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BLACK & VEATCH INTERNATIONAL

in association with

MONTGOMERY WATSON SABBOUR ASSOCIATES

Canal Cities Water & Wastewater Master Plans
USAID Contract No. 263-C-00-98-00052-00
USAID Project No. 263-0174-3-94145

BVI Project No. 59795
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United States Agency for International Development (USAID)
Zahraa El Maadi
Maadi, Cairo, Egypt

Subject: Canal Cities Water & Wastewater Master Plans

Ladies and Gentlemen:

Black & Veatch International, in association with Montgomery Watson Americas and Sabbour Associates, is pleased to submit three copies of the Canal Cities Water and Wastewater Master Plans. The Master Plan documents consist of eight volumes, as listed below.

- Executive Summary
- Volume 1 – Suez Water Master Plan
- Volume 2 – Suez Wastewater Master Plan
- Volume 3 – Ismailia Water Master Plan
- Volume 4 – Ismailia Wastewater Master Plan
- Volume 5 – Port Said Water Master Plan
- Volume 6 – Port Said Wastewater Master Plan
- Volume 7 – Institutional and Financial Report

Concurrently, we are submitting three copies of the Master Plans to the National Organization for Potable Water and Sanitary Drainage (NOPWASD), one copy to the Suez Canal Authority (SCA), and one copy each to the Governorates of Suez, Ismailia, and Port Said.

This project represents an important achievement in USAID's continuing program to provide sustainable water and wastewater infrastructure in Egypt. We trust that the recommendations presented in the Master Plans will result in a well conceived and manageable program for NOPWASD and SCA as they prepare for development and growth in Suez, Ismailia, and Port Said.

It has been a pleasure working with USAID and we look forward to the next opportunity to be of service.

CANAL CITIES MASTER PLAN # BLACK & VEATCH INTERNATIONAL #

Very truly yours,
BLACK & VEATCH INTERNATIONAL

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PN-ACJ-026

ARAB REPUBLIC OF
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NATIONAL ORGANIZATION FOR
POTABLE WATER AND
SANITARY DRAINAGE

SUEZ CANAL
AUTHORITY

CANAL CITIES WATER AND WASTEWATER PHASE II PROJECT MASTER PLAN

USAID CONTRACT No. 263-C-00-98-00052-00
USAID PROJECT No. 263-0174

VOLUME 1
SUEZ WATER MASTER PLAN

September 1999

BLACK & VEATCH INTERNATIONAL

In association with

MONTGOMERY WATSON

SABBOUR ASSOCIATES

PORT SAID

ISMAILIA

SUEZ

2

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Table of Contents

Table of Contents i
List of Tables v
List of Figures vii
List of Appendices viii
Acknowledgments ix
Abbreviations, Terms and Units xiv

Executive Summary ES-1

1.0 Introduction 1-1
1.1 Background 1-1
1.2 Objectives 1-1
1.3 Organization of the Report 1-3
2.0 Physical Conditions, Land Use and Population 2-1
2.1 Study Area 2-1
2.1.1 Study Area Boundaries 2-1
2.1.2 Administrative Boundary 2-2
2.2 Physical Conditions 2-2
2.2.1 Geography and Topography 2-2
2.2.2 Climate 2-5
2.2.3 Geology, Geomorphology, Soils, and Seismicity 2-6
2.2.4 Groundwater, Surface Water and Flood Hazard 2-7
2.2.5 Marine Biota, Terrestrial Biota, and Environmental Pollution 2-8
2.3 Socio-Economic Conditions 2-9
2.3.1 Historical Background 2-9
2.3.2 Socio-Economic Profile 2-10
2.3.3 Urban Environment 2-12
2.4 Current Land Use 2-16
2.4.1 Collecting and Interpreting Relevant Cartographic Data 2-16
2.4.2 Selection of Standard Mapping System 2-17
2.4.3 Primary Land Use Categorization 2-17
2.4.4 Site Reconnaissance: Validating Primary Land Use Categorization 2-17
2.4.5 Calculating Net Residential Densities 2-18
2.4.6 Land Use Categories 2-18
2.5 Current and Future Populations 2-18
2.5.1 Current Population 2-18
2.5.2 Projection Methodology 2-21
2.5.3 Reconciliation of Projected Employment Figures 2-25
2.5.4 Reconciliation of Future Development Plans 2-25

4

Table of Contents (Continued)

2.6 Land Use Projections 2-26
2.6.1 Variations to Residential Area Population Distribution 2-26
2.6.2 Variations to Other Land Use Area 2-30
2.6.3 Development of Water and Wastewater Planning 2-30
2.6.4 Proposed Modifications to Development Plans 2-30

2.7 General Recommendations 2-30
3.0 Water Demands 3-1
3.1 Water Demands Methodology 3-1
3.2 Development of Existing Demands 3-2
3.2.1 Existing Land Uses 3-2
3.2.2 Existing Water Use Factors 3-4
3.2.3 Unaccounted-for Water Estimates 3-5
3.2.4 Calibration of Derived Demands 3-5
3.2.5 Distribution of Demands 3-6

3.3 Development of Future Demands 3-6
3.3.1 Future Land Uses 3-6
3.3.2 Future Water Use Factors 3-7
3.3.3 Future Demands 3-8
3.3.4 Phasing of Future Demands 3-8
4.0 Existing Water Treatment Facilities 4-1
4.1 Raw Water Supply 4-1
4.2 Treatment Processes 4-3
4.2.1 Bamag 90 Treatment System 4-5
4.2.2 Bamag 45 Treatment System 4-5
4.2.3 CTE Treatment System 4-7
4.2.4 Bamag 180 Treatment System 4-7

4.3 Chemical Feed Systems 4-8
4.4 Laboratory Facilities 4-9
4.5 Treated Water Storage and Pumping Stations 4-9
4.6 Water Quality 4-10
4.7 Observed Needs for Upgrades or Improvement 4-10
5.0 Existing Water Distribution System 5-1
5.1 General 5-1
5.2 Primary Distribution System 5-1
5.3 Leak Detection Survey 5-1
5.3.1 Training 5-3
5.3.2 Leak Detection 5-3

Table of Contents (Continued)

5.4 System Pressure Measurements 5-6

5.5 Pump Performance Tests 5-8

5.6 Other Water Systems 5-8

5.6.1 Al Salam City Water System 5-8
5.6.2 Suez Oil Petroleum Company 5-9
5.6.3 El Nasr Fertilizer Company 5-10
5.6.4 North of Suez Gulf Industrial Area 5-10

6.0 Regulations, Laws, and Treatment Criteria 6-1

6.1 Water Quality Standards 6-1

6.2 Discharge Regulations 6-1

6.2.1 Environmental Law No. 4 of the Year 1994 6-1
6.2.2 Law No. 48 of the Year 1982 6-7

7.0 Water System Planning Criteria 7-1

7.1 Methodology for Water System Planning Criteria 7-1

7.2 Development of System Hydraulic Criteria 7-2

7.2.1 Water Supply Facilities 7-2
7.2.2 Storage 7-2
7.2.3 Service Pressures 7-4
7.2.4 Distribution Mains 7-5
7.2.5 Water Demand Peaking Factors 7-6

7.3 Water System Model 7-7

7.3.1 Overview 7-7
7.3.2 Hydraulic Model Selection 7-8
7.3.3 Development of a System Model 7-9
7.3.4 Model Calibration 7-10

8.0 Water System Evaluation 8-1

8.1 Existing (Year 2000) 8-1

8.1.1 Water Treatment Facilities 8-1
8.1.2 Water Distribution System 8-3

8.2 Year 2020 8-4

8.2.1 Water Treatment Facilities 8-4
8.2.2 Water Distribution System 8-4

9.0 Implementation Plan 9-1

9.1 Introduction 9-1

9.1.1 Phase 1 Improvements 9-1
9.1.2 Phase 2 Improvements 9-1

9.2 Opinion of Cost 9-1

9.2.1 Estimating Guidelines 9-1

6

Table of Contents (Continued)

9.2.2 Basis of Assumptions 9-6
9.2.3 Construction Contingency 9-6
9.2.4 Escalation to Mid-Point of Construction 9-6

9.3 General Recommendations 9-6
9.3.1 Leak Detection and Repair 9-7
9.3.2 Replacement of Old CI and AC Pipes 9-7
9.3.3 Closed Valve Inventory 9-7
9.3.4 Replacement of Distribution System Valves 9-7
9.3.5 GIS Mapping and Hydraulic Modeling 9-7

9.4 Phase 1 Recommended Capital Improvement Projects 9-8
9.4.1 CIP-1 Pipe Interconnections and Replacement 9-8
9.4.2 CIP-2 Pipe, Reservoir, and Booster Pumping Station 9-8
9.4.3 CIP-3 Water Treatment Plant Improvements 9-9

9.5 Phase 2 Recommended Capital Improvement Projects 9-9
9.5.1 CIP-4 Reservoir and Booster Pumping Station 9-9
9.5.2 CIP-5 Pipeline Interconnections, Parallel Pipes, and Pipe Replacement 9-10
9.5.3 CIP-6 Pipes and Pressure Sustaining Valves 9-11
9.5.4 CIP-7 Pipes and Pressure Sustaining Valve 9-11
9.5.5 CIP-8 Pipes 9-12
9.5.6 CIP-9 Pipes 9-13
9.5.7 CIP-10 Water Treatment Plant 9-13
9.5.8 CIP-11 Booster Pumping Station Expansion 9-14
9.5.9 Summary 9-14

7

List of Tables

Table V1-ES.1 Suez Existing and Projected Population ES-4
Table V1-ES.2 Suez Water Demands ES-7
Table V1-ES.3 Summary of Probable Capital Improvement Costs – Phase 1 ..... ES-9
Table V1-ES.4 Summary of Probable Capital Improvement Costs – Phase 2 ..... ES-11
Table V1-2.1 Suez Climatic Data 2-5
Table V1-2.2 Comparison of Types of Buildings Within Suez Qisms 2-11
Table V1-2.3 1996 Suez Manpower Data 2-11
Table V1-2.4 Suez Unemployment Rates 2-11
Table V1-2.5 Suez Hotels and Resorts 2-11
Table V1-2.6 Suez Hotel Rooms and Tourist Nights 2-12
Table V1-2.7 Suez Industrial Establishments 2-12
Table V1-2.8 Land Use Categories 2-20
Table V1-2.9 Suez Subdivisions Recommended for Relocation 2-30
Table V1-3.1 Suez Existing and Projected Demands 3-3
Table V1-3.2 Suez Land Use Categories 3-4
Table V1-3.3 Suez Existing Water Use Factors 3-6
Table V1-3.4 Suez Future Water Use Factors (2020 and Ultimate) 3-7
Table V1-3.5 Suez Interim Water Demands 3-8
Table V1-4.1 Primary Design Parameters-Suez Water Treatment Plant 4-5
Table V1-4.2 Treated Water Storage Capacity 4-9
Table V1-4.3 Summary of Water Quality (Directly Affected by Treatment) 4-10
Table V1-5.1 Inventory of Water Distribution Pipes - 1998 5-1
Table V1-5.2 Summary of Pipes Inspected for Leakage 5-3
Table V1-5.3 Summary of Detected Leaks 5-5
Table V1-5.4 Suez System Pressures 5-6
Table V1-5.5 Package-Type Water Treatment Plants 5-8
Table V1-6.1 Egyptian and U.S. Drinking Water Standards, World Health Organization and European Union Guidelines 6-2
Table V1-6.2 Waterways Protected by Law No. 48 6-7
Table V1-6.3 Standards for Discharge of Licensed Fluid Wastes Into Non-Potable Water Sources 6-8
Table V1-7.1 System Hydraulic Criteria 7-3
Table V1-7.2 Fire Flow Factors 7-4
Table V1-7.3 Table of Roughness Coefficients 7-6
Table V1-7.4 Historical Peaking Factors 7-6
Table V1-7.5 Hydraulic Model Calibration Summary 7-13
Table V1-8.1 Suez Water Treatment Plant Production 8-1

8

List of Tables (Continued)

Table V1-8.2 Year 2000 Recommended Pipeline Improvements 8-3
Table V1-8.3 Year 2020 Recommended Pipeline Improvements 8-5
Table V1-9.1 Summary of Probable Capital Improvement Costs 9-15

9

List of Figures

Figure V1-ES.1 Suez Study Area Boundary ES-2
Figure V1-ES-2 Suez Treatment Capacity vs. Projected Water Demands ES-10
Figure V1-1.1 Suez Location Map 1-2
Figure V1-2.1 Suez Study Area Boundary 2-3
Figure V1-2.2 Suez Administrative Boundaries 2-4
Figure V1-2.3 Suez Typical Building Densities 2-14
Figure V1-2.4 Existing Land Uses 2-19
Figure V1-2.5 CAPMAS Historical Population 2-21
Figure V1-2.6 Suez Governorate Historical Population 2-22
Figure V1-2.7 Population Projection with CAPMAS '86 & '96 Average Growth Rate 2-22
Figure V1-2.8 Population Projection with Suez '96 Annual Growth Rate 2-23
Figure V1-2.9 Population Projection with Suez '92, '95 & '96 Annual Growth Rate 2-23
Figure V1-2.10 Population Projections from Previous Studies 2-24
Figure V1-2.11 CCMP Population Projection 2-24
Figure V1-2.12 Population by Qism 2-27
Figure V1-2.13 Suez 2020 Land Use 2-28
Figure V1-2.14 Suez Ultimate Land Use 2-29
Figure V1-4.1 Suez Raw Water Supply 4-2
Figure V1-4.2 Suez Water Treatment Plant Site Layout 4-4
Figure V1-4.3 Suez Water Treatment Plant Process Flow Diagram 4-6
Figure V1-5.1 Suez Water Network 5-2
Figure V1-5.2 Suez Water Leak Detection Survey Areas 5-4
Figure V1-5.3 Suez Pressure Monitor Locations 5-7
Figure V1-7.1 Overview of Water System Planning Process 7-1
Figure V1-7.2 Nodal Polygon Development 7-11
Figure V1-8.1 Suez Treatment Capacity vs Projected Water Demands 8-2
Figure V1-9.1 Suez Water System Recommended Improvements 9-2
Figure V1-9.2 Suez CIP Details 1 9-3
Figure V1-9.3 Suez CIP Details 2 9-4
Figure V1-9.4 Suez CIP Details 3 9-5

10

List of Appendices

Appendix V1-4.1	Results of Analysis of Sweetwater Canal Water Samples
Appendix V1-4.2	SCA Letter to Ministry of Irrigation Re: Projected Water Requirements
Appendix V1-4.3	Filter Backwash and Clarifier Residuals Disposal
Appendix V1-7.1	Pump Curves
Appendix V1-7.2	EPANet Input Files (Existing and Year 2020)
Appendix V1-7.3	Modeled Water Distribution System

11

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14

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Abbreviations, Terms and Units

Abbreviations

ABB	ABB Susa Dillingham
ARE	Arab Republic of Egypt
B&V	Black & Veatch International
CAPMAS	Central Agency for Public Mobilization and Statistics
CCMP	Canal Cities Master Plan, Prepared by B&V in association with Montgomery Watson and Sabbour Associates
CIP	Capital Improvement Project
CMC	Construction Management Consultants (joint venture of Black & Veatch International and Montgomery Watson)
CTE	Compagnie Europeene de Traitement des Eaux
EEAA	Egyptian Environmental Affairs Agency
EU	European Union
GOPP	General Organization for Physical Planning
MOI	Ministry of Irrigation
NOPWASD	National Organization for Potable Water & Sanitary Drainage
SCA	Suez Canal Authority
USA	United States of America
USAID	United States Agency for International Development
USEPA	United States Environmental Protection Agency
WHO	World Health Organization

17

Terms

ADD	average day demands
BOD	biochemical oxygen demand
CADD	computer aided drafting and design
COD	chemical oxygen demand
dia	diameter
DO	dissolved oxygen
D_{60}, D_{10}	sand sizes (based on sieve analysis) for which 60% (10% of grains (by weight) are finer
ea	each
GIS	geographic information system
I/S	infiltration/salinity
LE	Egyptian Pound
LS	lump sum
MDD	maximum day demands
Mld	megaliters/day
MPN	most probable number
N/A	not applicable
O.D.	outside diameter
PHD	peak hour demands
ppb	parts per billion
ppm	parts per million
ppt	parts per thousand
S	slope
SS	suspended solids
STDO	salinity, temperature and dissolved oxygen
TDH	total dynamic head
TDS	total dissolved solids
TU	turbidity units
UFW	unaccounted-for water
ug/l	micrograms/liter
WTP	water treatment plant
WWTP	wastewater treatment plant
Y	wye connection
/	per

18

Units

cm	centimeter
d	day
gm	gram
ha	hectare
HP	horsepower
h	hour
hz	hertz (cycles/sec)
JTU	Jackson Turbidity Units
kg	kilogram
km	kilometer
km^2	square kilometer
kV	kilovolt
kVA	kilovolt-ampere
kW	kilowatt
kWH	kilowatt hour
l	liter
lm	linear meter
lpcd	liters per capita per day
lpd	liters per day
lpm	liters per minute
lps	liters per second
m	meter
m/sec	meters per second
m^2	square meter
m^3	cubic meter
m^3/d	cubic meter per day
$m^3/d/km^2$	cubic meters per day per square kilometer
m^3/h	cubic meters per hour
m^3/yr	cubic meters per year
mg	milligram
mg/L	milligrams per liter
min	minute
ml	milliliter
mm	millimeters
NTU	Nephelometric Turbidity Units
p/km^2	people per square kilometer
t	tonne (metric)
v	volt
yr	year

19

Executive Summary

Background and General Information

The City of Suez is one of three major cities along the Suez Canal. It is the southernmost point of entry to the Suez Canal and is the northernmost city on the Gulf of Suez. It is located 120 km east of Cairo and 75 km south-southeast of Ismailia.

