the Water Catchment 2 and Agriculture 2, according to the Emergency Resources Protection Plan contemplated by the Gaza Governorate, and the construction of the sewage treatment plant is restricted. Hence, due considerations should be given on the degree of treatment, the way of effluent discharge, and various other environmental protection measures, if the treatment plant is to be constructed within this area.

The whole land is owned by the Local Government, and the jurisdiction of the area was recently transferred to Khan Yunis City. Some portion of the land is illegally used for agricultural purpose. There are at present no residences in the site, but only several houses exist at more than 1 km from the site.

The surrounding area is mostly arable land and has a high potentiality of the effluent reuse for irrigation, if the sewage is made available. However, this location is not considered economically feasible because of its high elevation.

5) No.5 Alternative Site

The site situates about 10 km southeast of Khan Yunis City close to the delimiting line with the ground elevations of about 60 to 70 meters above sea water level. The area is predominantly agricultural lands, and will remain as agricultural land even in the future. Currently, no houses exist near the possible site, but other houses are located in Khuzaa village more than 3 km from the site.

A sufficiently wide land is available for the treatment plant. The lands are owned by the government and are lent for private farmers, therefore, the lands need not to be purchased. No involuntary resettlement of people will be required for the land acquisition. The access to the site is easy as a major road exist close to the site, thus, connecting the site to the major urban areas of Bani Sohaila, Khuzaa, Abassan Kabera, and Khan Yunis.

The land is arable and when the effluent is made available, the effluent reuse for crop irrigation is possible. Because of the high ground height and remote location of the site, more energy will be required than other candidate sites to convey all the wastewaters collected from the Khan Yunis District to this point.

6) No.6 Alternative Site

The site is located approximately 7 km north of the center of Khan Yunis City and about 2 km from the present northern boundary. Most of the land is owned by the Local Government, however, only small portion of the land is owned by farmers. Areas to the north and east of the site are presently used as orchard. In and around the site is mostly arable and promising for crop irrigation by the treated sewage effluent if and when it is applicable.

Topographically, the ground surface in the Study Area gradually declines toward the north, and the site is located at a lower point of the area ranging at 20 to 30 meters above sea water level. Much of the storm runoffs from the urban and irrigation lands during the winter season would flow down to this point. In the sewerage system planning, these topographic conditions appear to be favorable from both economical and technical viewpoints, since most of the ground elevations in the catchment area range 30 to 40 meters or higher, thus enabling the system to convey the collected wastewater by gravity down to this point with a little need of lift pumping station.

At present, this area is far from the urban areas and only a small village is located within 1 km, and such adverse impacts as the possible odors or noise from the treatment plant could be minimized to the environs. However, a large scale development plan is underway to construct schools, sports stadium, housing complexes, and other facilities within the area. Hence, there are strong objections to the construction of the sewage treatment plant at this site

This site is located at the ground elevations of 25 to 30 meters above sea level, therefore, this site will require less energy costs to pump up the wastewater to the plant than other alternative sites.

(3) Evaluation of Alternative Sites

1) Sewage Conveyance and Pumping

One of the most important factors to be considered in selecting a sewage treatment plant site is the economy of the sewage transportation. A sewerage system can be most economically planned if all the sewage is transported by gravity through the way to the treatment site. This is particularly true if the sewerage system of this scale is to be planned for an integrated regional system. In this regard, all the alternative sites other than No.6 will require considerable amount of costs for pump station construction and accruing operation and maintenance costs if the sewage from Khan Yunis area is to be conveyed.

2) Energy Costs

Since sewer layout plans have not been finalized yet, the actual costs accruing to each sewerage alternative plan conveying the sewage to the different alternative plant sites could hardly be made: However, all the alternative plans except Alternative No.6 will need to be provided with pumping provision to lift the sewage 50 meters or even more.

The total sewage flows in 2015 is estimated to be about 40,000 m^3/day, for which the required energy costs were estimated at approximately NIS 570,000 (electricity charge of NIS 0.5/kWh). In addition to the energy costs, construction, operation and maintenance costs are also required for the pumping stations and force main facilities. The calculations clearly indicate that for the lifting of the sewage to high locations will be costly and not economical.

3) Intangible Comparison

In view of the lack of a clear distinction between alternative wastewater treatment plant sites on cost and technical basis, non-quantifiable considerations become of importance in the selection of the alternative plans.

These include potentiality for wastewater reuse, and community/environmental impacts, and each item is rated either "excellent," "good," "fair," "poor," according to the significance of the impacts, with supporting commentary presented in the following:

a. Potential Wastewater Reuse

In view of the save of the water resources in the region, reuse of the treated effluent may be one of the most important strategies in the Area. Of the various reuse schemes, high priority is laid on the agricultural development. In the existing farm land in the area, various crops such as olive, dates, water melon, cucumber, corn, tomatoes and others are harvested. It would be possible in the future when the treated sewage effluent is available and sanitary problems of the crop irrigation are cleared, the treated effluent may become an important water source.

Among the alternative sites, the surrounding areas of Alternatives No.2, No.4, No.5 and No.6 are predominantly arable agricultural lands, and once the effluent is made available, the potentiality of reuse would be high, thus are rated as "good," in this regard. Whereas Alternatives No.1 and No.3 have less potential for reuse, and are rated as "fair."

b. Impacts to Community/Environment

The construction of the sewage treatment plant may accrue adverse environmental impacts to the surrounding areas, such as odors, noise, vibration, etc. during the construction stage and after operation started. Because a detailed Environmental Impact Assessment (EIA) is scheduled to be carried out later on the finally selected wastewater management strategy plan, the evaluation is briefly made here but in sufficient for the purpose of selecting the best site. The evaluation procedures include i) estimating probable negative environmental impacts of the options, and ii) assisting the screening of less favorable options

This evaluation analyzes potential adverse environmental impacts that are known to have occurred in similar wastewater management projects in Palestine and other countries. First, for thoroughness, most of the possible environmental factors are considered for all the alternative sites. Then, these factors are examined for each alternative based on the available information.

The adverse environmental impacts that are likely to occur in the wastewater plant siting is as follows:

Interference with other utilities: All the options have treatment facilities in sparsely developed area, and there will be only minimal interference to utilities. Alternative No.1, located relatively close to the populated area, may have a little more significant impact in this respect and rated as "poor," but all other alternatives are rated as "good.".

Blocking of access: All alternatives sites will ensure that locations are rationally selected and adequate land area will be acquired, so that this impact will not occur.

Involuntary resettlement: This impact should be minimized to the extent possible, since involuntary resettlement is usually a traumatic experience for affected people, apart from legal, institutional and social consequences to the project implementation.

For all the candidate sites, except Alternative site No.2, propose to make use of the government-owned land, whereas, in Alternative sites No.4 and No.6 site, people reside either legally or illegally, resulting in resettlement of residents or property in these areas. Other alternative sites are of agricultural or waste lands, and no houses exist within the sites. All the options are situated out of built-up areas, without residents close to the sites. The process of resettlement may become increasingly difficult in development projects in the Area. Therefore, Alternatives No.2 and No.6 are rated as "poor," whereas Alternatives No.1, No.3, and No.4 are rated as "fair," and No.5 as "good."

Proximity to present urban areas: Proximity to urban areas requires extra measures for minimizing hazards and nuisance to the neighborhood, such as provision of buffer zones and fences, noise and aerosol abatement, and contingency plans for accidental wastewater over flows or spills. According to the available regional development plans, urbanization of agricultural land in the near future is likely. Alternatives No.1 and No.3

are therefore rated as "poor," but Alternatives No.6 as "fair." All other Alternatives are rated as "good."

Land resource requirement: The degree of this impact is indicated by the land area required (natural resource cost) and the land unit price (social cost). All the options have substantial land resource requirements when secondary treatment processes are adopted. However, this is compensated by the relatively low social cost as these plants are located outside built-up areas. In general the land costs are in the range of 5 to 15 US$, but are in general higher toward the northern districts. The land area requirement is considered to be the same under this evaluation, but as Alternatives No.1, No.3 and No.6 sites are located closer to the urbanized areas, these are rated as "fair." Other Alternatives are rated as "good" in this respect.

Land acquisition & compensation: While the above impact is related to environmental and social costs, this impact is in connection with legal or institutional complexities. Except No.2 site, all other alternative sites are mostly government-owned and have less difficulties to acquire. Thus, alternative sites No.2 is justified inferior to other alternative sites and rated as "poor." Alternative No.6 is rated as "fair," while No.1, No.3, No.4 and No.5 are rated as "good."

Environmental aesthetics: This is related to the harmony of the design, structure and style of the facilities to the environs. All facilities will have a low profile and so will not create any aesthetic problem due to their height and size. All the candidate sites would be under the same conditions and rated as "good."

Groundwater protection: Candidate sites No.3 and No.4 are located within the designated area of "Water Catchment 2," wherein the treated sewage effluent or sludge disposal will be strictly restricted. This is a quite important factor in selecting the alternative plans and can be the decisive reason to exclude these alternatives from the candidate sites. In this regard, the sites No.3 and No.4 are inferior to other alternative sites, thus, both were rated as "poor," whereas other alternatives are all rated as "good" in this regard.

Impacts related to construction works: During the construction stage, interference of traffics may occur to some extent with all the alternatives. However, effects may could be more significant in Alternatives No.1 and No.6 as they are located closer to the built-up urban areas than other alternatives. Although these alternatives could create more adverse impacts to the surrounding areas than others because of transportation of materials, heavy equipment, excess soil, etc., these impacts could be mitigated by carefully controlling the frequencies and speeds of such traffics, particularly during night time or early in the morning.

During the construction stage, air quality may be temporarily affected to some extent by fugitive dust from construction sites. The effects of the dust on crops and people living in the vicinity of roads and treatment plants, would be relatively minor under all the alternative plans, however, Alternatives No.1, No.3 and No.6 may affect more impacts than other alternatives. Thence, these alternatives are rated as "fair," and others as "good." Other impacts such as noise, vibration, and odor can also be considered the same as that for 'fair.'

Impacts related to operation stage: Because at this moment, details of sewage treatment plant system is yet to be determined, extent of sewage treatment plants odor could hardly be assessed. The oxidation ditch process which will most probably be applied for the project might create some odor but is less significant than other process such as oxidation ponds or aerated lagoons. Although at present the extent of the odor level cannot be projected, it can be safely assumed that where residences do not exist within the distance of about 1 km from the plant, the sewage odor would not affect significantly to the surrounding areas. In view of this, Alternative site No.1 and No.2 are inferior to other alternatives, thus rated as "poor," whereas other alternatives are rated as "fair."

(4) Overall Evaluation

From the foregoing studies and discussions, it can be concluded that No.5 and No.6 sites are superior to other alternative sites with many advantages as to economic, socioeconomic and environmental respects, followed by Alternative site No.5.

These are summarized in the following Table M.9.3:

Table M.9.3 Rating of Alternative Plant Sites

Alternative Site	Costs	Potential for Effluent Reuse	Community/ Environmental Impacts
No.1	Fair	Fair	Fair
No.2	Poor	Good	Fair
No.3	Fair	Fair	Fair
No.4	Poor	Good	Fair
No.5	Poor	Good	Good
No.6	Fair	Good	Fair

Note: Rating represent judgment of the JICA Study Team.

The evaluation results indicate the advantages and disadvantages accruing to the alternative sites. The governing factor in selecting the best alternative site is the energy costs which is prohibitively high to lift all the sewage to the higher locations. In addition, the emergency water resource protection plan being in forth is also an important factor to be taken in selecting the sites.

In order to avoid such high energy consumption for the lifting of the wastewater, the possible means will be to divide the whole area into two catchment areas following the topographic conditions, thus the waste-waters from the southern part of the area would be led to the site No.5 mostly by gravity at least reducing the necessity of pumping provision. Thus, the need of lifting of significant amount of the wastewaters from Khan Yunis District and saving the costs.

In view of the foregoing evaluation results, it appears that No.5 is the most advantageous alternative site followed by Alternative 6 for the integrated regional sewerage system program, in particular when all the wastewaters generated in Khan Yunis City area.

9.4.3 Alternative Treatment Processes Considered

After preliminary screening of the possible sewage treatment processes alternatives, the following five alternative processes were studied in selecting the most suitable treatment process for the Study Area:

- Conventional activated sludge treatment,
- Oxidation ditch.
- Oxidation ponds,
- Aerated lagoons,

- Rotating biological contactors

Advantages and disadvantages of each process are discussed in the following paragraphs.

(1) Conventional Activated Sludge Process

Basically, the activated sludge process uses microorganisms in suspension to oxidize soluble and colloidal organics to CO_2 and H_2O in the presence of molecular oxygen. During the oxidation process, a portion of the organic material is synthesized into new cells. A part of the synthesized cells then undergoes auto-oxidation in the aeration tank, the remainder forming excess sludge. To operate the process on a continuous basis, the solids generated must be separated in a clarifier with the major fraction being recycled to the aeration tank and the excess sludge being withdrawn from the clarifier under-flow for further handling and disposal.

The process comprises grit chambers, primary sedimentation tanks, aeration tanks, final sedimentation tanks chlorine contact tanks, sludge thickeners, unheated sludge digesters, sludge dewatering facilities, and other auxiliary facilities. The wastewater is commonly aerated for a period of 6 to 8 hours based on the average design flow in the presence of a portion of the secondary sludge. The rate of sludge return expressed as a percentage of the average wastewater design flow is normally about 25 percent, with minimum and maximum rates of 15 to 75 percent.

The expected BOD removal efficiency of the conventional activated sludge process is 90 percent or higher when the system is properly operated. A typical flow sheet of a conventional activated sludge plant is illustrated in Figure M.9.4.

(2) Oxidation Ditch

The oxidation ditch process is an extended aeration consisting of a ring-shaped channel about 2 to 2.5 meters deep and other facilities same as those for the extended aeration process. An aerator is placed across the ditch to provide aeration and circulation of the sewage. The BOD removal efficiency is almost same as that of the extended aeration process. The flow sheet of the process is illustrated in Figure M.9.5.

(3) Oxidation Ponds

Oxidation ponds are large and shallow ponds in which organic wastes are decomposed by micro-organisms in a contamination of natural process involving both bacteria and algae. Oxidation ponds are one of the most economical methods of sewage treatment wherever wide land is available at relatively low cost. Their principal advantages are that they remove excreta pathogens at a much lower cost than any other form of treatment and that they have minimum operation and maintenance requirements. As shown in Figure M.9.6, this process consists of facultative and maturation ponds with necessary auxiliary facilities to remove the BOD to the level of 90 percent or higher.

(4) Aerated Lagoons

Aerated lagoon is a basin in which wastewater is treated on a flow-through basis. Oxygen is supplied by means of surface aerators. The action of the aeration and that of the rising air bubbles from the diffusers is used to keep the contents of the basin in suspension. As illustrated in Figure M.9.7, the process consists of aerated lagoon and maturation ponds, but the aeration is carried out in the aerated lagoons. Bacterial degradation of contaminants and removal of additional BOD will undergo in the maturation ponds. When designed and operated properly, this process will achieve a high performance and the better effluent than other processes can be expected in terms of bacterial removal.

(5) Rotating Biological Contactors (RBC)

As illustrated in Figure M.9.8, this process consists of a series of closely spaced discs (3.0 to 4.0 meters in diameter) mounted on a horizontal shaft and rotated while about one-half of their surface area is immersed in wastewater. The discs are typically constructed of lightweight plastic material. When the process is placed in operation, the microbes in the wastewater begin to adhere on the rotating surfaces and grow there until the entire surface area of the discs is covered with a layer of biological slimes. As the attached microbes pass through the wastewater reservoir, they absorb other organics for breakdown. The excess growth of microbes is sheared from the discs as they move through the reservoir. The process may produce 85 percent BOD removal. Because the flow velocity and turbulence in the compartment containing the disks are not high enough to keep heavy primary wastewater solids in suspension, a primary settling tank must precede the disks.

The advantages of these units are generally low power, low noise level, and resistance to organic and hydraulic shock loads. The main disadvantages of the process is the need to cover the disks to protect them from wind damage or vandalism, and to keep heavy rains from washing the growth off the disks. Since the process requires a wide surface area of plastic disks, e.g., for 20,000 m^3/day capacity plant more than 110,000 units of 2.4 meters diameter disk, which may require considerable costs for replacement. Furthermore, a relatively wide land area is required and that overall this process is considered to be not advantageous to apply for large scale treatment plants.

9.4.4 Evaluation of Alternative Processes

(1) Preliminary Screening of Alternative Processes

As discussed in the preceding sections, preliminary evaluations were made on the various possible alternative treatment processes as to the prominent advantages and disadvantages accruing to each of the processes. Some of the processes are apparently less advantageous than other processes, and that as a preliminary step less viable processes were excluded among the six possible alternative processes from further detailed evaluation.

The extended aeration process is less advantageous than other processes in its lower performance, high operation and maintenance costs, and lack of experience in actual operation in large scale public sewage treatment works like that of Khan Yunis sewerage system. Therefore, the remaining five more practical processes have been evaluated in more details, including i) conventional activated sludge, ii) oxidation ditch, iii) aerated lagoon, iv) oxidation pond, and v) rotating biological contactor processes.

(2) Detailed Evaluation

For evaluation of the five alternative processes, a comparative study has been made on the alternative processes with regard to:

- Land requirements.
- Capital costs.
- Operation and maintenance costs.
- Characteristics of operation, maintenance and other factors.
- Cost Effectiveness

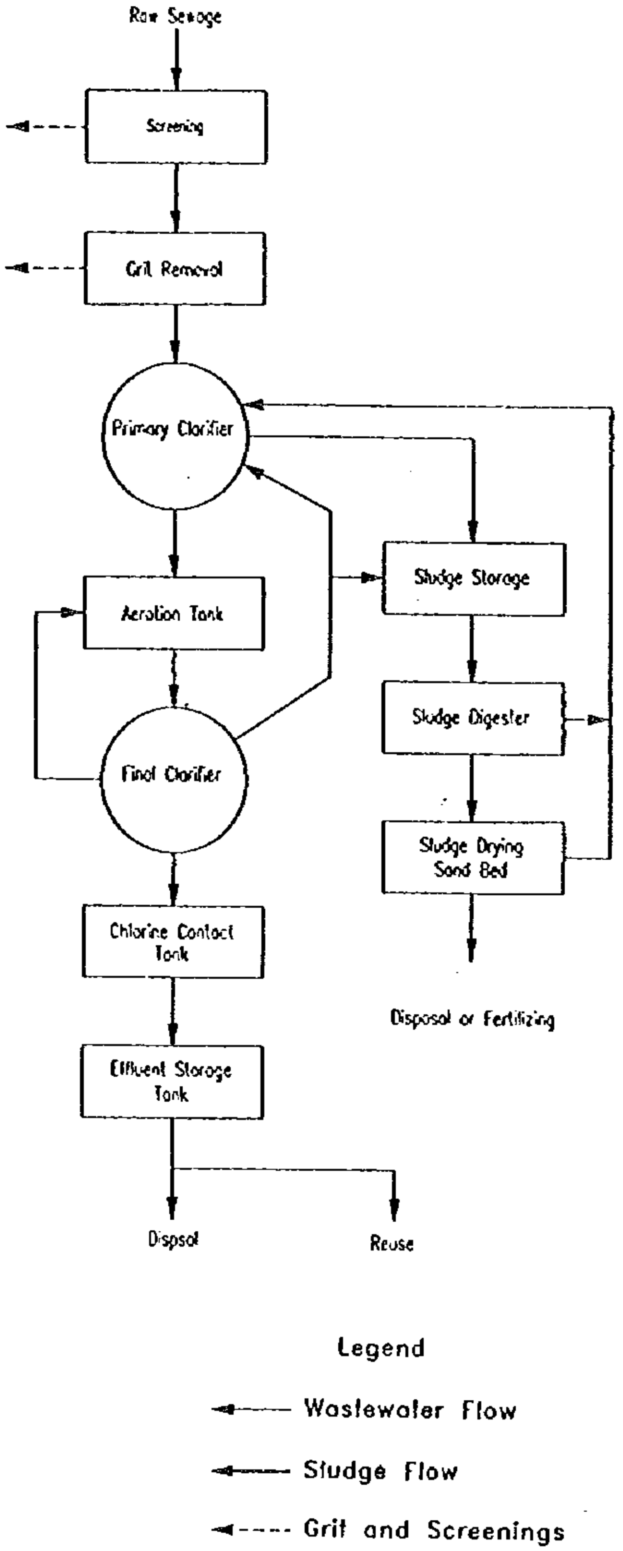


FIG.M.9.4	FLOW SHEET OF CONVENTIONAL ACTIVATED SLUDGE PROCESS

THE STUDY ON SEWERAGE DEVELOPMENT PLAN IN THE AREA OF KHAN YUNIS
IN PALESTINIAN INTERIM SELF-GOVERNMENT AUTHORITY

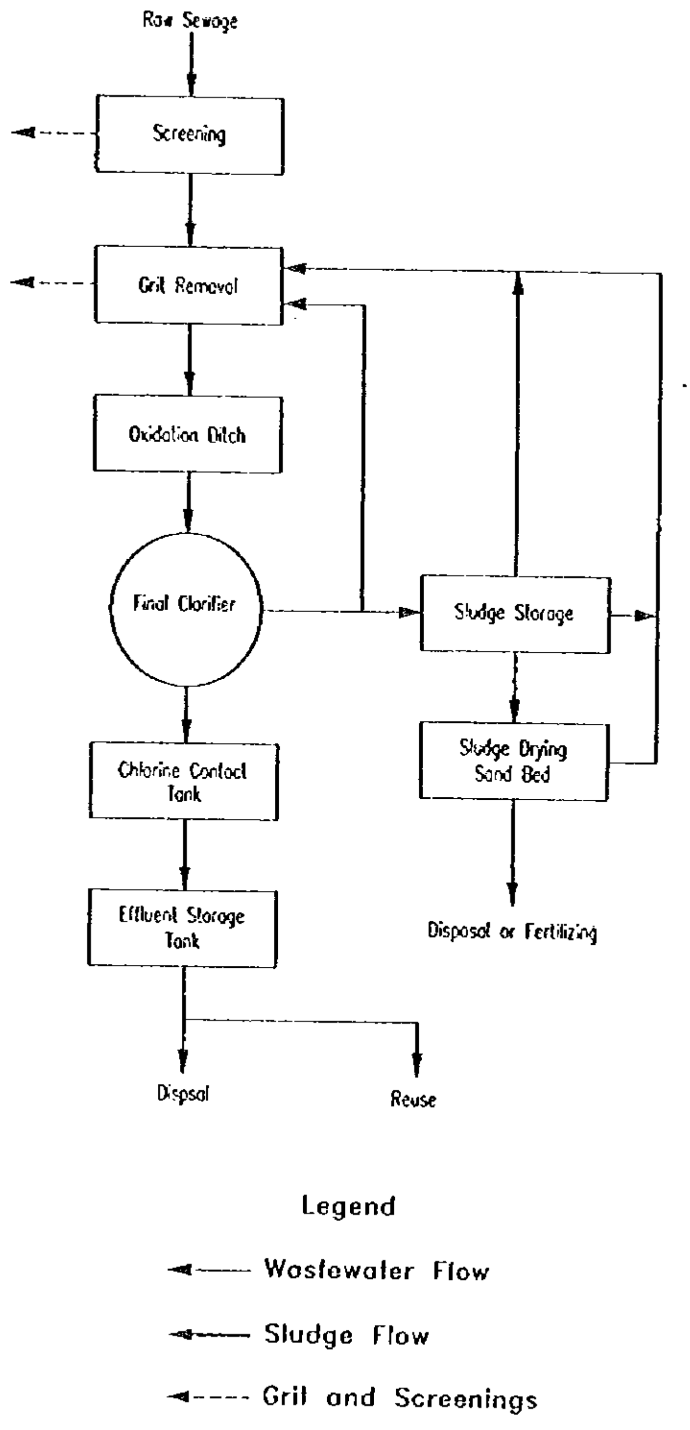


FIG.M.9.5 FLOW SHEET OF OXIDATION DITCH

THE STUDY ON SEWERAGE DEVELOPMENT PLAN IN THE AREA OF KHAN YUNIS
IN PALESTINIAN INTERIM SELF-GOVERNMENT AUTHORITY

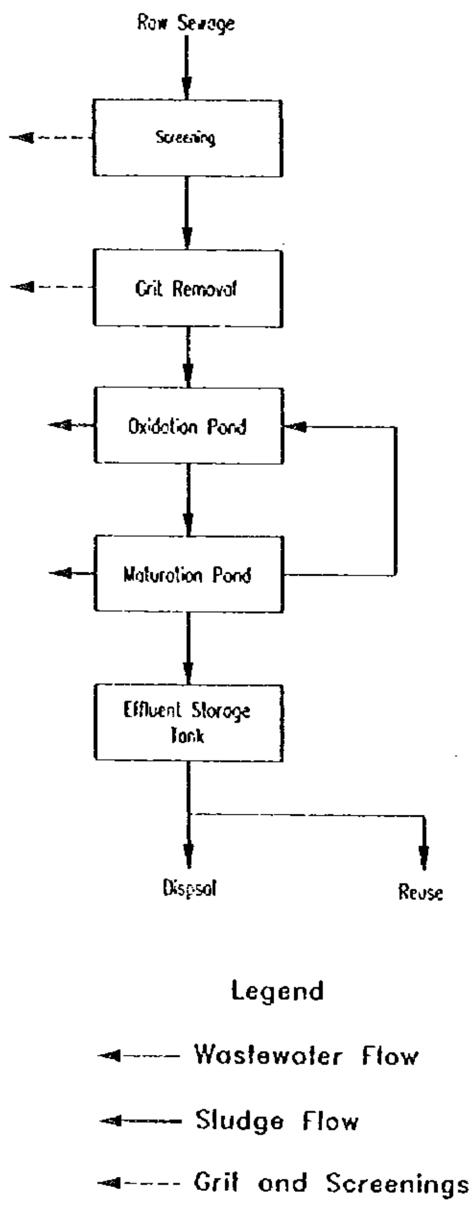


FIG.M.9.6 FLOW SHEET OF OXIDATION PONDS

THE STUDY ON SEWERAGE DEVELOPMENT PLAN IN THE AREA OF KHAN YUNIS IN PALESTINIAN INTERIM SELF-GOVERNMENT AUTHORITY

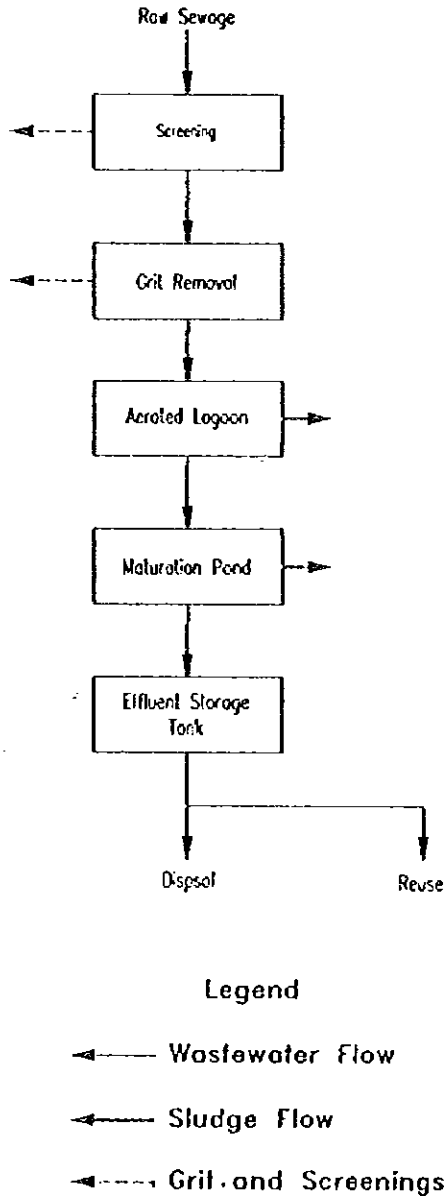


FIG.M.9.7 FLOW SHEET OF AERATED LAGOONS

THE STUDY ON SEWERAGE DEVELOPMENT PLAN IN THE AREA OF KHAN YUNIS
IN PALESTINIAN INTERIM SELF-GOVERNMENT AUTHORITY

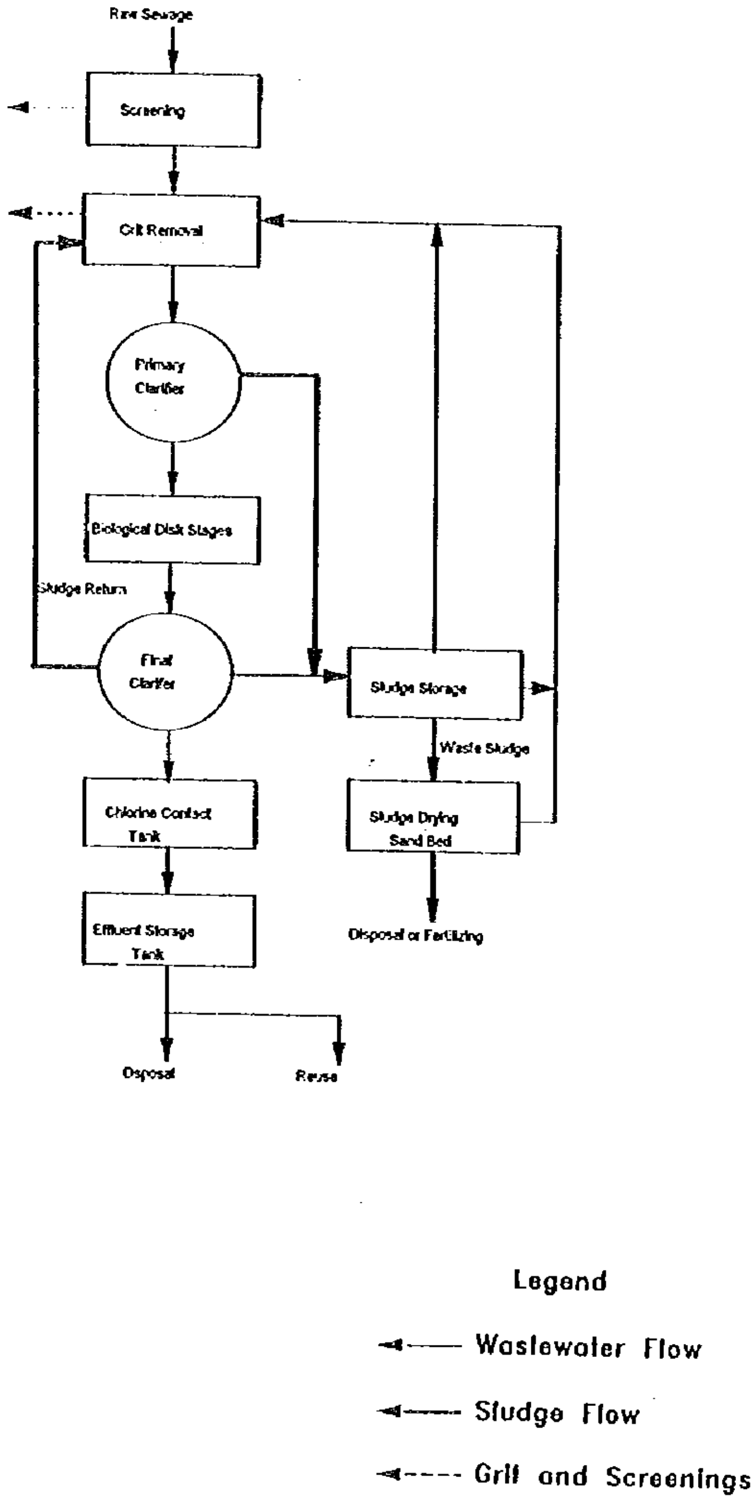


FIG.M.9.8	FLOW SHEET OF ROTATING BIOLOGICAL CONTACTORS

THE STUDY ON SEWERAGE DEVELOPMENT PLAN IN THE AREA OF KHAN YUNIS
IN PALESTINIAN INTERIM SELF-GOVERNMENT AUTHORITY

For the comparative analysis, a layout plan for each of the treatment processes with a treatment capacity of 20,000 m^3/day was worked out, then, required land area, and costs were estimated, for each of the alternative processes.

1) Land Requirements

On the basis of the layout plans for the alternative treatment processes, the required land areas and costs for acquisition were estimated (for comparison purposes, all the land is assumed to be acquired). In the estimated required land area, a buffer zone of about 10 meters are considered. For land cost, US$ 6,000/dunum (US$ 60,000/ hectare) were considered. The estimated land areas and costs are shown in the following table:

Table M.9.4 Land Requirements and Costs

Type of Process	Land Area(ha)	Costs (US$1,000)
Conventional activated sludge	3.16	189,682
Rotating Biological Contactor	8.64	518,400
Oxidation ditch	4.64	278,224
Aerated lagoon	10.06	603,858
Oxidation pond	55.77	3,346,154

2) Capital Costs

Capital costs for each of the processes are estimated as shown in Table M.9.5. The costs are expenditures required for construction of facilities, including all civil works, buildings, mechanical and electrical equipment, pipings, plant facilities, site roads, parking, etc.

Table M.9.5 Capital Costs (US$ 1,000)

Type of Process	Capital Costs
Conventional activated sludge	38,050
Rotating Biological Contactor	45,000
Oxidation ditch	36,969
Aerated lagoon	35,642
Oxidation pond	4,950

3) Operation and Maintenance Costs

Operation and maintenance costs of the sewage treatment plants comprise those for electricity and other energy, operation and maintenance labor, supplies and maintenance materials, raw materials, chemicals, administration and staff, etc. These costs for each of the processes are shown in the following:

Table M.9.6 Annual Average O/M Costs (US$1,000)

Type of Process	Costs
Conventional activated sludge	1,814.17
Rotating Biological Contactor	1,479.92
Oxidation ditch	1,252.08
Aerated lagoon	1,132.31
Oxidation pond	280.89

4) Cost Effectiveness

Based on the foregoing cost estimates, a cost effectiveness analysis was made on each alternative process. For the comparison, constant annual costs have been estimated considering the following conditions:

- Service life: Civil works and buildings 40 years
  Mechanical and electrical equipment 20 years
- Salvage value: Land 100 %
  Civil, mechanical, electrical facility 0 %
- Discount rates: 5.0 and 10.0 percent per annum.

Results of the estimation are summarized in the following table:

Table M.9.7 Annual Costs (US$ 1,000/year)

Item	Conventional activated sludge	Rotation biological reactor	Oxidation ditch	Aerated lagoon	Oxidation pond
Interest at 5.0 p.a.	74.64	86.54	72.79	70.51	17.96
Depreciation	1,303.08	1,541.10	1,266.05	1,220.61	169.52
O and M	1,814.17	1,479.92	1,252.08	1,132.31	280.89
Total annual cost	3,191.89	3,107.55	2,590.92	2,423.44	468.37
Interest at 10.0%	149.28	205.59	154.43	182.45	351.57
Depreciation	1,303.08	1,541.10	1,266.05	1,220.61	169.52
O and M	1,814.17	1,479.92	1,252.08	1,132.31	280.89
Total annual cost	3,266.53	3,226.97	2,672.56	2,535.37	801.98

Using the above mentioned costs, unit sewage treatment costs of each alternative process, at interest rates of 5 and 10 percent per annum, are calculated as shown below:

Table M.9.8 Treatment Costs per Unit Sewage Volume (US$/m³)

Type of Process	Discount rate (%/yr)	
	5.0	10.0
Conventional activated sludge	0.437	0.447
Rotating Biological Reactor	0.425	0.442
Oxidation ditch	0.355	0.366
Aerated lagoon	0.332	0.347
Oxidation pond	0.064	0.011

5) Processes Evaluation

As discussed above, the characteristics of each alternative process can be summarized as follows:

a. As can be seen from Table M.9.7, the annual expenditures of the aerated lagoon process at the two different discount rates are the least costly among the five alternatives, although the cost differences from other processes except the oxidation ponds are not so significant.

b. Land requirements for the treatment facilities are widely at variance with the type of treatment process. As shown in Table M.9.4, the oxidation pond process requires the widest land area followed by aerated lagoon process. The oxidation pond process requires vast land, for example, if the whole project area is to be covered and treated in one concentrated oxidation pond, the total required land area will be well over 120 hectares. Acquiring such a wide land will be practicably not possible in Khan Yunis Area where the available land is limited.

c. The capital costs vary by the type of process. The capital cost for the rotating biological contactor process is higher than other processes, even than the activated sludge process that requires more complex unit process operations. The costs for electrical and control equipment appear to differ not so significantly except those for the oxidation ponds because these costs are generally governed by power loads of the plant but not with the process itself.

d. Among the alternative processes, the oxidation pond system has the least complexity in operation and maintenance of the facilities, followed by the aerated lagoon, whereas the conventional activated sludge process requires the most complex operation and maintenance works. The oxidation ditch and rotating biological contactor systems require less complex operation and maintenance procedures than those for the conventional activated sludge process, while the oxidation pond requires the least care in operation and maintenance. As shown in Table M.9.6, the operation and maintenance costs for the conventional activated sludge process is the highest among the alternatives.

e. One of the advantages with the activated sludge process is the possible utilization of sludge gas for power generation at the treatment plant when the sludge digestion is applied. The gas produced in the activated sludge process of this scale may not be conceivable, particularly during the stages when the sewage inflow is expected to be low. Sludge digestion is in general not needed in oxidation ditch process, but when it becomes necessary to digest the excess sludge for the reason of disposal or another, sludge management process can be easily added to the system. For small treatment plant, most of sludge processing types are too complicated and require a high level of experience than is usually available, and for these reasons, sludge treatment facilities are not planned for the alternative plans except for the activated sludge process.

f. The conventional activated sludge process is not resistant to shock organic or toxic loadings, while other methods are in general resistant to such loadings.

g. The treatment cost per unit volume of sewage by the oxidation pond process is the lowest. This means the oxidation pond process is the most cost effective one.

h. The amount of evaporation from the aerated lagoons and oxidation ponds are high compared with other alternatives, therefore, these two processes are inferior to other systems from the view point of the effective effluent reuse for crop irrigation or other uses.

i. If the treated sewage effluent is to be reused for crop irrigation, lower nitrogen concentration in the effluent might be needed during certain time in the year, particularly during the fruition of certain kinds of crops. The oxidation ditch and rotating biological contactor processes have superior characters in the effective nitrogen control by applying the biological nitrification and denitrification processes. Experience gained from sewage treatment plants under the similar conditions to the Khan Yunis Region indicates that if the process is properly operated, the nitrogen removal rate as high as 90 percent or nitrogen concentration of 10 mg/l or lower could be achieved.

j. The aerated lagoon, oxidation ditch, and oxidation pond have long been in operation in Palestine and Israel, and the sufficient data and information are available for design, operation and maintenance of these processes.

k. Generally, the severer process control of the plant operation is possible in the oxidation ditch process than in the aerated lagoon process, if a little more effort is made. Thus it would be possible to produce better quality effluent than the aerated lagoon.

l. The capital cost requirements for the rotating biological contactor is the highest among the alternative processes because it requires wide land area and housing to cover most of the aeration tanks, although the costs may be overcome to some extent by easier operation and maintenance. The lower O/M cost makes this process more cost effective than the activated sludge process in terms of per unit sewage treatment cost.

The evaluation results of the alternative processes are summarized in Table M.9.9.

6) Conclusions

From the forgoing discussions, it is evident that the oxidation ditch process has many more tangible and intangible advantages than other processes in many aspects, and is considered superior to other alternatives for the following reasons:

a. The annual cost of the oxidation ditch process is low for its performance and the cost effectiveness is high.

b. The oxidation ditch process is a relatively simple process to operate and maintain the facilities.

c. Sludge generation of the oxidation ditch process is small and the excess sludge can be easily dried on sand drying beds, whereas the excess activated sludge is not easy t handle.

d. Relatively high organics removal efficiencies can be expected.

e. Denitrification could be achieved whenever required.

Because of its low energy requirement, low construction and O/M costs, ease of O/M, and high cost performance, the oxidation ditch process is selected to be the most suitable treatment method for the Project.

7) Treatment Facility

All sewage flow received at the treatment facility will be mechanically screened, passed through grit removal facilities, anaerobic ponds, oxidation ditches, settling, and be conveyed to chlorine chambers for disinfection. The effluent will be disposed of to the nearby irrigation land or recharged into ground through outfall pipes.

Table M.9.9

Summary of Alternative Watewater Treatment Processes

Treatment Proces	Characteristics of Processes	Environmental Nuisances	Operation and Maintenance	BOD Remova Rate (%)	Required Lan Area (ha)	Land Cost (US$1,000)	Capital Cost (US$1,000)	O/M Costs (US$1,000/yr)	Annual Cost (US$1,000/yr)
1. Conventional Activated Sludge	1) High treatment efficiency 2) Widely used process with long operation expperience. 3) Relatively low capital and O/M costs for its performance 4) Less land area. 5) More sensitive to shock loading and temperature. 6) More sludge volume. 7) Complex process. 8) Difficult sludge dewatering on sand bed. 9) Aeration may be disturbed due to sand accumulation	Minimum odor generation.	Complex and require operators skill.	90 <	3.16	189,682	38,050	1,814.17	3,266.53
2. Oxidaion Ditch	1) Primary clarifier may be omitted. 2) Robust to shock loads and inflow fluctuations. 3) Low sludge generation, easy dewatering on sand bed. 4) Less complex O/M problems than conventional AS. 5) Comparatively large land area is required. 6) Low odor emanation. 7) Nitrogen removal is possible. 8) Relatively high sludge carryover expected.	Moderate odor generation.	Relatively simple requires some skill of operators.	90 <	4.64	278,224	36,969	1,252.08	2,672.56
3. Aerated Lagoon	1) Simple O/M 2) Sludge returning not required. 3) Effective in bacteria treatment. 4) Large plant area required. 5) Algal growth may hinder treated effluent reuse. 6) High evaporation and sand accumulation.	Odors, insect generation, forming, spray from agita-tion.	Simple	80 - 90	10.06	603,858	35,642	1,132.31	2,535.37
4. Oxidation Pond	1) Least operation and maintenance required. 2) Effective in bacteria treatment. 3) Wide plant area. 4) Algal growth may hinder treated effluent reuse. 5) High evaporation and sand acumulation	Odors, insect generation, groundwater contamination caused by leakage.	Simple	80 - 90	55.77	3,346,154	4,950	280.89	801.98
5. Rotating Biological Contactor	1) Easy O/M 2) No return sludge required. 3) Resistant to shock loads, low process cotrol required. 4) Wide land area required for denitrification process. 5) Enclosures required thus making initial cost high. 6) Both primary and final clarifiers required. 7) Ammonia-nitrigen removal achievable. 8) Low energy requirements.	Moderate odor generation.	Relatively simple	80 - 90	8.64	518,400	45,000	1,479.92	3,107.55

Since the wastewater organic concentrations are expected to be high, anaerobic ponds will be provided ahead of the oxidation ditch process. The anaerobic ponds will be of rectangular units and will normally be operated at a loading rate of 400 g/m³/day of BOD or lower with the average detention time of 2 - 4 days. The BOD removal rate of 60 percent could be achieved.

8) Wastewater Solid Disposal

Sludge removed from the final settling tanks may vary in solids content from 0.5 to 1.0 percent. Each of settling tanks will have its own sludge withdrawal pipes for discharge to the sand drying beds.

Screenings, grit, scum and grease, and sludge solids should be safely disposed of to dumping places. It is proposed that the sludge be disposed of on available land, thereby making use of the sludge as a soil conditioner.

9) Recommendations for Wastewater Treatment

In view of the preceding discussions, it is concluded that an oxidation ditch sewage treatment plant for the project be constructed and expanded in parallel with sewer constructions.

Discharge of the wastewater with the secondary treatment could be used for crop irrigation and ground recharge if and when it is clarified that such effluent reuse will create no health hazards and appropriate for crop irrigation and groundwater.

9.5 Design Criteria

More details of design criteria for wastewater and drainage systems are discussed in the attached Appendix-C "Sewer and Pumping Facility Planning," Appendix-D "Wastewater Treatment Facility Planning" and Appendix-E "Stormwater Drainage System."

In general, and except for special reasons, the sewerage and drainage systems will be planned and designed on the basis of the following criteria:

9.5.1 Sewers

(1) Design Period

In general, sewers should be designed for the estimated tributary population in the year 2015, except in considering parts of the system that can be readily increased in capacity.

(2) Design Factors

In determining the required capacities of sanitary sewers the following factors should be considered:

1) Maximum hourly sewage flow ; daily average flow rate x 2.5.
2) Additional maximum sewage or waste flow from any facility where justified necessary.
3) Topography of area.
4) Depth of excavation
5) Pumping requirements

(3) Design Basis

Public sewers shall be not less than 200 mm in diameter except for house connection pipes. The Meaning's equation shall be used in principle for gravity sewers and stormwater drains in the form:

$$V = 1/n\ R^{2/3} S^{1/2}$$

where

V = velocity of flow, in m/sec
n = coefficient of roughness
R = hydraulic radius, in m
S = slope

Table M.9.10 Roughness Coefficients for Various Pipe Materials

Type of Pipe	Coefficient of Roughness (n)
Vitrified clay pipe (VCP)	0.013
Plastic pipe (PP)	0.010
Concrete pipe (CP)	0.013

(4) Velocity of Flow

All sewers shall be designed and constructed to give mean velocities, when flowing 60 percent depth, of not less than 0.6 m/sec, based on the Manning's formula using an 'n' value as shown in Table M.9.9. The velocity shall not exceed 2 m/sec in any type of sewers to protect sewer erosion, but in storm-water drains the velocity shall be 2.5 m/sec or lower.

(5) Slope

The following are the minimum slopes which should be provided; however, slopes greater than these are desirable:

Table M.9.11 Minimum Sewer Slopes

Sewer Size (mm)	Minimum Slope (meters per meter)
100	0.01000
200	0.00330
250	0.00245
300	0.00192
350	0.00157
400	0.00131
450	0.00112
500	0.00100
600	0.00100
700	0.00100
800	0.00100
900	0.00100
1,000	0.00100
1,100	0.00100
1,200	0.00100

(6) Alignments

Sewers shall be laid in general with straight alignment between manholes.

(7) Increasing Size of Sewers

When smaller sewers joins a larger one, the invert of the larger sewer should be lowered sufficiently to maintain the same energy gradient. An approximate method for securing these results is to place the sewer crown of both sewers at the same elevation.

(8) Joints and Infiltration

Sewer joints shall be so designed as to minimize infiltration and to prevent the entrance of roots or other obstacles.

(9) Manholes

Manholes shall be installed at the end of each line; at all changes in grade, size, or alignment; at all intersections; and at distances as shown in the following table:

Table M.9.12 Manhole Spacings

Sewer Diameter (mm)	Maximum Manhole Spacing (m)
200 or smaller	30
200 to 500	45
600 to 1000	80
1000 or larger	100

The manhole diameters shall as follows:

Table M.9.13 Manhole Diameters

Manhole Depth (m)	Manhole Diameter (m)
0-1	0.80
1-2	1.00
2-3	1.25
more than 3	1.50

9.5.2 Pumping Stations

Sanitary sewage and storm drainage pumping stations shall be designed on the basis of the peak flow rates. All pipings and conduits shall be designed to carry the expected peak flow rates. The following items should be given considerations in the design of sewage pumping stations. More details are discussed in Appendix-C "Sewer and Pumping Facility Planning."

(1) Type and Structure

For large pumping stations to lift the sewage submain or main sewers should in general be of a dry well type. Provision shall be made to facilities removing pumps and motors. Suitable and safe means of access shall be provided to dry wells of pumping stations and shall be provided to wet wells containing either bar screens or mechanical equipment requiring inspection or maintenance.

For intermediate sewage pumping stations require for lifting the sewage of branch and/or submain sewers should be of submersible type provided in a manhole or similar structures. Submersible pumps shall be readily removable and replaceable without de-watering the wet wells and with continuity of operation of the other unit or units.

(2) Screening

For dry well type pumping stations, protection for pumps and other equipment shall be provided by installing bar screens. All facilities should be readily accessible for maintenance. Channels shall be equipped the necessary gates to divert floe from any one screening unit. Provisions must also be made for dewatering each unit.

(3) Grit Removal Facilities

Grit removal facilities should be provided in principle for sewage and stormwater pumping stations. Where it may be necessary to pump the sewage prior to grit removal, the design of wet wells should receive special attention and the discharge piping shall be designed to prevent grit settling in pump discharge lines of pumps not operating. Grit removal facility should have at least 2 units.

Grit facilities located in deep pits should be provided with mechanical equipment for pumping or hoisting grit to ground level. Such pits should have a stairway, adequate ventilation, and adequate lighting. Impervious surfaces with drains should be provided for grit handling areas. An adequate supply of water under pressure shall be provided for clean up.

(4) Pumps

At least 2 pumps shall be provided for all types of pumping station. Pumps should be designed to fit actual flow conditions and must be of such capacity that with any one unit out of service the remaining units will have capacity to handle maximum sewage flows.

Submersible pumps shall be capable of unsubmerged operation without damage or reduction of service capability or positive provision shall be made to assure submergence.

(5) Controls and Valves

Control equipment should be so located as not to be unduly affected by flows entering the well or by the suction of the pumps. Float tubes in dry wells, where used, shall extend high enough to prevent overflow. Suitable shutoff valves shall be placed on suction and discharge lines of each pump. A check valve shall be placed on each discharge line, between the shutoff valve and the pump.

(6) Wet Wells

The effective capacity of the wet well shall provide a holding period not to exceed 10 minutes for the design average sewage flow. The wet well floor shall have a minimum slope of 1 to 1 to the hopper bottom.

(7) Ventilation

Adequate ventilation shall be provided for all pumping stations. Where the pump pit is below the ground surface, mechanical ventilation is required, so arranged as to independently ventilate the dry well and the wet well if screens or mechanical equipment requiring maintenance or inspection are located the wet well.

(8) Flow Measurement

Suitable devices for measuring flow should be provided at the major pumping stations.

(9) Alarm System and Emergency Power

Alarm system should be provided for pumping stations where it is practicable. The alarm shall be activated in cases of power failure, pump failure, or any cause of pumping station malfunction.

Provision of an emergency power supply for major pumping stations should be made. For the emergency power supply, in-place internal combustion engine equipment should be provided with a unit size adequate to provide power for lighting, ventilation and pump unit and such further system affecting capability and safety.

(10) Overflows

The provision of a high-level wet well overflow to supplement alarm systems and emergency power generation should be considered. Where a high level of overflow is utilized, consideration shall also be given to the installation of storage-detention tanks, or basins, which shall be made to drain to the station wet well.

(11) Force Mains

As design average flow, a cleansing velocity of at least 60 cm/sec shall be maintained. Automatic air relief valves shall be placed at high points in the force main to prevent air locking. Force mains should enter the gravity sewer system at a point not more than 60 cm above the flow line of the receiving manhole.

9.5.3 Wastewater Treatment Plant

The following items shall be taken into consideration in planning and design of the sewage treatment plant facilities:

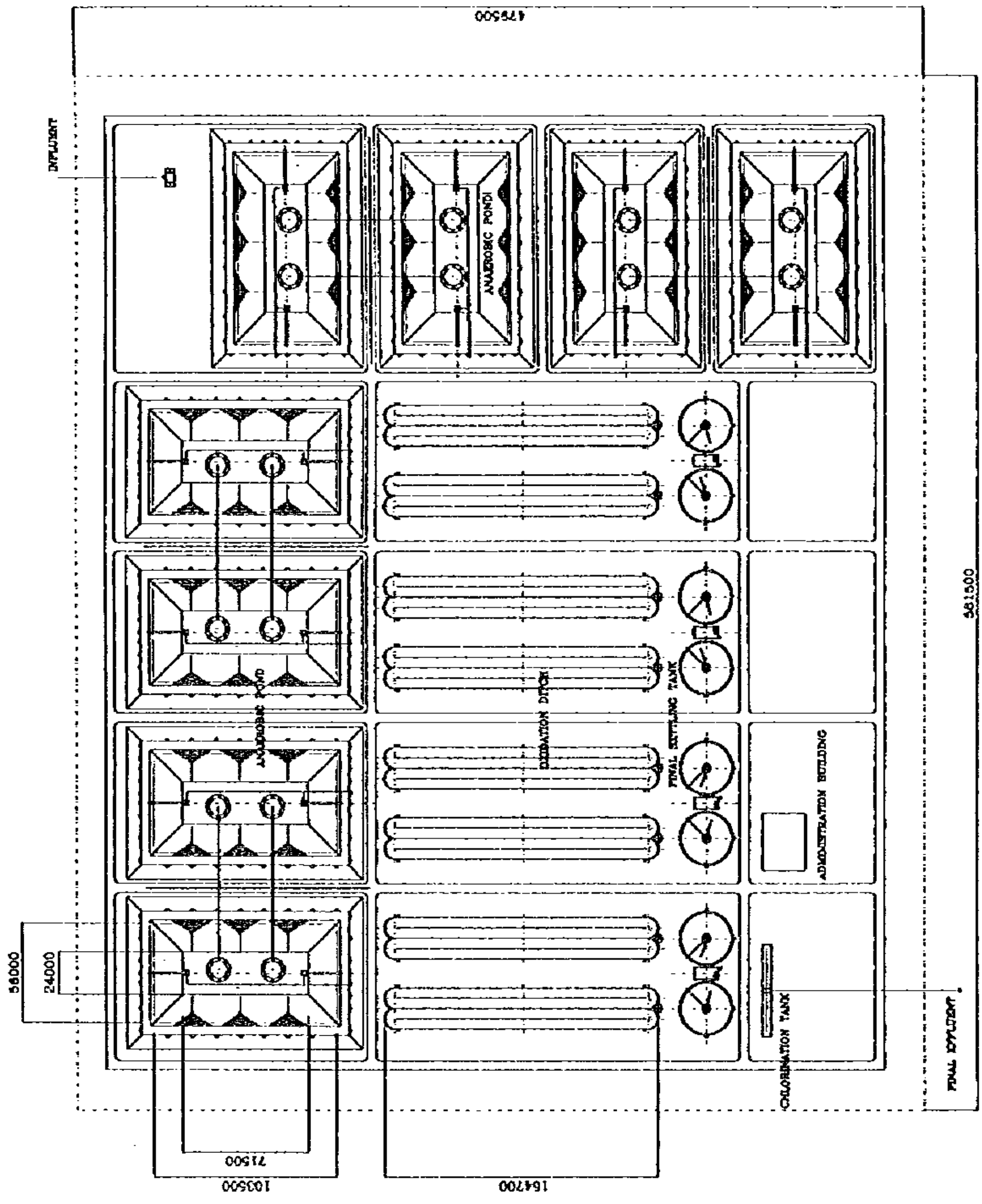
(1) Type and Degree of Treatment

On account of the possible effluent reuse for crop irrigation and other purposes, and for the environmental protection of the area, an oxidation ditch treatment process is recommended. The expected sewage influent and effluent qualities are as follows:

Item	Concentrations(mg/l)	
	Influent	Effluent
BOD_5	500	25
SS	620	31
T-P	30	30
T-N	130	39

(2) Hydraulic Loadings

In general, the design of the sewage treatment plant shall be based on the average daily rate of sewage flow rate. All pipings and conduits shall be designed based on the peak rate of flow. The following loadings are the recommended design standards for each of the units:



(unit : mm)

FIG.M.9.9	LAYOUT PLAN OF PROPOSED SEWAGE TREATMENT PLANT

THE STUDY ON SEWERAGE DEVELOPMENT PLAN IN THE AREA OF KHAN YUNIS
IN PALESTINIAN INTERIM SELF-GOVERNMENT AUTHORITY

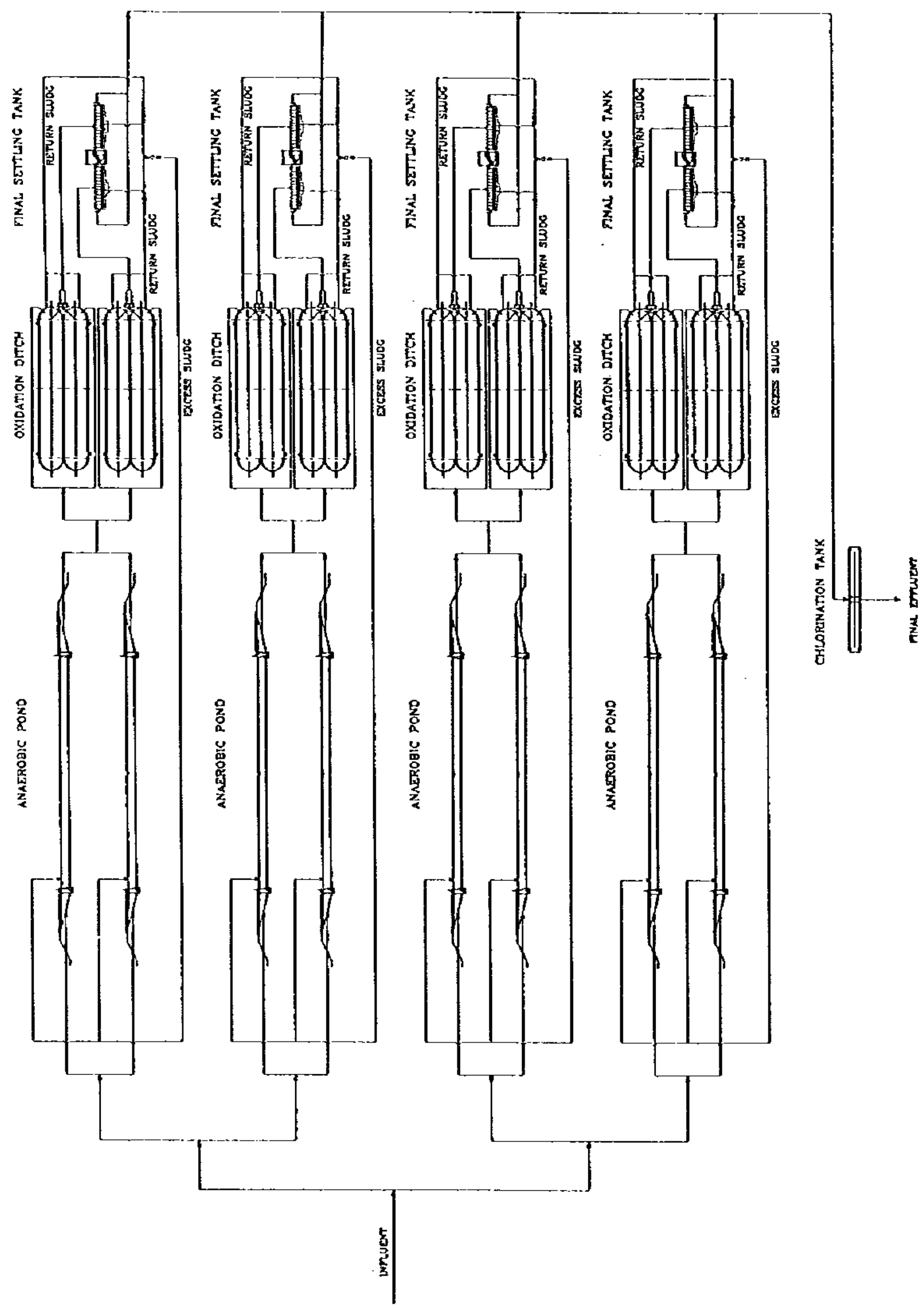


FIG.M.9.10 FLOW SHEET OF PROPOSED SEWAGE TREATMENT PLANT

THE STUDY ON SEWERAGE DEVELOPMENT PLAN IN THE AREA OF KHAN YUNIS IN PALESTINIAN INTERIM SELF-GOVERNMENT AUTHORITY

Table M.9.14 Standard Hydraulic Loadings

Units	Hydraulic Loadings
Screens	
Velocity of flow through bars	0.5 to 0.8 m/sec
Grit chamber	
Overflow rate	1,880 m^3/m^2/day
Detention time	30 second
Velocity of flow through channel	0.3 m/sec
Unaerobic ponds	
Detention time	2 days
Oxidation ditches	
Detention time	24 hours
Channel velocity	0.3 m/sec
Return sludge	50 to 150 % of inflow
Sedimentation basins	
Overflow rate	10 m^3/m^2/day
Detention time	8 hours
Weir loading	lower than 50 m^3/m/day
Chlorine contact tanks	
Contact time	15 minutes

(3) Organic Loadings

In general, the design organic loadings shall be calculated in the same manner as used in determining design flow. Standard organic loadings for each treatment plant unit are shown in the table below:

Table M.9.15 Organic Loadings

Units	Hydraulic Loadings
Oxidation ditches	
Aerator BOD loading	0.4 kg BOD/m^3 of ditch
MLSS	3,000 to 4,000 mg/l
ASRT	8 to 50 days
Oxygen transfer efficiency	2.2 kg O_2/kW-hr
Dissolved oxygen in aeration tank	0.5 mg/l
Excess sludge	
Concentration	0.8 % of sewage

(4) Arrangement of Units

Component parts of the plant should be arranged for greatest operating convenience, flexibility, economy, and so as to facilitate installation of future units.

(5) By-Passes

Except where duplicate units are available, properly located and arranged by-pass structures shall be provided so that each unit of the plant can be removed from service independently. Where the discharge of raw sewage is not permitted to the ground, a provision shall be considered to provide a storage facility of appropriate capacity.5

(6) Drains

Means should be provided to dewater each unit. Due consideration should be given to the possible need for hydrostatic pressure relief devices.

(7) Construction Materials

Due considerations should be given to the selection of materials which are to be used in sewage treatment facilities because of the possible presence of hydrogen sulfide and other corrosive gases, greases, oils, and similar constituents frequently present in the sewage.

(8) Emergency Power Failure

Standby power sources shall be provided to ensure the continuous operation of such important equipment as influent pumps, minimum number of aerators, and emergency lighting.

(9) Essential Facilities

Necessary facilities for operation and maintenance of the plant shall be provided, including:

1) Water supply facilities,
2) Drainage facilities,
3) Plant roads and parking facilities,
4) Service facilities, and
5) Connecting conduits.

(10) Safety

Adequate provision shall be made to effectively protect the operators and visitors from hazards.

(11) Oxidation Ditches

The dimensions of each independent aeration ditch shall be such as to maintain effective mixing and utilization of air. Liquid depth should be in general 3.0 meters. Inlets and outlets for each aeration tank unit shall be suitably equipped with valves, gates, stop gates, or other devices to permit controlling the flow to any unit and to maintain reasonably constant liquid level. The hydraulic properties of the system shall permit the maximum instantaneous hydraulic load to be carried with any single aeration ditch unit out of service.

The mechanism and drive unit shall be designed for the expected conditions in the ditch in terms of the proven performance of the equipment. Multiple mechanical aeration unit installation shall be so designed as to meet the maximum air demand with the largest unit out of service. The design should also provide for varying amount of oxygen transferred in proportion to the load demand on the plant.

If motor driven return sludge pumps are used, the maximum return sludge capacity shall be obtained.

(12) Sedimentation Basins

Inlets should be designed to dissipate the inlets velocity, to distribute the flow equally and to prevent short-circuiting. Channels should be designed to maintain a velocity of at least 0.3 m/sec at one-half design flow. Provision shall be made for elimination or removal of floating materials in inlet structures having submerged ports.

Effective scum collection and removal facilities, including baffling, shall be provided ahead of the outlet weirs on all sedimentation basins. Provisions may be made for discharging of scum with the sludge.

A sludge well should be provided or appropriate equipment installed for reviewing and sampling the sludge. Provisions should be made to permit continuous sludge removal from final sedimentation basin when the sludge is returned to the ditches.

(13) Chlorine Contact Tanks

Disinfection is accomplished with liquid chlorine or sodium hypochlorite or chlorine dioxide. The chemical should be selected after due consideration of waste flow rates, application and demand rates, pH of wastes, cost of equipment and the chemical, availability and maintenance problems.

Required chlorinator capacity should be determined to have a sufficient contact time between the chlorine compound and the sewage, but in general the contact time should be at least 20 minutes or longer to ensure bacterial destruction. Care should be taken to prevent short-circuiting by the pro-visions of appropriate baffling or other means.

An ample supply of water shall be available for operating the chlorinator. If a booster pump is required, duplicate equipment should be provided, and when necessary, standby power as well.

9.5.4 Stormwater Drainage System

(1) Stormwater Runoffs

1) Stormwater runoff rates shall be calculated in principle based on the Rational Method for small catchment areas.

2) Runoff coefficients shall be determined in principle based on the composite coefficient of the area in which the channels are designed, using the basic runoff coefficients for the different surface types.

3) Rainfall frequency of occurrence once in five years shall be used for runoff calculation.

4) Time of concentrations shall be estimated considering the inlet time and the time of flow in drain.

(2) Retention Basin

1) Retention basin capacity shall be determined by using hydrograph method.

2) Retention surface shall be protected with appropriate materials

3) Inlet and outlet structures shall have sufficient flowing capacity and be appropriately designed so as to flow the expected peak discharge smoothly.

(3) Hydraulic Design of Drainage Channels

1) Channel sections shall be determined based on the design peak runoff rates.

2) Layout of the drainage channels shall such as to minimize the hydraulic head losses, considering topographic conditions, soil conditions, road widths, and underground structures.

3) Slope, shape, and cross section of a drainage channel shall be determined so that the proper velocity of flow can be maintained to prevent the settlement of solids on the bottom.

4) Existing drainage channels shall be effectively used to the extent practicable.

5) Where a stormwater retention basin is considered, the basin capacity should be calculated by an appropriate hydrograph method.

(4) Street Inlets

1) Where necessary, stormwater flow on a street surface should be collected to street gutters through inlets connecting with the underground storm-water drains.

2) Gutters should be provided at street intersections where cross streets are not too far apart. Where the distance between intersecting streets exceed 100 or 150 meters, or where roofs or paved areas outside the street lines drain to the street gutter, the inlets should be provided at intermediate points.

3) Hydraulically appropriate gutter inlet castings shall be provided.

4) The connecting pipes to the drain shall be of 150 mm or larger in diameter.

(5) Pumping System

Pumping system shall be designed generally in accordance with those for the sanitary sewerage system.

CHAPTER 10 ALTERNATIVE WASTEWATER SYSTEM PLANNING

CHAPTER 10 ALTERNATIVE WASTEWATER SYSTEM PLANNING

10.1 Regional Wastewater Management System Plans

10.1.1 Basis for System Planning

(1) Wastewater Districts

As previously discussed in Section 9.1, the entire Project Area is divided into seven sewerage/sanitation districts. Within the sewerage districts, however, agricultural areas, within which no urban development plan is expected by 2015, are excluded from the sewerage system implementation area. The sewerage implementation areas and projected populations in the districts in 2015 are shown below:

Table M.10.1 Sewerage/Sanitation Districts

Name of District	Area (ha)	Population (in 2015)	Jurisdictional Area Covered
1. Khan Yunis	1,644	300,000	Khan Yunis
2. Kizan Area	519	52,000	Kizan Abu Humar, Kizan Al Najar, Ka'a Al Gorain, Wadi Saber
3. Bani Sohaila	404	38,000	Bani Sohaila
4. Qarrara	443	34,000	Qarrara
5. Abassan Saghera	89	12,000	Abassan Saghera
6. Abassan Kabera	404	26,000	Abassan Kabera
7. Khuzaa	129	14,000	Khuzaa
Total	3,632	476,000	

For sewerage system planning purpose, the sewerage implementation area is further divided into 19 sewerage sub-districts, following the topographic conditions and administrative boundaries of the area, as illustrated in Figure M.9.2.

(2) Wastewater Productions

As discussed previously in Chapter 7 "Wastewaters," the wastewater production rates and characteristics in 2015 are summarized below:

Table M.10.2 Wastewater Quantities and Qualities (2015)

Items	Projected Quantity and Quality
1. Wastewater Quantities	
Per capita daily average flow;	112 lpcd
Per capita peak flow;	280 lpcd
2. Wastewater Qualities	
BOD concentration;	500 mg/l
SS concentration;	600 mg/l
Per capita BOD load	55 g/day

Table M.10.3 Wastewater Production by District (2015)

District	Population	Sewage (m^3/d)	Sewage (m^3/s)
Khan Yunis	300,000	33,600	0.3889
Kizan	52,000	5,824	0.0674
Bani Sohaila	38,000	4,256	0.0493
Qarrara	34,000	3,808	0.0441
Abassan Saghera	12,000	1,344	0.0156
Abassan Kabera	26,000	2,912	0.0337
Khuzaa	14,000	1,568	0.0181
Total	476,000	53,312	0.6170

(3) Planning Basis for Wastewater System Facility

The alternative systems facilities are planned on the basis of the design criteria for sewers, pumping stations and sewage treatment plants, as described in Section 9.5 "Design Criteria," Appendix-C "Sewer and Pumping Facility Planning," and Appendix-D "Wastewater Treatment Facility Planning." The major features of the criteria are as follows:

- Minimum earth covering of sewers ;	1 meter
- Maximum depth of sewers;	6 meters
- Minimum velocity of flow in sewers ;	60 cm/sec
- Maximum velocity of flow in sewers;	3 m/sec
- Pipe materials 200 to 400 mm dia.;	PVC
- Pipe materials 450 mm in dia. or larger;	Reinforced concrete pipe
- Intermediate pumping stations ;	Submersible/Drywell type
- Maximum head of pumps;	30 m
- Treatment process;	Oxidation ditch

The topographic maps in the scale 1:10,000 with 5-meter interval contour lines and 1:20,000 with 10-meter interval contour lines have been used for determining water sheds and defining catchment areas.

10.1.2 Alternative Regional Systems

Initially, two alternative sewerage systems were considered, one was for a comprehensive sewerage system covering the whole Project Area, and the other for multiple independent sewerage systems.

Selection of the most desirable regional system will depend on the characteristics of the Area. The physical characteristics inherent to the Project Area are that i) populated urban areas are limited, ii) huge rural areas still remain to be developed in the future, iii) hilly dunes exist in the surrounding areas with uneven ground surface, and iv) wide areas exist with scattered villages producing small amount of wastewaters.

If a single comprehensive regional sewerage system is to be planned in a large area, long and deep main sewers would be required to convey the wastewater from the individual house all the way to the treatment plant (e.g. No.5 or No.6 alternative plant sites), thus requiring high initial investments, high operation and maintenance costs later, and a considerably long construction period, to cover small number of people. Consequently, an early commencement of the wastewater management system operation can hardly be anticipated.

Under the circumstances, it is practical and prudent that the Project Area be properly divided into several districts to deal with the wastewaters with an independent sewerage system, rather than planning a large single regional sewer system to cover the whole Project Area. The expected advantages with the divided districts systems are as follows:

(1) It is possible to design the sewer facilities based on the characteristics of each district.

(2) Implementation of construction will be flexible to adjust according to the degree of requirement and availability of financial resources.

(3) Long conveyance can be avoided, which will avert inconvenience in construction, enabling easier operation and maintenance and better control of sulfide build-up.

(4) Rural areas, in which urbanization plan is yet to be developed, will remain flexible for the future implementation.

The Project Area of 4,458 hectares in all is therefore divided into seven (7) districts following the jurisdictional boundaries; comprising i) Khan Yunis, ii) Kizan, iii) Bani Sohaila, iv) Abassan Saghera, v) Abassan Kabera, vi) Khuzaa, and vii) Qarrara. In dividing the Study Area, due consideration was given to both the present and future projected populations, topographic conditions, and trend of urban developments.

For the sewerage facility planning, these districts are further divided into sub-districts as necessary for the sewerage facility planning in view of the following:

(1) Population densities.

(2) Existing roads, railways, wadis, and other major structures.

(3) Land use patterns.

(4) Administrative boundaries.

(5) Conditions of built-up area.

(6) Topography

Several alternative delineation are considered, but with due note of the advantages for smaller delineation as stated earlier, the following division is considered to serve the purpose. The location of the sewerage/sanitation districts are shown in Figure M.10.1.

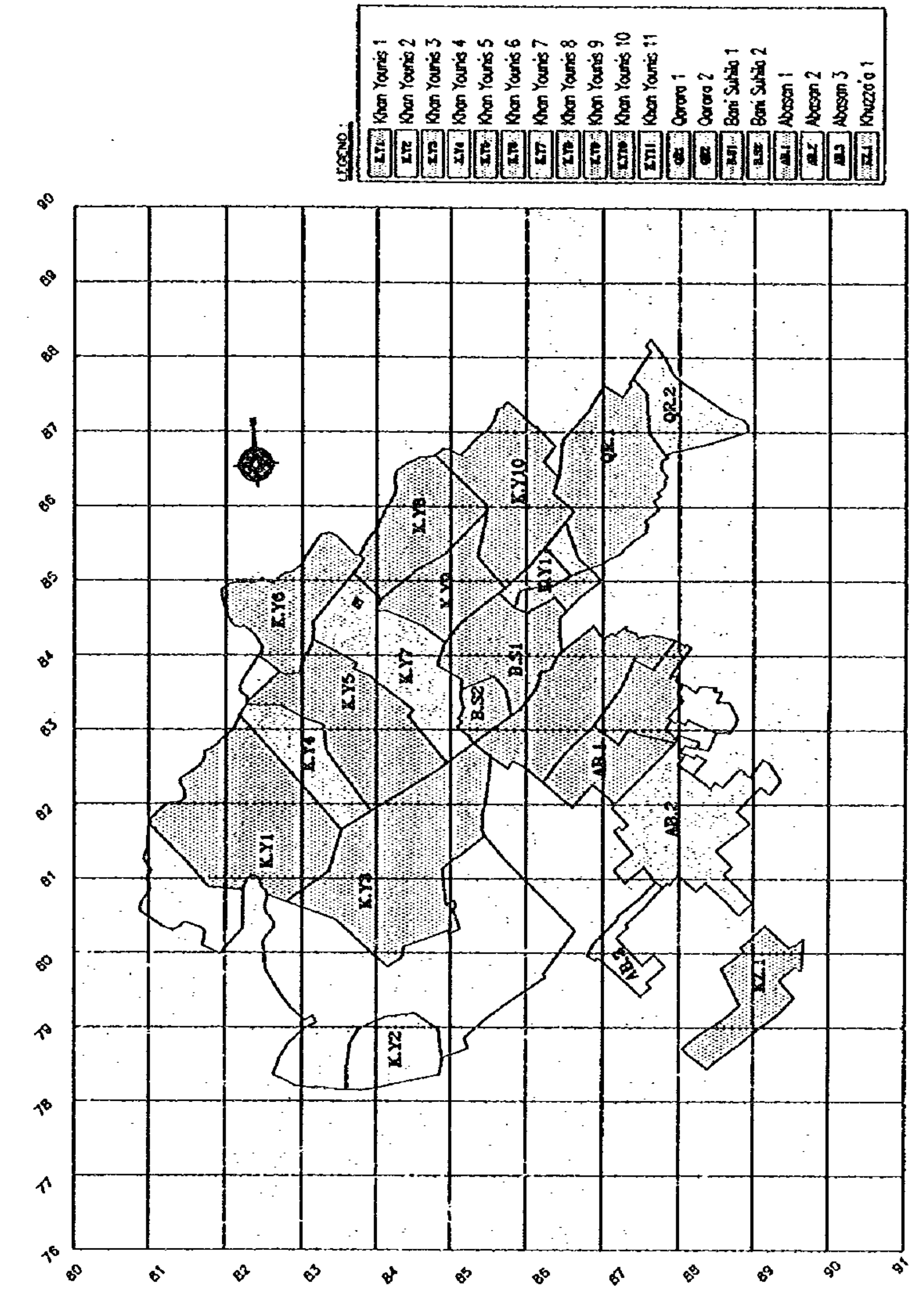


FIG. M.10.1 **SUB CATCHMENT AREA**

THE STUDY ON SEWERAGE DEVELOPMENT PLAN IN THE AREA OF KHAN YUNIS
IN PALESTINIAN INTERIM SELF-GOVERNMENT AUTHORITY

(1) Selected Alternative Programs

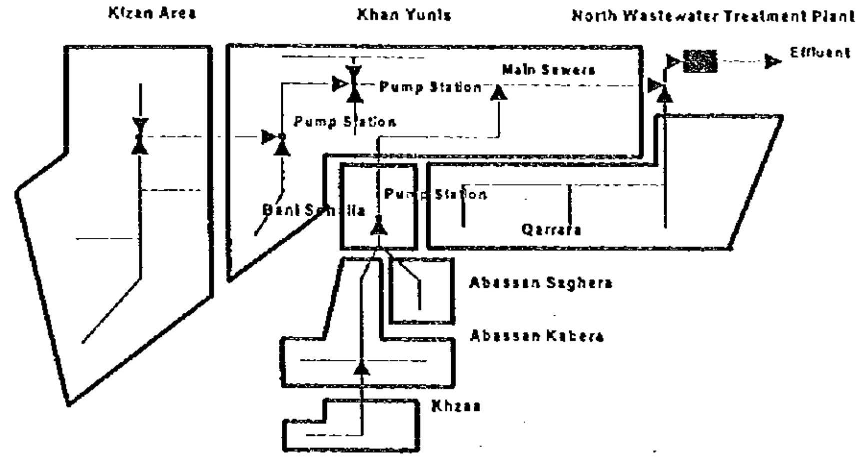
A preliminary analysis on the possible eight (8) alternative combinations of regional wastewater management system programs was made, and less feasible plans were screened out from further analysis. Thus, three most appropriate alternative regional wastewater management programs were finally selected for further detailed analyses. Major features of the selected alternative programs are as follows:

Alternative 1: Under this plan the whole sewerage implementation area is covered with the piped sanitary sewerage system, except some agricultural and undeveloped areas. The system would comprise sewer reticulations, pump stations, force mains, and a concentrated large scale sewage treatment plant (North sewage treatment plant) located at the site No.6 to the north of Khan Yunis City.

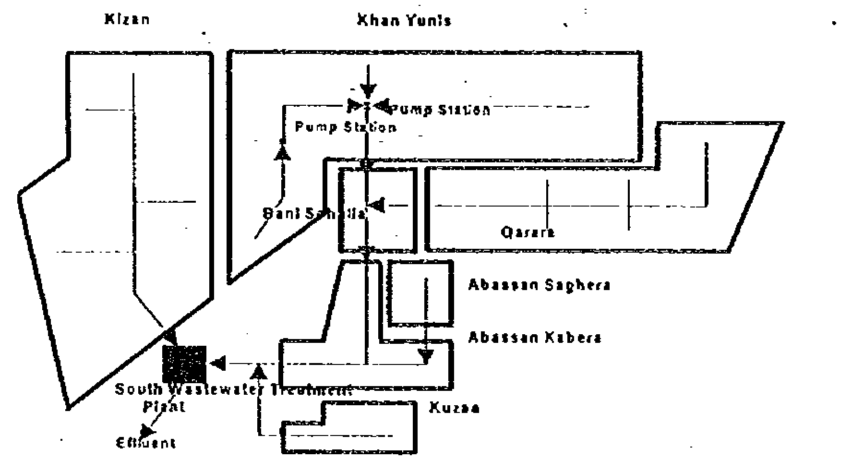
Alternative 2: The plan also covers the whole sewerage implementation area with the piped sewerage systems, but a concentrated sewage treatment plant (South sewage treatment plant) is to be provided at the candidate site No.5, south of Kizan area.

Alternative 3 : This plan divides the whole sewerage implementation area into two separate independent regional sewerage districts, North and South Regions, following the topographic conditions of the Area. Under this plan, two separate wastewater management systems will be provided.

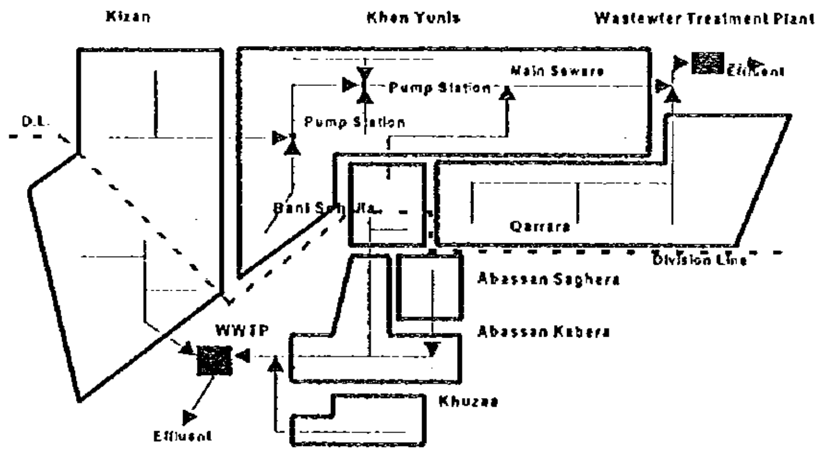
The contemplated three alternative sewerage facility layout plans are illustrated in Figures M.10.2 through 10.5 and explained in the following:.



