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No. 45

JAPAN INTERNATIONAL COOPERATION AGENCY

DAMASCUS CITY WATER SUPPLY AND SEWERAGE AUTHORITY
SYRIAN ARAB REPUBLIC

THE STUDY ON THE DEVELOPMENT OF WATER SUPPLY SYSTEM FOR THE DAMASCUS CITY

PHASE II

VOLUME II

FINAL REPORT
MAIN REPORT

DECEMBER 1997

NIPPON KOEI CO., LTD

JAPAN INTERNATIONAL COOPERATION AGENCY

DAMASCUS CITY WATER SUPPLY AND SEWERAGE AUTHORITY
SYRIAN ARAB REPUBLIC

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THE DEVELOPMENT OF WATER SUPPLY SYSTEM
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THE DAMASCUS CITY

PHASE II

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FINAL REPORT
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NIPPON KOEI CO., LTD

ESTIMATE OF PROJECT COST

Estimate of Base Cost : as of July 1997 Price Level

Currency Exchange Rate: US$1 = SL45 = Yen 115

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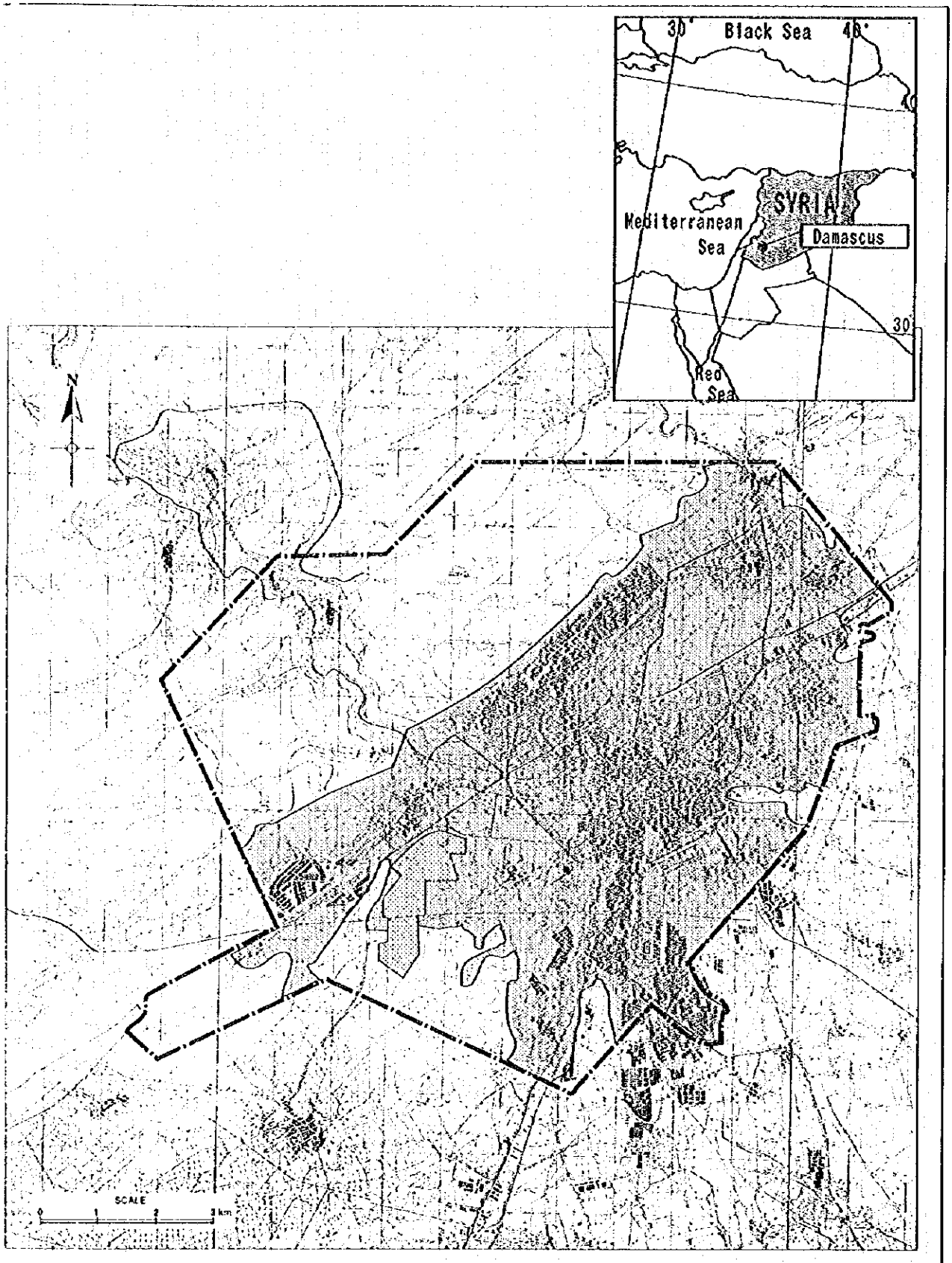

Legend

- Mezze-Razy & Kafar Souseh Informal Area
- Leakage Reduction Program Area
- Existing Boundary of The City

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

THE STUDY ON THE DEVELOPMENT OF WATER SUPPLY SYSTEM FOR THE DAMASCUS CITY

Location Map of the Study Area

NIPPON KOEI CO., LTD.

PREFACE

In response to a request from the government of the Syrian Arab Republic, the Government of Japan decided to conduct a study on the Development of Water Supply System for the Damascus City (Phase II) and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Syria a study team headed by Mr. Masato Fujinami Nippon Koei Co., Ltd. two times between April and November 1997.

The team held discussions with the officials concerned of the Government of Syrian Arab Republic, and conducted field surveys at the study area. After the team returned to Japan, further studies were made and 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 countries.

I wish to express my sincere appreciation to the officials concerned of the Government of Syrian Arab Republic for their close cooperation extended to the team.

December, 1997

Kimio Fujita
President
Japan International Cooperation Agency

December, 1997

Mr. Kimio Fujita
President
Japan International Cooperation Agency
Tokyo, Japan

LETTER OF TRANSMITTAL

Dear Sir,

We have the pleasure of submitting to you the Final Report of "The Study on the Development of Water Supply System for the Damascus City (Phase II)", in accordance with the Scope of Work agreed upon between the Damascus City Water Supply and Sewerage Authority and Japan International Cooperation Agency. The study was carried out for a total period of 10 months from March to December 1997, aiming to formulate water supply plan for the Damascus city.

The report consists of four volumes. The Executive Summary (Volume I) contains the summary of the study result. The Main Report (Volume II)presents the formulation of overall and strategic master plan for the water supply system in Damascus city. The Supporting Report (Volume III) describes the analysis and discussion in the sector of DMA system, Mezze-Razy & Kafar Souseh-Lawan system, water quality and environment, economic and financial evaluation, financial management, topographic survey, and leakage record of distribution mains to support the main report. Data Book (Volume IV) contains basic data of the study.

The study team sincerely hopes that the study result would contribute to the future water supply plan in Damascus city.

We wish to express our deep appreciation and gratitude to the personnel concerned of your Agency and Office in Syria, the Embassy of Japan in the Syrian Arab Republic, as well as officials concerned of the Government of Syrian Arab Republic.

Sincerely yours,

藤浪正人

Masato Fujinami
Team Leader
The Study on the Development of Water
Supply System for the Damascus City (Phase II)

THE STUDY
ON
THE DEVELOPMENT OF WATER SUPPLY SYSTEM
FOR
THE DAMASCUS CITY

PHASE II
MAIN REPORT

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ABBREVIATIONS

Organizations

ACSAD	-	The Arab Center for the Studies of Arid Zone and Dry Lands
BRGM	-	Bureau de Reche rche Geologique et Miniere, France
CBS	-	Central Bureau of Statistics
CGE	-	Compaginie Generale des Eaux, France
DAWSSA	-	Damascus City Water Supply and Sewerage Authority
EDWSSR	-	Establishment of Drinking Water Supply and Sewerage in the Rural Province of Damascus
EPEF	-	Establishment Public Des Eau De Damas (Figeh)
HIAST	-	Higher Institute of Applied Sciences and Technology
IED	-	Industrial Establishment for Defense
JICA	-	Japan International Cooperation Agency
MHU	-	Ministry of Housing and Utilities
MOI	-	Ministry of Irrigation
MOF	-	Ministry of Finance
SAR	-	Syrian Arab Republic
SPC	-	The State Planning Commission
STE	-	Syrian Telephone Exchange
WHO	-	World Health Organization

Others

CIP	-	Cast Iron Pipe
CIS	-	Customer Information System
DBMS	-	Data Base Management System
DIP	-	Ductile Iron Pipe
DMA	-	District Meter Areas
EIA	-	Environmental Impact Assessment
EIRR	-	Economic Internal Rate of Return
FLS	-	Financial Ledger System
FMIS	-	Financial Management Information System
GDP	-	Gross Domestic Product
GIS	-	Geographical Information System
HDET	-	Hand-held Data Entry Terminals
H/W	-	Hardware
IEE	-	Initial Environmental Evaluation
LAN	-	Local Area Network
LIMS	-	Laboratory Information Management System
MIS	-	Management Information System
MMS	-	Maintenance Management System
ND	-	Nominal Diameter
NPV	-	Net Present Value
O&M	-	Operation and Maintenance
OS	-	Operating System
PE	-	Polyethylene
PVC	-	Polyvinyl Chloride
SGP	-	Steel Galvanized Pipe
S/W	-	Software
SCADA	-	Supervisory Control and Data Acquisition (System)
UAS	-	Unified Accounting System
UFW	-	Unaccounted for Water
UPS	-	Uninterrupatble Power Supply System
VAT	-	Value Added Tax

ABBREVIATIONS OF MEASUREMENT

Length

mm	=	millimeter
cm	=	centimeter
m	=	meter
km	=	kilometer

Area

cm^2	=	square centimeter
m^2	=	square meter
ha	=	hectare
km^2	=	square kilometer

Volume

cm^3	=	cubic centimeter
l	=	liter
m^3	=	cubic meter
MCM	=	million cubic meter

Weight

mg	=	milligram
g	=	gram
kg	=	kilogram

Time

s	=	second
min	=	minute
h	=	hour
d	=	day
y	=	year

Electrical Measurement

V	=	Volt
A	=	Ampere
Hz	=	Herz
W	=	Watt
kW	=	kilowatt
MW	=	Megawatt

Other Measures

%	=	percent
HP	=	horsepower
°C	=	Celcius degree

Derived Measures

l/s	=	liter per second
m^3/s	=	cubic meter per second
m^3/h	=	cubic meter per hour
m^3/d	=	cubic meter per day
lpcd	=	liter per capita per day
kgf/cm^2	=	kilogram forceper square centimeter
kWh	=	kilowatthour
MWh	=	megawatthour
kVA	=	kilovolt ampere
mg/l	=	milligram per liter
μg/l	=	microgram per liter
meq/l	=	milliequivalents per liter
μS/cm	=	microsiemens per centimeter

Currency

US$	=	US Dollar
SL	=	Syrian Pound

CURRENCY EQUIVALENT

(as of July 1997)

US$ 1 = SL 45.0

TRANSLITERATIONS OF ARABIC PLACE NAMES (1/2)

عباسيين	Abasiyin	بيت جن	Beit Jenn
أبو زاد	AbuZad	بيت تيما	Beit Tima
أشرفية	Achrafye	برزة	Berze
عين عوينات	Ain Awenad	بلودان	Bloudan
عين بدا	Ain Beda	بقين	Boukein
عين حبيب	Ain Habib	دحاديل	Dahadil
عين حداد	Ain Hadad	دار المعلمات	Dar al Moalimat
عين حاروش	Ain Haroush	داريا	Daraya
عين حور	Ain Hour	دير مقرن	Deir Moukaren
عين عيسى	Ain Issa	دير العشاير	Deir al Ashayer Shahour
عين نورية	Ain Nourich	حوض التشتيت	Dissipation Basin
عين رضوان	Ain Roudwan	دربل	Dourbol
عين صبا	Ain Saba	دمر	Dummar
عين صالح	Ain Saleh	عسالي	El Esaly
عين الباردة	Ain el Baradeh	الفوار	El Fawar
عين الخضرة	Ain el Khadra	الفيض	El Feid
عين المالحة	Ain el Malha	حفيرية	El Hafirich
عين الصاحب	Ain el Saheb	الهامة	El Hame
عين التينة	Ain el Tineh	العرق	El Irk
أكراد	Akrad	الشواط	El Shuwhat
جامع القصاب	Al Aksab Mosque	عش الورور	Esh al Warwar
الضاحية	Al Dahia	فاسرّيا	Fasraya
الخضرة	Al Khadra	نبع الفيجة	Figeh Spring
المشارع	Al Mashare	فراسكن	Fraskin
القزاز	Al Qazzaz	الغوطة	Ghouta
السهل	Al Sahl	حفير الفوقة	Hafir el Foka
عرطوز	Artooz	حاليا	Halaya
قدم عسالي	Asalie Kadam	حسيبة	Hassibeh
الاعوج	Awaj	حسينية	Huseiniyeh
باب مصلى	Bab Mosallah	ابن النفيس	Ibn Alnafeas
باب شرقي	Bab Sharki	ابن عساكر	Ibn Assaker
باب السلام	Bab el Salam	جناني	Janani
شارع بغداد	Baghdad Street	جرمانا	Jaramana
بردى	Barada	جمرايا	Jemarya
بساتين	Basateen	جوبر	Jobar
بسيمة	Bassime	جوبر عكاش	Jobar Akache

TRANSLITERATIONS OF ARABIC PLACE NAMES (2/2)

جوبر عمادية	Jobar Imadye	قطيفة	Qutayfeh
جوبر قباني	Jobar Kabani	رنكوس	Rankous
جرجانية	Jourjaniyeh	رأس الحاجب	Ras Hasib
قابون	Kaboon	رأس الوادي	Ras el Wadi
قدم	Kadam	الرازي	Razy
كفرسوسة	Kafar Souseh	ربعة	Rimeh
كفر العواميد	Kafar el Awamid	ركن الدين	Rukn Aldyn
قنوات	Kanawat	سعسع	Saasaa
قاسيون	Kassioun	صفصافة	Safsafi
قطنا	Katana	سردا	Sarada
الكورش	Kersh	ساروجة	Sarouja
خان الفندق	Khan el Founduk	صياد	Sayafeh
خورشيد	Khorshead	سيبراني	Sebrani
قدسيا	Kudsaya	صيدنايا	Sednaya
كيوان	Kywan	شاغور	Shaghour
لوان	Lawan	شخاب	Shakhab
معلولا	Maaloula	ينابيع جانبية	Side Spring
معرونة	Maaroune	سومرية	Somareyeh
مضايا	Madaya	سيرونكس	Syronics
مهدي بن بركة	Mahadi Bin Baraka	طبالة	Tabbaleh
شارع الملكي	Malki street	طبية	Tabibiyeh
مزرعة	Mazraa	تضامن	Tadamoun
ميسلون	Meisaloun	تقدم	Takadom
ممبج	Membej	تلمذية	Talmasieh
مزة	Mezze	تكية	Tekieh
ميدان	Midan	المدينة القديمة	The Old City
منين	Minn	تشرين	Tishreen
مخيم	Mokhayam	المدينة الجامعية	University City
مهاجرين	Moulhajreen	وادي مروان	Wadi Marwan
النبوع	Naboua	الوالي	Wali
نهر عيشة	Naher Esheh	يعفور	Yaafoor
ناظم باشا	Nazem Basha	يرموك	Yarmouk
النبك	Nebk	زبداني	Zabadani
أمية	Omayad		
أمويين	Oumawiyin		
منطقة الرئاسة	Presidential Area		

1. INTRODUCTION

1.1 Background

Damascus City is located in the southwest of the Syrian Arab Republic (See Location Map). Damascus is the capital city and has a population of about 1.40 million and which recent years has grown at about 2%.