Suez suffered considerable damage to utilities and other infrastructure during the 1967-73 war. After the war, massive reconstruction efforts were initiated to bring the original residents back to the City. In 1979, a Water and Wastewater Facilities Master Plan was prepared and completed for the City of Suez.

The water treatment facilities and distribution system in Suez are owned and operated by the Suez Canal Authority (SCA). Since 1980, SCA has made significant improvements to the water treatment and distribution system based on the recommendations of the 1979 Water Facilities Master Plan.

In May 1998, Black and Veatch International, as prime contractor, in association with Montgomery Watson and Sabbour Associates, as subcontractors, was contracted by the United States Agency for International Development (USAID), to conduct a study and prepare Water and Wastewater Master Plans for the three Canal Cities that would guide utility development up to year 2020.

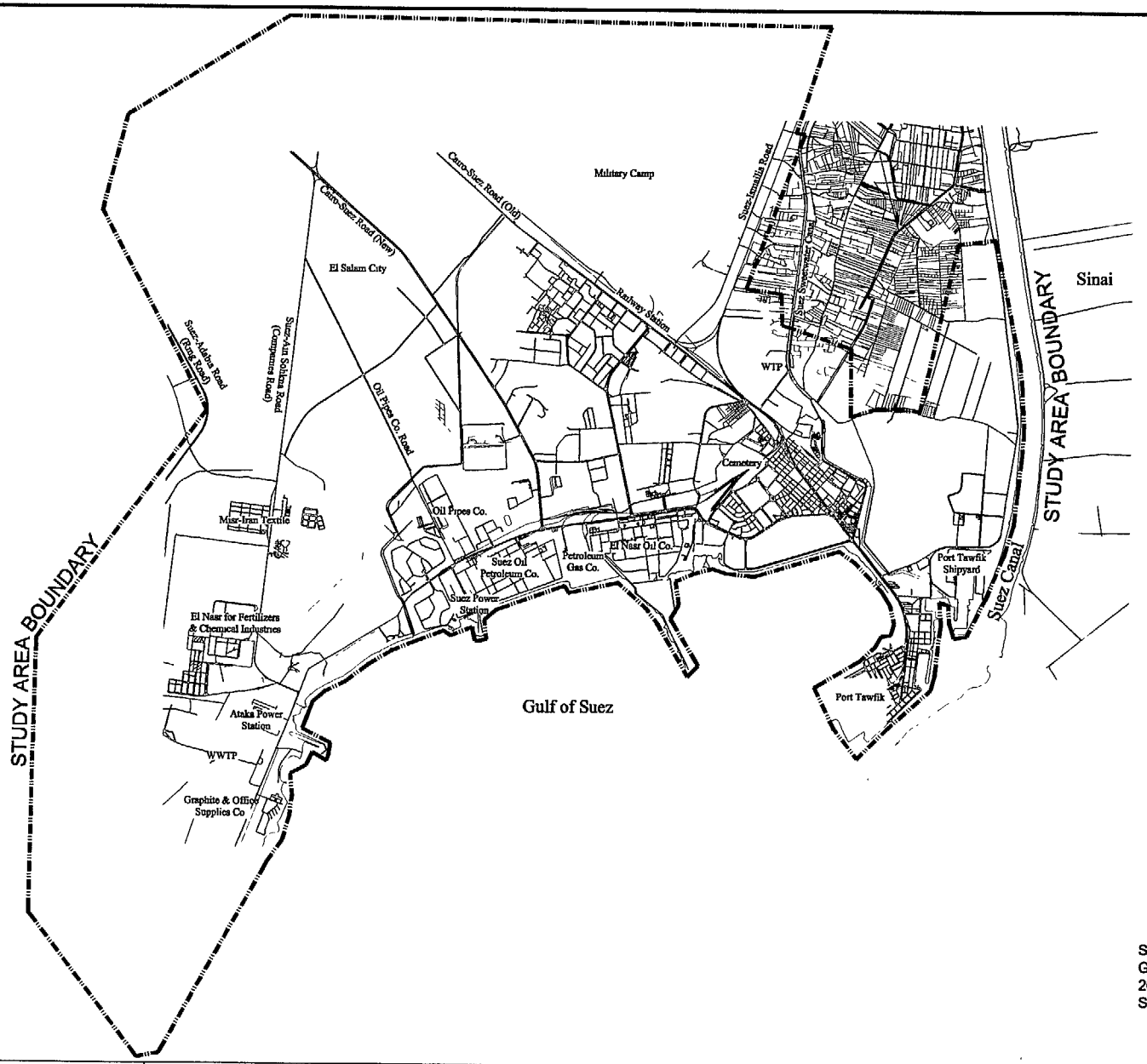
Master Plan Objectives

The primary goal of this master plan is to adequately define water and wastewater needs in Suez for both existing and future conditions. Deficiencies of the existing water distribution system, the water treatment plant, the wastewater collection system and the wastewater treatment plant are identified. New and modified facilities to rectify these deficiencies are recommended. Similarly, deficiencies anticipated in the future have also been identified and facilities needed to accommodate future growth are also recommended.

Study Area Boundary

The study area includes both the existing urban built-up area and future build-out areas of the City of Suez as allocated by local and central authorities for future urban development projects. The total area within the study area boundary is approximately 97 km^2.

The study area boundary is based on ratified boundary coordinates prepared by the Governorate and planning documents prepared by the General Organization of Physical Planning (GOPP) or the local planning department affiliated with the Ministry of Housing. The study area boundary is shown on Figure V1-ES.1, Suez Study Area Boundary.



Study Area Boundary Sources:
GOPP / Suez Governorate;
2015 Land Use Study for
Suez City 1993.

ARAB REPUBLIC OF EGYPT SUEZ CANAL AUTHORITY NATIONAL ORGANIZATION FOR POTABLE WATER AND SANITARY DRAINAGE	INTERNATIONAL ELLIPSOIDE - HAYFORD 1909 U.T.M. PROJECTION - ZONE 36 STEREOPLOTTING BASED ON GEODETIC TRIANGULATION OF EGYPTIAN SURVEY AUTHORITY	USAID CANAL CITIES WATER AND WASTEWATER MASTER PLAN	BLACK & VEATCH INTERNATIONAL IN ASSOCIATION WITH MONTGOMERY WATSON SABBOUR ASSOCIATES	SUEZ STUDY AREA BOUNDARY DATE. AUGUST 1999 FIGURE: V1-ES.1

Population and Land Use

Existing and future land uses were developed for the City of Suez based on the current Land Use Master Plan approved by the General Organization for Physical Planning (GOPP). Water demand factors were applied to the different land use categories to estimate water demands. Similarly wastewater production factors were derived based on historical data and land use data. These wastewater factors were also applied to determine projected wastewater flows. Estimates of existing and projected population to year 2020 were used to obtain per capita water use and wastewater production. This was used to verify estimates for the entire study area.

The most recent topographical maps were purchased from the Central Agency for Public Mobilization and Statistics (CAPMAS) and reflected 1994 land use conditions. In order to portray the current land use conditions, additional site inspections were carried out, particularly in selected fringe areas. The inspection findings, as well as modifications to the land use registered by CAPMAS up to October 1998, were included in the land use plan of existing conditions. Lists of ongoing and future housing and industrial development projects were compiled with the help of the Housing Department of each Governorate. The size, capacity, location, and progress status of each project were interpreted and then incorporated into the land use plan of existing conditions and, whenever applicable, into the 2020 land use plan.

The future land use plans were based on the Land Use Master Plan prepared in 1995 by the Third Region Planning Department and GOPP with the assistance of an independent consulting team. The current growth of Suez City follows the overall land use recommendations of the Suez City 1995 Master Plan concerning new growth urban areas. Current development status was evaluated for the overall feasibility of the land use categorizations allocated and assigned for future development by the Suez City 1995 Master Plan. Subdivisions on which construction work is progressing, as well as subdivisions that are unequivocally allocated for future development, were integrated into the CCMP future Land Use Plans.

Preliminary results of the CAPMAS 1996 census indicated that the population of the Suez Governorate, including people living in Suez City and in rural areas of Qism Al Ganayin, had reached 417,610. Following a cartographic analysis and a density analysis of Al-Ganayin urban and rural districts, it was estimated that this figure may be two to three percent high. However, the CAPMAS figure was used as the basis for CCMP population projections up to the year 2020. Population projections were developed using different growth rates from historical data obtained from CAPMAS and the Suez Governorate. The projections were compared with population projections of approved planning studies prepared by official

agencies such as the Governorate, NOPWASD, or GOPP. The projected population figures are listed in five-year increments in Table V1-ES.1, Suez Existing and Projected Population.

Table V1-ES.1 Suez Existing and Projected Population

Year	Population
Current	417,610
2000	466,374
2005	515,039
2010	567,390
2015	633,346
2020	701,434
Ultimate	871,199

The low occupancy housing rate methodology assumes that new housing developments would have occupancy rates equivalent to 70 percent of their maximum capacity in year 2020. Ultimate condition assumes new housing developments would have a maximum occupancy rate equivalent to 100 percent of their capacity.

Ultimate conditions in the study area will occur after 2020 or earlier depending on variations to the projected population due to unforeseen factors such as gain in employment rates or change in the prevailing rate of housing occupancy.

The following recommendations are suggestions to improve and, whenever feasible, to modify the provisions of the Governorate development plans:

- The Suez land use plan used for this master plan should be adopted and followed by Governorate Authorities. If deviations from the land use plan occurs, appropriate measures should be taken by the utilities to modify infrastructure to meet the revised development needs.
- Population growth should be monitored regularly and utility development adjusted accordingly.
- Utilities and government agencies should form joint committees to monitor land development and communicate regularly on changing utility needs.

Other land use principles that are anticipated for Suez in this master plan are listed below. Changes to this land use approach would result in changes to infrastructure needs and should be dealt with by utility planners accordingly.

- The amount of land assigned for development in the 1995 Suez Master Plan exceeds the amount of land required to accommodate the projected year 2020 population in the CCMP land use plan. Therefore, the extra urban growth land which has not been allocated for specific projects, will not be needed before the year 2020.
- Urban growth in Ataqa and Faysal should continue westward, away from agricultural land.

- The growth of Suez should be oriented toward the Gulf of Suez waterfront. The land use plan proposes the creation of a public recreational area that would end the long-standing practice of using the land along the Gulf's shores exclusively for industrial purposes. The City could border the waterfront with much-needed landscaped recreational grounds and lagoons. The environmentally friendly and construction-free Corniche and beaches would extend south along the coastal road leading to Al Adabiya. This would reverse the City's image as an industrial center and would help promote it as destination for local recreation and tourism.
- To further enhance the City's image and to compensate for the lack of public areas in Qisms Al Arbaein and Suez, the conversion of several ponds near Port Tawfik low-density residential zones into lagoons surrounded by public playgrounds, is also recommended.

Existing Raw Water Supply and Treatment Facilities

The City of Suez obtains its raw water supply from the Sweetwater Canal, which extends from the Nile River north of Cairo and flows northeasterly to Ismailia, a distance of about 135 km. At Ismailia, a southerly branch of the Sweetwater Canal supplies water to Suez. The amount of water in the canal is controlled by the amount of water released from the Aswan Dam into the Nile River. The Ministry of Irrigation (MOI) controls the release of the water in accordance with irrigation needs. At present, the Suez Water Treatment Plant draws up to a maximum of 230,000 m^3/d of raw water during summer. This is well within the MOI's current domestic water allocation for Suez of 340,000 m^3/d. SCA requested MOI future raw water allocation for Suez of 460,000 m^3/d in year 2005 and 600,000 m^3/d in year 2017. These water requirements are also well within the allocations provided by MOI.

However, SCA reports that for several days during summer, the water level in the Sweetwater Canal has fallen to the point where treatment plant production had to be reduced. In these cases, use from the canals by the SCA was significantly less than 230,000 m3/d. The eventual operation of Bamag 180 will increase the total raw water intake from the Sweetwater Canal to at least 410,000 m3/d. The capacity of the Sweetwater Canal to deliver water to Suez is limited both by its cross-sectional area and by culvert-type obstructions. These sections of the Suez branch of the Sweetwater Canal should be enlarged to increase its carrying capacity and provide the needed water to Suez.

The Suez Water Treatment Plant was originally built in five stages between 1915 and 1965. The first three stages were slow sand filters, the fourth stage was semi-rapid sand filters, and the fifth stage was rapid sand filters. The first three stages are non-operational and have long been abandoned. The fourth stage, or Group 4, was rebuilt into rapid sand filters by the French contracting firm Compagnie Europeenne de Traitement des Eaux (CTE) in the 1950s. It has a capacity of 60,000 m^3/d. The fifth stage was built in 1966 by Bamag of

Germany with a capacity of 45,000 m^3/d and is referred to as Bamag 45 in this report. In 1981, another treatment train, Bamag 90, was built by Bamag with a capacity of 90,000 m^3/d. The newest treatment train, Bamag 180, with a capacity of 180,000 m3/d, is presently under commissioning, and is expected to be fully functional in 1999.

Existing Water Distribution System

The Suez potable water distribution system consists of approximately 695 km of pipes in diameters ranging from 100 mm to 1200 mm. Pipe materials used include cast iron (CI), ductile iron (DI), asbestos cement (AC), and polyvinyl chloride (PVC).

The distribution system serves the built-up area of Suez. The system also supplies the Suez Cement Company, located approximately 42 km south of the city, and the areas of Adabiya and Ain El Sokhna, also located south of Suez. The total length of distribution mains (300 to 1200 mm diameter) included in the hydraulic model is approximately 134 km.

A leak detection survey was conducted on 71 km out of the 695 km (about 10 percent) of the pipes in the distribution system. During the leakage survey, one engineer and three technicians from the SCA Network Department were trained in the hands-on use of leak detection and pipe/valve locating equipment. At the conclusion of the survey, one set of the equipment was provided by USAID to SCA in each city for their continued use.

The results of the leak detection survey indicated that only a very small portion of the unaccounted-for water (UFW) is due to leakage in the pipes. The majority of the UFW is believed to be due to unmetered domestic, commercial, and industrial usage; defective (under reading) meters; hydrant use; main flushing, un-metered usage in governmental and military buildings and other public uses that are not metered. An accurate estimate of the UFW could not be made. Most of the treated water flow meters are not operational; therefore, an accurate comparison of treated water production with consumption is not possible. Also, estimates of the water production based on number of pumps running, rated capacities, and duration of operation would not be accurate because some pumps are operated below their design heads so that they are actually pumping more than their rated capacities.

Previous reports reviewed for UFW estimates indicated that a difference of 35 percent between production and consumption is typical, although the Central Accounting Agency estimates that only approximately 21 percent of the water produced is UFW. The 35 percent UFW was used in developing water demands for this study. The advantage of using the land use based approach is that there is no need for actual data indicating the UFW. The UFW is imbedded into the demands. If a lower UFW is used, then the water use factors would increase to match the water production.

Planning Criteria and Methodology

Detailed water demand analyses were conducted to identify current water demands and to project future demands. Demands were developed based on water use factors applied to existing and future land uses. Water use factors were developed for each land use category based on historical water use records. Future land use and population projections were based on local and government general land use plans. Table V1-ES.2, Suez Water Demands, shows the existing and projected average day demands and the maximum day demands.

Actual production records indicate that the maximum day demand is 1.3 times the average day demand, and the peak hour demand is 2.0 times the average demand. These peaking factors were used in this master plan to reflect actual production.

Table V1-ES.2 Suez Water Demands

Year	Average Day Demands (m^3/day)	Maximum Day Demands (m^3/day)
Current [1]	159,800	207,740
2000 [2]	188,600	245,180
2005 [2]	222,500	289,250
2010 [2]	262,600	341,380
2015 [2]	312,400	406,120
2020 [3]	367,600	477,880
Ultimate [3]	400,000	520,000

Notes:
1. Estimated current (about 1997) system demands; distributed and calibrated based on an analysis of land uses and water use factors.
2. Estimated from growth rate curve.
3. Based on an analysis of future land use and water use factors.