Regional Wastewater Management Program Alternative 1



Regional Wastewater Management Program Alternative 2



Regional Wastewater Management Program Alternative 3

FIG.M.10.2	ALTERNATIVE REGIONAL WASTEWATER MANAGEMENT PROGRAMS

THE STUDY ON SEWERAGE DEVELOPMENT PLAN IN THE AREA OF KHAN YUNIS
IN PALESTINIAN INTERIM SELF-GOVERNMENT AUTHORITY

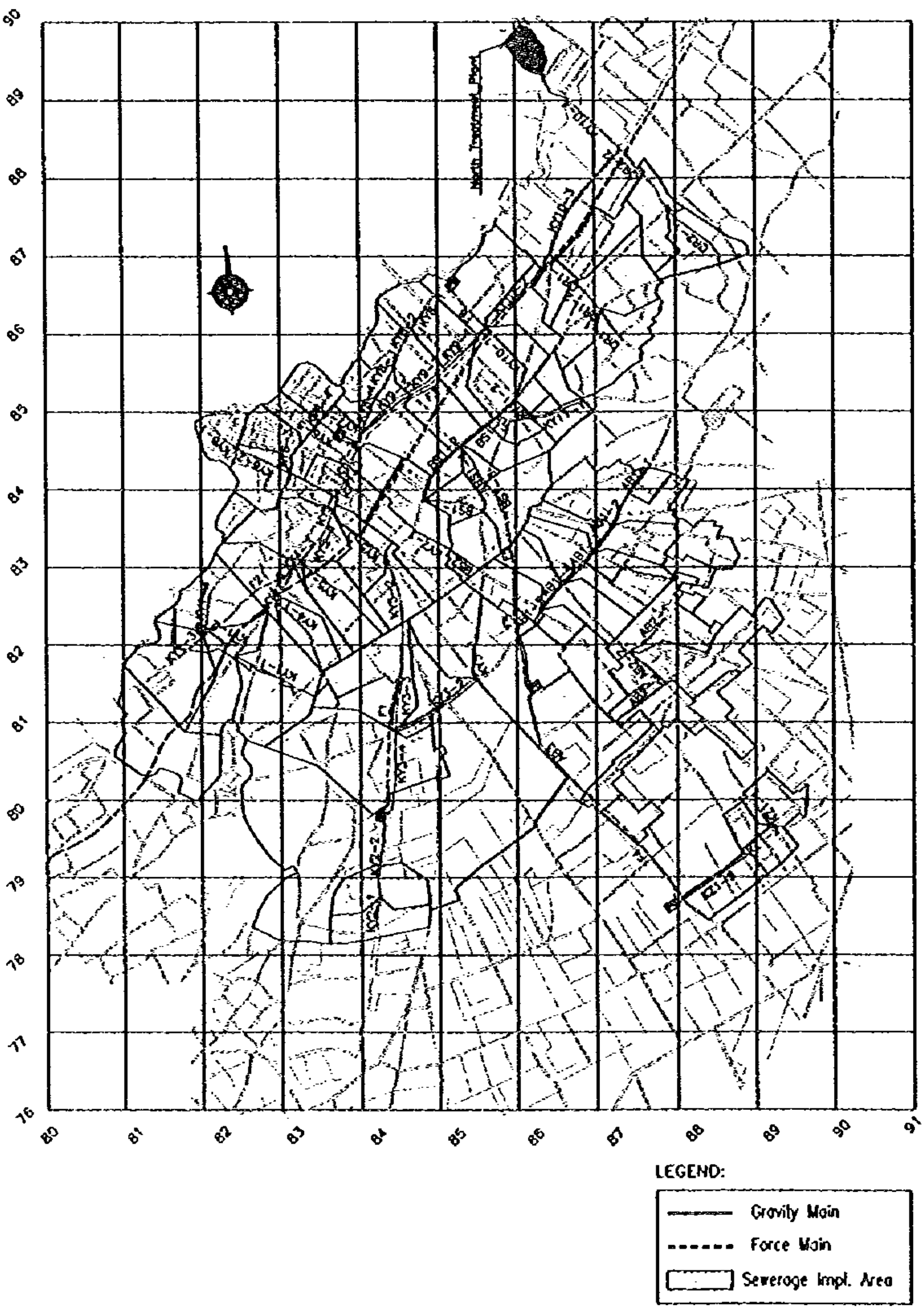


FIG.M.10.3	WASTEWATER MANAGEMENT PROGRAM - ALTERNATIVE 1

THE STUDY ON SEWERAGE DEVELOPMENT PLAN IN THE AREA OF KHAN YUNIS
IN PALESTINIAN INTERIM SELF-GOVERNMENT AUTHORITY

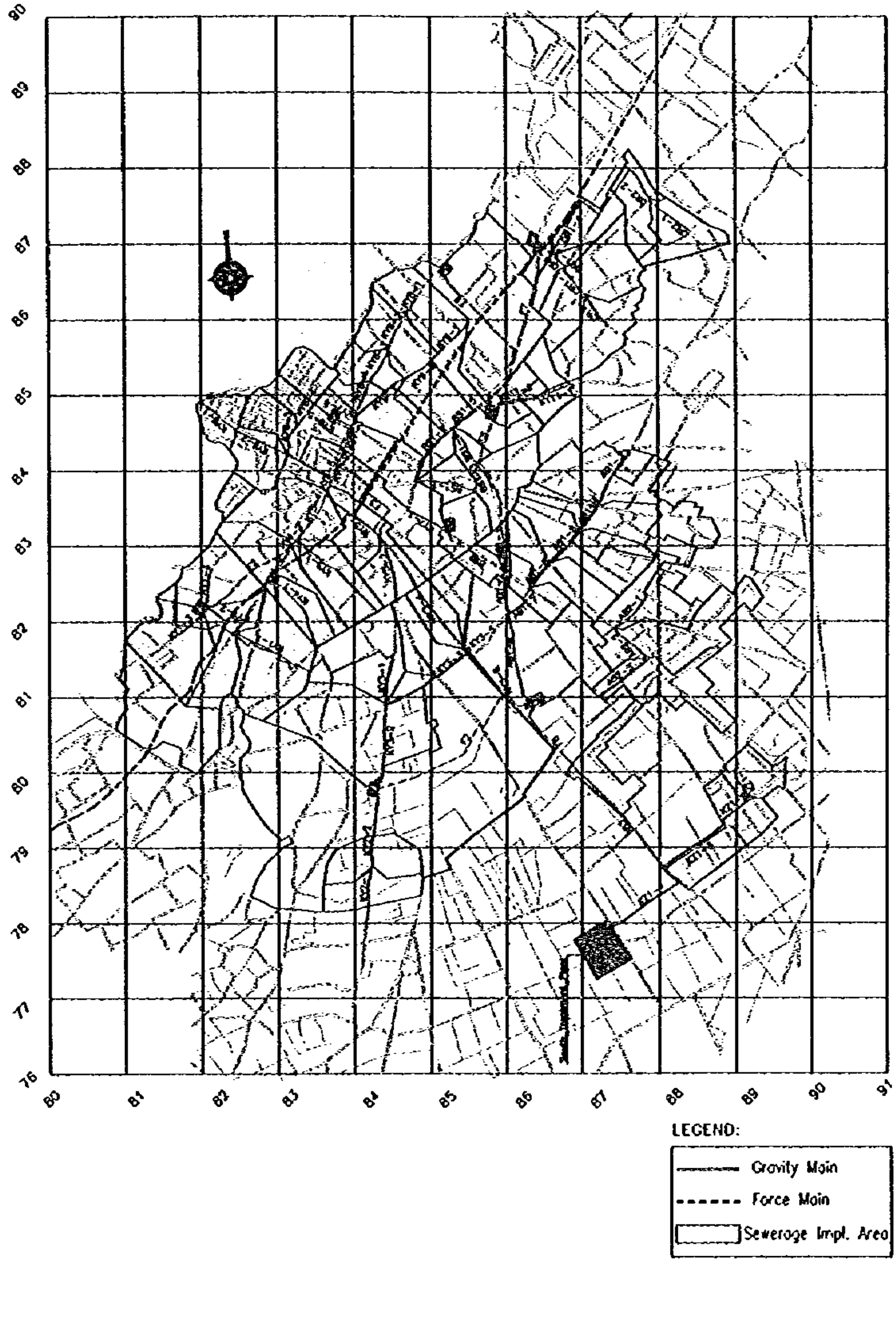


FIG.M.10.4 WASTEWATER MANAGEMENT PROGRAM - ALTERNATIVE 2

THE STUDY ON SEWERAGE DEVELOPMENT PLAN IN THE AREA OF KHAN YUNIS
IN PALESTINIAN INTERIM SELF-GOVERNMENT AUTHORITY

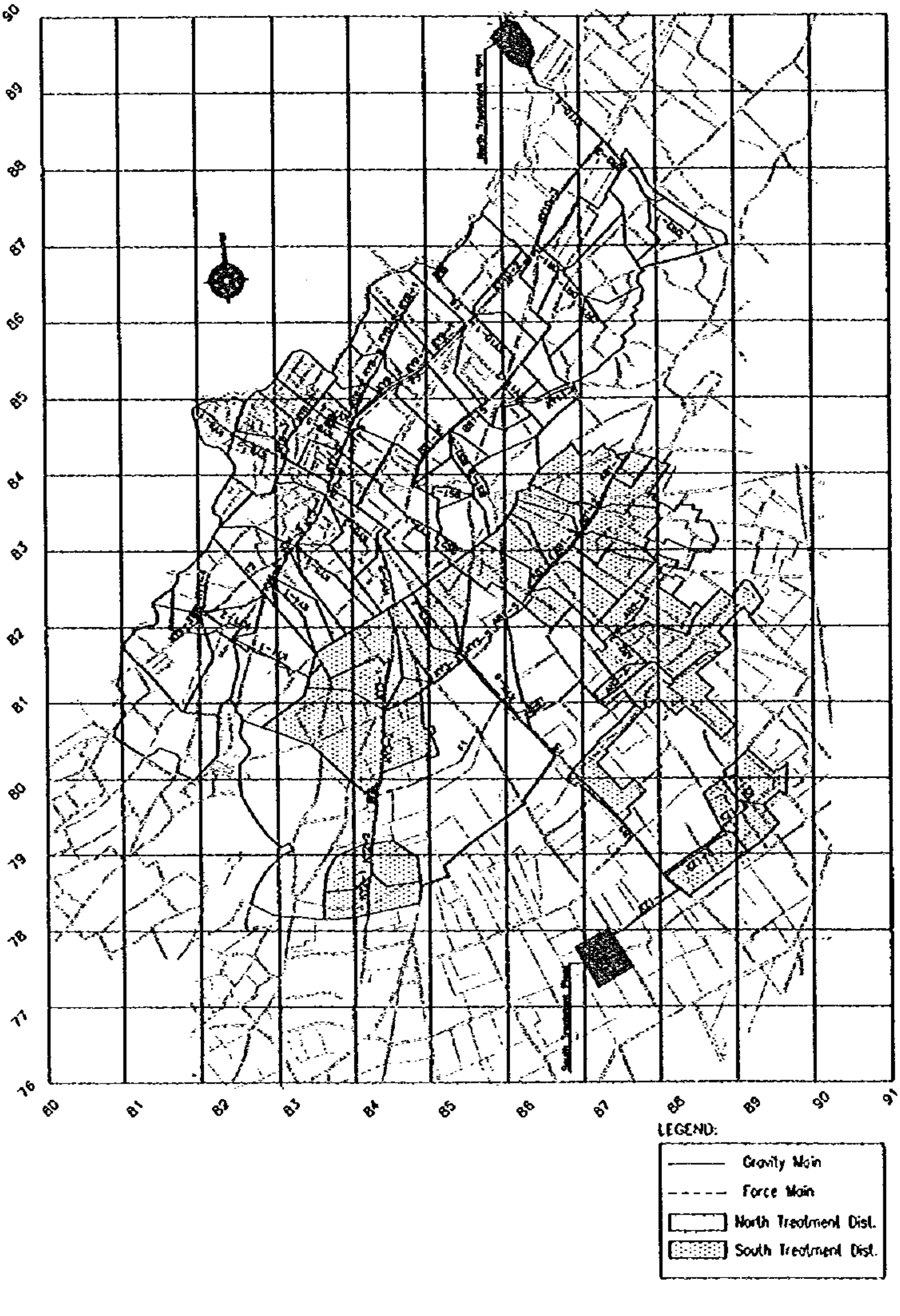


FIG.M.10.6 WASTEWATER MANAGEMENT PROGRAM - ALTERNATIVE 3

THE STUDY ON SEWERAGE DEVELOPMENT PLAN IN THE AREA OF KHAN YUNIS
IN PALESTINIAN INTERIM SELF-GOVERNMENT AUTHORITY

(2) Alternative 1

The system covers the entire sewerage implementation area of 3,632 hectares with the sewerage system. Most of the wastewaters generated in Khan Yunis City and Kizan area flow either by gravity or pressure to a lift pumping station near Block F road in Khan Yunis City. The wastewaters is then transmitted through a 3-km long force main pipe of 900 mm in diameter to a point northeast of the City, from where the wastewater continues its flow by gravity through a main sewer of 1,600 mm in diameter as far as the Khan Yunis sewage treatment plant at No.6 site (Local coordinate N-S 86.0, E-W 89.5, at about 22 meters above sea water level).

The wastewaters would be collected through sewer reticulations from their own administrative boundaries, diameters of which ranging from 200 to 250 mm. Due mainly to the prevailing topographic conditions of the area, the wastewaters from Kizan, southern part of Khan Yunis, Bani Sohaila, Abassan Kabera, Abassan Saghera, and Khuzaa, will have to be lifted up by sewage pumping stations in the Bani Sohaila and Kizan sewerage districts.

At the terminal of each sewer main leading the wastewaters out from its administrative boundary, an appropriate flow measuring device would be provided to meter the actual wastewater inflow rates from each jurisdictional boundary to the regional main or submain sewers.

The capacity of the sewerage system should be such that it could accommodate the anticipated flows in the target year from within the Project Area under full development conditions. The wastewater flows from all the sewerage implementation area would be conveyed to the sewage treatment plant, finally disposing of the flows into the Mediterranean Sea through an outfall pipe.

(3) Alternative 2

Under this plan, all the wastewaters will be collected through the sewer net-works and conveyed to the South Wastewater Treatment Plant. The waste-water generated in the Khan Yunis District would be boosted by a pumping station and sent to the sewage pumping station in the south. The wastewater of the Qarrara, and part of Bani Sohaila Districts will be transmitted through a force main to the highest point in the Bani Sohaila District at the ground elevation of about 90 meters above sea level, from where the wastewaters flow down by gravity through a regional main sewer together with the inflowing wastewaters from the Abassan Saghera, Abassan Kabera and Khuzaa Sewerage Districts. The wastewaters in Kizan District will be pumped to the south pump station and form where sent to the South Sewage Treatment Plant. Thus, totally eight (8) intermediate pumping stations will be required.

The South Sewage Treatment Plant will be built in a land located about 10 km southeast of Khan Yunis City (approximate local coordinates N-S 87.0, E-W 78). The treated wastewater effluent from the plant would be disposed of either to the nearby wadi or reused for crop irrigation.

(4) Alternative 3

Under the wastewater management program of this alternative, the whole sewerage implementation area is divided into two sewerage regions, the North and South Regions. Each Region will independently collect, convey and treat the wastewaters within its own region. Due considerations were given to the topographic conditions in the area so that the sewers could lead the collected wastewaters by gravity to the maximum extent possible.

Topographically, the sewerage implementation area is distinctly separated by hilly terrains into two large catchment areas. The northern hilly terrain, having the ground elevations range of 90 to 95 meters above sea level, runs from northeast to southwestern direction, and turns to the western direction at the south of Khan Yunis City, dividing Khan Yunis City from Kizan, southern part of Bani Sohaila, Abassan Saghera, Abassan Kabera, and Khuzaa Districts.

At the southeastern part of the implementation area is another continuous hilly terrain of 80 to 100 meters above sea level, where Abassan Saghera, Abassan Kabera, Khuzaa are located. The gradients are toward the south-western direction. Accordingly, much portion of the wastewaters from these villages tend to find their ways to the southern low-land areas, ranging from 50 to 65 meters ground elevations and lying in between the two hilly terrains. Thus, most of the wastewaters from these areas could flow down by gravity through the way to the South Sewage Treatment Plant.

The wastewater system would be provided for two independent catchment areas, each with sewer reticulations, pumping stations and one sewage treatment plant.

Khan Yunis District collects the wastewaters from Khan Yunis, Kizan and the northern part of Bani Sohaila from where the wastewaters will join by gravity to the main sewer in Khan Yunis running toward the north along the Road No.4. Whereas, the wastewater from Qarrara District will also flow down by gravity to a junction point of the Khan Yunis main sewer close to the North Sewage Treatment Plant.

10.2 Comparative Analysis

10.2.1 Cost Comparison

For the purpose of cost comparison between the alternative regional wastewater management programs described in the foregoing sections, an analysis was made of all costs accruing to each alternative over the 25-year period. For the comparison purpose, it is assumed that the fund is available for all the construction, and operation and maintenance costs, and 2002 is considered to be the earliest year that any long-range wastewater management facilities can be made operational. Details of these cost estimates and comparisons are discussed in Appendix-B "Regional Waste Water Management System Planning."

Capital costs of wastewater conveyance and treatment facilities included in the various alternative systems, and annual operation, maintenance, and energy costs for those facilities were estimated. All costs are at 1996 level; for purposes of economic comparison between alternatives, no consideration need be or should be given to cost escalation. It is to be emphasized that these cost estimates are order-of-magnitude, or reconnaissance level only, and that while they are satisfactory for planning purposes and comparisons between alternative courses of action, they are not adequate for detailed financial planning.

Future capital and operating costs were discounted to present values in 1997 using a 10 percent discount rates. For the estimation of the costs, the plant for the South Sewage Treatment Plant was assumed to be acquired. For simplicity, stage-wise construction schedules for the various facilities were not prepared, assuming that the total capital investment required for each facility would be made in the year in which the facility would need to be completed. Thus, the investments required for implementation of each of the alternative programs was assumed to be made by 10th year after the programs were implemented.

In estimating capital costs of pump stations and force mains, preliminary pipeline alignments were made from inspection of topographic maps, and ground surface profiles were checked at a scale adequate for planning purposes. Pipes were then sized to accommodate the design peak flows following standard hydraulic procedures. Sewage pump stations were limited to lifts of 30 meters where possible.

A summary of total construction, operation and maintenance costs, and economic costs accruing to the four alternative wastewater management programs through the 25-year period are set forth in Tables M.10.4 and M.10.5, respectively:

Table M.10.4 Construction Costs of Alternative Plans (in US$ 1,000 at 1997 price level)

Alternative Plan	Capital Costs
Alternative 1	126,577.31
Alternative 2	132,682.11
Alternative 3	129,573.77

Note: i) direct construction costs
ii) breakdowns of the costs are shown in Appendix-B.

Table M.10.5 Economic Costs of Alternative Plans (in US$ 1,000 discounted at 10 %)

Alternative Plan	Capital Costs	O/M Costs	Total Costs
Alternative 1	97,719	9,154	106,872
Alternative 2	101,893	9,404	111,297
Alternative 3	100,344	11,360	111,704

Note: Details of the economic analysis are shown in Appendix-B.

Table M.10.5 above shows that, on the basis of total economic costs, Alternative 1 would be the least cost regional wastewater management program in terms of economic costs, followed by Alternatives 2 and 3 in order. These can be explained that Alternative 2 would require more energy costs than Alternative 1 for pumping a considerable mount of the wastewaters from Khan Yunis district to the South Sewage Treatment Plant located at almost 50 meters higher than Khan Yunis, thus increasing the O/M costs of Alternative 2.

The capital cost of Alternative 3 is lower than Alternative 2, because the wastewater flow directions in the plan generally follow the topographic conditions, thereby large capacity pump stations would be eliminated, but O/M costs for the two separate sewage treatment plants would of course be higher than a single treatment plant with the same treatment capacity, thus increasing the total O/M costs of this alternative. The differences in the economic costs among the alternative plans are, however, not so wide.

As it is presumed that at the initial stage of the implementation only limited fund would be available, Alternative 3 would be the most realistic plan in terms of the project financing, since the Districts of lower priority such as Kizan, Abassan Saghera, Abassan Kabera, Qarrara and Khuzaa can be delayed. However, as stated earlier in this chapter, all alternatives were formulated on the assumption that all the costs would be readily available for implementation of the programs, and at the same time all the alternatives would be environmentally acceptable.

The initial capital investments required for the treatment facilities under Alternatives 1 and 2 would be less than Alternative 3 because of the economy of scale in the concentrated larger sewage treatment works in Alternatives 1 and 2. Although Alternatives 1 and 2 are identical, the O/M cost of Alternative 2 is higher than Alternative 1, as Alternative 2 requires a pumping of considerable amount of the wastewater from Khan Yunis to the location almost 50 meters higher than Khan Yunis area. Subsequently, additional energy cost would be required.

From the economic analyses summarized in Table M.10.5, Alternative 1 program is superior to other alternative plans in terms of costs effectiveness, but among the three Alternatives, no single regional wastewater management system is predominant in terms of cost effectiveness.

10.2.2 Comparison of Intangible Considerations

In view of the lack of a clear distinction between alternative wastewater management programs on a cost basis, non-quantifiable considerations become of importance in the selection of the recommended program. The most important such non-quantifiable considerations have been identified, and an evaluation made of the degree to which each is responded to by the various alternatives analyzed. The non-quantifiable considerations deemed of major importance in selecting among alter-natives are:

- flexibility.
- speed of project implementation.
- potential for wastewater reuse.
- community/environmental impact.

A rating of the four alternatives studied with reference to each of these is presented in Table M.10.6, with supporting commentary presented in the following paragraphs.

(1) Flexibility

Alternatives 1 an 2 have a least flexibility among the alternative programs, and followed by Alternative 3. Alternatives 1 and 2 programs have the large scale concentrated systems which would require high initial investments for the construction of the large sewage treatment and conveyance facilities. Such major investments would dictate the course of regional wastewater management for many years to come, and would render these alternatives inflexible. In adapting to future change in conditions, both of these alternatives are rated "poor" in terms of flexibility, as shown in Table M.10.6.

Alternative 3 is a flexible program, and is rated "good," because after the initial stage construction completed the operation of the system could be started at a relatively early stage, and possibly later, if wastewater flows from the districts do not grow to the extent presently anticipated, they could be modified.

There are many advantages to retaining flexibility in the regional program to the extent possible. The most important of these are discussed below.

1) As time passes, additional and further technological advances become known and available, and as experience is acquired in the initial stage facilities, it may be that improvement and upgrading of the facilities can be provided. If future experience shows that the capacity of the plants need to be or not to be expanded beyond the originally planned capacity, the expansion of the plants could be done or deferred substantially in time or possibly not required at all.

   The potential for such deferral would be lost under Alternatives 1 and 2. There is a possibility that wastewater flows from the area will not grow to the extent presently anticipated because of the possible wastewater reuse or other reasons.

2) Almost certainly there will be technological advances within the next decade which will render wastewater treatment less costly and less esthetically objectionable than at present, possibly by a substantial amount. Alternative 3

would offer the opportunity to take advantage of such technological advances, while Alternatives 1 and 2 would not.

3) Continued study over the coming 2 to 3-year period would provide a better understanding and technology development for the treated wastewater effluent reuse for crop irrigation. It may be discovered that much of the wastewater be used within catchment areas and that the capacity of the wastewater conveyance facility might not be fully utilized. The excess investments for such capacity could be deferred in time, made smaller, or possibly eliminated entirely.

Wastewater flows originating in the area may be greater or less in the future than now anticipated. Deferral of major investments in facilities to treat such flows will provide an opportunity to better assess the effectiveness of present efforts to direct patterns of growth within the suburban area.

(2) Speed of Implementation.

In Alternatives 1 and 2, the treatment plants would be an enlarged ones. The large mains, force mains, and pump stations would surely require considerable time to complete the construction. There would be a considerable delay in receiving the services in such sewerage districts far removed from the sewage treatment plants, thus delaying an early implementation of the woks.

In view of the foregoing discussions, Alternatives 1 and 2 have been rated as "poor" as substantially inferior to Alternative 3 in terms of capability to rapidly alleviate the existing sanitary problems within the areas. Alternatives 3 is on the other hand rated "fair," in this respect.

(3) Potential for Wastewater Reuse.

Alternatives 2 and 3 have a significant potentiality for the future wastewater effluent reuse compared with Alternative 1, since at present there is higher potentiality of effluent reuse at the south sewage treatment plant site than the north sewage treatment plant site. The effluents from both north and south sewage treatment plants would be discharged to the near agricultural lands, thereby commingling the effluent with the groundwater or other flows, and making it available as a water source when and if the effluent reuse procedures are established for irrigation.

Other water-using industries might be identified or developed in the areas close to the south sewage treatment plant site if an ample and relatively cheap source of industrial water were available. Future urban industrial development in the basin may provide reuse potential, but none is now apparent. Alternative 3, would have two separate wastewater treatment plants and that they can discharge effluent to the wider agricultural lands, particularly to the adjacent to the treatment plant in southern area.

For these reasons, Alternatives 3 has been classified as having "fair" for the effluent reuse potential. Alternatives 1 and 2 would have the similar potential for reuse because of their concentrated sewage treatment plants. However, the south sewage treatment plant would have more potentiality of effluent reuse for the crop irrigation than Alternative 1, since the groundwater qualities in the southern areas close to Alternative 2 plant site are worse than in the northern part of the area. Alternative 2 has, therefore, been classified as "good" in terms of potential for wastewater reuse, but Alternative 1 was rated as "fair."

(4) Community/Environmental Impacts

Under the Project, a detailed environmental impact assessment is scheduled to be conducted during the feasibility study stage, however, for the master planning purpose environmental impacts related to the sewage treatment plant construction were briefly made. Community impacts can be measured best by the readiness with which wastewater treatment facilities are accepted by the community within which they are located. Although such facilities are not generally as a desirable additions to any community, an assessment of the relative impact of the three alternatives examined herein can be made.

Alternative 2 was rated as "good" in terms of community impact because the treatment facilities involved would be located in an area presently devoted to agricultural land. The site is separated from residential and property. Residential property are removed to the site it is by more than 2 km away. The land is owned by the Government and no private land acquisition would be required.

Alternatives 1 and 3 could be considered somewhat less acceptable than Alternative 2, because the north plant site is located less than 1 km to residential area and presently some part of the candidate site is encroached by people. There might also be some other social problems relative to siting of the plant facilities, such as interference with other utilities, blocking access and involuntary resettlement. As the site is located near the communities and some industries, due considerations for minimizing hazards and nuisance would be required, such as provision of buffer zones and fences, and noise, vibrations, odor, and aerosol abatement. In view of these, both Alternatives 1 and 3 are rate as "poor."

Based on the present scarcity of land in the Region, it is anticipated that there will be a strong opposition to land acquisition and expansion of the treatment plant at present, although public attitudes may be less rigid at the time such acquisition would actually be necessary under Alternatives 1 and 3, particularly if technological advances are effective in rendering wastewater treatment facilities less esthetically objectionable than at present.

Table M.10.6 Rating of Alternative Wastewater Management PlansWith Reference to Non-Quantifiable Considerations

Alternative	Flexibility	Speed of Implementation	Potential for Effluent Reuse	Environmental/ Social Impact	Total Points
1	Fair	Poor	Fair	Poor	2
2	Poor	Poor	Good	Good	4
3	Good	Fair	Fair	Poor	4

Note: Ratings represent judgment of the JICA Study Team.
Good = 2 points, Fair = 1 point, Poor = 0 point

10.2.3 Conclusions

From the foregoing analysis, it is obvious that Alternative 1 does not represent satisfactory long-range regional wastewater management program, because of its lack of flexibility, the extended time required for their implementation, and much environmental impacts.

Alternative 2 program has more or less the same ratings as Alternative 3. The disadvantage of Alternative 2 program is the high energy cost requirements to transport the majority of wastewater to the far removed treatment site of No.5: however, this disadvantage might be overcome with a significant advantage to be derived from the efficient reuse of the effluent for crop irrigation, industries and the new airport. The Palestinian Government has placed emphasis on the water resource development plans, and has a strong desire to efficiently reuse the effluents as a new water source in order to alleviate the current acute water shortage in the region. Also, the treatment plant site has the least environmental and social adverse impacts with the treatment facilities among the alternative plans.

Alternative 3, on the other hand, would have two independent locations of sewage treatment facilities that makes this plan more flexible, and is more cost efficient in a long-range program than other alternative plans. However, large scale development plans are now under consideration by the Government and municipality at the surrounding areas of the plant site, including constructions of housing complexes, stadium, schools, and industries, thus inhibiting the provision of such precarious facility as wastewater treatment facilities in the area. Consequently, it is considered that Alternative 2 plan would be superior to other alternative plans from the socioeconomic viewpoints, and that this plan be adopted as the regional wastewater management system.

All necessary steps should be taken immediately to ensure that land will be available at the potential wastewater treatment plant site to enable construction of such a plant when and if the decision is made to do so. A thorough study should be made of the possible use of the effluent treatment wastewater. Continuing studies should be made of the possible reuse of the treated wastewater in agricultural areas. Finally, it is concluded that the construction of the wastewater management facility in Alternative 2 be undertaken.

CHAPTER 11 ALTERNATIVES DRAINAGE SYSTEM PLANNING

CHAPTER 11 ALTERNATIVE DRAINAGE SYSTEM PLANNING

11.1 Planning Basis for Drainage System

11.1.1 General Considerations

During the examination of the present stormwater drainage situation in the Study Area, it is found that the stormwater runoffs within the built-up urban districts flow down through road surfaces, natural drains, wadis, or stormwater drains, and finally find their ways to the surrounding agricultural or low-lying areas.

In the central portion of Khan Yunis City, where the ground elevations are low and population densities are high, the stormwater inundation has long been a preponderant social problem. Under the circumstances, stormwater runoff coefficients became high and so were the stormwater flow rates.

In the wide low-lying area of the Central Market near the Khan Yunis Municipality, the ground elevation ranges from 30 to 38 meters above sea water level (SWL), making a gravity discharge of the stormwater unrealizable. During the winter rainy season, rainwater runoffs flow down to the lowest point close to the grave yard in the market area. Only a small quantity of the stagnated stormwater can be pumped through the pumping equipment up to the nearby street of higher elevation. The pump capacity is such that cannot drain the whole inflow, and hence the market is frequently inundated. Other small depressed areas existing in the central part of the City, e.g. the area behind the Mosque, the stormwater is also pumped up to the nearby streets of higher location with limited capacities.

The stormwater thus discharged to the road further flows on the Jamal Abd. Nasir Street down to the existing drainage channels crossing the street at about 800 meters downstream. The channel further leads the runoff to the vacant land near El Katibah. Once a heavy storm comes, the stormwater reaching the lowest point apt to overflow to the neighboring low lands sometimes stagnating over several days. The stagnated water then gradually infiltrates into ground or evaporates and finally disappears. Because of such topographic conditions, there would be no other means to dispose of the water but to rely on pumping.

On the other hand, in the southern portion of the Study Area the stormwater drainage situation is quite different. Because of the predominantly permeable sandy soil ground combined with the low precipitation, a substantial amount of the runoff is absorbed into the ground or evaporated on its way, particularly in the southern peripheral areas of Khuzaa, Abassan Kabera, and Abassan Saghera villages. The rainwater in these areas has been used as a major water source for irrigation or ground recharge, and this current practice of the rainwater use is evidently the most economical and effective method to dispose of the rainwater and solve the inundation problem.

As already mentioned, the stormwater disposal in Khan Yunis City is more difficult than the southern parts of the Area due mainly to the unfavorable topographic conditions. The Khan Yunis City drainage system should, therefore, include the construction of pumping station(s) at the lowest depressed areas. The collected stormwater will then be discharged for ground recharge to a dune closely located at the security zone. Thus, the frequent inundation in the depressed areas can be alleviated and the water will effectively be used as a source for the ground recharged. The flood-prone areas in the Khan Yunis City are shown in Figure M.11.1.

11.1.2 Drainage Implementation Area

As previously discussed, Khan Yunis urban built-up districts have long been suffered from the frequent inundation, whereas most of the built-up areas in the southern villages are located at higher ground elevations than the surrounding areas. As a matter of course, these areas have less inundation problem. The ground elevations in the villages, ranging from 80 to 85 meters above SWL, are generally higher than in the peripheral agricultural land which declines toward south or west direction. Consequently, the stormwater runoffs can mostly be drained by gravity to the peripheral agrilcultural lands.

Notwithstanding the fact that the stormwater occasionally stagnates during heavy rainfall in some limited lots in the villages, it is generally easy to drain the water by gravity out to the nearby agricultural land without causing serious flooding damage to private and public properties. Topographically, the stonnwater flows down toward the agricultural land, and while it is flowing down either infiltrated to ground or led to the water reservoirs for irrigation.

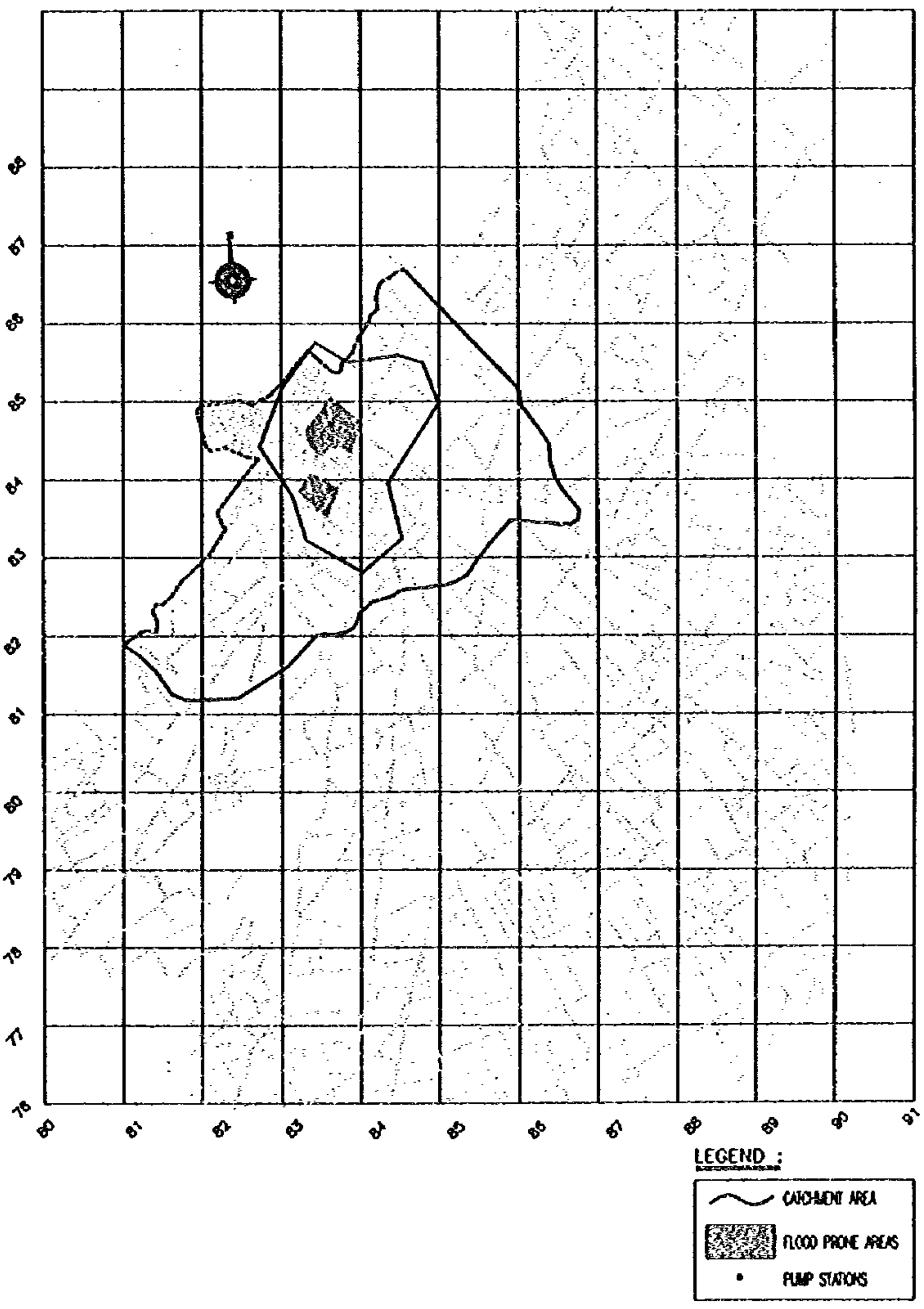


FIG.M.11.1 FLOOD PLONE AREA

THE STUDY ON SEWERAGE DEVELOPMENT PLAN IN THE AREA OF KHAN YUNIS
IN PALESTINIAN INTERIM SELF-GOVERNMENT AUTHORITY

As is discussed in Chapter 12, the priority of wastewater system implementation for the Khan Yunis City is the highest among other districts. The deteriorated wastewater and drainage situations have already been at a deplorable level, and an immediate improvement of the drainage system has now become imperative. Besides, Khan Yunis' higher population and beneficiaries of the system than other villages justify the early implementation of a drainage construction program in Khan Yunis City. Topographically, the ground slope in the northern portion of Bani Sohaila declines toward Khan Yunis City, and that the stormwater from this area be drained to the Khan Yunis Drainage District.

In view of the above reasons and the need for a cost effective investment plan, it is considered inevitable that these high priority districts be included in the stormwater drainage implementation area by the year 2015.

Under the circumstances, it is proposed that the stormwater drainage system for the central part of Khan Yunis District and the northwestern part of Bani Sohaila be implemented by the year 2015. Other areas could be deferred until such time when the villages have become urbanized and the drainage situation become more acute than it is now.

The stormwater system construction program could be reviewed of course as time passes and the developmental situations have significantly been changed. If the future experience shows that some district outside the implementation area needs to be provided with a new drainage facility, the expansion of drainage system or completely new system could be furnished.

The implementation area of the stormwater drainage system thus elaborated is illustrated in Figure M.11.2.

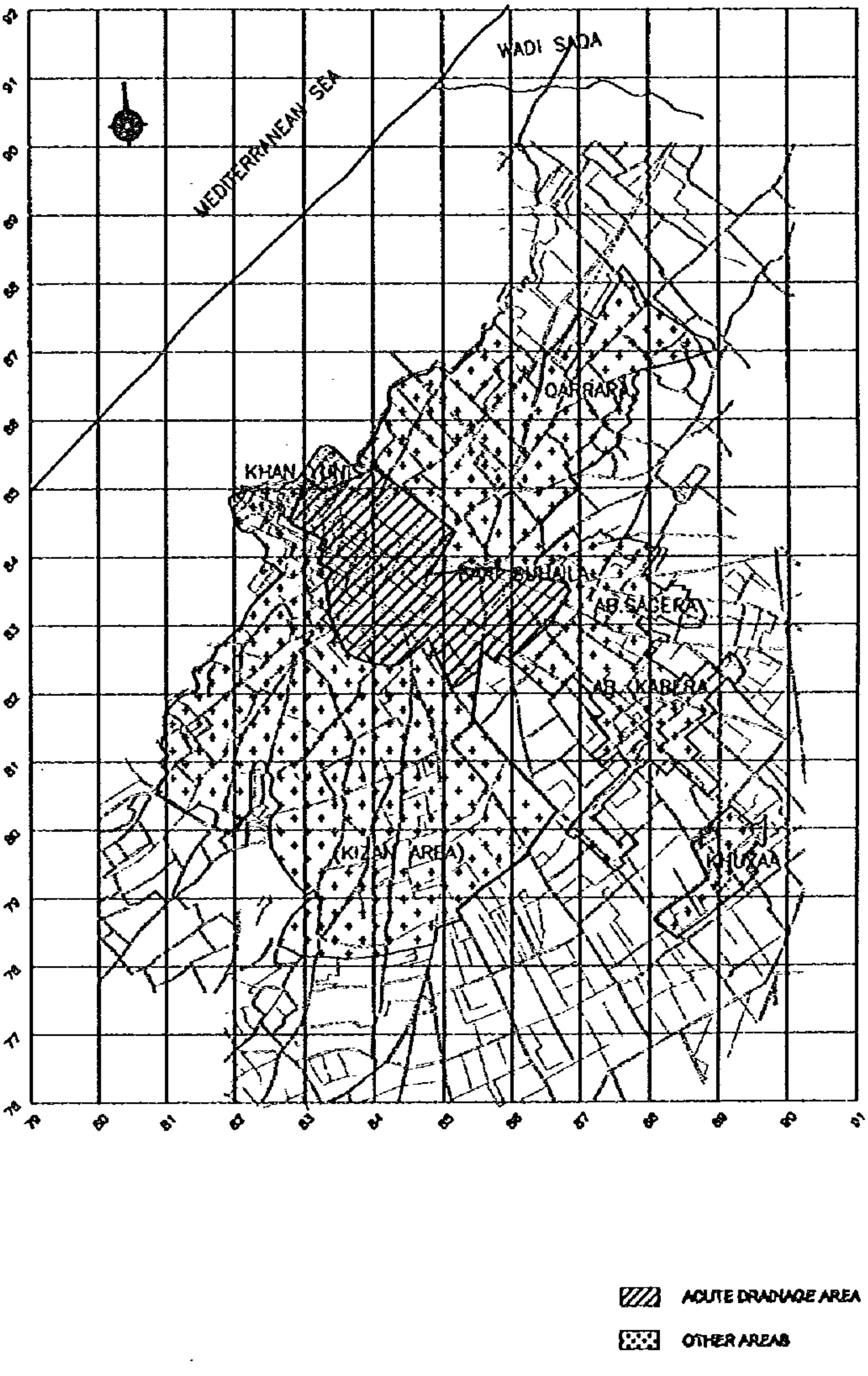


FIG.M.11.2	STORM WATER DRAINAGE SYSTEM IMPLEMENTATION AREA

THE STUDY ON SEWERAGE DEVELOPMENT PLAN IN THE AREA OF KHAN YUNIS
IN PALESTINIAN INTERIM SELF-GOVERNMENT AUTHORITY

11.2 Alternative Drainage Collection Systems

The stormwater runoffs will be collected and conveyed through appropriate drainage channels or conduits separately from the domestic wastewater. As previously discussed in Chapter 8, the stormwater runoff rates in the Study Area are relatively low, and the road surface drainage system has most commonly been used elsewhere in the Gaza Region. At certain locations, where traffic conditions do not allow the use of such system, underground culverts, pipe collectors, or open culverts have also been used. While large size drainage channels are expensive, most of the time of the year these are not fully utilized, thus requiring considerable efforts for operation and maintenance.

In selecting the optimum drainage system in the Area, the four possible options for the stormwater drainage channels and disposal have first been evaluated; namely i) underground stormwater sewers, ii) closed and open culverts, iii) road surface drains, and iv) soakaways.

These alternatives are then evaluated in their advantages and disadvantages, including:

(1) Inconvenience in traffics and pedestrians.
(2) Ease of operation and maintenance.
(3) Space requirements.
(4) Capital costs.
(5) Operation and maintenance costs.

11.2.1 Storm Sewers

This system collects stormwater runoffs on the streets through inlets connecting with the underground storm sewers. The inlets then discharge either directly into the storm sewers or catch basins that are intended to intercept the refuse and sediment flushed from the street surfaces. Where there is much accumulation of waste and sand, a grating placed in the gutter may be of little value in removing storm water as it may become either partially or completely obstructed at the first runoff from the storm.

Cleanliness of streets and adjacent sidewalks is essential to the successful functioning of the inlets. As the area's paved road accounts for 60 percent or lower, once it rains, it is quite likely that a considerable amount of sand inflows to storm sewers and easily accumulates on the sewer bottom. The accumulated sand may easily choke the sewers or considerably reduce the sewer flow capacity.

Under the prevalent conditions in the area, the storm sewer system would require more frequent degriting of the sewers than other systems, and would considerably increase maintenance costs. Moreover, these facilities are more costly than other options both in capital and O/M costs, although these will not hinder traffic and require less space for structures.

11.2.2 Closed and Open Culverts

Both closed and open culverts have either rectangular or square cross sections. The closed culverts are generally made of reinforced concrete structures, or in many cases with masonry walls and covered by reinforced concrete slabs. The cover slabs need to be designed to sustain the traffic loads. Since in the central portion of Khan Yunis City the land spaces are limited, vertical concrete walls are generally applied. At road crossings and in front of premises, however, the open culverts will also be covered with reinforced concrete slabs.

Open culverts require more spaces in general than closed culverts because of their slower wall slopes, whereas the box culverts generally require less spaces. The box culverts, on the other hand, would easily be clogged with flushed sand and other solid wastes flowing to the culverts. Both open and closed culverts are more costly in construction, operation and maintenance, than other alternatives.

11.2.3 Road Surface Drains

Road surface drainage system uses the road surface as part of secondary and tertiary drains. The road pavement surface and the curbstone form a shallow channel which is used for stormwater runoff inflowing from nearby land, and leading the flows down to either culverts, nearby wadis or agricultural lands. This system appears to be the most economical way of draining surface water in the region, because the existing builtup urban districts in the area are provided with road networks, much portion of which are paved with either asphalt or concrete. This system requires no such special structures to collect and transport the stormwater, as inlets or catch basins, and requires almost no particular operation and maintenance works.

Because this system uses road surfaces as part of drains, the stormwater tends to stagnate at locations where road cross sections are irregular, and may cause nuisance to pedestrians and vehicles. Also, at locations where road surfaces are not paved, heavy rainfalls may cause erosion of the road surfaces. These problems could be avoided, however, when the road surface sections are properly designed and constructed so as not to impede the smooth flow of the water.

Although this system may cause some inconvenience to traffics and pedestrians during heavy rainfalls, the use of road surface as part of drainage system is generally accepted because of the low rainfall intensities. Most of the time of the year no serious inconvenience or damage have been caused by the stormwater flow on road surfaces except in the depressed urban districts.

11.2.4 Soakaways

Wherever possible, surface drainage from buildings and roads may be discharge into a drain system . Occasionally, however, it may be more economical to discharge this to soakaways. Individual soakaways may be provided at each gully, or a number of gullies may be connected to a pipe which itself discharges to a soakaways.

A soakaway may be a pit provided with a roof slab and with open-jointed base and sides, similar to those used for cesspit or septic tank soakaways. The pit may be filled with rubble, it may obviate the need for a roof slab designed to take traffic loading.

The capacity of a soakaway is to allow a storage volume sufficient for a minimum of rainfall over the area to be drained, but the capacity is highly dependent upon soil permeability. The system will therefore be satisfactory in permeable soil or where they can be excavated down to a permeable stratum. They must also discharge above the maximum subsoil water level.

This method requires wide spaces to infiltrate the water into ground, but sufficiently wide areas to leach all the water are hardly obtainable in the area, particularly in the builtup central urban districts of Khan Yunis City. Furthermore, the soil within such congested districts is generally not permeable to absorb all the runoffs. Hence, the method appears to be less advantageous than other options in particular for a large drainage system like Khan Yunis.

11.2.5 Selection of Drainage Channel System

The above economic and technical comparisons among the drainage channel options have indicated that under the circumstances, the road surface drainage system was superior to other alternative plans.

In the road surface drains, the curbstone and paved road surface forms a shallow triangular, rectangular or trapezoidal channel, which flow the runoff down following the street gradients, and finally leading toward channels or nearby vacant lands. In the southern part of the area, the collected stormwater is led to the circumferential agricultural or vacant lands through road surface and channels, and thereafter will either be stored for irrigation purpose, infiltrate into ground or evaporate.

As the rainfall intensities in the area are relatively low, the surface drain system may not cause serious traffic inconvenience under the normal rainfalls, if the street surface is properly shaped and sloped. Hence, the road surface drainage system appears to be the most appropriate and economical way to drain the stormwater runoff with a minimum investment, avoiding construction of the deep and costly side drainage conduits.

In view of the above discussions, topographic and meteorological conditions of the area, and the financial resources available, it is prudent that the existing road surface drainage system be re-established rather than a completely new system be immediately constructed, since the cost of the cleaning and improvement work is relatively small compared with the cost of new construction.

With the limited funds available, the return for a given expenditure on the existing system will be greater in terms of improved stormwater drainage conditions than for the same expenditure on new construction work.

11.3 Retention Basins and Pumping Stations

The stormwater collected through the road surface drains will reach the low-lying area but the peak flow will reach the area some time after the rain started. The peak flow can be reduced with a provision of an appropriate retention basin; thus the pumping capacity can significantly be reduced.

In the central market area, only a very limited land is available for the retention basin, whereas at the El Katibah site a wider land space could be acquired to provide a large size retention basin. If the retention basin is built in El Katibah, it could also be used as an emergency wastewater storage facility in case of power failure or other troubles in operating the sewerage system.

As described in Chapter 8 "Stormwater Quantity" and Appendix-E "Stormwater Draiange System," the peak flow rate (calculated for a rainfall frequency of once in every five years) from the central catchment area of Khan Yunis City of about 423 hectares could be reduced to 8.73 m^3/sec if a retention basin with a 14,000 m^3 capacity is provided ahead of the pump station. The required pump capacity can further be reduced with a larger retention basin.

11.4 Final Disposal of Stormwater

Because of the topographic conditions of the area, most of the stormwater runoffs in Khan Yunis area find their ways to several depressed points scattering throughout the City, causing water stagnation in such areas. After passing through the retention basins, the stormwater can be disposed of only by means of pumping system to a nearby dune or other higher location for final discharge. Thus, the collected stormwater will be recharged to the ground.

11. 5 Strategy Plans for Stormwater Management

11.5.1 Alternative Drainage Systems

As discussed previously, the Khan Yunis stormwater drainage system consists of road surface drains, conduits, retention basins, pumping stations, and outfall pipes to dispose of the stormwater to the nearby dune, as schematically illustrated in Figure M.11.3.

The latest topographic survey results revealed that if a gravity conduit is laid from the market to EL Katibah pumping station along the Jamal Abd. Nasir Street, the pumping station at the market could be eliminated.

One of the most important factors in selecting the most desirable drainage design is of the land availability and its cost for retention basin. The retention basin capacity requirements for the market area and El Katibah are 5,000m^3 and 14,000 m^3, and the pumping capacity requirement of 5 m^3/sec. and 8.7 m^3/sec, respectively.

In the market area, there exists a wide vacant private-owned land to provide the retention basin. It is not clear at present whether or not such land can be acquired in the market area, the land cost is estimated to be almost US$ 5 million/ha for the required retention basin area, whereas that in El Katibah site is US$ 0.1 million/ha.

In order to compare the possible alternatives and select the most desirable drainage system for the Area, the following three alternative drainage plans have been elaborated and evaluated in their advantages and disadvantages:

- Alternative 1: Constructing a pumping station, a retention basin and a discharge pipeline at each site,
- Alternative 2: Connecting the market and El Katibah sites with a gravity conduit, but a retention basin, pumping station and discharge pipeline will be constructed only at El Katibah site, and
- Alternative 3: Installation of a pumping station and a retention basin at each site, but sending all the stormwater from the market area to El Katibah and disposing of the stormwater form El Katibah station to the dune.

The alternative plans are illustrated in Figures M.11.4, M.11.5 and M.11.6.

11.5.2 Evaluation of Alternative Systems

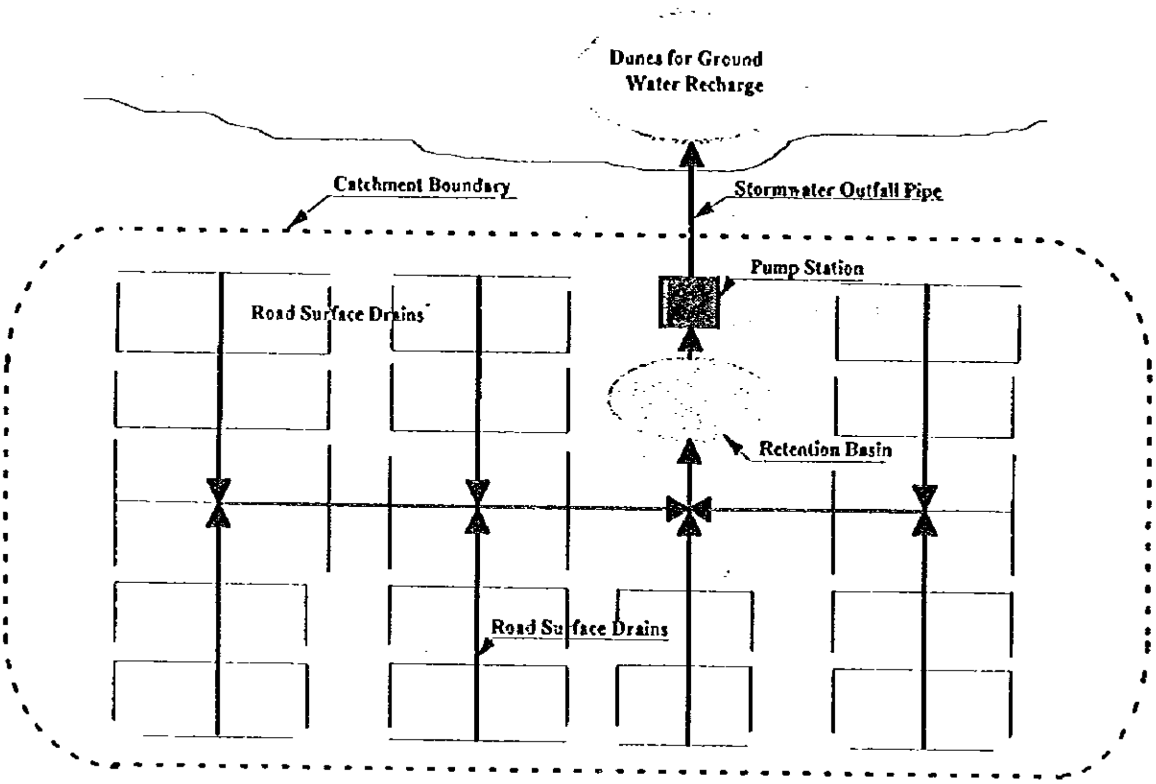
Each of the component facilities of the alternative plans is designed based on the following basis:

(1) Retention Basins/Pumping Station Facilities

The hydraulic analyses for the facilities are made based on the following criteria:

- Rainfall frequency : Once in every five (5) years
- Rainfall intensity-duration equation : $i = 2002/(t + 28)$
- Average runoff coefficient : C = 0.7(in 2015)
- Drainage catchment areas : Market area: 83.8 hectares; El Katibah: 313 hectares
- Secondary/tertiary drains : Road surface drains
- Primary drains : Closed conduits

The stormwater peak flow can be reduced and so is the pumping capacity with the provision of appropriately planned retention basin. In the Market area, only a limited land space is available for the retention basin, whereas the site at El Katibah pumping station a wide Government-owned land is available to build a large retention basin.



Khan Yunis Stormwater Drainage System Patterns

FIG.M.11.3	KHAN YUNIS STORMWATER DRAINAGE SYSTEM PATTERNS

THE STUDY ON SEWERAGE DEVELOPMENT PLAN IN THE AREA OF KHAN YUNIS
IN PALESTINIAN INTERIM SELF-GOVERNMENT AUTHORITY

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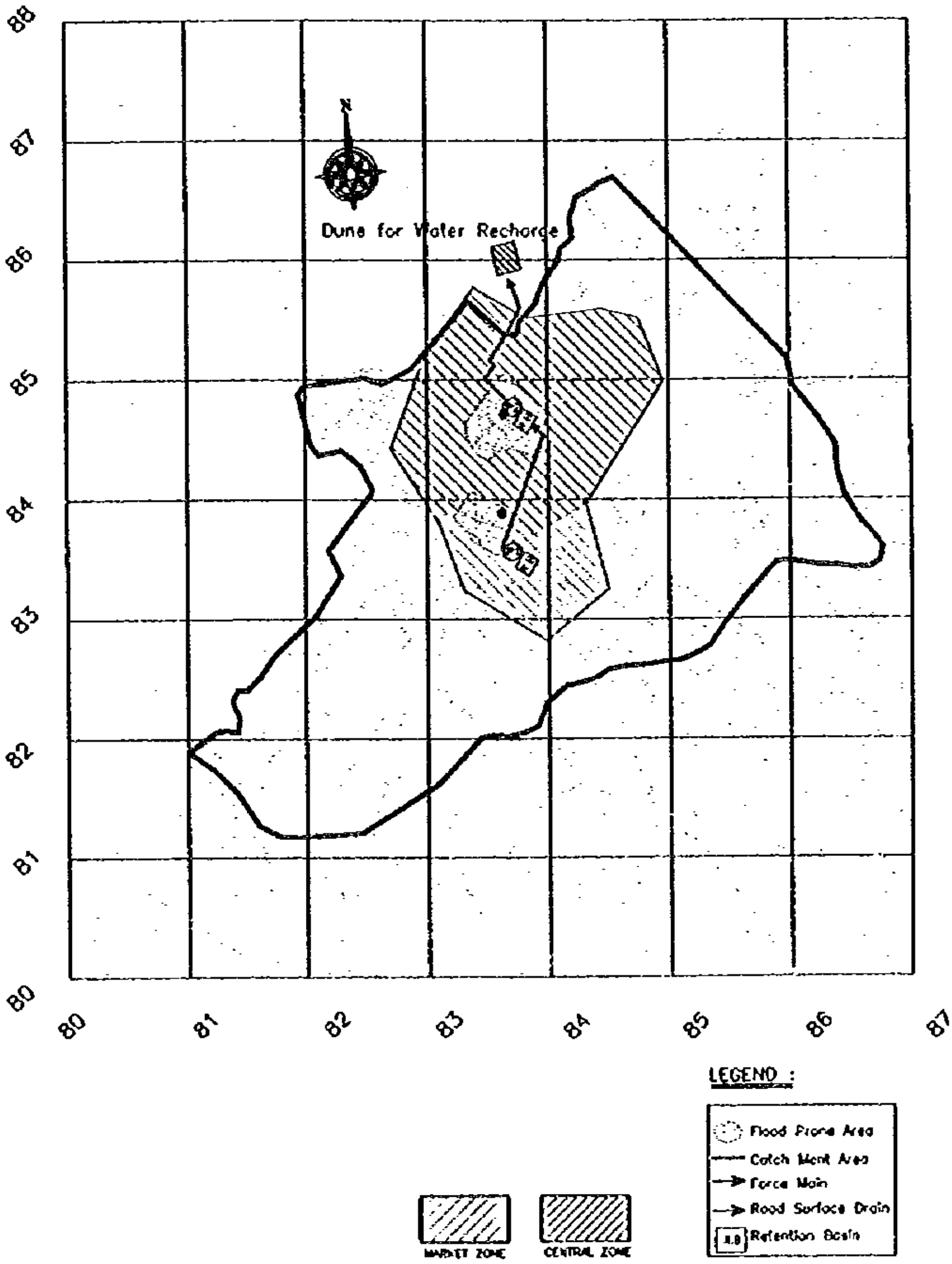

FIG.M.11.4 STORM WATER DRAINAGE MANAGEMENT ALTERNATIVE 1

THE STUDY ON SEWERAGE DEVELOPMENT PLAN IN THE AREA OF KHAN YUNIS IN PALESTINIAN INTERIM SELF-GOVERNMENT AUTHORITY

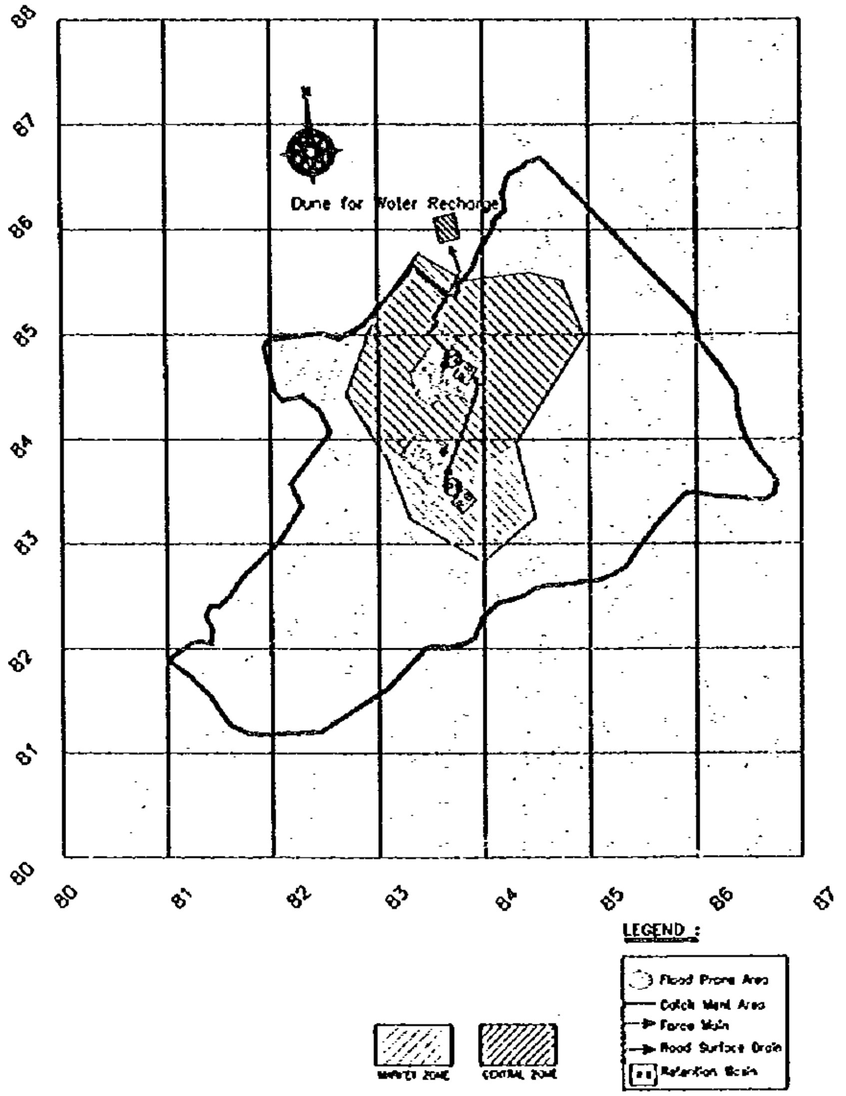

FIG.M.11.5	STORM WATER DRAINAGE MANAGEMENT ALTERNATIVE 2

THE STUDY ON SEWERAGE DEVELOPMENT PLAN IN THE AREA OF KHAN YUNIS
IN PALESTINIAN INTERIM SELF-GOVERNMENT AUTHORITY

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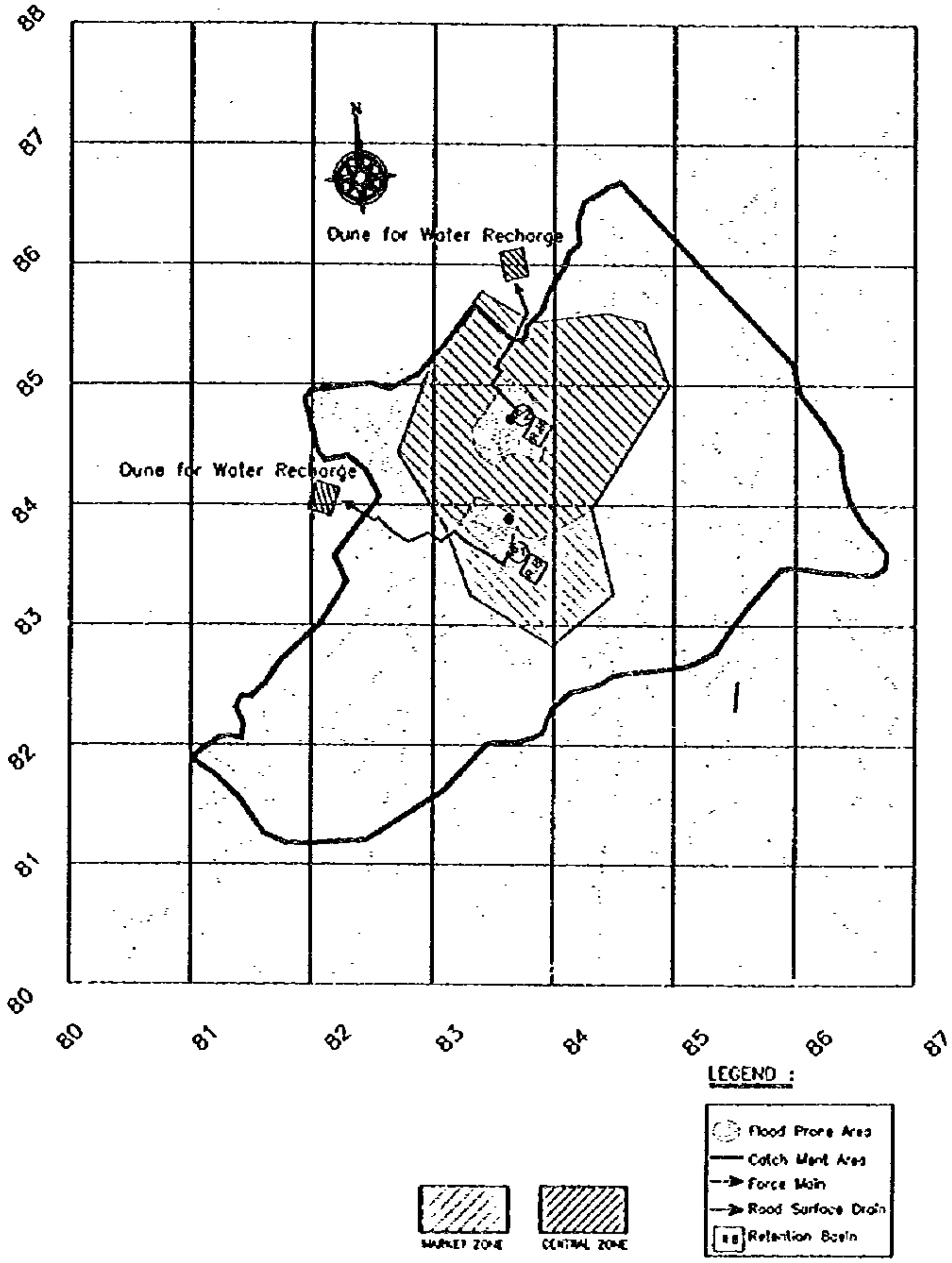

FIG.M.11.6 STORM WATER DRAINAGE MANAGEMENT ALTERNATIVE 3

THE STUDY ON SEWERAGE DEVELOPMENT PLAN IN THE AREA OF KHAN YUNIS
IN PALESTINIAN INTERIM SELF-GOVERNMENT AUTHORITY

(2) Hydrograph Simulations

The peak stormwater runoff rate from each alternative drainage plan has been computed by using a hydrograph method (Time/Area Method). The results of the simulation are illustrated in Figures M.11.7, M.11.8 and M.11.9. The calculated peak runoff rates to the pumping stations and required retention basins capacities are summarized as follows:

Table M.11.1 Costs of Alterntive Drainage Plans (in US$)

Alternatives	Capital Costs	Land Acquisition	Total Costs
Alternative 1	3,053,000	2,547,000	5,600,000
Alternative 2	1,910,000	1,981,000	3,891,000
Alternative 3	2,875,000	2,716,000	5,591,000

Table M.11.2 Simulation Results

Alternative Plans		Retention Basin Required Capacity (m^3)	Required Pump Capacity (m^3/sec)
Alternative 1	Market Area	2,500	0.05
"	El Katibah Area	11,300	0.20
Alternative 2	El Katibah Area	14,000	0.20
Alternative 3	Market Area	2,700	0.05
"	El Katibah Area	12,300	0.20

11.5.3 Stormwater Disposal

After passing through the retention basins, the stormwater can only be disposed of by means of pumps to the nearby dune or other higher locations for groundwater recharge.

11.5.4 Cost Comparison

Each of the alternative plans has been estimated in its capital and land acquisition costs, as summarized in the following table:

Table M.11.3 Capital Costs of Alternative Plans (US$)

Components	Alternative 1 Katibah	Alternative 1 Market	Alternative 2 Katibah	Alternative 2 Market	Alternative 3 Katibah	Alternative 3 Market
Land Acquisition	1,526,583	1,020,834	1,981,667	-	1,695,500	1,020,834
Pump	681,261	1,286,447	681,261	-	681,261	1,286,447
Force Main	165,000	229,500	165,000	-	165,000	18,900
Sub Total	4,909,625		2,827,928		4,867,942	
Land Acquisition	(1,558,250)		(63,333)		(1,560,833)	
Gravity Conduits						
MK3-12	0		93,800		0	
MK4	0		107,800		0	
CKY13	84,000		97,800		84,000	
CKY15, 17	189,800		211,900		189,800	
CKY18	216,000		324,000		248,400	
CKY20	201,400		228,000		201,400	
Sub Total	691,200		1,063,300		723,600	
Total	5,600,825		3,891,228		5,591,542	

Note: Above costs are estimated based on mid-1997 price levels in Khan Yunis District.

As shown in the above table, Alternative 2 is the least cost plan, the cost difference being about US$1.8 million. This is because the Alternative 2 could eliminate the pumping station and retention basin at the Market area. Moreover, the acquisition of the costly land of the Market area could be avoided.

Overall, Alternative 2 is superior in capital investments to other alternative plans but the difference of the operation and maintenance costs are minimal. Hence, Alternative 2 is apparently the most desirable drainage alternative plan.

11.6 Project Components

The drainage system plan thus selected comprises the following component facilities:

Road surface drains (using existing road networks),

A retention basin of 14,000m^3 ahead of El Katibah pumping station,

El Katibah pumping station having a pump capacity of 8.7 m^3/sec with auxiliary facilities, Gravity storm conduits of 1,580 m long, comprising circular pipes from 1,500 mm to 2,300 mm diameter, and

A 1 km long stormwater discharge steel pipeline of 400 mm in diameter from the pumping station to the dune with outlet facility.

11.7 Retention Basins

The designed capacity, size and shape of the retention basin are as summarized in the following:

Water surface width	:	56.4 m
Water surface length	:	100.6 m
Effective depth	:	3.5 m
Concrete wall slope	:	1 horizontal to 2 vertical

The wall surface of the basin is covered with concrete spray (10 cm thick) to protect the surface from erosion and also for easy maintenance of the basin.

11.8 Pumping Station

The pumping station has four units of vertical mixed flow pump. The pumps are operated directly with diesel engines. The control panel for the pumping operation will also be installed in the administration building. All control valves on the discharge pipeline for each pump are placed in a convenient location outside the wet well and are suitably protected from weather and vandalism. Some more details of the pumping equipment are as shown below:

No. of Pumps	:	3 units
Pump Specifications	:	90.0 m^3/min (2 units), 180.0 m^3/min (1 unit)
Engine Outputs	:	490 kw, 940 kw
Screens	:	Bar Screens (clear space 100 mm)

11.9 Drainage Conduits

The drainage conduits comprise the construction of the reinforced concrete pipes ranging from 1,600 mm pipes to 2,100 x 2,100 mm rectangular conduits with a total length of 1,580 m.

11.10 Ground Recharge

The stormwater transferred through the discharge pipelines will be disposed of to the ground at the dune near the security zone. The ground recharge facility consists of a reinforced concrete structure and an outfall pipe, which have a sufficient hydraulic capacity to smoothly discharge the peak stormwater flow rate.

The ground recharge outfall structure is so designed that the system is not clogged with floatables, debris, etc. The outfall facility has no such gate or valve that controls the rising or lowering the discharge pipe and outflow rate, and keep all the time a free flow at the pipe outlet. Also, an appropriate apron or concrete base is provided at outlet so that ground scoring with the discharged water can be avoided.

11.11 Proposed Stormwater Drainage Strategy Plan

As discussed in the previous sections Alternative 2 strategy plan appears to be the optimum system to immediately alleviate the Khan Yunis drainage situation, witch will compose the following component facilities:

(1) Road surface drains (using existing road networks), Gravity conduits along the Jamal Abd. Nasir street connecting to the retention basin at El Katibah pumping station site, including stormwater inlet facilities,

(3) A retention basin ahead of the pumping station at El Katibah,

(4) A stormwater pumping station with auxiliary facilities at El Katibah, and

(5) Stormwater discharge pipelines from the El Katibah pumping station to a dune, including an outlet facility.

CHAPTER 12 IMPLEMENTATION PROGRAM

CHAPTER 12 IMPLEMENTATION PROGRAM

12.1 Materials and Construction Method

Many of materials required for the construction of sewerage, sanitation and drainage systems are to be imported, such as wastewater treatment equipment, pumping equipment, and pipes. Major civil and building works materials such as sand gravel are locally available although reinforcing bars and steel products are to be imported.

Construction methods and standards now being applied for the sewerage construction programs in other parts of Gaza Region appear to be practical and it is believed the local construction industry will play a major role in the Project.

12.1.1 Construction Materials

Sand and gravel for concrete works are available in acceptable quality and quantity. Portland cement suitable for the sewerage and sanitation construction is to be imported. Steel bars both round and deformed are also to be imported.

Pipes currently available in the region are limited in size and material, but, various pipes can be imported from neighboring countries, such as Israel and Egypt. PVC pipes of good quality and suitable for sewer use, with accessories, ranging from 110 to 500 mm in diameters, are available in Israel. Reinforced concrete pipes as large as 2,000 mm in diameter are also available from Israel.

Concrete products, such as manhole cones, barrels, bases, concrete channels, gutters, etc. are locally produced generally of acceptable quality.

Mechanical and electrical equipment for pumping stations and wastewater treatment plant, particularly for oxidation ditch process, will have to be imported.

As mentioned above, materials for sewer construction are mostly available, either importing or procuring locally produced materials, and could be used for the sewerage construction works.

12.1.2 Capability of Local Contractors

The sewerage and sanitation project involves the construction of large-scale and complicated facilities, such as pumping stations and wastewater treatment plants to require skills and experience of the contractors. For such important construction works it would be appropriate for foreign and local firms to enter suitable working arrangements, such as a joint venture, in order to ensure efficiency and quality of the construction works.

Currently several sewerage and water supply construction projects are ongoing within the Region, and some of the contractors within the area have experience, with equipment and key staff to carry out the works to acceptable level. It would probably be advisable to pre-qualify local contractors according to their capability and experience so they can be fully utilized as effectively as possible in implementing the Project.

Although a significant labor force will be needed when the project starts, there would be no serious problem in finding unskilled labor, but skilled labor, tradesmen, foremen and construction managers at various levels could pose some difficulties in their availability. The Project should compromise an oxidation ditch system construction which will require some experienced contractors. This matter should be well considered in the tendering stage for the construction.

12.1.3 Construction Methods

Major construction works of the Project can be classified into three categories; namely 1) sewer pipe laying and ii) construction of pumping stations, and iii) construction of a wastewater treatment plant.

For sewer pipe laying, there will be two applicable construction methods, one is the open-cut method and the other tunneling method. The open-cut method is applicable where the sewer size is relatively small and the traffic condition allows to do it. Most of the sewers in the area could be laid using this method, since no severe traffic problem is excepted to occur except in central urban zones, thus this method is widely practiced.

The tunneling method, on the other hand, may be used for a large and deep sewer construction and where traffic is heavy and cannot be detoured. However, under the Project, the deepest excavations are limited about 6 to 7 meters, and large capacity pumping stations are to be located at relatively isolated area. Hence, tunneling methods need not to be applied. Since the structure of pumping stations itself will be quite deep, sheeting and bracing should be provided to prevent cave-in of the excavation walls or subsidence of adjacent area.

The construction sites for the wastewater treatment plant is rather isolated from the residential or commercial zones, consequently have less problem with respect to impacts to the surrounding areas than pumping stations. The excavation may be carried out in open cut, in some cases without sheeting. It is expected that in general the groundwater elevations are low, but in some low-lying areas where the groundwater elevations are high, appropriate dewatering should be practiced all through the construction works, which might lead into high construction cost.

12.2 Staged Implementation

The construction program has been divided into five interrelated components; namely, i) sewers, ii) pumping stations, iii) wastewater treatment plant, iv) storm water drainage systems and v) sanitation systems. Each component has its own place in the construction program recommendations, based on the estimated requirements for the designated period.

It is assumed that the construction will start in 1998 with the first stage to be completed by 2002, the second stage from 2003 to 2008, and the third stage from 2009 to 2015. This phasing, with the inherent flexibility of the system, will permit periodic re-evaluation as required.

The decision of implementation schedule will be considered regarding the scale and total investment costs of the project, kind of the financial source and an investigated conditions at the location and so no. In this chapter, it is assumed that the financial source is not considered with the special finance such as grand aid program. Therefore, construction works including the detailed design should be continued due to the construction efficiency through to the whole construction periods until the completion. On the other hand, the construction works of each stages will be required to be divided further two or three smaller phases depending on the financial sources. In that case, the order of priority to be constructed should be considered in term of investment efficiency which were examined from removed pollutant load, served population and others.

The basic initial facilities for the sewerage system are sewer pipelines such as main and reticulations sewer, pumping stations in the high priority districts and wastewater treatment plant, and for the drainage system, it will be composed the collection and discharge pipeline, pumping station and retention basin next to the P3 pumping station of sewerage. In addition, vacuum trucks for desludging and disposal from the on-site sanitation system are included.

This arrangement then permits the Khan Yunis City and other parts of the Study Area a maximum flexibility in construction arrangements upon completion of the fundamental facilities.

The implementation schedule is summarized in Table M.12.1.

Table M.12.1 Implementation Schedule

Item \ Year	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
[First Stage]																		
Preparatory Works	—																	
Detailed Design		—																
Construction Works			—	—	—													
[Second Stage]																		
Preparatory Works				—	—													
Detailed Design						—												
Construction Works							—	—	—	—	—							
[Third Stage]																		
Preparatory Works										—	—							
Detailed Design												—						
Construction Works													—	—	—	—	—	—

12.2.1 First Stage Program (1998 to 2002)

It is proposed that the first stage sewerage/sanitation/drainage construction program to be implemented in the Khan Yunis and Bani Sohaila Sewerage Districts. The component of works will include i) sewer pipelines, ii) three pumping stations, iii) one oxidation ditch wastewater treatment plant of 17,300 m^3/day treatment capacity, iv) five vacuum trucks for sanitation improvement and v) drainage system in market and a part of central area of Khan Yunis city.

Implementation of the first stage construction program is recommended to start in the year 1998 and end by the year 2002. When this five-year construction program is completed, the city's population of about 204,930 persons (as of 2015) within this Sewerage District of 848 hectares would have access to sewer service. Served areas and populations, and sewerage/sanitation system component facilities to be constructed under this stage are as follows:

Table M.12.2 First Stage Program

Components	District	Area (ha)	Population (as of 2015)	Sewer Length (m)	Pump Capacity (m^3/min)	Treatment Capacity (m^3/min)
Sewers	KY 5	268	55,640	57,800		
	KY 6	161	69,100	34,400		
	KY 7	222	61,550	56,700		
	BS 1	155	14,440	35,900		
	BS 2	42	4,200	8,800		
	Others	-	-	6,800		
Pumping Station	P3	-	-	-	30.0	
	P8	-	-	-	30.0	
Treatment Plant	South					17,300
Vacuum Trucks	(5 Nos.)					
Drainage System					180.0	
Total		848	204,930	200,400	240	17,300

12.2.2 Second Stage Program (2003 to 2008)

With the completion of the wastewater/sanitation/drainage facilities for the first stage, it is proposed to set the years from 2003 to 2008 as the Second Stage Program based on the current projection of development.

The wastewater system during this stage will include the sewer main and reticulations for the Qarrara, remaining part of Khan Yunis Districts. Additional wastewater treatment plant facility will be provided to treat the increased wastewater inflow of 22,400 m^3/day .

When the second stage construction is completed and connecting sewer reticulations are provided, additional about 149,920 persons (as of 2015) within the 1,451 hectares are will have access to the sewerage. The sewerage and drainage system components to be provided under this stage are summarized in the following table.

Table M.12.3 Second Stage Program

Components	District	Area (ha)	Population (as of 2015)	Sewer Length (m)	Pump Capacity (m^3/min)	Treatment Capacity (m^3/min)
Sewers	KY 1	349	31,960	73,800		
	KY 4	107	9,910	23,100		
	KY 8	180	27,350	37,800		
	KY 9	125	25,650	26,900		
	KY 10	217	17,280	45,600		
	KY 11	126	9,550	26,300		
	QR 1	106	20,030	26,400		
	QR 2	241	7,490	49,800		
Pumping Station	P2	-	-	-	6.2	
Pumping Station	P3 (add)	-	-	-	24.7	
	P4	-	-	-	0.8	
	P5	-	-	-	13.4	
	P6	-	-	-	3.4	
	P7	-	-	-	5.4	
	P8 (add)	-	-	-	38.9	
Treatment Plant (add)						22,400
Drainage System (add)					180.0	
Total		1,451	149,220	309,700	272.8	22,400

12.2.3 Third Stage Program (2009 to 2015)

The third stage construction program will be implemented for the remaining sub districts in Khan Yunis, Kizan, Abassan Kabera and Khuzaa Districts covering 1,333 hectares with a total population of about 122,460 by 2015. The component of works will include the construction of 291 km long sewers, newly found a P1 pumping station and extension the capacity of P8 pumping station and extension of the wastewater treatment plant in accordance with increase in served population.

Implementation of the third stage construction program is recommended to start in 2009 lasting until the end of 2015. The component works of the program are summarized in the following table.

Table M.12.4 Proposed Third Stage Program

Components	District	Area (ha)	Population (as of 2015)	Sewer Length (m)	Pump Capacity (m^3/min)	Treatment Capacity (m^3/min)
Sewers	AB 1	398	38,680	84,900		
	AB 2	253	16,740	54,800		
	AB 3	49	2,450	11,600		
	KZ 1	129	14,020	29,500		
	KY 2	106	10,600	22,600		
	KY 3	398	39,970	87,500		
Pumping Station	P1				7.6	
	P2 (add)	-	-	-	0.0	
	P3 (add)	-	-	-	0.0	
	P4 (add)	-	-	-	0.0	
	P5 (add)	-	-	-	0.0	
	P6 (add)	-	-	-	0.0	
	P7 (add)	-	-	-	0.0	
	P8 (add)	-	-	-	21.1	
Treatment Plant	(add)					14,300
Total		1,333	122,460	290,900	28.7	14,300

CHAPTER 13 COST ESTIMATION

CHAPTER 13 COST ESTIMATION

13.1 Basis of Cost Estimation

The major components involved in preliminary cost estimation and method of cost estimation are described below. The total investment cost is composed of direct construction cost, land acquisition cost, engineering fee and physical contingency.

The recommended plan for implementing sewerage, sanitation and drainage systems calls for construction, operation and maintenance in the three stages.

(1) Direct Construction Cost

The direct construction cost of wastewater treatment plant and pumping stations are estimated based on the preliminary design and cost function that has been reported in Progress Report (1) on December, 1996.

The unit cost of relevant sewer pipeline construction including for the drainage system has been estimated based on the unit cost to be investigated in Palestine and Israel on February 1997 and results of detailed cost estimation.

The direct construction cost are estimated as total cost including the materials, labors and some benefits, without Value Added Tax (VAT) and other taxes.

Detailed direct construction cost is described in Table M.K-7 in the Appendix K of Master Plan.

(2) Land Acquisition Cost

The required land area for the wastewater treatment plant and pumping stations are determined from results of the preliminary design.

The land cost of sewer pipeline installation is not considered since it will be installed underground the existing roads and other government reserved land in principle.

Detailed land acquisition cost is described in Table M.K-8 in the Appendix K of Master Plan in Volume III "Supporting Report."

(3) Engineering Fee

An engineering fee is the fee of designing and supervision of construction works which are conducted by the consultants after obtaining approval from Palestine. It has been assumed as ten (10) percent of the direct construction cost.

(4) Contingency

The contingency has been estimated as seven (7) percent of the direct construction cost.

13.2 Total Investment Costs

The cost involved in the investment of wastewater treatment plant, pumping stations and sewer pipeline for each construction stage, is summarized below in Table M.13.1. The direct construction cost and land acquisition cost are further breakdown in Table M.K-6 to M.K-7, and M.K-8 in the Appendix K of Master Plan in Volume III "Supporting Report."

Table M.13.1 Total Investment Costs

(Unit : US$)

No	Components	Construction Stages			Total
		First (1998~2002)	Second (2003~2008)	Third (2009~2015)	
1	Sewerage System	68,109,328	75,357,630	54,417,196	197,884,154
1.1	Direct Construction Cost	55,862,673	62,185,154	46,489,056	164,536,883
1.2	Land Acquisition Cost	2,750,000	2,601,000	25,000	5,376,000
1.3	Engineering Fee	5,586,267	6,218,515	4,648,906	16,453,688
1.4	Physical Contingency	3,910,387	4,352,961	3,254,234	11,517,582
2	Sanitation System	585,000	0	0	585,000
2.1	Direct Construction Cost	500,000	0	0	500,000
2.2	Land Acquisition Cost	0	0	0	0
2.3	Engineering Fee	50,000	0	0	50,000
2.4	Physical Contingency	35,000	0	0	35,000
3	Drainage System	9,080,276	2,500,677	0	11,580,954
3.1	Direct Construction Cost	7,658,356	2,137,331	0	9,795,687
3.2	Land Acquisition Cost	120,000	0	0	120,000
3.3	Engineering Fee	765,836	213,733	0	979,569
3.4	Physical Contingency	536,085	149,613	0	685,698
	Total	77,774,604	77,858,307	54,417,196	210,050,107
	Total (J-Yen)	9,332,952,483	9,342,996,846	6,530,063,525	25,206,012,854
	Total (J-Yen) =1.1+1.3+3.1+3.3	8,384,775,839	8,490,567,975	6,136,555,450	23,011,899,265

Note 1. Engineering Fee = (Direct Construction Cost) x 0.10
2. Physical Contingency = (Direct Construction Cost) x 0.07
3. Cost : as of March 1997.
4. Exchange Rate : 3.3 NIS/US$, 120 J-Yen/US$.

13.3 Operation and Maintenance (O/M) Cost

(1) Sewerage System

Operation and maintenance costs for sewerage system are composed of sewer pipeline, pumping stations and wastewater treatment plant.