The Damascus Water Supply and Sewerage Authority (DAWSSA) provides water for Damascus City. In 1992, DAWSSA supplied a total of approximately 210 million m^3, however water restrictions occurred during the dry season, in spite of supplemental groundwater pumped from deep wells in the City.

DAWSSA now faces two important challenges: i) providing adequate, reliable water supply in the dry season; and ii) finding measures to increase water available for consumption to meet the future demand of a rapidly growing population. Existing distribution facilities must also be reviewed since only 36% of all water supplied is accounted for. This unacceptably high level of unaccounted for water is due mostly to leakage from an aging infrastructure, and unmetered use from informal pipe connections. Therefore in addition to securing new water resources, measures for reducing losses in the distribution network are required.

As a first step to improving the above mentioned conditions, the Government of the Syrian Arab Republic (hereinafter referred to as "the Government of Syria") in February 1994 requested the Government of Japan to conduct a Study on the Development of the Water Supply System for Damascus City.

In response to the official request from the Government of Syria, the Government of Japan dispatched in March 1995 a JICA Preparatory Study Team to prepare the Scope of Works for the Project. The JICA Preparatory Study Team and the Government of Syria discussed the operation of the Study and signed the Scope of Work for the Study on March 23, 1995.

The Study consists of two phases, according to the schedule outlined in the "Scope of Work" for the Study. Phase I is the Mater Plan Study which was carried out from January 1996 to February 1997. Phase II is the Feasibility Study on priority projects which were selected by mutual consent from the Master Plan formulated during Phase I. Priority projects identified during Phase I include: the District Meter Area (DMA) system to enhance leakage detection efforts, and the extension of the water distribution network into the Mezze-Razy & Kafar Souseh-Lawan informal area and improving financial management.

1.2 Objectives

The objectives of the Phase II Study are summarized as follows:

1) to improve leakage detection efforts for the distribution network system in Damascus City,
2) to formulate the development plan for the distribution network in the Mezze Razy & Kafar Souseh-Lawan informal area,
3) to formulate the improvement plan for revenue management based on automation and integration of billing and collection functions, and
4) to transfer technology on planning methods and skills to DAWSSA counterpart personnel.

1.3 Study Area

The Study area for Phase II (Feasibility Study) covers the existing water distribution network system operating DAWSSA in the administrative area of Damascus City and Mezze Razy & Kafar Souseh-Lawan informal area.

1.4 Phasing of the Study and General Progress

Phase II consists of two field investigation periods and home work periods as follows:

A. Preparatory work in Japan
B. The First Filed Investigation (Study and Analysis)

C. The First Home Work (Formulation and Evaluation of Projects)

D. The Second Filed Investigation (Explanation and Discussion of Draft Final Report)

E. The Second Home Work (Preparation and Submitting of Final Report)

A general work plan for Phase II is shown in Figure 1.4.1. The work schedule for Phase II is shown in Figure 1.4.2.

The first field investigation of Phase II was initiated on April 21 1997, by the JICA study team, headed by Mr. M. Fujinami. The team was dispatched by JICA in accordance with the agreed to "Scope of the Work". The Inception Report for Phase II of the Feasibility Study was submitted to the DAWSSA on 22 April 1997. DAWSSA was briefed on the Inception Report by the JICA study team and comments were written in minutes dated April 24 1997. Main activities during the first field investigation included:

1) Supplementary data collection and analysis
2) Survey of existing DAWSSA water supply services and management
   - Operation and maintenance aspects
   - Water charge billing and collection
   - Utilization of computer
3) Existing distribution network analysis & DMA planning
4) Selection of pilot area for DMA and flow rates monitoring
5) Data collection for cost estimate and construction plan
6) Survey for Environmental Impact Assessment
7) Study of basic requirements for water supply
   - Mezze-Razy & Kafal Souseh-Lawan informal area
   - DMA plan
8) Preparation of Interim Report for Phase II.

This Interim Report covers the results on the first field investigation for Phase II. The Interim Report for Phase II of the Feasibility Study were submitted to DAWSSA on August 12 1997. The JICA study team and with DAWSSA officially discussed the Interim Report and comments were noted in minutes dated in August 14 1997. After the signing the study

team left for Japan and carried out the first home work to prepare the Draft Final Report for Phase II.

In October 1997, the Draft Final Report for Phase II was prepared, and submitted to DAWSSA on October 26. The JICA study team explained the contents of the Report and discussed the result of the Study with DAWSSA at Damascus from October 27 to November 1, 1997.

In December 1997, the Final Report was prepared with reference to the comments of DAWSSA through the discussion, and it sent to DAWSSA.

1.5 Organization of the Study and Staffing

In order to attain smooth implementation of the Study it is of vital importance to set up an efficient project organization to closely coordinate the many activities throughout the Study period. Organization of the Study is illustrated in Figure 1.5.1. The JICA study team dispatched its engineers to the study area according to the schedule described in the Inception Report, for the execution of the study. The Study went smoothly under the supervision of JICA's Advisory Committee. Engineers of the JICA study team enjoyed excellent cooperation from DAWSSA's team of counterpart personnel. The members of the JICA advisory committee and both teams are listed in Table 1.5.1. The assignment schedule for the JICA study team is shown in Figure 1.5.2.

1.6 Transfer of Knowledge

Throughout the Study DAWSSA participated in the field operations and in the office work, thereby learning the technology and needs on knowledge required. Mr. Hussan Hredden counterpart for water distribution network management, came to Japan for three weeks from September 9, 1997 to obtain training on distribution network management. During his stay in Japan, he learned many aspects of distribution network management including the DMA system and leakage control.

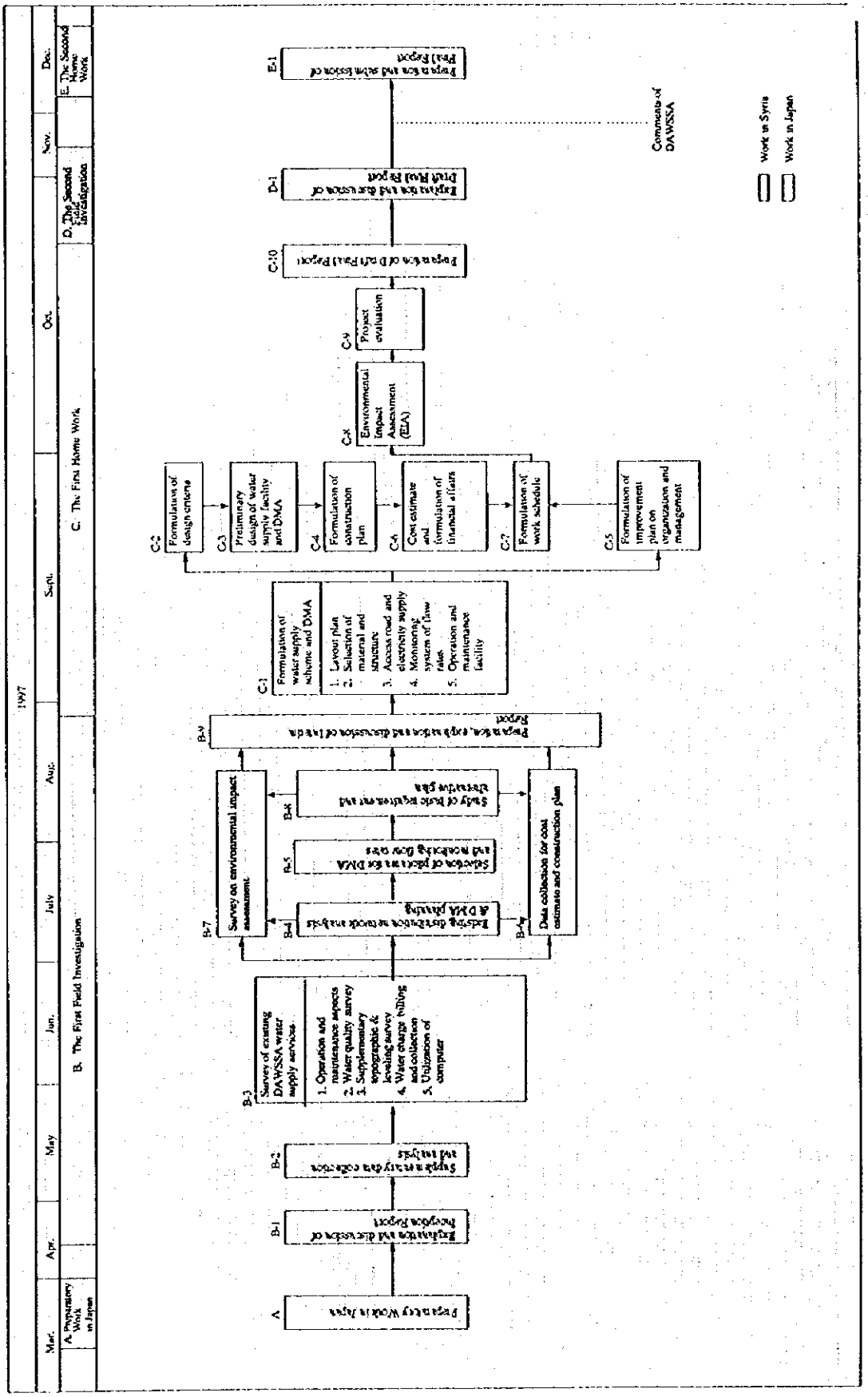
1.7 Procurement and Transportation of Materials and Equipment

The following equipment and materials necessary for the Study were prepared by JICA and transported to Syria during this period.

No.		Description	Model	Unit	Quantity
1.		IBM compatible computer (SOTEC Win Book)	Quattro/V J5P150X	set	1
2.		Printer for computer (EPSON)	Stylus color 1520	set	1
3.		Soft ware for network analysis	NTMSI-E	lot	1
4.	4.1	Portable ultra sonic flow meter	Tomas flow 1010WP	sets	2
	4.2	Standard transducer	991 NMS-3	sets	2
	4.3	Standard mounting track	992MTNHMA-3	sets	2
	4.4	Transducer cable	1010CPW9N-20	pcs	2
	4.5	DC Power adapter (AC90V~250V)	1015BC-1	pcs	2
	4.6	External portable battery (14.5V, 1A)	1015WBP (1015BCK3)	pcs	2
	4.7	Battery charger	1015WPA	pcs	2
	4.8	Coupling compound	CC114 - 22 ml	pcs	2
			CC117 - 12 ml	pcs	2
	4.9	Auxiliary transducer	991NMS-2	set	1
			991NMS-4	sets	2
			991NMS-5	set	1
	4.10	Auxiliary mounting track	992MTNHMA-2	set	1
			992MTNHMA-4	sets	2
			992MTNHMA-5	set	1

Table 1.5.1 Participants in the Study

Name	Assignment
Advisory Committee	
Dr.S. Kunikane	Chairman
Mr.Y. Omura	Member
Study Team	
Mr.M. Fujinami	Team Leader
Mr.H. Wakasa	Water Supply Planner
Mr.Y. Inabe	Water Supply Engineer
Mr. M. Fujii	Water Supply Engineer
Mr. F. Oyama	Water Supply Engineer
Mr.I. Sakaoka	Water Distribution Network Management Engineer
Mr.M. Kikuchi	Leakage Control Expert
Mr.T. Okada	Construction Plan/ Cost Estimate Expert
Mr.R. Despault	Institutional Expert/Project Economist
Dr.I. Okuda	Environmental Analyst/ Water Quality Expert
Counterpart Personnel	
Eng. Khaled Shalak	Chief counterpart
Eng. Riad Hashimi	Water distribution network operation/ Cost estimate and construction plan
Eng. Hussam Kassab	Water supply facility
Ms. Iptisam Nahhas	Water quality analysis
Mr. Hussam Hredden	Water distribution network management
Mr. Tawffeek Gahbra	Leakage control
Eng. Razan Khalifeh	Environment aspect
Ms. Nahida Al Sousse	Accounting/ Financial management
Mr. Yassar Zahri	Computer system
Ms. Hanadi Asfari	Organizational matters and personnel management
Ms. Nura Shirinian	Financial management



JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)	
THE STUDY ON THE DEVELOPMENT OF WATER SUPPLY SYSTEM FOR THE DAMASCUS CITY	
Figure 1.4.1 General Work Flow	
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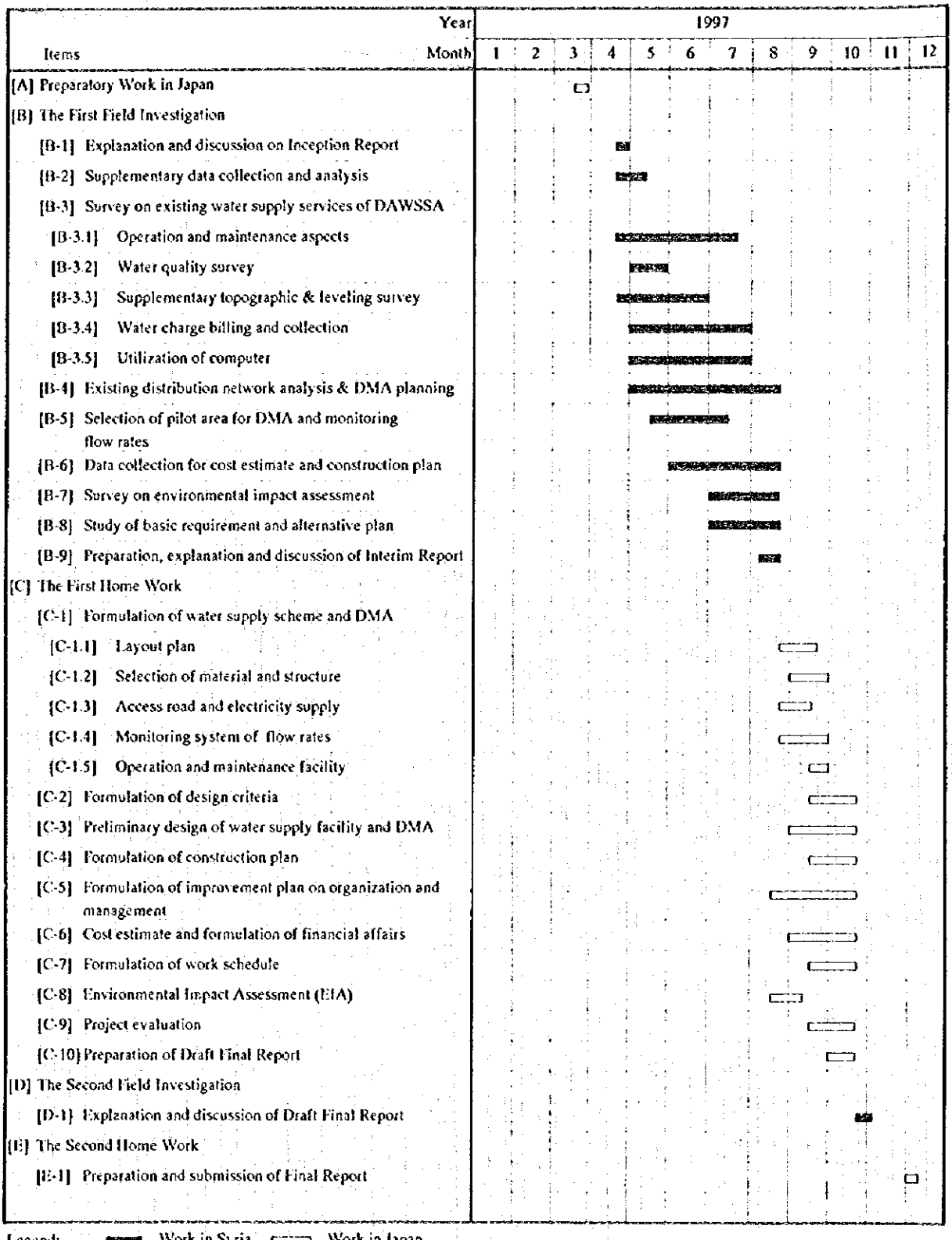

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

THE STUDY ON THE DEVELOPMENT OF WATER SUPPLY SYSTEM FOR THE DAMASCUS CITY

Figure 1.4.2
Work Schedule

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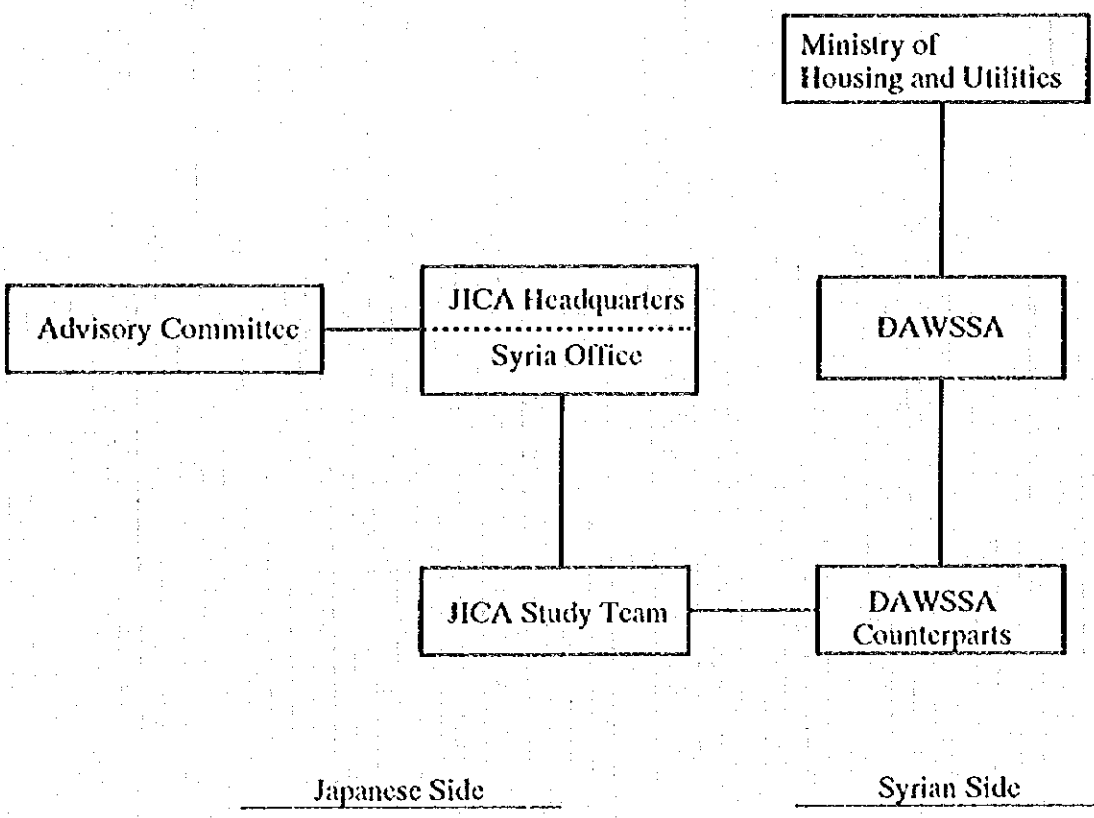

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
THE STUDY ON THE DEVELOPMENT OF WATER SUPPLY SYSTEM FOR THE DAMASCUS CITY
Figure 1.5.1 Organization of the Study
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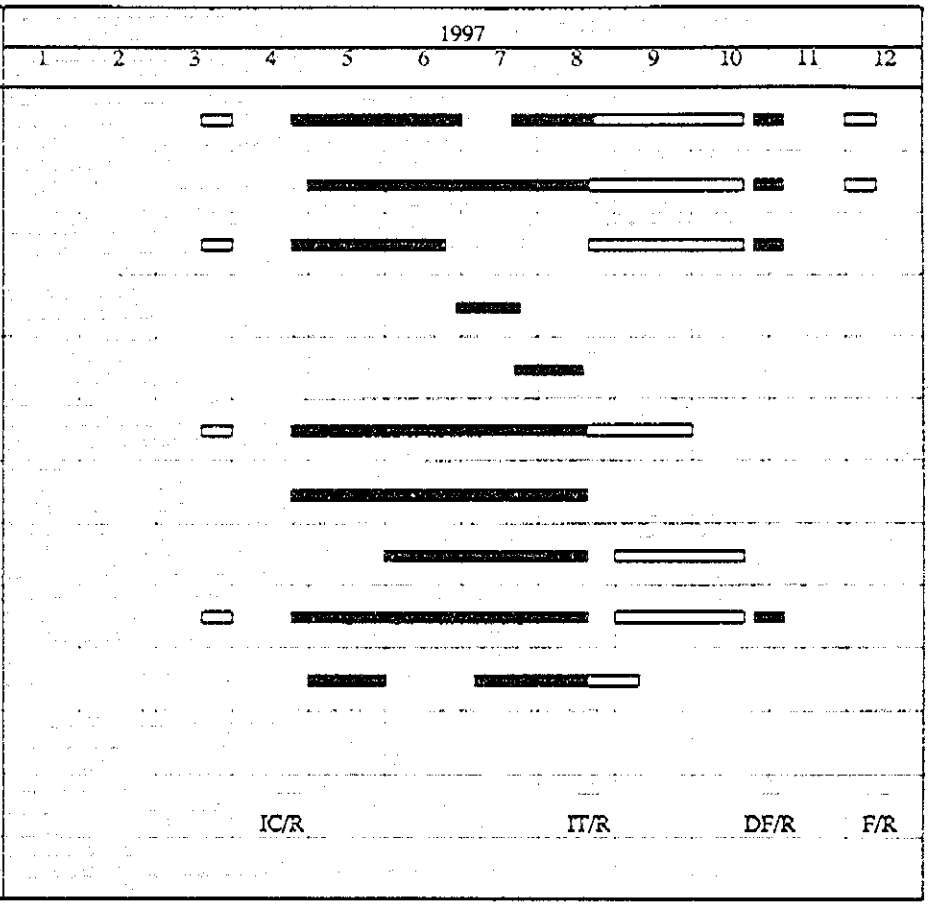
Position	Name
Team Leader	M. Fujinami
Water Supply Planner	H. Wakasa
Water Supply Engineer	Y. Inabe
Water Supply Engineer	M. Fujii
Water Supply Engineer	F. Oyama
Water Distribution Network Management Engineer	I. Sakaoka
Leakage Control Expert	M. Kikuchi
Construction Plan / Cost Estimate Expert	T. Okada
Institutional Expert / Project Economist	Robert Despault
Environmental Analyst / Water Quality Expert	I. Okuda



Legend: Work in Syria Work in Japan

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

THE STUDY ON THE DEVELOPMENT OF WATER SUPPLY SYSTEM FOR THE DAMASCUS CITY

Figure 1.5.2

Assignment Schedule

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2. GENERAL OUTLINE OF THE STUDY AREA

2.1 Location

The Syrian Arab Republic is located between longitudes 35° and 42° east , and latitudes 32° and 37° north and occupies a total area of 185, 180 km^2. Cultivated land occupies about 60,000 km^2 and the remaining area is occupied by desert and rocky mountains. The Syrian Arab Republic is bounded on the west by the sea, Lebanon, and Palestine, in the north by Turkey, in the east by Iraq, and in the south by Jordan. The Study Area which is located inside of the City of Damascus, is bounded by the mountain range of the Anti-Lebanon Mountain border on the west, see Location Map.

2.2 Topography and Geology

The City of Damascus is located at the point where the Barada River leaves the Anti-Lebanon Mountain Belt and flows east onto a plain of the El-Arab Trough. The urban area of Damascus, covers the alluvial fan created by the river. To the south east the land forms a plain gently dipping to closed depressions. The mountain belt consists of a series of parallel ridges and valleys running south-west to north-east. The mountain areas have developed karstic features in massive dolomites and limestones that are most strongly developed in areas of tectonic fracturing.

2.3 Socio-economy

Damascus, the capital of the Syrian Arab Republic, is situated in the southwest of Syria, which is the political, economic, and traffic center of the country. The gross domestic product (GDP) was 496,504 million SL in 1994 and the per capita GDP was 35,866 SL in 1994. Main domestic industries are petroleum, natural gas, textiles and agriculture (cotton, fruits, vegetables) ; petroleum accounted for about 50% of the total main export production in 1994. According to census information, the total population of the country in 1994 was 13.8 million and the rate of population increase has been about 3.3 % from 1981 to

1994. About 51% of the population lives in urban areas and the remaining in rural areas. The population of the Study Area was 1.39 million in 1994 and the growth rate was 2%.

2.4 Water Supply System

The Damascus City Water Supply and Sewerage Authority (DAWSSA) created in 1985, under the Ministry of Housing and Utilities, provides water to Damascus City. In 1995, DAWSSA was responsible for water supply to Damascus City and eight villages along the Barada river. The existing population served by DAWSSA is estimated at approximately 1.2 million based on available billing data. The water resources servicing Damascus City consist of spring water and groundwater from deep tube wells.

Groundwater from Barada spring and under Damascus city, is used to meet peak demands. Potable water is mainly abstracted from the Barada spring wells and the Figeh spring located at the upper reach of Barada river and conveyed to Damascus City , through the transmission pipeline consisting of a 16 km box culvert and a 15 km tunnel from the Figeh. The water is stored at Wali reservoir and then distributed to several service reservoirs located throughout the city.

In 1995, the amount of water abstracted from the wells at the Barada spring and the Figeh spring area was approximately 184.2 million cubic meter. This represents about 84% of the total water produced. Groundwater located under the city is pumped at various well sites to small service reservoirs located near each borehole and delivered to house connections throughout the network. The quality of the Barada and Figeh spring waters is generally good for drinking use without any water treatment. The quality of water from most other resources is also satisfied Syrian drinking quality standards.

There was an estimated 25 million m^3 demand which was not met in 1995. About 64% of the total water production was unaccounted for. The main components of UFW are attributed to: leakage (34.7%), meter malfunctions (14.4%), informal use (13.6%), and religious and public fountain use (1.7%).

3. PRESENT CONDITIONS OF THE STUDY AREA

3.1 Existing Distribution Network Systems

3.1.1 General

The main water sources used by DAWSSA are the Figeh spring and groundwater from the well fields in the Barada spring and the Damascus city areas. The water from the springs is conveyed to Wali reservoirs through tunnels by gravity flow and transmitted to the service reservoirs from Wali reservoir either by gravity flow or booster pumps. The groundwater in the city area is pumped up to a service reservoir at the well fields and distributed in the network during the water shortage period from June to February.