A hydraulic model of the Suez water distribution system was developed with this project. EPANet, a public domain software developed by the U.S. Environmental Protection Agency (USEPA), was used for this master plan because of its modeling power and ease of use. The hydraulic model was used to simulate operation of the distribution system at existing and future conditions; to identify system deficiencies, and to develop and evaluate potential facility improvements for correcting the deficiencies. The hydraulic model includes all distribution pipelines 300 mm and larger in diameter. The water distribution system that was modeled is shown on Figure V1-9.1, Suez Water System Recommended Improvements.

Recommendations

The following are general recommendations that could be implemented primarily by SCA without help from outside contractors. These will provide sustainability of the master plan.

- ***Leak Detection and Repair.*** SCA should continue and expand the leak survey to cover the entire distribution system using the leak detection equipment that was provided to SCA by USAID as part of this project.

- ***Replacement of Old CI and AC Pipes.*** SCA should continue the ongoing program of replacing old CI and AC pipes with DI and PVC pipes to further strengthen and reduce leaks in the system. There are approximately 3 km of 100 mm CI house connections and 20 km of 150, 200, and 250 mm AC pipes that need to be replaced. The total estimated cost for this program is approximately US $3 million.
- ***Closed Valve Inventory.*** The distribution system contains hundreds of valves, most of which are open. However, there appear to be a few valves that could have been inadvertently left closed. As part of this project, pipe and valve locating equipment were provided to SCA by USAID. This equipment could be used to locate the closed valves.
- ***Replacement of Distribution System Valves.*** There are approximately 300 gate valves in the distribution system that need to be replaced. These valves are old and most of them are difficult to operate and are not contained in valve boxes. Power-actuated butterfly valves contained in valve boxes should be considered as replacement.
- ***GIS Mapping and Hydraulic Modeling.*** A set of computers, printers, and digitizing equipment with GIS mapping and hydraulic modeling capability was provide to SCA by USAID under this project. The GIS mapping is critical in the ability to update the land use plans and to estimate the water demands at the water demand polygon level in the hydraulic model. The CCMP project will also provide training to the appropriate SCA personnel. SCA should continue to make use of the GIS capability and to use the hydraulic model to reflect changes in land use and in the distribution system.

Recommendations for further studies or preliminary design include the following:

- ***Plant Hydraulics Study.*** A study of the hydraulic grade line of the different hydraulic components of the treatment plant should be conducted to identify measures to increase the capacity of the components to their design capacities.
- ***Pump Rehabilitation and Replacement Study.*** This is a detailed study of the raw and treated water pumps to develop a pump rehabilitation and replacement program. This study should include a physical inspection of the pumps, review of operating and maintenance records, etc.
- ***Safety Improvement Study.*** CCMP noted various safety needs especially in the pump stations, and the need for safety equipment, e.g., gas masks, etc. This study is strongly recommended for the near future.
- ***Alternative Treatment Process Evaluation and Preliminary Design.*** Alternative treatment processes should be evaluated to determine the most feasible system components for future treatment plants.
- ***Filter Backwash and Clarifier Residuals Disposal Preliminary Design.*** A preliminary design should be done in the near future for a disposal system for the water treatment plant filter backwash and clarifier residuals. This system is a major plant retrofit and requires investigation of the plant's hydraulic grade line, multiple or a single centralized treatment unit alternatives and location(s), pipe sizes, lengths, alignment, etc.

The recommended facilities improvements are grouped into two priorities: Phase 1 improvements are needed to address immediate or near-term deficiencies and should be constructed within the next five years. Phase 2 improvements are additional facilities needed by year 2020. Phase 2 improvements should be reviewed prior to implementation based on the actual growth and water demand patterns that occur.

Recommended improvements to the existing water treatment plant includes rehabilitation of the CTE treatment train, replacement of treated water flowmeters for the Bamag 45 and Bamag 90 treatment trains, and installation of self-cleaning screens for all treatment trains except Bamag 180.

Capacity requirements for water treatment plants are based on meeting maximum day demands (MDD). A plot of the water demands against treatment capacity is shown on Figure V1-ES.2, Suez Treatment Capacity Vs Projected Water Demands. The existing Suez treatment plant with an evaluated capacity of 195,000 m^3/d is not adequate to meet the current MDD. After the Bamag 180 is operational and the CTE treatment train has been rehabilitated, the Suez water treatment plant would be able to supply enough treated water to meet the MDD requirement until about year 2012. After that time, another 105,000 m^3/d plant will be needed to meet the demands until year 2020.

The areas occupied by Group 1 and Group 3 slow sand filtration trains, which are no longer operational, are possible sites for this expansion. In addition, an adjacent vacant lot northeast of the water treatment plant could be acquired by SCA and used for the expansion.

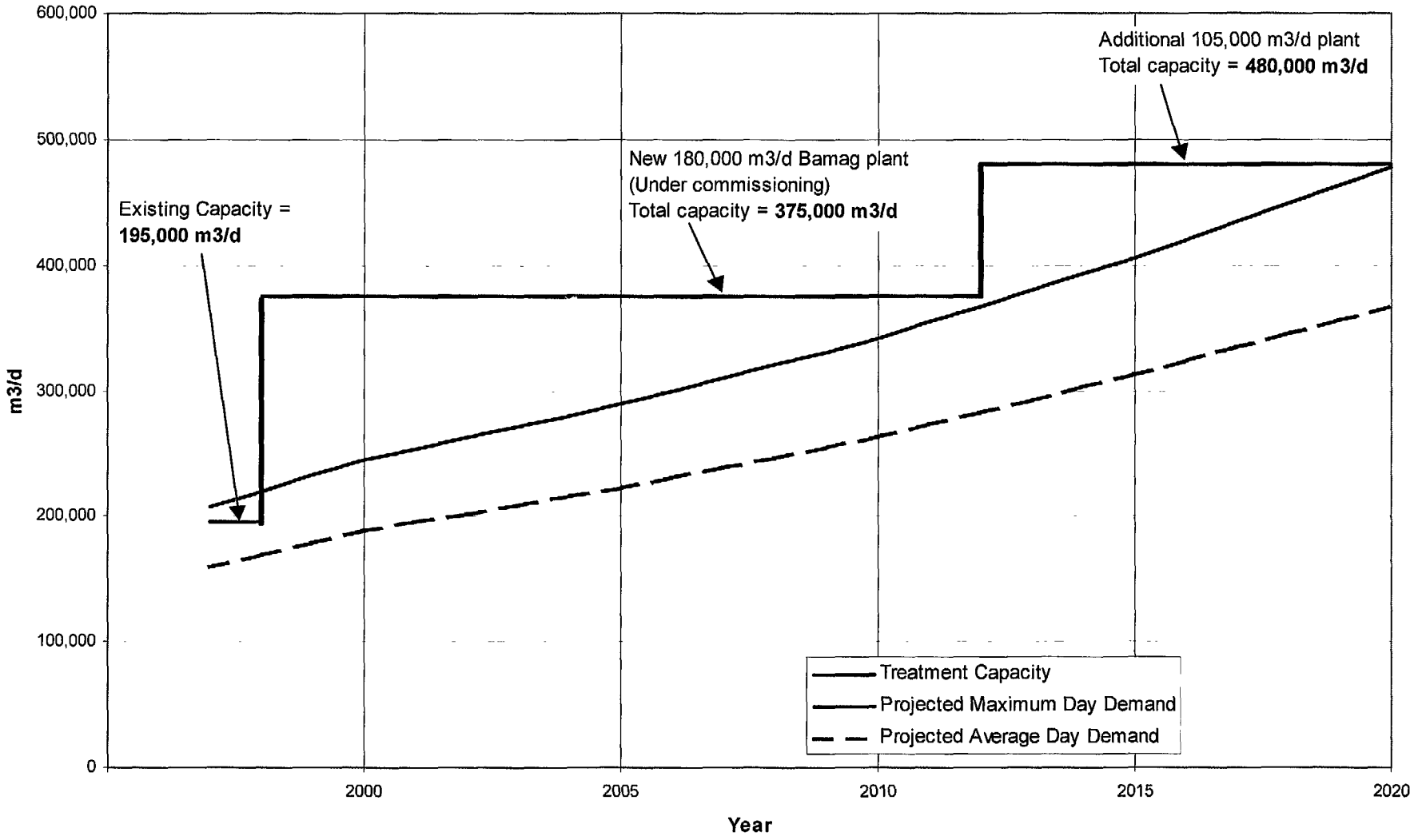
The recommended Capital Improvement Projects (CIP) are shown on Figure V1-9.1, Suez Water System Recommended Improvements. The Phase 1 improvements are summarized in Table V1-ES.3, Summary of Probable Capital Improvement Costs – Phase 1. The total cost of these improvements is approximately US $25 million.

Table V1-ES.3 Summary of Probable Capital Improvement Costs – Phase 1

CIP No.	Construction Cost, US$	Capital Cost, US$
CIP-1 – Pipe Interconnections and Replacement	2,560,000	3,072,000
CIP-2 – Pipe, Reservoir and Booster Pumping Station	5,503,000	6,604,000
CIP-3 – Water Treatment Plant Improvements	12,678,000	15,214,000
Total Capital Improvement Cost - Year 2000	**20,741,000**	**24,890,000**

Construction cost includes 20 percent construction contingency.
Capital Cost includes construction cost and 20 percent engineering and administration cost.

The recommended Phase 2 improvement projects are summarized in Table V1-ES.4, Summary of Probable Capital Improvement Costs – Phase 2. The total cost of Phase 2 improvements is approximately US $91 million.



ARAB REPUBLIC OF **EGYPT** SUEZ CANAL AUTHORITY NATIONAL ORGANIZATION FOR POTABLE WATER AND SANITARY DRAINAGE	**USAID** CANAL CITIES WATER AND WASTEWATER MASTER PLAN	**SUEZ** **TREATMENT CAPACITY VS PROJECTED WATER DEMANDS**	BLACK & VEATCH INTERNATIONAL IN ASSOCIATION WITH MONTGOMERY WATSON SABBOUR ASSOCIATES DATE: AUGUST 1999 FIGURE: V1-ES.2

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Table V1-ES.4 Summary of Probable Capital Improvement Costs – Phase 2

CIP No.	Construction Cost, US $	Total Cost, US$
CIP-4 – Reservoir and Booster Pump Station (Year 2010)	7,686,000	9,223,,000
CIP-5 – Pipe Interconnections, Parallel & Replacement Pipes	1,008,000	1,210,000
CIP-6 – Pipes and Pressure Sustaining Valves	19,910,000	23,892,000
CIP-7 – Pipes and Pressure Sustaining Valves	7,936,000	9,523,000
CIP-8 – Pipes	2,228,000	2,674,000
CIP-9 – Pipes	1,962,000	2,354,000
CIP-10 – Water Treatment Plant and Storage Reservoir	32,407,000	38,888,000
CIP-11 – Booster Pumping Stations Expansion	2,822,000	3,386,000
Total Capital Improvement Cost - Year 2020	**75,959,000**	**91,150,000**

Construction cost includes 20 percent construction contingency.
Capital Cost includes construction cost and 20 percent engineering and administration cost.

The construction cost include all earthwork, trench shoring and pipe laying and dewatering operations, as well as valves, fiitings, blow-off assemblies, imported bedding material, compacted backfill, surface restoration, disposal of excess excavated material and traffic controls. These costs are based on use of international contractors, management and inspection. These costs should be updated during detailed design to represent current costs based on the inflation index and methods of construction.

End of Executive Summary

1.0 Introduction

This section provides an overview of the work and objectives for the Suez Water Master Plan as part of the Canal Cities Master Plan Project.

1.1 Background

The City of Suez is one of three major cities along the Suez Canal. Figure V1-1.1, Suez Location Map, shows the location of Suez and the other two cities studied. Suez suffered considerable damage to utilities and other infrastructure during the 1967-73 war. After the war, massive reconstruction efforts were initiated to bring the original residents back to the City. In 1979, a Water and Wastewater Facilities Master Plan was prepared and completed for the City of Suez.

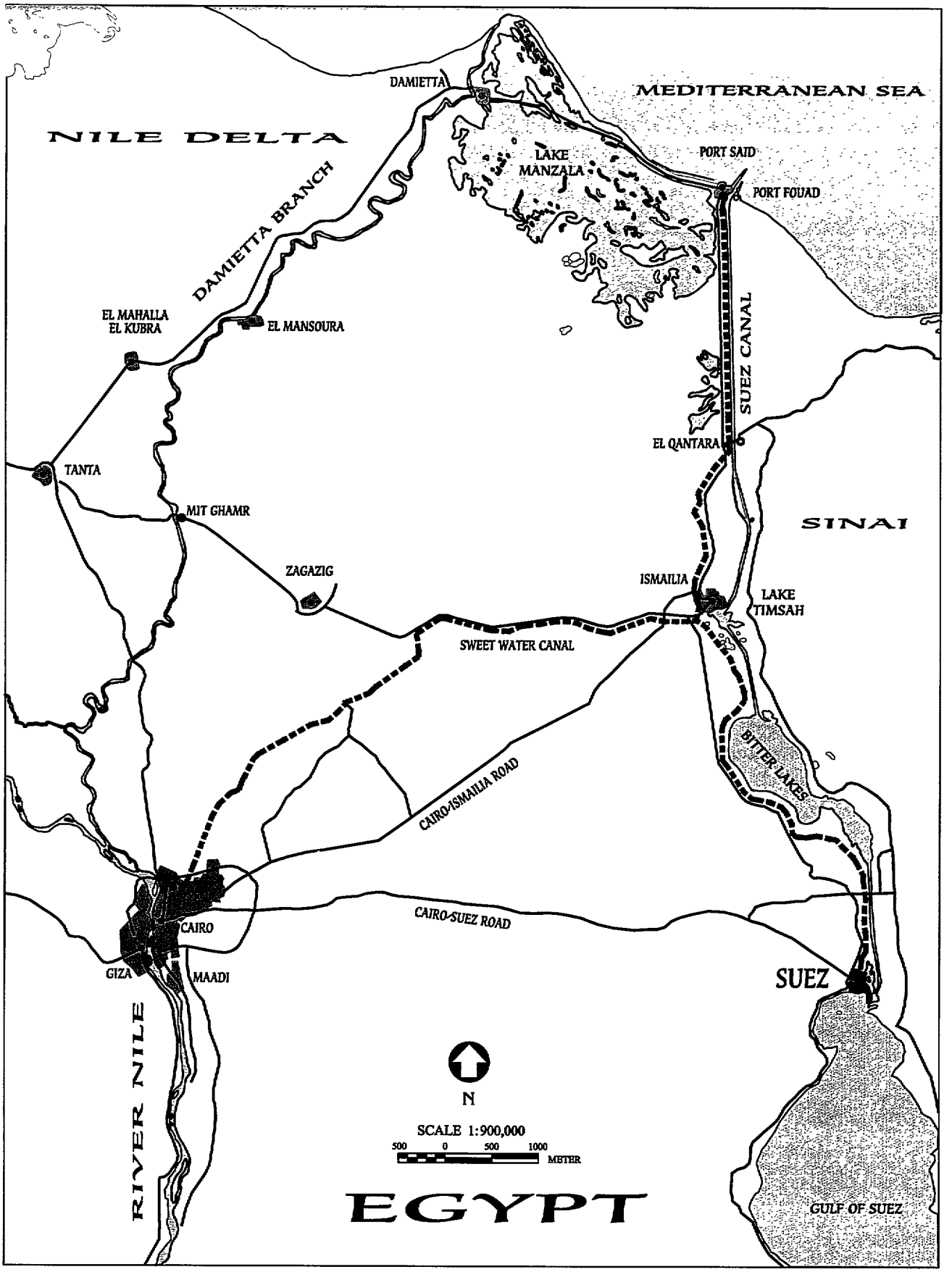
The water treatment facilities and distribution system in Suez are owned and operated by the Suez Canal Authority (SCA). Since 1980, SCA has made significant improvements to the water treatment and distribution system based on the recommendations of the 1979 Water Facilities Master Plan.

In May 1998, Black and Veatch International, in association with Montgomery Watson and Sabbour Associates, were contracted by the United States Agency for International Development (USAID), to conduct a study and to prepare Water and Wastewater Master Plans for the three Canal Cities that would guide utility development up to year 2020.

1.2 Objectives

The objective of this volume is to provide a water facilities master plan to guide water development in the City of Suez from year 2000 to year 2020. It includes the following activities:

- Define the Study Area and describe the physical setting.
- Develop 20-year population projections and anticipated land use.
- Define the existing and projected water demands.
- Describe and evaluate existing water treatment and distribution system.
- Develop a computer hydraulic model to identify existing distribution system deficiencies and to analyze system extensions.
- Conduct field tests to obtain data for the calibration of the hydraulic model.
- Recommend system extensions to serve future development.
- Recommend treatment improvements and identify expansion needs.
- Identify and prioritize capital improvement projects.