The wastewater treatment plant is composed of electricity, disinfectants, repairing costs and personnel expenses. Pumping stations are composed of electricity, repairing costs and personnel expenses. And that of sewer pipeline is composed of repairing costs, daily inspection, cleaning works and personnel expenses. The frequency of these works is assumed that they will be inspected twice a year and to be cleaned at least every year by use of thrusting rods and /or bucket machines, including power source, lubrication and minor repair of the equipment..

The annual O/M costs of the sewerage, sanitation and drainage system are shown in Table M.13.2. Moreover, there is further breakdown in Table M.K-9 in the Appendix K in Volume III "Supporting Report."

(2) Sanitation System

In sanitation system is composed of fuel and personnel expenses of the vacuum truck's drivers only.

Septic tanks and cesspool should be desludged periodically and the septage transported to the sludge dump stations for final treatment, but these costs are to be borne by users and not financed by the Project. O/M costs of the sludge dump stations are excluded.

(3) Drainage System

The drainage system is composed of electricity, repairing costs and personnel expenses, mainly during the rainy season of the four winter months. However some inspection and repair works will be done through the year.

Table M.13.2 Annual Operation & Maintenance Costs

(Unit : US$)

No	Year	Construction Stage	Sewer Pipeline	Pumping Station (P/S)	Wastewater Treatment Plant (WWTP)	Drainage System	Sanitation System	Personnel Expenses	Total O&M Cost
1	1999	1st	0	0	0	0	0	0	0
2	2000	1st	0	0	0	0	0	0	0
3	2001	1st	0	0	0	0	0	0	0
4	2002	1st	0	0	0	0	0	0	0
5	2003	2nd	203,341	223,597	534,641	44,951	59,700	213,000	1,279,231
6	2004	2nd	203,341	232,738	536,415	44,951	59,700	213,000	1,290,145
7	2005	2nd	203,341	242,335	538,277	44,951	59,700	213,000	1,301,604
8	2006	2nd	203,341	251,474	540,051	44,951	59,700	213,000	1,312,517
9	2007	2nd	203,341	260,793	541,859	44,951	59,700	213,000	1,323,644
10	2008	2nd	203,341	270,765	543,794	44,951	59,700	213,000	1,335,551
11	2009	3rd	458,748	498,023	1,092,429	60,914	59,700	354,000	2,523,814
12	2010	3rd	458,748	521,710	1,096,628	60,914	59,700	354,000	2,551,700
13	2011	3rd	458,748	545,525	1,100,842	60,914	59,700	354,000	2,579,729
14	2012	3rd	458,748	570,505	1,105,232	60,914	59,700	354,000	2,609,099
15	2013	3rd	458,748	597,785	1,109,998	60,914	59,700	354,000	2,641,145
16	2014	3rd	458,748	626,614	1,114,994	60,914	59,700	354,000	2,674,970
17	2015	3rd	458,748	658,272	1,120,441	60,914	59,700	354,000	2,712,075
18	2016	Comple	694,434	756,325	1,503,764	60,914	59,700	487,500	3,562,637
19	2017	Comple	694,434	756,325	1,503,764	60,914	59,700	487,500	3,562,637
20	2018	Comple	694,434	756,325	1,503,764	60,914	59,700	487,500	3,562,637
21	2019	Comple	694,434	756,325	1,503,764	60,914	59,700	487,500	3,562,637
22	2020	Comple	694,434	756,325	1,503,764	60,914	59,700	487,500	3,562,637
23	2021	Comple	694,434	756,325	1,503,764	60,914	59,700	487,500	3,562,637
24	2022	Comple	694,434	756,325	1,503,764	60,914	59,700	487,500	3,562,637
25	2023	Comple	694,434	756,325	1,747,048	60,914	59,700	487,500	3,805,920
26	2024	Comple	694,434	756,325	1,747,048	60,914	59,700	487,500	3,805,920
27	2025	Comple	694,434	756,325	1,747,048	60,914	59,700	487,500	3,805,920
28	2026	Comple	694,434	756,325	1,747,048	60,914	59,700	487,500	3,805,920
29	2027	Comple	694,434	756,325	1,747,048	60,914	59,700	487,500	3,805,920
30	2028	Comple	694,434	756,325	1,747,048	60,914	59,700	487,500	3,805,920

Note) Comple means that all three stages of construction have been completed.

CHAPTER 14 EVALUATION OF THE PROJECT

CHAPTER 14 EVALUATION OF THE PROJECT

14.1 Overall Evaluation

14.1.1 Outline

The proposed project will help to alleviate existing adverse water quality and sanitary conditions in Khan Yunis Area, which have severely reduced the beneficial uses of the groundwater and led to an overall deterioration in general public health through increasing incidences of water and sanitation-related diseases, as well as groundwater contamination. At present, no centralized wastewater management system exists within the Study Area. Communities instead rely on inappropriate and poorly functioning on-site cesspits and septic tanks as sanitation systems.

The Project will provide modern and cost-effective centralized wastewater collection and treatment facilities to serve the most densely developed and severely degraded urban districts in Khan Yunis City and neighboring areas within Study Area, which are compatible with a long-term strategy to serve the entire Area. The Project will also help introduce new water resources for the possible crop irrigation to the nearby agricultural lands and groundwater recharge.

14.1.2 Rationale

Present sanitation facilities in the Study Area are generally ineffective in dealing with the large amount of wastewater flows now penetrating into underground from the urban districts in the area. Most communities rely on cesspits or septic tanks which are generally inadequate or unsuited to the high density of development There is an urgent need to implement more effective sanitation facilities to alleviate the increasingly adverse environmental conditions and deteriorating public health situation. Development of a centralized wastewater collection and treatment system is compatible.

Without the implementation of a comprehensive wastewater management program, further environmental degradation and deterioration in public health will be inevitable and the economic development of the area will be slowed down.

The proposed project represents a long-term development program to provide continuously expanded wastewater collection and treatment facilities in the project Area through to the year 2015. It will assist the Government in implementation of policy reforms comprising development of wastewater reclamation and reuse practices, strengthening financial management, tariff reform, improved wastewater management and more integrated planning of public sanitation. The project will also support the economic development of the Province.

The project will provide an affordable and technically sound solution to the current pollution problems resulting in substantially improved wastewater services for communities and a noticeably cleaner environment. The project represents a major step toward improving the environment in the Project Area, resulting in reduced costs to the agricultural industries.

14.2 Technical Evaluation

14.2.1 General

The technical soundness of the proposed wastewater/sanitation management project is examined with regard to the following viewpoints:

- Appropriate technology levels.
- Likely ease of project implementation given to the local technical level.
- Soundness of operation and maintenance required to run the proposed system.
- Sustainable development of the system for further demand

14.2.2 Proposed Facilities

The proposed project up to the year 2015 represents the effective alternative plan meeting the Khan Yunis and surrounding villages' wastewater, sanitation, and stormwater drainage, defined as the improved environmental/sanitation for all the residents in the area, and an adequately treated wastewater effluent arrangement for irrigation and groundwater recharge purposes. Each of the component facilities is evaluated and confirmed for its appropriateness and soundness for implementation.

(1) Wastewater Collection System

The proposed wastewater collection system is a separate sewerage system which collects separately the domestic wastewaters from the stormwater. The system is more economical than the combined system since the Region has only low precipitation and that the sewers will have an excess capacity if the combined system is applied, the capacity of which is not effectively used most of the time in the year, especially in summer.

The sewer system is designed in principle to flow the wastewater by gravity, reducing to the maximum extent the energy need to pump up the wastewaters, consequently, the operation and maintenance of the system is easy and costs are low.

The sewers are designed to flow 60 percent of pipe depth during the peak flow rates. This will allow interior of sewers to supply sufficient ventilation avoiding unaerobic conditions of the wastewaters in the sewers thereby preventing the possible sulfide buildup.

(2) Wastewater Treatment Plant

The applied wastewater treatment process is the oxidation ditch process. The process is relatively easy to operate and manage the facilities compared with other processes such as activated sludge process, yet high performance of the waste loads reduction can be expected. By applying nitrification and denitrification process operation, the high removal rate of nitrogen in the wastewaters can be achieved, which otherwise could be harmful to the crops.

The whole excess sludge will be returned to the unaerobic ponds provided ahead of the oxidation ditches, wherein the sludge will be digested and withdrawn for land application or other purposes at about two-year frequencies, thus requiring no particular difficult process for dewatering and digesting.

(3) Sanitation Facilities (On-site System)

As a transitional measures for sanitation improvement system, the additional vacuum trucks and sludge dumping stations are proposed for the safe disposal of the sludge from septic tanks and cesspits in the unsewered districts. These low cost sanitation facilities will significantly contribute to improve the present deteriorated sanitary conditions.

(4) Stormwater Drainage Facilities

All the stormwater runoffs will flow down through road surfaces by gravity. In the southern part of the project area, most of the stormwater runoffs flow out to the surrounding farm lands for irrigation, where the rain water is either directly led to farm lands or stored in water reservoirs. Thus, the rainwater is fully used for irrigation purpose.

In Khan Yunis District, once a heavy rain falls, most of the runoffs flow down to the depressed central portion of the City. The stormwater runoffs thus collected through the secondary and tertiary drains will finally be led to the depressed ground or retention basins, from where the water will be pumped up to the nearby dune for the groundwater recharge. This system, while investing limited expenses, will relieve almost 300,000 residents from the frequent inconvenience, and at the same time assures the efficient recharge of the rain water into the ground.

From the foregoing facts and discussions, it is evident that the proposed wastewater/sanitation and stormwater drainage management systems are justified as technically sound.

14.3 Socio-Environmental Outlook

The most obvious impact of the project will be the improvements expected in the public health of the residents of Khan Yunis and its surrounding villages through the provision of the new wastewater management system. All the wastewaters in the sewered districts currently infiltrated into the ground will be shut off and collected through the sewers, and finally treated at the treatment plant to the level acceptable to the environment and reuse purpose, thereby the danger of the ground water contamination that has already become a deplorable level will be greatly reduced.

The effluent of the sewage treatment plant would be reused for irrigation of crops or other purposes as required and no raw sewage will be directly discharged either to the wadi or the land. On account of this, it is expected that the overall environmental impact of the sewerage system will be positive.

At many locations of the area, the agricultural production is essentially limited to only rainy season operation. The expected first stage project will provide a sewage treatment plant which can produce some 17,300 m^3/day new water source for irrigation and possibly for industrial purposes and others. The estimated quality of the treatment plant effluent shows that its characteristics will not cause significant adverse effects to the crop growing, if the plant is properly operated and suitable crops are selected for sewage reuse. The farmers are welcoming the reuse of appropriately treated wastewater due to scarcity of water in the region, as well as consumers.

The quality of the treated sewage effluent is important both for the health of farmers in contact with it and for particular application for which it is used. Although the treatment plant effluent is in general safer than the raw sewage, care must be taken to protect the health of farmers from the possible risks.

Since the sewage treatment plant construction site is selected at an isolated area far removed from the residential and commercial districts, the impact to environs by the treatment facilities will not be significant. Construction activities of the treatment plant may not significantly affect the nearby farmers and residents. Noise and vibration to be caused by the excavations, pilings, construction equipment may not be intolerable level in view of the isolated location of construction.

In designing the treatment plant facilities, particular care must be taken to prevent and control unwanted and annoying odors, noise and vibration which might be originated in the treatment plant facilities.

In abating odors from the facilities, a consideration was given to the configuration of the plant facilities, locating such units as grit chambers and other odor creating facilities as far as practicable away from the residences or other facilities with due consideration on wind direction. Odor levels expected at the treatment plant site boundary have been found to be within acceptable levels.

In reducing the noise at the sources, consideration was given in planning and design of the facilities. Shielding and improving the muffling of combustion engines and compressors, restricting the operation of noise producing equipment to certain hours of the day, and improving vibration characteristics of equipment are the major counter measures to reduce the noise level from the plant. In addition, the treatment plant site will be provided with solid barriers, planting of belts of trees and other vegetation receiving the effluent, and the use of sound-proof materials and shape of building exteriors, which are measures that reduce the propagation of sound.

Excavations for sewers and pumping stations throughout the project area may cause traffic interruption for several years, however, this problem can be avoided as much as possible by the well scheduled construction programs. The excavations may also cause soil erosion, but such erosion will be limited by minimizing excavation on steeply sloping the land and by requiring reasonable soil conservation measures by the contractors.

In view of the above conditions, the overall environmental impacts of the proposed system is evaluated to be positive.

14.4 Social and Institutional Evaluation

Since a new sewerage system will be implemented in Khan Yunis, a new institution must be established for operation and maintenance. A new institution should be firstly established in close relationship with the users. Otherwise they would be ignorant of the sewerage management and would not feel responsible to maintain the system. Sewerage service is also a mutual relationship of "Give and Take" like water supply: the users will pay for the service. If the service is good, they are willing to pay. If not, they are reluctant to do so. Once they become reluctant, the cost recovery would be difficult and system maintenance would be difficult.

According to the JICA survey, more than 80% of the people in Khan Yunis know about the piped sewerage system. They are expecting a new sewerage system to be established in Khan Yunis, with a high rate of 97%, because most of them (about 92%) are not satisfied with the existing sanitation system. The existing system is dirty, unhygienic, smelly and related to insects and flooding.

The existing sanitation system is relatively expensive, because about half of the households must require the desludging for more than once a month, and every time NIS 20 to 40, or even higher, must be paid.

People's high expectation to sewerage system is their readiness to accept it and maintain it by paying the users' charge. Therefore a new institution should be first established as important service within the municipality.

Then as the system develops, a further integration to cover a large area would be possible, which is more independent from the municipality. At the national level Palestinian Water Authority (PWA) will be responsible for overall management of water and guidance to the municipality. The Study Team recommends the following institutional development of wastewater management in Khan Yunis.

1) Municipality-based management
2) Regional management under Khan Yunis Governorate
3) Large area management of Gaza Governorates

The timing of regional and large area managements will be dependent upon the social acceptance and institutional development. PWA is the right organization to take the lead.

14.5 Economic and Financial Evaluation

14.5.1 Basic Concept and Methodology

(1) Basic Concept

In general, a project will be evaluated taken engineering, economic and financial aspects into consideration. The engineering aspects are studied on the technical feasibility of the project from the viewpoint of construction, operation and maintenance. And with regard to the financial aspects, the financial analysis is to be determined whether the authoritative institution or the enterprise is likely to be financially viable. The financial analysis focuses on the costs and revenues of the such authoritative institution or enterprise for the project, and is usually summarized in income and cash flow statements, loan repayment and balance sheet. However, the income statement and balance sheet are not included in the financial analysis on the project.

Economic analysis appraises a project under study in terms of a National Economy by comparing and measuring its economic costs and benefits. In other words, economic analysis evaluates a degree of economic impacts on a project under study that would bring about in the national economy.

Project inputs such as construction costs and operation and maintenance costs, including costs for electricity, repairing, disinfectant and wages and salaries for running for pumping stations and waste water treatment plant are evaluated in terms of the national economy. These project inputs evaluated in terms of the national economy are called as "economic costs."

When a waste water treatment system is completed, a part of the sanitation environment is improved. As a result, people living in the network area can get higher quality human life than before. Accordingly, they get enjoyable opportunities for their business and daily life with little medical expenses and more workable days because that the days for staying in or coming to hospitals and/or clinic will be less than in the situation without the waster water treatment system improved or newly constructed.

The economic benefit is to be evaluated from this viewpoint, namely the amount of medical fees to be saved and amount of wages and salaries to be received from those new generated workable days in the case of the said project under study are evaluated in terms of the national economy. These newly generated benefits are called as "the economic benefit". In this case, the benefit should be at least as great as those obtainable from other marginal investment opportunities.

Economic costs and benefits are estimated throughout the project life. The first year of the project life is the year when the first construction disbursement is made. The last year of the project life is the year when the facility constructed by the project is scrapped or has no meaning because of population growth or other social factors. The project life is usually set as 30 years from the commencement of the construction works in such a project as for improvement or construction of facilities for waste water treatment systems.

For the economic evaluation, the following steps will be taken:

1. Economic survey in the country,
2. Measurement of costs and benefits and comparison between them, and
3. Sensitivity test to the conclusion of base case of such comparison.

Economic costs and benefits throughout the project life are compared in terms of present values. If the total present value of economic costs equals that of economic benefits (when, B/C=1), the discount rate used to calculate the present value is called as "economic internal rate of return (EIRR)."

Financial costs and benefits throughout the project life are also compared in terms of present values. If the total present value of financial costs equals that of financial benefits (when, B/C=1), the discount rate used to calculate the present value is called as "financial internal rate of return (FIRR)."

(2) Methodology of Economic Evaluation

Economic Survey

Economic survey is divided broadly into two categories as general economic survey and special economic survey.

The general economic survey is made with regard to such general economic indices as geography, population, agriculture, industry, trade, transport, communication, national income, public finance, prices, consumption, living indices and so on using the national and regional statistic data.

On the other hand, the later is proper survey relating to only a project such as traffic survey for the transport project, survey for damages caused by flood for the river improvement project, electricity current measurement for such the electricity loss reduction project, or survey for income and expenses of the people living in the project area like those in the project under study. The field survey, if circumstances require, will be carried out in addition to the use of the existing data and the statistic data.

Identification of Economic Benefits

If a project would not be executed, the medical fees and income loss would remain as a high percentage from the viewpoint of national economy. These amounts to be paid without any project is called as an "amount to be necessary without the project."

The economic benefit of a project under study can be estimated as a difference between the amount to be necessary "with the project" and that "without the project." In the case of the Project under study, the amount of medical fees to be saved is taken as a part of economic benefit and the amount of wages and salaries to be received from workable days is taken as the other part of it. The total amount of them should be considered as the economic benefit.

Evaluation of Economic Benefits

Usually, diseases to be treated in hospitals are classified in:

(1) water borne,
(2) water washed,
(3) water based,
(4) water related vector borne,
(5) faecal disposal related, and
(6) housing and crowding related.

In order to evaluate the economic benefits for such a Project under study, amount of medical fees to be saved should be taken from water related diseases and faecal diseases among the said classified diseases, i.e. diseases from (1) to (5) mentioned above. Number of inpatients and their staying days in hospital and number of outpatients and, total cost of medical treatment in hospitals are also necessary to clarify. Using those data, the amount of medical fees to be saved are calculated as the amount to be paid when the project is not executed.

On the other hand, people lose their income when they should stay in hospitals as inpatients because of medical treatment for diseases, but these days in hospitals are workable days for them in actual fact. Therefore, if it is no necessary to stay in hospitals, the days will bring some income to them. For the outpatients too, if they will visit hospitals or clinic for diagnosis or treatment for their disease, they should stop their work at least one day for visiting the hospitals, and they should lose their income for one day.

In order to calculate these income loss, number of inpatients and their average staying days in hospitals and number of outpatients should be clarified together with their average daily income. The calculated income loss is reputed as probable income when the Project will be executed, and it is the other part of economic benefit.

Identification of Economic Cost

Economic cost of a project is identified as opportunity cost(1) of the project.

Evaluation of Economic Cost

(i) Foreign currency portion

The foreign currency portion of the construction costs is estimated in either Cost Insurance Freight (CIF) price or Free on Board (FOB) price. These international prices are assumed to reflect economic cost directly.

(ii) Local currency portion

Because it is presumed that local markets in developing countries are distorted by price controls and other regulations, prices in the domestic markets do not reflect economic scarcity of goods and services. This means that the prices can not be used to evaluate economic costs of local procurement and have to be converted into economic prices.

(1): Definition of opportunity cost : If goods and services would be invested in the project under study, they could no longer be utilized for other projects. This implies that the benefits of the other projects could have been created would be sacrificed. These sacrificed benefits of the other projects are called opportunity cost of the project.

In economic analysis of a project, conversion factors are used to convert the costs in domestic markets into economic costs of a project.

Using export and import statistics, a standard conversion factor (SCF) is estimated. The SCF converts the domestic commodity prices into the economic prices that can be assumed to reflect the economic scarcity of the local costs.

However, the SCF is applied to only tradable goods. The economic cost of non-tradable goods and services have to be separately evaluated. Conversion factors of land, skilled and non-skilled labors, and transportation are respectively estimated.

Then, the weighted average of the conversion factors is calculated, and apply it to the financial cost to convert into the economic cost.

Evaluation Criteria

The economic internal rate of return (EIRR) is calculated and used as an index of economic feasibility. This EIRR is defined by the following formula:

$$\sum_{t=1}^{t=T} \frac{C_{ep}}{(1+R)^t} = \sum_{t=1}^{t=T} \frac{B_{\alpha c}}{(1+R)^t}$$

where, T = the last year of the project life,

C_{ep} = an annual economic cost flow of the project under study in year t,

B_{ac} = an annual benefit flow derived from a project in year t, and

R = the Economic Internal Rate of Return.

(3) Methodology of Financial Evaluation

Outline

Financial analysis appraises the degree of financial return of a project under study that is expected to earn and is carried out in terms of a profitability for the authoritative institution of the project.

Project inputs are evaluated in terms of market prices. The inputs thus evaluated are called as "financial costs." Project outputs are also evaluated in terms of market prices. The outputs thus evaluated are called as "financial benefit."

Financial costs and benefits throughout the project life are compared in terms of present values. If the total present value of financial costs equals that of financial benefits (when, B/C=1), the discount rate used to calculated the present value is called as "financial internal rate of return (FIRR)."

Financial Costs and Benefits

Financial costs include direct construction cost, taxes, compensation, physical contingency, administration, and engineering expenses. However, price escalation is excluded from the costs. Financial benefit is the revenue in the form of service charge of waste water treatment system proposed by the Project under study.

Financial Internal Rate of Return

The financial internal rate of return is calculated and used as an index of financial feasibility of the project. This FIRR is defined by the following formula:

$$\sum_{t=1}^{t=T} \frac{C_{ft}}{(1+R_f)^t} = \sum_{t=1}^{t=T} \frac{B_{ft}}{(1+R_f)^t},$$

where, T = the last year of the project life,

C_{ft} = an annual financial cost flow of the project under study in year t,

B_{ft} = an annual benefit (cost) flow derived from the Project in year t, and,

R_f = the Financial Internal Rate of Return.

14.5.2 Estimation of Economic Benefit

(1) Family Size and Workable Persons per Household

Population projection is made as shown in Chapter 3, but charges paid out for the services of waste water treatment system are usually made by means of family unit financially. Therefore, both of economic and financial benefits should be estimated as family base amounts except one of economic benefits derived from medical expenses. And, for estimation of people's income loss, number of workable persons should be clarified.

According to social survey made by JICA this time, the average family size may be calculated as 9.43 persons per HH as shown in Table 14 in Appendix-I in Volume III "Supporting Report." And the workable persons are estimated as 4.41 persons per HH in average. In this case, it is assumed that these workable persons range from 20 years old and over in their age based on the said survey.

(2) Economic Benefit Derived from Medical Expenses

According to a medical statistics[2], there were 78,193 cases of main diseases in Gaza Governorates in 1995. Following Table shows a summary by cause and the detail is shown in Table 15 in Appendix-I.

Table M.14.1 Medical Cases by Cause in Gaza Governorates in 1995

Causes	Water borne	Water washed	Water related vector borne	Faecal disposal related	Housing and crowding related	Total
No. of cases	52,757	4,914	3	8,457	12,062	78,193
Share rate (%)	67.47	6.28	0.00	10.82	15.43	100.00

Source : Annual Report 1995 Palestine "Palestine Health Status", April 1996, Ministry of Health, PNA.

As indicated in the above Table, the share rate of water related diseases and faecal disposal related diseases is 84.57 % to the total number of cases. On the other hand, number of discharges from hospitals was 72,820 persons in total in 1995, and number outpatients was 292,041 persons in total in the same year. In 1995, population in Gaza Governorates was 860,369 according in the said statistics, so the distribution rates of inpatients and outpatients to the population were 8.46 % and 33.94 % respectively in 1995.

Total expenditure of hospitals for diagnosis, treatment and operation including overhead fees was US$35,798 thousand in 1995[3] said in the statistics. It means that average expenditure per patient was US$98/persons (equivalent to NIS.324) per year.

(2): Annual Report 1995 Palestine "Palsetine Health Status", April 1996, Ministry of Health, PNA.

(3): The amount of revenue from patients was US$22,095 thousand in total including health insurance premium with a coverage rate of 61.72 %. The amount of shortage was covered by UNRWA or some other international funds, said the statistics. Therefore, if this medical expenses can be saved, the Project may contribute to the national economy.

In order to estimate the medical expenses to be saved after completion of waste water treatment system proposed in the Project under study, those share rates of water related and faecal disposal related disease to the total cases and the distribution rates of patients to the population were assumed for applying for inhabitants living in the study area.

Here, it is assumed that impact of the Project under study to improve the environment of sanitation and/or health is 30 % according to that of similar project, and the first phase of the Project will end in 2002, so that the Project effect will realize after 2003.

The population in 2003 and 2015 is projected at 142,434 and 354,147, and number of effected persons will be 15,325 persons and 38,103 in the same year respectively. As a result, the amounts of medical expenses will be saved at sums of around US$1,504 thousand in 2003 and US$3,738 thousand in 2015 as shown in Table 16 in Appendix-I in Volume III "Supporting Report." These amounts can be taken as a part of economic benefit that derived from medical expenditures.

(3) Economic Benefit Derived from Income Loss of Inpatients

The average staying days in hospitals were 3.3 days according to the above mentioned medical statistics. By using the above mentioned workable persons per HH, share rate of water related and faecal disposal related diseases to the total cases, and the distribution rate of inpatients to the population, probable number of inpatients in 2003 and 2015 is estimated as 5,638 persons and 14,018 persons respectively.

As mentioned in previous Chapter, the average monthly income is NIS.1,059/month per HH in the study area(this income is almost the same amount of per capita income because only one person, family head, contributed to their family economy according to the social survey. The income of the other workable persons in their families is usually saved for their own purposes, i.g. for preparing the cost for marriage). This amount of income can be converted into daily income as NIS.42.36/day when workable days is assumed at 25 days per month in average.

Using the above mentioned information and assumption, the sum of US$238,815 per year and US$593,789 per year can be saved in 2003 and 2015 respectively in total as shown in Table 16 in Appendix-I in detail. These amounts can be taken as the other part of economic benefit.

(4) Economic Benefit Derived from Income Loss of Outpatients

As mentioned above, number of outpatients was 292,041 persons with 33.94 % of distribution rate against the population of 860,369 in Gaza Governorates in 1995. This distribution rate is assumed for applying to the inhabitants living in the study area. The share rate of water related and faecal disposal related diseases, workable persons per HH, and their average daily income are used as same rate in the case of inpatients.

As a result, the sum of US$290,230 per year and US$721,625 per year can be saved in 2003 and 2015 respectively in total as shown in Table 16 in Appendix-I in detail in Volume III "Supporting Report." These amounts can be taken as one more part of economic benefit.

(5) Economic Benefit in Total

Total economic benefit is as summarized in the following Table.

Table M.14.2 Annual Economic Benefit up to 2015

(US$/annum)

Year	Amount of medical fees to be saved	Income to be received from workable days in case of inpatients	Income to be received from workable days in case of outpatients	Economic benefit in total
2003	1,503,576	238,815	290,230	2,032,621
2004	1,553,591	246,760	299,884	2,100,235
2005	1,607,376	255,302	310,266	2,172,944
2006	1,655,027	262,871	319,464	2,237,361
2007	1,704,515	270,731	329,016	2,304,262
2008	1,755,924	278,896	338,939	2,373,760
2009	2,966,393	471,157	572,592	4,010,142
2010	3,086,640	490,256	595,803	4,172,699
2011	3,201,915	508,566	618,054	4,328,534
2012	3,323,914	527,943	641,603	4,493,460
2013	3,453,429	548,514	666,603	4,668,546
2014	3,591,273	570,408	693,210	4,854,891
2015	3,728,481	593,789	721,625	5,053,895

(Note) See detail shown in Table 16 in Appendix-I.

14.5.3 Estimation of Financial Benefit

(1) Cost Recovery

Willingness to Pay

According to a result of social survey this time made by JICA, treatment of gray waste water and black waste water vary:

(1) Use tanks for both the gray and black waste water (67 %),
(2) Dumping the gray waster water in their garden (17 %),
(3) Dumping the gray waste water into the streets directly (13 %), and,
(4) Others (3 %)

Among the households who use the treatment tanks mentioned above, de-sludging frequencies are as follows according to the said survey:

(1) Once a week to once a month (48 %),
(2) Once in every 2 months (20 %),
(3) Once a year (26%), and,
(4) Once in every 2 years (6 %).

Cost for these de-sludging services varies between NIS.20 and NIS.50 per time, but most households pay more than NIS.40 (57 %). Monthly charge per household is roughly calculated at NIS.39.62/month in weighted average based on the result of the said social survey.

Appendix I-1 in Volume III "Supporting Report" shows the average monthly family expenditure by item and income level in the study area. According to this data, the monthly family expenditure is NIS.951, while the monthly family income level is approximately NIS.1,059 both in overall weighted average. Difference between them, namely NIS.108 seems to be saved for other uses.

On the other hand, 97 % of households feel that a waste water management system is absolutely necessary for their residential area, the Municipality of Khan Yunis. Among them, 53 % of the households have a willingness to pay for waste water management system with 1.44 % of their income which means about NIS.15/month as shown in Table 17 in Appendix-I in Volume III "Supporting Report."

Affordability

As mentioned above, people living in the study area are currently paying for waste water treatment services at around NIS.40 per month per household, while the willingness to pay of them is NIS.15 per month per household with a rate of 1.44 % of their income.

On the other hand, they already pay charges for water and electricity supply with a rate of more than 14 % of their total income. Nevertheless, they also pay charges currently for waste water treatment services additionally with a rate of around 4 % of their income as mentioned above. Therefore, it is quite reasonable that the amount of their willingness to pay for waste water treatment services is less than a half of existing paid one.

The above mentioned situation means that people living in the study area have an affordability to pay charge at amount of up to NIS.40.

This situation should be considered to set tariff system for waste water management system after completion of construction works of waste water treatment facilities proposed in this Study.

Tariff System

As mentioned in Chapter 4, the Municipality of Khan Yunis has no any waste water management system at present, so there is no regulation or tariff system for it. However, existing tariff for waste water treatment services varies from NIS.20 to NIS.50 per time in de-sludging of their treatment tanks, and de-sludging frequency varies from once a week to once in every 2 years.

The Government of the PA has no unified regulation for establishing the tariff system for waste water treatment services to be applied in each Municipality. Therefore, each Municipality has its own tariff system based on the situation of its waster water treatment services system.

Accordingly, a tariff system of the Municipality of Khan Yunis for waste water management system should be established as the Municipality's own system based on the management system after completion of the construction works of waste water treatment facilities proposed in this Study considering the similar systems of other Municipalities of the PA. Nevertheless, the tariff system should be set considering the above mentioned situation as the minimum rate of NIS.15/month, the maximum rate of NIS.40/month, and the average rate of NIS.30/month per family.

The Municipality of Gaza and the Municipality of Rafah have their tariff systems for waste water treatment systems, and they may be considered as references because that the both Municipalities are in Gaza Governorates, so the income situation may be almost the same except the waste water treatment facilities. The tariff system of the both Municipalities are introduced hereunder for reference.

(i) Tariff System in the Municipality of Gaza

Surface area of around 65 % of the Municipality of Gaza is covered by the sewerage network, and remaining 35 % area still uses cesspits for sewage disposal. Therefore, the Municipality of Gaza has 2 tariff systems for waste water treatment services as follows.

- For served area by sewerage network:
  - A one-time subscription fee of NIS.80 for each floor of each building.
  - A monthly tax of NIS.4 for each floor of each building.
  - A tariff equal to 15 % of water consumption.

In this case, following water tariff system is adopted in the Municipality of Gaza:

  - Consumed volume of water from 0 to 10 m^3 : NIS.6.00/month as basic charge.
  - Consumed volume of water from 11 to 30 m^3 : NIS.0.50/m^3.
  - Consumed volume of water from 31 m^3 and over : NIS.0.90/m^3.

- For served area by non-sewerage network but use of cesspits:
  - A tariff of NIS.50 for each 18 m3 of waste water suction per time.

(ii) Tariff System in the Municipality of Rafah

Residents living in the Municipality of Rafah of 30 % (2,576 subscribers as of the end of 1996) are served by the sewerage network, and remaining 70 % of residents use cesspits without sewerage network. These cesspit users are served by both the Municipality and private sector. A following unified tariff system is adopted in the Municipality of Rafah for both the served areas by sewerage network and use of cesspits:

- NIS.35 for each 5 m^3 suction served by the private sector.
- NIS.20 for each 5 m^3 suction served by the Municipality.

Financial Position of the Government

As mentioned in previous Chapter, the Government of the PA adopted a self-supporting system in the Municipalities. The Government of the PA may give subsidies to the Municipalities only when they face to serious shortage in their budget. Therefore, any subsidies may not be expected from the central Government of the PA to the Municipality of Khan Yunis too in principle.

Availability of subsidies from or any other financial position of the Government of the PA should further be studied up to get results of economic and financial evaluation of the Project in the feasibility study of next stage.

Anyhow, self-supporting capability of the Municipality of Khan Yunis should be cleared first of all. In this case, residents' affordability to pay not only for tariff for waste water treatment services but also for the other tariff or charges as for water supply, electricity, and other tax or duties should be studied in more detail because that the revenue of the Municipality depends upon residents' capability or affordability to pay.

(2) Estimation of Financial Benefit

As mentioned above, people living in the study area have their willingness to pay with a rate of 1.44 % of their income in average for services of waste water treatment system. Their monthly income is NIS.1,059 in average per household, so the willingness of them to pay for the services can be calculated at amount of NIS.15.25 per month per household.

On the other hand, they actually pay for only existing de-sludging services at amount of NIS.39.62 per month per household according to the social survey.

It means that they have an affordability to pay for the new waste water treatment system proposed by the Project under study ranging from NIS.15 to NIS.40 per month per household.

According to the said medical statistics, they are paying the medical fees with the rate of 61.72 % of the total medical cost needed for treatment at amount of NIS.324 per patient per year, and a distribution rate of patients to the population was 42.41 % in Gaza Governorates in 1995 including both the inpatients and outpatients, so they can save the money at NIS.20 per month per household (=NIS.324/12 months x 0.6172 x 9.43 persons/HH x 0.4241 x 0.3) assuming the impact rate of the new waste water treatment system proposed by the Project under study with 30 % as mentioned in previous sub-clause. It means that they will have additional affordability to pay in addition to the amount of willingness of them to pay.

When it takes the situation mentioned above into consideration, the average connecting charge for network of the proposed waste water treatment system by the Project under study with a rate at amount of NIS.35 per month per household (=NIS.15 + NIS.20) may be reasonable one from the viewpoint of beneficiaries' burden for the system because that, after completion of the construction works of the system, they will have a complete waste water treatment system and they can use it without any care of gray and black waste water.

Then, the said amount of NIS.35 per month per household may be applied for probable financial revenue of the Municipality of Khan Yunis for operation and maintenance for the system as a financial benefit of the Project under study. An annual revenue will become at amount of NIS.420 per household. The Municipality of Khan Yunis should replace the facilities for the system within this amount in the future. The annual financial benefit flow is summarized as below, and the detail is shown in Table 18 in Appendix-I both together the case of NIS.36 per household per month for reference for setting tariff system of the new waste water treatment system proposed by the Project under study and to clarify a sensitivity from charge to revenue of the Municipality of Khan Yunis.

Table M.14.3 Annual Financial Benefit up to 2015

(US$/annum)

Year	Probable revenueas financial benefit	
	For case of NIS.35/HH.M	For case of NIS.36/HH.M
2003	1,922,372	1,977,296
3004	1,986,318	2,043,070
2005	2,055,083	2,113,800
2006	2,116,007	2,176,464
2007	2,179,279	2,241,544
2008	2,245,007	2,309,150
2009	3,792,633	3,900,994
2010	3,946,345	4,059,098
2011	4,093,755	4,210,719
2012	4,249,735	4,371,156
2013	4,415,324	4,541,477
2014	4,591,563	4,722,750
2015	4,779,772	4,916,337
2016	6,432,631	6,616,420

(Note) See detail shown in Table 18 in Appendix-I.

14.5.4 Economic and Financial Cost

The economic cost of the Project is converted from the financial cost under the some conditions and assumptions mentioned hereunder.

Transfer payments such as taxes and duties are assumed to be 17 % of market prices of commodities and services procured locally, and to be exempted from duties for those procured from abroad.

In order to estimate the standard conversion factor (the SCF), a following equation is usually applied:

$$SCF = (I + E)/((I + Ic) + (E - Et + Ss)) * 100$$

Where, SCF : the Standard Conversion Factor,

I : Import amount,

E : Export amount,

Ic : Import customs,

Et : Export taxes, and

Ss : Subsidies.

The SCF to be applied for local commodities and services in the case of this Project is estimated based on the trading data in Israel considering the existing situation of Palestine at 92.04 % as shown in the Table hereunder.

Table M.14.4 Calculation of SCF

(NIS.million)

Year	Export	Import	Export taxes	Export subsidies	Import customs	Import subsidies
1984	3,089	4,206	0	225	624	-15
1985	12,701	16,571	0	506	2,425	-82
1986	17,507	23,136	0	564	3,892	-109
1987	22,302	32,302	0	736	5,408	-88
1988	24,767	33,803	0	919	5,775	-88
1989	31,584	39,082	0	1,050	5,123	-25
1990	35,907	48,209	0	977	6,526	17
1991	40,511	61,186	0	827	8,969	-44
1992	50,068	71,858	0	832	10,947	-26
1993	62,139	90,834	0	510	12,233	2
1994	73,425	107,967	0	382	13,567	86
1995	84,846	126,160	0	317	15,557	60
1996	94,401	142,703	0	246	17,485	56
Total	553,247	798,017	0	8,091	108,531	-256
	SCF = (I + E)/((I + Ic-Is) + (E - Et + Es)) * 100 :					92.04%

Source : National Account 1986 - 1996, Central Bureau of Statistics, Israel.

Economic wage of unskilled laborers to be employed for the construction works is assumed to be 90 % of the actual market wage, taking of the employment opportunity of laborers in the study area.

Economic cost of land compensation is assumed to be 100 % of the financial cost, taking account of the opportunity cost of land use.

The economic and financial cost of the Project is given in the present value (PV) at the 1997-March price level and are taken no account of the price escalation during the periods of construction works and Project life for evaluation.

Economic costs for operation and maintenance (OM cost) after completion of first stage works to the end of the Project life are estimated based on the same assumptions of the said Project cost.

Replacement cost for the facilities is estimated at a rate of 55 % for pumping station to its total cost, 46 % : waste water treatment plant, 100 % : sanitation system, and 46 % : drainage system and their life time 25 years after completion of the construction works except sanitation system. The sanitation system consists only trucks, so that its life time is set as 10 years.

Project life is set as 30 years after commencement of construction works. Therefore, only the replacement cost for the sanitation system will be appeared during the Project life.

Annual allocation of the economic and financial costs of the Project is shown in Table 19 in Appendix-I in Volume III "Supporting Report" and summarized below.

Table M.14.5 Annual Allocation of Project Cost in Loan Basis

(US$1,000)

Year	Work stage	Financial cost	Economic cost
1998	Stage I	1,287	1,287
1999		21,416	17,912
2000		18,546	15,811
2001		18,262	15,569
2002		18,262	15,569
2003	Stage II	3,691	3,077
2004		15,160	12,930
2005		15,160	12,930
2006		15,160	12,930
2007		14,344	12,235
2008		14,344	12,235
2009	Stage III	689	683
2010		8,955	7,641
2011		8,955	7,641
2012		8,955	7,641
2013		8,955	7,641
2014		8,955	7,641
2015		8,955	7,641
Total			

(Note) See detail shown in Table 19 in Aappendix-I.

14.5.5 Economic and Financial Evaluation of Project

The Project is targeted to get a grant from Japanese Government, but a loan basis evaluation is made too in addition to a grant basis evaluation of the Project from the viewpoint of economic and financial aspect.

(1) Project Evaluation in Loan Basis

The evaluation of the Project is made by using cash flows of the said costs and economic benefits in both the economic and financial aspects as shown in Tables 20 and 21 in Appendix-I. The results are also shown in those Appendices and summarized below. In this case, B/C rates are comparison of benefit and cost in present value of them, and B-C means net cash balance between benefits and costs also expressed by their present value. For calculation of present value, a discount rate of 12 % is applied as same as in similar projects. The figures are expressed in terms of US Dollars in US$1,000 using 1997-August price level.

Table M.14.6 Result of Project Evaluation in Loan Basis

	EIRR/FIRR(%)	B/C	B-C(US$1,000)
From Economic Evaluation	-5.74	0.20	-68,400
From Financial Evaluation	-8.52	0.16	-84,344

(2) Project Evaluation in Grant Basis

In order to make the Project evaluation in the grant basis, the costs to be borne by the Municipality of Khan Yunis should be clarified first because that the initial investment cost will be granted by donor countries/foreign institutions.

Using the assumptions mentioned in aforementioned clause, cost flows are resulted as shown in Table 22 in Appendix-I and summarized in Table M.14.7 below as an annual allocation of the costs to be borne by the Municipality of Khan Yunis to be necessary for replacement in the same of order of the initial investment costs for Project evaluation.

Operation and maintenance cost and replacement cost are the same in the loan basis because the Project is designed to be operated by their own burden and responsibility.

Table M.14.7 Annual Allocation of Project Cost in Grant Basis

(US$1,000)

Year	Work stage	Financial cost	Economic cost
1998	Stage I	115	115
1999		5,391	4,086
2000		5,271	4,086
2001		4,998	3,875
2002		4,998	3,875
2003	Stage II	118	98
2004		4,105	3,183
2005		4,105	3,183
2006		4,105	3,183
2007		3,747	2,906
2008		3,747	2,906
2009	Stage III	44	44
2010		1,882	1,460
2011		1,,882	1,460
2012		1,882	1,460
2013		1,882	1,460
2014		1,882	1,460
2015		1,882	1,460
Total			

(Note) See detail shown in Table 22 in Appendix-I.

Benefits are not effected in the grant basis because that the initial investment will be made by donor countries/foreign institutions so that the Project will be completed.

The evaluation of the Project in the grant basis is made by using cash flows of the said costs and economic benefits in both the economic and financial aspects as shown in Tables 23 and 24 in Appendix-I. The results are also shown in those Appendices and summarized below. In this case, as same as in the evaluation in the loan basis, B/C rates are comparison of benefit and cost in present value of them, and B-C means net cash balance between benefits and costs also expressed by their present value. For calculation of present value, a discount rate of 12 % is applied as same as in similar projects. The figures are expressed in terms of US Dollars in US$1,000 using 1997-March price level.

Table M.14.8 Result of Project Evaluation in Grant Basis

	EIRR/FIRR(%)	B/C	B-C(US$1,000)
From Economic Evaluation	6.02	0.67	-8,0922
From Financial Evaluation	0.79	0.45	-19,378

(3) Conclusion of Project Evaluation from the Viewpoint of Economic and Financial Aspects

In the loan basis, both of the EIRR and the FIRR are negatively resulted as shown in the above Table M.14.6 as -5.74 % and -8.52 % respectively. It means that the Project is not fit for the loan to be executed from both the viewpoints of economic and financial aspects.

In the grant basis, the EIRR and the FIRR are resulted as shown in the Table M.14.8 as 6.02 % and 0.79 %. Generally, as suggested by such international institutions as the World Bank, a EIRR is expected to at least be cleared a hurdle of 5.0 % of EIRR from a viewpoint of basic human needs even such a project is in developing countries, and the Project under study satisfies this expectation with the resulted EIRR. Namely, the Project is economically sound from the viewpoint of basic human needs in the grant basis.

While, the FIRR is resulted as quite low, but it is slightly higher than zero percent. When the EIRR is zero, cumulative amounts of benefit (revenue) is equal to the cumulative amount of cost during the project life, and it means that the cost can be covered by a proposed average service charge system.

As shown in Table 24 in Appendix-I, the cumulative benefit (revenue) is US$125,997 thousand and cumulative cost is US$119,553 thousand, so that cumulative balance has become still positive one as US$6,445 thousand.

Accordingly, in the case of the said resulted FIRR, 0.79 %, the cumulative benefit (revenue) will be equal to the cumulative cost, to be borne by the Municipality of Khan Yunis by the average service charge of NIS.35 per HH per month to be collected from beneficiaries, in one year (US$6,445 thousand/US$6,433 thousand/12 months = 12 months) prior to the end of the Project life .

In other words, a surplus which is equivalent to the total revenue for 12 months will be generated from the cumulative amounts of cost and revenue during the Project life in the case of NIS.35 per HH per month.

According to the construction schedule, the replacement of main facilities should be commenced from 2029, but the replacement works do not request the whole costs in one time. Therefore, the Project may be financially sound from the viewpoint of self financial supporting basis for operation and maintenance for the facilities proposed by the Project under study by an average service charge of NIS.35 per HH per month.

14.6 Environmental Consideration

14.6.1 Preface

In order to support sustainable development, it is of great importance to give sufficient consideration to the environmental aspects in the implementation of the sewerage and drainage development programs. This chapter as environmental consideration is for the purpose of predicting possible environmental problems that may be caused by the proposed projects and incorporating adequate mitigatory measures against adverse environmental effects into the projects.

The Initial Environmental Examination (IEE) was conducted for the Master Plan. The examination has been undertaken at the outset of the development project planning stage to determine the environmental impacts that may be caused by the proposed project based on the existing information and data.

The Master Plan of the sewerage project is divided into several series of components related to the construction and management of sewer pipes, pumping stations, sewage treatment plant, sludge treatment plant and sludge disposal area for treating domestic, industrial and public sewage.

The Master Plan of the drainage project also consists of several components related to the construction and management of drainage pipes and a pumping station.

The objectives of sewerage and drainage project are to improve public health and sanitation condition and residents' living environmental condition. The plan imparts a strong positive (beneficial) impact on the living environment.

Unfortunately, since there is no national regulation or guidelines of environmental impact analysis by Palestinian National Authority, environmental guidelines formulated by JICA were referred to organize Project Description, Site Description, Screening, Scoping and Overall Environmental Evaluation.

14.6.2 Regulation and Organization

Since the establishment of the Palestinian National Authority (hereinafter: the "PNA") in 1994, 26 ministries have been established to regulate governmental concerns and to set the national plan to build the economy, rehabilitate the infrastructure and organize the national government body which will be the foundation for an independent state in the near future, according to the Oslo Agreement and related guidelines of the peace accords.

(1) Regulation and Law

After so many years of subjection to foreign domination by Turks, British, Egyptians and Israelis, the Palestinian Authority has been facing a major problem: the lack of discipline of most Gazans who have difficulties in accepting any kind of laws and regulations.

Palestine is in a special status following short to be recognized as a nation comfort to international law. So far Palestinian Interim Self-government Authority is organized as self-government within Israel, and hence Palestine has not joined any international treaty regarding environmental protection.

Preservation of natural environment and resources is required as rapid development in the Palestine is expected after the start of the self-government.

Some ministries and governmental agencies have direct relation with projects which focus on rehabilitation of the Palestinian infrastructure and environmental protection issues. Unfortunately, until today there are no clear laws and regulations that have been created by the Palestinian people to protect the fragile environment in Palestine, due to the long and harsh occupation since 1967.

(2) Organization

Along with the regulations and law of the environmental protection, a systematic organization has not been established in PNA. The Environmental Planning Directorate (EPD) within the Ministry of Planning and International Cooperation (MOPIC) is in charge for environmental planning with three (3) departments: Planning and Policy Department, Monitoring and Environmental Monitoring Department, and Information and Follow-up Department. However their capability of environmental monitoring is largely limited due to lack of necessary facilities.

This day Palestinian Environmental Authority (PEnA) was established and PEnA has submitted the draft of environmental law to the Palestinian Legislative Council (PLC). It is expected to be approved and become effective by the beginning of 1998.

14.6.3 Scoping

Scoping is studied corresponding to the adopted alternative 2 of sewerage planning. There are no differences in drainage alternatives for Screening and Scorping.

The Scoping is described in Table M.14.9, based on project description, site description and screening which are illustrated in Appendix G of M/P. Evaluation of each environmental item is grouped into 4 categories of A (Serious impact is expected.), B (Some impact is expected.), C (Extent of impact is unknown, Examination is needed. Impacts may become clear as study progresses.) and D (No impact is expected. IEE/EIA is not necessary.) 14 environmental items are categorized into B and C.

Table M.14.9 Scoping

No.	Environmental Item	Evaluation	Reason
Social Environment			
1	Resettlement	D	There are no residents around the site of TP and pump station.
2	Economic Activities	B	Present landuse of the TP site is farm land leased to farmers but owned by government. Social issues of lease termination and loss of farm production. Use of infiltrated treated wastewater for irrigation (indirect reuse) may affect farm products due to its high metal content (sodium)
3	Traffic / Public Facilities	C	Traffic disturbance during the facilities construction period. (TP, PS and Sewer)
4	Split of Communities	D	There are no structures to split any communities. Although installation of TP occupies some road area, they are small and do not split communities or affect transportation.
5	Cultural Property	C	Existence of valuable cultural assets is not sure. They may be damaged due to construction if any exist.
6	Water Rights and Rights of Common	D	Effluent from the TP is not discharged to sea or river.
7	Public Health Condition	C	Treated wastewater from the TP will be infiltrated underground. The TP influent water contains high concentration of Sodium, Nitrate, Chloride ion and other. So, utilizing the treated wastewater and sludge for agricultural use could affect human, farm land, farm product and groundwater.
8	Waste	C	Environmental and sanitation problems will occur if generated sludge at TP is not treated and discharged properly.
9	Hazards (Risk)	C	Safety concern due to failure of proposed high head PS (H=60m) caused by power failure or any other breakdown.
Natural Environment			
10	Topography and Geology	D	There are no large scale changes in topography and geology by the construction.
11	Soil Erosion	C	Treated wastewater from the TP will be infiltrated underground. Soil erosion may occur in the case the supply exceeds the ground permeable capacity.
12	Groundwater	C	Treated wastewater from the TP will be infiltrated underground. The TP influent water contains high concentration of Sodium, Nitrate, Chloride ion and others. So, utilizing the treated wastewater and sludge for agricultural use could affect human, farm land, farm product and groundwater. Treatment system will be affected and ground water will be polluted if inlet wastewater includes noxious materials.
13	Hydrological Situation	D	Treated water is discharged into ground and it does not affect river or other surface maters.
14	Coastal Zone	D	There is no affected element.

No.	Environmental Item	Evaluation	Reason
15	Fauna and Flora	C	If there are rare or endangered fauna and flora at the TP site, they would be affected since the TP site requires a large area. Discharging inadequately treated wastewater may deteriorate the environmental condition and affect the fauna and flora around TP area.
16	Meteorology	D	There is no affected element to the meteorology.
17	Landscape	D	There is no large scale construction to change the landscape.
Pollution			
18	Air Pollution	C	Heavy vehicles generate dust and exhaust during construction period and would cause air pollution. TP operation including sludge may cause air pollution (volatile gas) in the case of receiving polluted wastewater. It is possible fly breed at TP and PS.
19	Water Pollution	C	It is possible that treated water which is discharged into underground to affect the groundwater quality. This is similar to item No.12.
20	Soil Contamination	C	Treated wastewater from the TP will be infiltrated underground. And TP influent water contains high concentration of Sodium, Nitrate, Chloride ion and other. So, utilizing the treated wastewater and sludge for agricultural use could affect human, farm land, farm product and groundwater with soil contamination. Treatment system will be affected and ground water will be polluted if inlet wastewater includes noxious materials.
21	Noise and Vibration	C	Significant noise and vibration would be caused due to construction works, specially sewer line, PS and TP construction. TP and PS operation may cause noise and vibration to surrounding area (hospital, school, residents, livestock breeding, wild life) They will damage the surrounding facilities such as crack with the vibration in the case the ground condition is loose.
22	Land Subsidence	D	There is no affected element.
23	Offensive Odor	C	It is possible that TP, PS and outlet of sewer may affect the surrounding area due to offensive odor.

Note 1: Evaluation categories:

A : Serious impact is expected.

B : Some impact is expected.

C : Extent of impact is unknown (Examination is needed. Impacts may become clear as study progresses.).

D : No impact is expected. IEE/EIA is not necessary.

Note 2: TP : Wastewater treatment plant

PS : Pump station

Summarizing the result of the scoping, 16 environmental items are condensed into eight (8) items as shown in M.14.10.

Table M.14.10 Summarized EIA Works

No.	Items of major EIA study	Corresponding IEE Items
1	Land acquisition for wastewater treatment plant	(1) Economic activities
2	Cultural property	(3) Cultural property
3	Hazards	(6) Hazards
4	Discharge of treated wastewater	(4) Public health condition (7) Soil erosion (8) Groundwater (11) Water pollution (12) Soil contamination
5	Waste management of sludge	(5) Waste
6	Fauna and Flora	(9) Fauna and Flora
7	Air pollution, transportation, noise and vibration	(10) Air pollution (2) Traffic and public facilities (13) Noise and vibration
8	Odor	(14) Offensive odor

14.6.4 Alternatives Comparison in Environmental View Points

(1) Sewerage Planning

There are three (3) Alternatives for the Master Plan, according to the selected location of the wastewater treatment plant. In the alternative 1, one (1) wastewater treatment plant is located near sea side as No. 6. In the alternative 2, one (1) wastewater treatment plant is located at inland as No. 5. In the alternative 3, two (2) wastewater treatment plants are located near sea side and inland as No. 6 and No.5.

Based on the view point of the environmental aspects, characteristics of each alternatives are described in Table M.14.11.

Table M.14.11 Characteristics of Alternatives from the Environmental View Point

No.	Item	Alternative 1 (TP is near sea side)	Alternative 2 (TP is inside land)	Alternative 3 (Two TP are located near sea side and inside land)
1	Reuse	Δ	O	O¯
2	Discharge	O	Δ	O¯
3	O/M	Δ	Δ	O
4	Land acquisition	Δ	O	Δ
	Evaluation	Δ	O¯	O¯

Note : O : Good
Δ : Fair
× : Not good
¯ : Relatively lower grade

The JICA Study Team initially proposed Alt. 3 which locates the wastewater treatment plant near the seashore, where discharged treated wastewater can be drained to sea through wadi. Also the location is good for sewer planning to reduce the pumping head, that can decrease the operation and maintenance cost.

Although finally, the site of wastewater treatment plant is decided at inland as Alt. 2. One reason is the existence of a future urban development plan near the proposed wastewater treatment plant site of Alt.3. Other reason is to have the opportunity to utilize the treated wastewater as reclaimed water to improve the prevailing water shortage.

(2) Drainage Planning

There are three alternatives in drainage planning. There are no significant differences among them from environmental view points. So, Alt. 2 is decided as proposed drainage plan from economical view point because it is advantageous in investment cost and O/M.

14.6.5 Environmental Evaluation of Project

(1) Impacts with Project

1) Positive impacts with project

- Improvement of sewage discharge through the proposed network
- Decrease of diseases resulting from sewerage system
- Termination of wastewater discharge in streets and open sewers

- Termination of untreated wastewater discharge in sand dunes, polluting the aquifer
- Provision of wastewater and sludge reuse opportunity (mainly for agricultural purposes)
- Termination of untreated wastewater disposal on beaches and into sea, mitigating coastal water pollution
- Improvement of stormwater drainage system and usage of groundwater recharge
- Improvement of traffic congestion avoiding sewerage and stormwater overflow
- Increment of additional jobs and economic activities through subcontracts

2) Negative impacts with project

- Loss of Farmers working opportunity at the wastewater treatment plant site
- Anxiety of deterioration of groundwater quality, affecting farming, soil condition and human health by discharging treated wastewater into underground from a wastewater treatment plant
- Anxiety of construction accident, traffic congestion, illegal soil and debris (waste) disposal, noise pollution and air pollution during construction period

(2) Impacts without Project

1) Positive impacts without project

- Maintaining farmers working opportunity at the wastewater treatment plant site
- Maintaining present groundwater quality around wastewater treatment plant site
- Avoiding construction accident, traffic congestion, illegal soil and debris (waste) disposal, noise pollution and air pollution as there is no construction works.

2) Negative impacts without project

The existing living environmental problems will become more severe and may inhibit economic and social development of the area in the medium and long term:

- Degradation of the environment and reverse negative developments
- Depletion of the aquifer
- Dramatic decrease of both quantity and quality of the groundwater
- Degradation of the last remaining natural assets because of uncontrolled wastewater disposal in wadis
- Increment of groundwater over-exploitation
- Degradation of the health situation and increase of water related diseases due to poor wastewater management

(3) Environmental Evaluation of the Project

As result of IEE, eight (8) environmental items are summarized as some impacts are expected or extent of impact is unknown. It is evaluated that further study is required on: 1) land acquisition for wastewater treatment plant, 2) cultural property, 3) hazards, 4) discharge of treated wastewater, 5) waste management of sludge, 6) Fauna and Flora, 7) air pollution transportation, noise and vibration and 8) odor.

EIA shall be conducted during the Feasibility Study stage for these items to forecast and evaluate the environmental impacts by this project. The study items are evaluated not only in the project area but also in any area that may be directly or indirectly affected during the construction and the subsequent operation of the project. Also formulation of action program and recommendations on environmental monitoring and management is required in the study so as to enhance the positive impacts and minimize the negative impacts.

Although there are some uncertain environmental impacts by the project, this sewerage project is for improving public health condition and living environmental condition, so that it has high beneficial effect on enhancing the living environment.

There is plan to reuse treated wastewater for agricultural purpose and others. Pilot project shall be conducted on treated wastewater reuse to confirm its characteristics or effect to soil and plants before the start of full scale reuse project.

CHAPTER 15 RECOMMENDATIONS

CHAPTER 15 RECOMMENDATIONS

15.1 Sewerage/Sanitation System

The proposed sewerage/sanitation project for 1998-2015 represents the least cost alternative plan to meeting Khan Yunis Municipality and its surrounding villages' sewerage and water reuse needs, defined as improved sanitation for all the region's residents and an adequate treatment plant effluent arrangement for irrigation purpose.

(1) Sewers and Pumping Stations

For households with water connections should be provided with the least cost sewers and intermediate sewage pumping stations which removes both excreta and sullage. The system is proposed to commence its design and construction from 1998 and complete its first stage program in 2002. The second and the third construction stages are scheduled for periods of 2003 to 2008, and 2009 to 2015, respectively. For the first stage project a sewer network will cover 848 hectares built-up urban areas serving about 173,000 residents in Khan Yunis City at the end of 2002. By the year 2015, the sewer system is planned to cover a total sewerage implementation area of 3,632 hectares with an estimated served population of 472,300.

(2) Sewage Treatment and Disposal

The proposed oxidation ditch sewage treatment plant should be constructed. The plant effluent is planned for the effective use of crop irrigation or groundwater recharge, as well as for greening in the near-by industrial estate and airport.

(3) Sanitation System

Under the sanitation program, it is recommended that vacuum trucks for desludging of septic tanks and cesspits in the unsewered areas, and sludge duping stations be provided at pumping stations or treatment plant.

15.2 Stormwater Drainage System

Two drainage pump stations are proposed for Khan Yunis District under the first stage construction program to eliminate the flood prone areas in the central part of the City. The drainage program encompasses the construction of necessary storm water retention basins, channels and discharge pipelines. The stormwater is proposed for transmission through the discharge pipeline to the nearby depressed dune for the groundwater recharge.

15.3 Treated Effluent, Stormwater and Sludge Reuse

Gaza Governorates is situated in arid or semi-arid area with annual precipitation of 200 to 300 mm. It is expected that further returnees residing abroad will come back to already densely populated areas like Khan Yunis. Beside human activities agricultural and industries activities are on the rise and shall be more promoted to accommodate the increasing population.

As the result water is for more consumed than the accumulated storage in the underground. Gaza Governorates is largely dependent upon the water supply from Mekorot of Israel. This kind of situation will inevitably lead to rational saving of water, though normal people are not knowledgeable about the methodology of effective water consumption.

Treated effluent from the sewerage treatment plant is one of the rare and valuable water resources, which should not be wasted by discharging into the sea. However the water quality of the treated effluent will have to be made sure for agricultural and other purposes. About 70% of the respondents of the interview by the Study are supporting the positive reuse of the effluent for agriculture.

Stormwater will not be generally polluted, since a separated system is recommended in the Study. It is a good idea to promote the reuse of stormwater like treated effluent for agriculture or others, or for recharge into the underground after proper treatment to meet the standards.

The sludge contains about 60 to 70% of organic matters, which are valuable resources as agricultural fertilizer, if the levels of heavy metal concentrations are less than the regulation like WHO. More than 80% of the respondents are supporting the use of sludge.

The Study Team generally recommends the reuse of sludge, though due care should be taken of the measures to avoid from mixing in the factories by monitoring and guidance.

15.4 Recommended Actions

Detailed actions necessary to implement the Project are described in Chapters 13 and 14 and associated Appendices. Several steps are essential if the Project is to be successfully and efficiently implemented.

(1) The Palestinian Interim Self-government and Japanese Governments must approve the Project.

(2) Agreement of the Project must be obtained from the agencies concerned.

(3) Project finance must be arranged by the Palestinian Interim Self-government from international financing agency/agencies.

(4) The necessary changes in institutional responsibilities for the sewerage, sanitation and drainage must be implemented as soon as possible to enable the Palestinian Interim Self-government to control and implement the Project.

(5) The Khan Yunis Governorate and Municipality organizations must be modified and strengthened, with extensive training and retraining of staff for the proposed Project.

(6) Preliminary steps must be taken toward acquiring the land necessary for the sewage treatment plant and pumping stations.

(7) Necessary actions must be taken to implement a project for providing irrigation farm lands with auxiliary facilities as soon as possible so that the treated sewage of approximately 10,000 m^3 /day under the first stage can be effectively utilized.

(8) The Palestinian Interim Self-Government must promote the reuse of treated effluent, stormwater and sludge to the maximum extent.

(9) Palestinian Water Authority must be the principal organization at the national level as the regulatory function in close collaboration with the Municipality and Governorate of Khan Yunis as the executing and operating function.

(10) All opportunities should be used at school and community meeting to avoid water wastage, to encourage effective use of water, and to promote community participation.

PART 2

FEASIBILITY STUDY

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CHAPTER 1 MASTER PLAN REVIEW

CHAPTER 1 MASTER PLAN REVIEW

1.1 Introduction

1.1.1 Background of Review

The Study Team completed the first phase of the Study in FY 1996 and produced the Interim Report (hereinafter called as IT/R) at end of March 1997.

In the second year of the Study starting from May 1997, the Study Team visited Palestine in mid-May 1997 and submitted the IT/R to the Steering Committee.

The explanations and discussions on the IT/R were carried out in Palestine in May 1997. During the discussions the Palestinian side requested the Japanese side to revise the implementation schedule (see the details in M/M dated 21 May, 1997).

In the first year the Study Team was involved with the all relevant information for formulation of the Master Plan, while a topographic survey was subcontracted to a local consultant. The result was not available to the Study Team during the first field works from September to December 1996. The Study Team used the available map with scale of 1:20,000 for their field works. Because of roughness of the map, the Master Plan, which had been completed, needed to be checked and revised based on the new map with scale of 1:5,000 until March 1997. However the review process could not be completed due to the amount of works involved and time limitation. Therefore the related works are presented in this section.

1.1.2 Revised Implementation Schedule

As the agreed Scope of Works for the Study had the target year to 2015, the Study Team had divided the implementation period as follows:

- First Stage: from 1998 to 2002
- Second Stage: from 2003 to 2008
- Third Stage: from 2009 to 2015

However the Palestinian side explained to the Study Team that the residents in the areas to be implemented in late stages would be complaining a lot, and requested the Japanese side to accelerate the implementation schedule. The Study Team explained that it would be very difficult to accept the request, because such a change would require a lot of works from the Study Team. But the Palestinian side asked again the Japanese side to reconsider the revision. So the Japanese side agreed finally with it and the agreement for implementation schedule was reached as follows:

- First Stage: from 1998 to 2002
- Second Stage: from 2003 to 2006
- Third Stage: from 2007 to 2010

It was also agreed that only the implementation schedule would be changed, but that the planning itself would be the same aiming at year 2015.

1.1.3 Other Changes

One of the major changes in the second year was to use the dynamic model for computer simulations of sewerage and drainage systems.

In the formulation of the sewerage system the rational method was applied and the result was integrated into the dynamic model. Both results were mutually examined and finalized.

In the drainage system it was envisaged that there would be a large discrepancy between the time/area method and the dynamic modeling: the former was used for the Master Plan after reexamining both results. Due to the methodological difference a fundamental review of drainage master plan was required.

1.2 Sewerage Master Plan

1.2.1 Design Basis

(1) Hydraulics of Sewers and Pumping Stations

At the outset of the Feasibility Study, the design bases proposed under the Master Plan have been examined in the light of the latest conditions of the Area and revisions or additions were made thereon as necessary.

The hydraulic conditions considered in design of the sewerage facilities have been confirmed by the field survey conducted under the Feasibility Study. Then, the hydraulics of sewers designed by the conventional method have been examined by using the "Dynamic Model"

The originally proposed constant wastewater peak factor value of 2.5 was thoroughly reviewed based on the field survey results. Then, the major sewer hydraulic conditions have further been analyzed by the "Dynamic Model" to check whether or not any sewer hydraulic computations need to be changed. The results of the analyses have indicated that the peak factors in certain main and submain sewers could be reduced from the original applied value of 2.5, depending upon their location, served population, sewer size, capacity allowance, time of concentration, and hydro dynamics conditions.

Accordingly, sizes of certain main and submain sewers and capacities of pumping stations could have been reduced. The procedures and results of the simulation analysis are discussed in more detail in Appendix-I "Dynamic Model," Volume III Supporting Report.

(2) Design Period for Sewer Capacity

In general, sewers should be designed for the estimated tributary population in the year 2015, except in considering parts of the system that can be readily increased in capacity. Where it is considered more economical, a smaller pipe will be laid under the First Stage Program, then the additional pipe at the later stage. The sewer reticulations, consisting mostly of 200 mm diameter pipes, will be constructed to have the capacity sufficient for 2015 conditions.

(3) Design Factors

In determining the required capacities of sanitary sewers the following factors should be considered:

- Maximum hourly wastewater flow rate from individual household; daily average flow rate x 2.5 (as the basis for hydraulic analysis),
- Additional maximum sewage or waste flow from any facility where justified necessary, and
- A composite daily wastewater flow fluctuation in the representative households has been developed and used for the hydrograph analysis and Dynamic Model analysis.

1.2.2 Sewerage System Layout

Routes, locations and hydraulic capacities of the sewerage facilities have been re-examined taking into account the latest conditions of the project site, together with the additional data obtained from the field investigations and surveys under the Feasibility Study. The overall system planning was first examined, then each system component unit was elaborated as necessary based on the results of economic and technical evaluation.

The review results indicated that the division of the Sewerage Districts and Subdistricts, locations of pumping stations and force mains, and the design bases proposed in the Master Plan Study appropriately reflected the present conditions of the Area. The sewerage system under the Feasibility Study could basically follow the Master Plan, but only minor adjustment of these in some districts were necessary.

The originally proposed Sewerage Implementation Area of 3,632 hectares has not been changed, but the boundaries of sewerage subdistricts are slightly modified based on the latest topographic conditions. Accordingly, some of the sewer routes were changed.

Modifications of the Master Planning are that the location of Pumping Station No.8 (PST8), force main routes, and certain sewerage districts boundaries. Routes of the branch and lateral sewer reticulations were also adjusted in view of the field survey results and the topographic maps to the scale of 1:5,000 completed after the Master Plan Study was completed.

The force main F3 route originally planned to cross the cemetery in the Shaikh Mohammed area was changed to flow straight toward southeast. Consequently, the routes of gravity sewers KY3-4, KY3-5, KY3-6 were changed. The force main F3 will be laid on the parallel road running from about 300 meters to 1 km south of the original one, thereby a total of about 500 meters of the force mains and gravity sewers could be cut short.

The PST8 and the connecting force main were reallocated to the site about 500 meters to the south of the original site as the wastewater treatment plant lot was moved about 1 km to the south of the originally proposed site.

The sewerage system layout plan and the sewer network diagram thus revised are shown in Figure F.1.1 and F.1.2, respectively.

1.2.3 Pumping Stations

As previously mentioned, the hourly maximum wastewater inflow rates (peak flows) of the pumping stations were adjusted to lower side. The revised peak factors and flow rates of both PST3 and PST8 are as follows:

Station	Peak factor	Master Plan		First Sage	
		m^3/d	m^3/sec	m^3/d	m^3/sec
PST3	1.54	50,026	0.578	24,782	0.287
PST8	1.56	80,870	0.937	25,135	0.292
WWTP	1.55	83,030	0.962	25,000	0.289

1.2.4 Wastewater Treatment Plant

The wastewater inflow rates to the wastewater treatment plant in 2015 and the First Stage Project are as summarized in the following:

Stage	Daily Average m^3/d	Peak factor	Hourly Maximum	
			m^3/day	m^3/sec
2015	53,400	1.55	82,800	0.958
First Stage	16,100	1.55	25,000	0.289

There has been no change in the size of plant facilities as these are designed based on the daily average flow rate. Only the size of pipes and conduits which convey the peak flow rate will be changed accordingly.

1.2.5 Planning Basis for the First Stage Program

The changes and modifications thus made on the originally proposed wastewater management strategy plan and the selected First Stage Project are summarized and compared in Table F.1.1 below:

Table F.1.1 Sewerage System Plans of Master Plan, Revised Master Plan and First Stage Projects

Item	M/P (2015)	M/P (2015) Revised	First Stage (2002)(2006)
1. Development Plan			
Study Area (ha)	4,458	4,458	-
Implementation Area (ha)	3,632	3,632	874
2. Land Use Planning			
Agricultural Area (ha)	534	534	22
Commercial Area)ha)	266	266	177
Residential (A) (ha)	1,313	1,313	143
Residential (A)&(B) (ha)	1,358	1,358	371
Refugee Camp (Low density) (ha)	57	57	57
Refugee Camp (ha)	104	104	104
Total (ha)	3,632	3,632	874
3. Wastewater System Planning			
Service Area (ha)	3,632	3,632	874
Served Population (persons)	476,000	476,000	158,410
Daily average per capita sewage flow (l/d)	112	112	101.6
Peak per capita sewage flow (l/d)	280	280	254
Per capita BOD_5 load (g/d)	55	55	55
Per capita SS load (g/d)	70	70	70
Daily average wastewater flow (m^3/d)	53,312	53,400	16,100 (in 2006)
Hourly maximum wastewater flow (m^3/d)	133,280	82,800	25,000 (in 2006)
4. Wastewater Treatment Plant			
Treatment process	Anaerobic ponds + Oxidation ditches		
Treatment capacity (m^3/d)	54,000	54,000	16,100 (in 2006)
Plant land area (ha)		35	
Influent BOD_5 (mg/l)		500	
Influent SS (mg/l)		620	
Effluent quality BOD_5 (mg/l)	50	25	25
Effluent SS (mg/l)	62	31	31
Sludge treatment process	Settling, digestion and drying in anaerobic ponds.		
Sludge disposal	Disposal by hauling to dump sites.		
Frequency of pond clearance	Once in 2.3 years		
5. Sewers			
Pipe size (mm)		200 to 1,400	
Pipe length (m)	794,300	622,842	119,700
6. Pumping Stations			
No. of lift stations	8	8	2
No. of manhole type pump units	-	9	6

1.3 Drainage Master Plan

1.3.1 First Stage Program Under Master Plan

The stormwater runoff within Khan Yunis City district flows down toward agricultural or low-lying lands, either through road surfaces, natural drains or storm channels. In the central urban districts of Khan Yunis, the stormwater runoff finds its way to the low-lying central areas, causing frequent inundation and interrupting commercial activities during the rainy season

The ground elevation in the market area ranges from 30 to 32 meters above sea level, which is lower than most of the surrounding areas in the central part of Khan Yunis district. Consequently, the stormwater within the areas cannot be drained without the provision of pumping or conduit leading it to the outside low-lying areas.

Presently, the stormwater runoff to the market area is pumped up with small temporary pumps to the nearby street, from where the water flows down by gravity on the surface of Jamal Abd. Nasir street, then into the depressed point of 20 m above sea level near El Katibah. The drainage catchment areas, drain routes, and locations of pumping station are illustrated in Figure F.1.1.

The drainage system master plan comprises the gravity flow conduits, retention basin, pumping station at El Katibah, and pressure pipeline for ground recharge, in which all the stormwater runoff form the market area is planned to flow by gravity through the conduits to El Katibah retention basin. The stormwater will then be transmitted, through the pumping station and the pressure pipelines, to the dune located close to the security zone.

Capacities, sizes and numbers of the drainage system facilities were determined in the Master Plan based on the 2015 conditions. In particular, the stormwater runoff coefficients in 2015 will be higher than at present because of the expected urban development. For the First Stage drainage program, therefore, these design bases have been modified as required to meet the present condition, whereas the catchment area of 423 hectares selected in the Master Plan is kept same as in the Master Plan.

Accordingly, numbers, capacities and sizes of the First Stage system facilities have been thoroughly checked from technical and economical viewpoints, so as to reflect the actual present conditions in the plan.

1.3.2 Rationale of the First Stage Drainage System Selection

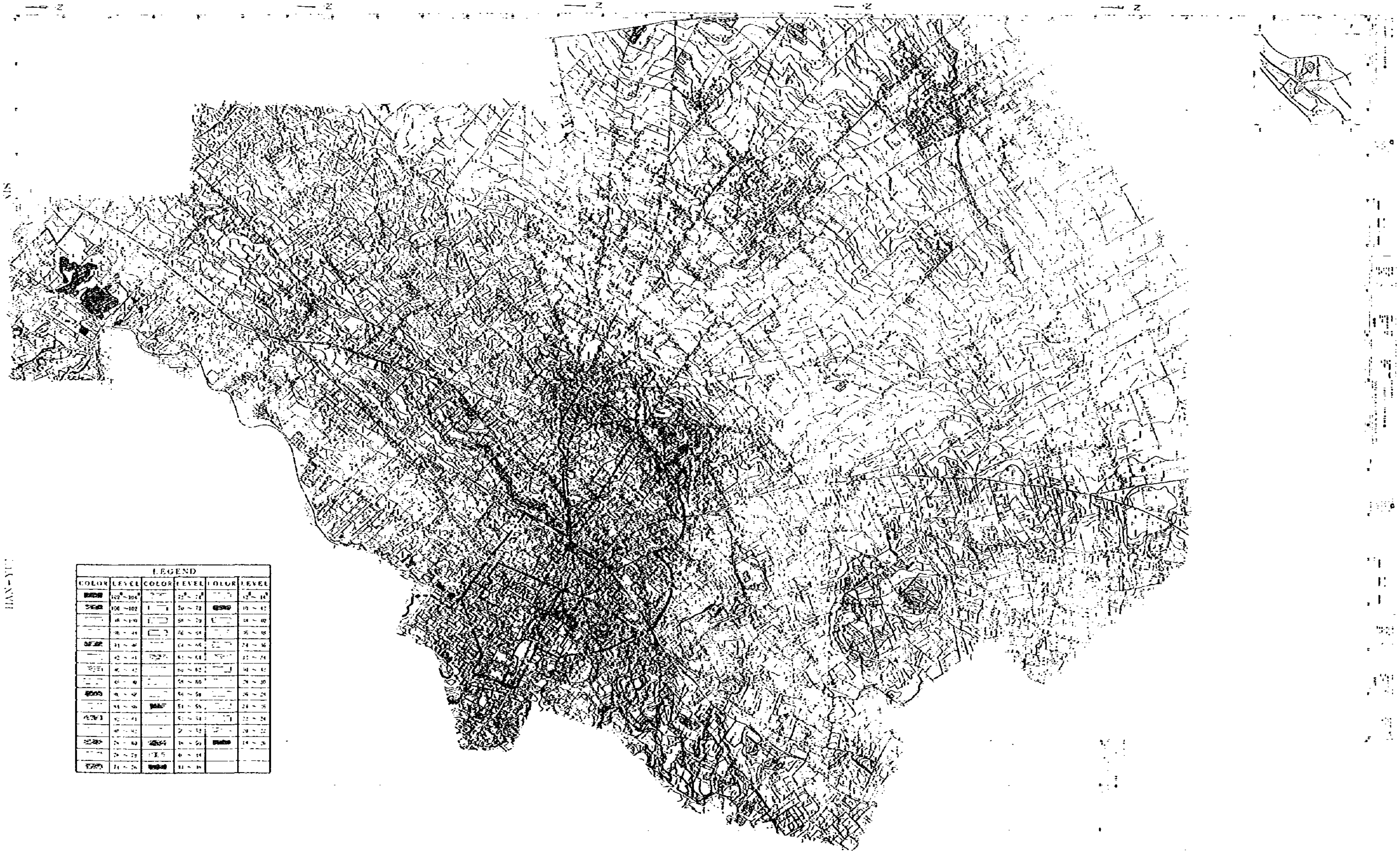
The selected First Stage Program in the Master Plan is the least cost drainage system among other alternatives. Also, it is confirmed by the latest topographic survey results that all the stormwater runoffs from the central market area can be emptied by gravity through the 1.3 km long conduits laid along the Jamal Abd. Nasir Street to EL Katibah pumping station. Thus, the pumping station at the market is eliminated.

Another important and factor in selecting the most desirable drainage design is of the land availability and its cost for the retention basin. If each site has a pumping station and retention basin, the retention basin capacity for the market area and El Katibah area would be 5,000 m^3 and 12,300 m^3, respectively.

In the market area, only a small vacant private-owned vacant land exists at present for the possible retention basin site, which will however be most probably used for commercial purpose because of its convenient location in the core of the market area. Furthermore, the land cost is prohibitively high accounting for US$ 5 million/ha or more whereas that in El Katibah site is only US$ 0.1 million/ha.

Under the Master Plan, three possible alternative drainage systems have been evaluated. The plan, connecting the market and El Katibah sites with the gravity conduits, and a retention basin, pumping station and outfall pipeline only at El Katibah site, is selected as the most desirable system. The schematic plan is illustrated in Figure F.1.2.

Figure F.1.1 **Regional Stormwater Drainage System Layout**



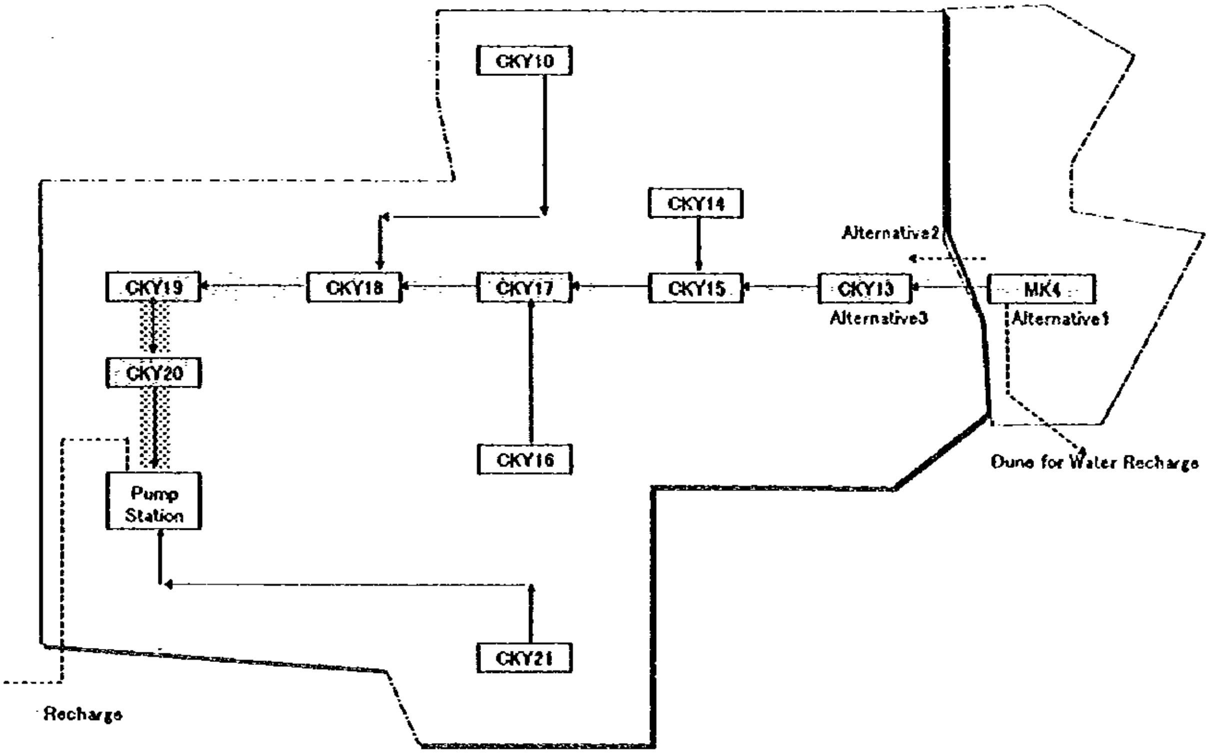


FIG.F.1.2.	SCHEMATIC DIAGRAM OF THE DRAINAGE SYSTEM

THE STUDY ON SEWERAGE DEVELOPMENT PLAN IN THE AREA OF KHAN YUNIS
IN PALESTINIAN INTERIM SELF-GOVERNMENT AUTHORITY

JICA AD 1997

1.4 Implementation Program

1.4.1 Materials and Construction Method

Many of materials required for the construction of sewerage, sanitation and drainage systems are to be imported, such as wastewater treatment equipment, pumping equipment, and pipes. Major civil and building works materials such as sand gravel are locally available although reinforcing bars and steel products are to be imported.

Construction methods and standards now being applied for the sewerage construction programs in other parts of Gaza Region appear to be practice and it is believed the local construction industry will play a major role in the Project.

(1) Construction Materials

Sand and gravel for concrete works are available in acceptable quality and quantity. Portland cement suitable for the sewerage and sanitation construction is to be imported. Steel bars both round and deformed are also to be imported.

Pipes currently available in the region are limited in size and material, however, variety of pipes can be imported from neighboring countries, such as Israel and Egypt. PVC pipes of good quality suitable for sewer use, with accessories, ranging from 110 to 500 mm in diameters, are available in Israel. Reinforced concrete pipes as large as 2,000 mm in diameter are also available from Israel.

Concrete products, such as manhole cones, barrels, bases, concrete channels, gutters, etc. are locally produced generally of acceptable quality.

Mechanical and electrical equipment for pumping stations and wastewater treatment plant, particularly for oxidation ditch process, will have to be imported.

As mentioned above, materials for sewer construction are mostly available, either imported or locally produced, and could be used for the sewerage construction works.

(2) Capability of Local Contractors

The sewerage and sanitation project involves the construction of large-scale and complex facilities, such as pumping stations and wastewater treatment plants, requiring skills and experience of the contractors. For such important construction works it would be appropriate for foreign and local firms to enter suitable working arrangements, such as a joint venture, in order to ensure efficiency and quality of the construction works.

Currently several sewerage and water supply construction projects are ongoing within the Region, and some of the contractors within the area have experience, with equipment and key staff to carry out the works to acceptable level. It would probably be advisable to pre-qualify local contractors according to their capability and experience so they can be fully utilized as effectively as possible in implementing the Project.