3.1.2 Service Area

The existing water supply system covers Damascus city and the villages along the Barada river valley. The city is divided into 4 service areas : Damascus Center, Berze, Berze East and Mezze. The 4 areas are further divided into 12 pressure zones of low, medium, high I, high II and superior high in accordance with the altitude of geographical features. Each pressure zone is established so as to keep the water head at 60 m for the maximum static head and 30 m for the minimum dynamic head at the end of distribution pipelines. At present the minimum head is only 10 m in Damascus Center.

3.1.3 Service Reservoirs

30 service reservoirs and 4 pressure regulation reservoirs are located in the existing service area and a total capacity is about 0.2 million m^3. Flow meters are provided at the entrance of both tunnels and Barada collecting reservoir, the outlet pipe of the service reservoirs and the delivery pipe of the pump stations although no meter is installed in some reservoirs. About half of the existing meters are working in good condition but the others are malfunctioning. Bulk metering is required on the outlet pipe of service reservoirs for operation and maintenance, and the analysis of leakage in the distribution system.

3.1.4 Production Wells

Production wells located in the Damascus city supplement water to the main water source of Figeh spring. The 101 wells in operation at 8 separate production well fields in the city area are used mostly during water shortage periods from June to February. Well water is conveyed to the reservoir in the production well center and distributed into the network by the booster pump. In addition there are 23 fringe wells and 58 emergency wells for supplement water supply. The fringe wells are operated for 16 hours per day with an average annual operation rate of 40 % in 1995. The emergency wells are checked twice a week by the Pump Set Maintenance Department of the Emergency Well Directorate

3.1.5 Pumping Stations

The pumping stations for transmitting the water to the other reservoirs at higher elevations are located at the following service reservoirs: Wali old, Wali new, Kassioun high, Eastern II, Mezze and Dummar. The pumps are horizontal single/multi-stage volute type with a rated head of 46 to 300 m and a capacity of 40 to 432 m^3/h. The pumping stations at the production well center are equipped with submersible pumps installed in the reservoir to distribute water to the distribution networks and are provided with a flow meter on the trunk main.

3.1.6 Transmission and Distribution Mains

The total length of the existing transmission and distribution mains is approximately 1,186 km. DAWSSA has laid a total of 479 km of ductile iron transmission and distribution mains from 1982 to 1992.

(1) Transmission mains

Spring water from Figeh and Barada is conveyed by 2 transmission tunnels with a total capacity of 15 m^3/s from Figeh spring to Wali reservoirs. The transmission pipelines are

mainly ductile iron pipe (DIP) ranging from ND 80 mm to ND 1200 mm. The lengths of transmission pipelines classified by material and diameter are summarized below :

(Unit: km)

Pipe Materials	ND80-150	ND250-500	ND600-800	ND1000-1200	Total
DIP	4.6	22.6	13.2	22.1	62.5
SP	0.3	0.6	3.3	2.3	6.5
CIP		0.7			0.7
Total	4.9	23.9	16.5	24.4	69.7

(Source: DAWSSA) DIP: Ductile iron pipe SP: Steel pipe CIP: Cast iron pipe

(2) Distribution mains

Distribution mains are mostly DIP ranging from ND 60 mm to ND 1200 mm. Most of the water for the center of Damascus is distributed through two mains of ND 800 mm and ND 600 mm from the Eastern reservoir and two mains of ND 1200 mm from the Western reservoir. The distribution mains are provided with sectional valves and control valves for optimizing distribution network operations. There are 552 fire hydrants of 100 mm located on the pipelines. About 124 km (11%) of existing distribution mains are lead joint cast iron pipe (CIP) ranging from ND 80 mm to ND 600 mm. According to the leakage survey carried out by the JICA Study Team from June to July 1997, the leakage of CIP is estimated at 30.3 m^3/h and 3.8 leakage points per linear km of distribution pipeline. The lengths of distribution pipelines classified by material and diameter are summarized below:

(unit : km)

Pipe Materials	ND 40 - 50	ND 60 - 150	ND 200 - 500	ND 600 - 1200	Total
DIP	-	725	166	37	928
CIP	-	40	71	13	124
SP	55	5	2	2	64
Total	26	686	288	96	1,116

(Source: DAWSSA) DIP: Ductile iron pipe, CIP: Cast iron pipe SP: Steel pipe

(3) Service connections and water meters

Service pipes are either polyethylene pipe (PE) or galvanized steel pipes (GSP). All new service connections to existing mains are installed by DAWSSA's own staff and includes everything from tapping on the distribution pipe to installing the service meter. About 99%

of the meters are 13 mm diameter and the remaining are 20 mm diameter and more. The number of meters by diameter of service connection is shown below :

13 mm	20 mm	25 mm	30 mm	40 mm	50 mm	60 mm <
250,200	365	730	26	291	194	80

(Source: DAWSSA)

According to meter reading records, in 1995 36.5 % of all meters were malfunctioning.

3.1.7 Leakage Record of Distribution Mains

Leakage problems occur mainly on the cast iron pipes, which form 11 % of the total length of the distribution mains in the network. Leakage of ductile iron pipes only occurs about once a month usually due to accidents with construction machinery, improperly seated rubber joints or connections made by informal water users. Repair works are carried out in three 8 hours shifts per day by two 3 person teams. The pipes which are installed near reservoirs and pumping stations and/or have large diameter, are repaired as a first priority. Only 30 - 50% of pipes can be repaired immediately after detecting leakage.

For the cast iron pipes, the average number of monthly leakage repair works on the distribution mains is 30.5 repairs/month from January 1993 to December 1996s resulting in 0.23 repairs/km/month. The frequency of repair works on distribution mains and service pipes has remained unchanged for the last 4 years, see Figure 3.1.1. This indicates that, the condition of leakage on the cast iron pipes has not been improved in spite of continuous repair efforts. It is also an indication that most of the cast iron pipes are too old and have too many weak points to be effectively repaired.

It is observed from Figure 3.1.2 that the frequency of repair works during the dry season is higher than the frequency during the rainy season. This is likely due to the fluctuation of water pressure caused by water rationing during dry season which stresses the weak cast iron pipe. From Table 3.1.1 it can be observed that the frequency of repair on large diameter pipes tends to be higher than that of small diameter pipes, and the frequency of repair on cast iron pipes does not correlate with the age of the pipes.

The average number of the monthly leakage repair works for service pipes is 348.3 repairs/month from January 1993 to December 1996. This is rather high compared to the monthly leakage repair works for distribution pipes is 30.5 repair/month. The two figures result in a total of 378.8 repairs/month. The leakage repair work on service pipes accounts for about 92 % of the total leakage repair workload.

The frequency of leakage on service pipes per house connection is estimated at about 1.46 /1,000 connections /month. It is assumed that service pipes connected to the cast iron pipes probably account for the majority of all leaking service pipes simply because the service pipes are as old as the cast iron pipes. Service pipes connected to the cast iron pipes should be replaced because the connections are usually a weak point prone to leakage.

3.1.8 SCADA and Telecommunication System

DAWSSA entered a turn-key contract agreement with Italian Contractor Nuovo Pignone to procure a SCADA and Telecommunication System in 1994. The Project was scheduled to be completed in April 1997, however construction works have not yet started.

As for the system components and function, field control and monitoring equipment is to be installed to control the flow rates of water distribution in the network. The system will consist of a supervisory control and a communication system. Data from the flow meters and control valves in the network will be collected and transmitted to relay centers by the underground cables and transmitted to the main control center via DAWSSA's alternate control center. Data on the service reservoirs and the pump control system will be transmitted directly to the main control center located at Wali service reservoir.

The remote control valves, the flow meters and the pressure meters will be installed by the project for controlling and monitoring of the water distribution conditions in the network. According to the preliminary design for SCADA, 28 control units were to be established in the network, but many of the control units have now been canceled. The control and monitoring equipment to be installed by the Project is listed up in Table 3.1.2.

3.2 Mezze-Razy & Kafar Souseh-Lawan Area

3.2.1 Urban Development Plan

(1) Existing urban developments

The Mezze Razy & Kafar Souseh-Lawan area belongs to the Kafar Souse district. The present land use in the area is classified into two categories; Residential & Commercial Area and Farmland/ Green Area as presented below (the area for each type of land use is estimated roughly by measurement on the topographic map with a scale of 1/2,000, prepared by the JICA Study Team);

(Unit: ha)

	Mezze-Razy	Kafar Souseh-Lawan
Residential & Commercial Area	106	34
Farmland/ Green Area	30	21
Total	136	55

(2) Future urban development plan

The Municipality of Damascus is currently working on a new master plan for Future Damascus City and Regional Area (hereinafter called the New Urban Development M/P) to promote sustainable growth to the year 2020. The report for the third stage study of the New Urban Development M/P was prepared on March, 1997. From this report, the future land use pattern in the City and the surrounding area of the City will not change from the existing land use pattern. The detailed development plan for the area of Kafar Souse district, is not available since the future land use plan has not yet been prepared by Damascus Municipality. However, it is assumed that there will not be much change in the existing Kafar Souse district area according to the Damascus and Regional Master Plan for 2020.

3.2.2 Physical and Social Conditions

(1) Topography and geology

The Mezze-Razy informal area is located on the south of the Faez Mansour Motorway. The total area is 136.0 ha and population is estimated at 32,786. The elevation varies from 701 m to 715 m above mean sea level. The area slopes down to the south with incline of 1.1 %. The Kafar Souseh-Lawan informal area is located in the south of the Hafez Al Assad Motorway. The total area is 55.0 ha and population is estimated at 14,000. The elevation varies from 697 m to 707 m above mean sea level. Average slope incline is about 1.5 % in this area.

The urban area of Damascus, covers the thick alluvial fan created by the river where the Barada River leaves the Anti Lebanon Mountain Belt and flows east onto a plain of the El-Arab Trough. Therefore, the surface of geology in the Mezze-Razy & Kafar Souseh-Lawan area consists of unconsolidated Quaternary deposits.

(2) Housing and social conditions

The cadastral survey in the Mezze-Razy and Kafar Souseh-Lawan informal areas was carried out, in order to know roughly the location of houses and the type of buildings. The results are summarized as follows:

(Unit: Properties)

Type of Building	Mezze-Razy	Kafar Souseh-Lawan	Total
Resident	2,402	945	3,347
School	4	2	6
Mosque	4	3	7
Store & Workshop	77	148	225
Public Bath	-	3	3
Nursery	4	2	6
Total	2,491	1,103	3,594

In this study, the interview survey on living environment in the area was also conducted during June, 1997. Based on the results of the interview survey, social conditions in the area are summarized below;

i)	Average family size:	8 persons per family
ii)	Average house hold income:	SL 3,500 to SL 6,000 (Low Class)
iii)	Classification of income source:	Public sector (18 %), Private sector (73 %), Agricultural sector (7 %), Other (2 %)
iv)	Average possession rate of automobile:	12 %
v)	Average possession rate of flush toilet:	100 %
vi)	Average possession rate of bath:	100 %
vii)	Average daily water consumption per capita:	172 lpcd
viii)	Water source of formal residents:	DAWSSA system (95 %), Communal well (5 %)
	Water source of informal residents:	Irrigal connection to DAWSSA system (95 %), Bottled water (4 %), Others (1 %)
ix)	Customer satisfaction with present water supply conditions	
•	Insufficient water quantity:	26 % in Mezze-Razy, 67 % in Kafar Sousch-Lawan
•	Low pressure:	26 % in Mezze-Razy, 56 % in Kafar Sousch-Lawan
x)	Use of water storage device:	97 % (average capacity is 1 m^3), Used every day (69 %), Automatic control (76 %)
xi)	Willingness to pay water charge:	96 % agreed to the existing tariff
xii)	Awareness of environmental issues:	Lack of safe drinking water (30 %) Pollute driver/canal (66 %) Odor (57 %)

3.2.3 Present Water Use

(1) Domestic use

The average daily water consumption in the area is estimated at 172 lpcd and 95% of residents including informally connected residents use water supplied from DAWSSA according to results of the interview survey. As for water costs per formal household, the average monthly payment for water is 125 S.L. and this water cost corresponds to 2.5% of average income (about 5,000 S.L.). The results of the interview survey in the Feasibility Study are almost similar to the result of the Master Plan Study. For planning the distribution

network in Mezze-Razy & Kafar Souseh-Lawan area, the present domestic water use in the area is estimated at 170 lpcd as adopted by the Master Plan Study.

(2) Non-domestic use

In the Master Plan Study, water consumption for non-domestic use was projected based on the analytical results of records, questionnaire survey and information provided by DAWSSA and other relevant data collected, such as the urban development plan, land use plan and statistical data. The present water consumption for non-domestic use is estimated based on the unit water consumption per connection adopted by the Master Plan Study as follows:

Type of Connection	Unit	unit water consumption (m^3/connection)	water consumption (m^3/d)
School	6	24	144
Mosque	7	4	28
Store & Workshop	225	0.6	135
Public Bath	3	15	45
Nursery	6	15	90
Total	247		442

3.3 Water Quality and Environment

3.3.1 General

Based on the existing information, a number of environmental issues were identified as potentially important environmental impacts associated with the DMA project and the Mezze - Razy & Kafar Souseh - Lawan System, which include 1) safety of the supplied water, 2) increase in wastewater, 3) protection of cultural assets, and 4) socio-economic impact to informal residents. The following studies were conducted in May - July, 1997 to further assess the potential environmental impacts of the proposed projects.

3.3.2 Water Quality Study

(1) Pesticide Analysis

In the Master Plan study, detailed water quality studies were carried out. The results showed that the overall quality of the water supplied by DAWSSA was good. However, there was an apparent inconsistency in the pesticide data analyzed at two different institutes, and the possibility of pesticide contamination (aldrin, dieldrin, heptachlor, and fenitrothion) at Oumawiyin wellfield could not be confirmed. To confirm this pesticide contamination problem, water samples from three wells (#1, 4 and 13) in Oumawiyin wellfield, where potential pesticide pollution had been suspected in the Master Plan study, were sampled in May, 1997. The analyses of pesticides were carried out independently at two different institutes for cross-examination. Pesticides were not found in any well water samples examined this time. Based on this result, there is no pesticide pollution problem at Oumawiyin. However, pesticides including illegal ones banned by Decision 10 (1980) are widely used in Syria. Therefore, regular monitoring of pesticides in potable water, which is not practiced at all, is strongly recommended.