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ARAB REPUBLIC OF **EGYPT** SUEZ CANAL AUTHORITY NATIONAL ORGANIZATION FOR POTABLE WATER AND SANITARY DRAINAGE	**USAID** CANAL CITIES WATER AND WASTEWATER MASTER PLAN	BLACK & VEATCH INTERNATIONAL IN ASSOCIATION WITH MONTGOMERY WATSON SABBOUR ASSOCIATES	SUEZ LOCATION MAP DATE: AUGUST 1999 FIGURE:V1-1.1

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A prioritized list of capital improvement projects includes the recommended water treatment plants, booster pump stations, ground storage reservoirs, and water mains, with order-of-magnitude cost estimates, that could be used by SCA to establish budgets and funding requirements.

1.3 Organization of the Report

The Suez Water Master Plan Report is one of eight volumes that constitute the Canal Cities Master Plan. The CCMP final report which addresses both the water and the wastewater facilities requirements of the three Canal Cities of Ismailia, Port Said, and Suez, consists of the Executive Summary and Volumes 1 through 7, listed as follows:

Executive Summary
Volume 1 – Suez Water Master Plan
Volume 2 – Suez Wastewater Master Plan
Volume 3 – Ismailia Water Master Plan
Volume 4 – Ismailia Wastewater Master Plan
Volume 5 – Port Said Water Master Plan
Volume 6 - Port Said Wastewater Master Plan
Volume 7 – Institutional and Financial Report

End of Chapter 1: Introduction

2.0 Physical Conditions, Land Use and Population

The objectives of this section of the CCMP Report are as follows:

- To present an analysis of physical conditions, land use and population in the City of Suez in support of the master planning of the City's water and wastewater infrastructure to the year 2020.
- To prepare Land Use Plans representative of existing conditions and projections of future conditions on a phased basis to the year 2020.
- To incorporate the findings and recommendations of present and future urban development plans approved by central and/or local government authorities into the Land Use Plan for 2020 and into projections of ultimate development conditions.

2.1 Study Area

2.1.1 Study Area Boundaries

The primary focus of the Canal Cities Water and Wastewater Master Plan is on the existing built-up areas of Suez. The urban area of interest extends approximately 17 km along the Gulf of Suez and 14 km from the Suez Canal west to the Ring Road of Suez City.

The Study Area Boundary (SAB) for Suez was determined according to the following criteria:

- The SAB demarcates either existing urban built-up areas or future build-out areas, or land allocated by local or central authorities for future urban development projects. These authorities include the Governorate Housing Department, the Ministry of Defense, the General Authority for Investment and the General Authority for Free Zones.
- The SAB marks urban districts but does not integrate all fringe area villages or rural satellite clusters. Such rural zones are excluded from the SAB even when located within the borders of districts administratively classified as urban. The exclusion is particularly applicable in the case of the Suez Governorate, since it ranks as an Urban Governorate. This jurisdictional classification means that the limits of the capital city are equivalent to the boundaries of the whole Governorate.
- The SAB is based on ratified boundary coordinates prepared by the Governorate. The boundary is defined based on the most recent available map and/or planning document(s) with precise cartographic coordinates, or is clearly marked on scaled maps. The planning document(s) have been prepared by an official planning agency, such as the General Organization of Physical Planning (GOPP) or the local planning department affiliated with the Ministry of Housing.

- The National Building Code and the National Urban Planning Code are applicable within the official limits of the City. The application of the Building Code is not compulsory in rural areas located outside the SAB.

A representation of the Study Area Boundary according to the above criteria is presented in Figure V1-2.1, Suez Study Area Boundary. The SAB is based on the officially ratified borders for development up to the year 2015 and shows land use allocations for future urban development.

The most comprehensive document establishing the borders of the SAB is the scaled map titled *Urban Limits of Suez City: The Approbation of Suez Build-out Area*, issued by the Third Region Planning Department of GOPP in January 1994. The urban limits were approved by the Governor of Suez, the President of the City's Local Council, and the President of Suez Urban Planning Department. The scaled limits of the City's build-out area were integrated into the GIS database.

2.1.2 Administrative Boundary

Study Area Boundaries also relate to administrative boundaries or official district borders. Administrative boundaries are classified as Muhafaza (Governorate), Markaz (District), Madina (Town), Hayy (Quarter), Qism (Police District), and Shiyakha (Neighborhood). These boundaries are used to register the corresponding population data in the survey system established by Central Agency for Public Mobilization and Statistics (CAPMAS). CAPMAS census data, and other available information based on the same survey system, were used in CCMP land use categorization and population projections as discussed further in this report.

Other administrative boundaries considered in CCMP future land use planning were Natural Reserve Boundaries of protected zones declared as National Parks by official decrees or laws. National Parks are excluded from all forms of development.

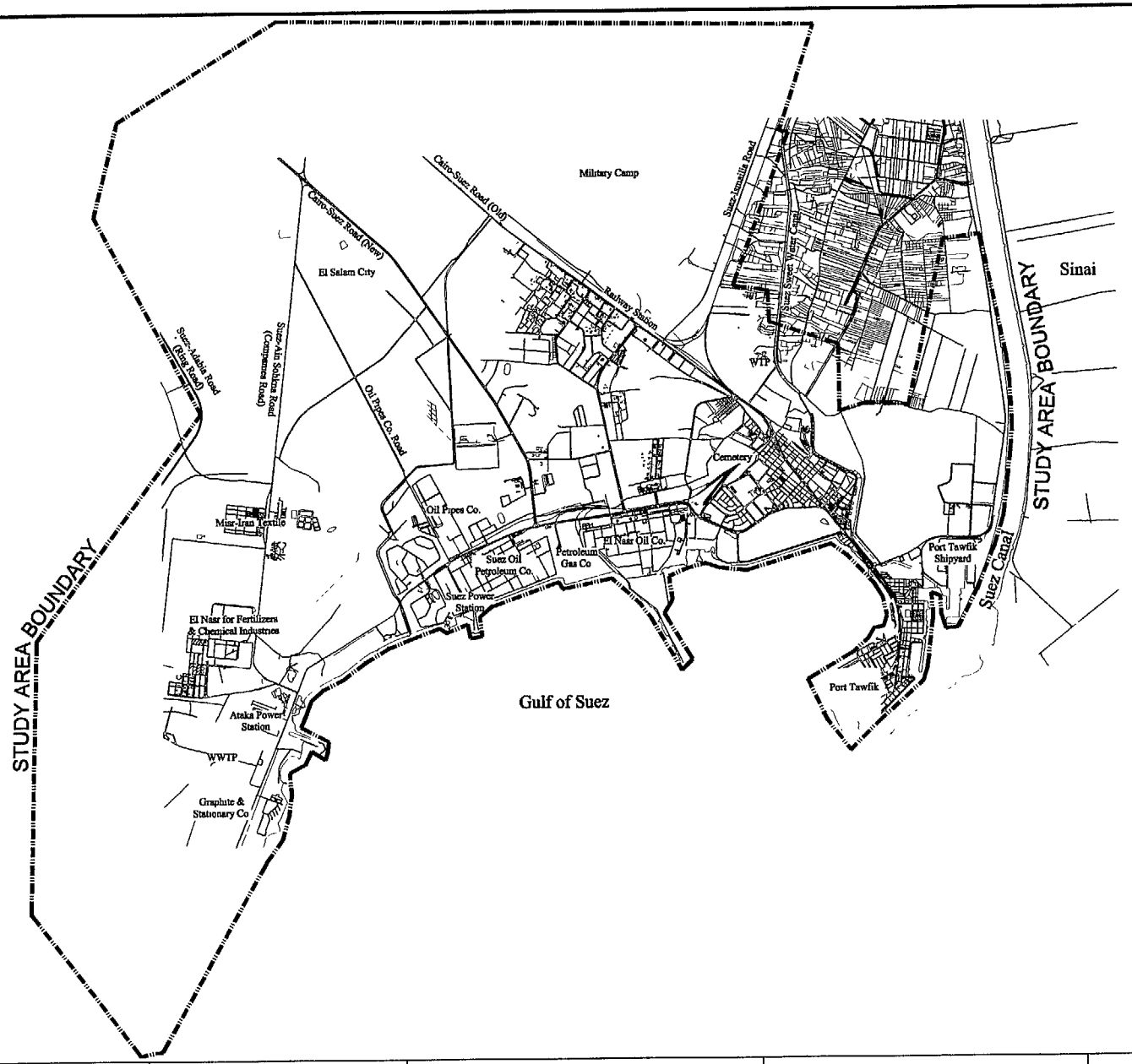
Based on the above criteria, the Administrative Boundaries of the City of Suez are presented in Figure V1-2.2, Suez Administrative Boundaries. The area within these boundaries consists of six Qisms divided into eight Shiyakhas.

2.2 Physical Conditions

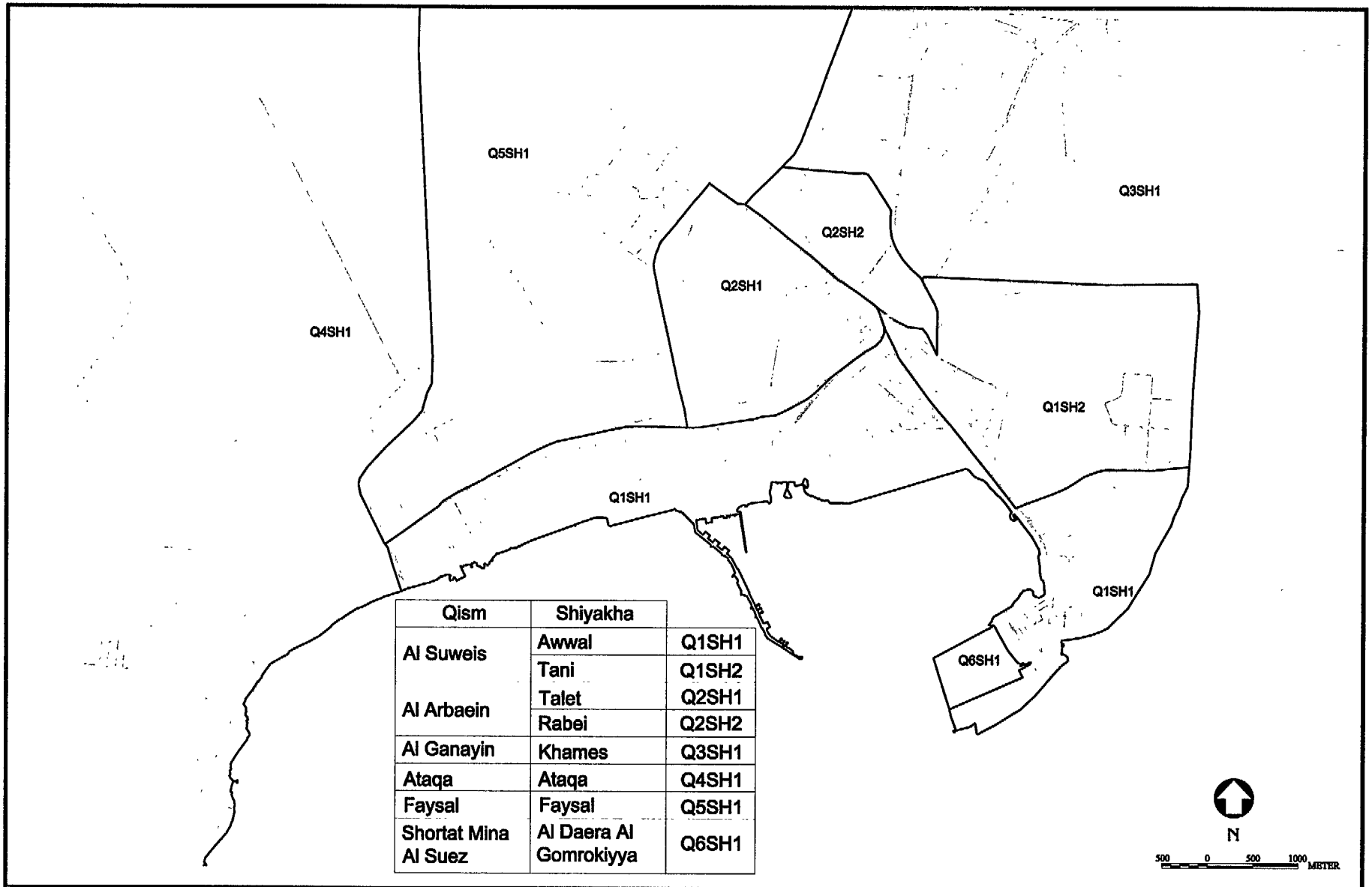
2.2.1 Geography and Topography

Suez is the southernmost point of entry to the Suez Canal and is the northernmost city on the Gulf of Suez. It is located 120 km to the east of Cairo and 75 km south-southeast of Ismailia.

Suez is bounded on the south by Suez Bay, on the east by the Suez Canal, and on the west by Gabal Ataqa (Ataqa Mountain), which rises up to 871 m above mean sea level outside the defined Study Area.



ARAB REPUBLIC OF **EGYPT** SUEZ CANAL AUTHORITY NATIONAL ORGANIZATION FOR POTABLE WATER AND SANITARY DRAINAGE	INTERNATIONAL ELLIPSOIDE - HAYFORD 1909 U.T.M. PROJECTION - ZONE 36 STEREOPLOTTING BASED ON GEODETIC TRIANGULATION OF EGYPTIAN SURVEY AUTHORITY	**USAID** CANAL CITIES WATER AND WASTEWATER MASTER PLAN	BLACK & VEATCH INTERNATIONAL IN ASSOCIATION WITH MONTGOMERY WATSON SABBOUR ASSOCIATES	**SUEZ** **STUDY AREA BOUNDARY** DATE: AUGUST 1999 FIGURE: VI-2.1



Qism	Shiyakha	
Al Suweis	Awwal	Q1SH1
Al Arbaein	Tani	Q1SH2
	Talet	Q2SH1
	Rabei	Q2SH2
Al Ganayin	Khames	Q3SH1
Ataqa	Ataqa	Q4SH1
Faysal	Faysal	Q5SH1
Shortat Mina Al Suez	Al Daera Al Gomrokiyya	Q6SH1

ARAB REPUBLIC OF
EGYPT
SUEZ CANAL AUTHORITY
NATIONAL ORGANIZATION FOR
POTABLE WATER AND SANITARY DRAINAGE

USAID
CANAL CITIES
WATER AND WASTEWATER
MASTER PLAN

SUEZ
ADMINISTRATIVE BOUNDARIES

BLACK & VEATCH INTERNATIONAL
IN ASSOCIATION WITH
MONTGOMERY WATSON SABBOUR ASSOCIATES

DATE: AUGUST 1999 FIGURE: VI-2.2

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Physically, the Suez area is diverse, consisting of mountains, plains, coastline, desert, and fertile areas. Its main physical features are Gabal Ataqa, Suez Bay, and the Suez Canal itself. Soil in the Suez area is composed of rocks of the Pleistocene era (the plain) and of the Eocene era (Gabal Ataqa). Limestone predominates; however, there is a diversity of minerals, e.g., dolomite, basalt, clays, sands, and gravels. The sands and gravels typically contain chlorides and sulfates. The Nile, via the Ismailia Sweetwater Canal, is the only source of freshwater for the area.

The area north of Suez is best characterized as desert plain. As one progresses southwest, along the western shore of Suez Bay, this plain surrenders to the foothills and plateaus of Gabal Ataqa.

Wadi Risis, the major wadi within the study area, flows southeast into Suez Bay. South of Wadi Risis are Wadi Al Ghal, Wadi Al Abar, and Wadi Abu Saiyala, all of which flow from the foothills of Gabal Ataqa into Suez Bay.

The Gulf of Suez is a shallow water shelf of the northwestern part of the Red Sea. It averages 19 to 24 km in width and has an overall average depth of 56 m – from 20 to 30 m near Suez, to 70 to 80 m at its southernmost end.

2.2.2 Climate

Climate within the Study Area is characteristic of the northern Red Sea desert region of eastern Egypt. Studies of the local climate indicate a dry, hot, relatively rainless seasonal pattern. Sporadic, localized rain showers occur from late October to early December and again from late January through February. Rainfall through the remainder of the year is rare to non-existent. Mean annual rainfall in Suez is approximately 24 mm.

As shown in Table V1-2.1, Suez Climatic Data, air temperatures range from about 9°C to 36°C.

Table V1-2.1 Suez Climatic Data

	Maximum Temperature °C	Minimum Temperature °C	Percent Humidity	Total Rainfall, mm
Summer	36	21	56	0
Winter	24	9	62	24

Perhaps of more consequence than the seasonal variation in temperature is the wide diurnal-nocturnal fluctuation characteristic of desert climates. Daily fluctuations range from 8°C to 15°C, with the widest daily fluctuations occurring during the hot, dry summer months when cloud cover is sparse. These changes in temperature make a significant contribution to the formation of dew during early morning hours. The depositions often tend to be heaviest during the spring and fall, when the moisture content of the air (relative humidity) is high and the evaporative power of the atmosphere is low.