Although a significant labor force will be needed when the project starts, there would be no serious problem in finding unskilled labor, but skilled labor, tradesmen, foremen and construction managers at various levels could pose some difficulties in their availability. The Project should compromise an oxidation ditch system construction which will require some experienced contractor(s). This matter should be well considered in the tendering stage for the construction.

(3) Construction Methods

Major construction works of the Project can be classified into three categories; namely 1) sewer pipe laying and ii) construction of pumping stations, and iii) construction of a wastewater treatment plant.

For sewer pipe laying, there will be two applicable construction methods, one is the open-cut method and the other tunneling method. The open-cut method is applicable where the sewer size is relatively small and the traffic condition allows to do it. Most of the sewers in the area could be laid using this method, since no severe traffic problem is excepted to happen except in central urban zones, thus this method is widely practiced.

The tunneling method, on the other hand may be used for a large and deep sewer construction and where traffic is heavy and cannot be detoured. However, under the Project, the deepest excavations are limited about 6 to 7 meters, and large capacity pumping stations are to be located at relatively isolated area. Hence, tunneling methods need not to be applied. Since the structure of pumping stations itself will be quite deep, sheeting and bracing should be provided to prevent cave-in of the excavation walls or subsidence of adjacent area.

The construction sites for the wastewater treatment plant is rather isolated from the residential or commercial zones, consequently have less problem with respect to impacts to the surrounding areas than pumping stations. The excavation may be carried out in open cut, in some cases without sheeting. It is expected that in general the groundwater elevations are low, but in some low-lying areas where the groundwater elevations are high, appropriate dewatering should be practiced all through the construction works which might lead into high construction cost.

1.4.2 Staged Implementation

The construction program has been divided into five interrelated components; namely, i) sewers, ii) pumping stations, iii) wastewater treatment plant, iv) storm water drainage systems and v) sanitation systems. Each component has its own place in the construction program recommendations, based on the estimated requirements for the particular period.

It is assumed that the construction will start in 1998 with the first stage to be completed by 2002, the second stage from 2003 to 2006, and the third stage from 2007 to 2010. This phasing, with the inherent flexibility of the system, will permit periodic re-evaluation as required.

The decision of implementation schedule will be considered the scale and total investment costs of the project, kind of the financial source and an investigate conditions at the location and so no. In this chapter, it is assuming that the financial source is not considered with the special finance such as Grand Aid. Therefore, construction works including the detailed design should be continued due to the construction efficiency through to the whole construction periods until completion. On the other hand, the construction works of each stages will be required to be divided further two or three smaller phases depending on the financial sources. In that case, the order of priority to be constructed should be considered in term of investment efficiency which were examined from removed pollutant load, served population and others.

The basic initial facilities for the sewerage system are sewer pipelines such as main and reticulations sewer, pumping stations in the high priority districts and wastewater treatment plant, and for the drainage system, it will be composed the collection and discharge pipeline, pumping station and retention basin next to the P3 pumping station of sewerage. In addition, vacuum trucks for desludging and disposal from the on-site sanitation system are included.

This arrangement then permits the Khan Yunis City and other parts of the Study Area a maximum flexibility in construction arrangements upon completion of the fundamental facilities.

The implementation schedule is summarized in Table F.1.2.

Table F.1.2 Implementation Schedule

Item \ Year	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
[First Stage]													
Preparatory Works	═												
Detailed Design		▓											
Construction Works			═	═	═								
[Second Stage]													
Preparatory Works					═								
Detailed Design						▓							
Construction Works							═	═	═				
[Third Stage]													
Preparatory Works									═				
Detailed Design										▓			
Construction Works											═	═	═

(1) First Stage Program (1998 to 2002)

It is proposed that the first stage sewerage/sanitation/drainage construction program be implemented in the Khan Yunis and Bani Sohaila Sewerage Districts. The component of works will include i) sewer pipelines, ii) three pumping stations, iii) one oxidation ditch wastewater treatment plant of 16,100 m^3/day treatment capacity, iv) five vacuum trucks for sanitation improvement and v) drainage system in market and a part of central area of Khan Yunis city.

Implementation of the first stage construction program is recommended to start in the year 1998 and end by the year 2002. When this five-year construction program is completed, the city's population of about 204,930 persons (as of 2015) within this Sewerage District of 848 hectares would have access to sewer service.

Served areas and populations, and sewerage/sanitation system component facilities to be constructed under this stage are as follows:

Table F.1.3 First Stage Program

Components	District	Area (ha)	Population (as of 2015)	Sewer Length (m)	Pump Capacity (m^3/min)	Treatment Capacity (m^3/min)
Sewers	KY 5	299	58,320	49,200		
	KY 6	177	73,100	30,400		
	KY 7	214	58,180	38,600		
	BS 1	142	13,000	25,300		
	BS 2	42	4,200	8,100		
	Others	-	-	5,700		
Pumping Station	P3	-	-	-	27.9	
	P8	-	-	-	27.9	
Treatment Plant						16,100
Vacuum Trucks	(5 Nos.)					
Drainage System					180.0	
Total		874	206,800	157,300	236	16,100

(2) Second Stage Program (2003 to 2006)

With the completion of the wastewater/sanitation/drainage facilities for the first stage, it is proposed to set the years from 2003 to 2006 as the Second Stage Program based on the current projection of development.

The wastewater system during this stage will include the sewer main and reticulations for the Qarrara, remaining part of Khan Yunis Districts. Additional wastewater treatment plant facility will be provided to treat the increased wastewater inflow of 15,000 m^3/day.

When the second stage construction is completed and connecting sewer reticulations are provided, additional about 147,600 persons (as of 2015) within the 1,423 hectares are will have access to the sewerage. The sewerage and drainage system components to be provided under this stage are summarized in the following table.

Table F.1.4 Second Stage Program

Components	District	Area (ha)	Population (as of 2015)	Sewer Length (m)	Pump Capacity (m^3/min)	Treatment Capacity (m^3/min)
Sewers	KY 1	359	33,000	59,000		
	KY 4	64	6,130	12,000		
	KY 8	174	26,200	28,400		
	KY 9	180	34,530	31,100		
	KY 10	172	10,560	29,300		
	KY 11	55	4,700	10,300		
	QR 1	278	22,390	46,700		
	QR 2	141	10,120	24,500		
	Others	-	-	6,000		
Pumping Station	P2	-	-	-	3.9	
Pumping Station	P3 (add)	-	-	-	16.2	
	P4	-	-	-	0.6	
	P5	-	-	-	9.2	
	P6	-	-	-	1.9	
	P7	-	-	-	4.5	
	P8 (add)	-	-	-	26.0	
Treatment Plant (add)						15,000
Drainage System (add)					180.0	
Total		1,423	147,630	247,300	242.3	15,000

(3) Third Stage Program (2007 to 2010)

The third stage construction program will be implemented for the remaining sub districts in Khan Yunis, Kizan, Abassan Kabera and Khuzaa Districts covering 1,335 hectares with a total population of about 122,150 by 2015. The component of works will include the construction of about 220 km long sewers and newly found a P1 pumping station and extension the capacity of P3 and P8 pumping stations and extension of the wastewater treatment plant in accordance with increase in served population.

Implementation of the third stage construction program is recommended to start in 2007 lasting until the end of 2010. The component works of the program are summarized in the following table.

Table F.1.5 Proposed Third Stage Program

Components	District	Area (ha)	Population (as of 2015)	Sewer Length (m)	Pump Capacit (m³/min)	Treatment Capacity (m³/min)
Sewers	AB 1	423	40,700	66,700		
	AB 2	246	16,390	41,000		
	AB 3	43	2,050	8,100		
	KZ 1	129	14,020	22,600		
	KY 2	106	10,600	19,700		
	KY 3	388	38,390	61,400		
Pumping Station	P1				7.4	
	P2 (add)	-	-	-	2.5	
	P3 (add)	-	-	-	12.2	
	P4 (add)	-	-	-	0.2	
	P5 (add)	-	-	-	2.6	
	P6 (add)	-	-	-	0.1	
	P7 (add)	-	-	-	1.8	
	P8 (add)	-	-	-	36.0	
Treatment Plant						22,300
Total		1,335	122,150	219,500	62.8	22,300

1.5 Cost Estimation

1.5.1 Basis of Cost Estimation

The major components involved in preliminary cost estimation and method of cost estimation are described below. The total investment cost is composed of direct construction cost, land acquisition cost, engineering fee and physical contingency.

The recommended plan for implementing sewerage, sanitation and drainage systems calls for construction, operation and maintenance in the three stages.

(1) Direct Construction Cost

The direct construction cost of wastewater treatment plant and pumping stations are estimated based on the preliminary design and cost function that has been reported in Interim Report on March, 1997.

The unit relevant construction cost of sewer pipeline including for the drainage system has been estimated based on the unit cost to be investigated in Palestine and Israel on February 1997 and results of detailed cost estimation.

The direct construction cost are estimated as total cost including the materials, labors and some benefits, without Value Added Tax (VAT) and other taxes.

Detailed direct construction cost is described in Table F.K'-7, in the Appendix K' of Feasibility Study in Volume III "Supporting Report."

(2) Land Acquisition Cost

The required land area for the wastewater treatment plant and pumping stations are determined from results of the preliminary design.

The land cost of sewer pipeline installation is not considered since it will be installed underground the existing roads and other government reserved land in principle.

Detailed land acquisition cost is described in Table F.K'-8, in the Appendix K' of Feasibility Study in Volume III "Supporting Report."

(3) Engineering Fee

An engineering fee is the fee of designing and supervision of construction works which are conducted by the consultants after obtaining approval from Palestine. It has been assumed as ten (10) percent of the direct construction cost.

(4) Contingency

The contingency has been estimated as seven (7) percent of the direct construction cost.

1.5.2 Total Investment Costs

The costs involved in the investment of wastewater treatment plant, pumping stations and sewer pipelines for each construction stage, are summarized in Table F.1.6. The direct construction cost and land acquisition cost are further broken down in Table F.K'-6 to F.K'-7, and F.K'-8, in the Appendix K' of Feasibility Study in Volume III "Supporting Report."

Table F.1.6 Total Investment Costs

(Unit : US$)

No	Components	Construction Stages First 1998~2002	Second 2003~2006	Third 2007~2010	Total
1	Sewerage System	65,923,913	65,537,822	65,076,127	196,537,862
1.1	Direct Construction Cost	53,969,157	53,792,156	55,599,254	163,360,566
1.2	Land Acquisition Cost	2,780,000	2,601,000	25,000	5,406,000
1.3	Engineering Fee	5,396,916	5,379,216	5,559,925	16,336,057
1.4	Physical Contingency	3,777,841	3,765,451	3,891,948	11,435,240
2	Sanitation System	585,000	0	0	585,000
2.1	Direct Construction Cost	500,000	0	0	500,000
2.2	Land Acquisition Cost	0	0	0	0
2.3	Engineering Fee	50,000	0	0	50,000
2.4	Physical Contingency	35,000	0	0	35,000
3	Drainage System	9,080,276	2,500,677	0	11,580,954
3.1	Direct Construction Cost	7,658,356	2,137,331	0	9,795,687
3.2	Land Acquisition Cost	120,000	0	0	120,000
3.3	Engineering Fee	765,836	213,733	0	979,569
3.4	Physical Contingency	536,085	149,613	0	685,698
	Total	75,589,189	68,038,499	65,076,127	208,703,816
	Total (J-Yen)	9,070,702,734	8,164,619,931	7,809,135,257	25,044,457,922
	Total (J-Yen) = Direct + Eng	8,200,831,630	7,382,692,243	7,339,101,523	22,922,625,396

Note 1. Engineering Fee = (Direct Construction Cost) x 0.10
2. Physical Contingency = (Direct Construction Cost) x 0.07
3. Cost : as of March 1997.
4. Exchange Rate : 3.3 NIS/US$, 120 J-Yen/US$.

Note 1. Engineering Fee = (Direct Construction Cost) x 0.10
2. Physical Contingency = (Direct Construction Cost) x 0.07
3. Cost : as of June 1997.
4. Exchange Rate : 3.3 NIS/US$, 120 J-Yen/US$.

1.5.3 Operation and Maintenance (O/M) Cost

(1) Sewerage System

Operation and maintenance costs for the sewerage system are composed of those for sewer pipelines, pumping stations and wastewater treatment plant.

Wastewater treatment plant O/M costs are composed of electricity, disinfectants, repairing costs and personnel expenses. Pumping stations O/M costs are composed of electricity, repairing costs and personnel expenses. And that of sewer pipeline is composed of repairing costs, daily inspection, cleaning works and personnel expenses. The frequency of these works are assumed that it will be inspected twice a year and to be cleaned at least every year by use of thrusting rods and /or bucket machines, including power source, lubrication and minor repair of the equipment.

The annual O/M costs of the sewerage, sanitation and drainage system are shown in Table F.1.7. Moreover, there is further breakdown in Table F.K'-9 in the Appendix K' of Feasibility Study in Volume III "Supporting Report."

(2) Sanitation System

O/M costs for the sanitation system are composed of fuel and personnel expenses of the vacuum truck's drivers only.

Septic tanks and cesspools should be desludged periodically and the septage transported to the sludge dump stations for final treatment, but these costs are to be borne by users and not financed by the Project. O/M costs of the sludge dump stations are excluded.

(3) Drainage System

The drainage system O/M costs are composed of electricity, repairing costs and personnel expenses.

Table F.1.7 Annual Operation & Maintenance Costs

(Unit : US$)

No	Year	Const Ruction Stage	Sewer Pipeline	Pumping Station (P/S)	Wastewater Treatment Plant (WWTP)	Drainage System	Sanitation System	Personnel Expenses	Total O&M Cost
1	1999	1st	0	0	0	0	0	0	0
2	2000	1st	0	0	0	0	0	0	0
3	2001	1st	0	0	0	0	0	0	0
4	2002	1st	0	0	0	0	0	0	0
5	2003	2nd	178,351	229,070	529,889	44,951	59,700	213,000	1,254,961
6	2004	2nd	178,351	238,521	531,723	44,951	59,700	213,000	1,266,246
7	2005	2nd	178,351	248,478	533,655	44,951	59,700	213,000	1,278,135
8	2006	2nd	178,351	257,754	535,455	44,951	59,700	213,000	1,289,211
9	2007	3rd	413,384	457,632	913,378	60,914	59,700	354,000	2,259,009
10	2008	3rd	413,384	479,179	917,197	60,914	59,700	354,000	2,284,374
11	2009	3rd	413,384	502,096	921,241	60,914	59,700	354,000	2,311,335
12	2010	3rd	413,384	526,087	925,451	60,914	59,700	487,500	2,473,036
13	2011	Comple	622,567	620,202	1,470,829	60,914	59,700	487,500	3,321,712
14	2012	Comple	622,567	651,025	1,477,199	60,914	59,700	487,500	3,358,904
15	2013	Comple	622,567	685,036	1,484,199	60,914	59,700	487,500	3,399,916
16	2014	Comple	622,567	721,513	1,491,669	60,914	59,700	487,500	3,443,863
17	2015	Comple	622,567	762,829	1,499,947	60,914	59,700	487,500	3,493,458
18	2016	Comple	622,567	762,829	1,499,947	60,914	59,700	487,500	3,493,458
19	2017	Comple	622,567	762,829	1,499,947	60,914	59,700	487,500	3,493,458
20	2018	Comple	622,567	762,829	1,499,947	60,914	59,700	487,500	3,493,458
21	2019	Comple	622,567	762,829	1,499,947	60,914	59,700	487,500	3,493,458
22	2020	Comple	622,567	762,829	1,499,947	60,914	59,700	487,500	3,493,458
23	2021	Comple	622,567	762,829	1,499,947	60,914	59,700	487,500	3,493,458
24	2022	Comple	622,567	762,829	1,499,947	60,914	59,700	487,500	3,493,458
25	2023	Comple	622,567	762,829	1,499,947	60,914	59,700	487,500	3,493,458
26	2024	Comple	622,567	762,829	1,499,947	60,914	59,700	487,500	3,493,458
27	2025	Comple	622,567	762,829	1,499,947	60,914	59,700	487,500	3,493,458

Note: Comple means the total system has been completed.

1.6 Economic and Financial Evaluation

1.6.1 Estimation of Economic Benefit

(1) Conditions and Assumptions for Estimation of Economic Benefit

Basically, the conditions and assumptions for estimation of economic benefit are the same with those used in the economic evaluation of the Project in the Master Plan except the affected number of people as summarized below. The affected number of people is changed because of changes of served population due to review the implementation program.

1) Family Size and Workable Persons per Household

Charges paid out for the services of waste water treatment system are usually made by means of family unit financially. Therefore, both of economic and financial benefits should be estimated as family base amounts except one of economic benefit derived from medical expenses. And, for estimation of people's income loss, number of workable persons should be clarified.

As mentioned in Part 1 of this Report, the average family size may be calculated as 9.43 persons per HH, and the workable persons are estimated as 4.41 persons per HH in average according to social survey made by JICA this time. In this case, it is assumed that these workable persons range from 20 years old and over in their age based on the said survey.

2) Basic Assumptions for Estimation of Number of Affected People

There were 78,193 medical cases of main diseases in Gaza Governorates in 1995. Following Table shows a summary by cause.

Table F.1.8 Medical Cases by Cause in Gaza Governorates in 1995

Causes	Water borne	Faecal disposal related	Housing and crowding related	Total
No. of cases	57,674	8,457	12,062	78,193
Share rate (%)	73.75	10.82	15.43	100.00

Source : Annual Report 1995 Palestine "Palestine Health Status", April 1996, Ministry of Health, PNA.

As indicated in the above Table, the share rate of water related diseases and faecal disposal related diseases is 84.57 % to the total number of cases. On the other hand, number of discharges from hospitals was 72,820 persons, and number outpatients was 292,041 persons in total among the total population of 860,369 in Gaza Governorates in 1995 according to the said medical statistics, so the distribution rates of inpatients and outpatients to the population were 8.46 % and 33.94 % respectively in 1995.

Total expenditure of hospitals for diagnosis, treatment and operation including overhead fees was US$35,798 thousand in 1995(1) said in the

(1): The amount of revenue from patients was US$22,095 thousand in total including health insurance premium with a coverage rate of 61.72 %. The amount of shortage was covered by UNRWA or some other international funds, said the statistics. Therefore, if this medical expenses can be saved, the Project may contribute to the national economy.

statistics. It means that average expenditure per patient was US$98/persons (equivalent to NIS.324) per year.

In order to estimate the medical expenses to be saved after completion of waste water treatment system proposed in the Project under study, those share rates of water related and faecal disposal related disease to the total cases and the distribution rates of patients to the population were assumed for applying for inhabitants living in the study area.

Here, it is assumed that impact of the Project under study to improve the environment of sanitation and/or health is 30 % according to that of similar project, and the first stage of the Project will end in 2002, so that the Project effect will realize after 2003. The sewerage facilities are designed to have a service capacity for a population in 2015.

(2) Economic Benefit

1) Economic Benefit Derived from Medical Expenses

The service population in 2003 and 2015 is projected at 143,544 and 476,611, and number of effected persons will be 15,444 persons and 51,280 in the same year respectively. As a result, the amounts of medical expenses will be saved at sums of around US$732 thousand in 2003 and US$4,916 thousand in 2015 as shown in Table 1 in Appendix I in Volume III "Supporting Report." In this case, it is assumed that 2 years will be necessary for full connection between whole living buildings and the sewerage systems. Therefore, one more year will be necessary to fully connect for the population in 2015, namely, the amount of medical expenses to be fully saved may be estimated at US$5,031 thousand in 2016. These amounts can be taken as a part of economic benefit that derived from medical expenditures.

2) Economic Benefit Derived from Income Loss of Inpatients

The average staying days in hospitals were 3.3 days according to the above mentioned medical statistics. By using the above mentioned workable persons per HH, share rate of cases in water related and faecal disposal related diseases to the total cases, and the distribution rate of inpatients to the population, probable number of inpatients in 2003 and 2016 is estimated as 2,841 persons and 18,865 persons respectively.

According to the Social Survey made by JICA in 1996, the average monthly income is NIS.1,059/month per HH in the study area(this income is almost the same amount of per capita income because only one person, family head, contributed to their family economy according to the social survey. The income of the other workable persons in their families is usually saved for their own purposes, i.g. for preparing the cost for marriage). This amount of income can be converted into daily income as NIS.42.36/day when workable days is assumed at 25 days per month in average.

Using the above mentioned information and assumption, the sum of US$120,338 per year and US$799,122 per year can be saved in 2003 and 2016 respectively in total as shown in the Table 1 of Appendix I in detail in Volume III "Supporting Report." These amounts can be taken as the other part of economic benefit.

3) Economic Benefit Derived from Income Loss of Outpatients

According to the medical statistics as mentioned above, number of outpatients was 292,041 persons with 33.94 % of distribution rate against the population of 860,369 in Gaza Governorates in 1995. It is assumed that this distribution rate may apply to the inhabitants living in the study area. The share rate of water related and faecal disposal related diseases, workable persons per HH, and their average daily income are used as same rate in the case of inpatients.

As a result, the sum of US$146,46 per year and US$971,163 per year can be saved in 2003 and 2016 respectively in total as shown in the Table 1 of Appendix J' in detail in Volume III "Supporting Report." These amounts can be taken as one more part of economic benefit.

4) Economic Benefit in Total

Total economic benefit is as summarized in the following Table.

Table F.1.9 Annual Economic Benefit up to 2016

(US$/annum)

Year	Amount of medical fees to be saved	Income to be received from workable days in case of inpatients	Income to be received from workable days in case of outpatients	Economic benefit in total
2003	731,968	120,338	146,246	998,552
2004	1,541,388	244,821	297,528	2,083,738
2005	1,595,626	253,436	307,998	2,157,060
2006	1,647,996	261,754	318,107	2,227,857
2007	2,208,551	350,788	426,308	2,985,648
2008	2,799,187	444,600	540,317	3,784,103
2009	2,910,656	462,304	561,833	3,934,794
2010	3,028,121	480,962	584,507	4,093,590
2011	3,650,067	579,746	704,559	4,934,372
2012	4,302,419	683,361	830,480	5,816,260
2013	4,490,902	713,298	866,862	6,071,062
2014	4,694,591	745,650	906,179	6,346,420
2015	4,915,877	780,797	948,893	6,645,568
2016	5,031,247	799,122	971,163	6,801,532

(Note) See detail shown in the Table 1 in Appendix F.

1.6.2 Estimation of Financial Benefit

(1) Conditions and Assumptions for Estimation of Financial Benefit

For the financial evaluation in the original Master Plan, the amount of NIS.35 per HH per month was applied as a basic charge for services of the new waste water treatment system proposed by the Project based on willingness of the people living in the Project area to pay of NIS.15 and the most likely amount of NIS.20 per HH per month that might be saved by households after completion of the system.

For the review, an another approach is taken to achieve the said basic charge based on the field work as summarized below including several new findings from it.

1) Existing Desludging Services in the Study Area

There are two (2) desludging service systems in the study area including the Municipality of Khan Yunis, namely the service given by the Municipality of Khan Yunis and the other desludging services given by private sector.

The result of the Social Survey relating to desludging services shows a complex situation of both the services given by the Municipality of Khan Yunis and private sector. The result says that people living in the study area including the Municipality of Khan Yunis have received the desludging services of 14 times a year, namely 1.17 times a month consisting of 17 times a year (1.42 times a month) for urban area, 12 times a year (once a month) for rural area and 10 times (0.83 times a month) for farmers as shown in Table 2 of Appendix I' in Volume III "Supporting Report."

Urban area has received a rather high desludging services comparing with other two (2) areas of rural and farmers. It seems that the result reflects an advantage of urban area.

Paid amount for desludging services vary from NIS.10 per time to NIS.150 per time according to their living situation as well as frequencies of them varying from weekly to by-annually.

Average actual paid amount per time and per month may be estimated at NIS.39.67 per household (HH) and NIS.46.28 per HH respectively based on the said result of the Social Survey as summarized below. Its detail is shown in Table 3 of Appendix I' in Volume III "Supporting Report."

Table F.1.10 Average Actual Paid Amount for Desludging Services in Study Area

(NIS)

Area	Paid amount per:	
	Time	Month
Urban	35.60	50.43
Rural	45.36	45.36
Farmers	43.34	36.12
Whole study area	39.67	46.28

Source : Social Survey made by JICA, 1996.

On the other hand, the result of the said Social Survey shows that their income level is NIS.1,059 per month per HH mentioned in the financial evaluation of the original Master Plan. Therefore, their actual paid amount for desludging services shares at 4.37 % to their income.

2) Existing Desludging Services Given by the Municipality of Khan Yunis

Ordinary Customers

At the present time, the Municipality of Khan Yunis has no any sewerage system, but they are giving a desludging or discharging services for black waste water for their people living in the Municipality of Khan Yunis and the areas in and around of it as mentioned above.

Up to February 1997, they have 5 vacuum truck for desludging the black waste from septic tank for whole households and public facilities including one hospital (the Naser Hospital), schools, and other public buildings. Since March 1997, they have get an additional vacuum truck, so as of May 1997, 6 trucks are under working for desludging services.

Their service objectives are categorized into 2 types, namely (1) ordinal customers and (2) public facilities.

The ordinary customers are further classified in to 3 types. The first class is so called as "cash base customer" who has applied for potable water supply, so names of the customers belonging to this class are registered in the water sector in the Municipality of Khan Yunis as water subscribers.

The second class is so called as "invoice base customer" who living in housing complex but not in charge of applicants for potable water supply, so the names of this class customers are not registered in the water sector. The Municipality of Khan Yunis sends invoices for desludging services to these customers based on the registered subscribers list of electricity supply.

The third class is the special class. The customers belonging to this third class consist of 85 households (HHs) who are living near the central market of the Municipality Khan Yunis with only 3 septic tanks for all of them because of topographic condition and houses crowding to a narrow place. Because of shortage of septic tanks, desludging service frequencies should be quite high, so the inhabitants burden should also be high comparing with other areas. By this reason, a board of inhabitants of this area has requested to the Municipality of Khan Yunis to lower their payment for desludging services, and this application has accepted by the Municipality. Now, the customers belonging to this class are paying at half amount of basic charge per time for desludging services given by the Municipality.

Desludging service objective public facilities include one hospital (El Naser Hospital), mosques, schools, slaughter houses, and other public buildings. The cost for these public facilities for desludging services are bearing by the Municipality itself. Industries located in the Municipality are treated as ordinary customers because of their scales. Almost of those industries discharge their waste water into ordinary septic tanks as same as those of ordinary customers. Detail of this situation is given here under.

Basic charge for desludging services was NIS.20 per time up to 14th of December in 1996, and this rate was revised on 15th of December 1996. Since then, they are applying a rate of NIS.15 per time for their desludging services.

Customers belonging to the third class and public facilities receive the Municipality's desludging services only.

Table 4 in Appendix F shows an existing situation of desludging services given by the Municipality of Khan Yunis together with the existing situation on potable water supply.

According to the recorded data on the third class customers in this Table, around 3.9 times of desludging services were necessary per HH per month from April to November 1996 in average as shown in the following Table.

Table F.I.11 Number of Trips for Desludging Services and Average Paid Amount

Year	Month	Nos. of trips	Paid amount(NIS)
1996	April	237	2,370
	May	355	3,550
	June	475	4,750
	July	204	2,040
	August	332	3,320
	September	369	3,690
	October	400	4,000
	November	288	2,880
	Total	2,660	26,600
Average per month		332.5	3,325
Average/HH		3.9	39
1997	January	157	1,178
	February	184	1,380
	March	246	1,845
	April	240	1,800
	May	251	1,883
	Total	1,078	8,036
Average per month		216	1,617
Average/HH		2.5	19

Note-1: Number of HH is 85 in total
Note-2: Paid amount is NIS.10 per time in 1996
Note-3: Paid amount is NIS.7.5 per time in 1997.

It means that they paid, in 1996, NIS.39 per HH per month (= 3.9 times x NIS.20/2), and in 1997, NIS.19 per HH per month for desludging services in average even if they were paying at half amount of basic charge of NIS.20 per time in 1996 and NIS.15 in 1997 as indicated in the above Table. The latter one is estimated based on the data for 5 months only. However, the average monthly frequency of desludging services for one year should not be so different with last year. In the case assuming the same frequency of desludging services, they are paying at amount of around NIS.30 per HH per month (= 3.9 times x NIS.15/2) at present.

This is of course a special case in desludging service frequencies, but it might be one evidence that people living in the Municipality of Khan Yunis can pay at amount ranging between NIS.30 and NIS.40 at present as desludging charges, and this information may be used as a reference for setting a sewage tariff system as well as the said result of the Social Survey.

Hospitals

El Naser Hospital in the Municipality of Khan Yunis is the oldest hospital in PA, which was established in 1958 with 120 beds for covering the population of 300,000 living in the southern area including of the Municipalities of Khan Yunis and Rafah. In 1972, number of beds were increased at 240 beds. As of May 1997, number of beds are 256 in total. Occupancy rate of beds were 76 % as of 1995, and rate of staying of admitted inpatients was 2.4 days with 19,800 inpatients admitted in the same time. Number of outpatients was 54,473 persons in 1995.

Working staff of the Naser Hospital is as follows;

Table F.1.12 Number of Staffs of the Naser Hospital

(persons)

Year	Doctors	Nurses	Administrative staff	Technicians	Other workers	Total
1995	112	191	48	51	72	474
1996	125	240	45	50	76	536

The Hospital buy a required water from the Municipality of Khan Yunis with 100 m^3 per day. Waste water is discharged without any treatment to its septic tanks, and the Municipality take these waste water directly from those septic tanks. And they dump these waste water to the ordinary dumping site without any treatment too as well as those from ordinary customers.

Three more hospitals are under construction or in preparation for medical activities in the Municipality of Khan Yunis. Among them, Al Hellal Hospital managed by Palestine Red Crescent Society (PRCS) is partially opened as clinic since January 1997 with the required water of 730 m3 per month in average as of May 1997 supplied by MEKOROT directly through the Ministry of Agriculture of PA with a rate of NIS.1.243 per m3 adding 17 % of VAT. This water charge is cheaper than that of the Municipality. This Hospital has a plan to start its operation with 130 beds within one or two years. The European Hospital has started its preparation for its medical activities. According to information, the European Hospital has its own treatment facility and treated waste water by the facility may be re-used for irrigation. Al Askar Hospital located in Abasaan Khabirah is established for official use only, and its scale is rather small.

The design of European Hospital was started in 1991, the construction had commenced since November 1993. As of June 1997, main buildings are almost completed. Now they are preparing facilities for operation and maintenance as for their medical activities. The hospital will open such examination and/or diagnosis as medical activities in the middle of 1998 with 240 beds and 650 staffs including medical doctors and nurse.

The hospital has an attached nursing collage. The hospital also has one complete system for waste water treatment system, and service system for reuse of treated waste water for irrigation.

Potable water to be consumed in the hospital is planned as an amount of 156 m3 per day, so the hospital has two (2) tanks for 150 m3 and 6 m3 in total. Designed discharge volume of waste water is 140 m3 per day.

The construction cost is US$ 50 million financing by joint donation of EC, UNRWA and PNA. The Danish consultant MTC has architectonically designed. The hospital has a target to cover the whole population in Gaza Governorates.

Industries

There are around 50 factories in the Municipality of Khan Yunis including one ice cream factory, three plastic factories, two plate factories and others. Their industrial waste water is now directly discharged into their septic tanks, and the Municipality of Khan Yunis take these waste waters to dump them to the ordinary dumping site without any treatment.

A field investigation was made according to the information of the Municipality of Khan Yunis. Actually, there are two (2) plastic process factories that they are using solid material to make plastic bags, and they do not discharge any poisonous liquid waste to their septic tanks. They discharge human black waste water only. Therefore, there is no any dangerous issue for connecting the proposed sewerage system directly.

Schools

At the present, the Municipality of Khan Yunis do not any charge for desludging services considering existing national situation. As a reference, a scholastic system is summarized as below:

Up to 1993/94 scholastic year, there were two scholastic systems in Palestine. In the West Bank, primary schools consist of 10 years from the first grade to 10th grade and secondary schools consist of 2 years affected by Jordanian system left in occupied era.

On the other hand, the primary schools consist of 6 years, preparatory schools consist of 3 years and secondary schools consist of 3 years up to 1993/94 scholastic year affected by Egyptian system.

Twelve (12) years mentioned above in both the systems were the period for basic stage education. Children who graduated 12 years basic stage scholastic education could enter into universities or collages.

Since 1994/95 scholastic year, the PNA has unified the scholastic system as that basic schools consist of 6 years, basic secondary schools (3 years), and secondary (3 years). These are the basic stage education. After graduated these schools, the children can enter into universities or collages. Usually, the secondary schools consist of 2 steps, the first year of the secondary school is a general course, and the second 2 years are specified technical courses as science, literature, commercial, agriculture, industry, and nursing.

Primary schools established by UNRWA do not any charges for schooling. Governmental schools charges a school fees children who enter into with a rate of NIS.50 or NIS.60 only per year. No any other fees are necessary. When the children enter newly into schools, fees for text books (UNRWA : free of charge), uniform purchasing cost, cost for such stationery as pencils, notebooks, school bags, etc. is necessary to pay for shops with around of US$50 to US$100, some households are paying at an amount of about US$200 or US$300.

Special Case

The area of the Municipality of Abasaan Sagherah belonging to the study area is in the most serious situation.

The Municipality of Abasaan Sagherah is located at about 8 km far from the central area of the Municipality of Khan Yunis, therefore, there is only private desludging services. Its fee is now NIS.25 per time.

On the other hand, some of septic tanks are installed under the main roads where traffic are passing on with interval ranging between 5 m and 10 m without any coverage that are always full occupied. Therefore, desludging services are necessary every 2 days with two (2) times desludging for one (1) calling. So, the people are now paying for desludging services at amount of NIS.750 (= 15 calling x 2 times x 25) per month per septic tank. And, this cost shares with 2 or 3 families in average. If it is sharing with 3 families, NIS.250 is paid for desludging services per month per HH.

Average income level of this area is now NIS.500 to NIS.600 according to the Mayor of the Municipality of Abasaan Sagherah. If so, almost half of their income should pay for desludging services.

3) A Trial of Tariff System to Be Recommended

Background

As mentioned above, the average monthly payment for desludging services was NIS.46.28 per HH according to the result of the Social Survey under the condition that the Municipality of Khan Yunis has 5 vacuum trucks with 640 times in number of monthly total trips in average with NIS.20 as a charge for desludging services per time, and private service sector has 15 vacuum trucks.

Under the condition when the Social Survey was made, namely a period for 3 months from September to November 1996, contribution rates of the Municipality of Khan Yunis and the private service sector were 25 % and 75 % respectively from the viewpoint of number of vacuum trucks. It means that the said average monthly per HH payment of NIS.46.28 should consist of NIS.11.57 for the Municipality and NIS.34.71 for private sector.

While a rate of desludging services given by the Municipality was increased by 50 % consisting of 25 % in the service charge which was revised from NIS.20 to NIS.15 and 20 % in the number of vacuum trucks which was increased from 5 trucks to 6 trucks since March as mentioned above. This service rate increase brings forth an effect as decrease of people's payment with the same rate as a whole.

Accordingly, the said average monthly payment of NIS.46.28 per HH should be revised at NIS.42.42 consisting of NIS.7.71 (NIS.11.57 x (100 - 50)%) and NIS.34.71 (no any changes in private service sector) under the present condition. That is to say, people living in the study area still pay at more than NIS.40 per month per HH in average even the Municipality cut the service charge and has an additional vacuum truck to release people from their burden.

As mentioned in previous sub-clause, people have an affordability to pay at amount of NIS.30 per month per HH for desludging services. As a matter of fact, it is necessary two (2) times of desludging services in one calling to empty a septic tank according to interview survey to the Municipality and private sector this time, so people should pay at least NIS.30 for Municipality's desludging services and NIS.40 or NIS.50 (some desludging servicemen request their service charges at amount of NIS.25 per time to people) for private sector's desludging services for their one calling.

Tariff to Be Recommended

A new tariff for sewerage system proposed by the Project should be set for keeping the existing people's burden. Moreover, it has better establish the tariff be lower than the existing level of people's burden if possible. This is a premise for formulating the tariff structure for the new sewerage system.

As mentioned above, the rate of NIS.30 should be the starting point as a basic charge to discuss for setting a tariff system for the Project.

According to the result of the Social Survey, around 65 % of gray waste water is also poured into septic tank. The remaining gray waste water is directly discharged into their gardens, streets and/or roads.

Existing desludging services including both of those given by the Municipality of Khan Yunis and private sector do not cover people's whole request to empty their septic tanks. Nevertheless, people should pay some penalties to the Municipality when they make their septic tanks overflow according to the regulation of the Municipality.

In the case of without any project for establishment of sewerage system, people will still be burdened with dirtiness, unhygienic living condition, bad-smell, insects, overflow of waste water and/or flooding in the future too.

In the case of with the project, the proposed sewerage system can treat not only black waste water but also all the gray waste water. Therefore, people will no more burdened with any unpleased conditions as mentioned above. The Project will be executed for the people, so the people should bear a part of the operation and maintenance cost (the OM cost) of the Project from the viewpoint of improvement of their living environment as well as a viewpoint of self-supporting for their living conditions.

From this viewpoint, the rate of the OM cost is assumed at 10 % of the said basic charge, namely, the sum of NIS.3 should be added to the basic charge as a part of beneficiary's burden.

The cost of desludging services for public facilities including public buildings, mosques, schools and slaughter houses are borne by the account of Municipality of Khan Yunis, and the Municipality had not charged this cost directly to their people because of quite little number of trips for desludging services to be necessary.

However, resources of this account of the Municipality is also taken from the people. If so, there is a reason to charge the cost directly to the people from the viewpoint of beneficiary's burden because that these facilities are the facilities for common use.

The frequency of this services shares at 5.81 % to the total numbers of trips for the ordinal customers per month in average during last 14 months since April 1996 according to the information of the Municipality. If the people living in the Municipality of Khan Yunis bear at amount of NIS.30 per month per HH for desludging services, the cost for public facilities can be estimated at NIS.1.74 per month per HH. Namely, the sum of around NIS.2 should be borne by the people.

As a result, a tariff for sewerage system due to the Project should consist of following components;

Component	(NIS)
Basic charge :	30
The OM cost to be borne by the people :	3
The cost for sewerage services for public facilities :	2
Total : unit tariff per month per HH :	35

In the case of without the Project, they should make septic tanks with costing, for example, at US$1,000 for 5-year capacity. In this case, the people should reserve at a sum of NIS.55 per month per HH (= US$1,000 x NIS.3.3/US$/5 years/12months) as a depreciation cost in no account of any interest rate. The above recommended tariff of NIS.35 is equivalent to only 64 % to the depreciation cost for a septic tank. In the case of with the Project, people do not necessary to reserve any depreciation cost more when they connect once to the proposed sewerage system. And the said tariff is within the affordability of them to pay as mentioned in previous sub-clause. The said recommended tariff may be sound from this viewpoint too.

The fixed tariff system should be taken into consideration for encouraging people's willingness to connect the proposed sewerage system so that expected connection rate would be kept after starting the sewerage treatment services.

There is one under-operating hospital in the Municipality of Khan Yunis named as El Naser Hospital as mentioned in previous sub clause. The Municipality of Khan Yunis charges desludging service fee to the Hospital with the same rate of NIS.15 per time. However, in the case of with the Project, the charge of sewerage treatment services to hospitals should generally be in accord with the actual water consumption because that waste water should vary with the water consumption according their scale. As mentioned above, there will be several hospitals in the Municipality of Khan Yunis. The variable tariff system should be taken into account from this viewpoint too.

As shown in Table 5 of Appendix I', an average monthly consumed water volume is 2,753 m3 during these 17 months since January 1996 in El Naser Hospital with paid amount of NIS.3,818 per month including VAT(2) from MEKOROT through the Ministry of Agriculture, PNA.

The Hospital has 256 beds in 1996 and average occupancy rate was 76 % in the same time. Therefore, 195 inpatients are always staying in this Hospital. Number of outpatients was 54,473 persons in 1996. It means that 151 outpatients had come every day to the Hospital in that year (= 54,473 persons /12 months/30 days).

On the other hand, the working staffs in the Hospital are 536 persons since 1996. So ordinary water consumption rate of total patients is 39.23 % to the total water consumption (= (195 persons + 151 persons)/(195 persons + 151 persons + 536 persons)). That is to say that around 60 % of water are consumed by the Hospital itself. This rate may be applied to the volume of waste water discharged by the Hospital.

During these 5 months from January to May 1997, the Hospital has paid for desludging services to the Municipality at NIS.2,640 per month as indicated in the following Table.

(2) : The Hospital should pay the value added tax (VAT) with 17 % to MEKOROT.

Table F.1.13 Average Volume of Wastewater and Paid Amount of Hospital

Year	Month	Nos. of trips	Paid amount
1997	January	150	2,250
	February	170	2,550
	March	200	3,000
	April	180	2,700
	May	180	2,700
	Total	880	13,200
Average per month		176	2,640

Source : The Naser Hospital, May 1997.

According to above situation, the Hospital has paid NIS.0.575 per m^3 as an existing paid amount as shown in the following Table.

Table F.1.14 Estimation of Unit Existing Charge for Desludging Services for Hospitals in Khan Yunis

(NIS)

Item	Paid amount to portable water[1]	Paid amount to waste water[2]
Total paid amount	3,813	2,640
Amount to be paid by the Naser Hospital itself	2,288	1,584
Average unit paid amount per m^3	0.831	0.575

Resources (1) Ministry of Agriculture.
(2) the Municipality of Khan Yunis.

The amount of NIS.0.575 per m3 is estimated based on unit price of potable water including VAT. So, this amount should be revised at NIS.0.49 per m3 (= NIS.0.575/1.17) as a net cost for existing desludging services against the consumed potable water volume. A rate rounded at NIS.0.5 should be a recommended rate as a basic tariff against unit potable water (m3) to be consumed for bulk consumers of potable water represented by hospitals.

(2) Estimation of Financial Benefit

As mentioned above, the amount of NIS.35 per month per HH for ordinary customers is applied for probable revenue of the Municipality for operation and maintenance for the system as financial benefits of the Project. The annual financial benefit flow is summarized in the following Table.

Table F.1.15 Annual Financial Benefit up to 2016

(US$/annum)

Year	Probable revenues as financial benefit
2003	968,676
3004	1,970,716
2005	2,040,062
2006	2,107,018
2007	2,823,707
2008	3,578,854
2009	3,721,371
2010	3,871,554
2011	4,666,732
2012	5,500,787
2013	5,741,768
2014	6,002,191
2015	6,285,113
2016	6,432,617

(Note) See detail shown in Table 6 of Appendix I'.

The Municipality of Khan Yunis should replace the facilities for the system within this amount in the future. Detail calculation process is shown in Table 6 of Appendix I in Volume III "Supporting Report."

1.6.3 Economic and Financial Cost

The economic cost of the Project is converted from the financial cost under the some conditions and assumptions mentioned hereunder.

The Palestine now has a taxation system with a rate of 17 % as the Value Added Tax for whole trading. Therefore, such taxes as transfer payments are assumed to be 17 % of market prices of commodities and services procured locally, and to be exempted from any taxes and duties for those procured from abroad.

The standard conversion factor (the SCF) to be applied for local commodities and services in the case of this Project is estimated based on the trading data in Israel considering the existing situation of Palestine at 92.04 % as already mentioned in the Project evaluation in the original Master Plan.

Economic wage of unskilled laborers to be employed for the construction works is assumed to be 90 % of the actual market wage, taking of the employment opportunity of laborers in the study area.

Economic cost of land compensation is assumed to be 100 % of the financial cost, taking account of the opportunity cost of land use.

The economic and financial cost of the Project is given in the present value (PV) at the 1997-August price level and are taken no account of the price escalation during the periods of construction works and Project life for evaluation.

Economic costs for operation and maintenance (OM cost) after completion of first stage works to the end of the Project life are estimated based on the same assumptions of the said Project cost.

Replacement cost for the facilities is estimated at a rate of 55 % for pumping station to its total cost, 46 % : waste water treatment plant, 100 % : sanitation system, and 46 % : drainage system and their life time 25 years after completion of the construction works except sanitation system. The sanitation system consists only trucks, so that its life time is set as 10 years.

Project life is set as 30 years after commencement of construction works. Therefore, only the replacement cost for the sanitation system will be appeared during the Project life.

Annual allocation of the economic and financial costs of the Project is shown in Table 7 of Appendix F in Volume III "Supporting Report" and summarized below.

Table F.1.16 Annual Allocation of Project Cost in Loan Basis

(US$1,000)

Year	Work stage	Financial cost	Economic cost
1999	Stage I	5,544	4,724
2000		23,454	20,226
2001		23,429	20,201
2002		23,162	19,973
2003	Stage II	3,999	3,399
2004		21,346	18,434
2005		21,346	18,434
2006		21,346	18,434
2007	Stage III	1,415	1,409
2008		26,222	22,659
2009		21,220	18,326
2010		21,220	18,326
Total		213,703	184,545

(Note) See detail shown in Table 10 of Appendix F.

1.6.4 Economic and Financial Evaluation of Project

The Project is targeted to get a grant from Japanese Government, but a loan basis evaluation is made too in addition to a grant basis evaluation of the Project from the viewpoint of economic and financial aspect.

(1) Project Evaluation in Loan Basis

The evaluation of the Project is made by using cash flows of the said costs and benefits in both the economic and financial aspects as shown in Tables 8 and 9 in Appendix I in Volume III "Supporting Report." The results are also shown in those Tables and summarized below. In this case, B/C rates are comparison of benefit and cost in present value of them, and B-C means net cash balance between benefits and costs also expressed by their present value. For calculation of present value, a discount rate of 10 % is applied as same as in similar projects. The figures are expressed in terms of US Dollars in thousand (US$1,000) using 1997-August price level.

Table F.1.17 Result of Project Evaluation in Loan Basis

	EIRR/FIRR(%)	B/C	B-C(US$1,000)
From Economic Evaluation	-5.11	0.23	-78,545
From Financial Evaluation	-7.57	0.19	-96,789

(2) Project Evaluation in Grant Basis

In order to make the Project evaluation in the grant basis, the costs to be borne by the Municipality of Khan Yunis should be clarified first because that the initial investment cost will be granted by donor countries/foreign institutions.

Using the assumptions mentioned in aforementioned clause, cost flows are resulted as shown in Table 10 of Appendix I' in Volume III "Supporting Report" and summarized in Table below as an annual allocation of the costs to be borne by the Municipality of Khan Yunis to be necessary for replacement in the same order of the initial investment costs for Project evaluation.

Table F.1.18 Annual Allocation of Project Cost in Grant Basis

(US$1,000)

Year	Work stage	Financial cost	Economic cost
1999	Stage I	481	481
2000		7,254	5,780
2001		7,229	5,755
2002		6,962	5,546
2003	Stage II	342	342
2004		5,228	4,164
2005		5,228	4,164
2006		5,228	4,164
2007	Stage III	364	364
2008		5,560	4,4229
2009		5,560	4,429
2010		5,560	4,49
Total		54,998	44,048

(Note) See detail shown in Table 10 of Appendix I'.

Operation and maintenance cost and replacement cost are the same in the loan basis because the Project is designed to be operated by their own burden and responsibility.

Benefits are not effected in the grant basis because that the initial investment will be made by donor countries/foreign institutions so that the Project will be completed.

The evaluation of the Project in the grant basis is made by using cash flows of the said costs and benefits in both the economic and financial aspects as shown in Tables 11 and 12 of Appendix I' in Volume III "Supporting Report." The results are also shown in those Tables and summarized below. In this case, as same as in the evaluation in the loan basis, B/C rates are comparison of benefit and cost in present value of them, and B-C means net cash balance between benefits and costs also expressed by their present value. For calculation of present value, a discount rate of 10 % is applied as same as in similar projects. The figures are expressed in terms of US Dollars in thousand (US$1,000) using 1997-August price level.

Table F.1.19 Result of Project Evaluation in Grant Basis

	EIRR/FIRR(%)	B/C	B-C(US$1,000)
From Economic Evaluation	5.57	0.74	-8,356
From Financial Evaluation	1.58	0.56	-17,445

(3) Conclusion of Project Evaluation from the Viewpoint of Economic and Financial Aspects

In the loan basis, both of the EIRR and the FIRR are negatively resulted as shown in the above Table R.6.10 as -5.11 % and -7.57 % respectively. It means that the Project is not fit for the loan to be executed from both the viewpoints of economic and financial aspects.

In the grant basis, the EIRR and the FIRR are resulted as shown in the Table R.6.12 as 5.57 % and 1.58 %. Generally, as suggested by such international institutions as the World Bank, a EIRR is expected to at least be cleared a hurdle of 5.0 % of EIRR from a viewpoint of basic human needs even such a project is in developing countries, and the Project under study satisfies this expectation with the resulted EIRR. Namely, the Project is economically sound from the viewpoint of basic human needs in the grant basis.

While, the FIRR is resulted as slightly over the zero percent. When the FIRR is zero, cumulative amounts of benefit (revenue) will be equal to the cumulative amount of cost during the project life, and it means that the OM cost including replacement cost for the facilities can be covered by a proposed average service charge system.

As shown in Table 12 in Appendix F in Volume III "Supporting Report," the cumulative benefit (revenue) is US$132,903 thousand and cumulative cost is US$119,807 thousand, so that cumulative surplus (cash balance) has become US$13,095 thousand. Namely, in the case of the said resulted FIRR, 1.58 %, the revenue by applying the recommended tariff system, NIS.35 per HH per month, will cover the whole costs to be borne by the Municipality of Khan Yunis within the Project life of 30 years.

From this viewpoint, the Project may be financially sound from the viewpoint of self financial supporting basis for operation and maintenance for the facilities proposed by the Project under study by an average service charge of NIS.35 per HH per month.

CHAPTER 2 SEWERAGE SYSTEM

CHAPTER 2 SEWERAGE SYSTEM

2.1 First Stage System Layout

2.1.1 Sewers and Pumping Stations

The First Stage program area of 874 hectares covers the KY5, KY6, KY7, BS-1 and BS-2 Sewerage Districts, as shown in Figure F.2.1. The wastewater from these Sewerage Districts will be collected from individual households through house connections to the public sewers, and conveyed by gravity through the way to PST3. At certain locations where gravity sewers become too deep, the wastewater will be pumped up through manhole type pumping units to further continue the gravity flow.

PST3 will lift the wastewater up to the peak flow rate of 1,032m^3/hour (0.287 m^3/sec.) and transport it through an 800 mm diameter force main to the highest point near the cemetery in Shaikh Mohammed Area. The pressurized wastewater is relieved at the highest point near the cemetery and further flows down to the gravity main sewer KY3-4. The wastewater is again lifted at PST8 and transported through the 1,000 mm diameter force main F8 up to another high point along the road about 1 km southeast, thence finally flows by gravity to the wastewater treatment plant.

2.1.2 Wastewater Treatment Plant

The wastewater treatment process is a combination of anaerobic ponds and oxidation ditches, followed by chlorine contact tank to disinfect the wastewater effluent. The treated effluent will be finally discharged through an outfall to the nearby infiltration ponds for ground recharge, or crop irrigation channels.

The First Stage Project components elaborated are summarized in the following table:

FIG.F.2.1 Regional Sewerage System Layout

Table F.2.1 Program of the Project

Components	District	Area (ha)	Population (as of 2006)	Sewer Length (m)	Pump Capacity (m^3/min)	Treatment Capacity (m^3/min)
Sewers	KY 5	299	40,962	24,200		
	KY 6	177	65,576	25,100		
	KY 7	214	39,197	29,200		
	BS 1	142	9,628	25,200		
	BS 2	42	3,047	10,100		
	Others	-	-	6,000		
Pumping Station	P3	-	-	-	17.2	
	P8	-	-	-	17.5	
Treatment Plant						16,100
Vacuum Trucks	(5 Nos.)					
Drainage System					180.0	
Total		874	158,410	119,800	214.7	16,100

Source: JICA Study Team 1997

2.2 Sewer System

2.2.1 House Connections

The wastewater from each household will be collected through house connections of 120 to 150 mm diameter PVC pipe connected either to manholes or branch and lateral sewers. The manholes will be installed at the end of each line; at all changes in grade, size, or alignments; at all intersections; and at distances of about 30 meters for small sewers.

Most of the house connection pipes would be connected to manholes so that the property pipes could easily be connected to the public sewers, thus minimizing unnecessary cutting of public sewer pipes. From multistory buildings or apartment complexes occupied by several families or enterprises, the wastewater may be collected through service pipes laid on the public road in front of such buildings. The service pipes then lead the wastewater to the nearest manhole.

2.2.2 Branch and Lateral Sewers

Branch and lateral sewers collect the wastewater from each household and convey it by gravity to sub main and/or main sewers. The size of branch and lateral sewers range from 200 to 300 mm in diameter. The branch and lateral sewers are designed in their elevations, flow rates, and locations, and profiles were prepared to check whether these sewers can be connected to sub main and/or main sewers. Where found necessary, corrections were made in the invert elevations of the receiving pipelines. Layout and hydraulic computation sheets of these pipelines are attached to the "Drawing" of Volume

IV and the hydraulic computation sheets in Appendix-D of Part 3 "Sewers and Appurtenances" of Volume III "Supporting Report."

2.2.3 Main Sewers

As shown in the sewer system diagram of Figure F.2.2, the wastewater from the First Stage Area of the Khan Yunis District inflows either by gravity or through intermediate lift pumping units to PST 3 station. The KY No.1 Line collects the wastewater from three subdistricts KY1, KY4, KY5 and KY7. The No.1 Line also receives the wastewater inflowing from KY No.8 Line and KY No.9 Line, covering subdistricts of KY6, KY8 and KY9.

The PST 3 station then lifts and transmit the wastewater through the force main F3 to the KY3-4. After flowing down through KY3-4, KY3-5 KY3-6, KY3-7 and AB1-9, the wastewater reaches PST 8 and again conveyed through the force main F8 to KZ1-4 and finally inflows to the wastewater treatment plant. The wastewater from BS-1 and BS-2 will flow to KY7 and finally inflows by gravity to PST3.

Under the First Stage Program, five Sewerage Districts of KY5, KY6, KY7, BS-1 and BS-2 will be covered. The hydraulic capacities of the sewers are designed to handle the peak flows estimated for the year 2015.

Main and sub-main sewer profiles and hydraulic computation sheets are shown in Volume IV "Drawings," and Appendix-D of Part 3 "Sewers and Appurtenances" in Volume III "Supporting Report", respectively.

2.2.4 Design Criteria

(1) General

In designing the sewer pipelines, the sewerage system design criteria proposed in the Master Plan Study have been examined and necessary revisions or additions made thereon.

The hydraulics of sewers designed by the conventional method have further been examined by the Dynamic Model to check if there are any portions of the sewers to be hydraulically strengthened or physically modified. The procedures and results of the simulation analysis are discussed in detail in Appendix-F of Part 3 "Dynamic Model" of Volume III "Supporting Report".

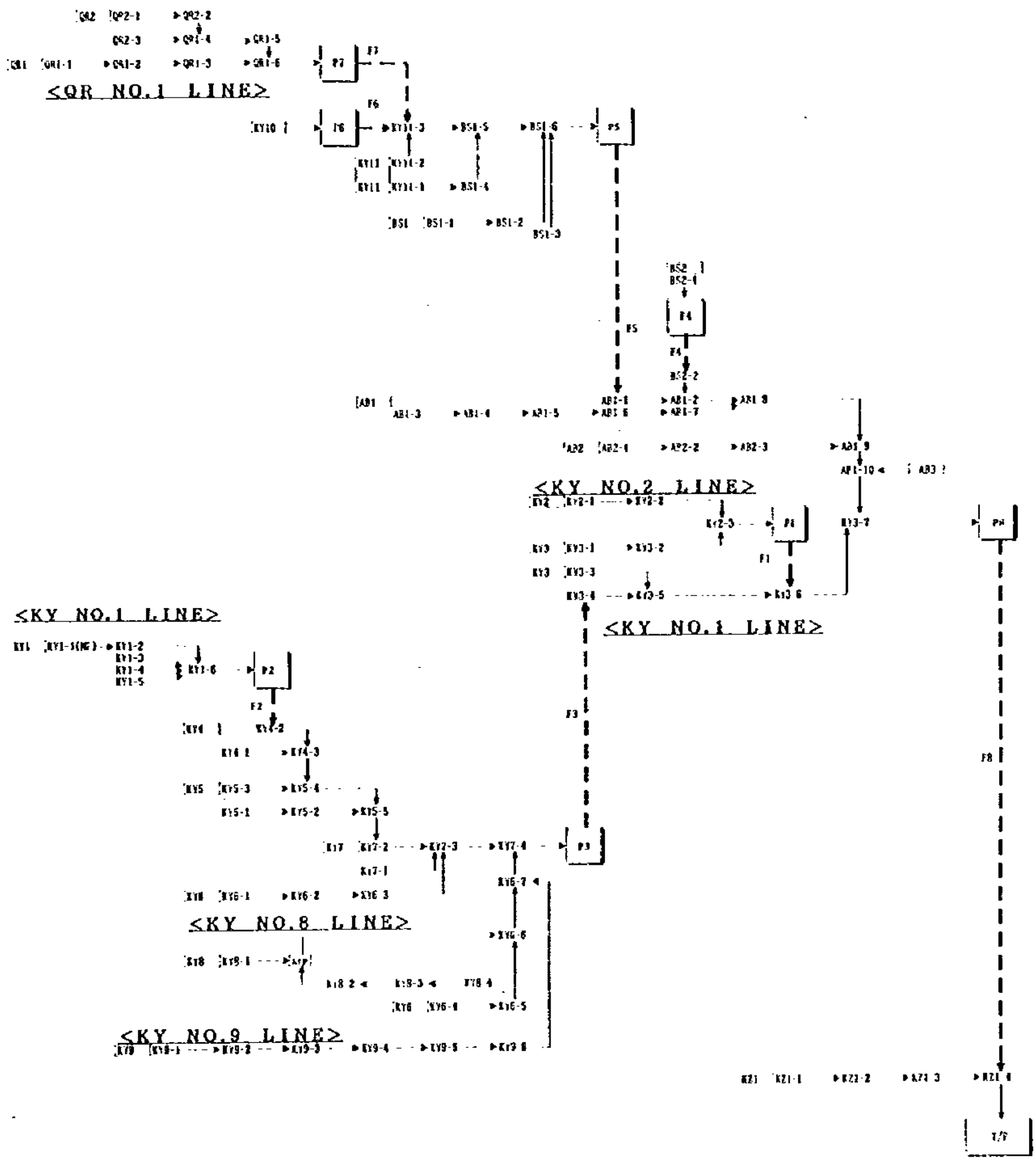


FIG.F.2.2 REGIONAL SEWERAGE SYSTEM DIAGRAM

THE STUDY ON SEWERAGE DEVELOPMENT PLAN IN THE AREA OF KHAN YUNIS
IN PALESTINIAN INTERIM SELF-GOVERNMENT AUTHORITY

AD 1997

(2) Design Period

In general, sewers should be designed for the estimated tributary population in the year 2015, except in considering parts of the system that can be readily increased in capacity.

(3) Design Factors

In determining the required capacities of sanitary sewers the following factors should be considered:

- Maximum hourly wastewater flow ; daily average flow rate x 2.5 (as the basis for hydraulic analysis),
- Additional maximum sewage or waste flow from any facility where justified necessary, and
- Composite daily wastewater fluctuation is used for the Hydrograph and Dynamic Model analyses.

(4) Hydraulic Computation of Sewer Pipelines

- Public sewers shall be not less than 200 mm in diameter except for house connection pipes.
- The Manning's equation shall be used in principle for gravity sewers and stormwater drains in the form:

$$V = 1/n\, R^{2/3} S^{1/2}$$

where

V = velocity of flow, in m/sec

n = coefficient of roughness (vitrified clay pipe 0.013, plastic pipe 0.010, and concrete pipe 0.013)

R = hydraulic radius, in m

S= slope

- All sewers shall be designed and constructed to give mean velocities, when flowing 60 percent depth, of not less than 0.6 m/sec, based on the Manning's formula using an 'n' value as shown above. The velocity shall not exceed 3 m/sec in any type of sewers to protect sewer erosion.

- Sewers shall be laid in general with straight alignment between manholes.

- When smaller sewers joins a larger one, the invert of the larger sewer should be lowered sufficiently to maintain the same energy gradient. An approximate method for securing these results is to place the sewer crown of both sewers at the same elevation.

- Sewer joints shall be so designed as to minimize infiltration and to prevent the entrance of roots or other obstacles.

- Manholes shall be installed at the end of each line; at all changes in grade, size, or alignment; at all intersections; and at distances as shown in the following:

Sewer Diameter (mm)	Maximum Manhole Spacing (m)
200 or smaller	30
200 to 500	45
600 to 1000	80
1000 or larger	100

- The standard manhole diameters are as follows:

Manhole Diameter (mm)	Type and Size of Connecting Sewers
0.9	Starting manhole, sewer of 600 mm or smaller, junction sewers of 450 mm or smaller.
1.2	Sewers of 900 mm or smaller, junction sewers of 600 mm or smaller.
1.5	Sewers of 1200 mm or smaller, junction sewers of 800 mm or smaller.
1.8	Sewers of 1500 mm or smaller, junction sewers of 900 mm

2.3 Pumping Stations

2.3.1 General

The PST 3 and PST8 pumping stations will convey all the wastewater coming from the First Stage Project Area of 874 hectares, comprising three high priority Sewerage Districts of KY5, KY6, KY 7, BS1 and BS2. As illustrated in Figure F.2.2, PST3 transports all the wastewater to PST8 through the force main and then through the gravity sewers. PST8 then transfers the received wastewater to the wastewater treatment plant through a force main and a gravity sewer.

2.3.2 Design Basis

The design hydraulic loadings for component facilities of PST 3 and PST8 pumping stations are as summarized below:

Table F.2.2 Design Hydraulic Loadings

Component Units	Hydraulic Loadings
1. Screens	
Velocity of low through bars	0.5 to 0.8 m/sec
2. Grit chambers	
Overflow rate	1,800 $m^3/m^2/day$
Detention time	30 to 60 seconds
Velocity of flow through channel	0.3 m/sec

The hydraulic conditions of PST3 and PST8 pumping stations in the year 2006, 2010 and 2015 are shown in Tables F.2.3 through F.2.5, respectively.

2.3.3 Design of Pumping System

The pumping stations have been designed based on the design criteria as discussed previously. The features of each pumping station thus determined are summarized in the following. Further details of the pumping stations capacity and hydraulic computations are shown in Appendix-E "Pumping Stations" of this Volume.

The hydraulics of each pumping stations in the First Stage and in the year 2015 are summarized in the following table:

Table F.2.3 Sewerage System Hydraulics in 2006

Pump Station No	SUB TREATMENT DISTRICT	Catchment Area ha	person/ha	POPULATION person	DAILY AVE. FLOW m^3/d	HOURLY MAX. FLOW m^3/d	Remarks
P1	KY2	106.0	21.0	2,224	226		
	KY3	285.2	43.6	12,443	1,264		
	Sub Total	391.2		14,667	1,490	2,309	
				14,700	1,500	2,400	
P2	KY1	359.0	42.9	15,397	1,561	2,450	
	Sub Total			15,400	1,600	2,500	
P3	P2	359.0	42.9	15,397	1,561		
	KY4	64.0	81.8	5,235	532		
	KY5	299.0	137.0	40,962	4,162		
	KY6	177.0	370.5	65,576	6,663		
	KY7	214.0	183.2	39,197	3,982		
	KY8	174.0	102.7	17,866	1,815		
	KY9	180.0	119.1	21,438	2,178		
	Sub Total	1,467.0		205,671	20,896	32,355	
	F/S Sub Total	874.0		158,410	16,100	25,000	
P4	BS2	33.8	72.6	2,452	249	396	Tentative Plan TO P3
	Sub Total	33.8		2,500	300	400	
P5	P6	172.0		9,116	926		
	P7	419.0		19,340	1,965		
	KY11	55.0	62.4	3,431	349		
	BS1	142.0	67.8	9,628	978		Tentative Plan
	Sub Total	788.0		41,518	4,218	7,011	TO P3
		788.0		41,600	4,300	7,100	
P6	KY10	172.0	53.0	9,116	926	1,488	
	Sub Total	172.0		9,200	1,000	1,500	
P7	QR1	278.0	48.7	13,533	1,375		
	QR2	141.0	41.2	5,807	590		
	Sub Total	419.0		19,340	1,965	3,123	
		419.0		19,400	2,000	3,200	
P8	P1	391.2		14,667	1,490		
	P3	1,467.0		205,671	20,896		
	P3 F/S	874.0		158,410	16,100		
	P4	33.8		2,452	249		
	P5	788.0		41,518	4,218		
	BS2	8.2	72.6	595	60		Tentative Plan TO P3
	KY3	102.8	43.6	4,485	456		
	AB1	423.0	71.1	30,069	3,055		
	AB2	246.0	48.2	11,857	1,205		
	AB3	43.0	37.4	1,607	163		
	Sub Total	3,503.0		312,921	31,792	49,700	
	P8 F/S	874.0		168,500	16,100	25,200	
T/P	P8	3,503.0		312,921	31,792	49,700	
	P8 F/S	874.0		158,500	16,100	25,200	
	KZ1	129.0	81.7	10,536	1,070		
	Total	3,632.0		323,457	32,862	51,300	
	F/S Total	874.0		158,500	16,100	25,200	

Note: (shadow) means the Districts to be covered by First Stage.

Table F.2.4 Sewerage System Hydraulics in 2010

Pomp Station No	SUB TREATMENT DISTRICT	Catchment Area ha	person/ha	POPULATION person	DAILY AVE. FLOW m^3/d	HOURLY MAX. FLOW m^3/d	Remarks
P1	KY2	106.0	42.0	4,452	473		
	KY3	285.2	61.3	17,471	1,855		
	Sub Total	391.2		21,923	2,328	3,608	
				22,000	2,400	3,700	
P2	KY1	359.0	59.1	21,207	2,252	3,627	
	Sub Total			21,300	2,300	3,600	
P3	P2	359.0	59.1	21,207	2,252		
	KY4	64.0	94.0	6,013	639		
	KY5	299.0	162.3	48,532	5,154		
	KY6	177.0	388.9	68,829	7,310		
	KY7	214.0	218.1	46,675	4,957		
	KY8	174.0	122.7	21,343	2,267		
	KY9	180.0	147.6	26,564	2,821		
	Sub Total	1,467.0		239,163	25,399	39,327	
		1,467.0		239,200	25,400	39,400	
P4	BS2	33.8	83.8	2,832	301	479	
	Sub Total	33.8		2,900	400	500	
P5	P6	172.0		10,367	1,101		
	P7	419.0		24,377	2,589		
	KY11	55.0	74.9	4,117	437		
	BS1	142.0	77.6	11,024	1,171		
	Sub Total	788.0		49,885	5,298	8,807	
		788.0		49,900	5,300	8,900	
P6	KY10	172.0	60.3	10,367	1,101	1,769	
	Sub Total	172.0		10,400	1,200	1,800	
P7	QR1	278.0	60.9	16,944	1,799		
	QR2	141.0	52.7	7,433	789		
	Sub Total	419.0		24,377	2,589	4,115	
		419.0		24,400	2,600	4,200	
P8	P1	391.2		21,923	2,328		
	P3	1,467.0		239,163	25,399		
	P4	33.8		2,832	301		
	P5	788.0		49,885	5,298		
	BS2	8.2	83.8	687	73		
	KY3	102.8	61.3	6,297	669		
	AB1	423.0	82.0	34,671	3,682		
	AB2	246.0	55.7	13,705	1,455		
	AB3	43.0	41.8	1,799	191		
	Sub Total	3,503.0		370,965	39,396	61,558	
	P8 Second Stage	2,297.0		292,600	31,100	48,600	
T/P	P8	3,503.0		370,965	39,396	61,558	
	P8 Second Stage	2,297.0		292,600	31,100	48,600	
	KZ1	129.0	93.7	12,090	1,284		
	Total	3,632.0		383,055	40,680	63,472	
	Second Total	2,297.0		292,600	31,100	48,600	

Note: (shadow) means the Districts to be covered by First and Second Stages.

Table F.2.5 Sewerage System Hydraulics in 2015 (total)

Pump Station No	SUB TREATMENT DISTRICT	Catchment Area ha	person/ha	POPULATION person	DAILY AVE. FLOW m^3/d	HOURLY MAX. FLOW m^3/d	Remarks
P1	KY2	106.0	100.0	10,600	1,187		
	KY3	285.2	98.9	28,219	3,161		
	Sub Total	391.2		38,819	4,348	6,739	
				38,900	4,400	6,800	
P2	KY1	359.0	91.9	33,002	3,696	5,789	
	Sub Total			33,100	3,700	5,800	
P3	P2	359.0	91.9	33,002	3,696		
	KY4	64.0	95.8	6,133	687		
	KY5	299.0	195.0	58,319	6,532		
	KY6	177.0	413.0	73,100	8,187		
	KY7	214.0	271.9	58,181	6,516		
	KY8	174.0	150.6	26,196	2,934		
	KY9	180.0	191.8	34,530	3,867		
	Sub Total	1,467.0		289,461	32,420	50,198	
				289,500	32,500	50,200	
P4	BS2	33.8	100.3	3,391	380	605	
	Sub Total			3,400	400	700	
P5	P6	172.0		10,561	1,183		
	P7	419.0		32,517	3,642		
	KY11	55.0	85.5	4,700	526		
	BS1	142.0	91.7	13,016	1,458		
	Sub Total	788.0		60,794	6,809	11,318	
				60,800	6,900	11,400	
P6	KY10	172.0	61.4	10,561	1,183	1,901	
	Sub Total			10,600	1,200	2,000	
P7	QR1	278.0	80.5	22,393	2,508		
	QR2	141.0	71.8	10,124	1,134		
	Sub Total	419.0		32,517	3,642	5,789	
				32,600	3,700	5,800	
P8	P1	391.2		38,819	4,348		
	P3	1,467.0		289,461	32,420		
	P4	33.8		3,391	380		
	P5	788.0		60,794	6,809		
	BS2	8.2	100.3	823	92		
	KY3	102.8	98.9	10,171	1,139		
	AB1	423.0	96.2	40,695	4,558		
	AB2	246.0	66.6	16,392	1,836		
	AB3	43.0	47.7	2,049	229		
	Sub Total	3,503.0		462,595	51,811	80,957	
				462,600	51,900	81,000	
T/P	P8	3,503.0		462,595	51,811		
	KZ1	129.0	108.7	14,016	1,570		
	Total	3,632.0		476,611	53,381	83,290	
				476,600	53,400	83,300	

Table F.2.6 Inflow Rates to the Pumping Stations by Stage

Construction Stage	Inflows	m^3/day	m^3/min
1. PST3			
Master Plan (2015)	Daily average	32,500	22.6
	Peak	50,026	34.7
First Stage (2006)	Daily average	16,100	11.2
	Peak	24,782	17.2
2. PST8			
Master Plan (2015)	Daily average	51,800	36.0
	Peak	80,870	56.2
First Stage (2006)	Daily average	16,100	11.2
	Peak	25,135	17.5

Source: JICA Study Team 1997

(1) PST 3 Pumping Station

The pumping station is of the dry-well type, being separated completely from wet-wells. A special attention is given to the inflowing channel and wet-well design to prevent grit from settling in the wells.

The pumps will be arranged to boost the wastewater pressure as high as 56 meters static head. Under the First Stage, totally three (3) units of horizontal and vertical type pumps will be installed, the larger size pump being of vertical and smaller ones of horizontal type.

Large floatable obstacles in the inflowing wastewater will first be removed with the manually cleaned course screens and mechanically-operated fine screens after passing through the sand pit. The screenings thus collected will be conveyed with a belt conveyor to the storage bins, from where the screenings will be further carried away by dump trucks for the final disposal.

Provision is made to facilitate easy removing of pumps, motors and other auxiliary equipment. Suitable safe means of access are designed to the dry-wells of the pumping station, including stairways, handrails and gratings where necessary.

Adequate ventilation is considered for the wet- and dry-wells. For the pump room floor below the ground surface, a mechanical ventilation is provided, so arranged as to independently ventilate the dry-wells. The wet-wells will be open and no mechanical ventilator will be provided. A layout and sections of the pumping station are illustrated in the separate Volume IV "Drawings."

Table F.2.7 Operational Conditions of Pumps in First Stage

Pumps	Discharge Rate (m^3/min)	Pumps in operation	Standby	1/3 Daily av. (m^3/min)	Daily av. (m^3/min)	Daily max (m^3/min)	Peak (m^3/min)
No.1	7.5	1	-	1	1	1	1
No.2	10.4	1	1	-	1	1	1
No.3	6.4	0	-	-	-	-	1
No.4		0	-	-	-	-	-
No.5		0	-	-	-	-	-
Total	18.9	2	1	1	2	2	3

Source: JICA Study Team 1997

(2) PST8 Pumping Station

The PST8 pumping station is in principle the same as PST3 in structures except for the pump system. Wet- and dry-well type with mechanically operated bar screens and sand pit, with auxiliary equipment.

Under the First Stage Program, totally three (3) units of a single stage horizontal centrifugal pump including one stand-by will be provided. Other equipment are also the same as those in PST3. The layout and sections of the pumping station are shown in Drawings of the separate Volume IV, "Drawings" of Volume IV. The operational conditions of the pumping stations under the First Stage are as follows:

Table F.2.8 Operational Conditions of the Pumps in First Stage

Pumps	Discharge Rate(m^3/min)	Pumps in operation	Standby	1/3 Daily av. (m^3/min)	Daily av. (m^3/min)	Daily max (m^3/min)	Peak (m^3/min)
No.1	12.0	1	-	1	1	1	1
No.2	16.5	1	1	-	-	1	1
No.3	11.2	0	-	-	-	-	-
No.4		0	-	-	-	-	-
No.5		0	-	-	-	-	-
Total	39.7	2	1	1	1	2	2

Source: JICA Study Team 1997

(3) Submersible Manhole Type Pumping Units

Under the First Stage Program, a total of six (6) manhole type submersible pump units will be installed to lift the wastewater from a sewer to another. The submersible manhole type pumping units are of completely submersible pumps and motors type installed within the appropriately sized manhole or similar structures. Typical submersible pumping units structures are illustrated in the Drawing of Volume IV, "Drawings."

2.3.4 Pump Equipment and Operation Control

Each of the pumping stations or units will have at least one standby pump. The pumps will be designed to have the sufficient capacity for handling the flows in excess of the estimated maximum inflows. The pumps will be operated each by each according to the increasing and lowering of the well water elevations, aiming to permit an effective pump operation and to reduce frequent on-off pump operations.

2.3.5 Emergency Operation

In designing the pumping station systems and their force mains, a particular attention has been given to ensure the efficient and uninterrupted operation of the whole system. Provision of emergency power supply for the pumping station will be accomplished by connection of the station to at least two independent public sources, where it is applicable, and by provision of a power generator at each pumping station to supply sufficient electrical energy required for operating the system.

As the measures to protect the pumping station against the flooding or overflows in case of emergency, a relief conduit will be provided to safely discharge the wastewater to the nearby storage basin. Close to PST 3 station site, a stormwater retention basin will be provided that could also be utilized as an emergency storage of the overflowed wastewater temporarily. Further, the allowance of the sewer pipes can be considered as an emergency storage of the wastewater. The main sewers that are usable as the emergency wastewater are checked and found to have some capacity.

2.3.6 Selection of Pump Type and Number

(1) Selection of Pumps

The required number of pump units has been determined based on the various factors as described in Appendix-E "Pumping Stations" of Volume III and features of each pumping stations are as summarized in the following table:

In the Master Plan study, a vertical shaft volute pumps (except for smaller pumps) are proposed for PST3 and PST8 pumping stations because the vertical pumps are considered generally more economical than horizontal pumps requiring less floor areas.

For the vertical shaft pump, the motors are provided at a higher level, and in this way all electrical equipment can be kept above the flood level. The horizontal pumps, on the other hand, may be apt to submergence by the possible flooding and a strong forced ventilation will be necessary to maintain a good operational condition. Also, the vertical shaft mixed flow volute type pumps are superior to horizontal double suction volute type pumps with regard to the agglomeration.

Although horizontal pumps are in general a few per cent less costly than vertical pumps, the costs for the vertical pump system compensated by the smaller underground structure surely offsets the costs for the horizontal pump system.

For the above reasons, the vertieal shaft mixed flow volute pump was selected for larger size pumps, but for smaller pumps horizontal pumps was considered.

(2) Measuring Equipment

An appropriate wastewater flow measuring equipment is provided to measure the inflowing wastewater fluctuation. A flow meter is equipped at the delivery pipe of the pumping stations. Among several commonly employed methods and apparatus for flow measurement, the electro-magnetic flow meter is selected. The most prominent advantage of the electro-magnetic meter is that it can be installed in existing system, head loss is insignificant, and it is self-cleansing.

2.3.7 Force Mains

At design minimum flow, a cleansing velocity of at least 60 cm/sec is to be maintained. Also, particular considerations are given to the possible water hammering action expected in the force main pipelines, and appropriate counter measures to protect the force main facilities from such phenomena.

2.3.8 Pumping Station Structures

(1) Inlet Chamber

An inlet chamber is provided at the head of the pumping stations, except manhole type pumping units, as shown in Volume IV, "Drawings." The inlet chamber receives the wastewater from the inflowing sewer and then leads to two direction for each of the two wet-wells.

In the chamber, a concrete flow deflector is so provided as to distribute the wastewater flow as equally to each wet-well as possible and to decrease the inflowing wastewater flow velocity in the wet wells.

Influent gates are installed for the convenience of operation and maintenance of the chamber, as shown in the attached drawings.

(2) Screens

Two (2) sets of bar screens will be provided in the screening channels succeeding the inlet chamber to remove fine floatable solids in the wastewater to prevent the possible clogging of the pumps. The structure of the screening channel is such that will ensure smooth flows at the upstream of bar screens and to minimize unnecessary turbulence in the channel.

The clear opening space between the bars of the screens are 50 mm and 30 mm for the course screen and fine screen respectively, and the bars are of rectangular cross-section. The course screen is inclined at 60 degrees to the horizontal whereas that for the fine screen is 70 degrees.

In view of the necessity for the efficient operation of the rakes and also for reducing the hydraulic head losses in the screens, the wastewater flow velocity reaching at the channels is planned to be at around 0.45 m/sec.

The course screen unit will be manually cleaned, but the fine bar screen unit is equipped with a motor-driven mechanical rake to remove the screenings on the bars. The removed screenings will be stored in trash containers and then dumped on trucks by means of a trolley hoist. Screenings are particularly obnoxious in both appearance and content and should be disposed of as soon as possible, or should be stored in a closed container or other appropriate means.

In the manhole type pumping units there will be no bar screens, but a basket type screen will be provided ahead of the pumps. The basket type screen will be periodically cleaned and the trapped screenings will be removed manually for the final disposal.

(3) Wet-Wells (Pump Wells)

Each of the wet-wells in PST3 and PST8 are divided into two separated compartments for the convenience of cleaning and inspection of the well. Each well is designed to have an individual wastewater inlet. When it is necessary to empty an well for cleaning or other purposes, the entrance sluice gate of the well will be closed and dried independently from another wet-well.

In order to prevent unnecessary vortices from forming in the wells, that will interfere proper pump functions, particular considerations are given to the bottom slopes and arrangement of suction pipes, thereby providing optimum hydraulic condition for the pump operation. The shape of the well and the detention have been determined so as to minimize deposition of solids and prevent the wastewater to become septic.

The configuration, shape and dimensions of the wet-wells are determined taking into account the above conditions. For more details of the calculations for designing the wet-well, refer to Annex-3, Pump Equipment Design.

(4) Dry-Well (Pump Room)

In the dry-well, sufficient room is maintained between pumps to move the pump off its base with ample clearance left over between suction and discharge piping, and room for on site repairs, inspection, or removal from the room to the surface for repairs.

The size of dry well has been determined based on the number and type of pumps selected and piping arrangement. The length and width of the dry well provides a sufficient space for the required length for pipes, valves and clearance for maintenance and repairs, as shown in the Drawings of "Drawing" of Volume IV.

The dry-well is well lighted by fixtures. All safety and other requirements are also implemented in accordance with local and national safety codes and regulatory agencies.

(5) Piping and Valves

Suction, discharge and header piping in the station are sized to handle the flows adequately. Pipes are sized so that the velocity in the suction line will not exceed 1.5 m/sec, and the discharge piping 2.4 m/sec.

Valves are provided on the suction and discharge side of each pump to allow proper maintenance of the unit as shown in the attached drawings. A butterfly valve is provided at each wet- well wall inlet pipe. To the discharge pipeline, electric motor-operated butterfly valves and the check valves with dash pot devices are installed to ensure the operation of each pump.

(6) Hoisting Equipment

An electric overhead bridge traveling crane is provided in the motor room for handling of equipment and materials which cannot be lifted readily or removed from the station by manual labor.

The weights of pumps and motors are as follows:

	Pumps		Motors	
PST3	300 mm diam.	2.0 t/unit	185 kW	3.5 t/unit
PST8	350 mm diam.	2.5 t/unit	110 kW	2.5 t/unit

The heaviest piece to be lifted in the initial installation is the 350 mm diameter pumps for PST8 weighing about 2.5 tons, whereas the assembled 185 kW motor and magnetic coupling for PST3 weighs about 3.5 tons. Therefore, a nominal lifting capacity of 5 ton is adopted for the crane.

2.3.9 Relief Conduit and Emergency Storage

(1) General

A provision of high level overflows and emergency storage basins should be considered in the pumping system in order to protect the tributary area and pumping station from the possible wastewater flooding in case of mechanical or electrical failure in the pumping station.

For this purpose, a study has been made on determining an appropriate overflow structure to safely dispose of the wastewater inflow to the nearby drains.

There may be several possible emergency cases that require the relief operation:

- When the wastewater inflow rate exceeds the pump station capacity and the wet well water level abnormally raised,
- In case of electrical failure from all independent public utility sources,
- Failure in operation of two or more pump units, and
- Malfunction of the force main pipeline.

In case of the emergency, the wastewater may either overflow from the pumping station, or upstream of manholes in the sewerage system, or stored within the sewer system using sewer capacity, where the temporary discharge or retention of the excess wastewater may be allowed.

When the power failure or malfunction of the pump operation is restored, the retained wastewater would be immediately taken back to the sewerage system with pumps and transported to the treatment plant. If no relief conduit is provided, the phenomena will be further intensified.

(2) Relief Conduit

A relief conduit will be provided at the major manholes and, in case of emergency, lead the overflows to the nearby secondary drain through a pipe. The relief pipe is capable of discharging the estimated maximum wastewater flow at the manhole.

However, it is not known how early the actual construction of the drainage system will start. Until the drainage improvement is done, the relief conduit may not be effective as planned. Therefore, the construction of the relief conduit facilities has to be postponed until the schedule for the drain improvement program is fixed.

If the drain improvement is not performed even after the pumping station starts its operation, the emergency relief can be made through the overflow weirs at the up streams of the sewerage. By doing so, serious flooding or overflowing of the wastewater down streams could be avoided and serious damage reduced.

The provision of a high level overflow should be considered in the pumping systems in order to protect the tributary area and pumping station from the possible wastewater flooding in case of mechanical or electrical failure in the pumping station.