(2) Water Quality in the Network

The quality of water supplied by DAWSSA is generally high (see Master Plan report). However, it is not uniform in dry season when city wells are in operation to supplement the shortage of supply from the Figeh Spring. To analyze the distribution of water quality in the network, a water quality module was developed and incorporated into the network simulation model. Based on this water quality simulation (Figure 3.3.1), it was possible to pinpoint the areas in the network where water quality is low (e.g., Kadam). The result was in good agreement with the result of the field water quality study in the Master Plan.

3.3.3 Suitability of Water Resources for Potable Water Supply

Based on the findings in the Mater Plan study (see Section 3.4 of the Main Report (Volume II) of Phase I) and the result of the water quality study conducted this time, the water qualities of existing and promising water resources are summarized below.

The overall quality of the water supplied by DAWSSA is high. This is mainly because nearly 80 % (1995) of the water supplied by DAWSSA is available from Figeh Main Spring; a major spring which has been recognized for its superb water quality and abundant yield for centuries. Indeed the water quality of Figeh Main Spring is one of the best in the area, and is characterized by low conductivity (around 300 µS/cm) and low hardness (around 150 mg as $CaCO_3$/L). The pH is around 7.7, and the total bacteria count is typically below 50 counts/100 mL.

With the recent increase in water demand, however, DAWSSA is being forced to use other water resources with less desirable water quality. There are numerous secondary water resources in the area. The water qualities of these water resources vary significantly from place to place. In general, the quality of water in the mountain areas (Zabadani, Figeh and Hermon areas) is high, and easily satisfies the Syrian Drinking Water Standard. The groundwater in Damascus is not as good as the water in the mountains, although the water from most city wells still meet the Syrian Drinking Water Standard. Typically the conductivity is around 700 - 1000 µS/cm, hardness is around 300 - 400 mg as $CaCO_3$/L, and the nitrate concentration is around 25 mg/L. The major groundwater problems in Damascus are localized to south Damascus (hardness and nitrate problems) and Dummar-Mezze area (hardness, sulfate and salinity problems).

Surface water in the study area is not a good resource for drinking water as it is heavily contaminated by sewage and industrial discharge. The lack of sewerage system seems to be the main reason for the surface water pollution.

3.3.4 Environmental Impact Assessment Survey

Mezze - Razy and Kafar Souseh - Lawan areas are known as informal areas because people in these areas have built houses informally without obtaining permits from the local government. To identify important environmental problems in the areas, an interview survey with 100 local residents was conducted in May-June, 1997 (see Appendix C for details). As

some of the socio-economic and water use issues were reviewed in preceding Section 3.2, the discussions in this section focus on major environmental issues.

1) Limited safe drinking water : 30 % of the residents claim that lack of clean, safe drinking water is the most serious environmental problem of the area. This problem is more pronounced in the Kafar Souseh - Lawan area. Because there is no other water resource in these areas other than the partially installed DAWSSA system, as many as 60 % of the people get water illegally by sharing a connection or making an informal connection to DAWSSA system. Such illegal systems are not reliable, and a large number of informal users reported low water pressure (43 %), lack of sufficient quantity (45 %), and water quality problem (7 %).

2) Surface water pollution : Nearly 70 % of the residents feel that the most serious environmental problem in the area is surface water pollution. Related problems, such as odor (61 %) and lack of wastewater control (23 %), are also considered as serious problems. Although there are limited sewer systems in the areas, there is no wastewater treatment. Consequently, all wastewaters generated in the study areas are discharged to nearby ditches and the Dirani river without treatment, which is the primary cause of surface water pollution.

3) Air pollution and noise : Fewer people complained about air pollution (4 %) and noise (6 %). The study areas are less urbanized than central Damascus, and sources of air pollution and noise are limited.

4) Concerns about the impacts of proposed projects : In the interview survey, the nature of the proposed water supply project was briefly explained to the residents, and their environmental concerns were noted. 80 % of the residents expressed no environmental concern about the proposed project. The local residents are aware of the direct benefit of the water supply project, and they are anticipating large long-term benefit of the project in comparison to the short-term adverse impact of the construction works. In addition, the municipality already did much digging in the area three years in a row for sewerage projects, and the residents seem to be used to construction works in the area, although they want the works to be done as fast as

possible. Among the concerns were children's safety during construction (about 7 %), dust problem (5 %), noise problem (4 %) and traffic problem (4 %).

3.4 Organization and Financial Management

3.4.1 Past and Present Financial Performance -Overview

Data on financial performance is presented in Tables 3.4.1 and 3.4.2. The improvement of financial management was selected from the master plan (JICA 1997) as a priority project for the present feasibility study recognizing the need for DAWSSA to generate the revenues required for developing, owning and operating the ever growing water supply system. Two areas in need of urgent improvement were identified: (1) the billing and collection process; and (2) measuring and reporting financial performance to senior management.

The delay in collecting revenue is on average 12.5 months (10.5 months for issuing and 2 months for collecting). This delay seriously hampers financial performance as well as financial management processes throughout the organization. Although the billing process was partly computerized in 1982, the administrative procedures remain manual, labor intensive and do not permit the analysis of consumption data for operational needs. The inability to control expenditures and identify the component costs of producing water, including support services, makes it impossible for management to plan budgets based on the true needs of the organization. The inability to breakdown the operating costs for each part of the organization also makes it impossible to identify potential operating problems and control spending for various activities.

3.4.2 Present Organization

The organization structure is presented in Figures 3.4.1 and 3.4.2. The process of generating revenue begins in the Consumer Affairs Directorate responsible for making service connections, meter reading, and payment collection centers. The Consumer Affairs Directorate is almost twice as large in terms of staff (276) as other directorates and has a rather broad mandate dealing with customer services and the operation of payment collection centers.The

task of managing budgets and daily financial transactions are the responsibility of the Finance Directorate which also has a very broad mandate including non-financial functions such as store keeping, procurement and some expenditure control functions that would be more appropriately managed by the Accounting Directorate. The Accounting Directorate is responsible for financial accounting of all revenue and expenditures and preparing customer billing statements using a computer system.

There is an overlap in functions between these three Directorates and a general need to clarify roles and responsibilities. Decisions regarding managerial and fiscal issues are vested with the Directors and the Director General with no approval authority delegated to other levels in the chain of command. As a result, senior management positions must deal with many micro management issues and have little time for strategic planning.

3.4.3 Customer Metering, Billing and Collection Processes

The process of customer subscribtion and providing a metered connection is the important first step required to generate revenue. It is during this initial stage that most of the data required for the billing system is captured. DAWSSA accumulates a great deal of information about customers and connections (e.g. building permit, municipal address, photo identification, water right agreements, ownership, rate classification, consumption, location of service line, etc.). The information changes constantly and because it accumulates randomly over time and from different places throughout the organization it is difficult to manage effectively with the existing manual process.

The consumption meter is DAWSSA's cash register. The ability to generate revenues is critical to support the investments required for the operation, maintenance, and expansion of the water supply system. Therefore, DAWSSA needs to render timely and accurate bills and actively collect overdue payments. It is DAWSSA's legal mandate to bill customers quarterly based on metered consumption readings. However, actual meter reading cycles have slipped to 5 months. As a result bills are issued every 6 months on the basis of two equal quarterly billing statements. In 1982, DAWSSA computerized the billing system but unfortunately, it does not provide automatic error verification, customer accounting or data analysis features.

The process for issuing bills is inefficient and considered one of the most urgent matters to be resolved. The total time lapse from meter reading to issuing a bill averages around 197 days per metering district (6.5 months). Refering to the schedule in Table 3.4.3 there are three significant delay points in the billing process: (i) after meter readings are completed there is waiting period of 67 day (2 month) before sending or entering the data into the computer, (ii) after the data is entered there is an average 28 day (1 month) delay before the bills are printed, (iii) after the bills have been verified for a second time by the Consumer Affairs Directorate and corrections made, there is an average 43 day (1.5 month) waiting period before the bills are actually issued to the payment collection centers.

The time taken to read meters in each district varies considerably from 10 to 27 days and represents only a very small part of the time spent in the overall billing process shown in Figure 3.4.3. Meters are difficult to read because they are often installed incorrectly, located in dark places or inaccessible when customers are not home. A review of five typical districts indicates that approximately 10% of meters on the reading route are skipped until the next billing cycle because meters cannot be accessed. This has a negative impact on cash flow because bills must be issued on the basis of a minimum monthly charge (20 SL).

The time for data entry also varies considerably from 1 to 25 days depending on the size of the district. Error detection and correction takes place as part of the data entry process and takes on average 28 days (1 month). Error checks are carried out again by the Consumer Affairs Directorate and takes an average of 21 days. The percentage of errors found during the second verification stage is a very low 0.5%.

Once the bills are issued, the time given to customers for paying bills is extremely generous. The first (and only notice) is delivered by hand sometime after 45 days has elapsed. Reporting of delinquent accounts is non-existent. Action is at the discretion and control of the cashiers and usually only occurs once the payments have slipped past four quarters (one year). About 15% of customers do not pay their bills until threatened with service disconnection just over one year later. As of May 31 1997, 41.5 million SL of billing issued in 1994 and 1995 remain unpaid.

3.4.4 Financial Management

The Finance Directorate coordinates preparation of the ordinary budget for the whole establishment. The budget is based on the list of the previous year's expenses and payments. The Accounting Directorate assists by forecasting revenues. In general, the line items (accounts) in the previous budget are adjusted up or down by a small percentage. Budgeting is a passive process limited to observing the variances between budgeted amounts and actual spending after the fact. Preparing the investment budget is slightly more sophisticated because it is linked to the five year investment plan set by the State Planning Commission. The Planning Directorate prepares the investment budget with input from other directorates on project needs. The Planning Directorate prepares project estimates, staffing requirements, and presents the investment budget to the Ministry of Planning for approval. Both budgets, once prepared, are reviewed by the Director General, then transmitted to the Ministry of Finance to receive funding.

The overall expenditure management system has a number of conceptual and organizational weaknesses. The payment processing system is completely manual, involving double handling of the same information in different work units. There is no real spending "control", only monitoring of expenditures. The budget breakdown for operating expenditures is not suficiently detailed and spending approval is allocated on a first come first serve basis as long as there is still enough money in the budget.

The term "cash management" is used to describe the activities required to control the movement of funds and establish financial equilibrium of DAWSSA's cash reserves (treasury). Activities that should be occuring but are virtually non-existant include: forecasting the treasury needs for the organization on an annual basis to produce a balanced financial plan for the coming twelve months, verifying the payments of the organization and following the balance of bank accounts, and forecasting the daily treasury needs. A lack of current information on bank balance and outstanding payments results in little or no treasury control and there is often a lack of funds available to pay for large expenditures.

3.4.5 Accounting

DAWSSA uses the Unified Accounting System (UAS) that all government institutions in Syria must use in order to integrate with the overall National budget. The system produces a balance sheet and a profit and loss statement but does not provide senior management with realistic measures of operational and financial performance because it is not based on a cost accounting structure. Accounting information is recorded manually in journals and posted to a computerized accounting system on a monthly basis to produce a trial balance. The existing computer equipment has been in service for some time and the staff are well trained in it's use. Unfortunately the system is not integrated with the processing of payments, and expenditures.

3.4.6 Information Technology

Existing COBOL applications for billing, accounting, stores inventory, and payroll were implemented in the early 80's. These are still in use and are supported by a UNIX based network with limited capacity. More recently, PC based engineering applications have been introduced and DAWSSA is currently implementing a local area network to link existing PC's and provide a client server environment at headquarters. Existing information systems and applications have evolved at different rates and have been implemented at different times without an overall plan or strategy. As the result of this development regime there are now several small "islands of automation" throughout the organization and integration between systems is either non existent or impossible.

Organizational responsibility for computer systems is not clearly identified. The New Works and Studies Directorate, is one of the most advanced computer users, and has created a special section dedicated to the development of information systems. By default, this section also provides technical support for other DAWSSA users. A review of DAWSSA's existing computer application needs and the status of their development is presented in Table 3.4.4.