Prevailing winds are from the north and northwest. Monthly average wind speeds vary from 13 km/h in December to 21 km/h in May, and are typically higher during summer months, from May to September. During the spring months, from February to April, wind direction is more uniform than at other times of the year. Average wind velocities are highest during the evening, reaching 23 km/h.

Relative humidity ranges from about 55 percent to 65 percent, with an annual mean of 59 percent. The overall monthly mean values indicate that humidity is slightly higher during the winter months and is also higher in early morning than in mid-afternoon. Diurnal variations are between 10 and 21 percent, with periods of widest fluctuation during June to September.

The rate of water evaporation is moderate, with the highest monthly average of 14 mm/d during June, and the lowest values during the winter months, November through February.

2.2.3 Geology, Geomorphology, Soils, and Seismicity

Most of the region surrounding Suez is composed of Eocene or younger sediments, with the exception of one small area of Cretaceous age material near Gabal Ataqa. Major topographic features are composed of Eocene limestone which forms the escarpments and dip-slopes. The escarpments of Gabal Ataqa are composed of hard crystalline limestone, which is chalky white when first exposed, but eventually weathers to a gray or brown color.

Oligocene deposits in the region consist of sands and gravel, usually loose or poorly cemented, and many basalt flows are found near Suez.

Extensive coarse sands from the Pleistocene era are present in and around Suez, filling the alluvial fans of smaller wadis and the sides of major wadis. The plain on which Suez lies consists of Pleistocene out-wash sands and gravel, randomly interbeded with alluvial clays.

Geomorphological processes in the Suez area have resulted in surface-deposited sediments, which can be grouped depending on their depositional environment into fluvial deposits, old marine deposits, and young marine deposits. The area north of the Cairo-Suez Road contains old, thin, piedmont deposits consisting mainly of dense quartz and limestone sands. Areas of younger piedmont material are found south of Cairo-Suez Road and near Wadi Risis.

The soils of the Suez area have morphological features common to arid regions. Soils have sandy or loamy sand texture and typically contain considerable amounts of gravel and coarse fragments. Sandstone, siltstone, and mudstone are usually encountered within the top 1 to 5 m of the soil and can occur as rock outcrops. Salic, gypsic, and natric horizons are also common.

Soil salinity is highest in areas where the water table is or has been near the soil surface. Generally, the carbonate content is very low in upper soil layers; however, in wadis, the carbonate content tends to be higher as a result of rainwater periodically washing limestone from the surrounding plateaus into the wadi beds. The water-holding capacity of the soil is low – about 35 percent under saturated conditions.

Suez is located about 225 km west of the Dead Sea shear zone where major earthquakes have occurred, some of which have produced perceptible shaking in Suez. In recent years, the major energy content of such shaking has been at a low frequency, with little impact on the integrity of man-made structures. However, examination of historical records indicates that Suez is in a region of epicentral destructive or damaging events. A number of earthquakes have occurred on a northeast-to-southwest belt about 70 km north of Suez. The earthquakes appear to have been minor adjustments to stress, similar to those experienced in relatively stable parts of the world.

Earthquakes under the Red Sea are the probable cause of tidal waves that have occurred in Suez in the past. However, the tidal waves are very infrequent and have typically given at least half an hour's warning of their arrival in Suez.

2.2.4 Groundwater, Surface Water and Flood Hazard

Major sources of groundwater supply near Suez include deep artesian aquifers, unconsolidated deposits along the Sweetwater Canal, and shallow regional aquifers. Large quantities of groundwater may be available from deep sandstone strata near Suez which form part of a regional aquifer system. Groundwater in these deep artesian aquifers is typically high in mineral content. Limited supplies of groundwater at shallow depths are also available in the vicinity of Suez, but low annual precipitation limits the overall amount of groundwater recharge.

Highly saline groundwater underlies the Suez coastal area. Occasional lenses of less saline water can be found floating on the denser saline groundwater bodies in some areas, such as Shiyakha Faysal. Sources of the lower salinity water may include seepage from wastewater pipes, canals, streams, and irrigated plots.

The cause of high salinity in the coastal deposits may be seawater and the concentration of groundwater through evaporation.

The shallow water table and poor drainage near Suez have contributed to the salinity of the soil. Where capillary rise from the water table extends to the soil surface, evaporation of groundwater results in the formation of a dry salt crust. Where the water table is within 300 mm of the ground surface, soils are damp and spongy.

Surface waters in the project area are the Suez Canal and the Gulf of Suez. The relatively narrow width and shallow depth of the gulf limits exchange of water with the open part of the Red Sea. Waters in the northern part of the gulf are especially noted for their high salinity, slow currents, and distinct high and low tides. Because of constant evaporation at the water surface, the absence of rivers contributing freshwater to dilute gulf water, and the low rate of water exchange with the Red Sea, the Gulf of Suez water is among the saltiest in the world.

Suez Bay is 13.2 km long (northwest-southeast axis) and 8.8 km wide (northeast-southwest axis). The mean sea level at Suez is 360 mm higher than at Port Said in March and April, and 23 mm lower than at Port Said in September. During ten months of the year, the

net movement of water is north through the Suez Canal. During August and September, net movement is south through the Canal into Suez Bay.

Water samples collected in Suez Bay show a relative uniformity in temperature and salinity in the horizontal and vertical gradients. Wind drift, density mixing, and tide mixing contribute to the complete homogeneity of the waters in the bay and in the northernmost parts of the Gulf of Suez. In deeper parts of the northern gulf, tidal currents cause northward movement of less dense, warmer waters, and southward movement of more dense, colder waters.

Waves in the bay seldom exceed 0.6 m and the current is gentle. The tidal range at Suez is 0.9 m to 1.5 m at neap tide.

Like in Ismailia and Port Said, the freshwater system in Suez is supplied by the Ismailia Sweetwater Canal and its extensions southward and northward, and by subsequently developed irrigation channels and agricultural drains. The Ismailia Sweetwater Canal is the main source of freshwater in the Governorate. It brings Nile water to the Suez Canal Region, including the three main cities of Port Said, Ismailia, and Suez. The canal is 125 km long, has a total flow of 9.5 million m^3/day, and contains three main branches:

- Suez Branch: 90 km long, including 50 km within the Suez Governorate.
- Port Said Branch: 77 km long, including 45 km within the Port Said Governorate.
- El Manayef Branch: 24 km long, entirely within the Ismailia Governorate.

While flooding is infrequent, potential flood hazards do exist in Suez. The effects are varied and include possible erosion, deposition and inundation. Evidence of surface runoff in Suez includes scour and fills in channel beds, bank erosion, and gully development where flow has been concentrated, with signs of width and depth expansion. Boulders and large gravel in channel beds indicate some flows have had high intensities. Depth of flow is indicated in some locations by scour marks and mud veneers on channel banks, and the height of brush and rubbish accumulations. This evidence shows that depth of flow in the Suez area rarely exceeds 1 meter and only in the larger channels. The same evidence also indicates that the width of most flows rarely exceeds a few meters.

Wadi Risis, which serves as a drain for surface water from the entire area north and east of Gabal Ataqa, has the greatest potential for flooding in the area. Other potentially hazardous areas are along the larger channels of the piedmont plain and the younger alluvial fans with large mountain catchments.

2.2.5 Marine Biota, Terrestrial Biota, and Environmental Pollution

Approximately 138 fish species representing 63 families have been recorded in the Gulf of Suez. Of this number, 28 species are of significant economic importance.

In terms of invertebrate species, the number and diversity of organisms increase seaward, in the direction of the prevailing winds. Invertebrates found in shallow, muddy bottoms

included eight species of sponges, two types of coelenterates, 13 polychaetes, 22 mollusks, 22 crustaceans, and 12 echinoderms.

Terrestrial vertebrate fauna found in the Suez area are limited in distribution and population, primarily by the harsh environmental conditions prevalent in the region. Altogether, 32 forms of amphibians and reptiles have been recorded in the Suez area.

A significant number of avian species inhabit the Suez area, either as year-round local residents or as transients in migration. Over 170 species have been sighted, most of them associated with the area bordering the Suez Canal or the coastline of the Bay and Gulf of Suez. Several species have been seriously reduced in numbers during the past 30 years and are now very rare. These include the white-tailed sea eagle (*Haliaetus Albicilla*), flamingo (*Phoenicopterus Ruber*), caspian tern (*Hydroprogne Caspia*), red-billed tropic bird (*Phaethon Indicus*), and gray heron (*Area Cinerea*). Many of these rare birds are not tolerant of human activities and have been indirectly eliminated from the fauna of Egypt.

Twenty-five species of mammals either inhabit or are periodically encountered within the Suez area. This number includes the giant shrew (*Crocidura Oliveri*), hedgehog (*Hemiechinus Auritus*), seven bat species, four gerbils, two sand rats, black and Norway rats, two jerboas (*Jaculus sp.*), Egyptian fox (*Vulpes vulpes*), sand fox (*Vulpes ruppellii*), and Egyptian mongoose (*Herpestes Ichneumon*). Other interesting mammals include the rare Nubian dorcas gazelle (*Gazella Dorcas*) found in vegetated wadis and hills west and south of Suez.

Considering pollution of land, air, and water in Suez, it appears that marine oil spills and discharges into Suez Bay are the dominant threats, with oil refinery operations constituting a limited local hazard. Other sources of water pollution include relief wastewater outfalls that discharge untreated sewage to the Suez Bay and Suez Creek, wastewater treatment plant and industrial waste discharges, flotsam and waste material discharged from passing ships, polluted groundwater, and agricultural runoff. Air quality measurements indicate that sulfur dioxide and particulate matter are the pollutants of the greatest concern in Suez. The major sources of sulfur dioxide are the refineries on the coastline. However, their impact on urban areas is minimized because prevailing winds are from the north 70 percent of the time.

2.3 Socio-Economic Conditions

2.3.1 Historical Background

The opening of the Suez Canal in 1869 enabled the small fishing and trading port of Suez to develop into an important mixed cargo port with direct communications to Cairo and Ismailia. With the development of an oil terminal in the early 1950s, Suez became the focus for industrial growth. Today, Suez is recognized as an important seaport and center of heavy industry.

In 1966, Suez had a population of over 250,000 and was a primary port on the Red Sea. During the 1967-1973 hostilities, most of the inhabitants were evacuated. Shelling destroyed much of the built-up area, causing heavy damage to water and wastewater facilities. After resettlement of Suez, which began in June 1974, the population increased from an estimated 8,000 to 194,000 at the time of the 1976 census, and to about 417,000 according to the 1996 census.

The evolution of development conditions in Suez may exert considerable influence on the City and area. If successfully exploited, these conditions can potentially be adapted to generate substantial economic growth and consequently important employment opportunities, which would increase both the population and the economic status of Suez. These conditions can be summarized as follows:

- The creation of Ain El-Sukhna new port is expected to add to the Suez area's maritime transport capacity and to attract industries associated with export markets in East Africa, Asia, and the Arab Gulf states.
- The number of the City's industrial establishments is expected to increase due to the availability of vacant developable sites within its four existing industrial zones and three future industrial zones south and southeast of Suez.
- Additional employment could be generated by the tourism development projects along the Gulf of Suez.

2.3.2 Socio-Economic Profile

Historic and current data on socioeconomic conditions and population statistics required to analyze present conditions and to anticipate future conditions to the year 2020 were obtained from several official sources, including:

- CAPMAS National Census of 1960, 1966, 1976, 1986 and 1996.
- Comparative surveys conducted in 1992, 1995 and 1996 by the Center of Information and Support to Decision Making, a research center affiliated with the Prime Minister Bureau.
- The local Information Center of Suez Governorate.

Additional information related to the urban environment was obtained through site reconnaissance and interviews with key officials in Suez.

Within the recent past, the Suez Governorate Center of Information and Support to Decision Making has compiled statistics on a variety of subjects. The following tables display some of this information, Table V1-2.2, Comparison of Types of Buildings Within Suez Qisms, Table V1-2.3, 1996 Suez Manpower Data and Table V1-2.4, Suez Unemployment Rates.

Table V1-2.2 Comparison of Types of Buildings Within Suez Qisms

Qism	Residential Housing	Commercial	Combined Housing and Commercial	Vacant	Other	Total No. of Buildings in Qism
Al Suez	2,357	1,212	573	264	196	4,602
Al Arbaein	12,878	1,004	492	1,095	598	16,067
Atakka	1,153	319	3	111	24	1,610
Al Ganayin	8,823	437	14	263	405	9,942
Shortat Mina		20				20
Faysal	910	910	124	1,480	102	3,526
Total	26	3,882	1,206	3,213	1,325	35,747

Table V1-2.3 1996 Suez Manpower Data

Workforce Statistics	
Employed	117,462
Unemployed	1,584
Never Been Employed	12,279
Total Workforce	131,325

Suez Governorate Information Center with the Center of Information and Support to Decision Making: Prime Minister Bureau, November 1997.

Table V1-2.4 Suez Unemployment Rates

Unemployment Rate	
1992	8.53%
1995	15.26%
1996	10.56%

Suez Governorate Information Center with the Center of Information and Support to Decision Making: Prime Minister Bureau, November 1997.

Suez may not be considered a major tourist destination; however, the number of beds in hotels and resort establishments in the city has increased to more than 1,300 beds. Table V1-2.5, Suez Hotels and Resorts, shows a breakdown of tourist accommodations in Suez and Table V1-2.6, Suez Hotel Rooms and Tourist Nights, shows that between 1992-1996, there was a nearly 17 percent growth in the number of hotel rooms and a similar growth in the number of nights these rooms were occupied by tourists.

Table V1-2.5 Suez Hotels and Resorts

Type of Establishment	Number
3 to 5 Star Hotels	3
Other Hotels	2
Holiday Resorts	4
Chalets	48
Youth Hostels	1
Total Number of Beds	1,314

Suez Governorate Information Center with the Center of Information and Support to Decision Making: Prime Minister Bureau, 1997.

Table V1-2.6 Suez Hotel Rooms and Tourist Nights

	Number of Tourist Rooms	Number of Tourist Nights
1992	532	61,907
1995	645	75,056
1996	622	72,380

Suez Governorate Information Center with the Center of Information and Support to Decision Making: Prime Minister Bureau, 1997.

2.3.3 Urban Environment

Before the 1967 war, urbanization in Suez was confined primarily to the area along the north shore of Suez Bay. Since then, the City has gradually expanded from Qism Al Suez and Qism Al Arbaein to the northwest of town. Growth to the north and west has been restricted by agricultural land and by the Sweetwater Canal. The location of oil refineries has encouraged expansion to the west of the town, along the northern shore of the bay. Between 1979 and 1990, the Army vacated part of the land it controlled along the Suez Canal and north of the City. One large military base remains north of Qism Faysal, but this base is not considered a major constraint to logical city growth.

Suez is home to over 60 industrial establishments. Table V1-2.7, Suez Industrial Establishments, provides a categorical list of these establishments.

Table V1-2.7 Suez Industrial Establishments

Type of Industry	No. of Establishments
Chemical Industries	3
Construction Materials	9
Metallic Work	1
Engineering Industries	11
Wooden Products	6
Spinning and Weaving	2
Paper Industries	8
Food Processing Industries	18
Miscellaneous	3
Total	61

Suez Governorate Information Center with the Center of Information and Support to Decision Making: Prime Minister Bureau, November 1997.

Three types of structures are common in Suez: wood-framed buildings with mud or stone in-fill, load-bearing brick walls and wood floors are found in areas built before 1950s and in semi-rural parts of Al Ganayin; load-bearing brick walls with concrete floors have been constructed more recently; and concrete frame construction with brick or block in-fill is the current building technique of choice.

Informal sector housing has been gradually expanding in several settlements in the City. It is concentrated mainly in Qism Al Ganayin, on the fringes of the rural area, and southward along Ain El-Sukhna Road where desert land is affordable and available.

Suez can be subdivided into six areas, or Qisms, according to the quality, density scale, and type of development. The morphological patterns of the six most distinct neighborhoods in Suez are shown and compared in Figure V1-2.3, Suez Typical Building Densities.

2.3.3.1 Qism Al Suez

Qism Al Suez is composed of two distinct neighborhoods, Shiyakha Awwal and Shiyakha Tani.

Shiyakha Awwal, the original main industrial zone of Suez, consists of oil refineries, storage facilities, and confined housing sectors for the companies' employees. The industrial area is bordered by a railroad track used for oil transport. The ground along the track is considered to be contaminated and to be a constraint to urban development in the central part of the City. The rail line is planned for removal within three years.

Shiyakha Tani, northeast of the Gulf, consists of three smaller quarters: Al Ghareeb, New Suez, and Tal El Qalzam. Tal El Qalzam is the oldest inhabited part of Suez. All three neighborhoods were heavily damaged during the 1967 to 1973 hostilities and were rebuilt or rehabilitated in the early 1980s. Shiyakha Tani contains a number of government and educational facilities constructed next to post-1973 government housing.