2.4 Wastewater Treatment Plant

2.4.1 Wastewater Treatment Process

The First Stage wastewater treatment plant facilities will collect and treat the wastewater from the First Stage Area of 874 hectares in Khan Yunis City and a part of Bani Sohaila with a total service population of 158,500 persons (in 2006).

The treatment process, a combination of anaerobic ponds and oxidation ditches, will treat the wastewater to the degree acceptable for the reuse of groundwater recharge or crop irrigation. The plant process sequence consists of the following components:

(1) Preliminary treatment- pumping, screening and degritting,

(2) Primary treatment - anaerobic tank

(3) Secondary treatment-oxidation ditches, and

(4) Sludge management-stabilization of excess sludge in the anaerobic ponds.

The location and layout plan of the treatment plant are illustrated in Figures F.2.3 and F.2.4, respectively. The process diagram, flow sheet of the process, and details of plant other facilities are shown in Volume IV "Drawings."

2.4.2 Wastewater Inflow Rates

The daily average, daily maximum and peak wastewater flows for the 2015 design year are summarized in the following table:

Table F.2.9 Wastewater Inflows to the Treatment Plant by Stage

Wastewater Type	First Stage(2006)		Final Stage(2015)	
	(m^3/day)	(m^3/sec)	(m^3/day)	(m^3/sec)
Daily Average Flow	16,100	0.186	53,400	0.618
Peak Flow	25,034	0.290	83,030	0.961

Source: JICA Study Team 1997

The hydraulic design of the wastewater treatment plant component facilities under the First Stage are made based on the daily average wastewater flow rate in the year 2006, whereas all pipings and conduits are based on the peak flow rate of flow in 2015. The maximum hydraulic flow to which the preliminary, primary and secondary treatment process components under the First Stage condition is 0.290 m^3/sec.

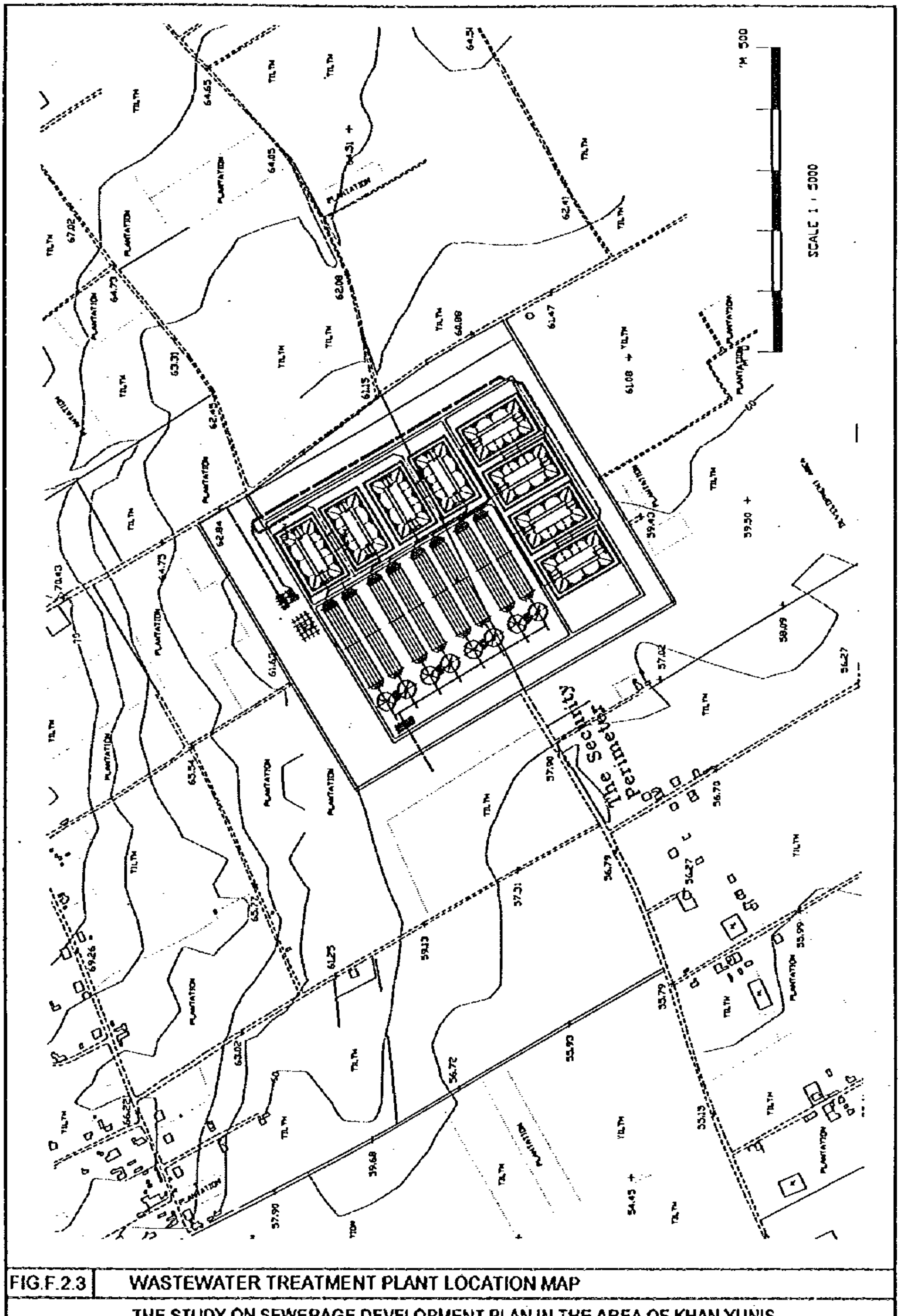


FIG.F.2.3	WASTEWATER TREATMENT PLANT LOCATION MAP

THE STUDY ON SEWERAGE DEVELOPMENT PLAN IN THE AREA OF KHAN YUNIS
IN PALESTINIAN INTERIM SELF-GOVERNMENT AUTHORITY

AD 1997

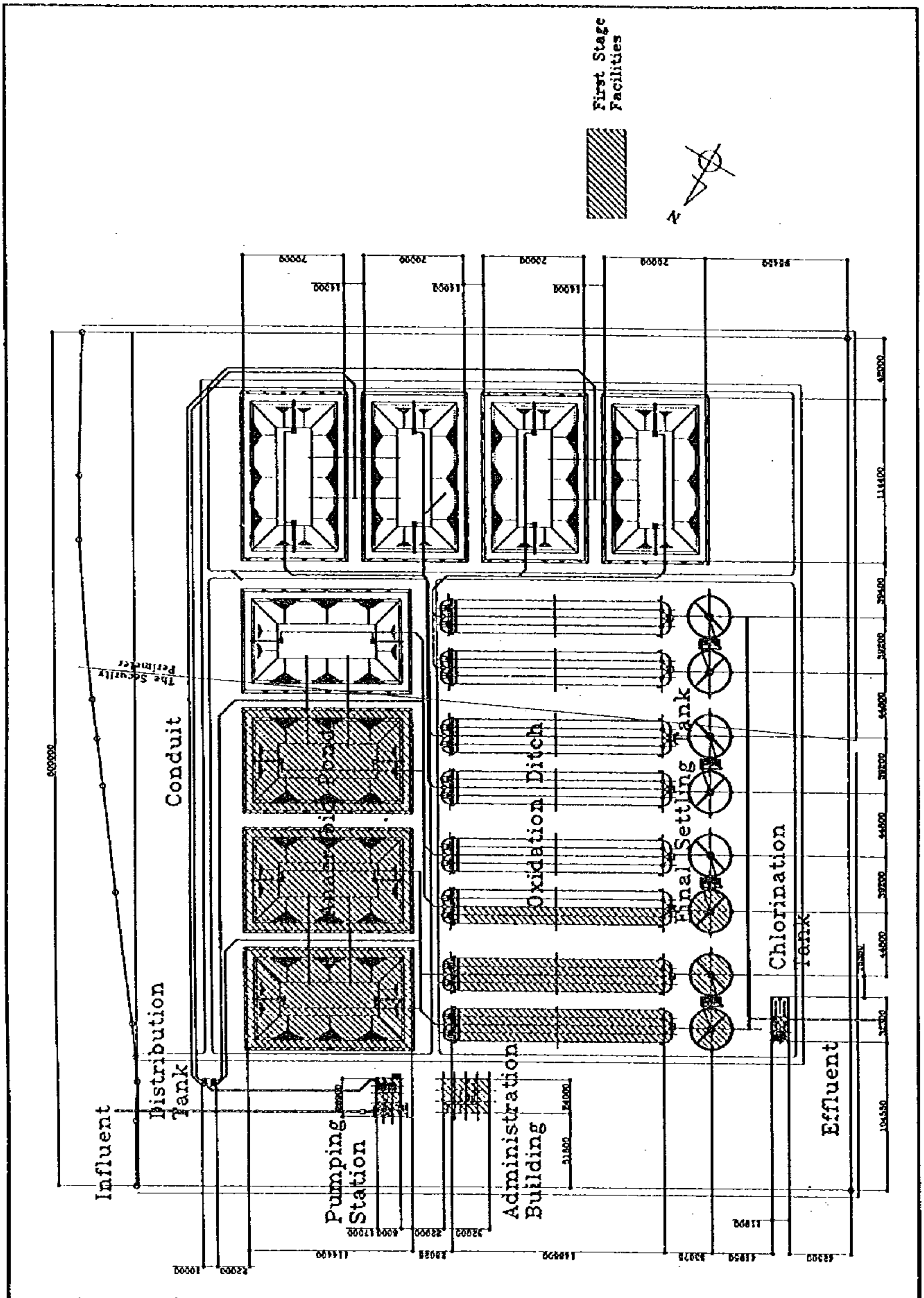


FIG.F.2.4 WASTEWATER TREATMENT PLANT LAYOUT

THE STUDY ON SEWERAGE DEVELOPMENT PLAN IN THE AREA OF KHAN YUNIS
IN PALESTINIAN INTERIM SELF-GOVERNMENT AUTHORITY

2.4.3 Wastewater Characteristics

The wastewater characteristics parameters used for the process design are listed in the following table:

Table F.2.10 Wastewater Characteristics Used for Process Components Design

Items	Daily per capita loads (g/day)	Concentrations in wastewater (mg/l)
BOD_5	55	500
COD	100	900
SS	70	620
T-N	14	130
T-P	3	30

Source: JICA Study Team 1997

2.4.4 Influent and Effluent Wastewater Qualities

On account of the possible effluent reuse for crop irrigation, groundwater recharge, or industries, and environmental protection of the surrounding area, all the wastewater is to be treated at least with the secondary treatment level. The expected influent and effluent wastewater qualities to be achieved are as follows:

Table F.2.11 Estimated Influent and Effluent Qualities

Items	Concentrations in wastewater (mg/l)	
	Influent	Effluent
BOD_5	500	25
COD	900	158
SS	620	31
T-N	130	39
T-P	30	30

Source: JICA Study Team 1997

2.4.5 Process Design

For the design for the treatment plant component facilities, the following design bases will be applied as a preliminary step to the detailed designs:

(1) Wastewater Flow Hydraulics

Each component facility for the First Stage Project is designed based on the following design hydraulic loadings:

Table F.2.12 Design Hydraulic Loading Rates

Plant Component	Hydraulic Design Basis (m^3/sec)	
	Daily average Load	Maximum Load
1. Preliminary Treatment		
Inflow Pipe to		
Outfall pipe	-	> 0.289
Fine screens	-	> 0.289
Degritting	-	> 0.289
Pump station	-	> 0.289
2. Primary Treatment		
Anaerobic ponds	> 0.186	-
Flow spliter to second treatment	-	> 0.289
Flow spliter to effluent outfall	-	> 0.289
3. Secondary Treatment		
Oxidation ditches	> 0.186	> 0.186
Final clarifiers	> 0.186	> 0.186
Chlorination tanks	> 0.186	> 0.186
4. All pipes and conduits	Hydraulic maximum	

Note: All works pertaining to the first stage program.

(2) Design Hydraulic Loadings of Component Facilities

Standard hydraulic loadings of each component unit are as follows:

Table F.2.13 Component Facility Hydraulic Loadings

Component Unit	Hydraulic Loadings
1. Screens	
Velocity of flow through bars	0.5 to 0.8 m/sec
2. Grit Chambers	
Overflow rate	1,800 m^3/m^2/day
Detention time	30 seconds
Velocity of flow through channel	0.3 m/sec
3. Anaerobic ponds	
Detention time	2 days
4. Oxidation ditch	
Detention time	34 hours
Channel velocity	0.6 m/sec
Return sludge	50 to 150% of flow rate
5. Final settling tanks	
Overflow rate	10m^3/m^2/day
Detention time	8.4 hours
6. Chlorine contact tanks	
Contact time	15 minutes

(3) Design Organic Loadings

In general, the design organic loadings shall be calculated in the same manner as used in determining design flow. Standard organic loadings for each treatment plant unit are shown in the table below:

Table F.2.14 Organic Loadings of Each Component Unit

Units of Facility	Organic Loadings
Oxidation ditches	
Aerator BOD loading	0.4 kg BOD/m^3 of ditch
MLSS	3,000 to 4,000 mg/l
SRT	8 to 50 days
Oxygen transfer efficiency	2.2 kg O_2/kW-hr
Dissolved oxygen in aeration tank	0.5 mg/l
Excess sludge	
Concentration	0.8% of sewage

(4) Design of the Treatment Plant Facilities

Each of the component facilities are designed based on the above design basis and criteria for the First Stage Program. The facility hydraulic and waste loadings have been calculated both for the years of 2015 and the First Stage conditions. Details of computations are included in Appendix-F "Wastewater Treatment Plant" of Volume III.

2.4.6 Component Units

The proposed oxidation ditch wastewater treatment plant general layout plan is shown in Figure F.2.4, and the detailed drawings for each component unit are illustrated in the "Drawings" of Volume IV. The treatment system will consist of the following facilities:

(1) Pumping Station

The wastewater treatment plant pumping station will lift the wastewater of hourly maximum flow rate, with an inlet gate, grit chambers, a sand trap, screens, wet wells, and other auxiliary facilities. Totally three (3) pumps, including one stand-by, will be installed to lift 25.9 m3/min hourly maximum wastewater inflow. The major features of the pumping station and sizes of each component facility are as follows:

a) Inlet Facility

- Inlet pipe diameter: 1,350 mm
- Discharge pipe diameter: 1,000 mm
- Elevation of inflow pipe invert 58.40 m above sea water level
- Outlet pipe invert elevation: 66.00 m above sea water level

b) Screens

Mechanically cleaned screens are proposed to be a front cleaned type, with 30 mm opening spaces between bars. Screenings will be stored in a storage bin provided close to the screening device. Major features of the screening equipment are as follows:

- Width of channel : 2.0 m
- Water depth: 1.0 m
- Thickness of bar plate: 9 mm
- Clear opening of bars: 30 mm
- Number of units: 1

c) Grit Chambers

Grit and screening chamber will have inlet gates, grit chamber with bucket grit collector and screens. The structure of the chamber will be of reinforced concrete. Simple grit washing and storage facilities will be constructed alongside the chamber, the supernatant liquor being returned to the incoming sewage flow for treatment. The chambers will be of the following features:

- Width of channel: 2.0 m
- Effective depth of channel: 1.0 m
- Number of units: 2
- Actual overflow rate: 337 m^3/m^2/day
- Actual surface area: 74.3 m^2

d) Pump Equipment

The pumps will be operated by the automatic starting and stopping by the level of the wastewater in the wet well, so that the higher the level of the wastewater in the well, the greater the pumping capacity in operation. The pump will start its operation when the inflowing conduit water elevation is

57.6 meters above sea water level and send the wastewater to the anaerobic ponds. The pump equipment are as follows:

- Pumps: No.1 pump; 1 x 12.4 m^3/min x 10.2 m x 37 kW
- No.2 Pump; 1 x 17.0 m^3/min x 10.2 m x 45 kW
- Discharge pipe: 1,000 mm dia.

(2) Anaerobic Ponds

The anaerobic ponds will have a hydraulic retention time of two days to daily average wastewater inflow. The rectangular shape ponds have an average depth of 4 meters, and the wastewater after being treated will be led to the oxidation ditches. The accumulated sludge will be removed at a 2-year frequency. The dimensions and capacity of ponds are as follow:

- Mid-depth breadth of pond: 40.0 m
- Mid-depth length: 83.4 m
- Effective depth: 4.0 m
- Hydraulic detention time: 2.0 days
- Number of unit: 3
- Total mid-depth volume of ponds: 40,032 m^3
- Mid-depth area of each pond: 3,336 m^2
- Total mid-depth area: 10,008 m^2
- Mid-depth volume of ponds: 29,800 m^3

(3) Oxidation Ditches

The ditch constructed by reinforced concrete, will consist of pockets, each aerated by two surface aerators. Return of activated sludge will be done by centrifugal sludge pumps feeding to a distribution channel where mixing with the incoming sewage flow will occur. The aerators impart a velocity of 0.3 m/sec to the ditch contents, sufficient to maintain the active solids in suspension. The effluent of the ditch flows to the final sedimentation tanks. Dimensions of the ditch are as follows:

- Width of ditch: 5.5 m
- Length of ditch (long circular): 145.6 m
- Depth of ditch: 3.0 m
- Number of ditches 5

- Volume of one ditch: 4,700 m^3
- Total ditch volume: 23,500 m^3
- Hydraulic retention time: 34 hours

(4) Final Settling Tanks

The tanks, constructed in reinforced concrete, will be of the radial flow type, with sludge removal by electrically driven scraper. Sludge removal will be by sludge pump being automatically operated at adjusted intervals. Under the First Stage a total of three (3) number of the clarifiers is required, each sized and planned as follows:

- Tank diameter: 29.2 m
- Effective side wall depth: 3.5 m
- Detention time: 8.4 hours
- Overflow rate: 10 m^3/m^2/day
- Tank surface area: 668 m^2
- Actual overflow rate: 8.0 m^3/m^2/day
- Actual weir loading: 59 m^3/m/day
- Number of clarifiers: 3 units
- Sludge pumps: 4 (2 standby)x 1.0 m^3/min
- Return sludge pumps 6 (3 standby)x 4.7 m^3/min

(5) Chlorine Contact Tank

The rectangular reinforced concrete tank will be longitudinal baffling type, with a contact time of about 15 minutes for the average daily flow rate. The turbulence created by a hydraulic action will provide chlorine mixing with the sewage. Chlorine equipment will be installed close to the chlorine contact tank, with necessary handling facilities for hypochlorite. Features of the tank are as follows:

- Tank width: 2.5 m
- Effective tank depth: 2.0 m
- Channel length: 13.9 m
- Channel number: 1
- Split of channel: 4 with a longitudinal baffle
- Effective volume: 278 m^3
- Actual contact time: 26.9 minutes
- Chlorine dosage rate: 5 mg/l

- Chemical: Hypochlorite

(6) Process Control

With the objective of simplicity of operation, the process control using sensors will be kept minimum and only used in such areas where it will have a visible financial pay back. The degree of instrumentation for the equipment will be minimal.

(7) General Facility

The treatment plant will be provided with:

- An administration building with office and a laboratory equipped for simple testing of sewage and sludge.
- Garage, workshop and store for spare parts.
- Standby electric power generator.
- Housing for management and staff as required.

More detailed description on the design of the wastewater treatment plant facilities are shown in Appendix-F "Wastewater Treatment Plant" of Volume III, including component units hydraulic calculations, capacity calculations, and other data. Structures, sizes and other features of the component units are also illustrated in the of Volume IV "Drawings."

2.5 Operation and Maintenance

2.5.1 Introduction

This section explains in general terms how a sewerage system should be operated and maintained, presenting general operation and maintenance requirements for the wastewater system to be constructed under the First Stage Project. Specific requirements for wastewater collection, pumping and treatment facilities in Khan Yunis and its surrounding areas are also addressed. Although it details some aspects of safety or operation, it is not intended to be a job description. A separate manual describing the requirements of each position should be prepared in due course by the concerned agency.

Operation and maintenance can be described as a combination of actions carried out to retain an item in, or restore it to, an acceptable condition. These actions require a variety of skills including technical knowledge and site experience and an understanding of the business of sewerage and wastewater treatment.

Operation and maintenance should not be a subject for consideration after the completion of the works but should be an integral part of the design and construction process,

The operation and maintenance profile over the life of the work is influenced by the policies, attitude and efficiency of the owner, especially in the context of financial and other constraints, the designers; those involved in construction; those responsible for the operation and maintenance policy. It is therefore important to seek a contribution from each of the above parties, particularly at the stages of inception and design, in order to achieve the objective of minimizing the tasks of operation and maintenance.

Over the phased construction period of the Khan Yunis wastewater management strategy plan a communication system should be set up for the operation and maintenance organization. The communication system is to interact with the design team so as to encourage feedback of information, which could contribute to the operation, and maintenance of the system over the design life of the wastewater program. This feedback of operation and maintenance information could enable the design team to "design out" as much maintenance as possible in order to reduce the overall cost of maintaining the scheme over its design life.

Work organized and carried out under a predetermined planned maintenance program which is categorized as planned preventive maintenance provides a disciplined approach to operation and maintenance. The tasks generally fall under four headings:

(1) Preparation of an inventory of the various elements of the infrastructure to be maintained,

(2) Scheduling of the information gathered into work units,

(3) Production of work orders for the operation and maintenance personnel, and

(4) Collection and Recording of Information.

Although not necessarily advocated at the present time it is appropriate for planned wastewater management authority to be aware of the trend in other parts of the world with regard to this maintenance function.

2.5.2 Project Components

Within the urban areas of Khan Yunis and its potential large-scale expansion into the surrounding districts, the main infrastructure components can be categorized as:

(1) Sanitation improvement,
(2) Groundwater pollution control, and
(3) Flood control.

Although the operation and maintenance aspects of a large-scale stormwater control are beyond the scope of this Project, there is an inter-relationship between these works and those required for water pollution control. There are similar components for both works, such as pumping stations, that may justify consideration of integrating some of the elements of the operation and maintenance organization so as to provide common planned maintenance where appropriate.

The main components of water pollution control at this stage can be sub-divided into:

(1) The stormwater drainage system,
(2) The proposed main, submain, branch and lateral, and house connection sewers,
(3) Storm drainage pumping stations,
(4) Wastewater pumping stations, and
(5) Wastewater treatment plant.

2.5.3 Project Management Organization

(1) Management and Coordination

Water pollution control and sanitation works in Khan Yunis have, to date, been the responsibility of the Khan Yunis Municipality. With the establishment of the wastewater management authority (under consideration), it will be appropriate for the responsibility for the project management and coordination to shift to this authority

The MOPIC, Khan Yunis Governorate and City will still retain a key involvement in the design and construction of the recommended project. The ongoing involvement and support of these organizations will be critical to the successful completion of the Project.

To date there has been no project group or office established in Khan Yunis, although the need for a separate coordinating office will become more evident as the project continues to increase in size, extent and complexity. The likely involvement of an international lending agency also reinforces the need to establish a separate project office.

Accordingly, it is recommended that a Project Office should be established in Khan Yunis Municipality to facilitate the planning, administration and coordination of the Strategy Plan with projects being concurrently undertaken by other related municipal departments and organizations. It is suggested that the Project Office should comprise senior representatives from the relevant City Departments and the Governorate.

This office would in fact take the role of a Steering Committee and be responsible for the overall planning and coordination of the Project. The establishment of this office would, inter alia, ensure that key project managers within the wastewater authority are not burdened with additional tasks beyond their vital roles in the design, construction, commissioning, operation and maintenance of the Project.

(2) Staffing Levels

Within the Wastewater Department of Khan Yunis Municipality, the head of the management organization for operation and maintenance should be a Chief Operations Manager responsible for all the activities relating to operation and maintenance of the overall Project including controlling water pollution within defined specified limits.

The second line of management should include personnel responsible to the Chief Operations Manager under the following designations:

a) Operations Supervisor,

b) Technical Support Supervisor responsible for electricians, mechanics, fitters, instrumentation technicians, building maintenance personnel and relevant tradesman for the protection of the components of the Project, and

c) Scientific Supervisor responsible for both the monitoring and control of discharges to sewers as well as water quality control of discharges through and from the wastewater treatment works.

These three Supervisors together with the Chief Operations Manager would be responsible for the control and direction of the personnel making up the allocated manning levels for the various stages of the project development.

Manning levels for the Project may need to be higher than for comparable programs in developed countries for the following reasons; i) labor costs are relatively small, and ii) the operation of facilities at the wastewater treatment plant, particularly those installed for secondary biological treatment and possibly nutrient removal, is a relatively new technology in Gaza Region.

Additional staffing levels may be necessary until a full understanding and knowledge of these facilities is attained:

a) The full extent of the wastewater collection system is not yet completely defined, and may require the construction of additional wastewater collection facilities and pumping stations, with consequent additional staffing requirements,

b) The implementation of automatic instrumentation and control systems is a common feature of modern sewerage systems. However the relatively recent implementation of wastewater collection and treatment facilities in Palestine has not yet reached the stage of accommodating automatic control systems.

Such systems will be progressively adopted in Palestine (in the same way that they have been in other developed countries), but there may be an initial preference to utilize available resources and to instead rely on manual detection and activation with a consequent higher manning requirement for wastewater collection and treatment facilities.

2.5.4 Operation and Maintenance Requirements for Reticulations

The high capital investment involved will dictate that the sewer network is designed for a long asset life and that this life is prolonged by effective maintenance to ensure the structural integrity and operational function of the system. The sewer network can be classified as:

a) Main, submain and reticulation sewers,
b) Sewer connections, and
c) Manholes.

The design of sewers should ensure that aerobic conditions are maintained within larger main sewers and appropriate ventilation provided throughout the sewerage system based on an air change at least every two days. In order to achieve this general requirement a number of principal ventilating effects will need to be taken into consideration including wind, rise and fall of wastewater in the sewers, and respiration of the wastewater.

Cleaning and flushing to remove blockages or build up of deposition of grit and wastewater debris is likely to be required from time to time. Uneven flow characteristics can sometimes be observed by looking at the surface profile and this should give sufficient indication of the possibility of blockages and the need for a more extensive inspection.

Regular inspection must be carried out if the sewer network is to be protected. The risk of structural deterioration should be assessed in relation to ground conditions, the quality of the constructed sewer, and the nature and characteristics of the wastewater.

This assessment will provide a base to judge inspection frequencies throughout the overall length of the sewers and the items to be observed and recorded when inspections tike place. Inspection of the interceptors should be carried out with the aim to detect trends of deterioration as well as obvious defects that might be observed during an inspection.

It is recommended that particular attention is given to selected sections of the main sewers, and that these sections are inspected for physical shape, surface hardness, and condition on systematic and regular basis. The objective is to record the rate of change of the measured parameters over an extended period of years. A sudden decline in condition, if this can be detected, would indicate the need to carry out a continuous inspection along the length of the man-entry sewer and to contemplate repairs.

It is difficult to recommend a frequency for inspection of the main sewers without appreciating more fully the potential risks. However, assuming a long asset life, inspection frequencies may be appropriate as follows:

General walk through the man-entry main sewers once every year.

a) Of the non man-entry sewers a visual inspection of the sewer from the manholes should also be carried out once every year, and

b) Detailed inspection of selected sections once every five years.

Collapsed sewers are encountered frequently and may result from any one of several causes such as; i) improper bedding, ii) pipe at insufficient depth to protect it from vibration and traffic load, iii) movement of soil, iv) openings into the sewer itself due to unplugged wyes, fault joints, or broken bells, and faulty tapping of the main for house connection.

The new type of joint design provides for flexible O-ring type joints, which allow a certain amount of joint movement without damage or leakage. Proper bedding under the pipe can increase its ability to withstand structural loads and helps to maintain a uniform gradient. These factors together with proper placement of the pipe at a suitable depth all help to protect the pipe against damage.

2.5.5 Overflows and Sewer Connections

Sewer connections are of particular importance and special attention should be given to the inspection and maintenance of these project components.

The regular removal of blockages, debris, rags and grit, which are interfering with or likely to affect the operation of the sewer connection, together with the maintenance of any mechanical and electrical equipment such as screens or valves, should be implemented.

Where mechanical or electrical equipment is provided good access is essential, with attention being paid to lighting, ventilation and general safety.

Hydraulic control devices such as orifices and throttle pipes can also be susceptible to blocking, particularly if they are less than 200 mm diameter, and these devices can become a major problem to maintain. Overflow or relief facilities should also be considered where build up of flow is likely to prevent access to blockages.

The general structural condition of chambers and hydraulic surfaces should be inspected for cracks, spalling, water ingress, corrosion, erosion and any other defects. Metalwork such as ladders, step irons, handrails and safety chains should be inspected for soundness and security of fixtures and fittings. Mechanical equipment should be checked for deterioration and wear of critical elements and security of fixings.

It is suggested that sewer connections should be inspected and routine maintenance carried out at least every two weeks to a planned maintenance program of work.

2.5.6 Manholes

Manholes from an access and safety point of view are important features and need to be maintained in good order. Manhole covers should be a minimum 600-mm diameter clear opening and should be checked for soundness and security and greased if necessary each time a manhole is lifted. Metalwork such as ladders, step irons, handrails and safety chains should be inspected for soundness and security. The general conditions of the manhole shaft, landings and benching should be inspected for defects such as cracks, water ingress, corrosion and spalling. Where surcharging occurs the manhole shafts should be cleaned down and any build up of wastewater debris or rags removed. The frequency of inspecting manholes should be in the order of at least once every year until a pattern of recorded information is built up at witch time the frequency can be reviewed.

Gangs of up to six operations personnel should be used in carrying out the necessary duties on the sewer network. The size of gangs will depend on the number and frequency of the activities to be performed.

2.5.7 Pumping Stations

Pumping stations are the most important and vulnerable component of both the sewer reticulation system and the wastewater treatment plant. The security of power supply to pumping stations is critical, while electrical, mechanical and instrumentation equipment plus structural and building components require regular inspection and maintenance.

As there are a significant number of items of equipment to be inspected, all of which are of importance, a detailed planned maintenance program should be prepared and mounted on display within the control panels of the small local district stations and within the superstructure of the larger pumping stations. The key points from electrical and mechanical manuals should be identified at an early stage and certainly before the commissioning of the station.

There are three general classes of failure, which can interrupt service of a wastewater pumping station. These are mechanical, electrical or physical clogging.

Most mechanical failures in a pumping station can be attributed to a poor preventive maintenance program. Complete and accurate records of preventive maintenance work are essential to assure that all equipment is cared for properly.

Pumps: Pump lubrication should be scheduled at regular intervals with periodic inspections, to be certain that the equipment is lubricated properly. Merely using oil or grease does not assure its reaching the bearing. In most of pumps over lubrication can cause severe problems. The operator of a pump station should familiarize himself with the pump manufacturer's instructions on servicing and lubrication, and follow them implicitly. It is poor practice to substitute an 'economy' lubricant for the type recommended.

Pumps and shafts should be aligned properly in accordance with the manufacturer's recommendations and the alignment maintained correctly. Vibration from misalignment, lose bearings, or worn bearings often will cause a shaft to wear out of round and cause serious bearing damage. Daily inspection should be given to the following: bearings for heat and noise; motors for operating speed; control equipment for cleanliness and condition; pump operation for vibration and noise; and packing glands for excessive leakage.

All moving parts should be checked for wear and all worn parts replaced. Spare bearings and packing gland parts should always be kept in stock, as these are the parts that most frequently wear. A maintenance chart should be made for each pump and placed on the wall of the pumping station.

Motors: Just as in the case of pumps it is important to warn operators against over lubrication of motor bearings. This has been the cause of untold number of motor failures. Lubrication should follow explicitly the manufacturer's recommendations. A routine cleaning program can eliminate dirt; anti-moisture precaution can be effective in combating moisture; use of proper oils and greases tends to eliminate frictions trouble; and regular daily inspections can check for undue vibration.

Valves: Valves should be operated periodically to assure that they are in proper functioning condition. The manufacturer of each gate and other type of valve provides lubricating instructions and a recommended lubricant for each particular type of valve.

Bar Screens: When properly serviced, maintained and lubricated, mechanically cleaned bar screens can serve a long useful life. They must be dismantled from time to time following the manufacturer's recommendations, to check for worn parts which, if found, should be replaced promptly.

For removing blockages, grit and sediment, high-pressure water jetting and/or vacuum systems can be utilized from fixed or mounted plant to extract the material from the station wet well.

Safe lighting can be provided in pumping stations through the provision of explosion-proof lamps and electrical switches, and extreme care should be taken to assure that there is no possibility of sparks from defective or improperly installed wiring. Motors should also be explosion-proof where necessary.

It is suggested that all large pumping stations should be permanently manned with two gangs working 12-hours shifts so as to maintain constant attendance. One or more mobile gangs could take responsibility for the smaller stations.

2.5.8 Pumping Mains

If pumping mains are lined with epoxy coal tar (or similar), provision should be made to dewater, clean and reline these mains after 10 years. If the lining is of cement mortar with satisfactory quality control it should not be necessary to reline for 25 years.

Provided that screens and grit traps at pumping stations are correctly operated and maintained, and none of the industrial discharges contain high concentrations of lime, fats or other substances which will coat the inside of the mains, then it should not be necessary to clean pumping mains when all the collection systems are connected and the flow is operating at the design velocity. Based on the above requirements, it is suggested that:

(1) The diameter of pressure mains is 30 mm greater than needed for the final discharge to allow relining with cement mortar eventually if necessary, and

(2) Dewatering and cleaning is carried out every 5 years or at shorter intervals if the resistance to flow increased.

2.5.9 Wastewater Treatment Plant

A range of engineering units and equipment require attention at the wastewater treatment plant.

(1) Screens and Inlet Pumping Station

It is essential that items of equipment within these facilities are kept in working order and it is desirable to have a continuous understanding of the performance of these components especially during times of fluctuating flows at the wastewater treatment works. Mechanical raked screens are vulnerable to "tripping out" and on such occasions need to be re-set. There is also a need to grease chains to screens, remove screenings and convey these to skips for disposal. Screenings from bar screens should be collected daily from each pumping station using a suitable truck or other means. Final disposal can be accomplished by incineration or by careful burial.

The priming of pumps and tightening of glands are standard procedures that will need to be carried out at the pumping station. As this is an important part of the wastewater treatment plant, a shift system should be introduced to ensure 24-hour cover and a minimum of two operations personnel should be engaged on each shift period of work.

As recommended for pumping stations, gates and valves should at regular intervals be operated over their full range of travel and greased where appropriate. Oil levels in gearboxes should be checked and filled where necessary. Specific areas should be brushed and hosed down on a regular basis.

Inspection of the sandpit should be made frequently to check the volume of grit accumulated on the channel bottom. Whether washed or unwashed, deodorized or not, grit rarely is clean enough to be disposed of in public areas. Burial of grit on the plant grounds or in a landfill is the most common method of disposal.

(2) Anaerobic Ponds

For the anaerobic ponds ahead of the oxidation ditches, there will be a continual sludge build-up. A certain portion of the volume of this pond should be reserved for this accumulation. When this volume/depth is exceeded, the ponds should be shut down and cleaned. Floating dredges for sludge removal may be used for this purpose. Alternatively, the supernatant liquid may be discharged into another pond and the sludge left to air dry. After the sludge has dried, it is quite inoffensive. The pond sludge can be disposed of in any of the customary ways used for wastewater sludge. The scum or mat in the anaerobic pond needs not to be removed unless such accumulation raises to a level, which may adversely affect to the normal operation.

Aside from the hazards to plant personnel, the pond also is a hazard to other persons, livestock and wildlife. There is not only the health hazard of coming in contact with the water and the pathogenic organisms, but also the hazard of falling into the water and drowning. For these reasons there is a requirement that the ponds be fenced in. The daily inspection and prompt repair of the perimeter fence is a primary safety measure.

(3) Oxidation Ditches

There are three basic categories of maintenance activities required for oxidation ditch system; i) performance-related maintenance, ii) maintenance of physical plant, and iii) safety.

Performance-Related Maintenance : The scum or mat should be broken up and removed. If the presence of mats and scum persist, a permanent spray may need to be set up, with a small pump to supply the spray with pond water from a point near the outlet.

For normal maintenance of the surface aerators, it is recommended that slow speed surface aerators be utilized to minimize the maintenance burden. In addition, the propellers should be made of stainless steel to avoid fatigue and other corrosion failure. All other metal parts in contact with the water phase must be adequately coated with anti-corrosion material.

Mechanical aerators operation requires the normal maintenance assigned to motors, bearings and gear reducers. Close attention should be paid to proper alignment and secure mounting because of the vibrations caused by subsurface currents. Accumulated trash and stringy material, and weakened support brackets can be remedied more easily if the preventive maintenance is done under favorable conditions of weather and wastewater flow.

Maintenance of Physical Plant: Physical plant maintenance requires that regular daily inspection be made to check deficiencies or deterioration, including correction of bank erosion and potential land subsidence, lining and rip-rap deficiencies, animal burrow damage, and road deterioration.

The control of vegetation must be undertaken on a regular basis. The following steps are essential to this work:

- Clearing all trees and shrubs from the ditches on and from the top and both side slopes of the embankments,
- Shallow-rooted perennial grasses may be planted on the embankments from 0.3 meter above the water line on the inside slope of the ditch or pond, across the top and down the outside face to the toe of the slope for all ditches and ponds, and
- Grass should be mowed on a regular basis. The height should be kept to 150 mm or less above the ground surface.

The daily inspection and prompt repair of the perimeter fence is a primary safety measure. Signs on the fence should indicate clearly that the ditches or ponds are wastewater treatment facilities. The signs should be inspected frequent for legibility.

Life preservers should be kept on display in visible and regular locations, preferably by mounting on posts set immediately adjacent to the ponds and ditches. This is especially important for ponds that have a normal operating depth of more than 1.2 meters.

It is also advisable to have a boat (with oars) and launching ramp to facilitate access onto the ponds. The boat should be kept in storage adjacent to the ponds. The boat can also be used for sampling and numerous other purposes including inspection of equipment. The boat and motor should receive the same maintenance attention as other plant equipment.

(4) Sludge Disposal

For the recommended anaerobic ponds and oxidation ditch system, sludge handling and dewatering is not a daily requirement. Frequency of desludging will range from 2 to 3 years. During desludging from the anaerobic ponds, for the train taken out for service, the supernatant should be transferred to the inlet of other parallel operating trains and the remaining content in the ponds left to air dry to achieve the required solids content prior to removal (by scraper or dragline) for transporting to suitable disposal sites for land fill. The desludging process should only be undertaken during the dry season of the year when wastewater flows are at a minimum.

The land disposal sites, land fill or reclamation, may be operated to minimize problems in the public sector. To prevent odor and insect problem, only well-stabilized material should be brought to the site.

One of the greatest difficulties associated with implementing land use or disposal programs for sludge is that of gaining public acceptance. An educational program seems to be a necessary and integral part of any large-scale land use program. The public must be informed more fully of the product stability and the lack of pathogenic risk, odor potential, and water contamination potential.

(5) Procedures

It is important to establish operational procedures at wastewater treatment plant in order to safeguard against potential hazards. Regular inspections of all parts of the works should be made to identify and eliminate developing dangerous situations. Particular attention should be paid to general tidiness. Tools and equipment should not be left lying around.

Every effort should be made to ensure that no fewer than two men are working together in isolated places, so that in the event of an accident assistance is readily available.

Unqualified persons should not be allowed to install, alter or tamper with electrical equipment. Special care is necessary because of the general presence of damp conditions at wastewater treatment works. In these conditions or in confined spaces, all fixed or portable electrical equipment should be watertight once it has been installed.

Before carrying out any maintenance or adjustment to any automatically and/or remotely controlled plant or equipment, it should have its power source isolated and locked off.

In the laboratory at wastewater treatment plant attention should be paid to the correct storage of materials and chemicals, adequate ventilation, fire precautions, eye protection, and hygiene during the examination of wastewater, sludge and effluent samples.

The nomination of sampling points at the wastewater treatment plant should ensure that the sample could be taken without risk to the sampler.

At a more detailed design stage it will be necessary to formulate a policy concerning the staffing of the workshops, vehicle and planned plant maintenance, and the administration function for the workforce.

As a guide the following typical standard equipment should be supplied to each of the operation and maintenance personnel who would normally be working on the sewer reticulation system and /or wastewater treatment plant.

- Safety helmet, safety harness, gloves and safety footwear,
- Each squad carrying out operational duties on the sewer reticulation system should be provided with a vehicle in which the following typical basic equipment should be housed,
- Hygiene: Clean water, soap, nail brush, towel or paper towels, disinfectant, first aid box, eye washer, scissors,
- General Small Tools: Fire extinguisher, sledge hammer and pinch bars, stiff brush, manhole lifting keys, drain rods, tool box containing a variety of spanners, screwdrivers and hacksaw, and
- Safety Equipment: Hand lines, hand lamps, cap lamps, atmosphere monitoring equipment, rescue/safety lines, self-escape rescue breathing apparatus, road barriers, etc.

2.5.10 Sewer Maintenance Equipment

Basic mobile equipment should be available for inspection work, for emergency and routine repairs, and for cleaning. In addition to the personal equipment described in the previous sections, the operation and maintenance of the new sewerage system will require the purchase of sewer cleaning and maintenance equipment for the local operations and maintenance staff.

For a wastewater project of the size and extent as that planned for Khan Yunis, at least one complete set of the of the following vehicles and equipment is considered appropriate:

- Van or truck
- On-board generator and compressor,
- Trailer-mounted high pressure jetting unit,
- Dewatering pump and hoses,
- Basic hand tools, lifting equipment and pipe rodding equipment,
- Compressor tools and power tools,
- Ventilators (1 no.),
- Gas detectors (1 no.) including battery charger and ancillary items (body harness, battery packs, carry cases, aspirator kits, etc.),
- Breathing apparatus (1 no.) including spare parts and ancillary items,
- Hand, belt and cap lamps (1 no. of each) including spare parts and ancillary items, and
- Safety harnesses, safety ropes and associated equipment (including tripod, winch, hand-held radios, etc.).

A satisfactory storage yards and shops for servicing of mobile equipment, storage of records, storage of tools, employee parking, suitable toilets, showers, locker room, meeting room, and adequate place for the storage of aggregate, sand, gravel and other construction materials which may be needed

The equipment, which has been listed, should be regarded as basic and minimum equipment for the performance of routine and emergency maintenance and servicing of sewers. Undoubtedly other equipment could be provided and sufficient additional funds for this purpose should be made available.

2.5.11 Health and Safety

The importance of safety in the conduct of their everyday duties cannot be over emphasized to sewerage personnel. From the nature of their work they are exposed frequently to a hazardous environment and should be thoroughly aware of the potential dangers. Each truck and other vehicles should be equipped with a first aid kit which should be inspected monthly for adequacy.

Personnel should be trained in proper safety practices under hazardous working conditions. Personnel should be instructed to work in teams in such hazardous locations so that at least one man will always be in a position to aid another in distress without himself being exposed to the hazardous conditions. They should be familiar with and be equipped with safety harnesses for entering manholes, pits, and underground structures.

Safety and the conduct of hygiene need to be defined and constantly reiterated to staff at all levels within the operations and maintenance sector.

(1) Safety

Where the working environment is in an enclosed area such as a manhole and pumping station wet well, where the area can be made hazardous by the entry of dangerous substances, procedures should be laid down by the employer for the workforce.

Standardized safe working procedures should be adopted for entry into confined spaces. The term "confined space" has a wide application and may include areas, which contain dangerous concentrations of toxic and/or flammable gases and/or an oxygen deficient atmosphere.

Typical safety procedures for working in sewers and chambers should include the following:

a) Preparation at the Depot

- Determine requirements for task, check plans and records,
- Check for local hazards and sewer conditions,
- Check weather,
- Check equipment.

b) Onsite Prior to Entry

- Inform Headquarters,
- Secure site and make safe with rod barriers,
- Ventilate manhole/chamber and adjacent manholes both upstream and downstream
- Check atmosphere in manhole/chamber,
- Check atmosphere in adjacent manholes both upstream and downstream,
- Check ladders, step irons, handrails and safety chains.

c) Entry into Sewer/Chamber:

- Descend on safety lines,
- Each man should have a gas monitor,
- Two men should remain on surface.

d) In Sewer/Chamber

- Maintain communications with men on surface.

e) In Sewer /Chamber - Emergency Procedures:

- If atmosphere monitor alarms are activated use self-escape breathing apparatus and evacuate sewer immediately:
- If depth or velocity of flow in sewer increases evacuate immediately.

f) Accident Procedures:

- If a person collapses due to gas or lack of oxygen self-escape breathing should be used and the sewer/chamber evacuated immediately,
- If possible remove the injured person by raising him on his harness and rope, and
- Call Emergency Services.

g) Exit from Sewer/Chamber

- Descend with safety lines,
- Replace manhole covers, and
- Carry out personal hygiene procedures.

g) Report on Inspection

- Clean and check equipment, and
- Report on findings and the condition of operational equipment.

h) Safety in Design

The employer should provide a safe place of work, safe plant and equipment and safe systems of work. These requirements are inter linked and contingent on each other for accident prevention capabilities. The aim should therefore be to increase the designers' knowledge of those aspects of design that affect the safe operation and maintenance of the proposed installations.

i) Safety in Construction

The responsibility rests with the contractor. However, it is necessary for the construction supervisory staff to be aware of the standards to be applied generally and to bring to attention the course of action to be taken on specific matters relating to safe working.

j) Operational Safety

Operational personnel must be trained in the tasks for which they are employed including any necessary safety precautions, safe working practices and procedures to be adopted. The training should cover hazards that may arise and precautions to be taken, use of breathing apparatus and emergency procedures.

(2) Hygiene

The strictest attention to personal hygiene should be paid by everyone working in a sewerage system or at a wastewater treatment plant (especially care of the skin and eyes) and adequate washing facilities should be provided at all places of work.

The inspection and routine planned maintenance should be carried out initially on a daily basis with a minimum of two operations personnel visiting each pumping station.

All persons who during their normal course of work are likely to come into contact with wastewater should be given protection against typhoid, tetanus, poliomyelitis and leptospirosis.

All protective clothing (e.g. waterproofs, jackets, non-slip safety boots and gloves) used in sewerage and wastewater treatment operations should on completion of those operations be disinfected by scrubbing with a suitable disinfectant then rinsed with clean water.

A laundry service should be provided for all personnel using overalls when employed in the operation and maintenance of the sewerage system and at the wastewater treatment plant. Overalls should not be taken away from the place of work and sufficient replacement pairs should always be available for use.

2.5.12 Training Program

(1) General

It is important when starting to build up a workforce for the operation and maintenance organization of the sewerage and wastewater treatment system that the operators, electricians, mechanics and laboratory chemists are trained through regular planned meetings to understand the overall process of the collection and treatment of waste-water. This will help to define each of their roles and highlight the importance of working together as a team so as to optimize the operation and maintenance input.

There will also be a need to conduct planned training courses, both locally and overseas, for the operations and maintenance staff. This training would be carried out with the assistance of management and finance experts and technical specialists to include the following topics:

- The establishment and running of training programs for staff (including managers, engineers, technicians, operators, chemists and accountants),
- The operation and maintenance of mechanical and electrical equipment,
- Current practices in safety and hygiene, and
- Current practices and techniques for monitoring, sampling, diagnosis and testing.

It is envisaged that training courses would be scheduled to suit the necessary training for different levels of management. This could entail the following for operation and management personnel:

- Senior Staff (Chief Operations Manager and Senior Supervisors) - short duration (up to 3week) overseas courses on general 0 & M management, programming and training requirements,
- Technical Staff (Operations, Technical Support and Scientific Supervisors) - several short courses (of up to 3 -week duration) carried out over an extended

period (3 to 6 months) in both local and overseas, on more specific technical requirements for the sewerage system and wastewater treatment plant, safety and hygiene practices and techniques for monitoring, testing and sampling,

- Day Staff (Operators and Day-labor Staff) - regular courses in Khan Yunis, conducted by the Technical Stiff based upon their training courses with overseas experts and specialists.

The need for overseas training will be influenced by the availability of suitable experienced and qualified personnel in Khan Yunis. A range of excellent training courses and programs are now offered by water authorities in other countries, which could be undertaken by 2 or 3 specialists in Khan Yunis for duration of up to 1month. The incorporation of at least one of these courses is considered appropriate as part of the Khan Yunis Project.

A suggested program for staff training is as follows:

- Overseas study tours during 1998 by appointed senior staff and technical staff (1 no. tour, each comprising 2 persons for up to 1 month),
- Visits to Khan Yunis during 1998 by overseas specialists (2 no. visits, each comprising 1 or 2 specialists for up to 2 weeks), and
- Local training during 1998 to 1999 of technical and day staff, including purchase of training equipment.

(2) Supervisors

Supervisors who are responsible for controlling the day-to-day work activities of the sewerage and wastewater treatment work force should be given training in the planning, organizing and control of work activities associated with their responsibility.

(3) Scientific Staff

Qualified chemists with a minimum understanding of sewerage and wastewater treatment processes should be provided with knowledge of obtaining representative samples of wastewater and sludge and also to the mechanics, optimization and control of wastewater treatment together with the problems associated with the various processes.

(4) Operators

In order to be able to delegate responsibility to the lowest possible level there is a need to train operational personnel so as to shorten the line of communication and so attempt to optimize man management. For example where a fitter would be needed to stuff glands on a pump an operator could be trained to carry out this type of function. Such training increases the flexibility of the workforce and therefore provides greater scope for management.

A technical introduction should also be given to operators on the basics of sewerage and wastewater treatment. The purpose would be to give a broad understanding of the sources and nature of wastewater and the treatment processes used to prevent water pollution. Subsequently this introduction could be further developed by knowledge of the fundamental mechanisms involved in the treatment of wastewater.

(5) Training Equipment

In addition to the operations and maintenance equipment described in the previous sections, it is likely that equipment will also need to be purchased to facilitate training programs for staff in Khan Yunis, and in particular for safety-related courses. This equipment could be purchased directly by the wastewater authority or could be provided by specialists as part of the training program.

- VTR, playback screen and videotapes,
- Projector and slides,
- Relevant publications on health and safety in design, constriction and operations,
- Gas detectors including battery charger and ancillary items,
- Breathing apparatus including spare parts and ancillary items,
- Hand, belt and cap lamps, and
- Safety harnesses, safety ropes and associated equipment.

2.5.13 Effluent and Wastewater Monitoring

The wastewater effluent monitoring will be required after the treatment plant starts its operation and a comprehensive, accurate and reliable wastewater/effluent-monitoring program will be an essential component of the Khan Yunis Wastewater Management Project.

An integral part of this program will be the purchase and installation of water quality and flow measurement equipment for effluent monitoring from the wastewater treatment plant, and for mobile analysis for use by the new wastewater management agency for wastewater/effluent discharges to, respectively, ground, and sewers.

Minimum analytical items in the laboratory in the wastewater treatment plant under the First Stage Project will be as follows:

Table F.2.15 Minimum Analytical Items

Sampling points	Daily or at the time of inspection	Periodical (once a week)	Periodical (once a month)
Inflow channel	Appearance, odor, water temperature, turbidity, pH	SS, COD	BOD, NH_4^+-N
Oxidation Ditch	Appearance, odor, water temperature, turbidity, pH	MLSS	Microorganisms MLSS
Final clarifiers effluent	Appearance, turbidity, pH	SS, COD, NH_4^+-N, NO_3^--N	BOD, NH_4^+-N NO_3^--N
Plant effluent	Appearance, turbidity, pH, chlorine residual	SS, COD	BOD, NH_4^+-N NO_3^--N

Source: Japan Sewage Works Association, "Guidelines for Planning, Design and Operation and Maintenance for Small Scale Treatment Works." 1996.

Analysis of some of the above items might be entrusted to reliable institutions or laboratories. A laboratory will need to be established at the wastewater treatment plant. A range of sampling and testing equipment to be purchased and installed may include:

- pH/temperature/conductivity meters (at least 2),
- DO meters (at least 2),
- Digital balances,
- Drying ovens,
- Hot plate stirrers,
- Digestion apparatus,
- Laboratory centrifuge,
- Vacuum pumps (large and small), with blower facility,
- Evaporation equipment (water baths, etc.),

- Distillation equipment (quick fit) and rotary film evaporator,
- Fume cupboards with ventilation equipment,
- COD apparatus,
- Turbidity meter,
- Miscellaneous instruments and spares (electrodes, etc.),
- Extensive range of laboratory ware (glass, silica, metal retorts, bunsens, etc.), and
- Continuous still (for distilled water) and deionizer units.

2.6 Dynamic Model

2.6.1 Introduction

The dynamic modeling activities were carried out in the period from June to August 1997.

The aim of the dynamic model was to study the function and capability of the sewerage system and the drainage system during the two stages of implementation. These stages are referred to as the Feasibility Study (F/S) and the Master Plan (M/P), with final completion in respectively year 2006 and 2015.

The dynamic modeling activity comprises the following tasks :

(1) Development of sewerage simulation model for the F/S and the M/P.

(2) Optimizing and validating preliminary sewerage design achieved with application of the rational method.

(3) Development of drainage simulation model for the present condition, the F/S and the M/P.

(4) Designing and analyzing an urban drainage system.

2.6.2 Numerical Models

The models applied for simulation of the sewerage system is the MOUSE Pipe Flow Model.

Simulation of the drainage system is performed with a combination of the MOUSE Run-off Model B and the MOUSE Pipe Flow Model, where the Run-off Model B simulates the run-off process on the catchments and the MOUSE Pipe Flow Model simulates the flow in the streets and in the sub-surface drain.

2.6.3 The Drainage System

The run-off is collected in locally depressed areas of the city, where it is stored. Accordingly, this cause flooding in the low-lying areas during heavy storms.

Areas facing flood problems are the market district and the central district located respectively along the Jamal Abd Nasr street and near the Municipal office (see Figure F.2.5). These two locations are occasionally flooded with a frequency of 1 to 2 times per year. Pumping facilities are either missing or inadequate and some areas are relying on the infiltration capacity to the ground only. Therefore the flooding can last for a long period causing damage on property and disruption of the daily life.

In order to improve the present conditions, it is proposed that a sub-surface drainage pipe is constructed along Jamal Abd Nasr street with a water intake at the market district, thereby connecting the flooded part of the market district to the El Katibah pumping station (see Figure F.2.6). Storm water from catchments in the central district is partly transported on the road surface (along Jamal Abd Nasr Street) and partly in the sub-surface drainage pipe.

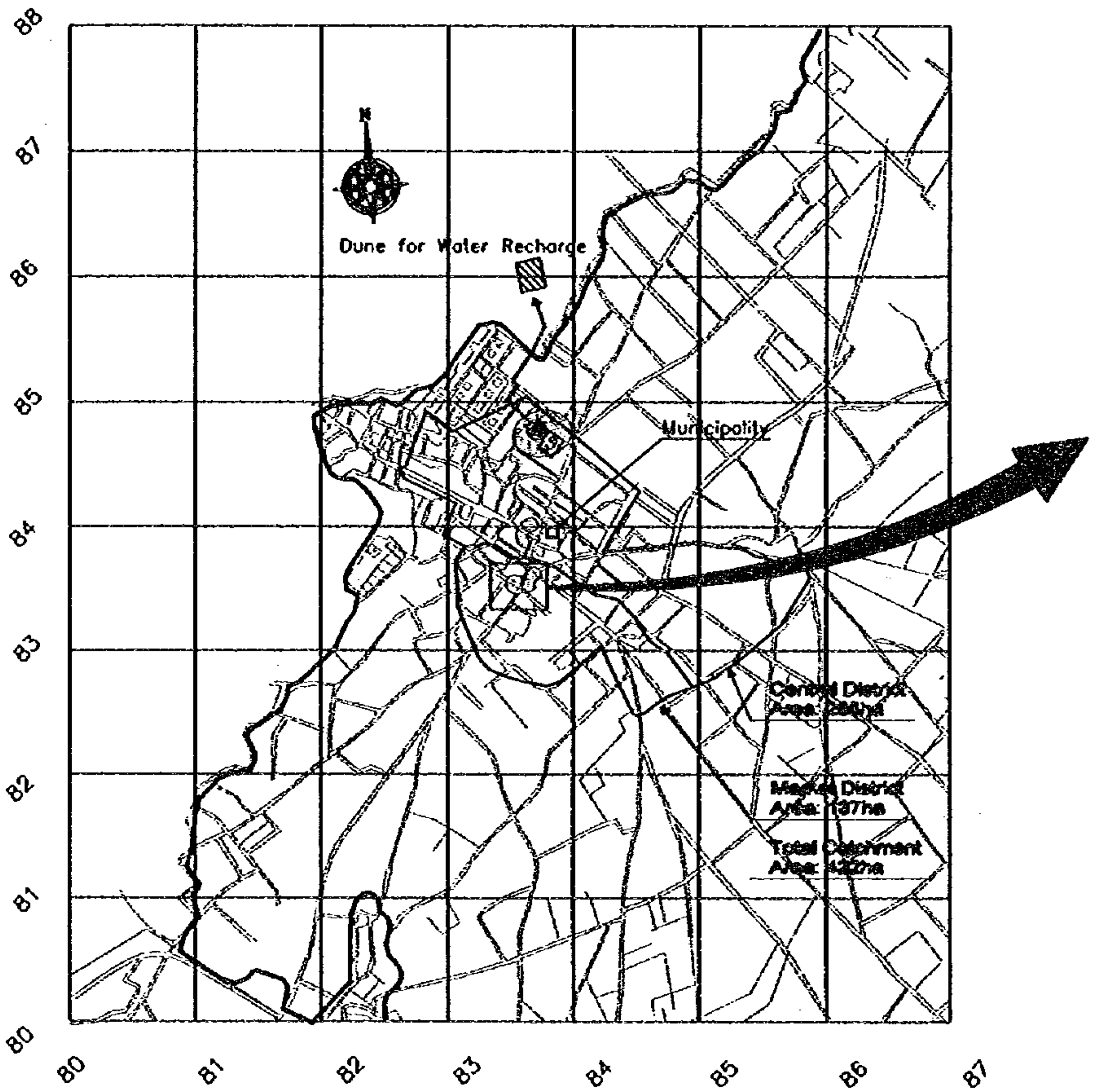
All the storm water flowing to the market district and the central district will finally be collected at the El Katibah pump station (PST 3) and pumped to the sand dunes where the storm water easily infiltrates to the ground.

(1) Data background

a. Topographical data.

In order to determine the slope of catchments and the elevation of streets and to compute the storage volumes in the depressed areas topographical data of the possibly affected areas were needed.

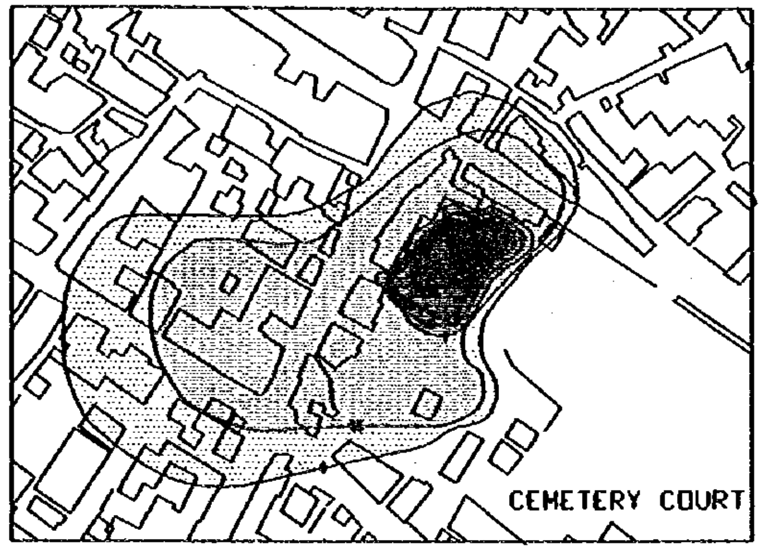
Topographical surveys were performed in several stages with different degrees of resolution and by different consultants. The topographical data utilised in the drainage model were based on the following sources of information.



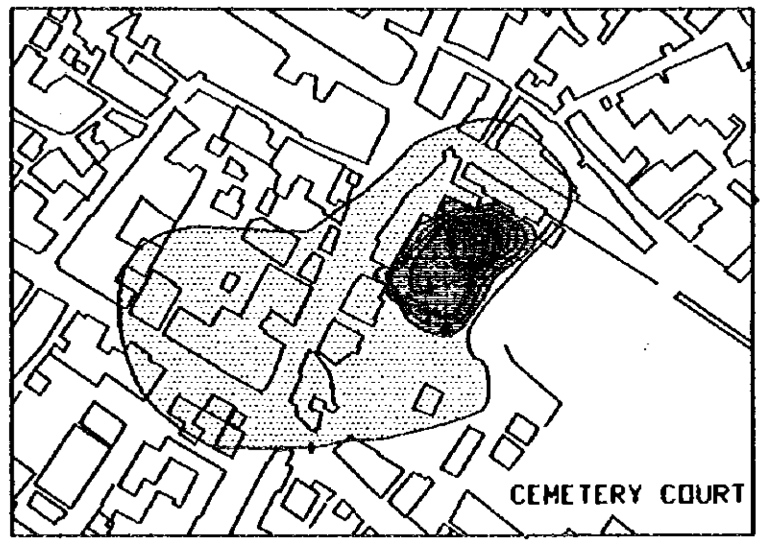
LEGEND :

- Flood Prone Area
- Pump St.
- Force Main
- Sub Surface Drain
- Retention Basin

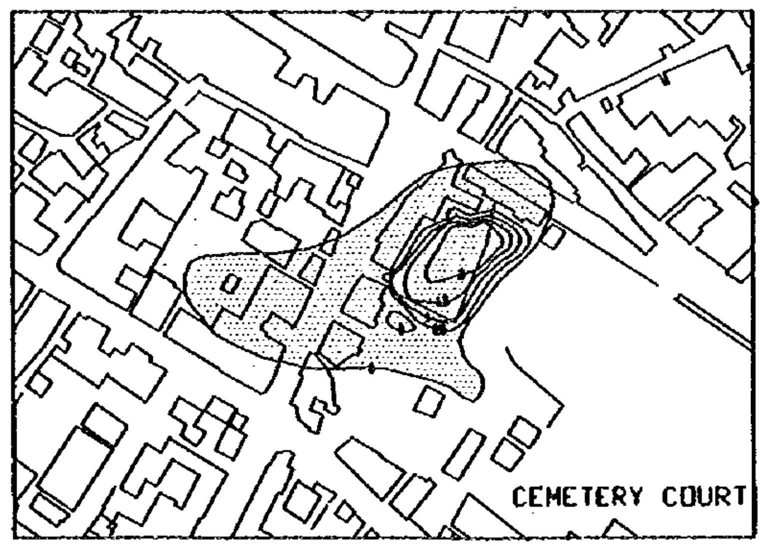
Present Flood Condition (Water Level : 36.0 m)



F/S Flood Condition (Water Level : 35.61 m)



M/P Flood Condition (Water Level : 35.28 m)



Flood Area and Flood Depth in Present, F/S and M/P Period

FIG. F.2.5

Flood Condition in Present, F/S and M/P Period

THE STUDY ON SEWERAGE DEVELOPMENT PLAN IN THE AREA OF KHAN YUNIS IN PALESTINIAN INTERIM SELF-GOVERNMENT AUTHORITY

JICA

JAPAN INTERNATIONAL COOPERATION AGENCY
AD 1997

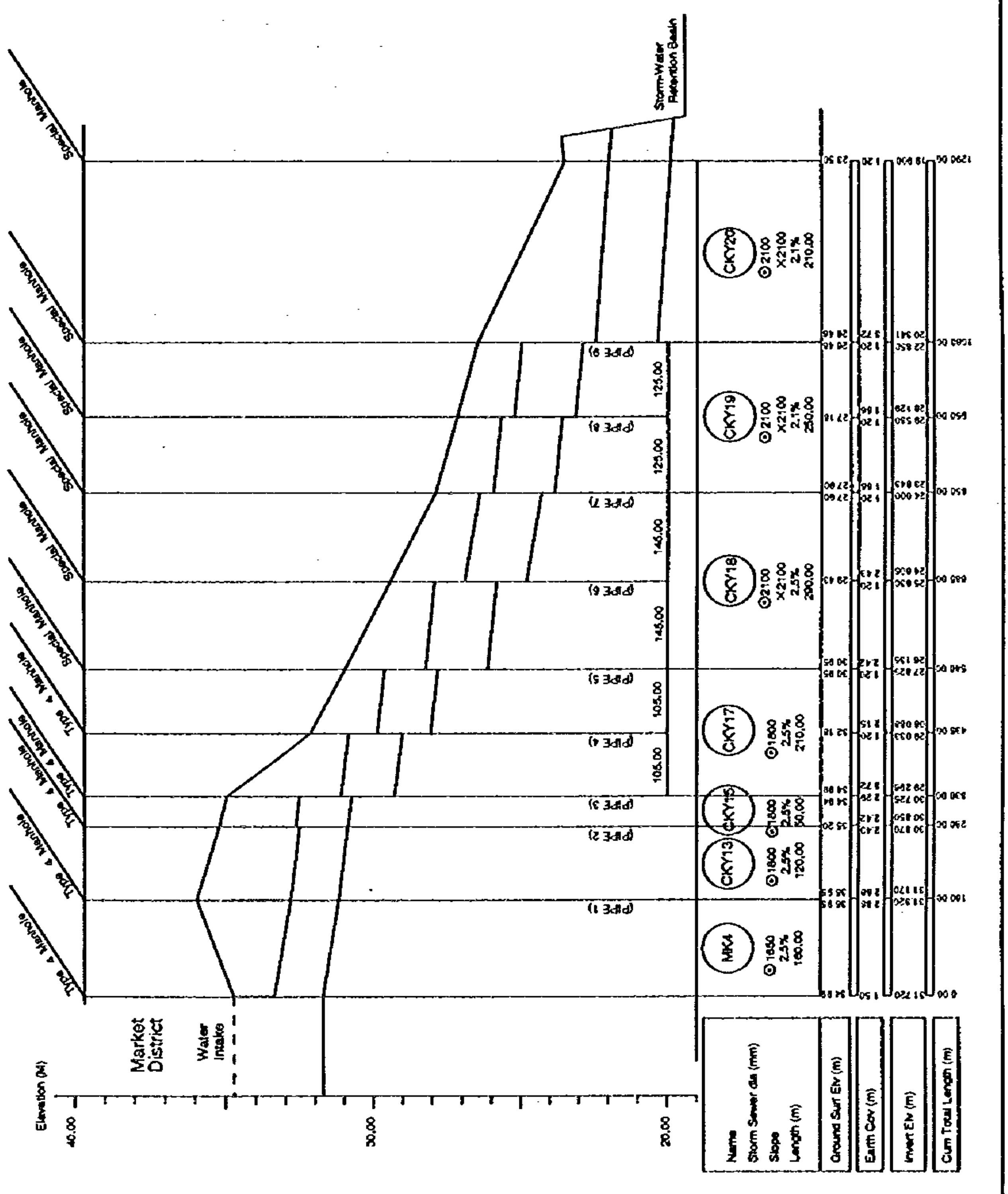


FIG. F.2.6 DRAINAGE PROFILE

THE STUDY ON SEWERAGE DEVELOPMENT PLAN IN THE AREA OF KHAN YUNIS
IN PALESTINIAN INTERIM SELF-GOVERNMENT AUTHORITY

JICA

AD 1997

(i) Aerial photographs (stereo pictures) taken at the altitude of approximately 500 metres. AutoCad maps to a scale of 1:5000 were produced. These maps contained iso-contour lines at every 2 metres depth variation, indication of roads, houses and other land use types.

(ii) A detailed topographical survey around the flooded part of the market district with 38 level points.

(iii) A detailed topographical survey of the major streets of Khan Yunis.

(iv) A detailed topographic survey along the Jamal Abd Nasr street and around the location for the drainage pump station and retention basin.

How and where the different topographical measurements were utilised in the model is more detailed described in the Supporting Report Appendix I.

b. Meteorological data

Only general meteorological data such as daily and monthly precipitation, temperature, humidity, evaporation and wind directions were available. Records of 16 years or longer has been measured at the Gaza Meteorological Station.

c. Rain data

No short duration rainfall intensity data exist, and rain events were constructed from design storms. Monthly and yearly precipitation has been recorded by the meteorological station of Gaza City over a period of 14 years. Monthly average precipitation is shown in Table F.2.16 below :

Table F.2.16 Average Precipitation

(unit: mm)

Month	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
Precipitation	71	77	34	34	2	1	0	0	2	16	66	66

Source : Gaza Meteorological Station.

The storm water drainage system planning and design, will be based on a 5 years recurrence rain event with intensity-duration curves extracted from the

Dorot meteorological station in Israel. The five year recurrence rainfall intensity - duration relationship is shown in the table below :

Table F.2.17 Storm Water Intensity

Duration (min)	18	24	36	48	60	120	180	360
Intensity (mm/hr)	46	38	30	25	22	14	10	6.8

Source : The Dorot meteorological station in Israel.

The design rain event is shown on Figure F.2.7. The rain depth for the design storm is 32.7 mm.

d. Evaporation

The monthly average evaporation rates for a 25 years period is shown in the table below.

Table F.2.18 Evaporation

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Evaporation (mm)	63	73	94	116	133	136	174	138	125	114	91	79

Source : Israel Meteorological Service (Atlas of Israel 1985)

Since the most intense rain events occurs in the wettest period (Dec. - Feb.), the evaporation rate applied to the drainage model is set to the average value for these 3 months i.e. 72 mm/month = 2.8×10^{-8} m/s.

e. Soil data

A soil survey was conducted at the location of the future treatment plan, app. 7 km from the city center. Four boreholes uniformly distributed around treatment plant site were taken. The purpose of the survey was to determine the surface permeability. The average permeability rate were determined to be $k = 7 \times 10^{-6}$ m/s.

(2) Model development

The model development can be split into the following activities.

(i) Catchment description, i.e. determination of which land surface characteristic types should be applied and accordingly the hydrological losses for each surface type.

(ii) Division into sub-catchments and determination of area, slope, length and distribution of land surface characteristics for each sub-catchment.

(iii) Determination of urban development up to year 2015, in order to forecast the future run-off.

(iv) Construction of dynamic Pipe flow model based on maps of major roads (paved roads and large gravel roads).

a. Catchment description

MOUSE Run-off Model B offers the option to give a detailed description of the surface characteristic of each catchment. All together five different surface characteristics are available. For each surface type specific values of Manning numbers and hydrological losses such as evaporation, wetting, infiltration and surface storage can be specified.

Generally, the evaporation is constant and independent of the precipitation. The wetting is a discontinuous loss. When the precipitation starts, a part of the precipitation is used for wetting of the surface, if the surface is initially dry. The wetting loss is set to zero as soon as the surface has become wet.

The infiltration is the loss to the lower ground caused by the porosity of the catchment surface. It is assumed that the infiltration rate starts when the wetting of the surface has been completed. The infiltration is described with the Horton's equation which is further described in the supporting report.

The hydrological losses are subtracted from the precipitation in order to extract the effective precipitation. If the effective precipitation is negative, a zero value is assumed.

The following land surface characteristics are applied in the Khan Yunis drainage model : (1) paved areas, (2) green areas, (3) sand areas, (4) houses draining to paved areas, (5) houses draining to sandy areas.

The table below summarizes the hydrological losses for each surface characteristic type.

Table F.2.19 Hydrological Losses on Catchment Surfaces

Surface Characteristic type	Paved area	Houses draining to paved roads	Sand area	Houses draining to sand roads	Green area
Catchment group in MOUSE	A	B	D	E	F
Parameter type in MOUSE	Impervious surface (roof)	Impervious surface (flat area)	Semi-pervious surface (big infiltration)	Semi-pervious surface (small infiltration)	Pervious surface (planted + unplanted)
Evaporation loss (m/s)	$0.28x10^{-8}$	$0.28x10^{-8}$	$0.28x10^{-8}$	$0.28x10^{-8}$	$0.28x10^{-8}$
Wetting loss (mm)	1	1	1	1	1
Storage loss (mm)	-	10	5	10	10
Start infiltration rate (m/s)	-	-	$3x10^{-6}$	$3x10^{-6}$	$3x10^{-5}$
End infiltration rate (m/s)	-	-	$2x10^{-6}$	$2x10^{-6}$	$2x10^{-6}$
Exponent (s^{-1})	-	-	$1x10^{-4}$	$1x10^{-4}$	$1x10^{-4}$

The hydraulic routing of the surface run-off is simulated by using a kinematic wave description. This requires a specification of the a length and slope for each catchment and the roughness for each surface characteristic type in terms of the Manning's number. The table below gives an overview of the applied Manning's numbers for the different catchment surface characteristic.

Table F.2.20 Roughness for each Catchment Surface

Surface Characteristic type	Paved area	Houses draining to paved roads	Sand area	Houses draining to sand roads	Green area
Manning number ($m^{1/3}/s$)	45	45	30	30	12

The hydraulic process is described with the kinematic wave equations for the entire surface at once. This description assumes uniform flow conditions, i.e. equal water depth over the entire surface of eertain category (a so-called non-linear reservoir model). For details refer to the Supporting Report.

b. Division into sub-catchments and determination of surface characteristics

The total area contributing to the market district is 137 ha., which were split into 34 sub-eatchments. The total area contributing to the central district were 285 ha., which was more coarsely divided into 30 sub-catchment. I.e. totally the sum of model area were 422 ha divided into 64 sub-catchments.

Determination of the surface characteristics for each sub-catchment was derived from respectively aerial photographs and AutoCad files (which were extracted from aerial photographs). An overview of the catchments and the composition of the catchment surface characteristics in 1997 is shown on Figure F.2.7.

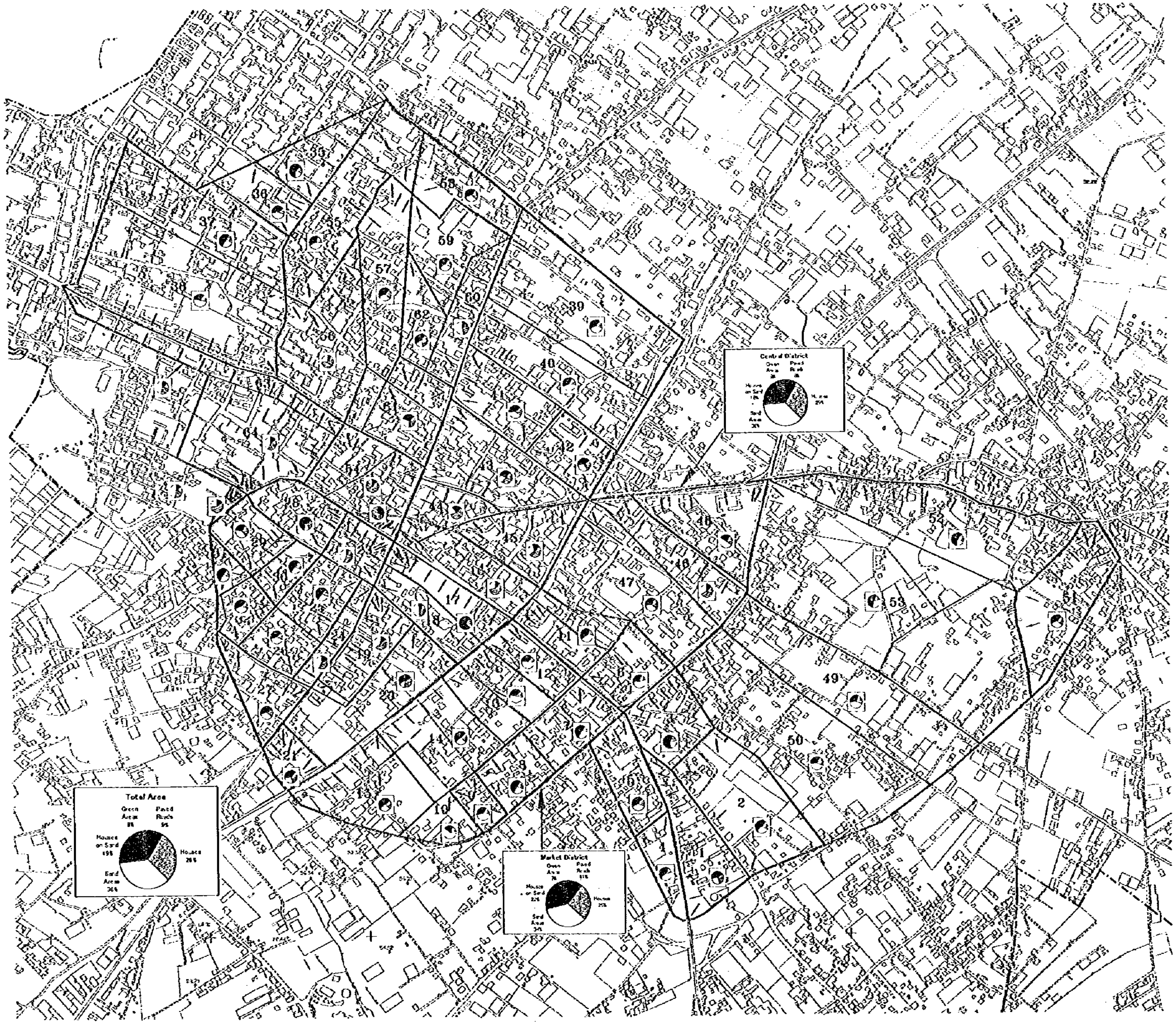
c. Forecasting the urban development

The Master Plan operates with the target year 2015, i.e. the drainage system must be able to meet the demand for drainage facilities in this year. The degree of urbanisation was expected to increase significantly from 1997 to 2015. An increase in the degree of urbanisation will create more intensive run-offs during storms.

It was estimated that the residential areas will double and the area utilised for paved surfaces would triple within the study area. Accordingly green and sandy areas were decreased, so the total area were kept constant within each sub-catchment.

An overview of the forecast of catchment surface characteristics for the M/P target year 2015 are shown on Figure F.2.9.

The 64 catchments were split into smaller catchments, so the inflow to the Pipe flow model were more continuously distributed along the catchment boundary.



N

Catchment Surface Characteristics

Legend

Flow direction on catchment

Central district catchment

Market district catchment

SCALE 1 : 5000

FIG. F.2.7

DISTRIBUTION OF CATCHMENT SURFACE CHARACTERISTICS YEAR 2015 APPLIED FOR URBAN DRAINAGE MODELING

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d. Creation of pipe-flow model

The transportation on the road surface is described by the dynamic MOUSE Pipe flow model. The Pipe flow model was based on AutoCad files, containing data of major roads.

For the free-surface drainage, such as roads, artificial man-holes were inserted when the cross-section shape change, if the slope changes significantly, when there is a junction or if the horizontal curvature deviates significantly from a straight line. Man-holes have been defined at approximately every 50 metres.

The Pipe flow model of the drainage network (i.e. the roads), has not been changed when forecasting the drainage systems behavior into year 2015. No plans of future road constructions were available and the influence of changing the network seems to be very limited, contrary to the effect of the change in the catchment surface characteristics which plays an important role.

Detailed description of the volume as a function of the water level has been defined at the flooded area around the market place. The description has been based on the local topographic survey[1].

The volume has been changed slightly going from the present condition to the M/P model. The intake will be placed in the public street where the lowest level is 35.00 m, and volumes below this level has accordingly been ignored in the M/P model.

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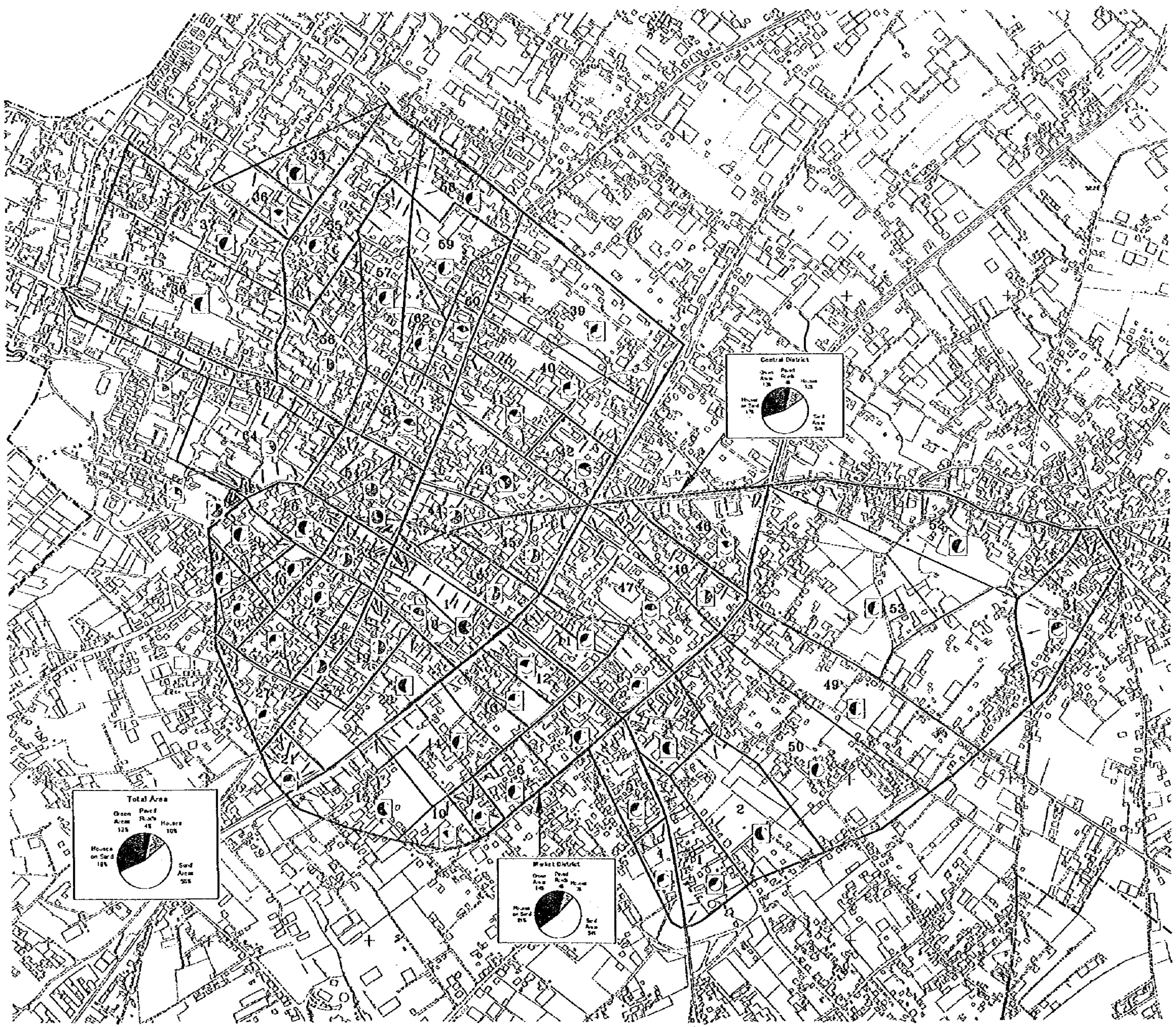
[1] Cross-sections at every 20 m around the flooded area of the market place were given as input to a MIKE 11 model. The volume as a function of the water level were accordingly extracted.