Table 3.1.1 Summary of Leakage Repair Works of Cast Iron Pipes

(By Installed Year)

Installed year	Length (m)	(%)	Repair per month Carried	Frequency of Leakage Repair
1920	3,100	2.3%	0.54	0.17 /km
1930	9,500	7.1%	0.77	0.08 /km
1940	16,450	12.2%	3.48	0.21 /km
1950	60,300	44.8%	13.34	0.22 /km
1960	42,440	31.5%	11.04	0.26 /km
1970	2,900	2.2%	1.33	0.46 /km
	134,690	100.0%	30.50	0.23 /km

(By Pipe Diameter)

Pipe Dia(mm)	Length (m)	(%)	Repair per month Carried	Frequency of Leakage Repair
80	2,500	1.9%	0.15	0.06 /km
100	22,620	16.8%	3.46	0.15 /km
150	19,200	14.3%	3.85	0.20 /km
200	26,400	19.6%	4.48	0.17 /km
250	35,970	26.7%	7.81	0.22 /km
400	9,600	7.1%	2.65	0.28 /km
500	7,300	5.4%	1.58	0.22 /km
600	11,100	8.2%	6.52	0.59 /km
	134,690	100.0%	30.50	0.23 /km

Source: DAWSSA

Table 3.1.2 Equipment to be installed in the Network by SCADA System

Control Unit in Network	Remote Cotrol Valve (Pipe Dia. mm)									Flow Meter (Pipe Dia. mm)					Pressure Meter (Pipe Dia. mm)											
	150	200	250	300	500	600	800	1200	Total	250	400	600	1200	Total	80	100	200	250	300	400	500	600	700	800	1200	Total
1									0					0				1								1
2	1	1		1					3		1			1			2			1						3
3									0			1		1								1				1
4									0	1				1				1	1		1					3
5									0					0												0
6			1		2			1	4					0				1			1		1	1		4
7			2	1	1				4	2				2				2	1		1					4
8					1			1	2				1	1											1	1
9						2		1	3			2		2				1				2				3
10									0					0				1								1
11									0					0	1	1	1	1								4
12									0					0												0
13									0					0												0
14									0					0												0
15									0					0												0
16									0					0												0
17					1				1					0				1			1					2
18									0					0												0
19									0					0												0
20									0					0												0
21									0					0												0
22									0					0												0
23					2	3			5					0				7								7
24									0					0												0
25									0					0												0
26									0					0												0
27									0					0			2									2
28						1			1					0												0
Total	1	1	3	2	7	6	1	2	23	3	1	3	1	8	1	1	5	16	2	1	4	3	1	1	1	36

Table 3.4.1 - Operating Income & Expenditure Statement
(Source DAWSSA accounting directorate)

	1990	1991	1992	1993	1994	1995
Water Produced (000 m3)	154,680	172,900	201,490	212,000	209,000	222,080
Water Sold (000 m3)	53,280	64,515	66,328	70,000	69,582	63,596
Water Sold (% of total production)[1]	34%	37%	33%	33%	33%	29%
Water delivered to water rights (000 m3)[2]	14,020	15,750	15,154	15,750	15,028	14,859
Total accounted for water (000 m3)	67,300	80,265	81,482	85,750	84,610	78,455
Unnaccounted for Water (% of total production)	56%	54%	60%	60%	60%	65%
Average Cost (SL/m3 produced)[3]	0.63	0.66	0.69	0.69	0.86	0.97
Average Tariff (SL/m3 sold)[3]	2.17	3.00	2.70	2.67	4.61	4.37
Operating Revenues						
Water Sales	115,657,868	193,306,344	179,126,281	187,163,513	320,991,221	278,191,915
Cost Recovery Services & Fees	13,352,711	21,422,020	23,233,802	24,690,816	48,426,323	55,229,006
Sale of Connection Materials	2,219,513	2,507,869	3,215,977	4,230,948	3,450,660	3,348,949
Other Revenue	4,339,884	3,390,899	3,446,209	5,377,817	6,654,672	8,241,847
Bank Interest	39,176	114,414	160,222	318,931	320,690	315,122
Previous Year's Adjustments	-	1,036,641	-	3,356,824	-	-
Total Revenues	135,609,152	221,778,187	209,182,491	225,138,849	379,843,566	345,326,839
Operating Expenses						
Salaries & Wages	40,365,378	43,370,708	52,721,801	57,313,006	74,336,324	83,344,723
Benefits	7,970,999	8,563,920	11,925,133	12,116,067	17,914,417	22,941,860
Sub-total	48,336,377	51,934,628	64,646,934	69,429,073	92,250,741	106,286,583
Energy & Utilities	22,077,927	29,130,575	36,898,942	27,356,795	32,018,654	45,841,074
Chemicals	1,861,063	3,619,879	3,579,510	4,075,856	3,727,908	5,442,000
Purchase of service connection materials for re-sa	781,410	1,227,297	1,632,034	2,821,856	3,068,393	2,939,940
Materials	2,455,063	1,931,080	3,432,293	5,470,420	2,798,561	2,758,720
Service fees	18,979,171	24,059,394	25,290,988	28,501,920	31,624,374	36,511,580
Other Expenses	395,658	561,914	441,249	384,844	290,522	1,293,726
Previous Year's Expenses	2,710,021	1,313,215	2,603,988	8,093,270	13,830,897	15,352,013
Total Direct Expenses	97,596,690	113,777,982	138,525,938	146,134,034	179,610,050	216,425,636
Depreciation	32,449,648	36,137,223	40,019,431	39,749,619	50,234,879	54,100,434
Net Income (deficit)	5,562,814	71,862,982	30,637,122	39,255,196	149,998,637	74,800,769
Profit tax	4,664,141	53,221,000	29,305,275	33,721,759	87,535,873	48,338,215
Net Income (deficit) after taxes	898,673	18,641,982	1,331,847	5,533,437	62,462,764	26,462,554
Financial Indicators						
Working ratio (direct expenses/revenue)	0.72	0.51	0.66	0.65	0.47	0.63
Operating ratio (total expenses/revenue)	0.96	0.68	0.85	0.83	0.61	0.78
Profit margin (before taxes)	0.04	0.32	0.15	0.17	0.39	0.22

(1) based on metered billings
(2) based on metered billings, but no revenue collected
(3) equal to income from water sales divided by volume of water sold

Table 3.4.2 Source & Use of Funds

	1990	1991	1992	1993	1994	1995
Source of Funds						
Operating IncomeBefore Taxes	5,562,814	71,862,982	30,637,122	39,255,196	149,998,637	74,800,769
Depreciation	32,449,648	36,137,223	40,019,431	39,749,619	50,234,879	54,100,434
Loans Received	127,897,417	147,653,462	178,604,884	613,720,042	359,577,715	585,899,631
Grant Aid			1,501,319			
Increase in Capital						750,806,933
Increase in Payables	85,069,595	90,030,062	26,290,126	206,992,610	146,154,451	(93,870,388)
Total Sources	250,979,474	345,683,729	277,052,882	899,717,467	705,965,682	1,371,737,379
Uses of Funds						
Capital Investments	70,544,102	74,458,203	76,767,380	334,161,986	264,051,482	240,639,313
Foreign Loans Repayment	14,741,655	15,905,054	-	67,944,821	37,855,453	38,900,000
Loans Interest	76,325,174	85,103,348	81,197,520	143,496,345	150,804,247	258,630,013
Increase in receivables	(24,492,565)	121,977,844	62,451,454	298,041,267	(35,745,886)	758,833,713
Increase in inventories	(3,903,507)	174,171	22,732,739	60,674,664	19,108,430	(15,754,784)
Income Taxes	4,664,141	53,221,000	29,305,275	33,721,759	87,535,873	43,562,410
Transfer to Ministry of Finance	-	2,000,000	-	-	-	
Total Use of Funds	137,879,001	352,839,620	272,454,368	938,040,842	523,609,598	1,324,810,665
Net working capital (SL)	113,100,473	(7,155,891)	4,598,514	(38,323,375)	182,356,084	46,926,714
SUS @ official exchange rate of 45 SL/US$	2,692,868	(170,378)	109,488	(912,461)	4,341,812	1,042,816
Financial indicators						
Income/total sources	2.2%	20.8%	11.1%	4.4%	21.2%	5.5%
Loans/total sources	51.0%	42.7%	64.5%	68.2%	50.9%	42.7%
Capital investment/total sources	28.1%	21.5%	27.7%	37.1%	37.4%	17.5%
Capital investment/ loans rec'vd	55.2%	50.4%	43.0%	54.4%	73.4%	41.1%
Debt service/total sources	36.3%	29.2%	29.3%	23.5%	26.7%	21.7%

Table 3.4.3 Existing Billing Schedule

(Source DAWSSA - billing cycle No. 269 - final quarter 1996)

No.	District name	Collection centre		Consumer Affairs Directorate				Accounting Directorate								Consumer Affairs Directorate					
				Read Meters				Enter Data			Verify &	Produce Bills				Correct Statements				Issue Statement	Total Time
			No. of Bills	start	end	duration	delay	start	end	duration	Correct	print	issue	duration	delay	Receive bills	Back to Acty	duration	delay	To cashier	lapse [3]
1	Kanawat	A-Kanawat	15,987	25-Jul-96	11-Aug-96	17	94	13-Nov-96	22-Nov-96	9	9	1-Dec-96	16-Dec-96	15	3	19-Dec-96	24-Jan-97	36	5	29-Jan-97	188
		B- DAWSSA		25-Jul-96	11-Aug-96											19-Dec-96	24-Jan-97	36	113	17-May-97	296
2	Ziftia	Bab Musala	6,294	4-Sep-96	28-Sep-96	24	44	11-Nov-96	12-Nov-96	1	39	21-Dec-96	22-Dec-96	1	0	22-Dec-96	24-Jan-97	33	59	24-Mar-97	201
3	Akrad	A- Akrad	11,031	28-Jul-96	20-Aug-96	23	80	8-Nov-96	13-Nov-96	5	26	9-Dec-96	16-Dec-96	7	10	26-Dec-96	20-Jan-97	25	10	30-Jan-97	146
		B-Al jeser Al Abiad		28-Jul-96	20-Aug-96											26-Dec-96	20-Jan-97	25	10	30-Jan-97	186
4	Janoub Yazid	Janoub Yazid	6,587	10-Aug-96	25-Aug-96	15	75	8-Nov-96	9-Nov-96	1	32	11-Dec-96	16-Dec-96	5	4	20-Dec-96	20-Jan-97	31	10	30-Jan-97	173
5	Salhia Sharkia	A-Al jeser Al Abiad	8,731	4-Aug-96	21-Aug-96	17	93	22-Nov-96	29-Nov-96	7	5	4-Dec-96	16-Dec-96	12	13	29-Dec-96	20-Jan-97	22	10	30-Jan-97	179
		B- DAWSSA		4-Aug-96	21-Aug-96											29-Dec-96	20-Jan-97	22	117	17-May-97	296
6	Salhia Gharbia	Salhia Gharbia	9,094	4-Aug-96	21-Aug-96	17	112	11-Dec-96	11-Dec-96	0	37	17-Jan-97	19-Jan-97	2	0	19-Jan-97	3-Feb-97	15	12	15-Feb-97	195
7	Mohajreen	Mohajreen	13,923	18-Aug-96	18-Sep-96	31	47	4-Nov-96	29-Nov-96	25	66	3-Feb-97	4-Feb-97	1	1	5-Feb-97	20-Feb-97	15	17	9-Mar-97	203
8,9,10	Kimana	A-Shagour	22,294	22-Aug-96	18-Sep-96	27	66	23-Nov-96	11-Dec-96	18	66	15-Feb-97	19-Feb-97	4	1	15-Feb-97	26-Feb-97	11	4	2-Mar-97	192
		B-Baghdad st.		22-Aug-96	18-Sep-96											16-Feb-97	26-Feb-97	10	4	2-Mar-97	192
		C-Bab Touma		22-Aug-96	18-Sep-96											19-Feb-97	26-Feb-97	7	39	6-Apr-97	227
		D-Abasyin		22-Aug-96	18-Sep-96											19-Feb-97	26-Feb-97	7	39	6-Apr-97	227
11	Sharky Al Tijara	Abasyin	1,835	19-Oct-96	31-Oct-96	12	10	10-Nov-96	13-Nov-96	3	57	9-Jan-97	19-Jan-97	10	0	19-Jan-97	13-Feb-97	25	52	6-Apr-97	169
12	Barza Al Balad	Masaken Barza	3,012	15-Oct-96	6-Nov-96	22	52	28-Dec-96	30-Dec-96	2	10	9-Jan-97	16-Jan-97	7	3	19-Jan-97	3-Feb-97	15	34	9-Mar-97	145
13	Shagour	A-Shagour	1,001	18-Aug-96	3-Sep-96	16	71	13-Nov-96	17-Nov-96	4	44	31-Dec-96	2-Jan-97	2	0	2-Jan-97	20-Jan-97	18	41	2-Mar-97	196
		B- DAWSSA		18-Aug-96	3-Sep-96											2-Jan-97	20-Jan-97	18	117	17-May-97	272
14	Midan	A-Al Ashmar	15,141	23-Sep-96	15-Oct-96	22	64	18-Dec-96	8-Jan-97	21	4	12-Jan-97	16-Jan-97	4	3	19-Jan-97	16-Feb-97	28	45	2-Apr-97	191
		B-Bab Masala		23-Sep-96	15-Oct-96											19-Jan-97	16-Feb-97	28	36	24-Mar-97	182
15	Sarouja	A-Baghdad st.	14,241	1-Sep-96	22-Sep-96	21	43	4-Nov-96	9-Nov-96	5	54	2-Jan-97	4-Jan-97	2	1	5-Jan-97	25-Jan-97	20	36	2-Mar-97	182
		B- DAWSSA		1-Sep-96	22-Sep-96											5-Jan-97	25-Jan-97	20	112	17-May-97	258
16	Mezze [2]	Mezze 1	16,127	10-Nov-96	30-Nov-96	20	59	8-Jan-97	13-Jan-97	5	12	25-Jan-97	27-Jan-97	2	0	27-Jan-97	16-Feb-97	20	113	9-Jun-97	211
		Mezze 2		10-Nov-96	30-Nov-96											27-Jan-97	16-Feb-97	20	113	9-Jun-97	211
17,18	Kiwan, Doumar [2]	Doumar	12,701	2-Nov-96	12-Nov-96	10	82	2-Feb-97	2-Feb-97	0	23	25-Feb-97	2-Mar-97	5	0	2-Mar-97	30-Mar-97	28	71	9-Jun-97	219
19	Masaken Barza	Masaken Barza	7,182	8-Oct-96	31-Oct-96	23	84	23-Jan-97	27-Jan-97	4	20	16-Feb-97	16-Feb-97	0	1	17-Feb-97	2-Mar-97	13	7	9-Mar-97	152
20	Kaboun	Kaboun	5,492	17-Oct-96	29-Oct-96	12	82	19-Jan-97	30-Jan-97	11	4	3-Feb-97	4-Feb-97	1	1	5-Feb-97	15-Mar-97	38	11	26-Mar-97	160
21	Joubar	Joubar	9,801	17-Sep-96	5-Oct-96	18	72	16-Dec-96	18-Dec-96	2	47	3-Feb-97	12-Feb-97	9	19	3-Mar-97	20-Mar-97	17	17	6-Apr-97	201
22	Tabala	Tabala	2,826	23-Sep-96	17-Oct-96	24	62	18-Dec-96	19-Dec-96	1	18	6-Jan-97	19-Jan-97	13	0	19-Jan-97	3-Feb-97	15	51	26-Mar-97	184
23	Moukhtaam [2]	Moukhtaam	18,813	13-Nov-96	3-Dec-96	20	78	19-Feb-97	27-Feb-97	8	12	11-Mar-97	12-Mar-97	1	0	12-Mar-97	22-Mar-97	10	79	9-Jun-97	208
24	Kadam	A-Kafersousse	4,900	24-Oct-96	14-Nov-96	21	66	19-Jan-97	20-Jan-97	1	6	26-Jan-97	27-Jan-97	1	0	27-Jan-97	3-Feb-97	7	49	24-Mar-97	151
		B-Al Ashmar		24-Oct-96	14-Nov-96											27-Jan-97	3-Feb-97	7	58	2-Apr-97	160
25	Kafersousse [2]	A-mezze	9,332	21-Oct-96	15-Nov-96	25	74	28-Jan-97	1-Feb-97	4	24	25-Feb-97	1-Mar-97	4	0	1-Mar-97	15-Mar-97	14	86	9-Jun-97	231
		B-Kafersousse		21-Oct-96	15-Nov-96											1-Mar-97	15-Mar-97	14	9	24-Mar-97	154
26	Kassioun	A-Akrad	9,599	14-Sep-96	2-Oct-96	18	42	13-Nov-96	27-Nov-96	14	26	23-Dec-96	28-Dec-96	5	0	28-Dec-96	30-Jan-97	33	0	30-Jan-97	138
		B-Mohajreen		14-Sep-96	2-Oct-96			13-Nov-96	27-Nov-96	14	26	23-Dec-96	28-Dec-96	5	0	28-Dec-96	30-Jan-97	33	38	9-Mar-97	176
		Total	225,944		Average [4]	20	67		Average [4]	7	28		Average [4]	5	3		Average [4]	21	44	Average [4]	197
				Time to complete one cycle		**131**						**Time to complete one cycle**		**128**							