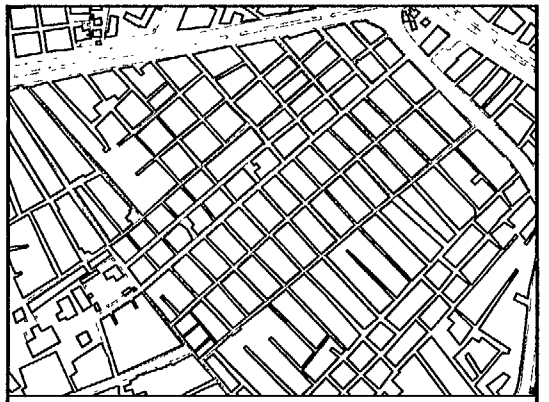
Two large landscaped green areas were recently created along the seafront at both ends of the industrial area in Shiyakha Awwal. These areas include recreational facilities, gardens, and lagoons. They are becoming the predominant green feature of Suez and help offset the town's industrial image.

Port Tawfik is also part of Shiyakha Awwal. It is a man-made island, connected to the rest of Suez by a road and rail causeway. In addition to the port facilities, the administrative offices of the Suez Canal Authority, housing for its staff, and community facilities are located on the island.

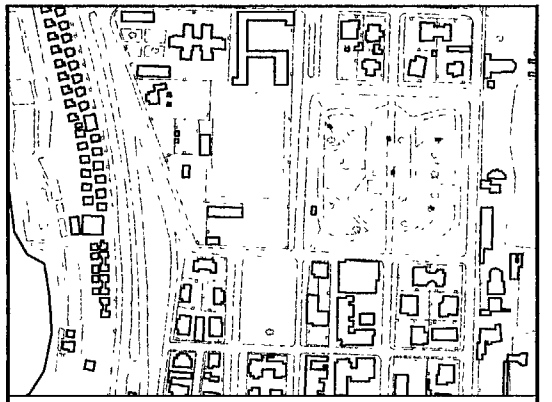
2.3.3.2 Qism Al Arbaein

Al Arbaein is the old, traditional core of Suez. It consists of somewhat decayed buildings and is classified as a high-density area. Al Arbaein houses the poorest segment of the population. The Qism consists of two residential and mixed residential-commercial districts, Shiyakha Talet and Shiyakha Rabei, located on both sides of the railroad track along the Cairo-Suez Road. Approximately half of the Suez population resides in Al Arbaein. Shiyakha Talet is built on a small block grid pattern and consists mainly of four- and five-story buildings in reasonable to poor condition, occupied primarily by commercial or service oriented businesses on the ground floor and residential housing on the upper floors. Owing to the very compact nature of this Qism, there is little open space other than the roads and circulation areas surrounding the buildings. In general, all urban services need substantial improvement.

FAYSAL NRD:14,000 ABH: 5

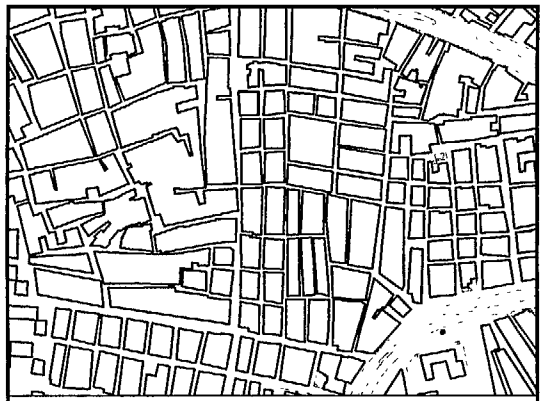


AL ARBAEIN NRD:46,000 ABH: 4

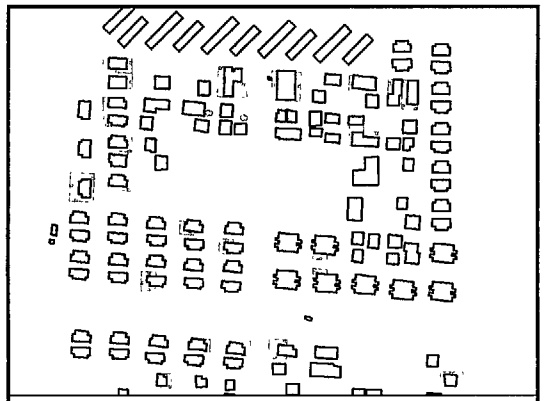


PORT TAWFIK NRD:12,000 ABH: 3

AL SUWEIS NRD:24,000 ABH: 5



AL ARBAEIN NRD:46,000 ABH: 4



ATAQA NRD:12,000 ABH: 4

N

SCALE 1 5,000

500 0 500 1000 METER

NRD = NET RESIDENTIAL DENSITY (persons/km²)

ABH = AVERAGE BUILDINGS HEIGHT (no. of floors)

ARAB REPUBLIC OF EGYPT SUEZ CANAL AUTHORITY NATIONAL ORGANIZATION FOR POTABLE WATER AND SANITARY DRAINAGE	INTERNATIONAL ELLIPSOIDE - HAYFORD 1909 U.T.M. PROJECTION - ZONE 36 STEREOPLOTTING BASED ON GEODETIC TRIANGULATION OF EGYPTIAN SURVEY AUTHORITY	USAID CANAL CITIES WATER AND WASTEWATER MASTER PLAN	BLACK & VEATCH INTERNATIONAL IN ASSOCIATION WITH MONTGOMERY WATSON SABBOUR ASSOCIATES	SUEZ TYPICAL BUILDING DENSITIES DATE: AUGUST 1999 FIGURE: VI-2.3

Over the years, expansion has tended to take place vertically, with the replacement of old buildings or the addition of extra floors on concrete buildings. Despite the development of new residential settlements in Faysal and Ataqa, Al Arbaein still accommodates most of the commercial and business activities of Suez. The Master Plan prepared in 1979 included a new City Center in the northwestern extension of Suez, but this new center has not been developed.

2.3.3.3 Qism Faysal

Qism Faysal is adjacent to the western and northern extension of Al Arbaein. It is expected to accommodate the largest share of the residential population increase up to the year 2020. The Qism has little commercial or service-oriented activity.

Development of the Qism began with the reopening of Suez in 1975 when a number of government housing developments were built west and northwest of the City Center. Among the housing developments were Herafien, Sabah City, and Faysal City along the Cairo-Suez Road, and employee housing near the oil refineries and the fertilizer factory in Ataqa. The more recent developments by private and public sectors west of Faysal and Al Sabah districts occupy the area south of the railway track. Buildings consist of four- to six- story apartment blocks. The typical occupancy rate is between 50 and 70 percent, despite the very high-density design.

2.3.3.4 Qism Al Ganayin

Qism Al Ganayin is located north of the built-up portion of Suez and borders on private agricultural land. As elsewhere, this agricultural land cannot be exploited for urban use.

The principal Shiyakha in the Qism is Shiyakha Khames, which is divided into two distinct quarters, an informal settlement near Shiyakha Rabei and an initially rural settlement north of Shiyakha Tani. In both settlements, the original rural housing has been gradually replaced with urban structures constructed of concrete and brick. Buildings in the Qism have an average height of three stories. Streets are narrow and winding.

2.3.3.5 Qism Ataqa

Qism Ataqa is the largest Qism in Suez. It occupies the southern extension of Faysal and is the planned site of future industrial development. A regional power plant and the new wastewater treatment plant are located in Qism Ataqa. Some worker housing is in Qism Ataqa and the qism is expected to accommodate a small share of the population increase expected by the year 2020.

2.3.3.6 Qism Shortat Al Mina Suez

Qism Shortat Al Mina Suez includes restricted port, shipyards, and customs facilities, and a portion of Port Tawfik. The area is used for docking facilities, Suez Canal Port Authority's offices, fuel storage, and shipyards.

2.3.3.7 Suez Industrial areas

Two future large industrial zones west of Ain El-Sukhna and the expansion of the existing industrial zone in Ataqa are planned for the year 2005. These projects would add substantially to the four existing industrial zones in the vicinity of Suez.

- Two light industrial zones along the Ismailia-Suez Road. The first, 169 ha, is about 20 percent vacant and 20 percent occupied by the Army. The second, 80 ha, is approximately 15 percent vacant.
- The industrial zone along Nasser Road, south of Qism Faysal and Al Sabbah residential districts. Currently, only 4.5 ha of the 5.5 ha zone are in industrial use. The remaining area is being gradually occupied by informal housing.
- The 878 ha industrial zone in Qism Ataqa is the main concentration of industries in Suez. Approximately 130 ha of this zone is vacant land.

2.4 Current Land Use

The methodology used in the land use plans for existing conditions in each of the three cities is summarized below.

2.4.1 Collecting and Interpreting Relevant Cartographic Data

More than 120 maps at different scales and coordinate systems showing land use information were compiled. The maps provide detailed data relative to the following:

- Built-up areas and building utilization.
- Administrative district divisions linked to the corresponding population data for each district.
- Topographical features.
- Soil and land suitability.
- Land management organization.
- Agricultural use.
- Built-out areas.

The maps were prepared or published by several institutions and agencies, including the following:

- Central Agency for Public Mobilization and Statistics.
- Centre Français d'Etudes Demographiques et Juridiques.
- Egyptian Geographical Society.
- Egyptian Survey Authority.
- General Organization of Physical Planning.
- Information Centers of Port Said, Ismailia, and Suez Governorates.
- Military Survey Authority.
- Ministry of Agriculture.

- Military Aerial Photographic Authority.
- National Organization for Potable Water and Sanitary Drainage.
- Several national and international consulting firms.

2.4.2 Selection of Standard Mapping System

Based on an evaluation of the collected maps, the mapping system used by CAPMAS was selected as the most appropriate for CCMP. Particular reasons for this selection include the following:

- It is a comprehensive system that includes all the layers of cartographic data required for CCMP work.
- It covers all the urban areas of the three Canal Cities.
- It is the most up-to-date system identified.
- It is the only map available in electronic digital format.
- It incorporates the population data of the most recent CAPMAS census.

Following this evaluation, the CCMP project purchased a license from CAPMAS to use a set of 52 electronic maps.

2.4.3 Primary Land Use Categorization

Cartographic data from the compiled maps were interpreted to determine the land use of buildings and open areas. Buildings and areas used for similar activities were grouped into polygons which were color-coded according to use, with each color representing a specific land use or facility. This categorization approach was adopted (a) to facilitate water and wastewater master planning and system modeling and (b) to interpret current and projected urban environment conditions. The aim of interpreting urban environments is to allow the incorporation of general land use recommendations pertaining to sustainable planning approaches for the year 2020 into the CCMP Report.

2.4.4 Site Reconnaissance: Validating Primary Land Use Categorization

The findings of the primary land use categorization were confirmed through six site reconnaissance visits to each of the three cities. The site reconnaissance examined specific urban characteristics to identify the following:

- Locations of unserved areas.
- Overall major urban rehabilitation requirements and sanitary conditions.
- Urban morphology and housing typologies.
- Future development trends in neighborhoods.
- Environmental constraints.

The most recent maps available reflected 1994 land use conditions. In order to portray the 1998 land use conditions, additional site inspections were carried out, particularly in selected

50

fringe areas. The inspection findings, as well as modifications to the land use registered by CAPMAS up to October 1998, were included in the land use plan of existing conditions.

Lists of ongoing and future housing and industrial development projects were compiled with the help of the Housing Department of each Governorate. The size, capacity, location, and progress status of each project were interpreted and then incorporated into the land use plan of existing conditions and, whenever applicable, into the 2020 land use plan.

2.4.5 Calculating Net Residential Densities

Net residential densities at existing conditions were calculated according to the following steps:

1. Administrative boundaries of shiyakhas were demarcated on the land use plan of existing conditions.
2. Residential areas within each shiyakha were marked to form residential polygons.
3. The area of each residential polygon was computed and calculated.
4. The Net Residential Density of each residential polygon was calculated by dividing the population of the respective shiyakha by the area of the polygon. Net Residential Density is a value that indicates the number of residents per square kilometer.
5. Residential polygons with net residential densities of the same or similar nature were combined into larger polygons.
6. Residential polygons were classified as having Very Low, Low, Moderate, High, or Very High Net Residential Densities.

2.4.6 Land Use Categories

Land use categories, taking into account current and future land use and population densities, were applied to the land use map of existing conditions as shown in Figure V1-2.4, Suez Existing Land Uses. The map defines areas, major facilities, and boundaries for both existing and future conditions.

Table V1-2.8, Land Use Categories, describes the areas identified in the Land Use Legend on these figures and, where applicable, defines the net residential densities for that category. The same land use categories are applied to the land use maps for future conditions.

2.5 Current and Future Populations

2.5.1 Current Population

Preliminary results of the CAPMAS 1996 census indicated the population of Suez Governorate, including people living in Suez City and in rural areas of Qism Al-Ganayin, had reached 417,610. Following a cartographic analysis and a density analysis of Al-Ganayin urban and rural districts it was estimated that this figure may be two to three percent higher.

LEGEND

Study Area Boundary

WWTP- Wastewater Treatment Plant

WTP- Water Treatment Plant

SUEZ EXISTING LAND USE

- Agricultural Land
- Beach Setback
- Cemetery
- Commercial - Office & Gov't
- Commercial - Tourism
- Educational Facilities
- Future Development
- Industrial - Low Water Use
- Irrigated Parks & Open Spaces
- Military Camps
- Residential - High Density
- Residential - Low Density
- Residential - Very Low Density

NOTE Land use categories shown represent average densities derived from GOPP land use maps

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ARAB REPUBLIC OF
EGYPT

USAID
CANAL CITIES WATER AND WASTEWATER MASTER PLAN

SUEZ EXISTING LAND USE

MONTGOMERY WATSON

DATE AUGUST 1999

FIGURE VI-2.4

Table V1-2.8 Land Use Categories

Land Use Category	Description
Residential – Very Low Density	Predominantly residential area with population density of less than 20,000 people/km^2.
Residential – Low Density	Predominantly residential area with population density of 20,000 to 30,000 people/ km^2.
Residential – Medium Density	Predominantly residential area with population density of 30,000 to 45,000 people/ km^2.
Residential – High Density	Predominantly residential area with population density of 45,000 to 65,000 people/ km^2.
Residential – Very High Density	Predominantly residential area with population density greater than 65,000 people/ km^2.
Commercial, Office and Governmental	Area mostly occupied by government administration and office buildings with some residential use. It may also include services and commercial uses and seaport facilities such as docks and Port Authority's administration buildings.
Irrigated Parks and Open Spaces	High water use irrigated parks, large landscaped gardens, and greenhouses. It may also include lower water use irrigated areas, such as outdoor sports facilities, large school playgrounds, and large parking lots.
Industrial – Low Water Use	Low water use industrial activities such as auto workshops, warehouses, and oil companies including on-dock seafront areas with fuel storage reservoirs and related equipment.
Industrial – Moderate Water Use	Moderate water use industries, within or outside designated Industrial Zones.
Unique Water Use	Exceptionally high water use industries such as refineries and chemical plants.
Future Development	Land or water surface (to be landfilled) allocated for future development.
Beach Setback	Undeveloped seafront areas and beaches.
Military Camps	Land designated for use by military or security forces. These are controlled by the Armed Forces and may be independently supplied with water and wastewater services.
Commercial Tourism	Areas occupied by hotels, resorts, or camping sites.
Water Bodies	Sea, Suez Canal, and major irrigation and drainage canals.
Large Educational Facilities	Group of buildings occupied by large educational facilities, such as universities, schools, or vocational training centers.
Fish Farms and Salt Ponds	Aquaculture or salt production.
Agricultural Land.	Agriculture land with little or no residential
Cemetery	Cemetery and related facilities

However, the CAPMAS figure was used as the basis for CCMP population projections up to the year 2020.

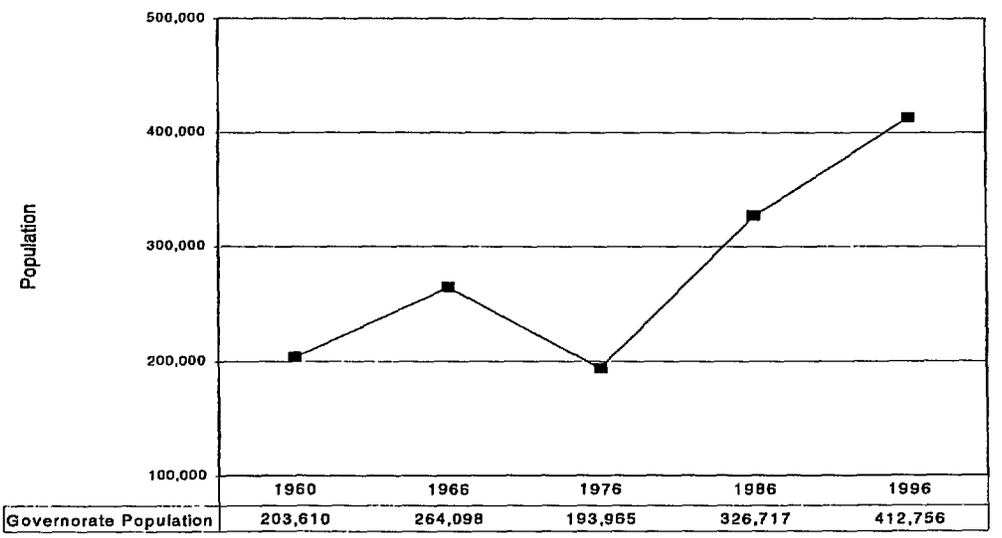
At the time this report was prepared, the final results of the CAPMAS 1996 census had not been published. Yet, because the preliminary results include socioeconomic data relevant to CCMP work, and assuming that the difference between the preliminary and final results would be minor, the adjusted preliminary figures were used in CCMP review of the current socioeconomic conditions in Suez.