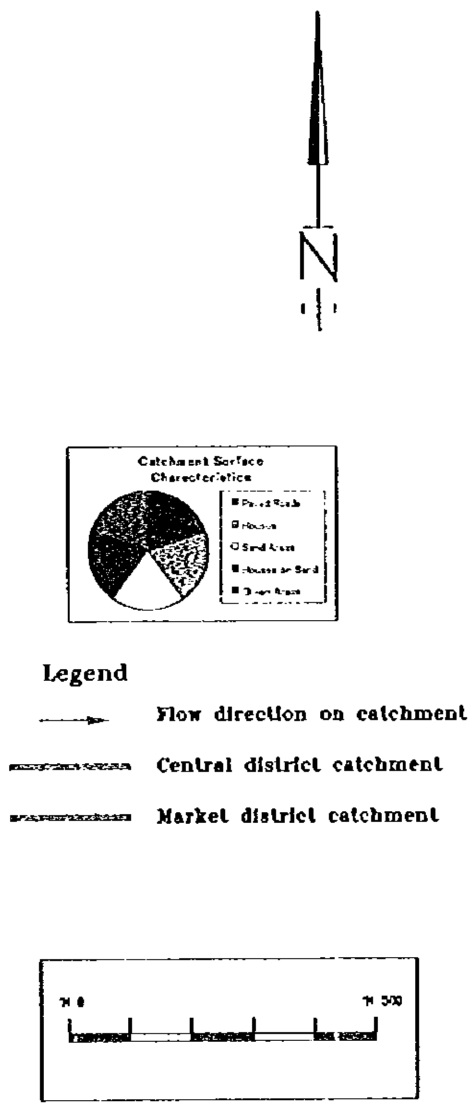


FIG. F.2.8

DISTRIBUTION OF CATCHMENT SURFACE CHARACTERISTICS YEAR 1997 APPLIED FOR URBAN DRAINAGE MODELING

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(3) Design criteria

The design criteria for the drainage system is thoroughly described in Chapter 4 of Volume II "Main Report".

The following objective were set for respectively the F/S and the M/P with respect to the drainage system :

(i) At the F/S stage : Pipes are designed to take the flow at M/P stage. An orifice will reduce the inflow. In this way the overflow at pump station P3 is prevented. One metre flood above the local lowest point is still permitted at the market place. Simulations are carried out with M/P catchments, the actual run-off and flooding at the F/S target year (2006) is expected to be lower.

(ii) At the M/P stage : The orifice will be removed. The inflow to the pump station P3 will increase and additional pump capacity will be installed. Not more than 300 mm flooding above the lowest point is allowed anywhere.

(4) Simulation results

The following simulation scenarios were carried out :

- Present condition, i.e. surface characteristics as in year 1996, no drainage system.
- Surface characteristics as in year 2015, sub-surface drainage as in F/S stage (i.e. limited flow through an orifice and 3 m^3/s pump capacity).
- Surface characteristics as in year 2015, sub-surface drainage as in M/P stage (i.e. no orifice and 6 m3/s pump capacity).

a. Present condition

The present condition is an important scenario, since this can be compared with the impact from recent flood events. Inspection on the site gave information about the level of the last flood[2]. This was determined to be at approximately the level at 35.80 m, i.e. 0.8 m above the lowest street level.

[2] The flood levels from last flood event could be seen from marks on the house walls.

From eye witness explanations floods of this magnitude had a frequency of 1 to 2 times per year.

As it can be seen from Figure F.2.5. A good agreement with the simulation results and the records of the flood level.

b. F/S stage condition

The F/S stage condition is assumed that an open area near the local lowest point will remain unused and a certain storage capacity can be expected in there. The flow from the market area can be limited with an orifice through a conduit to the site of El Katibah (PST 3).

There will be installed with only two pumps at PST 3 to pump storm water from the retention basin to the near-by dune.

This condition is assumed to allow a water level by 0.61 m above the intake. However this kind of flooding will not be visible even once in five years. The flooding areas can be seen in Fig. F.2.5.

c. M/P stage condition

This is the final condition of the project, when it is completed, assuming that there will be already some buildings in the open area near the local lowest point. The storage capacity cannot be expected any more. By installing the pumping capacity at PST 3 at El Katibah, the flooding condition will be ultimately improved by allowing only 0.28 m water level above the intake. There will be no need for the orifice to be used. The flooding areas, though invisible are shown in Fig. F.2.5.

2.6.4 The Sewerage Model

Currently no sewer system[3] exists in Khan Yunis. The present sanitation system consists only of cesspits and septic tanks, which are leaking and contaminating the ground water. The contamination is seriously effecting the public health. The aim is to formulate a Master Plan (M/P) of the sewerage system up to year 2015, and to conduct a feasibility study (F/S) for the priority project with implementation in year 2006.

[3] A separate sanitary sewer system was previously planned by the Israeli government in 1977 and part of the system constructed. The work was never finalized and reuse of the old system has been excluded.

The F/S area covers the larger parts of the Khan Yunis district (690 ha.) and the Bani Sohaila district (184 ha.). The total area to be cover at the F/S stage is 874 ha. It is expected that the population within the Feasibility Study will grow to 158,500 in year 2006.

The M/P area covers all Khan Yunis district (1644 ha.), Kizan area (519 ha.), Bani Sohaila (404 ha.), Abasan Kabera (404 ha.), Abasan Saghera (89 ha.), Qarrara (443 ha.) and Khuza (129 ha.). The total area will be 3,632 ha. and the population within this area is expected to be 476,600 at year 2015.

Two MOUSE Pipe flow models covering respectively the F/S and M/P area were accordingly created.

The F/S model is a more detailed model, consisting of 622 man-holes. This model were not used on the designing stage, since it was too detailed and too large for performing a vast amount of simulations needed at the designing stage. The F/S model served as a check model after the design.

The M/P model is a more coarse model containing only description of the principal collector network. The M/P model consist of less man-holes of 370, even though the model covers a much larger area than the F/S model. A preliminary M/P design were outlined using the rational method.

(1) Data Background

a. Network data

Network data for the M/P model was initially originated from a preliminary design achieved by application of the rational method. The design were afterwards optimised by using the fully dynamic MOUSE Pipe Flow model, so the network data were correspondingly changed during the work.

The F/S model was a sub-model to the M/P model. It was created as a more detailed model for the investigation of the sewerage systems behavior with the F/S inflow.

All ground levels were, for both F/S and M/P model, based on the levels extracted from aerial photographs (see topographic survey under Table F.2.21). Levels from aerial photographs were the only available data covering the whole study area, at the time of the model development.

The table below summarizes the key numbers from the two models.

Table F.2.21 Key Numbers for the F/S and M/P Model

Model	Pipe length (km)	Volume in pipes (m^3)	Area coverage (ha)	No. of population	No. of manholes	No of pipes	No. of catchment
F/S	32.5	11,002	874	158,500	622	620	88
M/P	73.6	14,550	3,632	476,600	370	365	327

b. Boundary conditions

The boundary conditions consist of wastewater flow only. Infiltration has not been considered, since the ground water elevations are generally low.

Illegal drainage connections to the sewerage system from houses must accordingly be avoided, since this can cause surcharge to the ground during rain events.

The daily average wastewater production was measured at 95 l/capita/day (1997)[4]. The assumption is, that the daily average wastewater production will increase to respectively 101.6 l/caita/day (2006) and 112 l/capita/day (2015). These figures has been applied in the F/S - model and the M/P - model as appropriate.

The study team projected the future population growth based on a study conducted by MOPIC as follows :

- From 1997 to 2000 6.5 % p.a.
- From 2001 to 2005 5.0 % p.a.
- From 2006 to 2010 3.5 % p.a.
- From 2011 to 2015 3.0 % p.a.

This gives an increase in the population of 60 % at the F/S stage and 112 % at the M/P stage.

The industrial wastewater is very limited and is estimated to be insignificant. There are 136 small factories employing 1186 workers. Only 39 factories produce industrial wastewater in the range from 0.5 to 10 m3/ day.

[4] The 95 l/capita/day is estimated by MOPIC. Measurements of waste water production from households in Khan Yunis showed an average production of 52 l/capita/day. The waste water production will typically increase once a sewerage system is installed and the MOPIC estimation was accordingly applied.

The daily wastewater flow pattern is based on a survey conducted on households scattered around in the Khan Yunis area. A detailed description of the measurement methods and results are described under Appendix A in Volume III "Supporting Report." The data from this survey have been analyzed in order to extract reliable wastewater time series. Determination of the hourly peak flow rate plays an important role in designing the sewerage system.

The daily peak flow factor reduces as larger populations are taken into consideration. The peak factor reduces due to 3 effects, these are :

(i) Reduction through the diversity in the wastewater production between different households.

(ii) Time lag due to transportation in the system, reducing the overlap between different households peak production of wastewater.

(iii) Dispersion effects in the pipes, man-holes retention basin's and pump wet-wells.

The total population of 476.000 people has been split into 327 catchments, ranging from 500 - 4000 people in size. The peak factor for each catchment will vary depending on the population size. The variation in the peak factor has been extracted from the field survey of the wastewater flow pattern and from MOUSE computations.

The change in the peak factor as a function of the population size was curve-fitted using the following formula :

$$PF = \beta \exp(\alpha P)$$

where

PF	= The daily peak factor.
P	= The population size.
α,β	= Constants.

The constants α and β are determined separately in the two regions i.e. one curve fitting for population sizes less than 475 where the diversity effect is most pronounced and another curve fitting in the region from 475 to 5000 where the effect of time lag and dispersion become more significant. The curve-fitting is based on the linear regression method.

Conclusively the peak factor could be determined from the following equation :

$$PF(P)=\begin{cases}2.95577\exp(-0.001292097P)\,for\,P<454\\ 1.65726\exp(-1.85931\cdot10^{-5}P)\,for\,P\geq454\end{cases}$$

The two lines meet at the point P = 454. The result is shown in Fig. F.2.9.

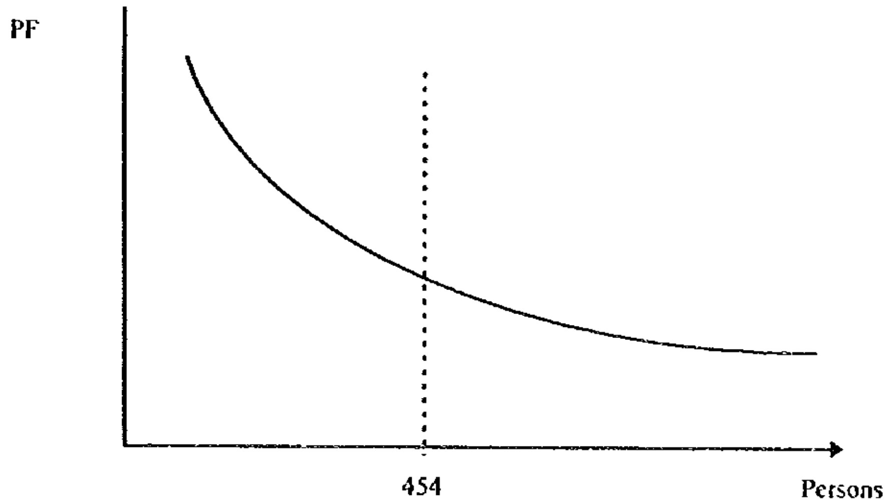

Fig F.2.9 Peak Factor Variation

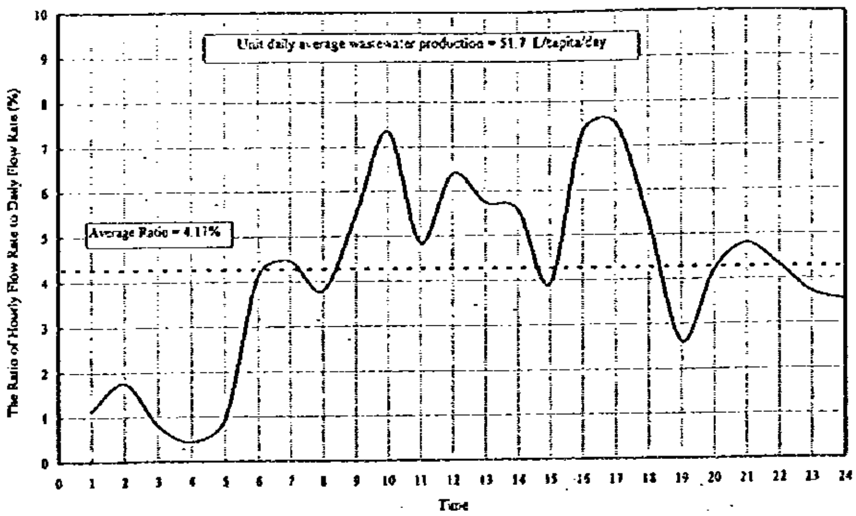

Fig. F.2.10 Daily Discharge Ratio

A computer program extract the information of the number of inhabitants for each catchment from MOUSE and generate all the boundary conditions at once, i.e. one discharge boundary for each catchment.

(2) Design criteria

The sewerage system is designed using the following design criteria :

- All pipes may not be more than 60 pct full at any time ($H_{MAX}/D < 0.60$).
- The peak factor is variable and set according to the previous section.
- The average foul flow is set to 101.4 l/day in 2006 and 112 l/day in 2015.
- The minimum velocity allowed during peak flow is 0.6 m/s
- The minimum earth cover is set to 1 m.

Pipes less than 400 mm were designed by applying the rational method, while larger pipes and pump stations were designed by MOUSE.

(3) Simulation results

- The following simulations were carried out.
- The F/S model with an average foul flow of 101.4 l/day/PE.
- The M/P model with an average foul flow of 112 l/day/PE.

The results of interest are :

(i) Pump capacities which must be utilised during the F/S and M/P stage.
(ii) How full the pipes are.
(iii) The inflow to the treatment plant.
(iv) The velocities in the pipes.

a. The F/S model

The pipes, pump stations and other elements in the sewerage system are designed using the M/P model. The F/S model is used to check how the M/P sewerage design will perform with the reduced inflow which is present during the first implementation at the F/S stage. The F/S only cover a limited part of the total area implemented during the M/P stage, but the F/S model is more detailed compare to the M/P model.

The pump capacities are mainly designed for the M/P stage, but it will be possible to implement only a limited part of the pumps for the pump stations which consist of multiple pump units, due to the reduced inflow at the F/S stage. Limiting the number of pumps is necessary in order to reduce the construction and maintenance cost. The proposed pump capacities at the F/S stage are shown in the Table F.2.22 below.

Table F.2.22 Pump Capacity at the F/S Stage

Pump station	3	4	5	8
Capacity (l/s)	125.0	7.2	132.7	297.0

The predicted pump operation during one daily cycle for pump station 3,4,5 and 8 are shown on respectively Fig F.2.11.

As expected, no sewer lines are more than 60 % full (flow depth as percentage of the pipe diameter) during the F/S stage. Most of the sewer lines are in the range of 20 to 30 % full.

The daily volume received at the treatment plant is 16130 m3, equivalent to 159,073 PE (for a waste water production of 101 l/day/PE).

The plant plot on Fig. F.2.12 show the expected velocities in the pipes during the peak flow. Some of the sewer lines have very low velocity rates. These pipe are not self cleansing and sedimentation problems might occur. It could be beneficial to analyze the sedimentation problem using a sediment transport simulation model such as MOUSE ST.

b. The M/P model

All sewerage elements such as pipes and pump stations has been designed using the M/P simulation model.

The Table F.2.23 below gives a detailed overview of the pump capacities, the number of PE connected to the pump station for the 9 pump stations.

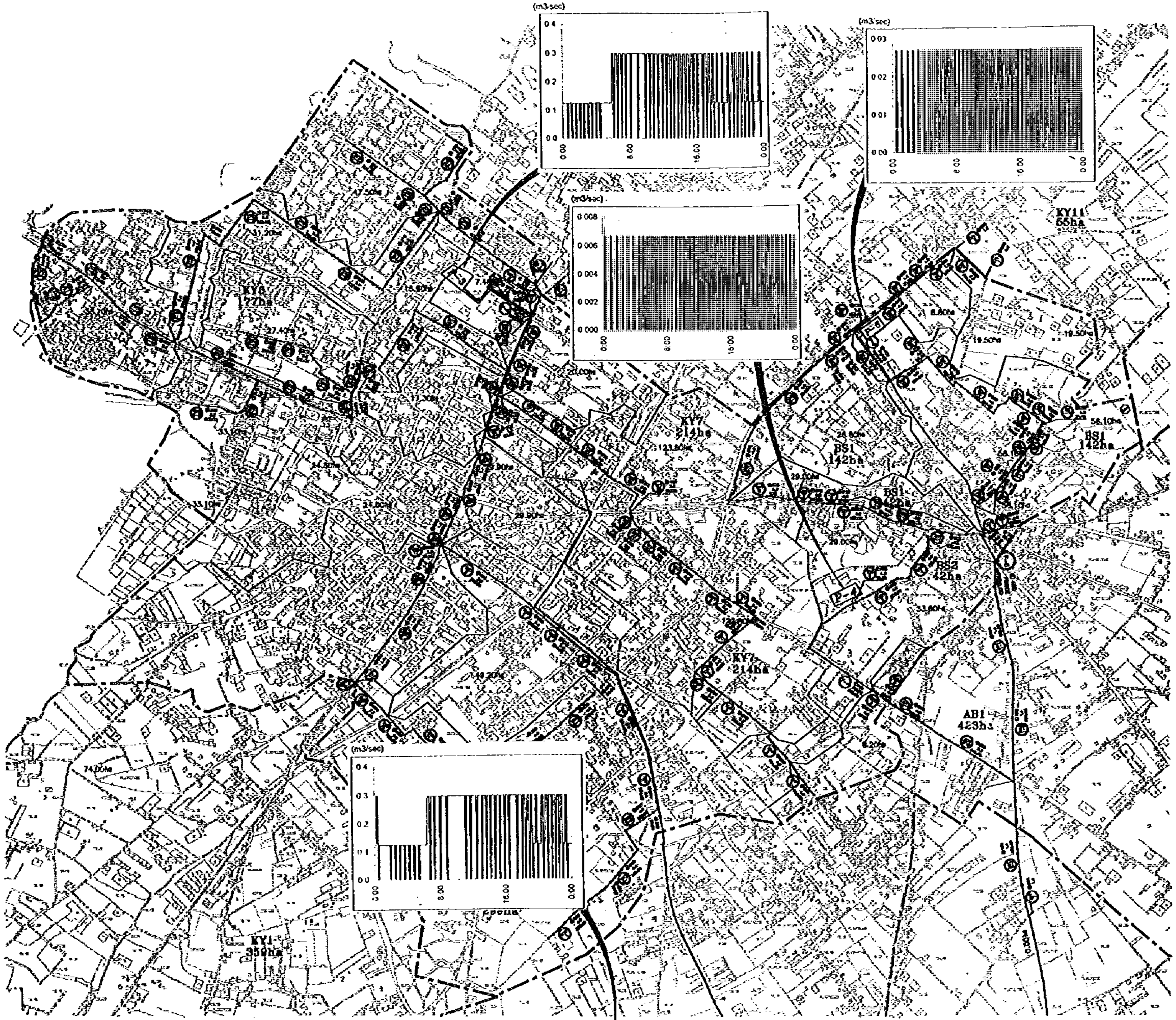

FIG.F.2.11

OVERVIEW OF PUMP OPERATION DURING F/S STAGE

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Table F.2.23 Pump Capacity at the M/P Stage

Pump station	1	2	3	4	5	6	7	8	wwtp
Capacity (l/s)	80	66	478	7.2	133	22	70	936	965
PE	38,834	33,104	291,973	3,585	18,343	11,898	34,076	417,052	476,413

The predicted pump operation during one daily cycle for the pump stations 1-8 are shown on Fig F.2.14. The pump station at the WWTP is not included in the simulation model. Pump station 3 and 8 are split up in two separate plot, since these pump stations consist of more than three units which is the limit for a pump station in MOUSE. Accordingly the total flow can be found by superposition of the two curves.

The daily volume received at the treatment plant is now increased to 53,280 m^3, equivalent to 475,714 PE (for waste water production equal 0.112 m^3/PE/day).

The flow depth in the sewer lines does not exceed 60 % of the pipe diameter during the M/P stage. The larger main sewers are now more efficiently utilised compare to the F/S stage, due to the higher inflow and larger population expected at the M/P stage. Most of the sewer lines are now in the range of 40 to 60 % full.

The expected velocities in the pipes during the peak flow will increase during the M/P stage and sedimentation problems will become less pronounced compare to the F/S stage.

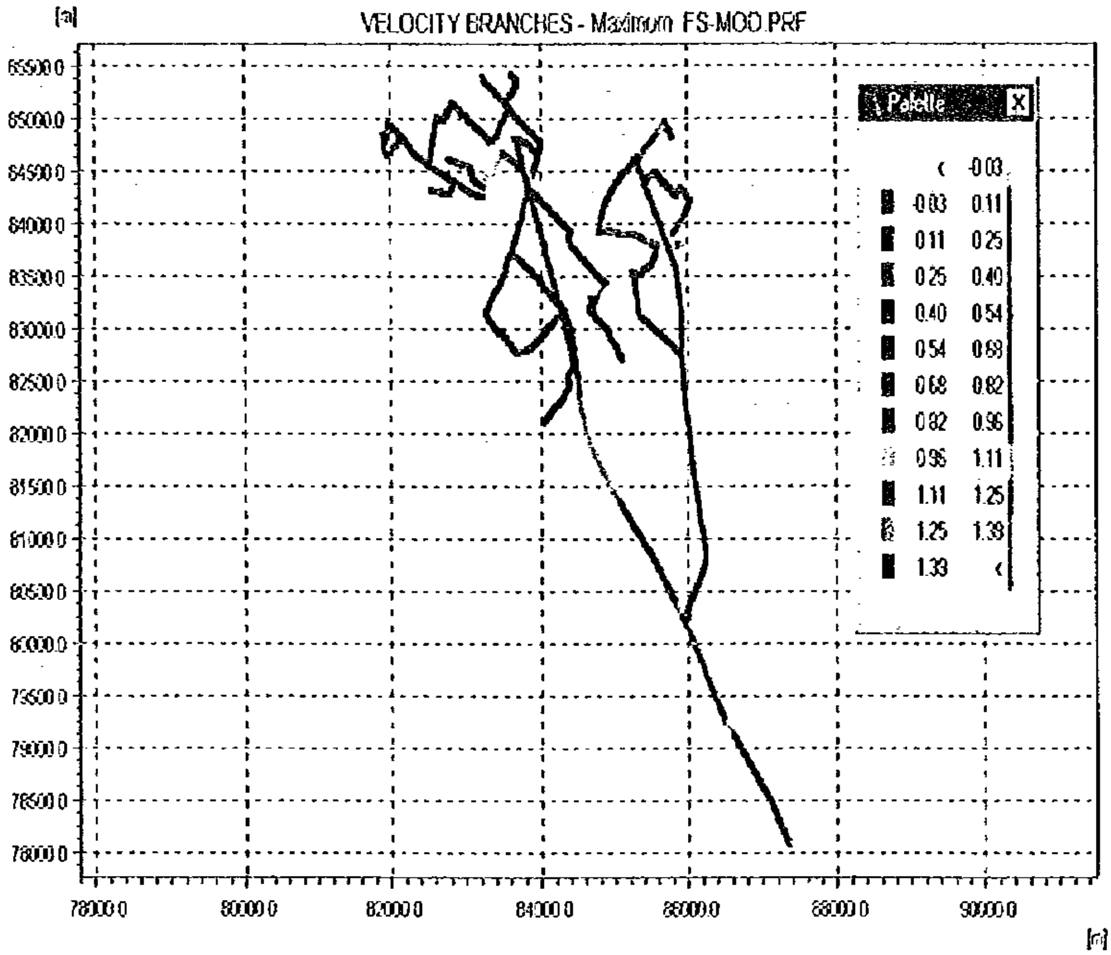

FIG. F.2.12	VELOCITY BRANCHES (MAXIMUM)

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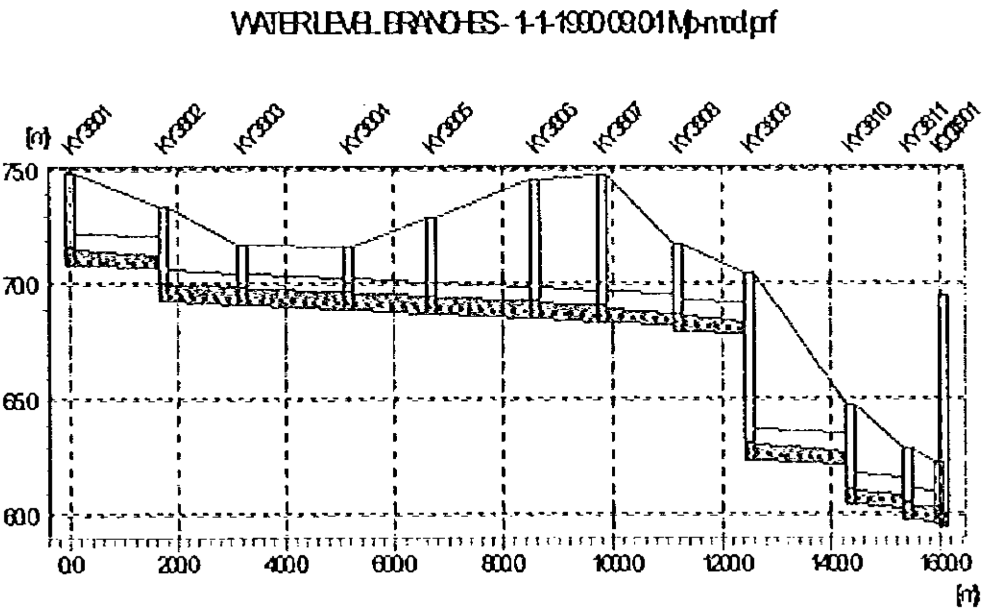

Fig. F.2.13 Longitudinal Profile of the Main Sewer Pipe Flowing into the Treatment Plant.

FIG. F.2.14

OVERVIEW OF PUMP OPERATION DURING M/P STAGE

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2.6.5 Summary

The aim of the dynamic model was to study the functionality and capability of the sewerage system and the drainage system during the two stages of implementation. These stages are referred to as the Feasibility Study (F/S) and the Master Plan (M/P), with final completion in respectively year 2006 and 2015.

The design of the sewerage system and drainage system was initially designed applying the rational method. Results from dynamic simulations should accordingly be used to optimise and validate the design.

The dynamic drainage simulation model proved to deliver reliable results such as flood levels in the low-lying areas, which could be verified from measurements of previous flood levels, despite the lag of short term rain intensity curves.

A solution with a sub-surface drainage pipe connecting the flooded market district of Khan Yunis with El Katibah pump station, pumping storm water to the sand dunes proved to be the most feasible solution.

Design of pump station capacity as well as drainage pipe sizes were validated by the dynamic model.

The two sewerage simulation models (the M/P and the F/S model) increased the understanding of the system. A combination of analyzing the boundary conditions (waste water production) as well as the reduction in the peak factor of the daily waste water flow during the transportation in the sewerage system proved, that significant construction and maintenance cost could be saved on pipes lines and pump capacities compared to the sewerage system initially designed by the rational method. The design was accordingly adjusted.

Several parts of the F/S main pipe lines are designed with M/P inflow data. This shall avoid replacement of pipes constructed during the F/S-stage when the M/P-stage is implemented. The pipes at the F/S stage will therefore be larger than required. Simulations with the dynamic model shows that velocities are generally low during the F/S-stage, which can cause sedimentation problems. It is recommended to study the sediment transport problems before the final implementation, since the maintenance might be considerable.

CHAPTER 3 FACILITY/EQUIPMENT PLAN OF SANITATION IMPROVEMENT

CHAPTER 3 FACILITY / EQUIPMENT PLAN OF SANITATION IMPROVEMENT

3.1 Present Condition

Present sanitary condition of the Study Area is identified as shown in Table F.3.1, based on 600 household interview and survey and Municipality interview survey conducted by JICA Study Team.

Table F.3.1 Sanitary Condition

Study Item	Result	Remarks
Toilet Existence	99 %	
Sharing of Toilet with other household	5 %	95 % of household has own toilet.
Toilet Type Leaching pit Septic Tank	 95 % 5 %	 Dia.: 2~2.5m, Depth : 5~6m (about 15~20m^3)
Graywater Disposal Leaching pit Street, garden and etc.	 65 % 35 %	
Desludging Frequency	once per 1 day ~ 4 year	Once per 2 - 4 weeks in average
Desludging Charge	NIS 15 ~ 40	per each time
Satisfaction on desludging service	10 %	Majority of households (90%) is not satisfied with desludging service.
Problems facing the current system Smell Unhygienic Flooding Insects Dirty	 75 % 70 % 65 % 65 % 60 %	

Source: JICA Study Team 1997

Desludging service in the Study Area is now provided responding the household request both by public sector and private sector using vacuum trucks. At this time private sector service is not controlled by public sector, each service is conducted independently. Number of vacuum trucks of public sector is 10 trucks and 18 trucks of private sector, with the total of 28 vacuum trucks as shown in Table F.3.2.

Private sector owning vacuum trucks is all independent as one owner operates or maintains one vacuum truck.

Normally desludging is conducted with two trips for one leaching pit, one trip desludging 5 m^3 of septage from cess pit by vacuum trucks and taken to disposal site. The normal desludging charge is NIS 15 for one trip, so normally NIS 30 for two trips by municipality. But desludging charge of private sector is about NIS 25 for one trip as shown in Table F.3.2.

3.1.1 Cess Pits

Leaching pits have been used for the sanitary facilities in Khan Yunis for about 30 years. The system is assembled of concrete block (12cm wide, 47cm long and 25cm high), as shown in Figure F.3.1. The construction method is like caisson method or vertical excavation method, as the blocks are installed as segments. The blocks are assembled with mortar above ground level to be about 2.5m cylinder of about 1 m high. The cylinder is settled by gravity after the inside soil of the cylinder is dug out. Then again the blocks are assembled on the assembled cylinder and the digging soil is continued. The process is continued up to the around 5m depth.

One cess pit is constructed within about 3 days and the cost is about US$ 800.

There are another type of cess pit which is about 60cm in diameter, about 10m deep made of used steel dram with holes. Installation ratio of this type of cess pit is not high comparing with the other one. And the cess pit was prohibited in 1996 as they might deteriorate the groundwater aquifer as the installation depth is too deep. At present only the 5m depth leaching pit is constructed.

But there is no regulation according to the cess pit such as volume of leaching pit, corresponding number of users or location of the installation. Today the cess pits are constructed by the house owner without any control. This situation will interfere with urban amenities such as sewer installation of the sewerage system, as they are often placed under public road beside the house.

Usually one household family size is about 8 and one cess pit serves for about 2 to 3 households.

3.1.2 Desludging

Desludging service is conducted with using vacuum trucks. There are two location for septage disposal site is shown in Figure F.3.2. One is near the refugee camp served for the Municipality of Khan Yunis, Kizan area and Bani Sohaila. The other one is near the Khuzaa beside the border of Israel served for the Municipality of Abassan Kabera, Abassan Saghera, Qarrara and Khuzaa. There was another disposal site near Village of Qarrara, which was used until 1996. But today the service is stopped as the land owner does not accept further use of the land as septage disposal site.

Camp sludge disposal site is only about 200m from the nearest residential area. It is noticed that there is good aquifer around the camp area. Although it is important that the aquifer should be protected from the pollution caused by the disposing septage there, there are no alternative locations. So, since the Qarrara disposal site was closed, septage has been disposed at the one near the Camp.

Desludging frequency is about once in two weeks to once in 4 years. But in some cases there are cess pits desludged every day. It is noticed that first desludging is conducted after about 4 years of the construction, next desludging is conducted with following intervals, 8 months, 5 months, 3 months, 2 months, 1 month, 2 weeks and 1 week according to the Khan Yunis Municipality interviewed by JICA Study Team. At the study area ground soil consists of generally sand so that wastewater can infiltrate into the ground without overflow. Typical case study is described below regarding to infiltration of wastewater and sludge accumulation,

No. of users 8 p/household x 3 household/cess pit = 24 person

Cess pit (leaching pit)	size	:	Dia. 2.5m, depth 5m
	volume	:	24.5m^3
	surface area	:	44.2m^2 (total), 4.9m^2(bottom)

Inflow of wastewater generation into a cess pit

80 liter/c/d x 24 p =1,920 l/d

Required permeability to infiltrate without overflow

1,920 l/d / 44.2m^2 = 0.043 m/d

Sludge accumulation 40 liter/c/y x 24 p =960 liter =1 m^3/y

5 years accumulation is about 5 m^3

As described above, required permeability is about 0.04 m/day which is less than the sand permeability, about 0.5 to 1 m/day, so the influent wastewater can easily infiltrate into ground at initial stage. And the sludge is generated about 5 m^3 after 5 years, that occupies the volume about one fifth so it does not affect infiltration system so much. On the other hand after about 4 years the leaching pit require the desludging as the ground surface becomes wet and smell and sometimes overflow. After 5 years of the construction the intervals of desludging is about 3 month. The ground permeability is estimated as below,

Remaining volume and surface of leaching pit

Volume : 24.5 m^3 - 5 m^3 = 19.5 m^3

surface area : 4 x 2.5 x 3.14 = 31 m^2 (except bottom)

Permeability after 5 years

(1,920 l/d x 3 m x 30d - 19.5m^3) / 31 m^2 / 90d = 0.05 m/d

As mentioned above after 5 years of the construction the ground permeability is decreased about less than one tenth after the long use of cess pit. It is identified that when the wastewater is continuously flown into ground, organic maters fill up the spaces of soil and the permeability decrease. It is also identified if the wastewater flow is stop and the ground become dry, the permeability recovers as the initial value.

Frequency of desludging normally increases in summer season (May to October) as temperature is high so water consumption increases comparing to winter season. However at some low area the frequency is high in winter season that is also rainy season as ground is saturated by rain water.

House owner usually requests the vacuum truck for desludging, when the ground surface around the leaching pit become wet, smell or overflow. The desludging service is managed by Public Health Department which is also responsible for solid waste management in Khan Yunis. There is a regulation in Municipality of Khan Yunis: when overflowing leaching pit is found, the Municipality can order the household owner to request the desludging. If the owner does not accept it, the owner is taken to court and charged NIS 50.

According to the JICA Study Team survey as shown in Table F.3.2, the total No. of trips is about 10,800 trips per year, of which 8,100 trips are to camp septage disposal site for Khan Yunis area, and 2,700 trips are to Khuzaa disposal site for eastern area. Those are equivalent to 40,500m^3 of septage disposal in Camp, 13,500m^3 in Khuzaa and 54,000m^3 as total per year.

At some households located especially in eastern area, desludging is done by household themselves and removed septage is used as fertilizer at farm.

3.1.3 Operation and Maintenance

Operation and maintenance of vacuum trucks service is surveyed to relevant municipalities and some private sectors. Number of trips and desludging frequency of cess pit per year are tabulated in Table F.3.3. According to the table the average desludging frequency is about once in 1.3 month.

According to the balance sheet most municipalities show a net loss, so the management shall be improved.

As shown in Table F.3.2 the workshop for vacuum trucks are available only in the Municipality of Khan Yunis. There are two workshop; one is old and the other one which was donated by the German Government has been in operation since 1996.

3.2 Sanitary Improvement Management

Although most of the households own toilets, sanitary condition is not that good due to overflowing of wastewater and the widely prevalent unhygienic condition caused by it. This problem might be caused by inadequate desludging work and insufficient structure of leaching pit. Wastewater other than toilet water (graywater) from household is also discharged into leaching pit (65%) or others open areas like street and garden, which might be infiltrated or evaporated.

Two (2) project components, mainly installation of sewerage system and improvement of septage management, are proposed in order to improve the sanitary condition of the Study Area. Sewerage system is planned for highly urbanized area and it is described in Chapter 2 of Main Report.

The project works of septage management improvement is comprised of two (2) segments. They are as follows.

1) Procurement of additional vacuum trucks
2) Enhancement of environmental awareness and improvement of cess pit system

3.2.1 Procurement of Additional Vacuum Trucks

It is proposed to improve the management of desludging service by increasing the number of vacuum trucks. Accordingly, the requirement of vacuum trucks is estimated based on the following basic assumptions.

1) Family size is eight (8) in one household.

2) No. of household connecting one cess pit is 2.5 households.

3) Covering ratio of desludged household is 90 %.

4) Desludging frequency is once in every one and half (1.5) months.

   a. Capacity of leaching pit is 20 m^3 (20,000 liter).

   b. Rate of wastewater accumulation is 10 liter/person/day

   c. Capacity of vacuum truck is 5 m^3 (5,000 liter).

   d. No. of trip is 2 trips (2 times desludging by vacuum truck at once)
   So desludging volume is 10,000m^3.
   Desludge volume is about half of volume of leaching pit, 20 m^3.

   e. Desludging frequency of 1.5 months is calculated as follow,
   (10,000 liter) / (10 liter/person/day) / (2.5 household/cess pit) /
   (8 person/household) = about 45 days

5) Desludging operation cycle is 6 cess pit/vacuum truck/day

   a. No. of trip is 2 trips (2 times desludging by vacuum truck at once)

   b. Number of cycle per day is 12 trip/vacuum truck/day which is equivalent to 6 cess pit/vacuum truck/day.

6) Working day in a year is 340 day based on

   (365 day/year) / (6.5 day working day / 7 day)

7) Standby allowance of vacuum trucks is 10 %.

Under the above basic assumptions and also with due consideration to the decrease in population requiring desludging service in tandem with the provision of conventional sewerage service, according to the sewerage development plan of the Master Plan, the requirement of vacuum trucks for desludging service of the whole study area is estimated as shown in the Table F.3.4.

As evident in the Table F.3.4, the required vacuum trucks of 5 m^3 capacity in 1996 becomes 47, which is much higher than existing vacuum trucks under operation of only 28. Then more realistic procurement plan of vacuum trucks, so that the number of trucks in operation by the year 1999 become 56 is proposed in Table F.3.5. This procurement plan assumes a depreciation period of 10 years for vacuum trucks, as there are some extra vacuum trucks in some years.

In the Table F.3.5 as a urgent procurement of vacuum trucks to municipalities, 5 trucks are scheduled to be procured for public sector. One vacuum truck would be delivered to each 5 municipalities of Khan Yunis, Kizan area, Bani Sohaila, Abassan Kabera, Abassan Saghera and Khuzaa. Qarrara village does not have organization at present, and the village shall be served by other municipalities. Other truck requirements are schedule to be procured by private sector. In future all desludging works is planned to be conducted by private sector as an executive agency controlled by Municipality or Governorate office. No. of procurement also managed by the economic condition so the desludging charge shall be decided by economic principles.

As mentioned previously the present status of sanitation is shown in Figure F.3.2. After the First Stage of sewerage system is constructed, this sludge dumping site will be eliminated as shown in Figure F.3.3. The sludge removed from on-site systems will be discharged into the sewerage system through a pumping station or treatment plant.

3.2.2 Enhancement of Environmental Awareness

The result of the Study shows that people's awareness on deterioration of environmental sanitation is still quite low. This lack of environmental awareness is an important factor attributed to deterioration of environmental condition of the Study Area. For example, adequate frequency of desludging work would be managed by household so as not to allow overflow of wastewater from the leaching pit. These kinds of education would required by a campaign and so on.

Hence, enhancement of environmental awareness including public health education is strongly recommended as the key of environmental sanitation improvement.

In the structural point of view, it is recommended to improve the present cess pit. Now the cess pit is about 5 to 6 m deep, but it shall be elevated up to about 3m, and two cess pits shall be constructed at a distance of about 10m apart (twin leaching pit). So this type of cess pit construction cost might not be much higher than the present one. They could be used alternatively. When one is saturated, it shall be desludged and wastewater should be flown into other cess pit which has already been dried up and the infiltration rate been recovered at that time. If a twin cess pit is operated in this way, the total desludging frequency may decrease. And also the efficiency of natural soil treatment may increase without deteriorating the groundwater quality.

Table F.3.2 Condition of Vacuum Truck Service in Study Area

Name of Municipality		Khan Yunis	Kizan area	Bani Sohaila	Abassan Kabera	Abassan Saghera	Qarrara	Khuzaah
1 Existence of Organization of vacuum trucks Service		Yes	belong to Khan Y.	Yes	Yes	Yes	No served by P.	Yes
2 Covering Ratio by Municipality		40%		25%	25%	100%	0%	50%
3 Covering Ratio by Private Sector		60%		75%	75%	0%	100%	50%
4 Covering Ratio for agricultural use by farmer						3%		
5 No. of Vacuum trucks of Municipality	(trucks)	6 5m3 4pcs 7.5 m3 2pcs		1 5m3 (out of order)	1 5m3 (out of order)	1 5m3 (out of order)	0	1 5m3
6 No. of Vacuum trucks of Private Sector	(trucks)	15		3	with 5 m3 vacuum trucks are served for eastern area.			
7 Desludging Charge of Municipality	(NIS/trip)	15		15	25	20		15
8 Desludging Charge of Private Sector	(NIS/trip)	25		25	25	25	25	25
9 No. of driver in Municipality		9		1	1	1	0	1
10 No. of worker in Municipality		9		0	0	0	0	1
11 Location of septage dumping site		side of Camp site		side of Camp site	Not specified near Kuzzah	near Khuzaah	near Khuzaah	near Khuzaah
12 Existence of workshop for vacuum trucks		Exist		not exist	not exist	not exist	not exist	not exist

Table F.3.3 Vacuum Truck Service by Municipality and Private Sector

Vacuum truck service by municipaliy

Name of Municipality		Khan Yunis	Kizan Area	Sub total of KY, KA	Bani Sohaila	Abassan Kabera	Abassan Saghera	Qarrara	Khuzaa	Sub total of Eastern area	Total
1 No. of Vacuum trucks of Municipality	trucks	6	0	6	1	1	1	0	1	4	10
2 No. of Trip for once cess pit desludging	No. of trip/cess pit/once	1.7			1.7	1.7	1.7		1.7		
3 No. of Trips	No. of trip/a truck/day	10.8		10.8	6	8	20		20	54	11.9
	No. of trip/all trucks/day	65		65	6	8	20		20	54	119
	No. of trip/all trucks/month	1,811		1,811	167	206	557	0	557	1487	3298
4 No. of Working Day	working day/week	6.5		6.5	6.5	6	6.5		6.5		
	working day/month	27.9		27.9	27.9	25.7	27.9		27.9		
	working day/year	339		339	339	313	339		339		
5 No. of cess pit desludged	No. of cess pit/a truck/day	6.4		6	3.5	4.7	11.8		11.8		
	No. of cess pit/all trucks/day	38.2		38	3.5	4.7	11.8		11.8	31.8	70
	No. of cess pit/all trucks/month	1065.8		1,066	97.7	120.8	329.2		329.2	876.9	1942.7
	No. of cess pit/all trucks/year	12,950		12,950	1,187	1,471	4,000		4,000	10658	23608

Vacuum truck service by private sector

		Khan Yunis / Kizan Area / Sub total of KY, KA	Bani Sohaila / Abassan Kabera / Abassan Saghera / Qarrara / Khuzaa / Sub total of Eastern area	Total
1 No. of Vacuum trucks of Municipality	No. of Trucks	15	3	18
2 No. of Trip for once cess pit desludging	No. of trip/household/once	1.7	1.7	
3 No. of Trips	No. of trip/truck/day	15	15	15
	No. of trip/all trucks/day	225	45	270
	No. of trip/all trucks/month	6278	1256	7534
4 No. of Working Day	working day/week	6.5	6.5	
	working day/month	27.9	27.9	
	working day/year	339	339	
5 No. of cess pit desludged	No. of cess pit/a truck/day	8.8	8.8	
	No. of cess pit/all trucks/day	132.4	26.5	158.9
	No. of cess pit/all trucks/month	3,694	739	4433.4
	No. of cess pit/all trucks/year	44,884	8,984	53868

Total vacuum truck service

		Khan Yunis	Kizan Area	Sub total of KY, KA	Bani Sohaila	Abassan Kabera	Abassan Saghera	Qarrara	Khuzaa	Sub total of Eastern area	Total
No. of cess pit desludged a year											
by municipality	No. of cess pit/all trucks/year	12,950		12,950	1,187	1,471	4,000		4,000	10,658	23,608
by private sector	No. of cess pit/all trucks/year			44,884						8,984	53,868
Total	No. of cess pit/all trucks/year	12,950		57,834	1,187	1,471	4,000		4,000	19,642	77,476
Family(household) size	people/household	8	8		8	8	8	8	8		
No. of household per a cess pit	No. of household / cess pit	3	2		2.5	2	2	2	2		
Population in 1996	No. of people	132,700	4,700	137,400	16,900	11,600	5,500	11,100	6,200	51,300	188,700
No. of household in 1996	No. of household	16,588	588	17,176	2,113	1,450	688	1,388	775	6,414	23,590
No. of cess pit for household	No. of cess pit	5,529	294	5,823	845	725	344	694	388	2,996	8,819
Ratio of No. cess pit (public/household)		15%	10%		10%	10%	10%	10%	10%		
No. of cess pit for public	No. of cess pit	829	29	859	85	73	34	69	39	300	1,158
Total No. of cess pit	No. of cess pit	6,358	323	6,682	930	798	378	763	427	3,296	9,977
Desludging No. for a cess pit in a year	No. of dislodge/cess pit/year	2.0	0.00	8.70	1.30	1.80	10.60	0.00	9.40	6.60	8.80

Table F.3.4 Requirement of Vacuum Trucks (1996 ~ 2016)

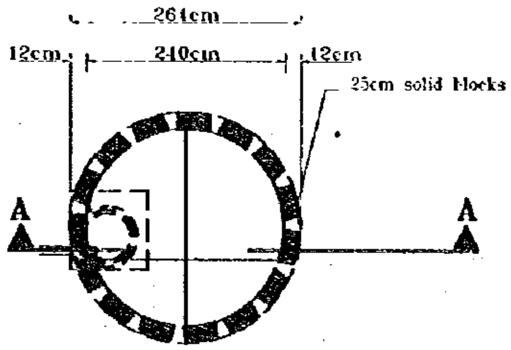
Year	Sewerage Construction Stage	Total Population	Sewerage Served Population	Sanitation Served Population	No. of household	No. of cess pit for household	No. of cess pit for public use	Total No. of cess pit	No. of cess pit desludged by vacuum trucks	No. of cess pit desludged in a day	No. of Vacuum trucks (No standby)	No. of Vacuum trucks with standby
		TP	SP	VP= TP - SP	NH= VP / FS	NCH =NH / NHC	NCP =NCH x RP	NC =NCH + NCP	NC= NC x RC	/DP /WD x365	NV= NCD / DC	NVS= NV x (1+SA)
1996	1st	188,700	0	188,700	23,588	9,435	1,415	10,850	9,765	233	39	47
1997	1st	201,302	0	201,302	25,163	10,065	1,510	11,575	10,418	249	42	50
1998	1st	214,773	0	214,773	26,847	10,739	1,611	12,350	11,115	265	44	53
1999	1st	229,181	0	229,181	28,648	11,459	1,719	13,178	11,860	283	47	56
2000	1st	244,596	0	244,596	30,575	12,230	1,835	14,065	12,659	302	50	60
2001	1st	257,756	0	257,756	32,220	12,888	1,933	14,821	13,339	318	53	64
2002	1st	271,698	0	271,698	33,962	13,585	2,038	15,623	14,061	335	56	67
2003	2nd	286,473	132,435	154,038	19,255	7,702	1,155	8,857	7,971	190	32	38
2004	2nd	302,149	136,903	165,246	20,656	8,262	1,239	9,501	8,551	204	34	41
2005	2nd	318,789	141,570	177,219	22,152	8,861	1,329	10,190	9,171	219	37	44
2006	2nd	332,209	250,236	81,973	10,247	4,099	615	4,714	4,242	101	17	20
2007	2nd	346,389	260,023	86,366	10,796	4,318	648	4,966	4,470	107	18	22
2008	2nd	361,390	270,312	91,078	11,385	4,554	683	5,237	4,713	112	19	23
2009	3rd	377,288	281,142	96,146	12,018	4,807	721	5,528	4,975	119	20	24
2010	3rd	394,169	383,055	11,114	1,389	556	83	639	575	14	2	2
2011	3rd	410,437	398,976	11,461	1,433	573	86	659	593	14	2	2
2012	3rd	427,773	416,162	11,611	1,451	580	87	667	601	14	2	2
2013	3rd	446,292	434,686	11,606	1,451	580	87	667	601	14	2	2
2014	3rd	466,118	454,753	11,365	1,421	568	85	653	588	14	2	2
2015	3rd	487,399	476,611	10,788	1,349	540	81	621	559	13	2	2
2016	Complete	487,399	476,611	10,788	1,349	540	81	621	559	13	2	2

Remarks

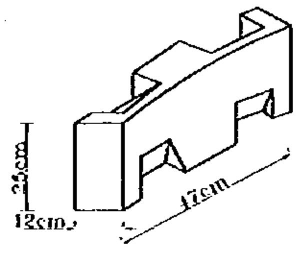
Mark	Meaning	value
FS	Family size	8 person/family
NHC	No. of household per one cess pit	2.5 cess pit / household
RP	Ratio of No. of cess pit for household and public	0.15 =No.of public CP / No. of household CP
RC	Covering ratio of cess pool desludged	0.9
DP	Desludging frequency	45 day/desludg
WD	Working day in a year	340 day/year
DC	Desludging cycle	6 cess pit/vacuum truck/day
SA	Standby allowance of vacuum truck	0.2

Table F.3.5 **Procurement Schedule of Vacuum Trucks**

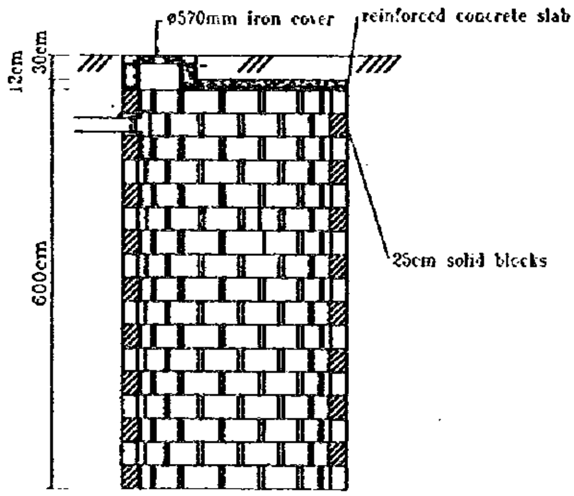
Year	Sewerage Construction Stage	No. of Required Vacuum Trucks (RT)	Public Sector					Private Sector					No. of Operating Vacuum Trucks (OT)	Difference OT - RT
			Existing	New Procurement				Existing	New Procurement					
1996	1st	47	10					18					28	-19
1997	1st	50	10	5				18	13				46	-4
1998	1st	53	10	5				18	13				46	-7
1999	1st	56	10	5				18	13	10			56	0
2000	1st	60	10	5				18	13	10	11		67	7
2001	1st	64	10	5				18	13	10	11		67	3
2002	1st	67	10	5				18	13	10	11		67	0
2003	2nd	38	10	5				18	13	10	11		67	29
2004	2nd	41		5					13	10	11		39	-2
2005	2nd	44		5					13	10	11		39	-5
2006	2nd	20		5					13	10	11		39	19
2007	3rd	22								10	11	2	23	1
2008	3rd	23								10	11	2	23	0
2009	3rd	24									11	2	13	-11
2010	3rd	2										2	2	0
2011	Complete	2										2	2	0
2012	Complete	2										2	2	0
2013	Complete	2										2	2	0
2014	Complete	2										2	2	0
2015	Complete	2										2	2	0
2016	Complete	2										2	2	0



SEEPAGE PIT PLAN



Detail of Solid Block for Seepage Pit



SEEPAGE PIT
SECTION A-A

FIG. F.3.1	TYPICAL STRUCTURE OF CESS PIT

THE STUDY ON SEWERAGE DEVELOPMENT PLAN IN THE AREA OF KHAN YUNIS
IN PALESTINIAN INTERIM SELF-GOVERNMENT AUTHORITY

JICA
AD 1997

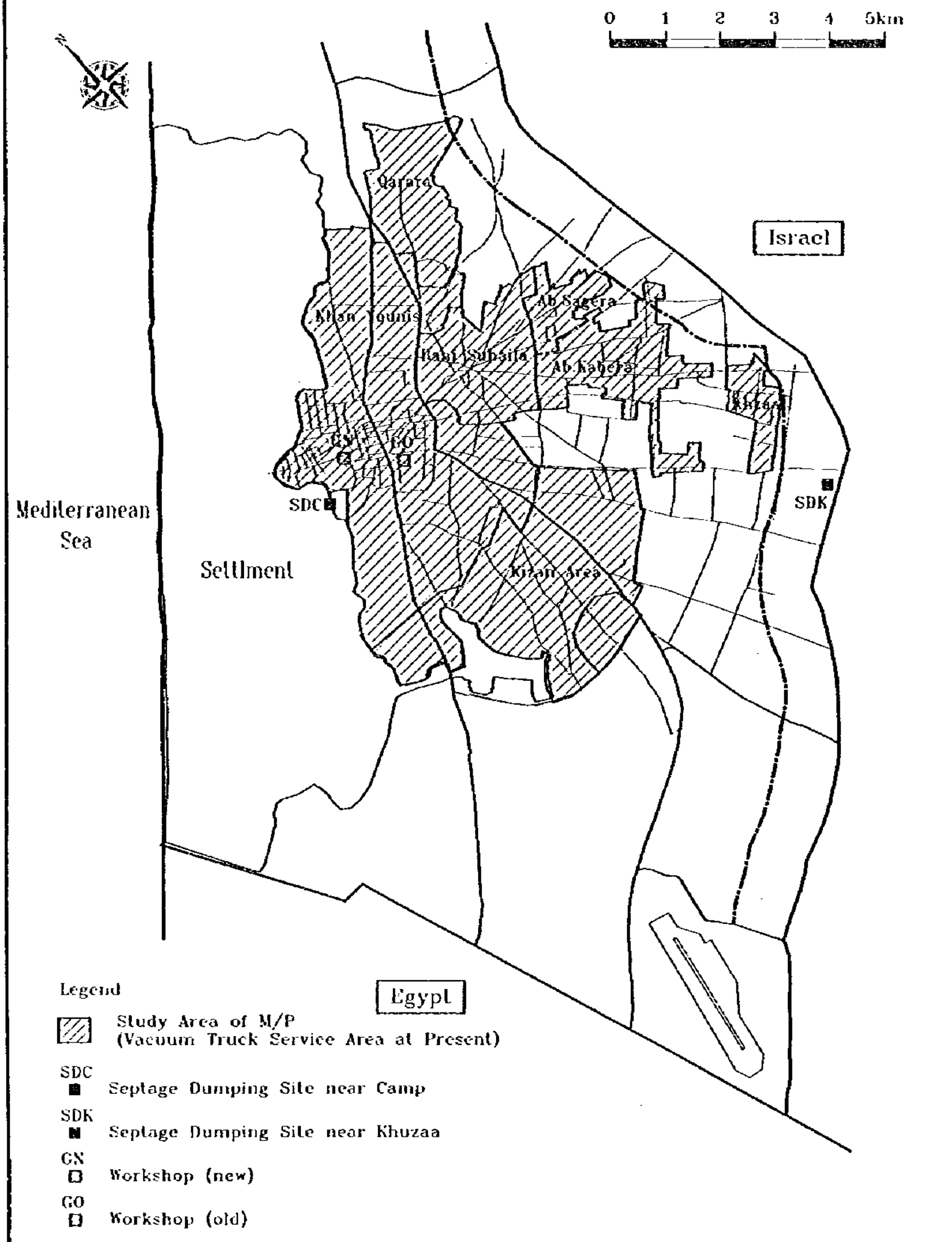


FIG.F.3.2 LOCATION OF PRESENT SEPTAGE DUMPING SITE

THE STUDY ON SEWERAGE DEVELOPMENT PLAN IN THE AREA OF KHAN YUNIS IN PALESTINIAN INTERIM SELF-GOVERNMENT AUTHORITY

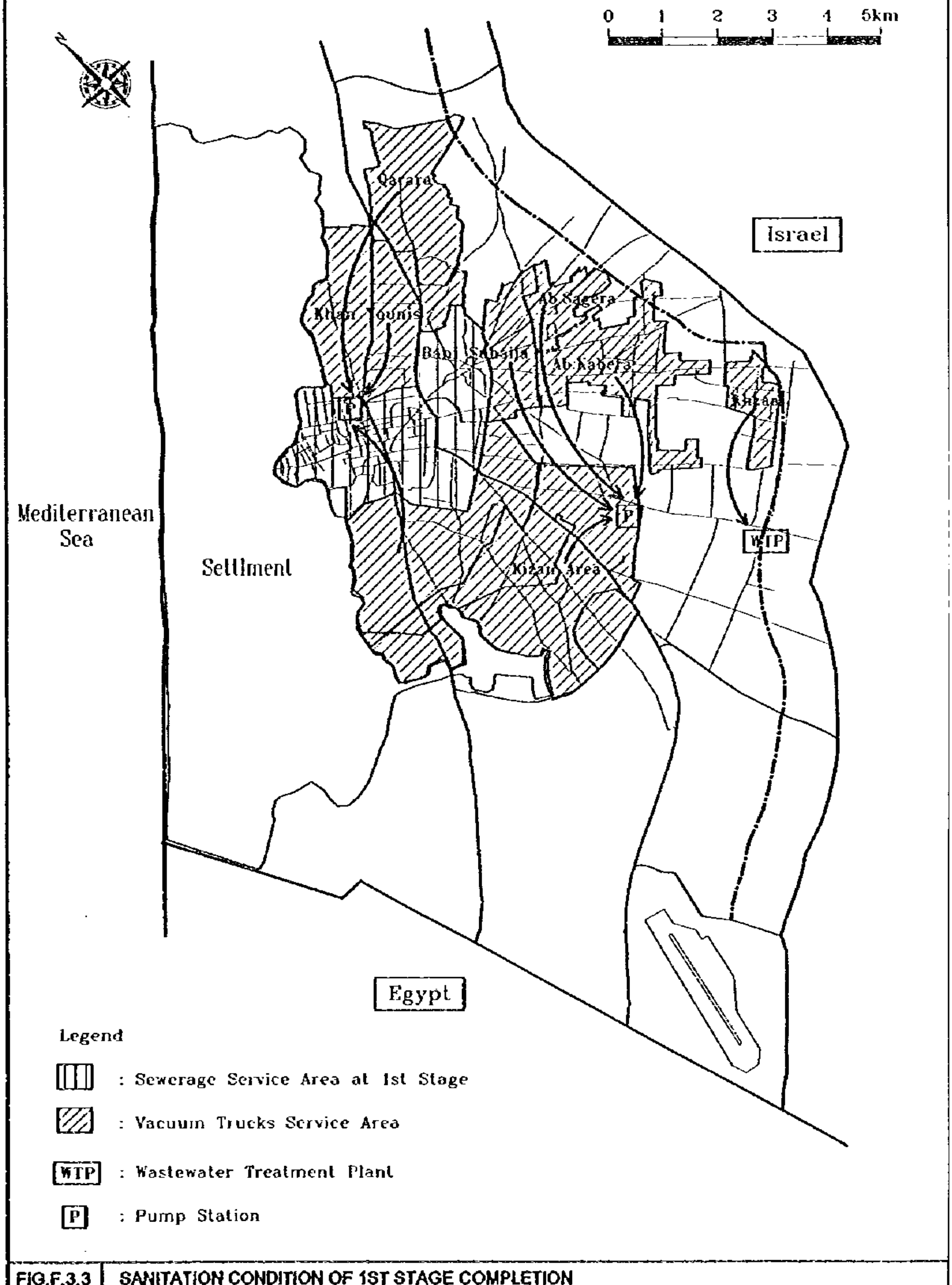


FIG.F.3.3	SANITATION CONDITION OF 1ST STAGE COMPLETION

THE STUDY ON SEWERAGE DEVELOPMENT PLAN IN THE AREA OF KHAN YUNIS IN PALESTINIAN INTERIM SELF-GOVERNMENT AUTHORITY

CHAPTER 4 DRAINAGE SYSTEM

CHAPTER 4 DRAINAGE SYSTEM

4.1 Facility Planning

4.1.1 Design Basis

The hydraulic analyses are made based on the following design criteria:

- Rainfall frequency : Once in every five (5) years
- Rainfall intensity-duration equation : I = 2002/(t + 28)
- Drainage catchment areas : Market area 134 hectares; El Katibah 289 hectares; Total 423 hectares
- Secondary/tertiary drains : Road surface drains
- Primary drains : Closed conduits

4.1.2 Hydrograph Analysis (Time/Area Method)

The peak stormwater runoff rate at each drainage catchment area is calculated in the Master Plan using the hydrograph method (Time/Area Method). Based on the calculated peak runoff rates conduits, retention basin and pumping station sizes and capacities are determined (Refer to Chapter 11, Part 1 of Volume II and Appendix-E, Part 3 of Volume III).

4.1.3 Dynamic Model Analysis

These facilities are then thoroughly examined by using the "Dynamic Model" in their hydraulic conditions, and necessary adjustment or modification thereon are made on the size or capacities of the facilities.

4.2 Project Components

4.2.1 Drainage Conduits

The gravity drainage conduits comprise the construction of circular and rectangular reinforced concrete conduits, which size ranging from 1,650 mm to 2,100 x 2,100 mm with a total length of 1,290 m. The drainage system layout plan, and conduits profiles are shown in Figures F.4.1, F.4.2, F.4.3 and F.4.4, respectively.

FIG.F.4.1 Regional Stormwater Drainage System Layout

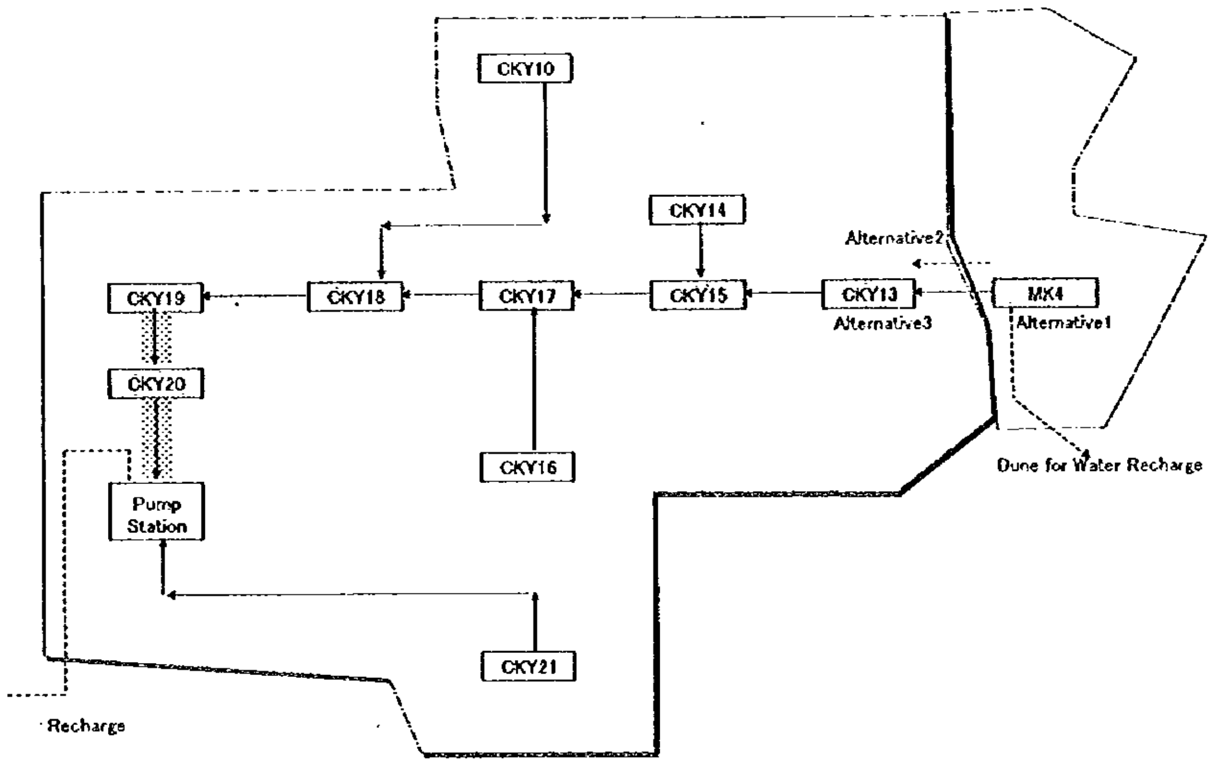


FIG.F.4.2	SCHEMATIC DIAGRAM OF THE DRAINAGE SYSTEM

THE STUDY ON SEWERAGE DEVELOPMENT PLAN IN THE AREA OF KHAN YUNIS
IN PALESTINIAN INTERIM SELF-GOVERNMENT AUTHORITY

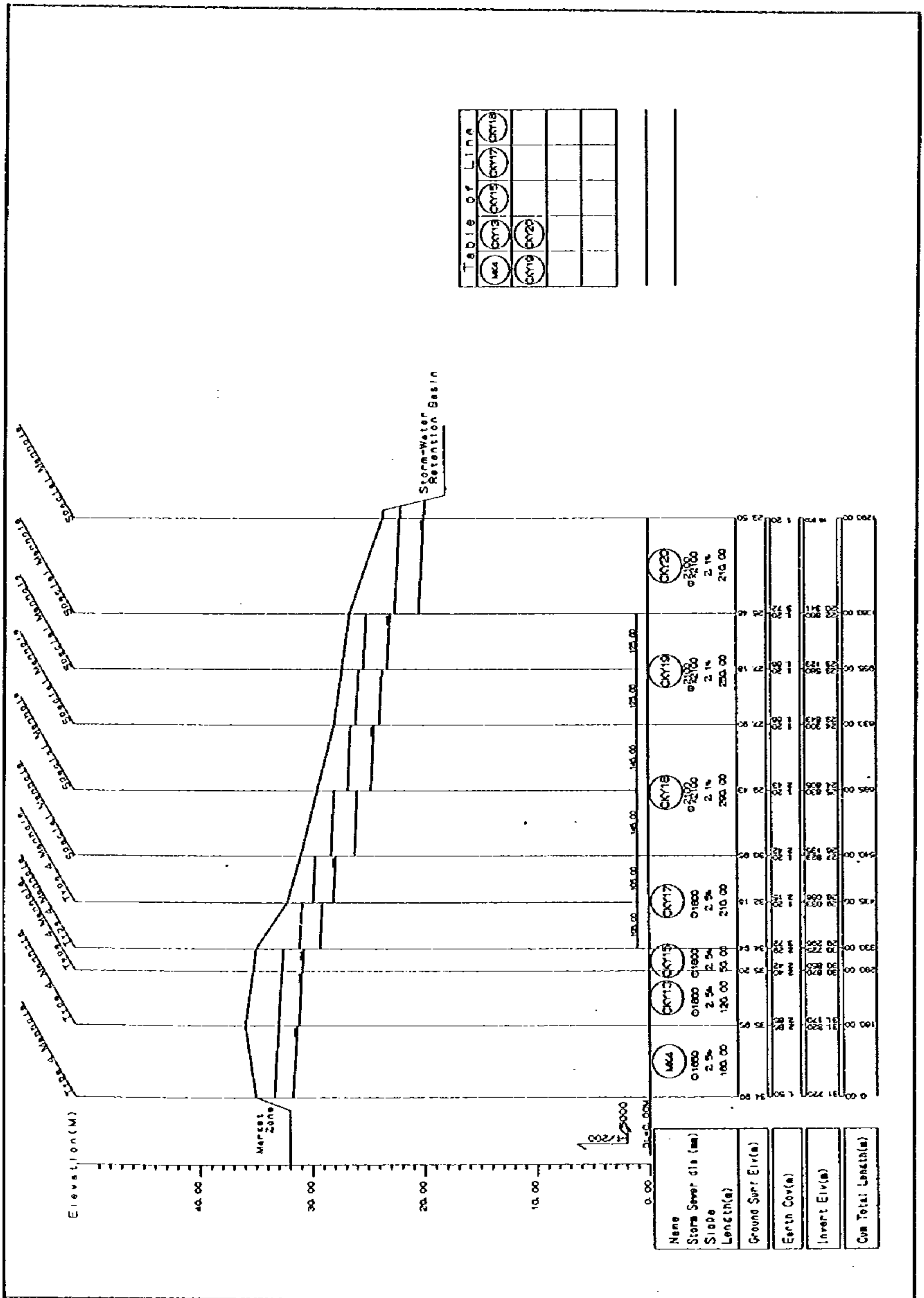


FIG.F.4.3 PROFILE OF DRAINAGE CONDUIT (1)

THE STUDY ON SEWERAGE DEVELOPMENT PLAN IN THE AREA OF KHAN YUNIS IN PALESTINIAN INTERIM SELF-GOVERNMENT AUTHORITY

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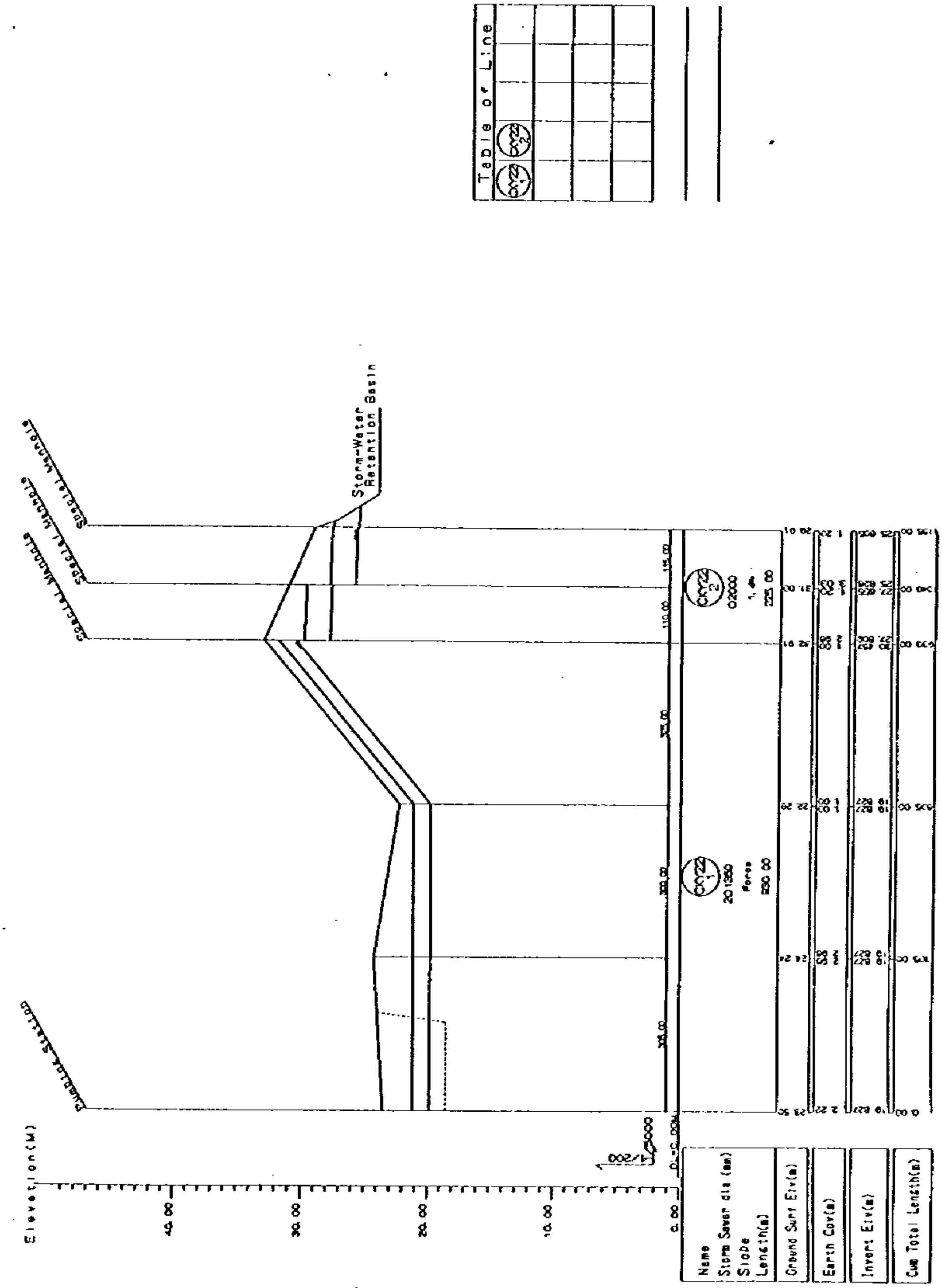


FIG.F.4.4 PROFILE OF DRAINAGE CONDUIT (2)

THE STUDY ON SEWERAGE DEVELOPMENT PLAN IN THE AREA OF KHAN YUNIS
IN PALESTINIAN INTERIM SELF-GOVERNMENT AUTHORITY

4.2.2 Retention Basin

The retention basin capacity, size and shape are as summarized in the following and illustrated in the Drawing of Volume IV:

- Water surface width : 56.4 m
- Water surface length : 100.6 m
- Effective depth : 3.5 m
- Concrete wall slope : 1 horizontal to 2 vertical

The wall surface of the basin is covered with concrete spray to protect the surface from erosion and for easy maintenance of the basin.

4.2.3 Pumping Station

The pumping station is of a vertical submersible type. The wet well is made of reinforced concrete structure; with the provision of easy removal of submersible pumps without dewatering the wet well, and with continuity of operation of the other unit. The submersible pumps are operated manually according to the variation of inflow rates.

The pumping station has two (2) units of submersible pump. Each of the pumps is driven by a diesel engine. The control panel for the pumping operation will be installed in the administration building. The design calculations of the pumping station are presented in Appendix-G, Part 2 of Volume III and illustrated in the Drawings of Volume IV "Data Book and Drawings" under the separate cover.

Table F.4.1 Stormwater Pumps Under the First Stage Project

No. of Pump	Pump Specifications	Screens (bar space)	Engine Output (kW)
2	800 mm x 15.5 m x 90 m^3/min	100 mm	490

4.2.4 Ground Water Recharge

The stormwater transferred through the pressure pipelines will be disposed of to the ground at the dune near the security zone. The ground recharge facility consists of a reinforced concrete structure and an outfall pipe, which have a sufficient hydraulic capacity to smoothly discharge the peak stormwater flow rate.

The ground recharge outfall structure is so designed that the system is not clogged with floatables, debris, etc. The outfall facility has no such gate or valve that controls the rising or lowering the discharge pipe and outflow rate, and keep all the time a free flow at the pipe outlet. Also, an appropriate apron or concrete base is provided at outlet, so that ground scoring with the discharged water can be avoided.

4.3 Proposed First Stage Drainage Facilities

Sizes and capacities of component facilities are summarized in the following table:

Table F.4.2 Components of First Stage Drainage System

Component Units	Quantity/Lengths	Size/Capacity
1. Retention Basin	1 basin	13,400 m^3
2. Pumping Station		
Total head of pumps		15.5 m
No. of pumps	2 units	
Pump discharge		90 m^3/min each
Pump internal diameter		800 mm
3. Pressure Pipeline (mm)	930 m	1 line x 1,350 mm steel pipe
4. Gravity Conduits		
MK4	160 m	1,650 mm circular RC
CKY13	120 m	1,800 mm circular RC
CKY15, 17	260 m	1,800 mm circular RC
CKY18, 19	540 m	2,100 mm x 2,100 mm rectangular RC
CKY20	210 m	2,100 mm x 2,100 mm rectangular RC
CKY22-2 (outfall)	225 m	2,000 mm circular RC

4.4 Operation and Maintenance

4.4.1 Retention Basin

The retention basin will be installed to control the stormwater inflow rates either to the pumping station or discharge channel, and a proper operation and maintenance is vital for attaining the overall drainage system functions as intended. The ground surface in the area is predominantly sandy soil and the sand tends to inflow to the drains and accumulate on the bottom of the basins or discharge facility, thus may decrease the retention basin capacity.

As the routine maintenance, the following works should be undertaken:

(1) Periodical inspection of the facility,

(2) Periodical cleaning and dredging of sand or other obstacles,

(3) Repair and improvement of the facility where found necessary, and

(4) Take necessary preventive measures to the possible accident or other risks.

The inspection shall be made before rainy season to determine the intervals of the above works from the experience obtained in the system operation. The accumulated sand level should not exceed the allowable level.

During rainfall, the water elevation in the basin shall be continuously monitored to check if the water elevation reaches the highest design surface water elevation. The water surface elevation over the highest level may cause water overflow into the surrounding area.

Sudden rising and falling of the surface water elevations could cause erosion of the natural earth wall. This phenomenon could be caused due to the damage in basin wall or water leakage. The rising of water elevation may be caused by screen clogging.

4.4.2 Pumping Station

The stormwater pumping station design bases are in principle the same as those for wastewater pumping stations. However, the stormwater drainage pumping station is of vertical mixed flow type and that a particular attention is required for appropriate operation and maintenance.

Because of the security of power supply to the pumping stations and also for saving the basic electric charge, the pump station is planned to have an independent diesel engine for driving pump.

Since the pumps will be used only in the rainy seasons, the pumps and other mechanical equipment shall be periodically inspected and maintained at best conditions. These inspections and necessary repair and maintenance should be made at least once a year during dry seasons.

Replacement or repair of the pumping equipment shall be made according to the instruction and operation manuals of the equipment manufactures. The inspection, operation and maintenance of the system should be carried out by operators: however, during the rainy seasons, with three gangs working 8-hour shifts be considered to maintain constant attendance. During the time of operation, gangs shall occasionally inspect the screen facility so as to prevent any risks of people or vandalism. The screened large floatables retained on bar screens shall be immediately removed so as not to intervene smooth flow of water. The screenings may contain organic and putrescible materials that will give off offensive odors and will provide bleeding ground for flies and other insects. The screenings must be frequently collected and stored in a bin or other appropriate storage facility for sanitary landfill. Grit accumulated in the pump wells shall be occasionally removed and disposed of to landfill.

4.4.3 Discharge Pipes

All the stormwater collected to the pumping station will be transferred through pressure pipelines to the dunes for ground recharge. The design minimum flow velocity in the discharge pipes will be maintained to that which can prevent sand from depositing in the pipeline. Each pipeline will be provided at least one drain valve at the low point of the pipes. Dewatering and cleaning of pipes shall be carried out every year or shorter intervals if the resistance to flow increases.

CHAPTER 5 IMPLEMENTATION PROGRAM

CHAPTER 5 IMPLEMENTATION PROGRAM

5.1 Implementation Program

5.1.1 Materials and Construction Method

Many of materials required for the construction of sewerage, sanitation and drainage systems for Khan Yunis areas are to be imported, such as equipment and facilities for wastewater treatment, pumping stations, and pipes. Most materials for civil and building works such as sand gravel are locally available although cements, reinforcing bars and steel products are to be imported from neighboring countries.

Construction methods and standards now being applied for the sewerage construction programs in other parts of Gaza Region appear to be also practical to the Project. It is believed the local construction industry will play a major role in the Project.

(1) Construction Materials

Sand and gravel for concrete works are locally available in acceptable quality and quantity. Portland cement suitable for the sewerage and drainage construction is to be imported from neighboring countries. Steel bars, both round and deformed, are also to be imported from those countries.

Pipes currently available in the region are limited in size and material, however, a large variety of pipes can be imported from neighboring countries, such as Israel and Egypt. PVC pipes of good quality suitable for sewers, with necessary accessories, ranging from 110 to 450 mm in diameter, are available in Israel. Reinforced concrete pipes as large as 2,000 mm in diameter and other concrete products are also available from Israel. The steel pipe, coated with mortar lining inside for corrosion prevention, to be used for force mains are to be imported from neighborhood countries.

However, local concrete products, such as manholes cones, barrels, bases, concrete channels, gutters, etc. are able to be used for general purpose with acceptable quality.

Mechanical and electrical equipment for pumping stations and wastewater treatment plant, particularly for oxidation ditch process, will have to be imported from outside.

As mentioned above, most materials for sewer construction are locally available, either imported or locally produced, and can be used for the sewerage construction works.

(2) Capability of Local Contractors

The sewerage and drainage project involves the construction of large-scale and complicated facilities, such as pumping stations and wastewater treatment plant, requiring skills and experience of the contractors. For such important and complicated construction works, it will be appropriate for foreign and local firms to have suitable working arrangements, such as a joint venture, in order to ensure efficiency and quality of the construction works.

Currently several sewerage and water supply construction projects are ongoing within the region, and some of the contractors have gained experience, with equipment and key staff to carry out the works to acceptable level. It would probably be advisable to pre-qualify local contractors according to their capability and experience so they can be fully utilized as effectively as possible in implementing the Project.

Although labor forces of different levels will be needed when the Project starts, there would be no serious problem in finding unskilled labors, but skilled labors, tradesmen, foremen and construction managers at various levels might be difficult to obtain due to limited availability in the markets. The Project will comprise an oxidation ditch system construction which certainly will require experienced contractors. This matter should be well considered in the tendering stage for the construction.

(3) Construction Methods

Major construction works of the Project can be classified into three categories; namely i) sewer and drainage pipe laying, ii) construction of pumping stations, and iii) construction of a wastewater treatment plant.

For sewer pipe laying, there will be two applicable construction methods; i) the open-cut method, and ii) the tunneling method. The open-cut can be commonly applied to the case where the sewer size is relatively small and the traffic condition allows this method. Most of the sewers in the area could be laid by this method, since no severe traffic problem is excepted to occur except in the central urban zones of Khan yunis Municipality. This method is widely practiced. For the excavation works, the retaining walls for safety of the construction works should be applied as one of preventive methods, depending upon the soil conditions. It will be used when the required trench depth of the sewer and drainage pipeline are more than 4 m under the ground level.

The conditions of excavation and retaining wall for pipe laying works are assumed as follows, since it is considered from the results of other projects on-going in Gaza and Rafah districts at present.

- H < 3 m : Direct excavation.
- H = 3 to 4 m : 1/2 steep slope excavation.
- H > 4 m : Direct excavation with retaining walls

  where : H = Trench depth (m)

The tunneling method, on the other hand, may be used for a large and deep sewer construction and where traffic is extremely heavy and cannot be detoured. However, under the Project, the deepest excavations are limited about 6 to 7 meters, and large capacity pumping stations are to be located at relatively isolated area. Hence, the application of tunneling methods will not be required. Since the structure of pumping stations itself will be quite deep, sheeting and bracing should be provided to prevent collapse of the excavation walls or subsidence of adjacent area.

The construction sites for the wastewater treatment plant is rather isolated from the residential or commercial zones, consequently haveing less problem with respect to impacts to the surrounding areas than the pumping stations. The excavation may be carried out in open cut, in some cases without sheet piling for the retaining walls. It is expected that in general the groundwater elevations are low, but in some low-lying areas where the groundwater level is high, necessary dewatering should be practiced all through the construction works, though this might lead into high construction cost.

(4) The Influence of the Rainfall upon the Construction Works

In accordance with the statistics of rainfall data since 1987, the rain season in the project site is almost from October to March. Average precipitation of each month is shown in Table F.5.1. From the table, number of the rainfall days of more than eleven (11) millimeters a day is about 10 days per year. Therefore, the influence of the rainfall upon the construction works will be almost not necessary to be considered.