Notes

1. Days = calendar days, seven calendar days=six working days, 1 day= .86 work days
2. Bills have not been delivered to collection centres as of June 9 1997, but meters have been read for next billing cycle.
3. Time from last meter reading until bill issued to payment collection centre
4. Averages are for completing one district

Table 3.4.4 Computer Application Needs and Status of Development

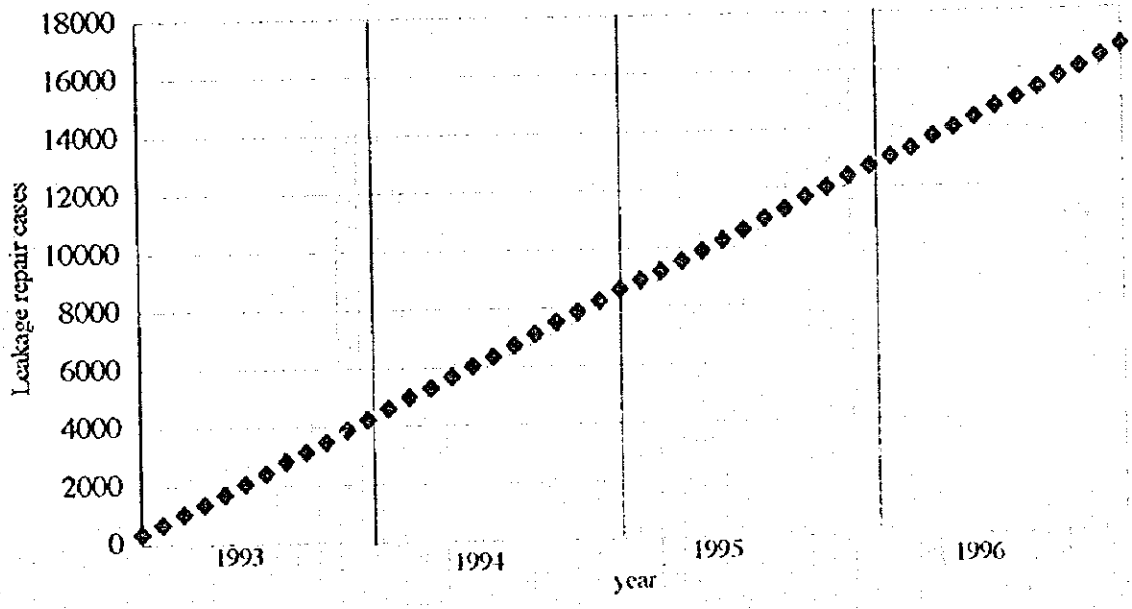
Applications	Functional Areas: Production Centers	Distribution Network	Engineering	Customer Service	Finance	Accounting	Administrative Services	Human resources
Office automation	○	○	○	○	○	○	○	○
Budgeting	○	○	○		○			
Meter Reading			○	○		○		
Billing				○	○	○		
Customer Information				○	○	○		
General Ledger						●		
Cost Accounting						○		
Expenditure Control					○	○		
Cash Management					○			
Inventory Management						○		
Purchasing					○	○		
Project Management			○		○	○		
Laboratory Information	○	○	○	○				
Production Operations	○	○						
Maintenance Management	○	○	○	○		○		
Human Resources Management					●	○	○	
Geographic Information	○	○	○	○				
Computer Aided Drawing	○	○	○	○				

Partially Developed ○

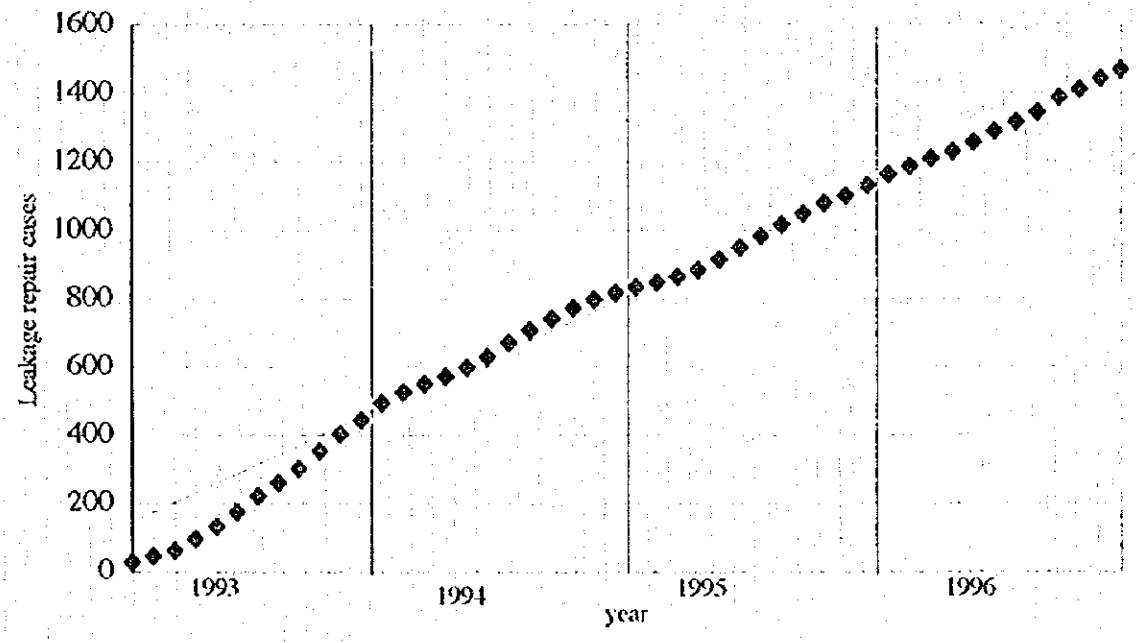
Exists ●

Needed ○

Cumulative monthly repair record from January 1993 to December 1996
for leakage on service pipes

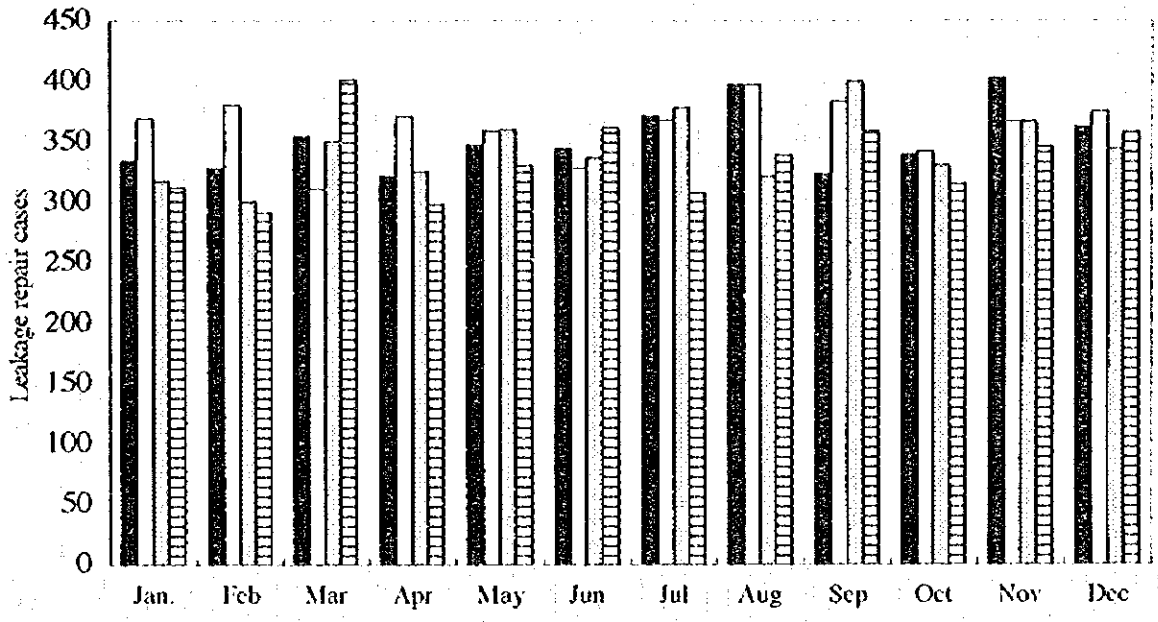


Cumulative monthly repair record from January 1993 to December 1996
for leakage on distribution pipes

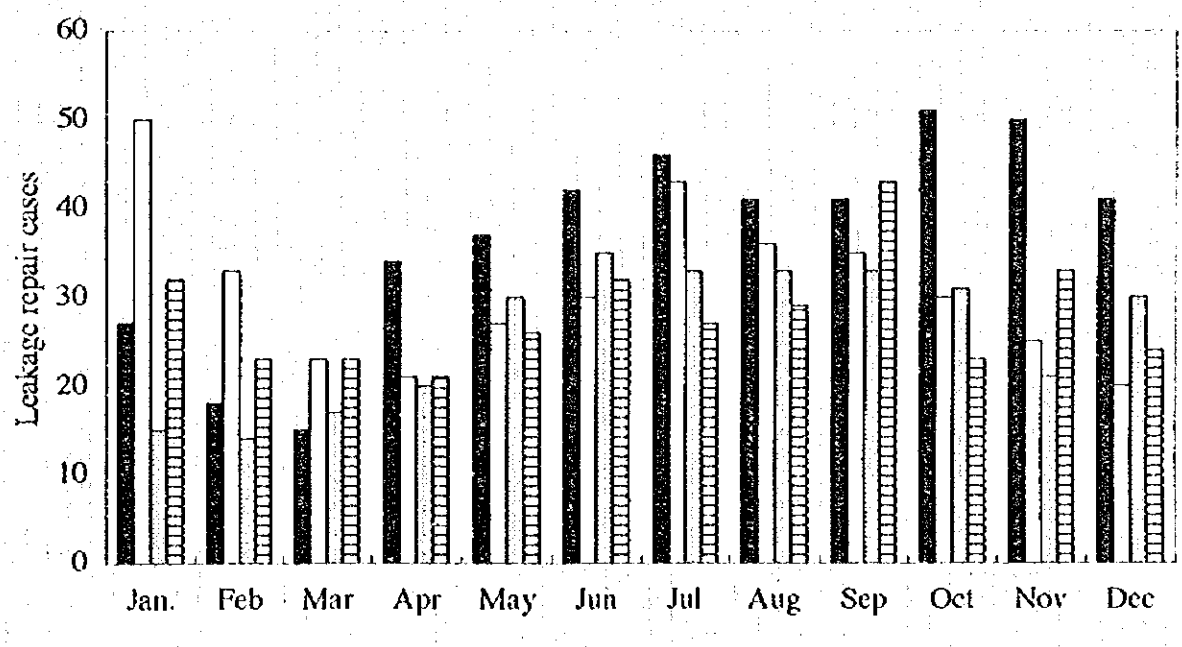


JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
THE STUDY ON THE DEVELOPMENT OF WATER SUPPLY SYSTEM FOR THE DAMASCUS CITY
Figure 3.1.1 Cumulative Monthly Leakage Repair Record
NIPPON KOEI CO., LTD.