2.5.2 Projection Methodology

The methodology of projecting the number of inhabitants from 1996 to 2020 and the potential distribution of population on future development land is summarized in the following steps:

1. Compile historic population data by qism and shiyakha according to CAPMAS National Census data for 1960, 1966, 1976, 1986, and 1996, and according to the Governorate surveys for 1992, 1995, and 1996. These data are presented in Figures V1-2.5, CAPMAS Historical Population Data, and V1-2.6, Suez Governorate Historical Population Data.
2. Project the population of each qism in five-year stages, starting with 1996 and through the years 2000, 2005, 2010, 2015, and 2020. Use the following growth rates in three projection scenarios:
   - Population growth rate from 1986 to 1996 according to CAPMAS Census.
   - Average growth rate for the years 1992, 1995, and 1996 according to the surveys conducted by the Governorate.
   - 1996 growth rate assumed by the Governorate.
3. Compare the results of the three scenarios illustrated in Figures V1-2.7, V1-2.8, and V1-2.9, with the population projections of approved planning studies prepared by official agencies such as the Governorate, NOPWASD, or GOPP, illustrated in Figure V1-2.10.
4. Select the most likely scenario. Ideally this would be the closest to the approved projection described above.

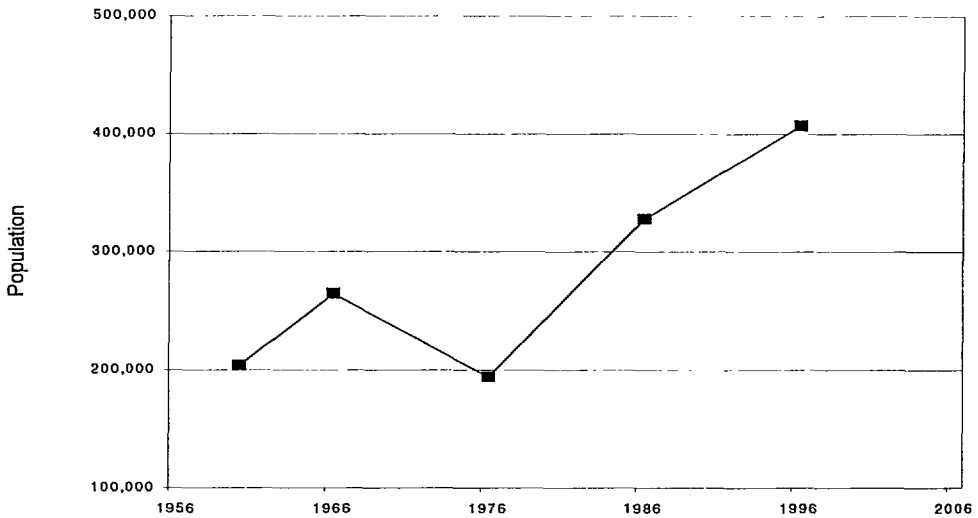
Figure V1-2.5 CAPMAS Historical Population



Source: 1960 – "Statistical Year Book", CAPMAS, June 1964; 1966 – "Statistical Year Book", CAPMAS, June 1970; 1976 "– "1976 General Census Final Results: Suez Governorate," CAPMAS, September 1978; 1986 – "1986 Complete Population Census: Suez Governorate," CAPMAS, June 1988; 1996 – "1996 Census Report for Suez Governorate," CAPMAS, July 1997

54

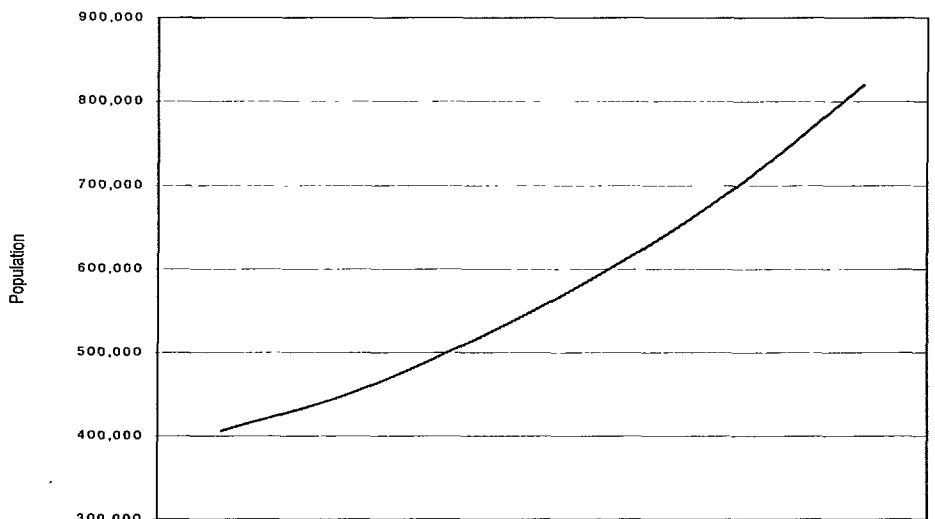
Figure V1-2.6 Suez Governorate Historical Population



	1960	1966	1976	1986	1996
Total Suez City	203,610	264,098	193,965	327,717	406,658

Source: "Suez Governorate Statistical Yearbook," Governorate Information Center, November 1997. No data available for Shortat Mina Al Suez.

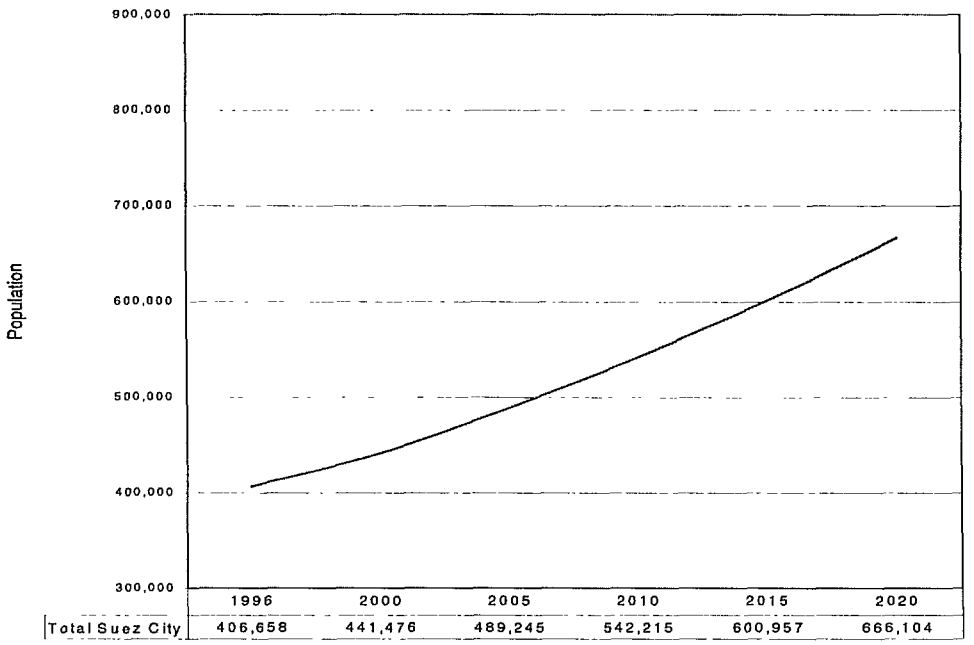
Figure V1-2.7 Population Projection with CAPMAS '86 & '96 Average Growth Rate



	1996	2000	2005	2010	2015	2020
Total Suez City	406,658	451,318	517,574	598,230	697,109	819,123

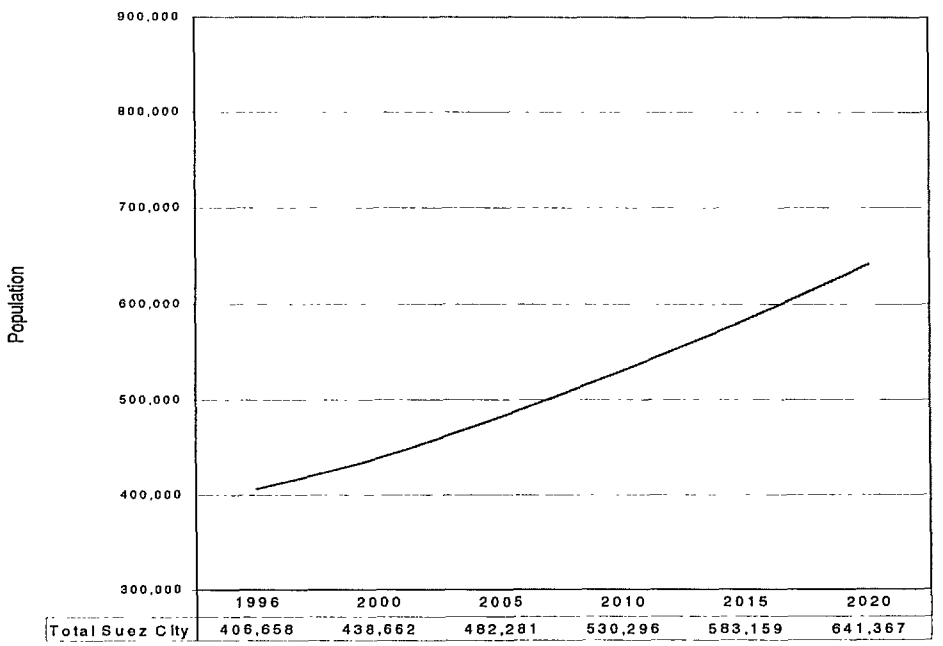
Source: "1986 Complete Population Census: Suez Governorate" CAPMAS, June 1988 and "Finalized Results of 1996 Census Report for Suez Governorate", CAPMAS, July 1997

Figure V1-2.8 Population Projection with Suez '96 Annual Growth Rate



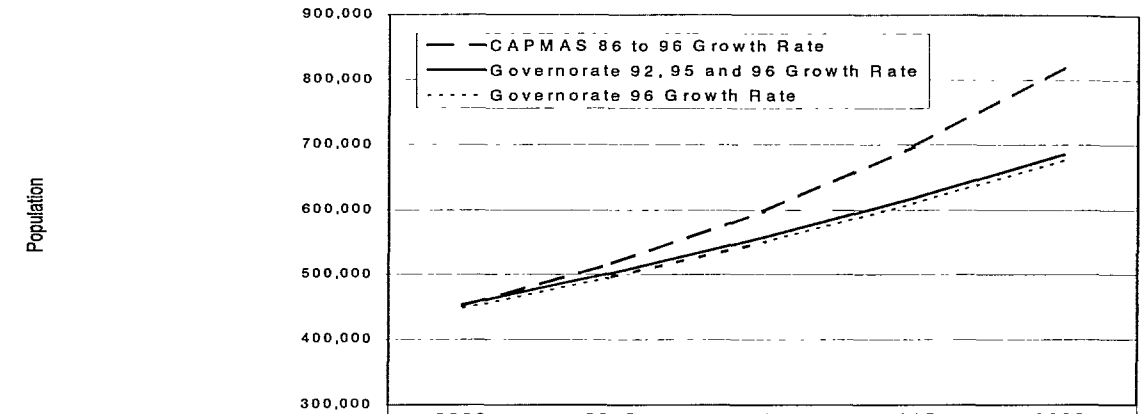
Source: CAPMAS "1996 Census Preliminary Report for Suez Governorate"; 1996 Growth Rate – "Suez Governorate Year Book," Suez Governorate Information Center, November 1997.

Figure V1-2.9 Population Projection with Suez '92, '95 & '96 Annual Growth Rate



Source: 1996 Base – "Finalized Results of 1996 Census Report for Suez Governorate," CAPMAS, July 1997; Average Growth Rates – "Suez Governorate Year Book," Governorate Information Center, Nov. 1997.

Figure V1-2.10 Population Projections from Previous Studies



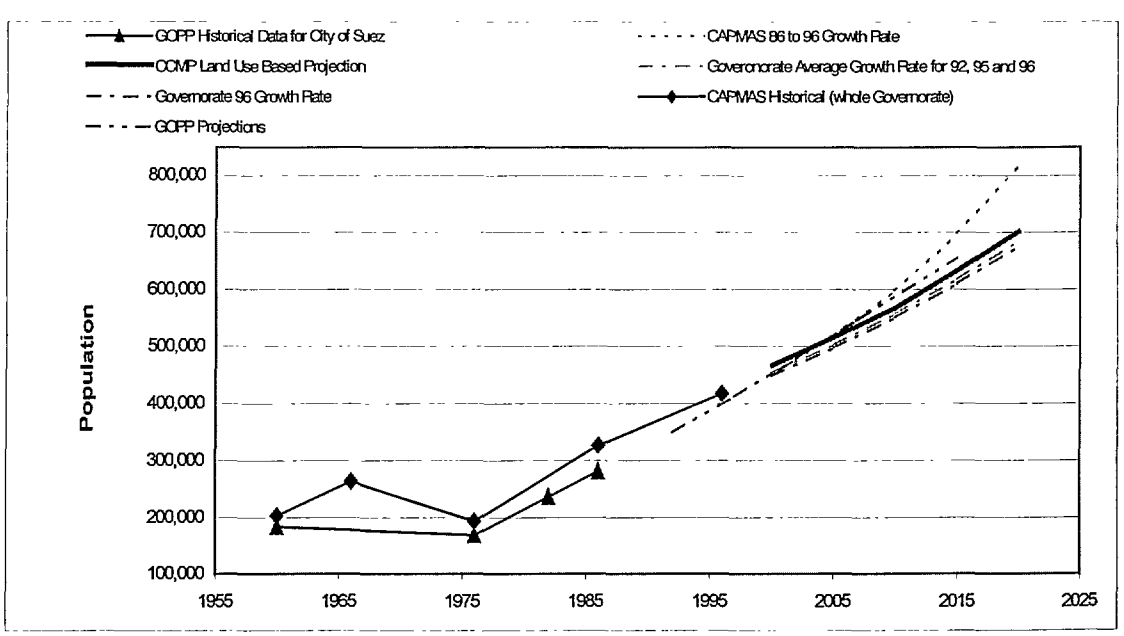
	2000	2005	2010	2015	2020
CAPMAS 86 to 96 Growth Rate	451,318	517,574	598,230	697,109	819,123
Governorate 92, 95 and 96 Growth Rate	453,508	502,750	557,338	617,854	684,941
Governorate 96 Growth Rate	448,098	496,596	550,354	609,979	676,105

Source: GOPP – "Urban Boundaries of Suez City," Ministry of State for New Urban Communities, December 1995; Chemonics Consultants – "Suez Sewer Evaluation Report," May 1995; NOPWASD – "Updating the National Plan for Potable Water and Wastewater, Suez Governorate," 1996.

The selected "most likely scenario" is the projection based on CAPMAS population growth rate from 1986 to 1996. This is the closest to GOPP projection in the official report titled "Study of the Urban Boundaries of Suez" prepared in September 1992.

Figure V1-2.11, CCMP Population Projection, presents line-chart graphical depictions of population projections based on the three scenarios described in Item 2 above.

Figure V1-2.11 CCMP Population Projection



57

2.5.3 Reconciliation of Projected Employment Figures

The Third Region Planning Department and GOPP have conducted comprehensive surveys to analyze the future economic development prospects of Suez and to project the number of new jobs that would be created in the City to the year 2015. The studies have assessed future employment opportunities in the areas of fisheries, industry, mining, services, port and transport, tourism and commercial activities. The results were first published by GOPP in 1995 in a report titled *Suez City Master Plan for the year 2015 – Part 2: Sectors Studies*. The GOPP report projected that in 2015, the total workforce in the City of Suez would reach 188,625, excluding the rural areas of the Governorate.

This figure corresponds with the results of the CCMP population projection, taking into account the following considerations:

- In 1992, the average percentage of the Egyptian workforce, compared to the whole population, equaled approximately 30 percent.
- Taking into account technological progress and mechanization in Egypt, it is predicted that by the year 2015, the average percentage of the workforce compared to the whole population will have gradually increased to 33 percent.

This suggests that the total core population of Suez in 2015 would be about 571,621. Adding to this the projected year 2015 population of the Al Ganayin urban area of 44,626, the total population of the Study Area will be approximately 616,247. The GOPP total is compatible with CCMP figure for the year 2015, which is approximately 633,346, or about 616,000, plus additional available residential areas for about 17,000 people.