Table F.5.1 Number of Rainfall Days in Project Site

Year	Average (between 1987 to 1994)					
Precipitation	~ 1mm	~ 5 mm	~10mm	~30mm	31mm ~	Total
Month						
1	4.1	2.6	2.0	2.5	0.5	11.8
2	2.5	2.9	2.0	1.9	0.6	9.9
3	2.1	1.6	0.9	0.5	0.5	5.6
4	0.4	0.4	0.0	0.0	0.0	0.8
5	0.5	0.3	0.0	0.0	0.0	0.8
6	0.1	0.0	0.0	0.0	0.0	0.1
7	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0
9	0.1	0.0	0.0	0.0	0.0	0.1
10	2.3	0.1	0.8	0.1	0.0	3.3
11	2.6	1.9	1.0	0.9	0.8	7.1
12	2.0	1.9	0.9	1.3	0.6	6.6
Total	16.8	11.6	7.5	7.1	3.0	46.0

Data Source : Gaza Meteorological Station

5.1.2 Implementation Schedule

The construction program has been divided into five interrelated components; namely, i) sewers, ii) pumping stations, iii) wastewater treatment plant, iv) storm water drainage system and v) sanitation system. Each of the components has its own place in the construction program recommendations, based on the estimated requirements for the particular period.

It is assumed that the basic design and financial procedures for this program will start in 1998 and it will be completed by 2002.

The decision of implementation schedule will be considered with the construction scale and total investment costs of the project, kind of the financial source and an investment condition at the location.

The Project will need to be further divided into two or three smaller phases depending on the financial sources and investigation conditions. In that case, the order of construction priority should be considered in term of investment efficiency which is to be examined from removed pollutant load, served population and others.

The basic initial facilities for the sewerage system are sewer pipelines such as main and reticulations sewers, pumping stations and wastewater treatment plant in the higher priority districts, and the drainage system. In addition, procurement of the vacuum trucks for desludging and disposal from the on-site sanitation system are included.

The implementation schedule is summarized in Table F.5.2.

Table F.5.2 Implementation Schedule

Item \ Year	1st Year 1998	2nd Year 1999	3rd Year 2000	4th Year 2001	5th Year 2002	6th Year 2003
Preparatory Works						
Basic & Detailed Design						
Construction Works						

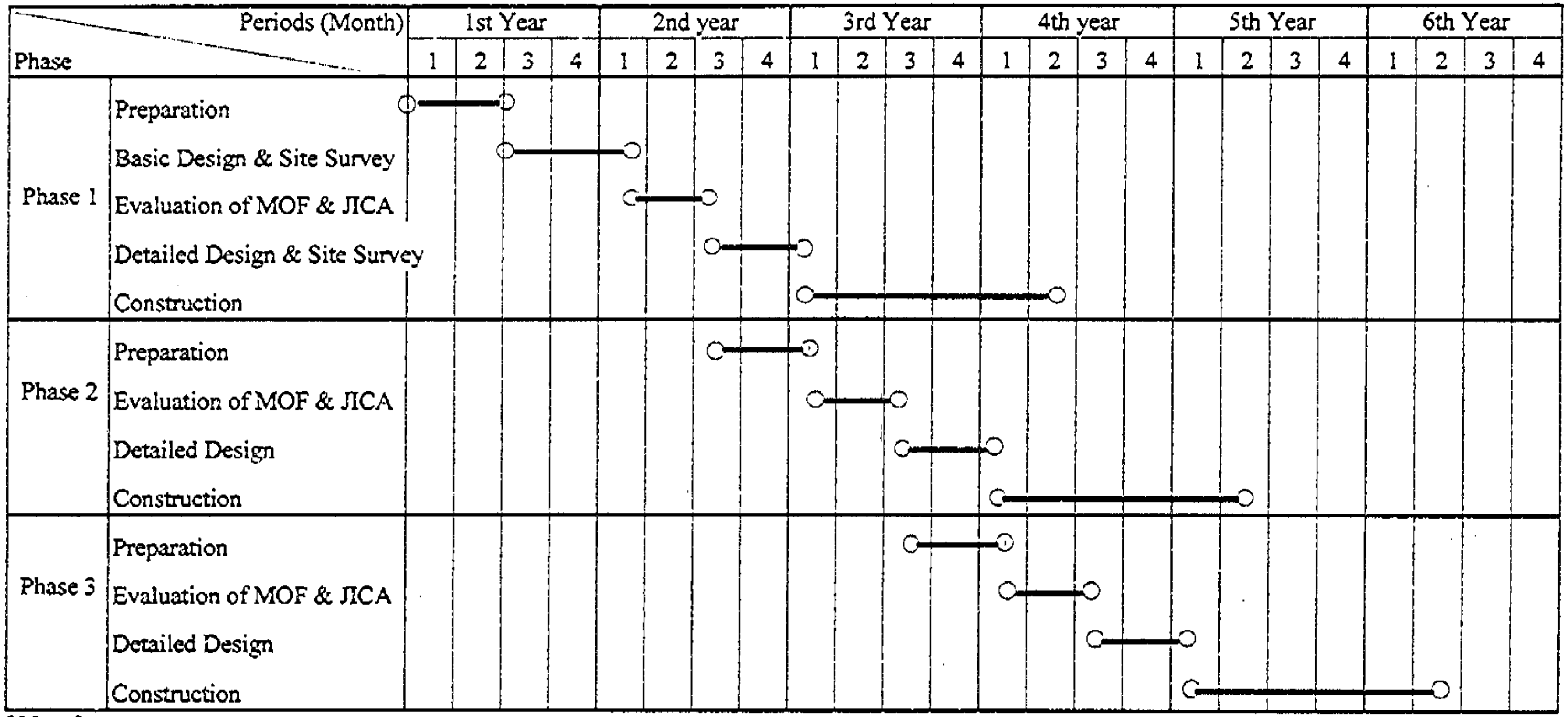
The more detailed tentative implementation schedule is summarized in Table F.5.3.

(1) Implementation Program (1998 to 2002)

It is proposed that the Project of sewerage/sanitation/drainage construction program will be implemented in the Khan Yunis area. The component of the works will include i) sewer pipelines, ii) two pumping stations, iii) one oxidation ditch wastewater treatment plant of 16,100 m^3/day treatment capacity, iv) five vacuum trucks for sanitation system and v) drainage system in market and central area of Khan Yunis city.

Implementation of the construction program is targeted up to 2006 when the construction works of next construction stage will be completed. It is recommended that the program start in the year 1998 and end by the year 2002. When this five-year construction program of sewerage system is completed, the city's population of about 158,000 persons (as of 2006) within the sewerage districts of 874 hectares would have access to sewer service. Therefore, the capacity of equipment in the Project will be able to use up to 2006. Served areas, populations, and systems component facilities to be constructed under this Project are as follows:

Table F.5.3 Detailed Implementation Schedule (Tentative)



[Note]

GOJ : Government Of JAPAN

MOF : Ministry Of Foreign Affairs, JAPAN

JICA : Japan International Corporation Agency

Table F.5.4 Program of The Project

Components	District	Area (ha)	Population (as of 2006)	Sewer Length (m)	Pump Capacity (m^3/min)	Treatment Capacity (m^3/day)
Sewers	KY 5	299	40,962	24,200		
	KY 6	177	65,576	25,100		
	KY 7	214	39,197	29,200		
	BS 1	142	9,628	25,200		
	BS 2	42	3,047	10,100		
	Others	-	-	6,000		
Pumping Station	P3	-	-	-	17.2	
	P8	-	-	-	17.5	
Treatment Plant						16,100
Vacuum Trucks	(5 Nos.)					
Drainage System					180.0	
Total		874	158,410	119,800		16,100

The total length of sewer pipe materials that to be carried out in the Project is shown in Table F.5.5.

Table F.5.5 Total Length of Sewer Pipeline

Pipe Materials	Diameter (mm)	KY5 (m)	KY6 (m)	KY7 (m)	BS1 (m)	BS2 (m)	Others Main (m)	Total (m)
Served Area (ha)		299	177	214	142	42		874
PVC	110	1,560	766	290				2,616
	160							
	200	13,887	12,777	15,274	15,747	6,972		64,657
	250	1,103	1,894	255	712			3,964
(for catch basins)	250	5,770	6,400	6,790	6,350	2,560	350	28,220
	300		927	225				1,152
	350	398	981	225				1,604
	400	612	420	1,233				2,265
	450		757					757
Sub-Total (PVC)		23,330	24,922	24,292	22,809	9,532	350	105,235
CP (Concrete Pipe)	500		45	799	535			1,379
	600	676			551			1,227
	700	215	90	443	20			768
	800			110				110
	900			251				251
	1,000							0
	1,100			350			1,405	1,755
	1,200						1,445	1,445
	1,350						1,795	1,795
	1,400							0
	1,500							0
	1,650							0
	1,800							0
Sub-Total (CP)		891	135	1,953	1,106	0	4,645	8,730
SP (Steel Pipe)	100					610		610
	200							0
	250							0
	300							0
	350							0
	450				1,255			1,255
	500							0
	600							0
	700							0
	800			2,930				2,930
	900							0
	1,000						955	955
	1,100							0
	1,200							0
Sub-Total (SP)		0	0	2,930	1,255	610	955	5,750
	Total	24,221	25,057	29,175	25,170	10,142	5,950	119,715

Description	Unit	KY5	KY6	KY7	BS1	BS2	Others Main	Total
Main + Reticulation	(m)	18,451	18,657	22,385	18,820	7,582	5,600	91,495
Main + Reticulation + Catch basin	(m)	24,221	25,057	29,175	25,170	10,142	5,950	119,715
Unit Sewer Length	(m/ha)	62	105	105	133	181	-	105
〃 (including catch basin)	(m/ha)	81	142	136	177	241	-	137

5.2 Cost Estimation

5.2.1 Basis of Cost Estimation

The major components and the methods involved in the cost estimation are described below. The total investment cost is composed of the following components; (1) direct construction cost, (2) land acquisition cost, (3) engineering fee and (4) physical contingency.

The recommended plan for implementing sewerage, sanitation and drainage systems calls for construction, operation and maintenance.

(1) Direct Construction Cost

The direct construction cost of the wastewater treatment plant and pumping stations are estimated based on the preliminary design and the cost functions reported in previous reports.

The unit construction costs related to the sewer pipeline including for the drainage system have been estimated based on the unit costs that have investigated and obtained in Palestine and Israel during the field investigations in 1997.

The direct construction cost are estimated as total cost including the materials, labors and some benefits of contractors, without Value Added Tax (VAT) and other taxes.

(2) Land Acquisition Cost

The required land area for the wastewater treatment plant and pumping stations are determined from results of the preliminary design.

The land cost of sewer pipeline installation is not considered since it will be installed underground the existing roads and other publicity reserved land in principle.

(3) Engineering Fee

An engineering fee is composed with the fee of designing and supervision of the construction works which are conducted by the consultants after obtaining approval from Palestine Authority. It has been assumed that the engineering fees for the sewerage and drainage system and sanitation system are twelve (12) percent and three (3) percent of the direct construction cost respectively.

(4) Contingency

The contingency has been estimated as seven (7) percent of the direct construction cost.

5.2.2 Total Investment Cost

The total investment costs including sewerage, sanitation and drainage systems is summarized below in Table F.5.6 and F.5.8.

The direct construction cost and land acquisition cost in above costs are further breakdown in Table F.5.8 and F.5.9. Concerning the more detailed construction works of pipe laying are described in Table F.H-7 in Appendix H of Part 3 Volume III "Supporting Report.".

Table F.5.6 Total Investment Cost for the Project

(Unit: US$)

No	Components	Amount
1)	Direct Construction Cost	52,984,496
2)	Land Acquisition Cost	2,860,000
3)	Engineering Fee	6,313,139
4)	Physical Contingency	3,708,915
	Total	65,866,550

Table F.5.7 Detailed Total Investment Cost

(Unit: US$)

No	Components	Amount
1	Sewerage System	56,357,894
1.1	Direct Construction Cost	45,023,440
1.2	Land Acquisition Cost	2,780,000
1.3	Engineering Fee	5,402,813
1.4	Physical Contingency	3,151,641
2	Sanitation System	550,000
2.1	Direct Construction Cost	500,000
2.2	Land Acquisition Cost	0
2.3	Engineering Fee	15,000
2.4	Physical Contingency	35,000
3	Drainage System	8,958,656
3.1	Direct Construction Cost	7,461,055
3.2	Land Acquisition Cost	80,000
3.3	Engineering Fee	895,327
3.4	Physical Contingency	522,274
	Total	65,866,550
	Total (J-Yen)	7,903,985,996
	Total (J-Yen) =Direct + Eng	7,115,716,231

[Note] 1. Percent of Engineering Fee is shown below.
1) Sewerage and Drainage System : (Direct Construction Cost) x 0.12
2) Sanitation System : (Direct Construction Cost) x 0.03
2. Physical Contingency : (Direct Construction Cost) x 0.07
3. Cost : as of August 1997.
4. Exchange Rate : 3.3 NIS/US$, 120 J-Yen/US$.

Table F.5.8 Direct Construction Cost

(Unit : US$)

No	Components	Description		Unit	Quantity	Unit Price	Amount
1	**Sewerage System**						45,023,440
1.1	Sewers	Total Lengh	119,800				16,177,858
1)	KY5 (Area:299 ha)	Lengh (m)	24,200	Set	1		2,226,859
2)	KY6 (Area:177 ha)	Lengh (m)	25,100	Set	1		3,416,880
3)	KY7 (Area:214 ha)	Lengh (m)	29,200	Set	1		4,353,085
4)	BS1 (Area:142 ha)	Lengh (m)	25,200	Set	1		2,449,930
5)	BS2 (Area: 42 ha)	Lengh (m)	10,100	Set	1		813,718
6)	Other Main Sewer	Lengh (m)	6,000	Set	1		2,917,385
1.2	Pumping Stations						4,372,044
1)	P3	q = (17.5 / 35.3) m3/min		m³/min	35.3		1,751,555
2)	P8	q = (17.5 / 56.5) m3/min		m³/min	56.5		2,320,489
3)	Man-hole Type			places	6.0	50,000	300,000
1.3	Wastewater Treatment Plant	Q total = 16,100 m3/day		Set	1		24,473,539
1)	Unaerobic Ponds + OD	Q1= 16,100 m3/day		m³/min	16,100		20,654,952
2)	Primary Electric Power			Set	1		200,000
3)	Pumping Station in WWTP	q1= (16,100/53,400) m3/day x 1.6		m³/min	59.3		2,388,588
4)	Discharge Infiltration Ponds	Q1= 16,100 m3/day		Set	1		1,230,000
2	**Sanitation System**						500,000
1)	Trucks	Vacuum Truck Type		Nos	5	100,000	500,000
2)	Sludge Dump Stations				0		0
3	**Drainage System**						7,461,055
3.1	Market Area						1,349,450
	Drainage Pipeline	dia 1,200	(Havg=3.5m)	m	140	480.0	67,200
		dia 1,650	(Havg=4.0m)	m	160	650.0	104,000
		dia 1,800	(Havg=4.5m)	m	120	750.0	90,000
		dia 1,800	(Havg=4.3m)	m	50	750.0	37,500
		dia 1,800	(Havg=4.0m)	m	210	720.0	151,200
		2100*2100	(Havg=4.0m)	m	290	1,145.0	332,050
		2100*2100		m	460	1,145.0	526,700
	Manhole (main sewer)	ID1,800mm		pcs	6	2,700	16,200
		2500*2500		pcs	6	4,100	24,600
3.2	Central Area						6,111,605
1)	Pumping Station	Central Area : q =180 m3/min		m³/min	180		3,314,205
2)	Retention Basin	V=14,000 m3		set	1		2,030,000
3)	Discharge Pipeline	dia 1,350 (SP)	(Havg=1.6m)	m	930	680	632,400
		dia 2,000 CP)	(Havg=1.5m)	m	225	600	135,000
	Total						52,984,496
					Total (J-Yen) :		6,358,139,492

Note : 1. Cost : as of August 1997.

2. Exchange Rate : US$ 1 = NIS 3.3 = J-Yen 120

Table F.5.9 Land Acquisition Cost

(Unit : US$)

No	Components	Required Area (ha)	Unit Price (US$/ha)	Amount
1	Sewerage System			2,780,000
1)	Sewers	0.00		0
2)	Pumping Stations			80,000
	P3	0.25	100,000	25,000
	P8	0.55	100,000	55,000
3)	Wastewater Treatment Plant			2,700,000
	WWTP of South	27.00	100,000	2,700,000
	Discharge Infiltration Ponds	0.00	100,000	0
2	Sanitation System	0.00		0
3	Drainage System			80,000
1)	Pumping Station (Central Area)	0.40	100,000	40,000
2)	Retention Basin for P/S	0.40	100,000	40,000
	Total			2,860,000

[Note]
1. Cost : as of August 1997.

5.2.3 Operation and Maintenance (O/M) Costs

(1) Sewerage System

Operation and maintenance costs for the sewerage system are composed of i) sewer pipeline, ii) pumping stations and iii) wastewater treatment plant.

Wastewater treatment plant O/M costs are composed of electricity, disinfectants, repairing costs and personnel expenses. Pumping stations costs are composed of electricity, repairing costs and personnel expenses. And that of sewer pipeline is composed of repairing costs, daily inspection, cleaning works and personnel expenses. The frequency of these works are assumed that it will be inspected twice a year and to be cleaned at least every year by use of thrusting rods and /or bucket machines, including power source, lubrication and minor repair of the equipment..

The annual O/M costs of the sewerage, sanitation and drainage system are shown in Table F.5.10. Moreover, there are further breakdown in Table F.II-10 in Appendix II of Part 3 Volume III "Supporting Report."

(2) Sanitation System

The sanitation system O/M costs and composed of fuel and personnel expenses of the vacuum truck's drivers only.

Septic tanks and cesspools should be desludged periodically and the septage transported to the wastewater treatment plant or sludge dump stations for final treatment, but these costs are to be borne by users and not financed by the Project.

(3) Drainage System

The drainage system is composed of electricity, repairing costs of pipeline and pumping station, and personnel expenses.

Table F.5.10 Annual Operation & Maintenance Costs

(Unit : US$)

No	Year	Sewer Pipeline	Pumping Station (P/S)	Wastewater Treatment (WWTP)	Drainage System	Sanitation System	Personnel Expenses	Total O&M Cost
1	1999	0	0	0	0	0	0	0
2	2000	0	0	0	0	0	0	0
3	2001	0	0	0	0	0	0	0
4	2002	0	0	0	0	0	0	0
5	2003	128,775	203,533	545,234	43,604	59,700	213,000	1,193,846
6	2004	128,775	212,089	547,963	43,604	59,700	213,000	1,205,131
7	2005	128,775	221,103	550,837	43,604	59,700	213,000	1,217,019
8	2006	128,775	229,501	553,516	43,604	59,700	213,000	1,228,096

[Note] 1) Exchange Rate : 3.3 NIS/US$, 120 J-Yen/US$.
2) Cost : as of August 1997.
3) Repairing Cost : Direct Construction Cost x 0.5 %/Year
4) Life of the Facilities ; Sewer : 50 Years, P/S : 25 Years, WWTP : 25 Years

5.3 Financial Plan

For operation and maintenance for the new sewerage treatment system to be constructed by the Project, Khan Yunis Governorate and Khan Yunis Municipality should prepare financial supporting system so that they can finance the necessary costs for operation and maintenance including replacement cost by themselves. For this purpose, a proper tariff should be set.

In this clause, a tariff system for financial support to the sewerage treatment system to be established is presented as a recommended one.

5.3.1 Fixed Tariff System for Ordinary Customers

A new tariff for sewerage system proposed by the Project should be set for keeping the existing people's burden. Moreover, it has better establish the tariff to be lower than the existing level of people's burden if possible. This is a premise for formulating the tariff structure for the new sewerage system.

From this viewpoint, a structure of tariff consisting of following components for sewerage system due to the Project may be reasonable because of satisfying the above mentioned premise.

Component	(NIS)
Basic charge :	30
The OM cost to be borne by the people :	3
The cost for sewerage services for public facilities :	2
Total : unit tariff per month per HH :	35

Detail background is discussed in Chapter 6 of Part 2 "Master Plan Review" in Volume II "Main Report" (hereinafter referred to as "Part 2").

In the case of without the Project, they should make septic tanks with costing, for example, at US$1,000 for 5-year capacity. In this case, the people should reserve at a sum of NIS.55 per month per HH (= US$1,000 x NIS.3.3/US$/5 years/12months) as a depreciation cost in no account of any interest rate. The above recommended tariff of NIS.35 is equivalent to only 64 % to the depreciation cost for a septic tank. In the case of with the Project, people do not need to reserve any depreciation cost more when they connect once to the proposed sewerage system. And the said tariff is within the affordability of them to pay as mentioned in previous sub-clause. The said recommended tariff may be sound from this viewpoint too.

The fixed tariff system should be taken into consideration for encouraging people's willingness to connect the proposed sewerage system so that expected connection rate would be kept after starting the sewerage treatment services.

5.3.2 For Bulk Consumers of Potable Water

There is one under-operating hospital in the Municipality of Khan Yunis named as El Naser Hospital. The Municipality of Khan Yunis charges desludging service fee to the Hospital with the same rate of NIS.15 per time. However, in the case of With the Project, the charge of sewerage treatment services to hospitals should generally be in accord with the actual water consumption because that waste water should vary with the water consumption according their scale. As mentioned in Part 2, there will be several hospitals in the Municipality of Khan Yunis. The variable tariff system should be taken into account from this viewpoint too.

As also mentioned in Part 2, an average monthly consumed water volume is 2,753 m3 during these 17 months since January 1996 in El Naser Hospital with paid amount of NIS.3,818 per month including VAT from MEKOROT through the Ministry of Agriculture, PNA.

The Hospital has 256 beds in 1996 and average occupancy rate was 76 % in the same time. Therefore, 195 inpatients are always staying in this Hospital. Number of outpatients was 54,473 persons in 1996. It means that 151 outpatients had come every day to the Hospital in that year (= 54,473 persons /12 months/30 days).

On the other hand, the working staffs in the Hospital are 536 persons since 1996. So potable water consumption rate of total patients is 39.23 % to the total water consumption (= (195 persons + 151 persons)/(195 persons + 151 persons + 536 persons)). That is to say that around 60 % of water are consumed by the Hospital itself. This rate may be applied to the volume of waste water discharged by the Hospital.

During these 5 months from January to May 1997, the Hospital has paid for desludging services to the Municipality at NIS.2,640 per month as indicated in the following Table.

Table F.5.11 Average Volume of Wastewater and Paid Amount of Hospital

Year	Month	Nos. of trips	Paid amount
1997	January	150	2,250
	February	170	2,550
	March	200	3,000
	April	180	2,700
	May	180	2,700
	Total	880	13,200
Average per month		176	2,640

Source : The Naser Hospital, May 1997.

According to above situation, the Hospital has paid NIS.0.575 per m^3 as an existing paid amount as shown in the following Table.

Table F.5.12 Estimation of Unit Existing Charge for Desludging Services for Hospitals in Khan Yunis

(NIS)

Item	Paid amount to portable water[1]	Paid amount to waste water[2]
Total paid amount	3,813	2,640
Amount to be paid by the Naser Hospital itself	2,288	1,584
Average unit paid amount per m^3	0.831	0.575

Resources (1) Ministry of Agriculture.
(2) the Municipality of Khan Yunis.

The amount of NIS.0.575 per m^3 is estimated based on unit price of potable water including VAT. So, this amount should be revised at NIS.0.49 per m^3 (= NIS.0.575/1.17) as a net cost for existing desludging services against the consumed potable water volume. A rate rounded at NIS.0.5 should be a recommended rate as a basic tariff against unit potable water (m^3) to be consumed for bulk consumers of potable water represented by hospitals.

This recommended sewerage treatment service rate of NIS.0.50 per consumed unit potable water of m^3 as a variable rate for the new Sewerage Treatment System due to the Project is based on the data on hospitals as mentioned above. When such other bulk consumers as large scale restaurants, factories, hotels etc. will make their business activities in the future, this rate should be modified.

5.3.3 Recommended Tariff System for Sewerage Treatment Services

The costs applied in this Project evaluation includes that of the house connection for ordinary customers, so no additional house connection cost is needed. However, the house connection cost for bulk consumers of potable water should be borne by themselves.

In this case, the cost of trunk sewer network construction is included in the costs of the Project. Therefore, the said bulk consumers of potable water should burden only the cost of piping works from their houses (hospitals, factories and so on) to the nearest man-hole. From the viewpoint of technical and design criteria for sewerage network to be constructed, an average distance of house connection is around 100 m with pipes of 300 mm in diameter. Under this condition, a sum of around US$7,000 to US$10,000 will be necessary for house connection works.

The recommended tariff system is as follows:

	Consumer type	Tariff type	Tariff
1.	Ordinary customers	Fixed rate	NIS.35/month/HH
2.	Bulk consumers of potable water	Variable rate	NIS.0.5/m^3 of potable water

For bulk consumers of potable water, the Municipality of Khan Yunis should check their water meter every month. At present, the potable water of MEKOROT is supplied through the Ministry of Agriculture as the Representative of PNA. So the El Naser Hospital as a bulk consumer are paying its water charge to MEKOROT through the Ministry of Agriculture. According to the information of the Palestine Water Authority (PWA) and the Ministry of Agriculture, this role will be shifted to the PWA. Therefore, the Municipality should closely keeping the relationship with those institutions to exchange the information on water consumption because that water meter in consumers' side is sometimes unreliable.

5.3.4 Financial Plan for Operation and Maintenance for Wastewater Treatment System

As mentioned in Part 2, the said recommended tariff system might be applicable for proposed waste water treatment system by the Project in the case of whole works consisting of three (3) stages.

In this section, financial capability of the Project including first stage only as a feasibility study is discussed using the above mentioned tariff system. Following Table shows cash outflow and cash inflow for the Project implementation up to the first completion of the replacement of the main facilities of the year 2029.

Table F.5.13 Financial Cash Flow in Grant Basis for First Stage

(US$1.000)

Year	Outflow					Inflow				Accumulated cash balance
	Construction cost	OM cost	Replacement cost for sanitation	Total cost	Accumulated outflow	Grant	Revenue	Total	Accumulated inflow	
1999	1.662			1.662	1.662	1.662		1.662	1.662	0
2000	19.326			19.326	20.988	19.326		19.326	20.988	0
2001	19.318			19.318	40.306	19.318		19.318	40.306	0
2002	19.069			19.069	59.375	19.069		19.069	59.375	0
2003		1.194		1.194	60.569		969	969	60.344	-225
2004		1.205		1.205	61.774		1.971	1.971	62.314	540
2005		1.217		1.217	62.991		2.040	2.040	64.354	1.363
2006		1.228		1.228	64.219		2.107	2.107	66.461	2.242
2007		1.228		1.228	65.447		2.170	2.170	68.632	3.184
2008		1.228		1.228	66.675		2.236	2.236	70.867	4.192
2009		1.228	293	1.521	68.196		2.304	2.304	73.171	4.975
2010		1.228	293	1.521	69.716		2.374	2.374	75.545	5.829
2011		1.228		1.228	70.945		2.446	2.446	77.991	7.016
2012		1.228		1.228	72.173		2.518	2.518	80.508	8.336
2013		1.228		1.228	73.401		2.592	2.592	83.101	9.700
2014		1.228		1.228	74.629		2.670	2.670	85.771	11.142
2015		1.228		1.228	75.857		2.750	2.750	88.521	12.664
2016		1.228		1.228	77.085		2.791	2.791	91.313	14.228
2017	Replacement of main facilities by Khan Yunis itself. ↓ (2017–2023)	1.228		1.228	78.313		2.791	2.791	94.104	15.791
2018		1.228		1.228	79.541		2.791	2.791	96.896	17.354
2019		1.228		1.228	80.769		2.791	2.791	99.687	18.918
2020		1.228	293	1.521	82.290		2.791	2.791	102.479	20.189
2021		1.228	293	1.521	83.811		2.791	2.791	105.270	21.460
2022		1.228		1.228	85.039		2.791	2.791	108.062	23.023
2023		1.228		1.228	86.267		2.791	2.791	110.853	24.586
2024		1.228		1.228	87.495		2.791	2.791	113.645	26.150
2025		1.228		1.228	88.723		2.791	2.791	116.436	27.713
2026	520	1.228		1.748	90.471		2.791	2.791	119.228	28.757
2027	6.468	1.228		7.696	98.167		2.791	2.791	122.019	23.852
2028	6.460	1.228		7.688	105.855		2.791	2.791	124.811	18.955
2029	6.211	1.228		7.439	113.294		2.791	2.791	127.602	14.308
Total	79.034	33.091	1.172	113.294	113.294	59.375	68.229	127.602	127.602	14.308

The above indicated cash flow, the detail shown in Table 6 in Appendix J of Part 3 in Volume III "Supporting Report", may be illustrated as following figure:

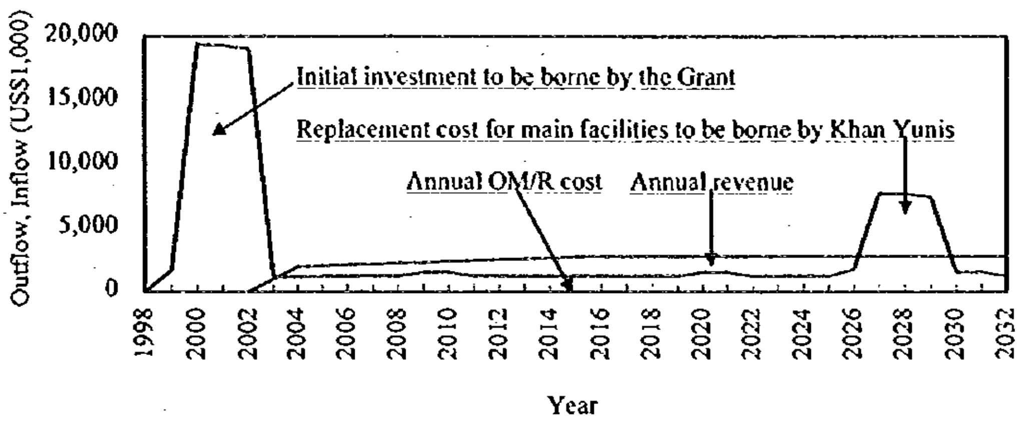


Fig. F.5.1 Financial Cash Flow of the Project in Grant Basis for First Stage

As indicated in the above Table, a negative balance will be just in the first year only after completion of the construction works of the main facilities for waste water treatment system, but the balances of succeeding years will be always positive.

And, it seems that the replacement cost for the main facilities of waste water treatment system will not covered by the annual revenue of the Municipality of Khan Yunis. However, the Municipality will get higher accumulative amount of inflow than that of outflow from the second year after completion of the works as shown in above Table, so that the large amount of replacement cost for main facilities will be covered by the accumulative cash balance as illustrated below:

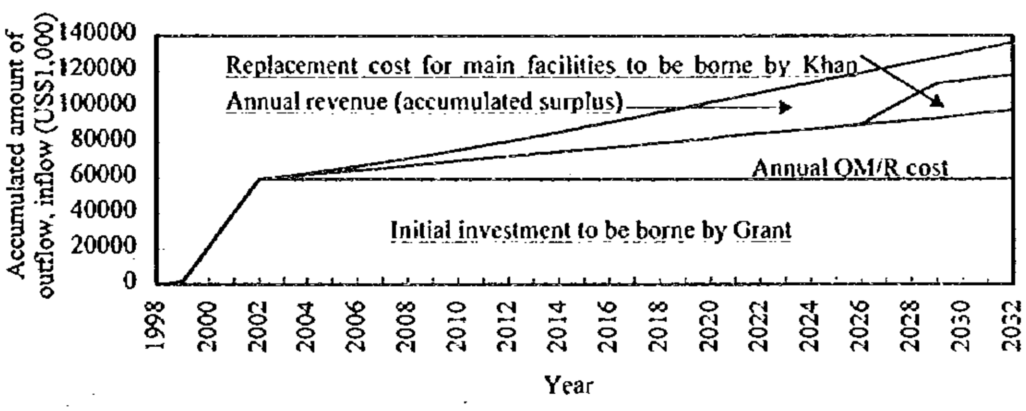


Fig. F.5.2 Financial Stability of the Municipality for Operation and Maintenance of the Proposed Wastewater Treatment System

Accordingly, the operation and maintenance including replacement of sanitation trucks and replacement of main facilities of waste water treatment system proposed by the

Project might be financed by the revenue of the Municipality of Khan Yunis applying the recommended tariff amount as mentioned in previous section in this Chapter.

When the Municipality of Khan Yunis establishes the tariff system for the services due to the new waste water treatment system proposed by the Project, it is suggested that the said recommended tariff amount, namely NIS.35 per HH per month, should be taken into consideration as an average rate to get self-supported financing ability if the Municipality would like to establish a variable tariff system rather than fixed tariff system. However, it seems that the fixed tariff system using the said tariff amount has better to be established for encouraging willingness of people living in the study area to connect to the proposed sewerage system for the first time considering the existing situation.

5.4 Institutional Plan

5.4.1 Institutional Alternatives

It shall be noted that a sewerage project will require a large investment, especially at the initial stage, in which the number of the beneficiaries is still limited. Therefore the revenue is limited to only the users' charges, unless some governmental subsidies are provided. It is a common understanding of the people that the sewerage service charge should be lower than the water supply, because the drinking water is considered to be more important than wastewater discharge to the environment.

However the ignorance of the sewerage system will result in a total serious damage of the environment including groundwater and surface water. In many cases such environmental damages will be unrecoverable, or will take a long period for recovery.

Based on such perceptions of the people including the policy makers, the sewerage development has been neglected or ignored, until certain serious impacts occur due to lack of the sewerage systems in many countries including developed ones.

First of all it should be recognized that sewerage investment is certainly capital-heavy, and that the O/M costs are also hard to be recovered by the users' charge. Therefore a well-designed system is required and an effective management is essential, because the failure of a good design and an effective management will cost much to the people and society.

There is at present no operational sewerage system in Khan Yunis, except one designed and partially constructed by Israel during 1970's. But this system was never used for the purpose and abandoned about 20 years ago. The residents in the area, therefore, are using cess pits and septic tanks for their wastewater discharge, knowing that this kind of practice is contaminating heavily the environment and damaging the hygienic conditions of the area. They are not satisfied with the existing system of desludging, complaining that it is too unhygienic, smelly and dirty, according to the social survey by the JICA Study Team in 1996.

Since there is no existing sewerage system in Khan Yunis, the Study Team recommends that a gradual stepwise developments be considered for the new institutional plan along with the national strategy of Palestine. The Study Team propose to discuss the following four alternatives:

Alternative 1: Municipality based Institution

A new organization will be established within the municipality. In this Study Municipality of Khan Yunis will have one organization, either attached or separate, within the existing municipal organization. On the other hand other municipalities will have a similar organization, separately from each other.

Alternative 2: Governorate-based Institution

Governorate of Khan Yunis was established just in 1996. A new organization for sewerage management will be established within the Governorate. The existing sanitation divisions of the municipalities will be absorbed and integrated into the Governorate of Khan Yunis.

Alternative 3: Regional Institution

A new single organization for sewerage management will be established to cover the whole region of Gaza Governorates, either within the existing organization like PWA(Palestinian Water Authority) or independently. The whole functions related with the sewerage management from customer service to treatment/disposal of wastewater will be integrated into the new organization, including sanitation services.

Alternative 4: Governorate/Municipality-based Institution

A new organization of high level will be established within the Governorate of Khan Yunis to maintain the main sewers, pumping stations and the treatment plant, while the existing sanitation function will remain within municipalities in the Khan Yunis area.

Alternative 5: Regional/Governorate/Municipality Institute

This option with have the present PWA as the coordination function with the whole Gaza Region. Originally the PWA is playing a regulatory role to control, monitor and advise the Governorate in the water sector. However the PWA will be responsible to implement the proposed system according to the water institution in Gaza. Therefore it is recommended that the Coordination Office will be established with the present staff in PWA, as shown Figure F.5.3.

In the near future the PWA will be reorganize to cover the whole region, or generate a new organization such as Gaza Water Undertaking Company (GWUT).

However certain steps will be required for the development of PWA. The proposed coordination office will be headed with one manager and five Governorate coordinators, shown as Figure F.5.3

In the Governorate of Khan Yunis the Wastewater Department will be established. In the Municipality of Khan Yunis the existing Health & Slaughter Division will be reorganized to the Sanitation Division.

It should be noted that these five alternatives have some advantages and some disadvantages. Careful considerations shall be given to the selection for the institutional development plan of Khan Yunis sewerage project, taking into account the historical background, social acceptance, effective management, and future development, etc. of the sewerage system in the area.

The Study Area comprises six municipalities as well as Kizan area within the Governorate of Khan Yunis. For planning purposes, the study team considers the study area as one unit especially when identifying the location of treatment plant, pumping stations and main sewers. This situation requires a new approach for the set up of operation and maintenance organization. The current practice of the operation and maintenance organizations in Gaza governorates is to have a sewage department within the municipality to take over the operation and maintenance of the sewerage system.

In some cases, the sewage and water are dealt within one department. The semi-regional organization has not been established yet in Gaza Governorates except for the solid waste management in middle and Khan Yunis area. The arrangement for solid waste collection organization was made to have the operation and maintenance at the local level and the regional level.

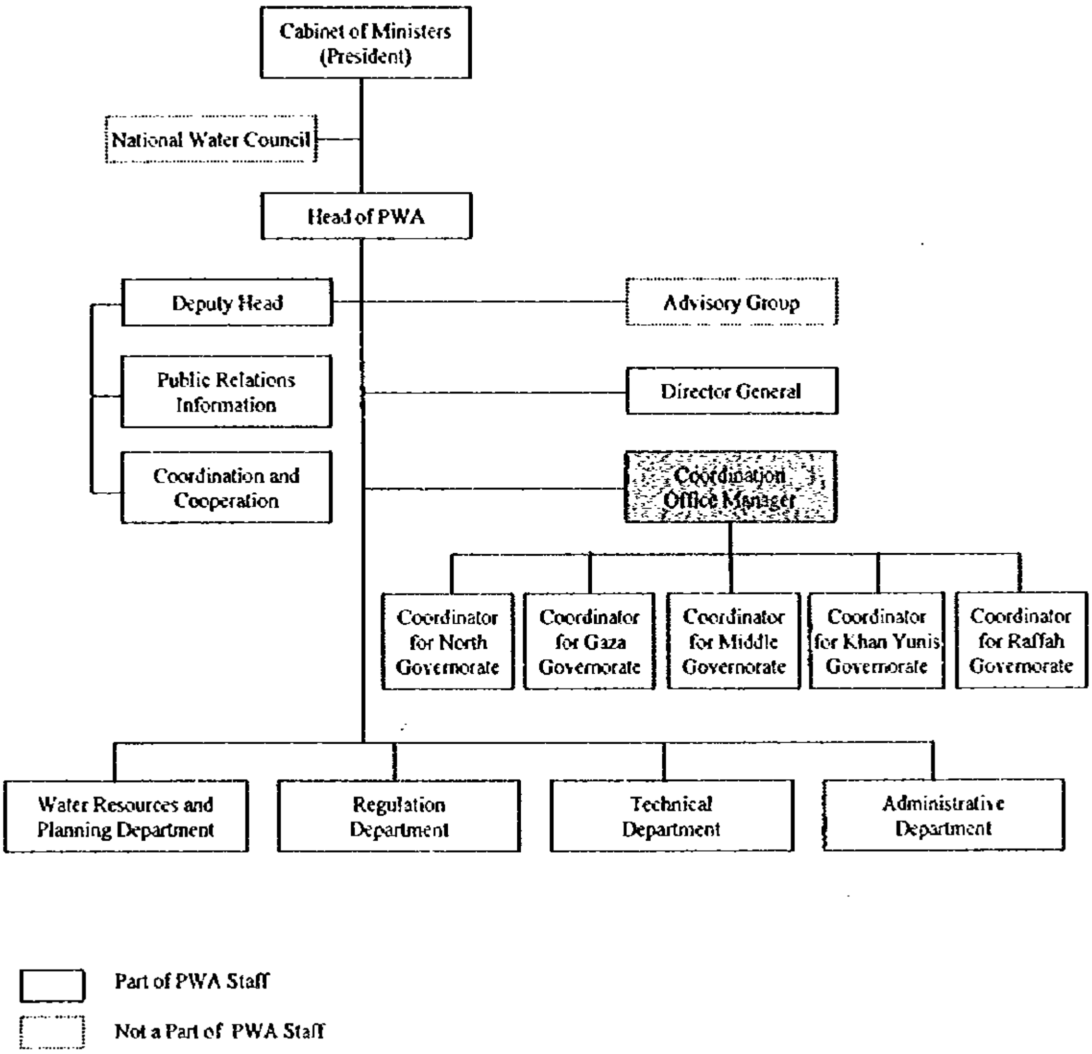


FIG. F.5.3 PROPOSED COORDINATION OFFICE STAFFING OF PWA

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The collection of solid waste from the consumers into containers spread over the city or village is considered as the responsibility of that municipality, where as the collection from the containers and dumping in one site is considered the responsibility of the Solid Waste Council, which represents all the mayors of the municipalities that share in the project.

A similar approach can be followed in the set up of the organization structure in Khan Yunis Governorate.

5.4.2 Organizational Development

(1) General

In order to provide and sustain a level of service which is acceptable to the consumers, the organization structure should be based on the following two items:

1) Cost Recovery: The provision of sanitation services should be recognized as being a commercial activity whereby the cost of providing the services must be met in full. This means that a service provider must ensure an economic level of income to cover its costs for both operations and maintenance, and for investment in infrastructure.

2) Efficient Management: The set-up of the organization structure should consider the special characteristics of the project area as well as the existing institutional environment into which the new organization must fit. As mentioned above, the project area comprises six municipalities and each municipality has administrative boundaries. Above this level of local governments, Governorate of Khan Yunis has been established to have a full authority over the municipalities as well as the areas outside the administrative boundaries.

Based on the above, the tasks of sewerage operation and maintenance will be split between the municipalities and the Governorate of Khan Yunis. The criteria for splitting the tasks is simply to keep the operation and maintenance of the network and customer services within the municipalities, where as a sewerage department within the Governorate of Khan Yunis will keep all the responsibilities of operation and maintenance of the treatment plant, all pumping stations, sewers outside the administrative boundaries of the municipalities in addition to all new works.

(2) Governorate of Khan Yunis

The Governorate of Khan Yunis as well as four governorates in Gaza Governorates have been established according to the President's resolution issued on 27/12/1994. On August 13, 1996 the Governor of Khan Yunis has been appointed by the President and since that time the Governorate of Khan Yunis started to act as the intermediate organization between the Ministry of Local Government and the Municipalities in Khan Yunis area. Figure F.5.4 shows the structural organization of Khan Yunis Governorate. The Public Relations Administration, Legal Affairs Administration and Development and Projects Administration as well as the Secretary Section are the only existing bodies in the Governorate. In addition, the Executive Council which represents all the mayors of the municipalities in Khan Yunis area has been established. The existing staff employed in the existing administrations is eleven persons.

For the time being, there is no plan that shows the future development of other administrations in the Governorate. However, Governorate of Khan Yunis has submitted a proposal to the Ministry of Finance in order to establish all the administrations with a key staff of three persons for each administration.

According to the President's resolution mentioned above, the budget of the Governorate should be based on percentages of taxes and fees collected in the Governorate area by the Central Government. For the time being there is no clear financial policy and the only financial source for the budget of the Governorate of Khan Yunis is the financial assistants which come from the Central Government.

(3) Organizational Development within the Governorate

Wastewater Department will be established within the Governorate of Khan Yunis to deal with the operation and maintenance of all common facilities such as treatment plant, pumping stations and main sewers. As shown in Figures F.5.5, F.5.6 and F.5.7 the new established department will be responsible to the Executive Council, headed by the Governor, which represents all the mayors of the municipalities. This linkage will create good coordination between the sanitation divisions in the municipalities and the Wastewater Department in the Governorate.

Wastewater Department will have two divisions: (1) Operation Division and (2) Development Division.

Operations Division will be responsible for the operation and maintenance of the treatment plant, all pumping stations, buildings stores and workshop as well as the main sewers including all the force mains and gravity sewers above 450 mm diameter. Some kind of coordination will be needed between the manager of the Operation Division and the operations sections in the municipalities.

As part of the operations division, the Quality Control Section will be responsible for wastewater quality analysis and to keep control over the performance of the treatment plant. This can be achieved by reporting about the matching between design criteria of the treatment plant and the day by day operational data of the influent and effluent in order to enable the Department manager taking any necessary actions. Therefore a plant operation laboratory at the treatment plant site will be needed and it will need to be equipped with all instruments and materials necessary to perform the daily and weekly tests.

Development Division will be responsible for the planning, design and construction of new works for sewerage system within the Governorate of Khan Yunis. All the planning and design works should be done based on the master plan that has been made by JICA Study Team with some amendments if needed. The allocation of any new works between the municipalities will be decided by the Executive Council of the Governorate after consulting with the division of new works.

To ensure that sanitation revenues which are transferred from the municipalities to the Governorate, will not be used for any purpose other than the Wastewater Department use, a financial and accounting section should be established within the Wastewater Department and will be responsible to the manager of the Department. This section will make control over the revenues and expenditures of the Department to keep the financial independence of the Department.

(4) Organizational Development Within Municipalities

As shown in Figure F.5.8 and Figure F.5.9, a sanitation division is to be established within the municipality of Khan Yunis during the implementation of the First Stage of the project. This division will be a model for other municipalities when the sewerage network is extended to cover the other villages.

The sanitation division is divided into two sections: (1) operation section and (2) customer services section. Obviously the new sanitation division will have lines of communications with other divisions in the municipality such as engineering, revenue, accounting, procurement and personnel divisions.

Revenue Division is responsible for reading of water and electricity meters and collect all the taxes and charges from the consumers. The billing system used by the revenue division has already included an item for sewerage fees, but for the time being it is kept empty. The only thing needed to collect the sewerage fees is to feed the computer with tariff system, and no additional personnel will be required.

All the administrative, accounting and procurement matters will be managed by relevant divisions in the municipality without any need for additional staff. This can justify the establishment of Sanitation Division within the municipality. Having established the Sanitation Division, the management of desludging the cess pits will be transferred form health division to the new sanitation division.

Therefore, the new established division will be responsible for sewers cleaning, new connection to the customers and receiving and following up the customer complaints as well as the management of cess pits desludging.

Referring to Figure F.5.8, the new division will be responsible to mayors of each municipality. The mayors who are represented in the Executive Council in the governorate will keep the coordination between the sanitation division of the municipality and the wastewater department in the Governorate of Khan Yunis.

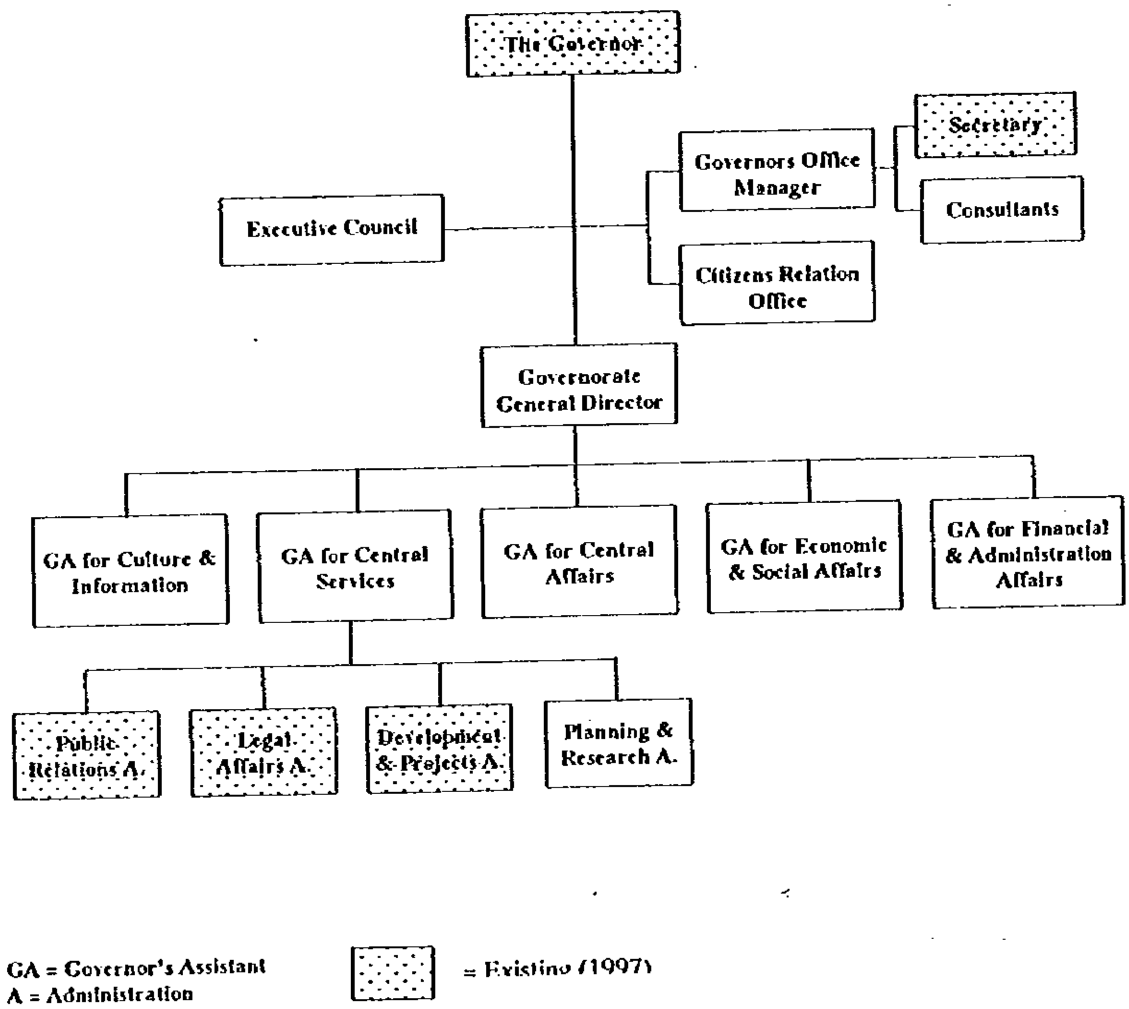

FIG. F.5.4 ORGANIZATION SET UP FOR GOVERNORATE OF KHAN YUNIS (PLANNED)

THE STUDY ON SEWERAGE DEVELOPMENT PLAN IN THE AREA OF KHAN YUNIS
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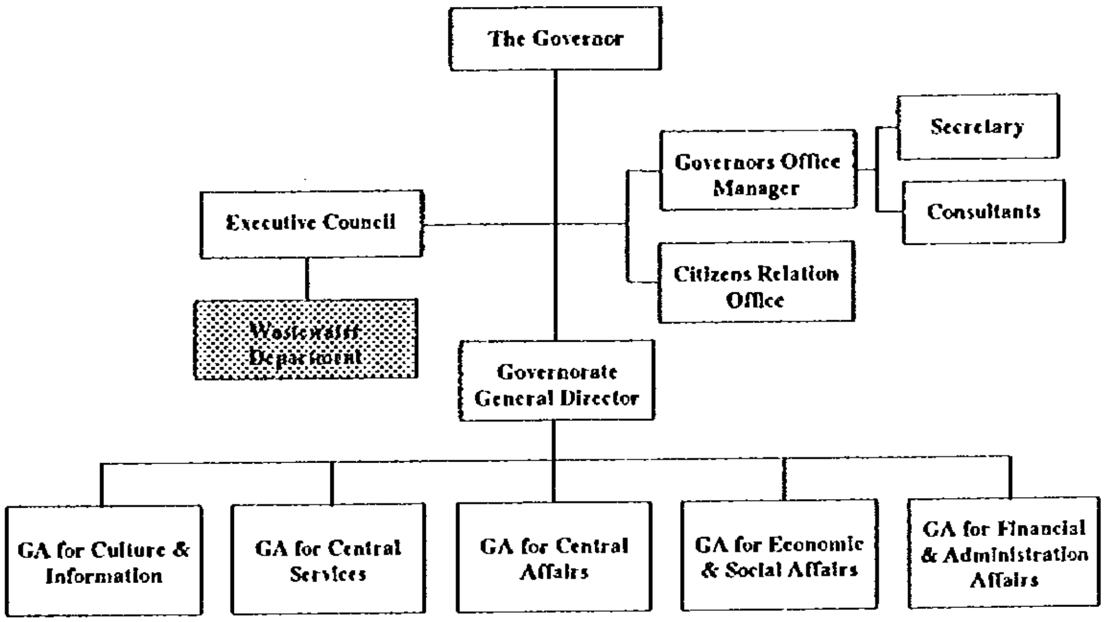

GA = Governor's Assistant

FIG. F.5.5 PROPOSED SET UP FOR WASTEWATER DEPARTMENT WITHIN GOVERNORATE OF KHAN YUNIS

THE STUDY ON SEWERAGE DEVELOPMENT PLAN IN THE AREA OF KHAN YUNIS
IN PALESTINIAN INTERIM SELF-GOVERNMENT AUTHORITY

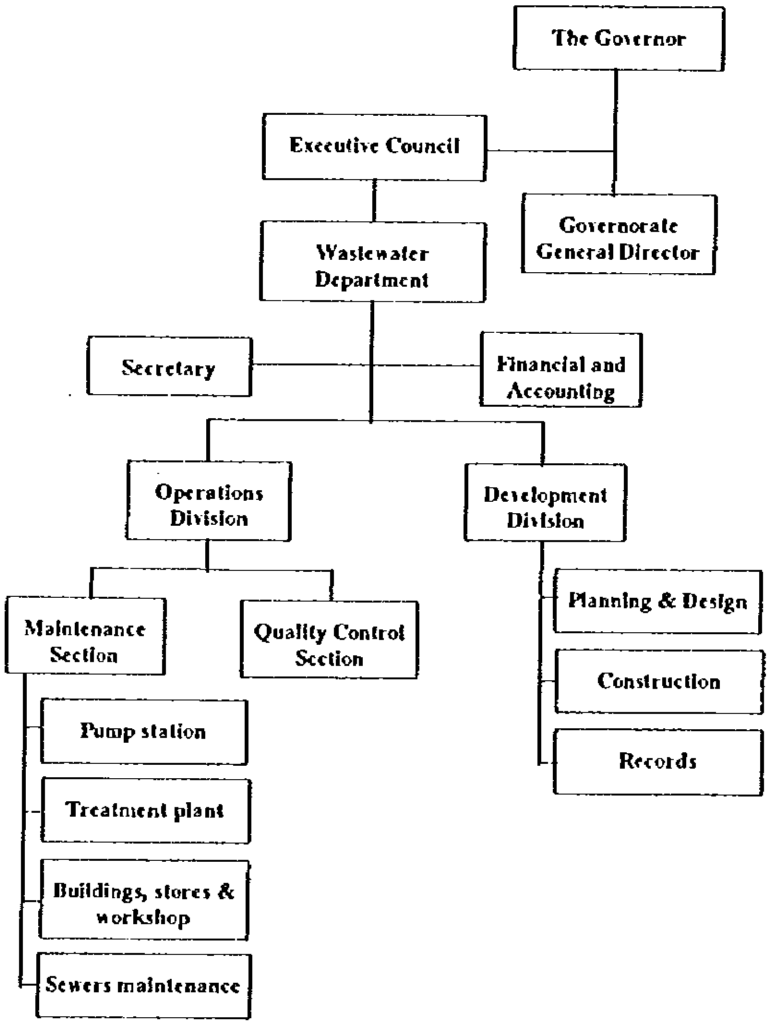

FIG. F.5.6 PROPOSED ORGANIZATIONAL STRUCTURE FOR WASTEWATER DEPARTMENT IN GOVERNORATE OF KHAN YUNIS (AT END OF 2002)

THE STUDY ON SEWERAGE DEVELOPMENT PLAN IN THE AREA OF KHAN YUNIS IN PALESTINIAN INTERIM SELF-GOVERNMENT AUTHORITY

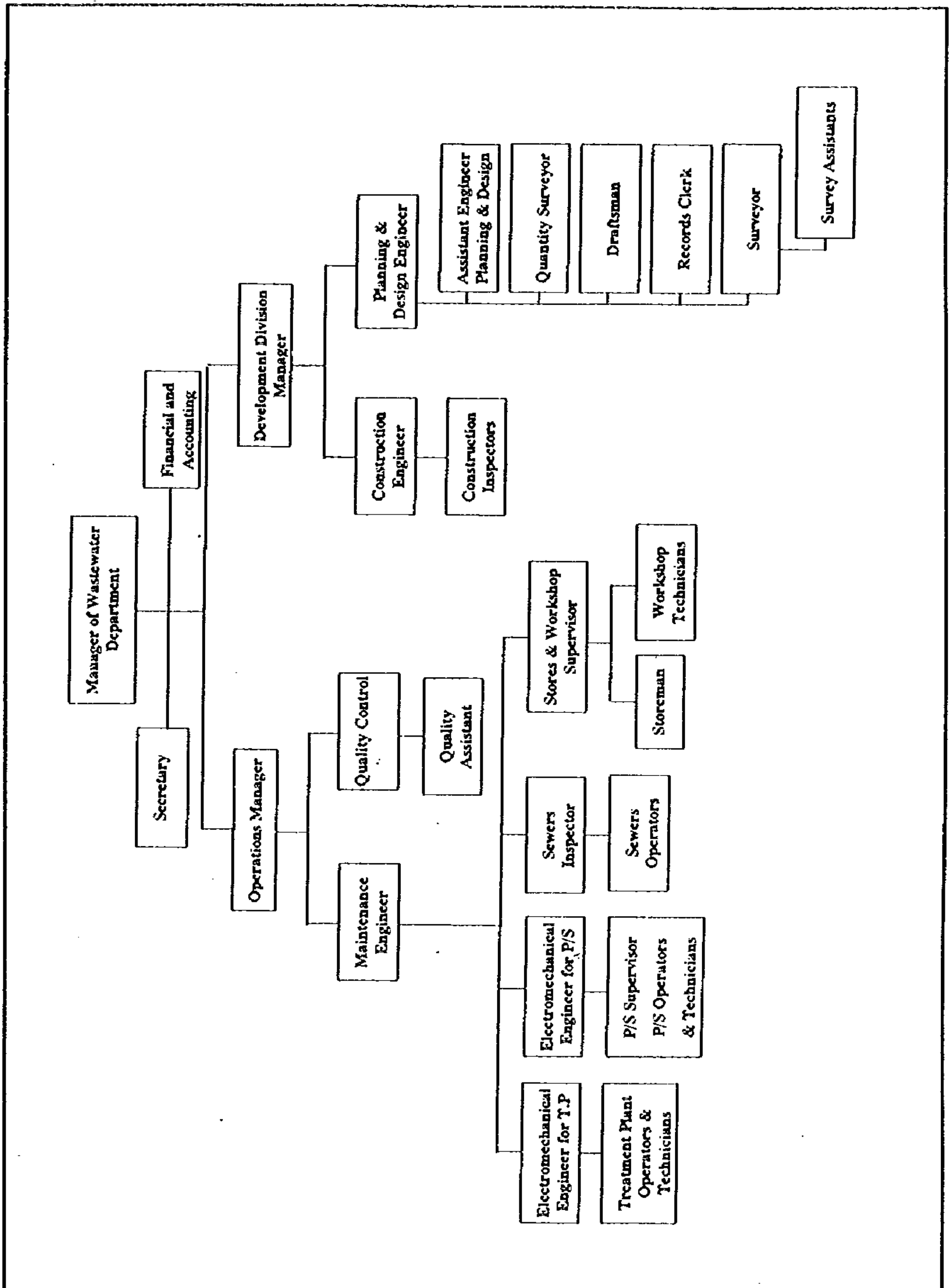

FIG. F.5.7	PROPOSED FUNCTIONAL ORGANIZATIONAL CHART FOR WASTEWATER DEPARTMENT IN GOVERNORATE OF KHAN YUNIS (AT END OF 2002)

THE STUDY ON SEWERAGE DEVELOPMENT PLAN IN THE AREA OF KHAN YUNIS
IN PALESTINIAN INTERIM SELF-GOVERNMENT AUTHORITY

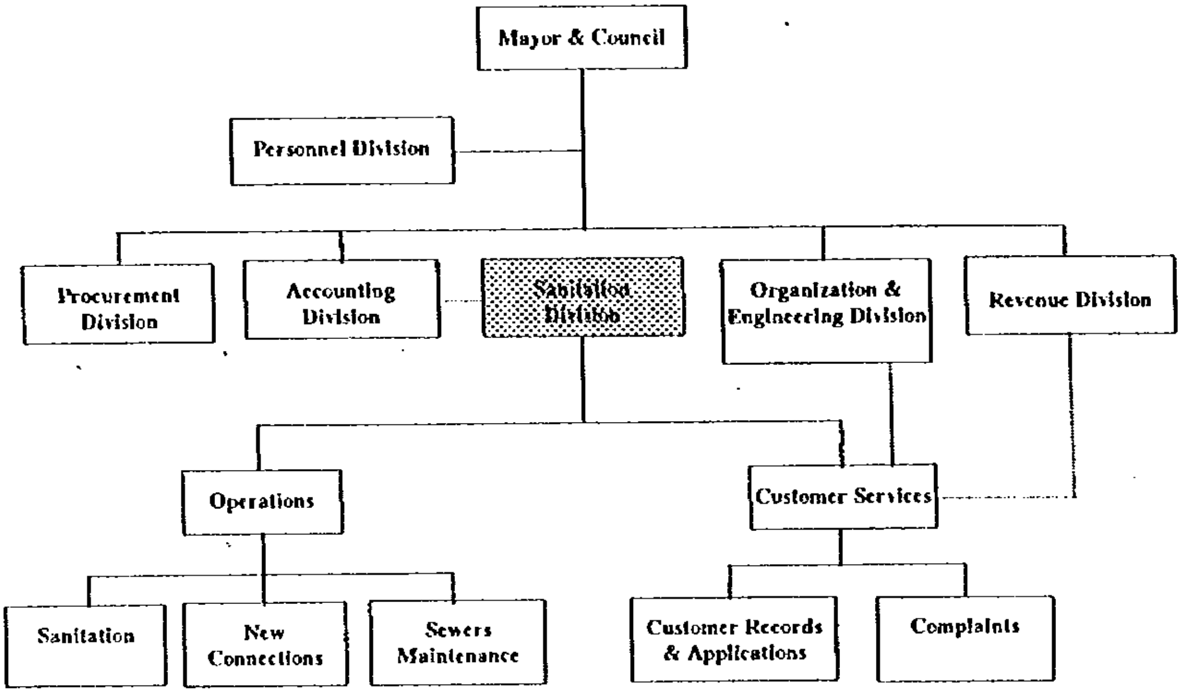

FIG. F.5.8	PROPOSED FUNCTIONAL ORGANIZATIONAL CHART FOR SANITATION DIVISION IN THE MUNICIPALITY OF KHAN YUNIS AND OTHER RELEVANT DIVISION

THE STUDY ON SEWERAGE DEVELOPMENT PLAN IN THE AREA OF KHAN YUNIS
IN PALESTINIAN INTERIM SELF-GOVERNMENT AUTHORITY

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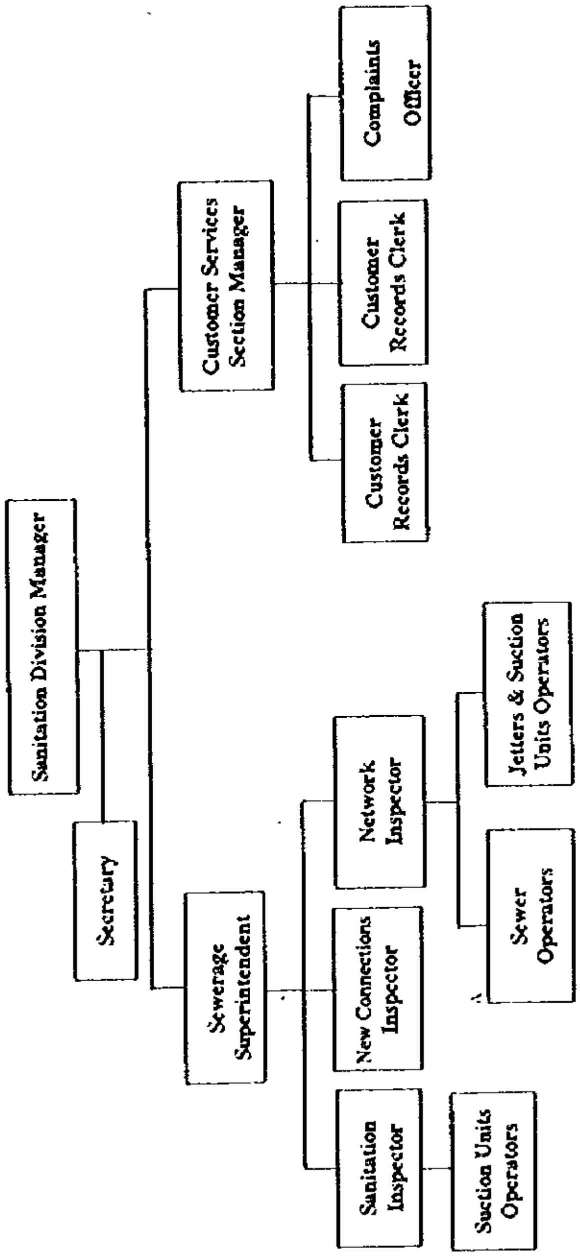


FIG. F.5.9	PROPOSED SENIOR MANAGEMENT ORGANIZATION CHART FOR SANITATION DIVISION IN THE MUNICIPALITY OF KHAN YUNIS (AT END OF 2002)

THE STUDY ON SEWERAGE DEVELOPMENT PLAN IN THE AREA OF KHAN YUNIS IN PALESTINIAN INTERIM SELF-GOVERNMENT AUTHORITY

(5) The Relationship between Wastewater Department and Sanitation Divisions

As mentioned earlier, the entire sewerage system of Khan Yunis area will be managed, operated and maintained by two levels of organizations, (1) the regional level within the governorate, and (2) the local level within the Municipality. Since the components of sewerage system are connected and dependent on each other, the coordination between the two levels of organizations is considered as an essential element in successful management. Also because the sewerage revenues are collected by the municipalities, an agreement between the Governorate and each municipality should be made to allocate the revenues between the two parties.

It should be mentioned that the municipality share in the revenues should be estimated according to the expenditures of all the staff of the Sanitation Division.

The remaining part of the revenues will be shifted to the Wastewater Department in the Governorate of Khan Yunis. In case that revenues are exceeding all the expenditures of the Wastewater Department, and no new works are needed, the profit should be allocated between the municipalities according to their share in the revenues.

(6) Organization Staging

One of the outputs of the Master Plan is to identify the implementation stages for the project. The Study Team has divided the implementation program into three stages: (1) First Stage from 1998 to 2002, (2) Second Stage from 2003 to 2006, and (3) Third Stage from 2007 to 2010.

The First Stage program which will start in 1998 and end by 2002 is proposed to be implemented in Khan Yunis. The component of works will include: 1) sewer pipe lines 2) two pumping stations, 3) one oxidation ditch wastewater treatment plant, 4) two sludge dump stations and five vacuum trucks for sanitation improvement and 5) drainage system in market area.

The context of each component might be amended as a result of the Feasibility Study. Accordingly, the Sanitation Division within the Municipality of Khan Yunis is to be established by the end of the First Stage.

At the beginning of the implementation stage the manager of Sanitation Division should be appointed to follow up the detailed design and the construction works. Immediately when the system is ready to function, and households are allowed to connect to the sewerage system, staffing for all the positions mentioned in Fig. F.5.7 have to be appointed.

On the other hand, the manager of Wastewater Department as well as the Operation Division manager and Development Division manager are to be appointed at the beginning of the First Stage. According to the progress of the implementation works other positions such as the maintenance manager and mechanical engineers for pumping stations and treatment plant will be appointed. By the end of the First Stage all the positions of the operations division have to be established.

In the Second Stage which lasts from 2003 to 2006, Qarrara, Bani Sohaila and the remaining parts of Khan Yunis will be covered by the network. Additional wastewater treatment plant facility will be provided. The Sanitation Division in both Qarrara and Bani Sohaila should be established in this stage and the development of these divisions will be the same as Khan Yunis municipality. For Khan Yunis sanitation division, additional staff will be needed. The additional wastewater treatment plant facility will require additional technicians to be appointed in the maintenance section of the governorate.

The Third Stage construction program which lasts from 2007 up to 2010 will be implemented for the remaining sub-districts in Khan Yunis, Kizan, Abassan Kabera and Khuza'a. Accordingly new sanitation divisions will be established in Abassan Kabera and Khuza'a, and additional staff will be needed in Khan Yunis. Moreover, additional staff will be required in operations division of the Governorate of Khan Yunis to cope with new pumping station and the extension of the wastewater treatment plant.

(7) Linkage With National Strategy for Water Supply and Wastewater

Although a national strategy has not yet been formally approved, the direction of the future strategy can be inferred from the findings of a workshop held in April 1994 under the auspices of the Technical and Advisory Committee.

The recommendations envisage the establishment of four regional combined water supply and sanitation utilities covering the northern, central, southern and coastal regions. These utilities will be responsible for design, construction, operation and maintenance of retail consumer services including: water supply, wastewater collection and reuse, stormwater collection, treatment and reuse, and water and treated wastewater supplies for irrigation.

The Regional Water Utilities will be local government owned, with community representation on their boards. They will be administratively and fiscally autonomous, although tariffs will be reviewed, and water abstraction and discharge will be licensed and monitored by the PWA.

The creation of a new semi-independent organizations on a regional level under the umbrella of the Governorate will be a model for practicing a regional organization for management and operation of water supply and wastewater. Moreover, this semi-independent organization will make it easy to transfer from Governorate of Khan Yunis to the Regional Water Utilities. Furthermore, good coordination between the Wastewater Department in the Governorate of Khan Yunis and the Sanitation Divisions in the Municipality will become a good example for the relationship between the Regional Water Utilities and wastewater sections of the Regional Utilities.

5.4.3 Human Resources Development

The adequate number of operation and maintenance staff and the qualifications of each staff member are the key for good management of the sewerage system. The development of human resources will be staged according to the progress of the implementation of sewers and other facilities.

(1) Staff Requirement for O/M in The First Stage

The components of the sewerage system which are expected to be implemented in the first stage are:

1)	Sewers length	=	120 km
2)	No. of pumping stations	=	2
3)	No. of manhole type pumps	=	6
4)	No. of drainage pumping stations	=	1
5)	Treatment plant	=	1
6.)	No. of vacuum trucks	=	5

In order to keep the level of sewerage services acceptable at all times, the sewerage system components should be provided with the number of staff as described below:

1) Operation & maintenance of sewers

a. Daily Inspection Work:

A team of three persons can maintain 400 ~ 500 m sewer length per day. Frequency of daily inspection works are estimated at 3 times per team per year. Therefore, to operate and maintain 120 km, it is required to have

4 teams of 3 persons each = 12 persons

b. Mechanical Cleaning:

At least two combined suction and jetter units will be required for the First Stage. For each unit, two laborers as well as a driver are needed. Therefore, for mechanical cleaning, 5 laborers including drivers will be required.

< Calculation >

Nos. of team are estimated as follows:

$$\frac{120 \text{ km} \times (1 \sim 1.5) \text{ times/y}}{0.2 \text{ km} \times 260 \text{ d/y}} = 3.5 \rightarrow 4 \text{ teams}$$

4 teams x 5 persons = 20 persons

2) Operation and maintenance of lifting pump stations and manhole pumps (6):

To supervise 3 teams a chief and two subworkers are required. Therefore the total persons required for 2 pumping stations are 30 persons.

The two pump stations need:

4 operators, of 3 teams for each

1 electrician 1 mechanic
1 craftsman 1 laborer

3) O/M of drainage pumping stations and pipeline:

Since the drainage P/S will work occasionally, there seems to be no need to keep permanent staff. However, maintenance works of the pipeline will be required through a year. Required persons are estimated at 5 persons as operation and maintenance workers.

4) O/M of treatment plant

There will be three shifts working for 8 hours. One team consists of 6 persons. In addition a chief and 6 workers are required for 3 series.

2 operators	1 electrician
2 mechanics	1 craftsman
1 laborer	2 watch guards

5) Vacuum trucks

No. of vacuum trucks = 5

For each truck, one driver and two laborers are needed. However the existing 5 trucks require the same number of workers.

The total = 30

The total number of staff members for the sanitation division and wastewater department is summarized in Tables F.5.14 and F.5.15. The tables show all the staff needed including engineers, technicians, administrative staff, operators and laborers. The qualifications of the Senior staff members are mentioned in Appendix J.

Table F.5.14 Summary of Staff Requirements for Wastewater Department in Governorate of Khan Yunis in the First Stage

	Adm. Staff	Engineers	Technicians	Operators	Laborers	Total
Administration	3	6		3	8	20
Sewers	1	2	4	0	25	32
P/S	1	1	3	12	13	30
T/P	2	1	3	15	4	25
Drainage			1	2	2	5
Total	7	10	11	32	52	112

Note: P/S = Pumping Station, TP = Treatment Plant

Table F.5.15 Summary of Staff Requirements for Sanitation Division in Khan Yunis Municipality in The First Stage

	Adm. Staff	Engineers	Technicians	Laborers	Total
Administration	2	2	1	1	6
Sanitation			2	22	24
Total	2	2	3	23	30

(2) Staff Requirement in the Second and Third Stages

In the second and third stages, additional areas will be covered with sewers, new pumping stations will be constructed and the treatment plant will be extended. As a rule of thumb, when each municipality covered with sewerage system, a new sanitation division is to be established. The same number of staff which has been identified for Khan Yunis Municipality will be needed except the number of laborers. As mentioned earlier, the number of laborers needed for the maintenance of sewers can be decided according to the criteria used for Khan Yunis municipality.

The laborers needed for vacuum trucks can be decided as mentioned before, that is 3 laborers including the driver is needed for each truck.

Due to the construction of new pumping stations, the number of operators, electricians, mechanics, craftsmen and laborers will be increased according to the criteria which is set up in the First Stage.

(3) Training

Implementation of the proposed structure must be supported by adequate training of staff in order that they can undertake their designated responsibilities and duties. This training should cover all levels of staff and be related strictly to the requirements of the posts as defined in the job descriptions.

The training courses can be classified into three categories:

1) Training for senior management staff:

This training should cover the manager of the wastewater department, the managers of the divisions in the Governorate of Khan Yunis and Municipality of Khan Yunis. The training course should focus on the efficient management for sewerage systems in addition to general concepts of the operation and maintenance of different components of the system. This type of training can be done through hiring expertise to conduct these courses.

2) Training for maintenance engineers and technicians:

Special training courses which focus on the maintenance of electro-mechanical equipment should be given to mechanical engineers and technicians who are involved in the maintenance of pumping stations and treatment plant. Such training can be held under the supervision of maintenance expertise form neighboring countries.

3) Training for operators and laborers:

The concept of operation and maintenance as well as an explanation about the components of the sewerage system should be the key topic in the training course, which cover all the operators and sewers inspectors and cleaners. More attention should be paid on the various methods of cleaning and clearing of the sewers. These courses should be held locally with the assistance of some expertise from Arabic countries like Egypt or Jordan.

(4) Foreign Experts

It is expected that the Palestinian side will face some difficulties in the planning, detail designing, implementation and operation of the Khan Yunis Sewerage Project, because the proposed sewerage system will be new in the Khan Yunis area and require a institutional changes in both the municipalities and the Governorate of Khan Yunis.

The foreign experts will be required mainly to the following aspects:

1) Before the implementation

The foreign experts will play an important role for the institutional set-up, strengthening of the legal system, assistance of the detailed design, preparation of the implementation and training programs .

2) During the implementation

The foreign experts will assist and advise the Palestinian side for institutional and legal strengthening, training of the managers and operators, construction works and preparation of O/M

3) After implementation, or for operation and maintenance

The foreign experts will advise the Palestinian side for the detailed O/M works of the treatment plant, pumping stations and sewers, to assure all the system working as the original design.

There will be required some modifications or adjustments during all the periods, and the foreign experts will provide the Palestinian side with proper advises in a good timing.

5.4.4 Operation and Maintenance

The concept of operation and maintenance of the sewerage systems on a trouble or emergency basis should be developed to be more comprehensive in order to include the planned operation and preventive maintenance. To keep all the facilities of the sewerage system in good operational condition, the tasks below should be achieved:

(1) Main Tasks of the O&M Division in the Municipality of Khan Yunis

1) Receiving and responding in a timely manner to alarms on cases of blockage and overflow of sewer system.

2) Determining the best method of cleaning (flushing, digging up affected sections, etc.) and carrying out removal of blockages.

3) Identifying the cause for malfunction and eliminating it.

4) Keeping records of occurrences and causes of blockage and times elapsed for attending to and solving of the problem in each case.

5) Making active checks of pipelines to discover existing and imminent problems.

6) Receiving information concerning new house connections from the Customer Services Section.

7) Carrying out surveys of house connections and informing customers about the standard of work and other regulations concerning the construction of house connections.

8) Inspecting house connection work by the customer or a contractor employed by the customer, approving the work and preparing as-built drawings of the house connections.

(2) Main Tasks of the O&M Division in the Governorate of Khan Yunis

1) Checking daily the running of M/E equipment of sewage pumping stations.

2) Notifying the M/E Maintenance Team of any existing or imminent failure needing their attention.

3) Performing routine maintenance measures of M/E equipment according to preventive maintenance schedules.

4) Recording operation data (running times, electrical consumption, etc.) of M/E equipment.

5) Inspecting the treatment plant storage and keeping constantly available spare parts and consumables needed for the routine O&M of the network system.

6) Participating in taking-over inspections of network sections from contractors, assuming responsibility for the O/M from the Development Division after taking-over.

7) Measuring and analyzing water quality at different stages of the treatment to assess the performance of each unit process or operation.

8) Measuring and analyzing the quality of the final effluent to check the performance of the entire treatment process and to verify the compliance of the final effluent with the effluent criteria.

9) Keeping records of operational data, treatment results and operation costs.

10) Providing on-the-job training to new staff and regular refresher training to the existing staff.

11) Carrying out overhauls and minor repairs of M/E equipment.

CHAPTER 6 PROJECT EVALUATION

CHAPTER 6 PROJECT EVALUATION

6.1 Technical Evaluation

6.1.1 The First Stage Project

It is envisaged that the project implementation will be undertaken in five (5) parts as follows:

(1) Wastewater Collection and Transfer Facilities

Supply of materials and construction of trunk sewers, secondary sewers, lift/pumping stations and force mains.

(2) Wastewater Treatment and Disposal Facilities

Supply of materials and construction of treatment facilities, effluent pumping station and force mains, including civil works, and manufacture, supply, delivery, installation and commissioning of mechanical, electrical and control equipment for lift stations, pumping stations.

(3) Stormwater Drainage System Facilities

Supply of materials and construction of conduits, retention basins, pumping stations, and force mains. Manufacture, supply, delivery, installation and commissioning of mechanical, electrical and control equipment for effluent pumping stations.

(4) Property (House) Connections

Supply of materials and construetion of property connections to serve the Khan Yunis District.

(5) Sanitation System

Supply of materials and construction of sludge dumping spots, and vacuum trucks for septic tanks/cesspits desludging.

6.1.2 Justification of the Proposed System

(1) Sewerage System

At present there is no functional wastewater collection or treatment system in operation. Households and communities rely on poorly-performing cesspits and septic tanks, whilst no industries operate pretreatment facilities which meet acceptable effluent discharge standards.

Existing drainage systems are utilized in limited districts for collection of wastewater and septic tank effluent, although these systems are inappropriate for this purpose and instead tend either to infiltrate into ground or accumulate large volumes of septic waste.

A wide range of strategy planning options have been identified and evaluated, ranging from localized solutions (incorporating several small treatment facilities) to centralized solutions (involving one or two large treatment facilities). Finally three (3) alternative wastewater management strategy options were selected and evaluated in detail for costs, environmental impact (by initial environmental evaluation), social impacts and technical features. The option comprising one (1) large central treatment plant servicing entire districts was selected as the optimum long-term strategy for the following reasons:

- It represents the least-cost solution,
- It can achieve the desired wastewater quality objectives,
- It has minimal negative environmental and social impacts,
- It involves no resettlement, and
- It is financially viable and affordable.

The recommended strategy involves collection and treatment of domestic/commercial/ industrial/institutional wastewaters. The strategy is based on maximum use of separate sewerage (to maximize cost-efficiency). The large central treatment facilities will comprise relatively simple, low-cost and reliable oxidation ditch processes combined with anaerobic ponds, and will be situated in remote locations to the east of Khan Yunis City so as to have minimal impact on existing and future urban areas.

(2) Stormwater Drainage System

Under the First Stage Program, the stormwater drainage system will cover a total catchment area of 423 hectares encompassing most of the urban builtup districts in Khan Yunis City. The stormwater runoff in the catchment area will be collected by gravity through the existing road network as secondary and tertiary drains and led to the gravity stormwater conduits connecting the central market area to the retention basin at PST 3 in El Katibah. The runoffs will then be discharged through pumps and a force main to the nearby dune for ground recharge.

This proposed drainage system will fully utilize the existing road surfaces and flow down the runoffs following the ground slopes so as to minimize not only capital investment but also operation and maintenance cost. The First Stage drainage system, while investing limited construction costs, will be able to relieve almost 100,000 residents in the central part of Khan Yunis City from the persistent inundation and inconvenience. In addition, the proposed drainage system will assure the efficient recharge of stormwater into ground.

(3) Sanitation System

Until the year 2015 when the proposed new sewerage system completes and all the residents have access to the sewerage network, 5 units of vacuum trucks and sludge dumping facilities will be provided as a transitional measures for the safe disposal of existing cesspits and septic tanks sludge from the unsewered districts. These sanitation facilities will significantly contribute to improve the present deteriorated sanitation condition at the low investment.

(4) Overall Justification

The proposed implementation of the First Stage Program involves the least-cost intermedium-term strategy plan for the high priority districts in the Project Area, and will serve the most densely developed, high priority urban districts. Further expansion of the wastewater collection and treatment system is planned under two (2) further implementation stages, to serve existing and future urban development in the southern regions of the Khan Yunis Directorate.

The First Stage Project will serve a total area of about 874 hectares. Approximately 158,000 people will be served by the sewerage system by the year 2015 (representing about 40 % of the estimated total population in the Study Area).

The First Stage Project will cater for the average wastewater flows up to 25,112 m3/day (on the year 2015 basis). The long-term strategy plan will eventually provide full wastewater facilities to about 476,000 people, and handle a total flow of up to 53,300 m3/day by 2015.

The First Stage drainage system facilities will cover a total of 423 hectares in the central part of Khan Yunis built up urban districts. When the drainage facilities are completed, about 100,000 people will be relieved from the persistent inundation problem, and at the same time the stormwater discharged to the dune will significantly contribute to recharge fresh water to the ground.

Furthermore, the provision of a gravity conduit draining the water from the central business and commercial districts, particularly from the central market zone, will help promote commercial activities which otherwise would often be interrupted during winter rainy seasons.

Overall, the proposed First Stage Program is justified to be technically sound and will contribute to a large extent to the improvement of currently deteriorated public sanitation and environment in the Khan Yunis District.

6.1.3 Project Execution

The Government is presently considering the establishment of a Wastewater Utility Company (WUC) to coordinate pollution control strategy and action plans throughout the Gaza Province, regardless of administrative boundaries. It is proposed that the WUC, which may be established, would coordinate pollution control projects prepared by MOPIC and the municipalities/villages within the Governorate. It would then assume responsibility for implementing, operating and maintaining such projects.