The monthly repair record from January 1993 to December1996
for leakage on service pipes



The monthly repair record from January 1993 to December 1996
for leakage on distribution pipes



LEGEND

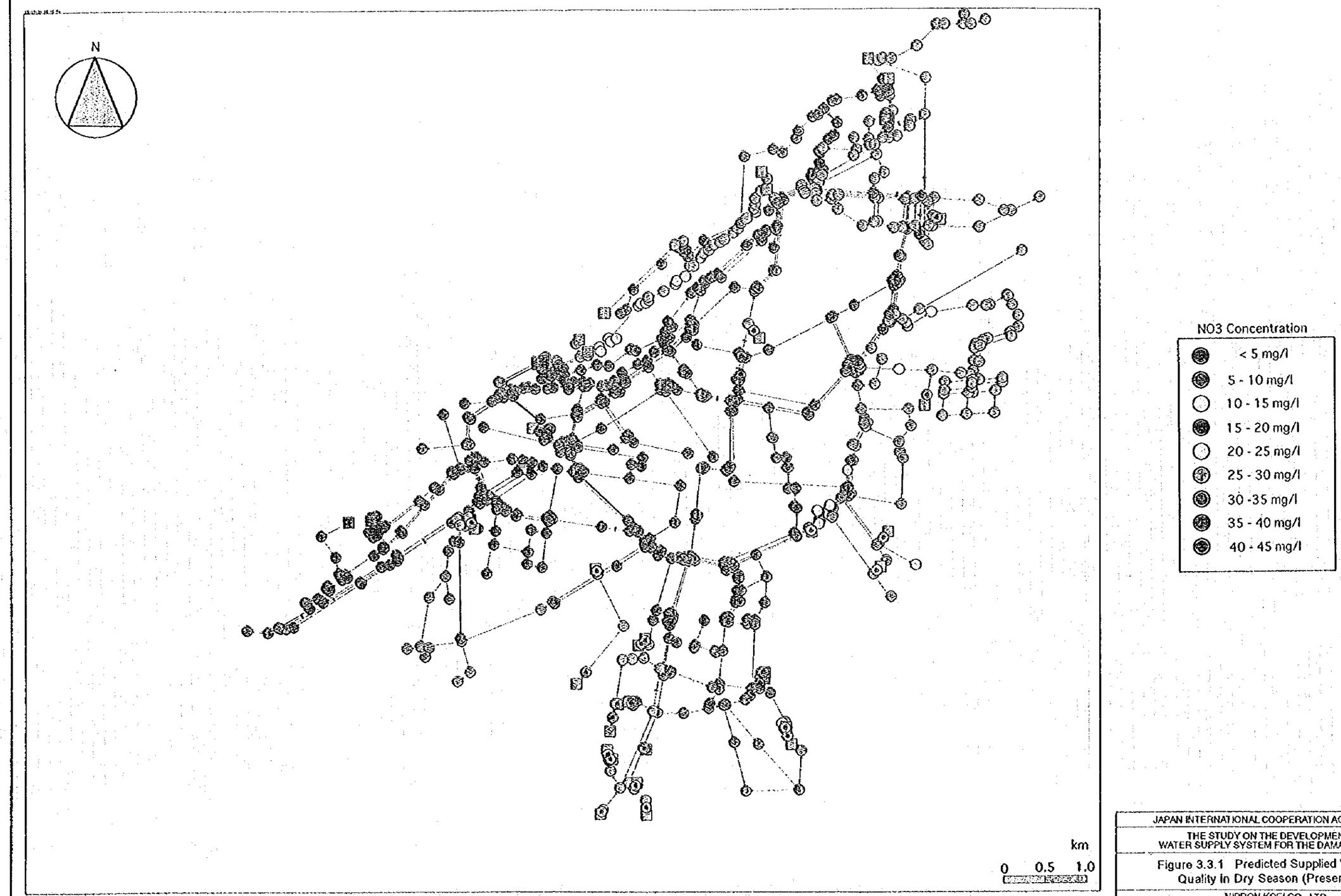
- 1993
- 1994
- 1995
- 1996

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

THE STUDY ON THE DEVELOPMENT OF
WATER SUPPLY SYSTEM FOR THE DAMASCUS CITY

Figure 3.1.2
Monthly Leakage Repair Record

NIPPON KOEI CO., LTD.

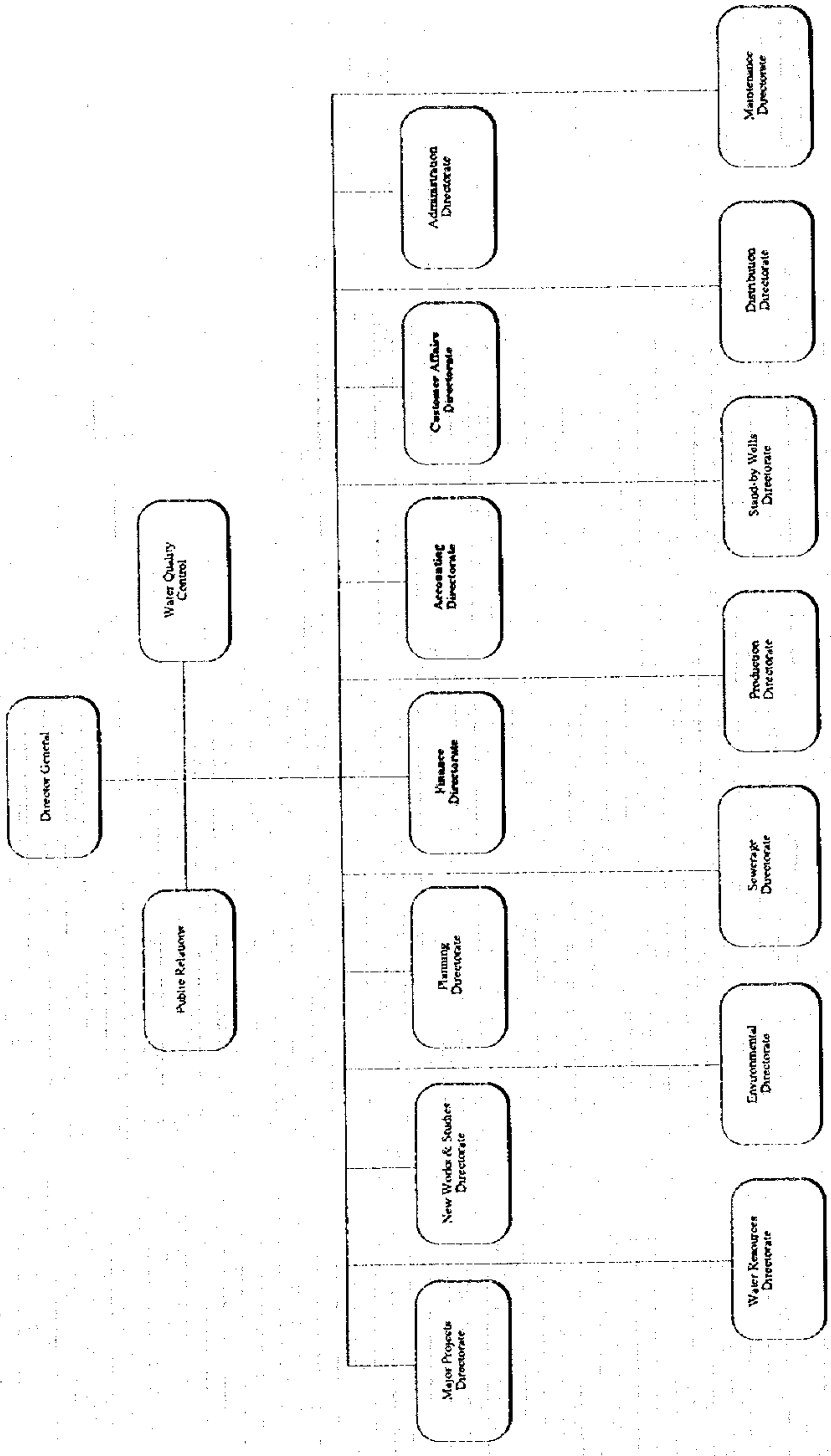


JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

THE STUDY ON THE DEVELOPMENT OF WATER SUPPLY SYSTEM FOR THE DAMASCUS CITY

Figure 3.3.1 Predicted Supplied Water Quality in Dry Season (Present)

NIPPON KOEI CO., LTD.



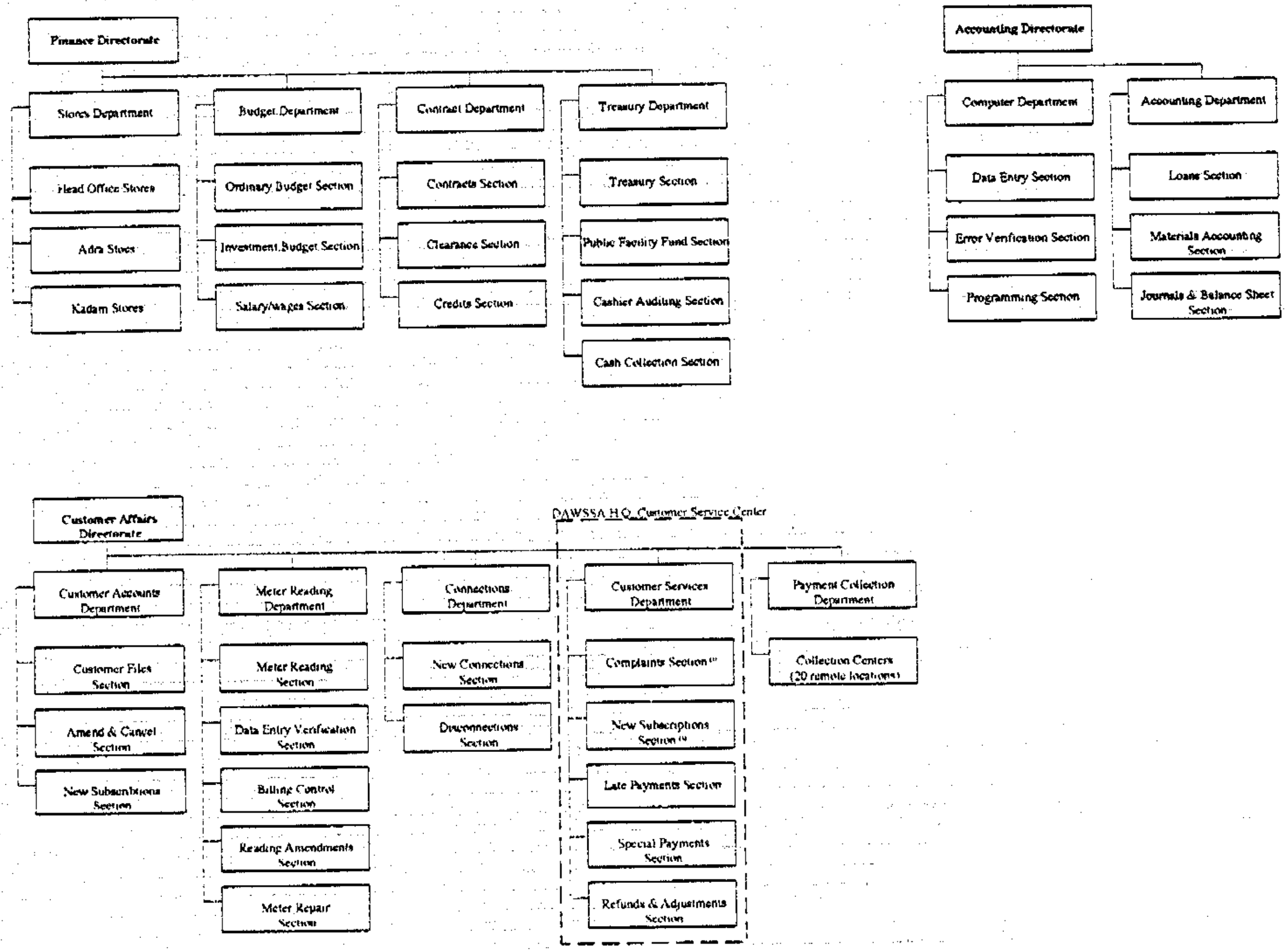
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

THE STUDY ON THE DEVELOPMENT OF
WATER SUPPLY SYSTEM FOR THE DAMASCUS CITY

Figure 3.4.1

Exiting Organizational Structure

NIPPON KOEI CO., LTD.



(1) Customer service representatives for new subscribers and complaints are located at three payment collection centers

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

THE STUDY ON THE DEVELOPMENT OF WATER SUPPLY SYSTEM FOR THE DAMASCUS CITY

Figure 3.4.2 Organizational Structure
Directorates Involved In Financial Management

NIPPON KOEI CO., LTD.

Billing district No. Name	Bills	July 1	July 2	July 3	July 4	August 1	August 2	August 3	August 4	September 1	September 2	September 3	September 4	October 1	October 2	October 3	October 4	November 1	November 2	November 3	November 4	December 1	December 2	December 3	December 4	January 1	January 2	January 3	January 4	February 1	February 2	February 3	February 4
1 Kanawat	15,987				m															d													
3 Akrad	11,031					m													d														
4 Janoub Yazid	11,031						m												d														
5 Salhia Sharkia	6,587					m														d													
6 Salhia Gharbia	9,094					m																	d										
13 Shagour	1,001							m												d													
7 Mohajreen	13,923							m										d															
8 9,10, Kimaria	22,294							m													d												
2 Ziftia	6,294									m									d														
15 Sarouja	14,241									m								d															
14 Midan	15,141											m												d									
21 Joubar	9,801											m												d									
26 Kassioun	9,599											m								d													
22 Tabala	2,826												m											d									
19 Masaken Barza	7,182														m														d				
20 Kaboun	5,492															m												d					
11 Sharky Al Tijara	1,835															m			d														
12 Barza Al Balad	3,012															m									d								
17 18, Doumar, Kiwan	12,701																	m												d			
24 Kadam	4,900																m											d					
25 Kafersousse (2)	9,332																m												d				
16 Mezze(2)	16,127																		m								d						
23 Moukhaiam (2)	18,813																			m												d	

m = meter reading;
d = data entry;

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

THE STUDY ON THE DEVELOPMENT OF WATER SUPPLY SYSTEM FOR THE DAMASCUS CITY

Figure 3.4.3 (1/2) Billing Schedule for Fourth Quarter 1996

NIPPON KOEI CO., LTD.

Billing district		January				February				March				April				May				June			
No. Name	Bills	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
1 Kanawat	15,987				1															HQ					
3 Akrad	11,031				3,20																				
4 Janoub Yazid	11,031				20																				
5 Salhia Sharkia	6,587				3															HQ					
6 Salhia Gharbia	9,094							4																	
13 Shagour	1,001									6										HQ					
7 Mohajreen	13,923										5														
8 9,10 Kimaria	22,294									6,7				8,9											
2 Zifta	6,294												2												
15 Sarouja	14,241									7										HQ					
14 Midan	15,141												2	11											
21 Joubar	9,801													16											
26 Kassioun	9,599				20						5														
22 Tabala	2,826												17												
19 Masaken Barza	7,182									10															
20 Kaboun	5,492												15												
11 Sharky Al Tijara	1,835													9											
12 Barza Al Balad	3,012										10														
17 18, Doumar, Kiwan	12,701																						14		
24 Kadam	4,900												19	11											
25 Kafersousse (2)	9,332												19										12		
16 Mezze(2)	16,127																						12,13		
23 Moukhaiam (2)	18,813																						18		

1,3 = bills issued to payment collection centers No. 1 and 3;

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

THE STUDY ON THE DEVELOPMENT OF WATER SUPPLY SYSTEM FOR THE DAMASCUS CITY

Figure 3.4.3 (2/2) Billing Schedule for Fourth Quarter 1996

NIPPON KOEI CO., LTD.