WUC is expected to be the catalyst in generating increased private sector participation in implementation, operation and maintenance of wastewater projects. At such time as the proposed WUC is established and staffed, arrangements satisfactory to the Government and the various agencies concerned will be made to transfer to it the responsibility for project implementation.

The Khan Yunis Governorate will be the Executing Agency for the Project, in association with Khan Yunis Municipality and WUC, and will take responsibility for the project implementation. WUC will comprise professional staff with experience in wastewater pollution control, and administrative and support staff, and will coordinate project implementation at Governorate level. It will liaise with the municipalities throughout the Governorate, as well as with other government authorities providing public facilities which may be affected during the project implementation (such as roads, railways, water and public utility services).

WUC, MOPIC, Water Authority and Governorate may jointly establish a Project Steering Committee chaired by the Governor of Khan Yunis, or their designates, and comprising representatives of the municipalities.

MOPIC will take steps to procure the services of consultants to prepare detailed designs, drawings and tender documents, under a budget allocation from JICA's fund. Consultants will also assist in construction supervision and staff training.

6.1.4 Procurement

Contract packaging proposals will be developed for the procurement. Civil works contracts are to be awarded through competitive biddings for construction of wastewater collection, transfer, and wastewater treatment and disposal facilities; sanitation facilities; and stormwater drainage facilities, These include mechanical and electrical contracts for plant and equipment, whilst construction of property connections may be planned under several smaller contracts for local contractors.

6.1.5 Consulting Services

Consulting services will be required in one tender package, for assistance in project implementation, construction supervision, and to undertake training courses for local staff involved in the Project. Detailed design work for the Project will be undertaken by consultants appointed and funded under a budget allocation from the JICA Fund.

6.1.6 Implementation Schedule

It is envisaged that implementation of the Project will proceed rapidly, since the major works will be carried out under several large parallel works covering the construction of the wastewater collection, transfer, treatment and disposal facilities, together with stormwater drainage facilities.

It is planned that the First Stage Project will be implemented over a period of 5 years with full completion being achieved by the end of year 2002, which may be divided into three (3) consecutive phases. Implementation and commissioning of the main project components of the Phase 1 of the First Stage Project is programmed to be completed over a two-year period by the end of year 2000.

Interim commissioning of the project facilities is planned to be carried out during the Phase 1 period to enable earliest possible utilization of the new facilities and early introduction of cost recovery measures.

6.1.7 Operation and Maintenance

There is a distinct lack of operational and maintenance knowledge and experience for wastewater systems in Khan Yunis. The preliminary engineering design prepared for the Project has therefore focused on the provision of modern, simple, reliable components requiring minimal operational and maintenance experience. Nevertheless, extensive staff training courses will need to be implemented to ensure that the project facilities are correctly operated and maintained. Consulting services proposed to be carried out as part of the Project will ensure that close attention is given to this requirement.

6.1.8 Wastewater Monitoring and Development Program

In conjunction with the Project, a range of measures will also be developed to provide early environmental benefits both within the Project Area and in Districts not served by the Phase 1 works. These measures include:

(1) Implementation of a pro-active wastewater monitoring and enforcement program to ensure commercial, industries and other large point sources comply with currently acceptable discharge standards,

(2) Active encouragement of small to medium commercial and industrial works (which do not operate pretreatment facilities) to dispose of their wastewater by trucks or tankers to new treatment facilities until such time as new wastewater collection systems are installed, and

(3) Encouragement of households more frequent desludging of cesspools and septic tanks within the on-site sanitation areas, and disposal of the sludge to the new wastewater treatment system, by using in more efficient manners vacuum trucks to be provided under the Project.

6.1.9 Land Acquisition And Rights

New wastewater collection sewers and force mains, and most pumping stations, will be constructed within road reserves or on government-owned land. Totally two (2) large pumping stations and six (6) small manhole type pumping units will need to be constructed on a total of about 3 hectares of privately owned land, which will be purchased as part of the Project. Pumping station sites have been selected so that no resettlement will be required. One large land sites totaling about 35 hectares will also need to be acquired for the central treatment facilities.

For the First Stage stormwater drainage system, a retention basin of about 14,000 m^3 capacity needs to be built at the vacant land near El Katibah. For the retention basin, about 1.2 hectares land area will need to be acquired.

6.2 Economic and Financial Evaluation

6.2.1 Summary of the Project Status as a Whole

The whole works of this Project consists of three (3) stages that will start in 1999 and end in 2010 as mentioned in Part 2. In this reviewed Master Plan, both of the EIRR and the FIRR are negatively resulted as shown in the following Table as -5.11 % and -7.57 % respectively in the loan basis. It means that the Project is not fit for the loan to be executed from both the viewpoints of economic and financial aspects.

Table F.6.1 Result of Project Evaluation in Loan Basis for the Whole Works (Master Plan Review Level)

	EIRR/FIRR(%)	B/C	B-C(US$1,000)
From Economic Evaluation	-5.11	0.23	-78,545
From Financial Evaluation	-7.57	0.19	-96,789

While, in grant basis, both the EIRR and FIRR resulted as follows:

Table F.6.2 Result of Project Evaluation in Grant Basis for the Whole Works (Master Plan Review Level)

	EIRR/FIRR(%)	B/C	B-C(US$1,000)
From Economic Evaluation	5.57	0.74	-8,356
From Financial Evaluation	1.58	0.56	-17,445

Generally, as suggested by such international institutions as the World Bank, a EIRR is expected to at least be cleared a hurdle of 5.0 % of EIRR from a viewpoint of basic human needs even such a project is in developing countries, and the Project under study satisfies this expectation with 5.57 % of the resulted EIRR. Namely, the Project is economically sound from the viewpoint of basic human needs in the grant basis.

On the other hand, the FIRR analysis has resulted with a rate of 1.58 %, slightly over the zero percent. When the FIRR is zero, the cumulative amount of benefits (revenue) will be equal to the cumulative amount of costs during the project life. This means that the OM costs including replacement costs for the main facilities can be covered by a recommended tariff of NIS.35 per month per HH in average in the proposed service charge system for the new sewerage treatment facilities.

According to the result in Part 2, the cumulative benefit (revenue) is US$132,903 thousand and cumulative cost is US$119,807 thousand, so that cumulative surplus (cash balance) has become US$13,095 thousand. Namely, in the case of the said resulted FIRR, 1.58 %, the revenue by applying the recommended tariff system, NIS.35 per HH per month, will cover the whole costs to be borne by the Municipality of Khan Yunis within the Project life of 30 years.

In succession to the result of evaluation of the Project in the Master Plan Review level mentioned above, an evaluation of the Project for the Feasibility Study is made hereunder which includes the first stage works only to make clear a feasibility of the works that will be granted by the Japanese Government.

6.2.2 Estimation of Economic Benefit of Project in Feasibility Study Level

The first stage of the Project is planned to commence its works in 1999 and to end in 2002. Therefore, all the benefits will accrue in 2003 and after.

(1) Economic Benefit Derived from Medical Expenses

According to the Master Plan, total expenditure of hospitals for diagnosis, treatment and operation including overhead fees was US$35,798 thousand. It means that average expenditure per patient was US$98/persons (equivalent to NIS.324) per year.

Here, it is assumed that impact of the Project under study to improve the environment of sanitation and/or health is 30 % according to that of similar project, and the first stage of the Project will end in 2002, so that the Project effect will realize after 2003 as mentioned above.

The service population in 2003 and 2015 is projected at 143,544 and 206,830, and number of effected persons will be 15,444 persons and 22,253 in the same year respectively. As a result, the amounts of medical expenses will be saved at sums of around US$732 thousand in 2003 and US$2,151 thousand in 2015 as shown in Table 1 in Appendix J. In this case, it is assumed that 2 years will be necessary for full connection between whole living buildings and the sewerage systems. Therefore, one more year will be necessary to fully connect for the population in 2015, namely, the amount of medical expenses to be fully saved may be estimated at US$2,183 thousand in 2016. These amounts can be taken as a part of economic benefit that derived from medical expenditures.

(2) Economic Benefit Derived from Income Loss of Patients

As mentioned in Part 2, the average family size may be calculated as 9.43 persons per HH according to the result of the Social Survey made by JICA in 1996. And the workable persons are estimated as 4.41 persons per HH in average. In this case, it is assumed that these workable persons range from 20 years old and over in their age based on the said survey.

The ANNEX also says that the share rate of water related diseases and faecal disposal related diseases is 84.57 % to the total number of cases. On the other hand, the distribution rates of inpatients and outpatients to the population were 8.46 % and 33.94 % respectively in 1995.

Economic Benefit Derived from Income Loss of Inpatients

The average staying days in hospitals were 3.3 days according to the above mentioned medical statistics. By using the above mentioned workable persons per HH, share rate of cases in water related and faecal disposal related diseases to the total cases, and the distribution rate of inpatients to the population, probable number of inpatients in 2003 and 2016 is estimated as 2,841 persons and 8,187 persons respectively.

As mentioned in Part 2, the average monthly income is NIS.1,059/month per HH in the study area. This amount of income can be converted into daily income as NIS.42.36/day when workable days is assumed at 25 days per month in average.

Using the above mentioned information and assumption, the sum of US$120 thousand per year and US$347 thousand per year can be derived as a economic benefit from their probable income loss in 2003 and 2016 respectively in total as shown in the Table 1 of Appendix J in detail. These amounts can be taken as the other part of economic benefit.

Economic Benefit Derived from Income Loss of Outpatients

The number of outpatients was 292,041 persons with 33.94 % of distribution rate as mentioned above against the population of 860,369 in Gaza Governorates in 1995. It is assumed that this distribution rate may apply to the inhabitants living in the study area. The share rate of water related and faecal disposal related diseases, workable persons per HH, and their average daily income are used as same rate in the case of inpatients. The probable number of outpatients in 2003 and 2016 is estimated at 11,393 persons and 32,832 persons respectively.

As a result, the sum of US$146 thousand per year and US$421 thousand per year can be derived as the other economic benefit from their income loss in 2003 and 2016 respectively in total as shown in the Table 1 of Appendix J in detail. These amounts can be taken as a part of economic benefit too.

(3) Economic Benefit in Total

Total economic benefit is as summarized in the following Table.

Table F.6.3 Annual Economic Benefit up to 2016

(US$ thousand/annum)

Year	Saved medical fees	Income loss of inpatients	Income loss of outpatients	Total
2003	732	120	146	999
2004	1,541	245	298	2,081
2005	1,596	253	3308	2,157
2006	1,648	262	318	2,228
2007	1,697	270	328	2,295
2008	1,749	278	338	2,364
2009	1,802	286	348	2,436
2010	1,857	295	358	2,510
2011	1,913	304	369	2,586
2012	1,969	313	380	2,662
2013	2,028	322	391	2,741
2014	2,088	332	403	2,823
2015	2,151	342	415	2,908
2016	2,183	347	421	2,952

(Note) See detail shown in the Table 1 of Appendix J.

6.2.3 Estimation of Financial Benefit

As mentioned in Section 5.3 in previous Chapter, the amount of NIS.35 per HH per month is a recommended tariff rate due to social reasonability and financial supportability.

Accordingly, the amount of NIS.35 per month per HH for ordinary customers is applied for probable revenue of the Municipality for operation and maintenance for the system as financial benefits of the Project. The annual financial benefit flow is estimated as shown in Table 2 in Appendix J and summarized in the following Table.

Table F.6.4 Annual Financial Benefit up to 2016

(US$ thousand/annum)

Year	Probable revenues as financial benefit
2003	969
3004	1,971
2005	2,040
2006	2,107
2007	2,170
2008	2,236
2009	2,304
2010	2,374
2011	2,446
2012	2,518
2013	2,592
2014	2,670
2015	2,750
2016	2,791

(Note) See detail shown in Table 2 of Appendix J.

The Municipality of Khan Yunis should replace the facilities for the system within this amount in the future.

6.2.4 Economic and Financial Cost of Project

The economic cost of the Project is converted from the financial cost under the some conditions and assumptions mentioned hereunder.

The Palestine now has a taxation system with a rate of 17 % as the Value Added Tax for whole trading. Therefore, such taxes as transfer payments are assumed to be 17 % of market prices of commodities and services procured locally, and to be exempted from any taxes and duties for those procured from abroad.

In order to estimate the standard conversion factor (the SCF), a following equation is usually applied:

SCF = (I + E)/((I + Ic-Is) + (E - Et + Es)) * 100

Where, SCF : the Standard Conversion Factor,
I : Import amount,
E : Export amount,
Ic : Import customs,
Is : Import subsidies,
Et : Export taxes, and
Es : Export subsidies.

The SCF to be applied for local commodities and services in the case of this Project is estimated based on the trading data in Israel considering the existing situation of Palestine at 92.04 % as mentioned in Part 2.

Economic wage of unskilled laborers to be employed for the construction works is assumed to be 90 % of the actual market wage, taking of the employment opportunity of laborers in the study area.

Economic cost of land compensation is assumed to be 100 % of the financial cost, taking account of the opportunity cost of land use.

The economic and financial cost of the Project is given in the present value (PV) at the 1997-August price level and are taken no account of the price escalation during the periods of construction works and Project life for evaluation.

Economic costs for operation and maintenance (OM cost) after completion of first stage works to the end of the Project life are estimated based on the same assumptions of the said Project cost.

Replacement cost for the facilities is estimated at a rate of 55 % for pumping station to its total cost, 46 % : waste water treatment plant, 100 % : sanitation system, and 46 % : drainage system and their life time 25 years after completion of the construction works except sanitation system. The sanitation system consists only trucks, so that its life time is set as 10 years.

Project life is set as 30 years after commencement of construction works. Therefore, only the replacement cost for the sanitation system will be appeared during the Project life.

Annual allocation of the economic and financial costs of the Project is shown in Table 3 of Appendix J and summarized below.

Table F.6.5 Annual Allocation of Construction Cost for First Stage

(US$ thousand)

Year	Work stage	In loan basis		In grant basis	
		Financial cost	Economic cost	Financial cost	Economic cost
1999	Stage I	5,361	4,589	520	520
2000		20,263	17,508	6,885	5,499
2001		20,255	17,500	6,877	5,492
2002		19,988	17,272	6,610	5,283
Total		65,867	56,870	20,8922	16,794

(Note) See detail shown in Table 3 of Appendix J.

6.2.5 Economic and Financial Evaluation of Project

The Project is targeted to get a grant from Japanese Government, so that the evaluation is made from the viewpoint of grant basis for both the economic and financial aspects.

The evaluation of the Project in the grant basis is made by using cash flows of the said costs and benefits in both the economic and financial aspects as shown in Tables 4 and 5 in Appendix J. The results are also shown in those Tables and summarized below. In this case, B/C rates are comparison of benefit and cost in present value of them, and B-C means net cash balance between benefits and costs also expressed by their present value. For calculation of present value, a discount rate of 10 % is applied as same as in similar projects. The figures are expressed in terms of US Dollars in thousand (US$1,000) using 1997-August price level.

Table F.6.6 Result of Project Evaluation for First Stage of the Project in Grant Basis

	EIRR/FIRR(%)	B/C	B-C(US$1,000)
From Economic Evaluation	7.44	0.83	-2,870
From Financial Evaluation	2.88	0.60	-8,412

The EIRR and the FIRR are resulted as shown in the above Table as 7.44 % and 2.88 %. Generally, as suggested by such international institutions as the World Bank, a EIRR is expected to at least be cleared a hurdle of 5.0 % of EIRR from a viewpoint of basic human needs even such a project is in developing countries, and the Project under study satisfies this expectation with 7.44 % as the resulted EIRR with enough affordability. Namely, the Project is economically sound from the viewpoint of basic human needs in the grant basis.

While, the FIRR is resulted as 2.88 % clearing easily the zero percent. Here, the Project is targeted to accommodate the sewerage treatment facilities to people living in the study area as a facilities for common use, and is not for commercial operation. As mentioned at the beginning of this Section on the Project evaluation for the Master Plan Review level, when the FIRR is zero, cumulative amounts of benefit (revenue) will be equal to the cumulative amount of cost during the project life, and it means that the OM cost including replacement cost for the facilities can be covered by a proposed average service charge system. From this viewpoint, the Project may be financially sound for the Municipality as a self-supporting institution for operating and managing the facilities.

When it takes the existing national economy in Palestine into account, the Municipality of Khan Yunis can not expect any subsidies for the Project from the central Government of PNA. Therefore, it has surely better to set more high tariff rate than the recommended one as mentioned above. But, a rate of NIS.35 per month per HH is the critical one taking existing paid amount for desludging services by people and their income level into consideration. The higher tariff rate than this should be expected by their own effort in the future.

6.2.6 Sensitivity Test of Project Evaluation

(1) Sensitivity of Project in Regional Economy

The economic internal rate of return changes its value depending on the parameters employed for the calculation. Out of these parameters, the construction cost of the Project and its benefit are the most important determinants of the economic analysis.

Therefore, a sensitive analysis is made for 9 combined cases including base case under the benefit of -5 % and -10 %, and the cost of +5 and +10 % taking into account of fluctuation of the benefit and the cost both in safety side.

Fig. F.6.1 and Table F.6.7 hereunder show the results of sensitivity analysis for economic features.

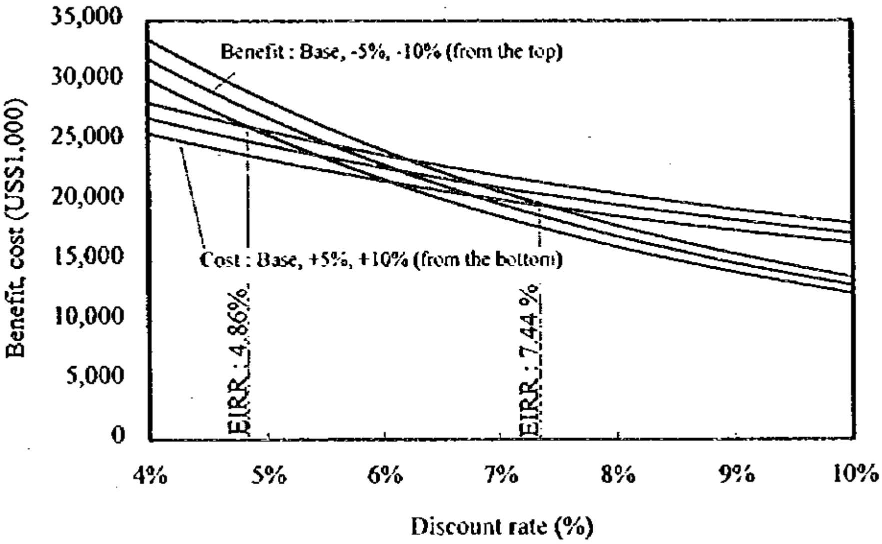


Fig. F.6.1 Sensitivity of EIRR

Table F.6.7 Sensitivity of Regional Economy

(EIRR : %)

Cost	Benefit		
	Base case	-5 %	-10 %
Base case	7.44%	6.78%	6.08%
+5 %	6.81%	6.15%	5.45%
+10 %	6.21%	5.55%	4.86%

Source: JICA Study Team 1997

The EIRR under both the benefit and the cost in base case is calculated as 7.44 % as mentioned above. However, nevertheless under the case of the benefit of 10 % decrease and the cost of 10 % increase as the most pessimistic case, the EIRR is calculated as 4.86 % which is low comparing with that of the base case. But, this rate may say as still enough high one which is almost equal to 5 % expected by the international institutions for these kind of projects.

This means that, even if the saved amount of medical expenditures is decreased from NIS.324 per year to NIS.291, and their income loss is decreased from NIS.42 per day to NIS.38, and the operation and maintenance cost and replacement cost for the sewerage treatment facilities is increased with a rate of 10 %, the Project is still keeping economic feasibility as a project to be valuable to their regional economy.

(2) Sensitivity in Financial Stability

By the same reason mentioned in the sensitivity of EIRR, a sensitive analysis is made for 9 combined cases including base case under the benefit of -5 % and -10 %, and the cost of +5 and +10 % taking into account of fluctuation of the benefit and the cost both in safety side.

Fig. F.6.2 and Table F.6.8 hereunder show the results of sensitivity analysis for financial features.

The FIRR under both the benefit and the cost in base case is calculated as 2.88 % as mentioned above. While, under the case of the benefit of 10 % decrease and the cost of 10 % increase as the most pessimistic case, the FIRR is calculated as negative one as -0.12 %.

As mentioned in the beginning of this Section on the Project evaluation for the whole works in the Master Plan Review level, when the FIRR is zero, cumulative amounts of benefit (revenue) will be equal to the cumulative amount of cost during the project life, and it means that the OM cost including replacement cost for the facilities can be covered by a proposed average service charge system. From this viewpoint, the Project shows a financial stability in the Municipality of Khan Yunis because resulted FIRR of -0.12 % is almost the same with the zero percent even if a tariff to be set is lowered from NIS.35 per month per HH to NIS.31.5 and the operation and maintenance cost and replacement cost for the sewerage treatment facilities is increased with a rate of 10 %.

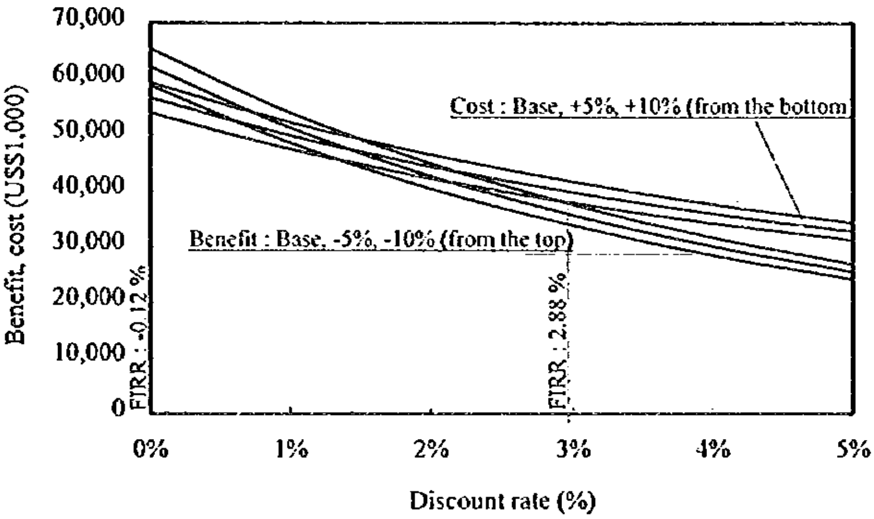


Fig. F.6.2 Sensitivity of FIRR

Table F.6.8 Sensitivity in Financial Stability in the Municipality of Khan Yunis

(EIRR : %)

Cost	Benefit		
	Base case	-5 %	-10 %
Base case	2.88%	2.14%	1.34%
+5 %	2.18%	1.42%	0.60%
+10 %	1.49%	0.72%	-0.12%

Source: JICA Study Team 1997

On the contrary, there should be additional revenue from such several bulk consumers of potable water as hospitals as mentioned in Chapter 5. Therefore, financial benefit will be higher than that applied in the Project evaluation in this Section, so that the financial stability will become higher in the future.

6.3 Institutional Evaluation

The different Alternatives proposed for the institutional plan to manage the new sewerage system in Khan Yunis can be summarized as follows:

Alternative1: A new organization within the municipalities:

This option means that the proposed new organization shall be established as a separate department or to be jointed with the existing water department in each of the municipalities to operate and manage the proposed new sewerage system. If the central area of Khan Yunis Municipality is covered with the system, the existing organization of the Municipality can be reorganized for the management of the sewerage system.

However the new system is proposed to be established beyond the municipal boundary. The treatment plant and one pumping station will be constructed out of the boundary. Many main sewers will cross other communities and beyond the municipal boundary. If this option is selected, a strong coordination will be required among municipalities and Khan Yunis Governorate as well as Ministry of Local Government.

Alternative 2: A new organization within the Governorate of Khan Yunis:

A new Wastewater Department with all necessary sections such as revenue, accounting and other sections will be established within the Governorate of Khan Yunis. In this option, the proposed department will be responsible for management, operation and maintenance of the sewerage system as well as the customer services, within the boundaries of Khan Yunis Governorate.

However the fact should be considered that the Governorate of Khan Yunis was established just in 1996 with other four governorates in Gaza Governorates. The Governorate of Khan Yunis is at present staffed with only 11 key persons including the Governor. The financial position is so weak to be dependent on the presidential allocation for its budget. This means that it would be premature that a new organization will be established completely under the Governorate of Khan Yunis.

Alternative 3: An new independent organization under the Palestinian Water Authority (PWA):

This option can be achieved in two forms:

a. As a Public Utility linked to PWA
b. As a Private Company owned by the Palestinian Authority and linked to PWA.

This option may be advantageous in terms of effective management, because a single regional organization will enable to recruit qualified personnel to operate and manage the new sewerage system. However this option will have a fundamental weakness due to the limited experience of the Palestinian side. There are only three treatment systems in Gaza Governorates, all poorly functioning and discharging low-quality effluent. This option may be applied first when certain steps have been taken with more experiences of management and operations by the Palestinian side.

Alternative 4: An organization of two levels, the Governorate level, and the Municipality level.

This option will compromise Alternatives 1 and 2 to overcome their weakness. In the Governorate of Khan Yunis the Wastewater Department will be established to operate and maintain the main facilities such as the treatment plant, pumping stations, main sewers and others. In the Municipality of Khan Yunis the Sanitation Division will be reorganized from the existing Health & Slaughter Division. The Sanitation Division will be more oriented to customer services such as house connections, lateral sewers and lateral pits as well as user charge collection.

This option shall be strengthened by the linkage with the central government, which is the policy of the Palestinian Authority.

This option may have a weakness to develop to a more independent organization.

Alternative 5: Regional/Governorate/Municipality Institution will be established

All the three levels for sewerage management reorganized for strengthening the linkage with the central government.

As the central function the Palestinian Water Authority (PWA) will be responsible in close coordination with the Governorate and Municipality of Khan Yunis.

At the initial stage the coordination office will be established in PWA to enforce the close relation with the local government. This office will be aimed at coordinating with the Governorate of Khan Yunis as well as other four governorates in the region.

The new organizations in the Governorate and Municipality of Khan Yunis will be the same as proposed Alternative 4.

This option will have a wider possibility to develop to an independent self-financing organization.

The Table F.6.9 summarizes the advantages and disadvantages of each Alternatives:

The analysis of the five Alternatives for the institutional structure indicates that Alternative 5 can be more practical for the short term management of the sewerage system in the area of Khan Yunis. Therefore this Alternative is recommended for the F/S.

For the long-term development of the sewerage institution further considerations shall be made to the following points:

(1) the Palestinian side will accumulate more experiences including this sewerage system

(2) Effective management will be possible by Palestinian managers.

(3) Technical know-how will be learned by all the levels of technicians.

(4) Technological developments will enable to operate and the sewerage system more efficiently, in particular in the area of computer technology.

Based on these considerations, the Study Team recommends that a review process be scheduled after the F/S period in year 2002. At that time the Governorate of Khan Yunis will be fully staffed and functioning well, and PWA will be able to have a united organization to cover the whole Gaza Governorates. This will be also a matter of the political decision by Palestinian Authority and people.

Table F.6.9 Advantages and Disadvantages of Institutional Options

Alternatives	Advantages	Disadvantages
Alternative 1	* Services are considered municipal responsibility. * Easier to collect sewerage charges. * Link to development planning of the municipality .	* Not efficient management due to the size of service level * High risk of interference in operational responsibilities between different municipalities. * Sewerage revenues may be used for other purposes. * Less acceptable to funding agencies. * Constraints on staffing issues. * Less motivation to employees. * High number of staffing.
Alternative 2	* More clearly defined responsibility, authority and accountability. * More control over equipment, tools and materials. * Closer to regional management. * Links to governorate planning.	* Needs to be connected with water management. * Difficulty in customer services. * Revenues may not be related to sewerage requirements. * Requires revenue and accounting staff, now few
Alternative 3	* More clearly defined responsibility, authority and accountability. * Sole focus on level of service. * Efficient management * Easier to formulate medium and long term plans * Acceptable to funding agencies. * Easy matching with national strategy. * Control over physical resources.	* Requires legislation for development * Requires long process to transfer the responsibilities from the governorate/municipality to the new utility. * It needs to be established on regional level.
Alternative 4	* Customer services are considered as municipality responsibility. * Less staff requirements. * More clearly defined responsibility, authority and accountability. * Links to comprehensive planning of the area * Increased control over equipment, tools and materials. * Low risk of interference in operational decisions.	* Management may be inefficient and financial position may weaken. * Revenues may not be used for sewerage requirements.

Alternatives	Advantages	Disadvantages
Alternative 5	* Customer services are considered as municipality responsibility * Region-based management and links to comprehensive planning of the area * Increased control over equipment, tools and materials * Low risk of interference in operational decisions * Easy matching with national strategy * Easy development of the regional institution for water sector	* Inefficient management and weak financial position may occur at the initial stage. * Revenue allocation may be difficult, and all the revenue may not be used for the sewerage system of Khan Yunis. * Requires comprehensive regulations of wastewater management

Source: JICA Study Team 1997

However it shall be noted that Alternative 5 recommended by the Study Team will be capable to deal with most changes of the situations that Khan Yunis might be facing in the future. The alternative is not a temporary solution for the institutional development. The required man-powers will be almost the same as discussed in other section.

6.4 Environmental Evaluation

6.4.1 General

The reduction of the level of polluted water reaching the ground will improve the quality of life for those living in the Area. Improving the disposal of domestic, commercial and industrial wastewater will also improve the quality of life for those living in urban areas and near the factories premises. The Project will also contribute to improvement in the beneficial uses from the groundwater or treated wastewater effluents, such as crop irrigation or other reuse of the treated wastewater for industrial purposes.

(1) Social Considerations

A socio-economic survey on representative sample of households undertaken in Khan Yunis and its surrounding villages elicited community attitudes to the current wastewater disposal and treatment system and to propose improvements to the wastewater disposal system. It also obtained general social and economic information on the Khan Yunis area community.

A supplementary survey was undertaken to improve the available information on the community's willingness to pay for improvements to the wastewater system and to assist in identifying the attributes of the various target groups. Survey information was supplemented with information from existing studies and reports and with discussions with key people in the Governorate.

Poor wastewater disposal practices are one of the major causes of unsanitary conditions and groundwater pollution in Khan Yunis area. The reliance on cesspits and simple septic tank units for the disposal of sanitary waste in areas of extremely high population density, and on-site treatment of waste and its unmanaged discharge into the ground, have resulted in high pollutant loads on the ground and high incidents of water-borne diseases.

(2) Social and Economic Impacts

Residential areas will be served by a combination of separate sewerage systems/ sanitation/drainage. This, in combination with the collection and treatment of industrial wastewater, will reduce the amount of pollutants flowing into the ground. The major benefits for residents will be a reduction in noxious odors and, if combined with health education, a reduction in water-related diseases.

An improved wastewater management system will result in reduced overall costs for factories in comparison to on-site treatment, although it will mean higher operating costs for factories that are currently spending inadequate amounts on treatment or have no treatment facility at all. Factories and commercial operations will also be required to pay for the costs of their connection to the trunk sewer or interceptors. Overall, however, operating costs are likely to comprise a relatively small proportion of factory turnover.

(3) Other Beneficial Uses

1) Flood Control

Improvement and rehabilitation of the existing drains will occur as part of the construction of the system for the high density areas. Provided this improvement is maintained it is likely to have a beneficial effect through improved stormwater drainage. This will have benefits for those living and operating businesses in areas prone to flooding.

2) Reuse

Agricultural people believe that poor water quality due to domestic wastes pollution of the groundwater has resulted in losses in agricultural production. They are also affected by saline groundwater and it is difficult to assess the separate effect of each cause. With a groundwater pollution abatement program, agriculture is likely to benefit from an increase in crop yields.

3) Water Resources

With implementation of the proposed wastewater management strategy, it is possible that groundwater could be used as a source of water, thus alleviating the water demand on groundwater abstraction and assisting in reducing the present potable water shortage in the southern districts of the Area. However, this will depend on the efforts made to control wastewater pollution in heavily populated areas.

4) Hygienic Improvement

The Area has an above average incidence of water-related diseases which is felt most badly by the lower income groups. Low income families tend to live in high population density areas, and suffer from greater exposure to wastewater and poorer sanitation facilities. The Project will provide an effective means for collection and removal of wastewater from these areas, resulting in substantial improvements in the poor environment currently experienced by low income families and impoverished members of these communities.

The Project will improve the quality of water in the ground, thus reducing their role as a source of pathogens. The effectiveness of the Project in improving the health of the people of the Area will be greatly enhanced by combining a reduction in the source of pathogens with a reduction in the means of their transmission to humans. This is best achieved through a program of improved public health education and through enforcement of better environmental standards on factory premises and construction sites.

(4) Negative Impacts

Negative impacts may potentially arise from the resumption of land for treatment facilities and through the disruption caused by the construction of the wastewater collection and transfer facilities, particularly sewers and pumping stations in the urban districts.

Under the recommended option, some 40 hectares of land will be required for the wastewater treatment plant and pumping stations. Such lots currently are being used for agriculture and indications are that there are no informal settlements on the land, thus there should be no land users to be relocated. This situation should be confirmed as early as possible before the detailed design phase to enable land acquisition to be undertaken as quickly as possible.

The centralized option requires large trunk sewers, the laying of which will cause disruption in what is already a heavily congested urban area. Contractors will be required to reduce disruption by working at nights to construct pipelines under the roads. A policy of informing the public through the print and radio media of major roadwork will also help to reduce disruption.

Finally, the treatment of the wastewater itself will generate a certain level of pollution in the form of noxious odors from aeration ponds, wastewater storage areas and in the form of noise pollution arising from the operation of the treatment plant. The sites proposed for the pumping stations and central wastewater treatment plant have been chosen so as to minimize the effects of pollution on the residents of Khan Yunis and villages. The sites are away from current planned residential areas, however, there is likely to eventually be some urban encroachment, particularly around the urban areas. The wastewater treatment plant has, therefore, been designed to minimize noise and air pollution.

6.4.2 Introduction of Environmental Impact Assessment

Environmental Impact Assessment (EIA) was conducted to study, forecast and evaluate the environmental impacts of this project. The EIA study items were defined through Initial Environmental Examination (IEE) conducted at the stage of Master Plan (M/P) Study. The study items were evaluated not only in the project area but also in any area that might be directly or indirectly affected during the construction and the subsequent operation of the project.

EIA works for the sewerage development plan under the recommended project by Feasibility Study (F/S) as First Stage Program were sublet to the local consultant in cooperation of JICA Study Team and the EIA study was conducted from May 1997 to September 1997.

Objectives of the EIA study are as follows,

1) Estimation and evaluation of environmental impacts during all 3 stages of pre-construction, construction and post-construction period.

2) Formulation of action program and recommendations on environmental monitoring and management so as to mitigate the negative impacts.

6.4.3 Identification of Activity Plans

This Feasibility Study consists of 1) sewerage system, 2) sanitation system and 3) drainage system. These project components are shown in Table F.6.10.

Table F.6.10 The First Stage (F/S) Project

Components		Service Area (ha)	Population (as of 2006)	Sewer Length Dia. 0.2-1.2m (m)	Pump Capacity (m^3/min)	Treatment Capacity (m^3/day)
Sewers		874	158,410	119,800		
Pumping Station	P3				17.5	
	P8				17.5	
Manhole Type Pump	6 pcs					
Treatment Plant						16,100
Vacuum Trucks	5 Nos.					
Drainage System		423			180.0	

Sewerage system project area is shown in Fig. F.6.3. Five (5) Vacuum trucks will be procured for the 5 municipalities of Khan Yunis, Kizan area, Bani Sohaila, Abassan Kabera, Abassan Saghera and Khuzaa. These sewerage project and vacuum trucks procurement is for improvement of sanitary condition. Drainage system project area is shown in Fig. F.6.4 and the drainage project is for flood control especially for the market area.

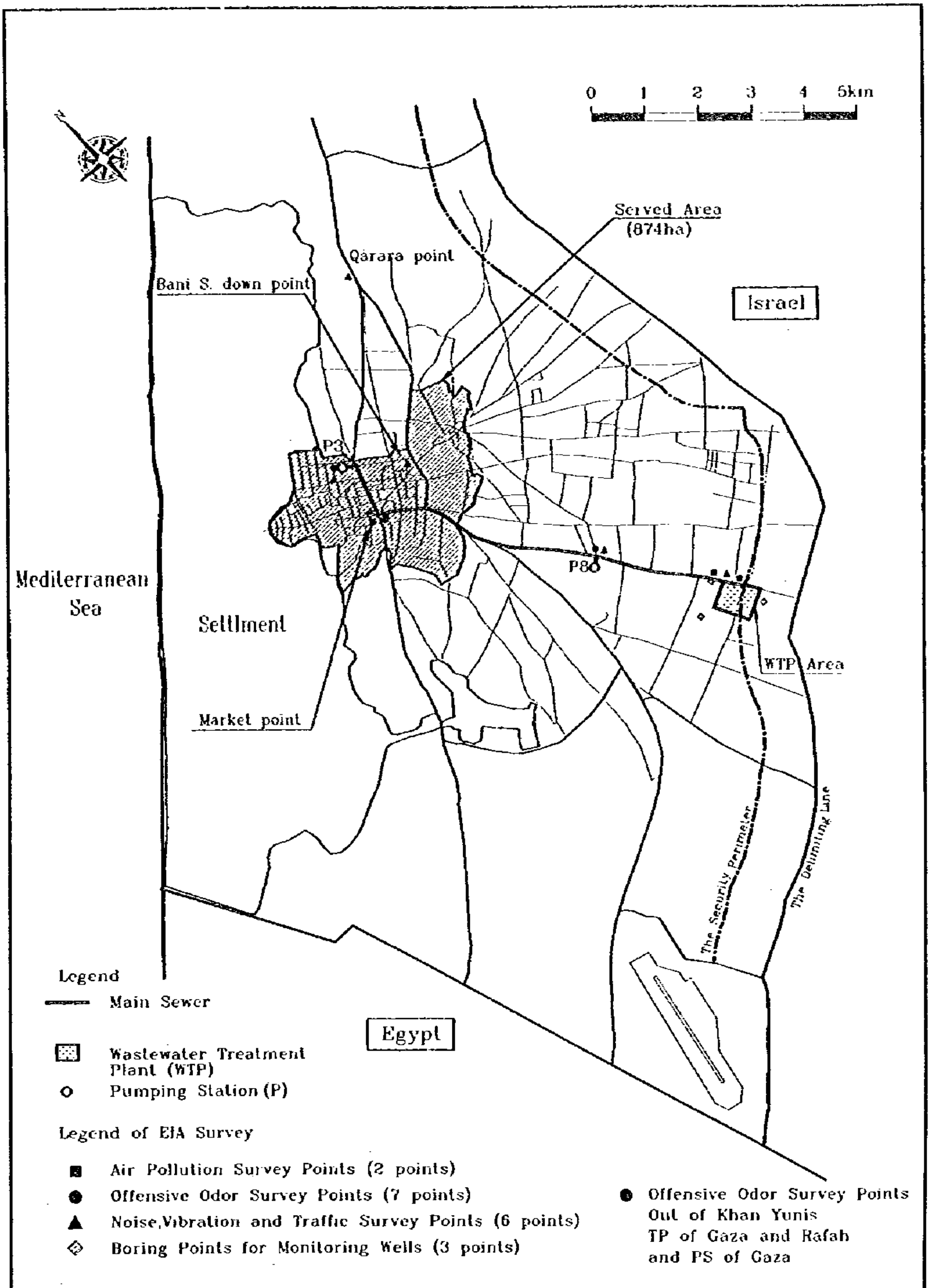


FIG.F.6.3	Major Facilies of Sewerage Development Project and Location of EIA Survey

THE STUDY ON SEWERAGE DEVELOPMENT PLAN IN THE AREA OF KHAN YUNIS
IN PALESTINIAN INTERIM SELF-GOVERNMENT AUTHORITY

JICA

AD 1997

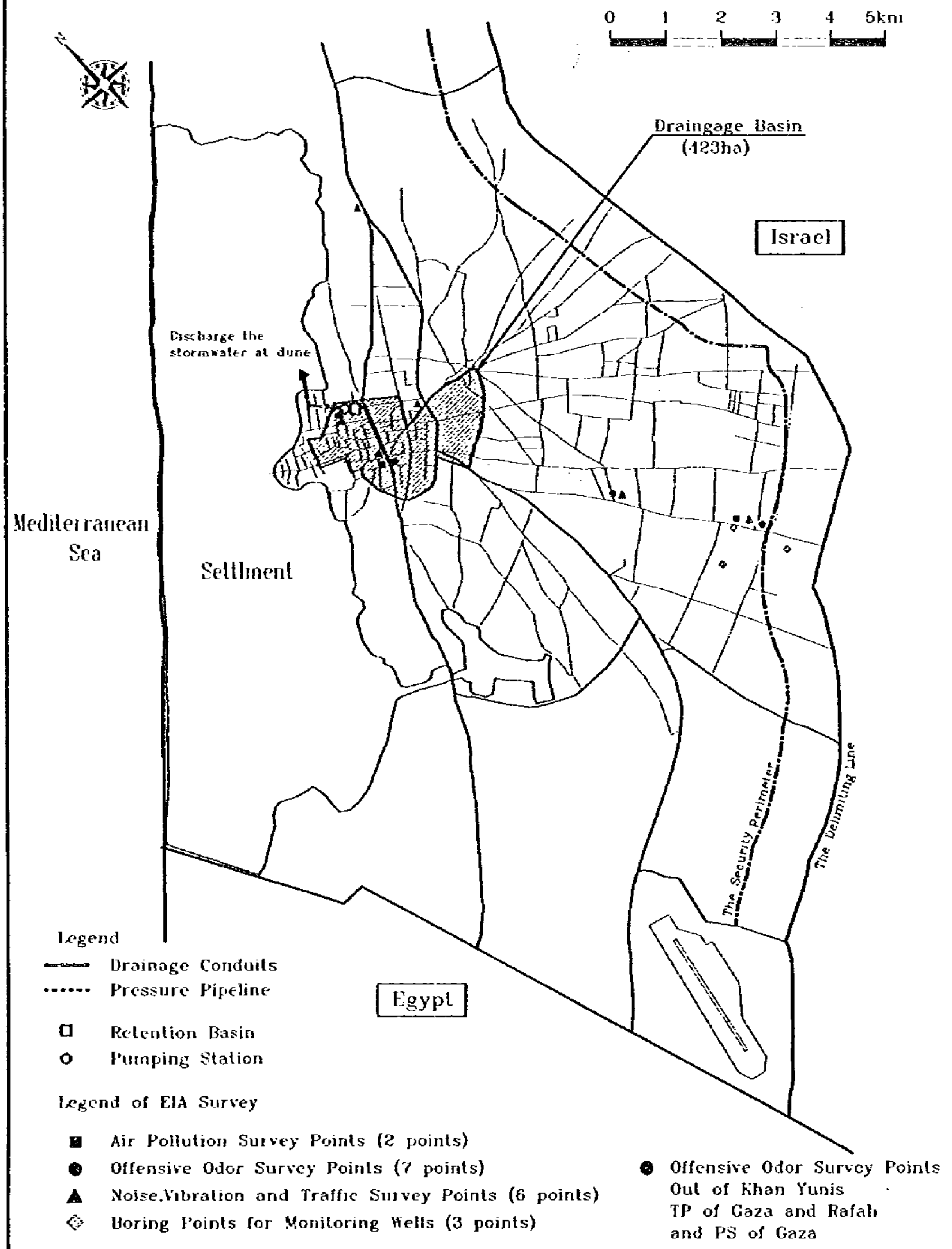


FIG.F.6.4	Major Facilies of Drainage Development Project and Location of EIA Survey

THE STUDY ON SEWERAGE DEVELOPMENT PLAN IN THE AREA OF KHAN YUNIS
IN PALESTINIAN INTERIM SELF-GOVERNMENT AUTHORITY

6.4.4 Identification of EIA works

Initial Environmental Examination (IEE) study was conducted at the stage of Master Plant (M/P) study from September 1996 till March 1997. EIA study was conducted at the stage of Feasibility Study (F/S) from May 1997 till September 1997 based on the results of the IEE.

Survey items identified by IEE study are (1) Economic activities, (2) Traffic and public facilities, (3) Cultural property, (4) Public health condition, (5) Waste, (6) Hazards, (7) Soil erosion, (8) Groundwater, (9) Fauna and Flora, (10) Air pollution, (11) Water pollution, (12) Soil contamination, (13) Noise and vibration and (14) Offensive odor.

These 14 study items are summarized in eight (8) items as shown in Table F.6.11.

Table F.6.11 Summarized EIA Works

No.	Items of major EIA study	Corresponding IEE Items
1	Land acquisition for wastewater treatment plant	(1) Economic activities
2	Cultural property	(3) Cultural property
3	Hazards	(6) Hazards
4	Discharge of treated wastewater	(4) Public health condition (7) Soil erosion (8) Groundwater (11) Water pollution (12) Soil contamination
5	Waste management of sludge	(5) Waste
6	Fauna and Flora	(9) Fauna and Flora
7	Air pollution, transportation, noise and vibration	(10) Air pollution (2) Traffic and public facilities (13) Noise and vibration
8	Odor	(14) Offensive odor

It is necessary to obtain consensus with concerned local agencies in regard to survey contents and the results of EIA. So, workshops were held for explanation and discussion of 1) Inception Report illustrating the conduct of EIA works and 2) EIA Draft Final Report . The workshops were organized by the local consultants and JICA Study Team and attended by related local agencies such as MOPIC, PLC, Khan Yunis Governorate, PWA, Khan Yunis Municipality and so on.

6.4.5 Result of EIA Study

Major study items were enumerated as follows, 1) Study on land acquisition for wastewater treatment plant, 2) Study on cultural property, 3) Study on hazards, 4) Study on discharge of treated wastewater, 5) Study on waste management of sludge, 6) Study on Fauna and Flora, 7) Study on air pollution, transportation, noise and vibration and 8) Study on odor.

The 8 items were studied and evaluated as follows,

(1) Land acquisition for wastewater treatment plant and pump stations

1) Present condition

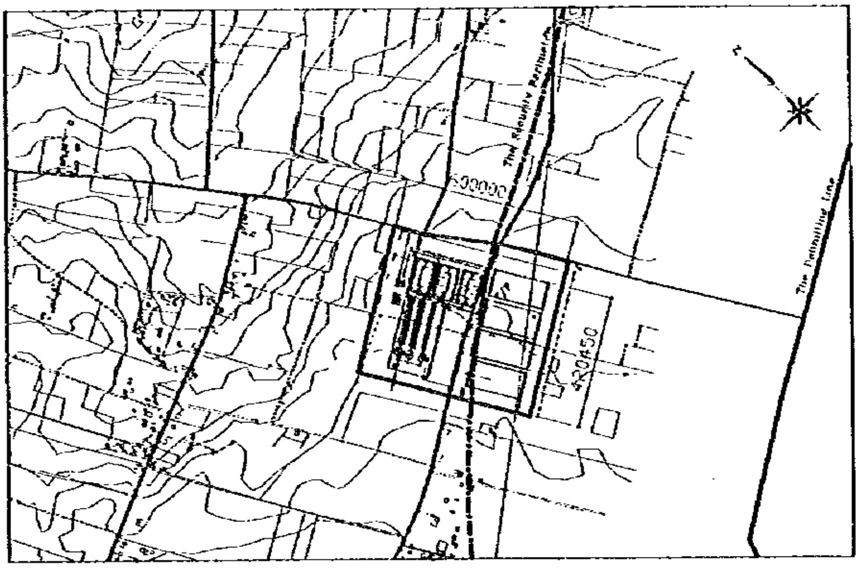
Required lands for wastewater treatment plant and pump station are shown in Fig. F.6.3 and Fig. F.6.5 and each of the required area is shown in Table F.6.12.

Table F.6.12 Required Land for Facilities

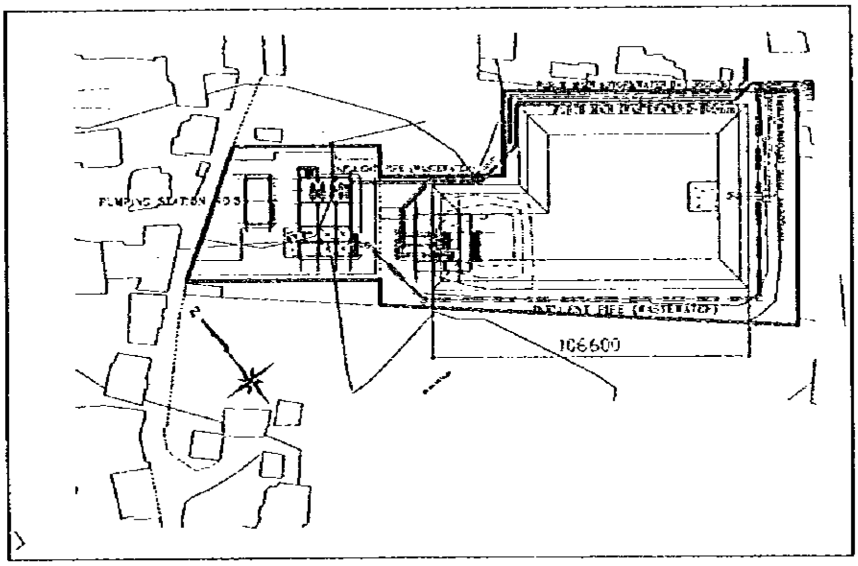
Facility Name	Required Area	Present Landuse
Wastewater treatment plant	about 31 ha	Farm land
Pump Station of P3	about 1.2 ha	Vacant area but surrounded by residential area
Pump Station of P8	about 0.4 ha	Mostly farm land surrounded by a few houses

Proposed wastewater treatment site belongs to public land but farmers have right to use the land for agriculture at present. Proposed land of pump station P3 and P8 partly belongs to public and partly to private.

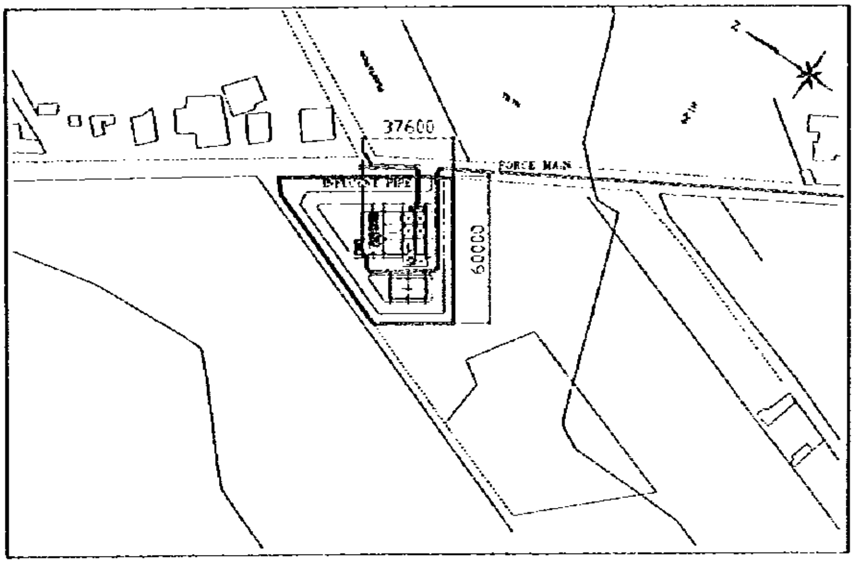
There is a system to acquire the land for public purpose with proper compensation. The land requiring process for this project is going well with the cooperation of concerned Palestinian agencies and also the land owner and land user have understood the importance of providing the land for the project.



WASTEWATER TREATMENT PLANT
(about 31ha)



PUMP STATION NO.3/
STORM-WATER RETENTION BASIN AND PUMP STATION
(about 1.2ha)



PUMPING STATION NO 8
(about 0.4ha)

Legend
☐ : Required Area

FIG.F.6.5	LOCATION OF LAND ACQUISITION FOR WASTEWATER TREATMENT PLANT AND PUMP STATION P3 AND P8

THE STUDY ON SEWERAGE DEVELOPMENT PLAN IN THE AREA OF KHAN YUNIS
IN PALESTINIAN INTERIM SELF-GOVERNMENT AUTHORITY

2) Evaluation

Importance of the project is recognized by local government and land users/owners. Process of land acquisition is going to be managed with appropriated compensation.

It was evaluated there would not be significant problems in land acquisition and economic activities. There would be positive impact with this project generally speaking.

(2) Cultural property

1) Present condition

Khan Yunis area does not have many cultural properties. The main cultural property in the area is the Khan Yunis Castle which is located in the center of the city. Other cultural properties are found in the eastern side of Khan Yunis, located out of the F/S area. It is development of the Byzantine Islamic Arch in Abassan. These locations of cultural properties are shown in Fig. F.6.6. According to the Ministry of Tourism and Antiquity there is no information available about the possible siting of any cultural property at the proposed treatment plant site.

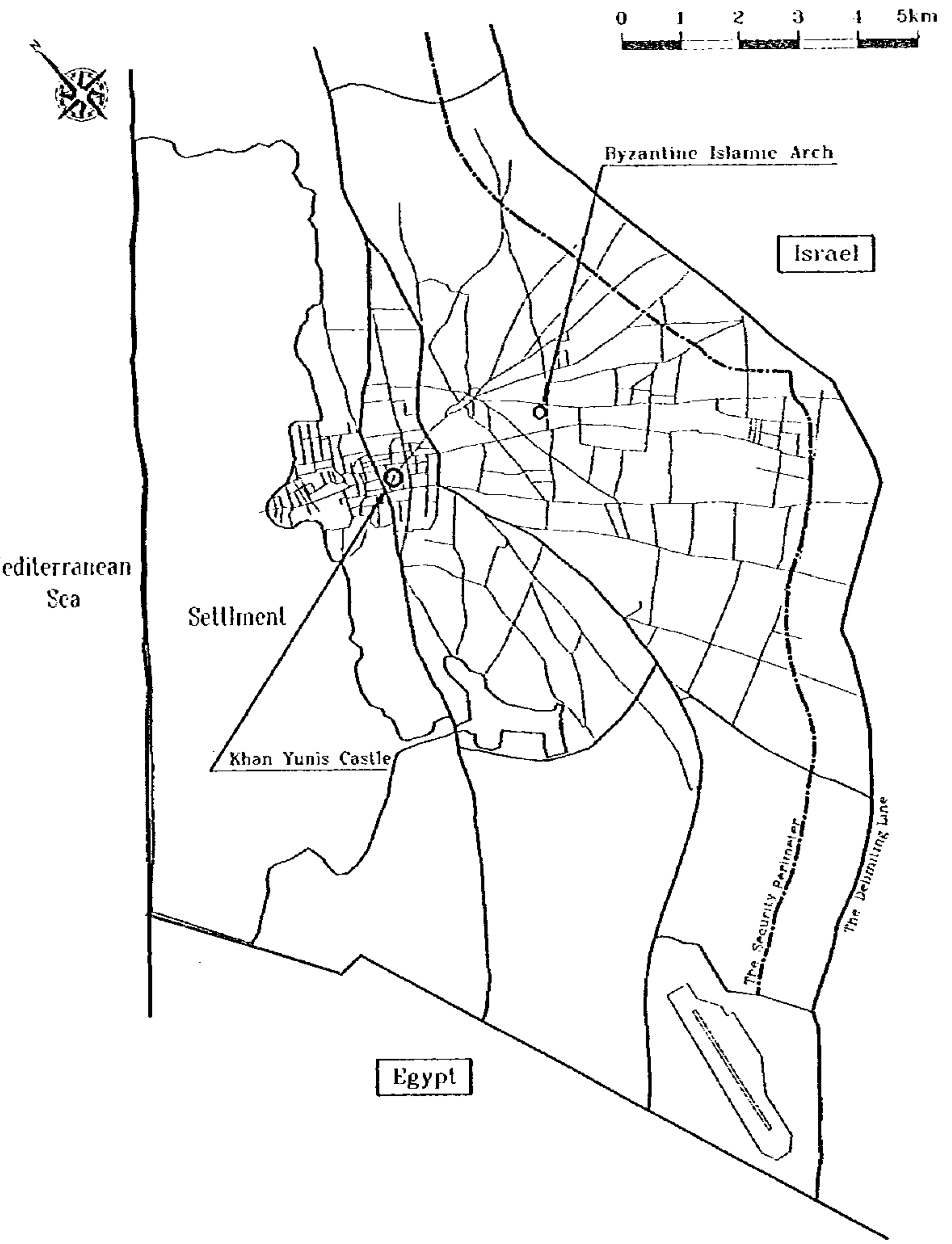


FIG.F.6.6 LOCATION OF CULTURAL PROPERTIES

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2) Evaluation and mitigation

During the constructing period, cultural properties such as the Khan Yunis Castle can be protected with careful construction planning of any sewers. It is possible some other cultural properties being buried underground. So, when any excavation work for sewer, pump station or wastewater treatment plant are conducted, the work shall be done carefully.

(3) Hazards

1) Potential cause of problems

There is a possibility to occur transportation accidents or any other hazards during the constructing period. And also there are possibilities of flooding caused by malfunction of pumping station or sewers.

2) Evaluation and mitigation

During the constructing period, transportation accidents or any other hazards can be prevented with careful construction management. In the operation period, pump stations and wastewater treatment plant shall be properly operated and maintained not to cause any undue nuisance to surrounding living environment.

Wastewater treatment plant and pump stations are provided with backup system for power source and others. But proper operation and maintenance will be required.

(4) Discharge of treated wastewater

There are two kinds of discussion regarding discharge of treated wastewater from wastewater treatment plant, as 1) Quantity and 2) Quality as follows,

(4.1) Quantity consideration

1) Potential cause of problems

In case infiltration capacity is less than the amount of discharge, overflow / flooding may occur around wastewater treatment plant.

2) General evaluation

In the treatment plant design, treated wastewater disposal site, that is infiltration ponds, is separated in more than 4 ponds, and every day effluent of treated wastewater will be discharged in to one of the infiltration ponds. Other 3 ponds will not accept any treated water to recover the permeability of ground. So, the disposal pond is designed with less than 25 % workability, that is necessary for long term period requirement but it is corresponding to more than 4 times of safety ratio in short term period.

So, if the infiltration is not working well, treated wastewater will be discharged to other ponds as a contingency measure.

3) Evaluation and mitigation

In view of the quantity check for rapid infiltration pond, it is evident that the infiltration ponds have enough capacity to drain/dispose of the treated wastewater into the ground.

It is necessary to monitor the proposed infiltration system to determine whether the capacity is enough or not during operating stage, although the infiltration system is designed considering the soil permeability. If it identified that the capacity of the infiltration is not enough, the infiltration system shall be improved.

The improvement system could be applied by two methods. One is by enlarging infiltration pond area, another one is by increasing ground infiltration rate with replacing ground materials with high permeable materials such as sand.

(4.2) Quality consideration

1) Potential cause of problems

In case wastewater treatment plant discharge any polluted water, there would be effects to soil, groundwater, farm product and public health by infiltrating the treated wastewater into ground.

2) Discussion

Present groundwater condition is as shown in Figure F.6.7. It is identified that NO3-, Cl-, SO4 are high, but heavy metal is not significant.

a) BOD, COD, SS, N,P

System of wastewater treatment plant is a combination of anaerobic pond and oxidation pond. Designed quality of treated wastewater by JICA Study Team is as, BOD_5: 25 mg/l, COD: 45 mg/l, SS: 31 mg/l, T-N: 39 mg/l and T-P: 30 mg/l.

Corresponding concentrations for artificial groundwater recharge as per the Jordanian Standard are as follows, BOD: 50 mg/l, COD: 200 mg/l, TSS: 50 mg/l, T-N: 50 mg/l and PO_4-P: 15 mg/l. Designed effluent wastewater quality from the wastewater treatment plant meets the Jordan standard (groundwater recharge) in BOD, COD, SS, T-N but T-P.

Regarding T-P, Effluent of treated wastewater T-P is 30 mg/l that is higher than Jordan standard (PO4-P : 15mg/l), but it is expected that the water can be treated by the infiltration process of treated wastewater at disposal pond. It was evaluated it might not affect surrounding condition as soil absorbs the phosphorus during treated wastewater infiltration into ground.

Quality of effluent of T-N is 39 mg/l. The value is relatively higher although it is less than the standard value of recharge. It is evaluated the effluent of treated wastewater which contains the nitrogen might not affect the surroundings as quality of present groundwater is also relatively high as about 100mg/l in NO3-.

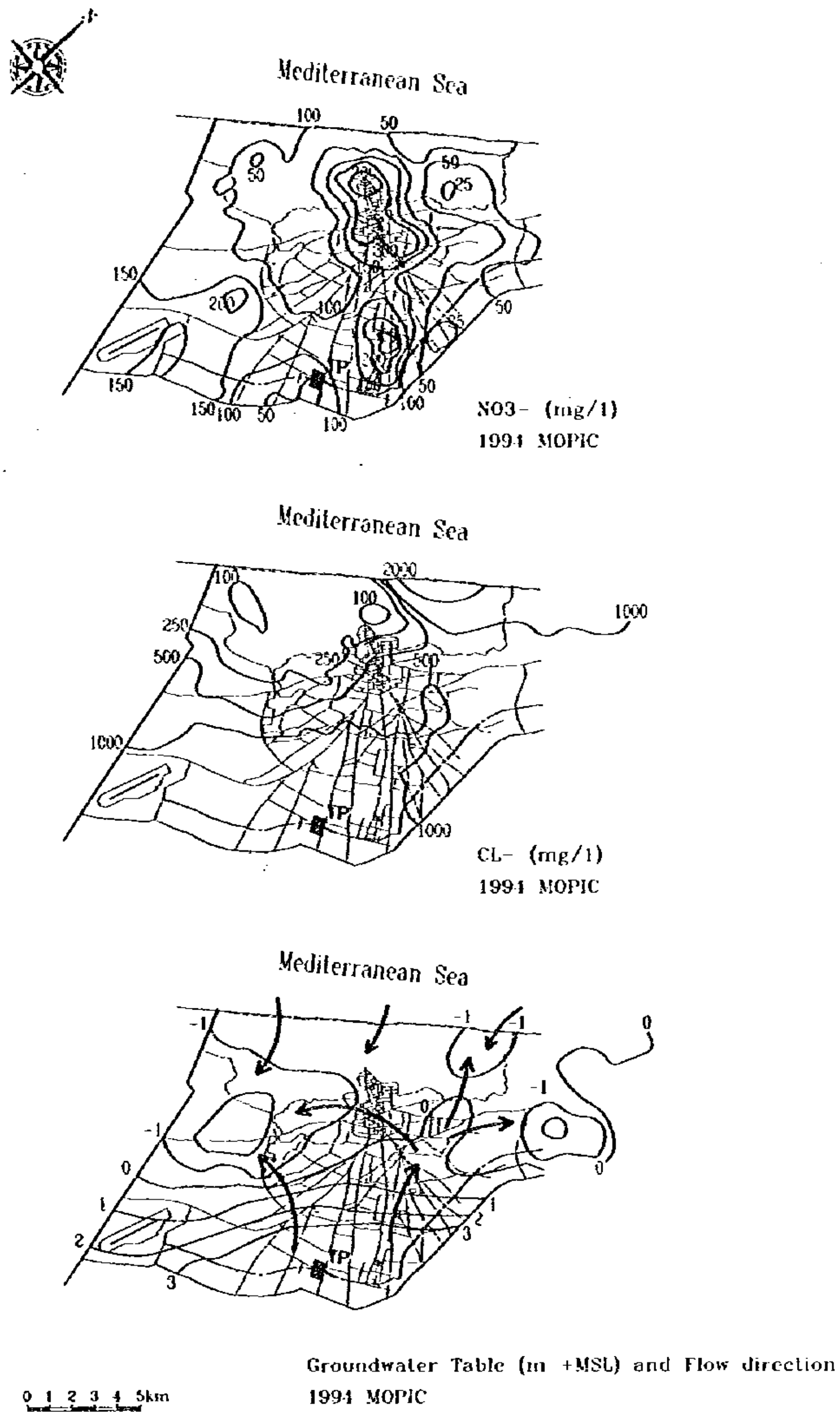

FIG.F.6.7 Ground Water Condition

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b) Minerals

Another problem of wastewater is high mineral contents. Data of wastewater quality surveyed by the Study Team also show that Na, Cl concentration and SAR value are above the standard for ground recharge. This is confirmed as sodium (Na) in influent and effluent at present wastewater treatment plant is about 200 mg/l to 700 mg/l, on the other hand the Jordanian Standard for ground recharge is 230 mg/l. In the view point of present groundwater quality of about 1,000 mg/l referring to the JICA survey as shown in Table F.A.4, the high mineral contents may not affect the present groundwater quality. This groundwater is used for agriculture at present.

c) Wastewater from factory

In case wastewater effluents from factory and hospital is discharged into sewerage system without any pretreatment, wastewater treatment system may be affected. Regulation is necessary to ensure pretreatment of industrial and hazardous waste prior to disposal to the sewerage system.

At present, there are 3 plating factories, of which 2 factories are operating, and 3 hospitals, of which one the hospital has about 500 staffs including about 50 doctors in Khan Yunis. They are using several chemicals those may affect wastewater treatment system. And they are discharging the harmful wastewater as same as domestic wastewater into cess pits. These factories or hospital shall equip own wastewater treatment facilities not to discharge harmful wastewater into sewerage system. It is necessary to establish low or regulation to control the wastewater effluent.

d) Solid waste management

In case storm water carries the any harmful materials such as lead or oil, which are contained in solid waste, they may also affect wastewater treatment system. It is necessary to stop dumping harmful solid waste as same as ordinal solid waste. Any harmful materials shall be separated and they must be properly treated before dumping. It is necessary to establish the appropriate law or regulation for the solid waste management.

e) Disinfection at wastewater treatment plant

In the wastewater treatment plant, chlorinating process is applied before discharging the treated wastewater into the underground with infiltration pond. It is known chlorinating process may produce chlorinated hydrocarbones. But chlorine is the most prevalent disinfectant in the world. There is risk of producing chlorinated hydrocarbons and compounds such as chloroform may be carcinogenic. But, the risk is not high. Wastewater treatment plant system consists of anaerobic ponds, Oxidation ditches and final settling tanks. There is no well around the wastewater treatment plant. Nearest well from the plant is located about 1.5 km away at Khuzaa. Treated wastewater is discharged by infiltration system into underground, so further treatment of treated wastewater is expected with land treatment. Although necessity of disinfection is not high, disinfection system of chlorination is adopted for sanitary purpose. In case wastewater infiltration disposal site is not operated well, anybody can enter the ponds and have contact the water. The chlorinating process can prevent hygienic accident. In chlorination method, it is difficult to operate facilities using the chlorine gas. So chlorination method with sodium hypochlorite is applied as it is in liquid form and it is easy to maintain the facilities. In operation and maintenance, quality of treated wastewater is to be monitored. It is proposed that the injection rate of sodium hypochlorite be controlled refering to the treated wastewater quality. In case coliform group is high the hypochlorite is injected and when coliform group is low the hypochlorite is not injected.

Other disinfection method, such as ultraviolet (UV) light method or ozonation system, is not adopted from the viewpoints of experimental nature, financial requirement and treatment aspect.

3) Evaluation and mitigation

Soil, groundwater, farm product and public health may not be affected by infiltrating the treated wastewater into underground, provided sewerage and solid waste is managed by well-trained operators under proper laws and regulations.

Pilot project shall be conducted for treated wastewater reuse to confirm the characteristics such as effect to soil and plants before the start of full scale reuse.

Monitoring system will be required to ensure the quality of inflow and effluent of wastewater treatment at certain intervals. Monitoring of groundwater quality is recommended if groundwater recharge will be implemented because there is no data about relationship between wastewater and groundwater qualities in the area

(5) Waste management of sludge

Sludge disposing management was evaluated in view points of quantity and quality.

(5.1) Quality Consideration

1) Potential cause of problems

In case sludge includes any harmful materials, there would be pollution problems around the sludge disposing site.

2) Evaluation and mitigation

Quality of sludge was estimated based on present operating wastewater treatment plants located at Gaza and Rafah as shown in Table F.A.5 in Supporting Report. As can be seen from the table, no abnormal values were observed. It was evaluated the sludge might not affect the surroundings under proper sewerage management and solid waste management.

(5.2) Quantity Consideration

1) Potential cause of problems

In case there is no certain sludge disposal site, there would be problems in sustainable operation of the wastewater treatment plant

2) Evaluation and mitigation

It was evaluated most of the sludge could be disposed at inside of the treatment plant in the First Stage. Further disposal site need to be identified for future sludge management.

Regarding the reuse of the sludge, pilot project shall be conducted first to utilize it as fertilizer or soil conditioner and also materials of land fill with proper management. It is suitable to utilize the sludge as a reuse product as fertilizer or soil conditioner for sustainability sewerage system in environmental view point. So, if the pilot project is successful, it is recommended to fully utilize the sludge as fertilizer. However, if the generated sludge contains harmful materials, it shall be managed so as not to affect the surroundings.

The monitoring system will be required to ensure the quality of sludge for intended reuse or disposal.

There will be still vacuum trucks service for non sewerage service area, even with the operation of sewerage works. But septage will not be disposed at the present dumping sites anymore. The generated sludge will be disposed to the sewerage system, and the septage will be accepted at the pumping stations or wastewater treatment plant, so that all the generated sludge will be treated by the sewerage treatment plant once the sewerage system is operated. This is positive impact by this sewerage project as no more generated septage will be discharged at present disposal site and it will not affect groundwater quality around the location.

(6) Fauna and Flora

1) Potential cause of problems

In case there are any valuable species around wastewater treatment plant, they may be affected due to the existence of the wastewater treatment plant.

2) Evaluation and mitigation

It was evaluated there is no significant flora and fauna at this project area. That means there might be no affected flora and fauna by this project.

(7) Air pollution, transportation, noise and vibration

1) Potential cause of problems

In construction period, construction transportation vehicles run through the Khan Yunis Municipality and surroundings and construction heavy vehicles work at the project site. There is a possibility these works may cause air pollution, traffic disturbance, noise and vibration affecting the project area.

2) Evaluation and mitigation

Present condition of air pollution, transportation, noise and vibration were surveyed around the project area, and the noise and vibration were estimated and evaluated for the project. It is expected that they would be generated by construction work, such as earth work, concrete work and heavy vehicle running,

During the constructing period, transportation, noise, vibration can be controlled not to cause serious environmental impact with careful construction, planning and execution.

(8) Odor

The wastewater treatment plant is proposed to be located at about 7 km away from the center of Khan Yunis. The treatment plant may become a source of offensive odor, and such impact is to be estimated and evaluated. The study was conducted on the concentration of odor at the proposed treatment plant site, existing treatment plant sites and pumping station sites.

1) Present condition

There are no regulations regarding odor control in Khan Yunis and Palestine at present. Design criteria are sought from a range of countries whose practices are considered to have some issues relevant to the development of the odor control system.

Gaza wastewater treatment plant, Rafa wastewater treatment plant and Gaza pumping station were selected as the similar facilities of this project. Both treatment systems are of aerated lagoon. Considered odor sources were ammonia (NH_3) and Hydrogen sulfide (H_2S) in this study.

Offensive odors have been measured at two (2) existing wastewater treatment plant sites, one (1) pump station site, one (1) site of center of Khan Yunis and the planned treatment plant site as shown in Fig. F.6.8.

It was found Hydrogen sulfide is detective much higher than Ammonia. Sensual survey was also conducted at the same location. It was identified that smell was sensed around present wastewater treatment plant and pump station and some smell was sensed around propose site of pump station No.3, where is one of the crowded area in Khan Yunis city.

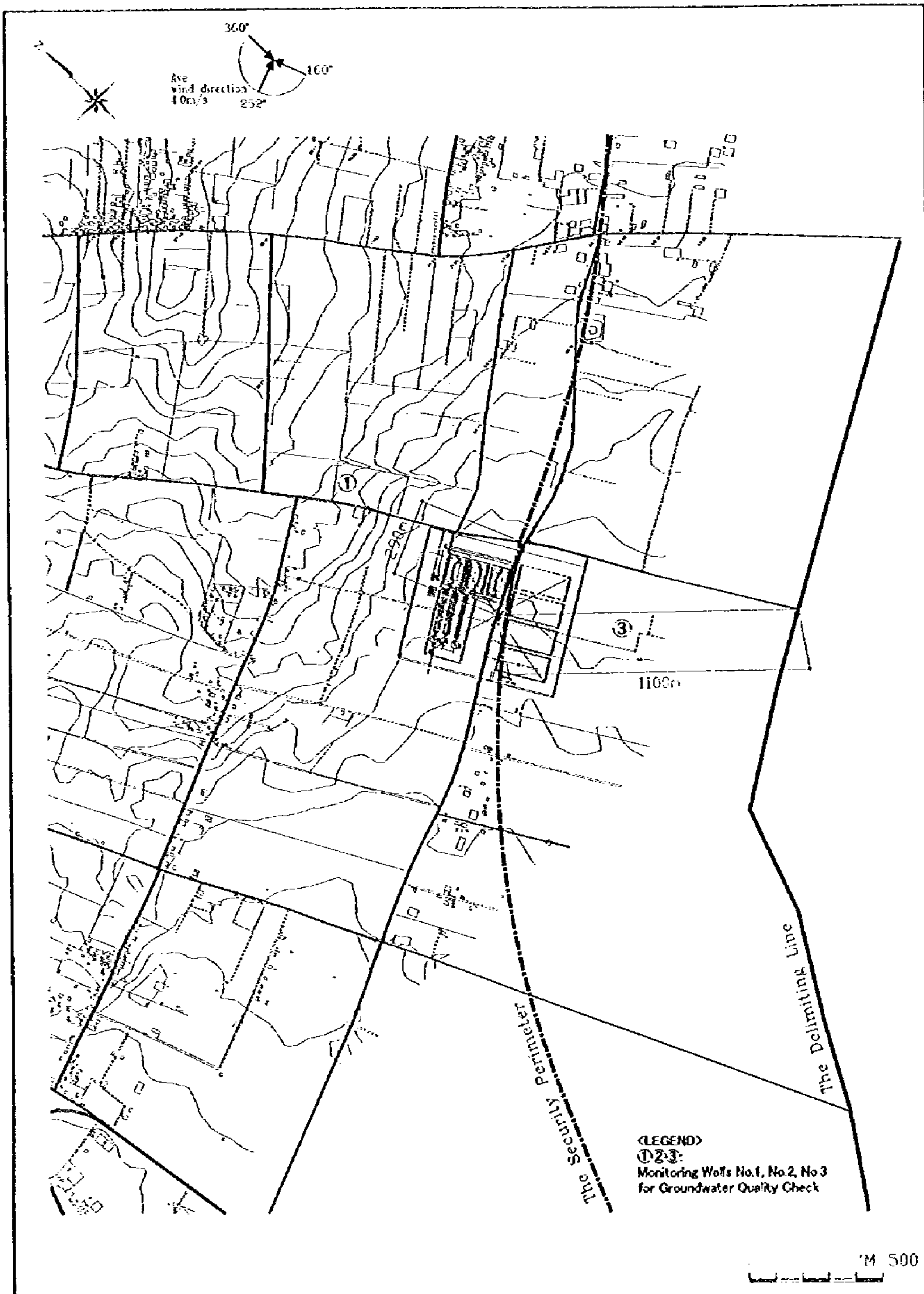

FIG.F.6.8 LOCATION MAP OF WASTEWATER TREATMENT PLANT AND LOCATION OF MONITORING WELLS

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2) Evaluation

The evaluation was conducted comparing the offensive odor standard and considering the odor level at the WTP border and Israel border.

Regarding to the site of Israel border, the estimated concentration of ammonia and hydrogen sulfide was less than the standard at day time and night time. Odor level was almost less than 2 level, "Smell but do not know which one". And land use of Israel around the delimiting line is farm, so there is no affected object by odor.

Regarding to the site of WTP border, it was less than the standard at day time but night time. Although it did not satisfy the standard at night time at WTP border, the odor level is 3, "Tolerable". And the site of the land use is farm land, so there is no affected object by this effect.

Finally it is evaluated that generated offensive odor was the odor level which does not affect most of area and person around the planned wastewater treatment plant site based on the above mentioned discussion,

3) Operation and Maintenance

The odor control will be heavily dependent upon proper operation and maintenance of the facilities. Disposed sludge at inside of wastewater treatment plant shall be covered with earth properly, so that the generation of odor will be reduced.

6.4.6 Formulation of Action Program and Recommendations on Environmental Monitoring and Management

(1) Establishment of law and regulation for sewerage system

Law and regulation for sewerage system shall be established along with solid waste management. This regulation shall ensure users of sewerage system not to discharge any harmful materials into the sewerage system.

(2) Establishment of monitoring system

Monitoring system is required to maintain the groundwater quality as treated wastewater is discharged under ground. Influent and effluent of wastewater quality and groundwater shall be sampled and analyzed periodically to ensure the safety water quality.

(3) Establishment of appropriate construction program

It is necessary to conduct safe and appropriate construction for the facilities. Appropriate construction program shall emphasize safety and proper construction method to mitigate construction accident, to reduce traffic congestion, noise and vibration and to protect any buried cultural assets.

(4) Establishment of appropriate operation and maintenance program

It is necessary to operate and maintain sewerage system, sanitary system and drainage system in satisfactory condition. Appropriate operation and maintenance program shall state operation schedule to clean sewers, to maintain pump station and wastewater treatment plant.

6.4.7 Overall Evaluation

Summary of the results of EIA is described in Table F.6.13. It is estimated there are some undesirable environmental effects in the EIA result such as unpleasant traffic congestion during construction period and odor generation around wastewater treatment plant. Although there are these undesirable environmental effects, they are not very severe negative impacts. Most of them can be managed to minimize the adverse effects.

This sewerage project is for improving public health condition and living environmental condition, so that it has high beneficial effect to living environment.

In summary, it is evaluated the F/S project is to improve living environmental condition with proper construction and operation and maintenance.

Table F.6.13 Summarized EIA Works

No.	Items of major EIA study	Corresponding IEE Items	Outline of EIA	Evaluation
1	Land acquisition for wastewater treatment plant	(1) Economic activities	Importance of the project is recognized by local government and land user/owner. Process of land acquisition is going to be managed with appropriated compensation. It was evaluated there would not be significant problems in land acquisition and economic activities. There would be positive impact with this project generally speaking.	0
2	Cultural property	(3) Cultural property	Although there are cultural properties, they could be maintained not to be damaged with appropriate construction management.	0
3	Hazards	(6) Hazards	This project consists of civil works. It can be maintained with appropriate construction management not to meet accidents. Although pump station No.3 has high pump head, there is enough technology to maintain it and there is a precedent of pump station at Gaza. Pump station will provide backup system for power failure and spare pump. As a result, it was expected any hazards might be protected with proper management.	0
4	Discharge of treated wastewater	(4) Public health condition (7) Soil erosion (8) Groundwater (11) Water pollution (12) Soil contamination	1) Quantity matter Infiltration ponds were designed to keep enough capacity for discharging treated wastewater at wastewater treatment plant, so overflow/soil erosion from the plant would not be expected. Although infiltration pond were planned like this way, it is necessary to ensure the infiltration capacity during the 1stage operation period. 2) Quality matter According to the survey result, effluent of treated wastewater quality mostly fits Jordanian groundwater recharge standard. In regard to phosphorus, although effluent quality is higher than the standard, it is expected phosphorus might be absorbed during infiltrating process under ground. Wastewater from factories or hospitals shall be pretreated at their own facilities before they discharge harmful wastewater into sewerage system, that is to keep the appropriate treatment function. This shall be maintained by establishment of corresponding law or regulation. Treated wastewater shall keep proper quality with appropriate operation and maintenance. Based on the mentioned discussion, it is evaluated there would be not negative impact to groundwater, soil condition and public health.	1) 0 2) 0

			Additionally, there will be opportunity to reuse treated wastewater for agriculture and so on. In case reuse will be applied, pilot project will be conducted to ensure the safety to circumstances.	
5	Waste management of sludge	(5) Waste	It is evaluated sludge disposing program is ready for about 2 years of F/S project, as generated sludge at wastewater treatment plant will be initially maintained at inside of the wastewater treatment plant site. But, it is necessary to decide the final disposing system for further sludge management.	0
6	Fauna and Flora	(9) Fauna and Flora	There are no significant fauna and flora around the project area. There will be no effect to them.	0
7	Air pollution, transportation, noise and vibration	(10) Air pollution (2) Traffic and public facilities (13) Noise and vibration	Although it is expected some air pollutant, noise and vibration will increase during construction period, it can be minimize with appropriate construction program.	-
8	Odor	(14) Offensive odor	Odor might be generated during operation period. Odor was estimated at border of the wastewater treatment plant and border of Israel. In regard to the results, night odor at border of plant is over a standard and others are under the limit. Present land use is farm land at the proposed wastewater treatment plant and future land use will be also as same as farm land. It was evaluated odor might not affect significantly the present circumstances.	-

Remarks

Evaluation	Meaning
++	Improving environment comparing present condition
+	Slightly improving environment comparing present condition
0	Almost no difference comparing present condition
-	Slightly changing worse comparing present condition
--	changing worse comparing present condition

6.5 Recommendations

The success of a intermediate-term strategy for sanitation improvement and environmental protection in the Khan Yunis City and its surrounding areas (the Study Area) require the implementation of a range of actions. Recommendations include:

(1) Enforcement of controls over what enters the Governorate groundwater particularly from commercial and industrial activities which will need to enhance their wastewater pre-treatment practices,

(2) Establishment of an executing agency at Governerate of Khan Yunis in coordination with Municipality of Khan Yunis, to take responsibility for the management, implementation and operation of the Project,

(3) Construction of new sanitary sewers to collect wastewater from the urban areas, followed by full connection of property wastewater discharges to them,

(4) Construction of a central treatment facility to serve areas of the Khan Yunis and its surrounding area, to provide biological treatment to all wastewater flows,

(5) Reuse of treated wastewater effluent for crop irrigation and recharge it into ground in the southern part of the Area,

(6) Construction of stormwater drainage system to relieve the low-lying districts from frequent inundation, and disposing of the collected rainwater for groundwater recharge,

(7) Improvement of sanitary conditions by providing additional vacuum trucks and sludge disposal facility attached to the sewer system to collect and dispose of the sludge from existing septic tanks and cesspools in a safe manner,

(8) Introduction of public education programs to promote community participation and understanding of the importance and benefits of public sanitation works

(9) Training of personnel in project management, financial management, operation and maintenance of wastewater facilities, and testing and monitoring, techniques;

(10) Planning for the future to ensure that future urban developments are provided with wastewater/sanitation facilities.

Some important institutional arrangements will need to be established so that the new executing agency can assume full control and responsibility for the planning, financing, construction and operation of the wastewater collection and treatment facilities together with other sanitation facilities.

The support and technical advice of other government departments, particularly the MOPIC and Khan Yunis Governorate, will be essential for the success of the Project, and to ensure that users of the new wastewater system are provided with a reliable, efficient and effective service.

A comprehensive charging policy, based on the "polluter pays principle," is recommended; tariffs developed on this basis would be levied on all properties located within the service area. Alternative cost recovery approaches are considered, both providing for full coverage of operating costs and debt service and eliminating the need for operational subsidy. For the initial stage of construction (1998 to 2000), financing of construction costs is heavily dependent upon grant funds. In later years, internal cash generation would become a significant source of financing.

Implementation of the whole Project will be undertaken over a 20-year period, with full completion of the First Stage project being achieved in 2002, with commissioning being commenced in 2001.

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