2.5.4 Reconciliation of Future Development Plans

The urban growth of Suez follows a Master Plan prepared in 1995 by the Third Region Planning Department and GOPP, with the assistance of an independent consultant team.

The planning period of the Suez City 1995 Master Plan extends to the year 2015. The Plan suggests that by the year 2015, the population of Suez City, excluding the population of Qism Al Ganayin, would reach 656,000, compared to 600,957 by 2015 and 666,104 by 2020 as projected by CCMP. The Plan does not give any specific recommendations concerning development of the existing urban areas of Suez City.

The current growth of Suez City follows the overall land use recommendations of the Suez City 1995 Master Plan concerning new growth urban areas. The growth areas, aside from the existing urban areas, are identified graphically on the map titled *Urban Limits of Suez City: The Approbation of Suez Build-out Area*, issued in January 1994 by the Third Region Planning Department of GOPP. This is the same document that identifies the Study Area Boundary as discussed in Section 2.1.1.

Current development status was evaluated for the overall feasibility of the land use categorizations allocated and assigned for future development by the Suez City 1995 Master

Plan. Subdivisions on which construction work is progressing, as well as subdivisions that are unequivocally allocated for future development, were integrated into the CCMP future Land Use Plans. Including these areas, the land currently being developed or allocated for future residential use would accommodate all the 666,104 people projected by CCMP for the year 2020, as well as an additional 35,330 people.

Recommendations to exclude land assigned for urban growth in the Suez City 1995 Master Plan, but not yet allocated for residential use, are discussed further in Section 2.6.

2.6 Land Use Projections

2.6.1 Variations to Residential Area Population Distribution

Through analysis of overall existing urban conditions, urban development trends, current net residential densities, and experience in similar municipal areas, projections were made to determine the following:

- Future Net Residential Densities of existing residential areas.
- Future Net Residential Densities of future development areas.
- Ultimate rate of housing occupancy, or the highest Net Residential Density, in future development areas.

The future land use plan presents the land use and residential densities in year 2020 based on low housing occupancy rates. The low occupancy housing rate methodology assumes that new housing developments would have occupancy rates equivalent to 70 percent of their maximum capacity. Ultimate condition assumes new housing developments would have a maximum occupancy rate equivalent to 100 percent of their capacity.

Ultimate conditions in the study area will occur after 2020 (or before, if there is a variation to the projected population due to unforeseen factors such as gain in employment rates or change in the prevailing rate of housing occupancy).

The low occupancy rate rationale for new housing developments reflects the following considerations:

- Low housing occupancy rate is generated by widespread real estate speculation. Speculators purchase apartments or individual residences and keep them vacant, assuming their market value will increase. Some may refrain from renting them to avoid leasing regulations that give near-ownership rights to the tenants. Others would buy apartments or houses for their young children and keep them unused for many years until the beneficiary son or daughter marries and becomes the occupant.
- Low housing occupancy rate reflects high market demand for affordable housing. In other terms, it reflects an excess supply of unaffordable housing produced by developers in both private and public sectors. They cater mainly to high revenue clientele in the formal housing sector. The high sale price of the residential units remains out of reach for the majority of low-income Egyptians. Therefore, the newly

built residential units may remain vacant or unfinished for long periods before being sold.

- Low housing occupancy rate is encouraged by the low property taxes imposed on housing in Egypt.

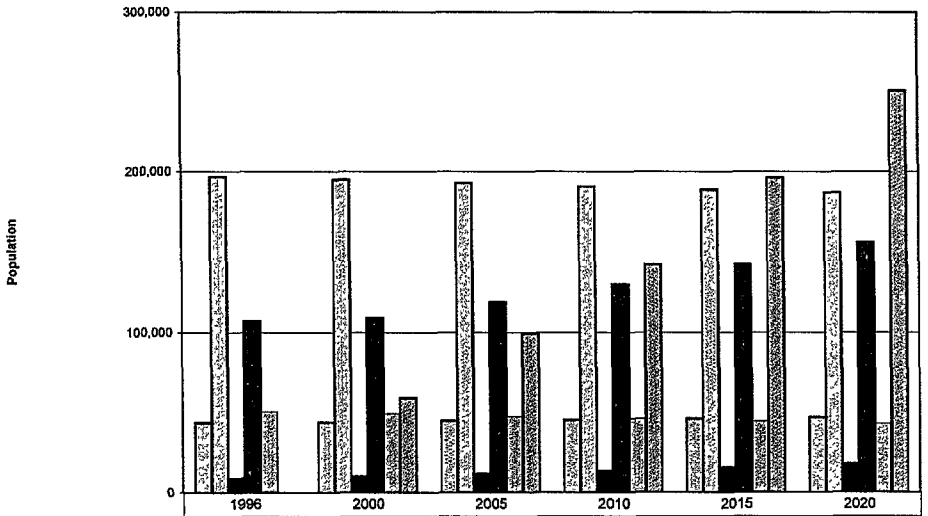
Working with Governorate officials, an evaluation was conducted according to the following steps:

1. Review and make recommendations regarding approved urban and economic development plans undertaken by central and local governmental authorities.
2. Select the most appropriate location and calculate the land area needed to accommodate additional population until the year 2020.
3. Distribute the additional population projected for the year 2020 among existing urban areas and selected future development land.
4. Stage population increases in five-year increments (2000, 2005, 2010, and 2020) as required.

Figure V1-2.12, Projected Population by Qism presents in bar graph form the projected population by Qism. Figure V1-2.13, Suez 2020 Land Use, presents the projected land use in the year 2020, and Figure V1-2.14, Suez Ultimate Land Use, presents the land use for ultimate conditions.

The CCMP land use is based on these projections and should be reviewed periodically for any changes in the projections, staging, or distribution.

Figure V1-2.12 Population by Qism



	1996	2000	2005	2010	2015	2020
Al Suweis	43,590	44,124	44,807	45,511	46,234	46,977
Al Arbaein	196,770	194,997	192,847	190,767	188,756	186,811
Ataqa	8,875	9,962	11,509	13,297	15,363	17,750
Faysal	106,755	108,904	118,723	129,739	142,098	155,964
Al Ganayin	50,666	49,330	47,709	46,142	44,626	43,160
Future Development		59,057	99,442	141,934	196,268	250,772

Cairo - Suez Road
Industrial Road
Suez - Ismailia Road
Suez Sweetwater Canal
WTP
Sinai
Gulf of Suez
Port Tawfik
Suez Canal
WWTP
LEGEND
Study Area Boundary
WWTP- Wastewater Treatment Plant
WTP- Water Treatment Plant
SUEZ 2020 LAND USE
Agricultural Land
Beach Setback
Cemetery
Commercial - Office & Gov'l
Commercial - Tourism
Educational Facilities
Future Development
Industrial - Low Water Use
Industrial - Moderate Water Use
Irrigated Parks & Open Spaces
Military Camps
Residential - High Density
Residential - Low Density
Residential - Very Low Density
NOTE Land use categories shown represent average densities derived from GOPP land use maps
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ARAB REPUBLIC OF
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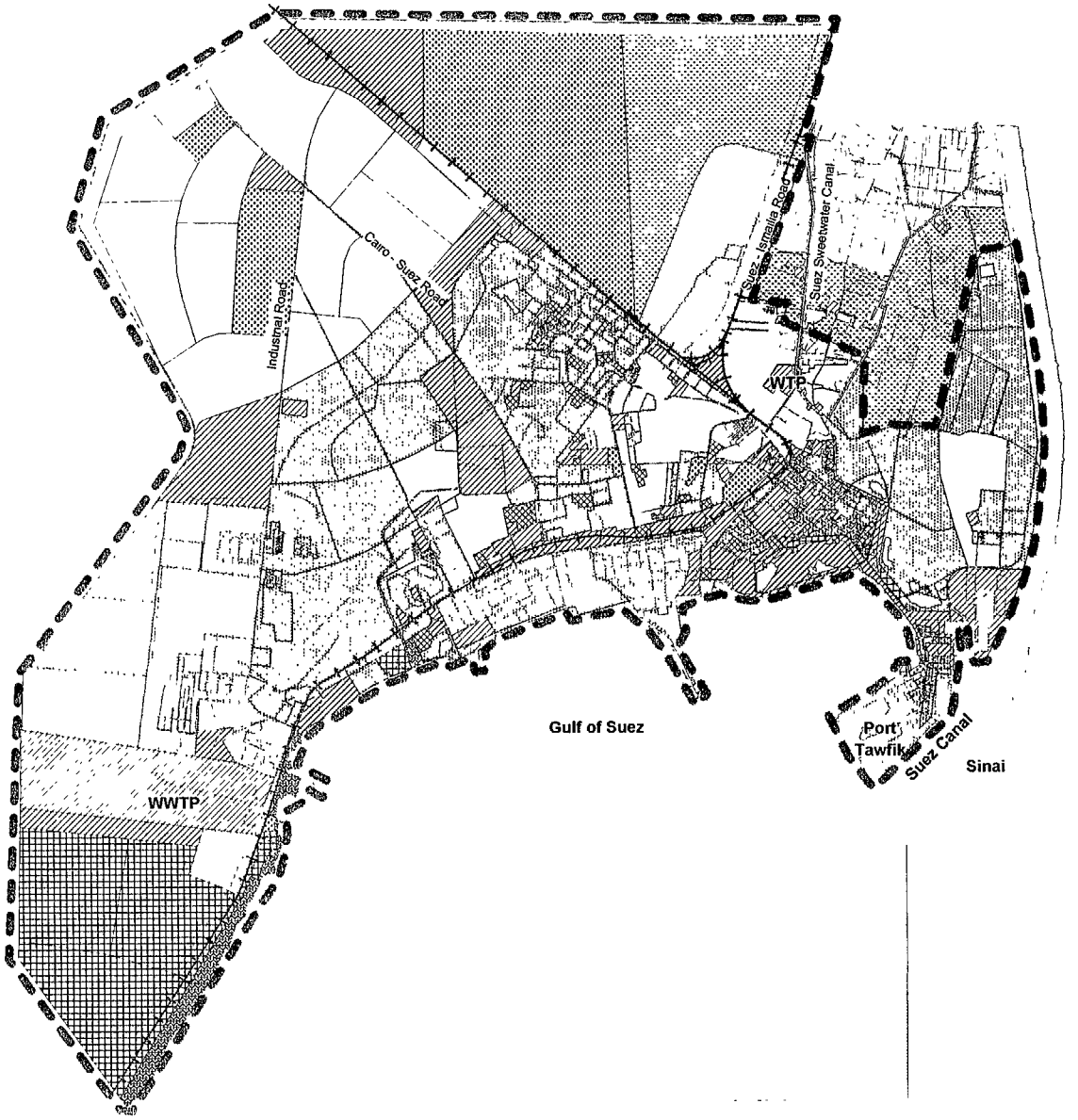
SUEZ 2020 LAND USE
DATE AUGUST 1999
FIGURE V1-2 13



LEGEND

Study Area Boundary

WWTP- Wastewater Treatment Plant

WTP- Water Treatment Plant

SUEZ ULTIMATE LAND USE

- Agricultural Land
- Beach Setback
- Cemetery
- Commercial - Office & Gov't
- Commercial - Tourism
- Educational Facilities
- Industrial - Low Water Use
- Industrial - Moderate Water Use
- Irrigated Parks & Open Spaces
- Military Camps
- Residential - High Density
- Residential - Low Density
- Residential - Very Low Density

NOTE Land use categories shown represent average densities derived from GOPP land use maps

N

ARAB REPUBLIC OF
EGYPT

USAID

MAP NAME
SUEZ ULTIMATE LAND USE

DATE AUGUST 1999 FIGURE V1-2 14

2.6.2 Variations to Other Land Use Area

Planning for all other land use categories is assumed to remain approximately the same as at present or to follow the current growth and development trends.

2.6.3 Development of Water and Wastewater Planning

With the creation of land use areas for existing conditions, and the projections and staging of population growth, future land use areas could be developed to coincide with the projected development. This information was entered into computer databases developed for electronic mapping of the study area.

MapInfo, a Geographic Information System (GIS) software program, was selected for this work because it can accommodate multiple layers of information on one base map. Utilizing GIS, water and wastewater planning can be developed for the CCMP project and added to the same database of information.

2.6.4 Proposed Modifications to Development Plans

Previous master plans or land use plans have allocated more land than needed to meet the anticipated population. As noted in Section 2.5, most of the subdivisions programmed in the Governorate's expansion scheme have been integrated into CCMP future land use plans. Some subdivisions have not been incorporated into CCMP plans and they are identified in Table V1-2.9, Suez Subdivisions Recommended for Relocation. Although these proposed changes have little or no impact on water and wastewater capacity needs they should be evaluated to preserve and foster green areas, agricultural areas and recreational areas.

Table V1-2.9 Suez Subdivisions Recommended for Relocation

District	Sub-divisions	Location Proposed by Suez City Master Plan	Recommended Reallocation or Use
1	1, 2 and 3	Along the Suez Canal	Cultivated area
1	4	Along the Suez Canal	Recreational green area
1	5 and 6	East of Suez along the Suez Canal	Low density development after 2020
6	1	Eastern part of subdivision 1, Qism Faysal	Recreational green area
7	5	Western part of subdivision 5, Qism Faysal	Recreational green area

2.7 General Recommendations

The following recommendations are suggestions to improve and, whenever judge feasible, to modify the provisions of the Governorate development plans:

1. The Suez land use plan used for this master plan should be used by Governorate Authorities. If deviations from the land use plan occur appropriate measures should be taken by the utilities to modify infrastructure to meet the revised development needs.
2. Other land use principles that are anticipated in this master plan are listed below. Changes to this land use approach would result in changes to infrastructure needs and should be dealt with by utility planners.

- The amount of land assigned for development in the 1995 Suez City Master Plan exceeds the amount of land required to accommodate the projected year 2020 population in CCMP land use plan. As noted in Section 2.6.4 Proposed Modifications to Development Plans and as reflected in Table V1-2.9, Suez Subdivision Recommended for Relocation this excess land should be preserved as recreational, green or agricultural land.
- Urban growth in Ataqa and Faysal should continue westward, away from agricultural land. The strip of land along the Suez Canal should continue to be cultivated or used as public recreational area.
- The growth of Suez should be oriented toward the Gulf of Suez waterfront. The Land Use Plan proposes the creation of a public recreational area that would end the long-standing practice of using the land along the Gulf's shores exclusively for industrial purposes. The City could border the waterfront with much-needed landscaped recreational grounds and lagoons. The environmentally friendly and construction-free Corniche and beaches would extend south along the coastal road leading to Al Adabiyya. This would reverse the City's image as an industrial, gloomy center and would help promote it as destination for local tourism.
- To further enhance the City's image and to compensate for the lack of public areas in Qisms Al Arbaein and Suez, the conversion of several ponds near Port Tawfik low-density residential zones into lagoons surrounded by public playgrounds is also recommended.

3. Population growth should be monitored regularly and utility development adjusted accordingly.
4. Utilities and government agencies should form joint committees to monitor land development and communicate regularly on changing utility needs.

End of Chapter 2: Physical Conditions, Land Use and Population

3.0 Water Demands

This section describes current and projected water demands. The future water demands are based on land uses which have a treated water demand with a water use factor applied.

3.1 Water Demands Methodology

A land use based approach was used to distribute the existing and projected future water demands. This approach starts with the development of electronic maps of existing land uses and future land uses and builds on the information in Section 2, Physical Conditions, Land Use, and Population. Land use categories were identified which reflect differing consumption patterns. For example, the various residential land use categories selected reflect existing and projected population density ranges. A water use factor, or land use unit demand, in cubic meters per day per square kilometer ($m^3/d/km^2$), was developed for each existing land use category. The use factors were based on metered water consumption data or data from other cities with similar consumption characteristics. System-wide estimates of unaccounted-for water (UFW) were prepared and applied to each of the water use factors.

The water use factors were applied to the land use areas, called polygons, using the Geographic Information System (GIS), an electronic mapping and database tool. By applying the water use factors to the appropriate areas of each land use, it is possible to calculate a water demand. This calculated water demand was compared with water treatment plant production estimates. The water use factors were adjusted until the calculated demands matched the production estimate. Using GIS, demands were then calculated by "nodal polygon areas" or areas assigned to specific hydraulic model nodes and input to the model. The allocation of the water demands to specific model nodes is discussed further in Section 7.

The adjusted *existing* water use factors were used as the starting point for *future* water use factors. Assumptions were made as to how consumption patterns may change in the future, and the future water use factors were adjusted to reflect the assumptions. The future water use factors were then applied to the electronically mapped future land uses using GIS to generate projected demands.

A land use based approach, versus either a per capita consumption approach, an estimate of number of accounts per model node, or a socio-economic modeling approach, was chosen as the method for determining demands to be input to the hydraulic model. This approach was chosen for CCMP because, based on experience with similar municipal settings, it produces more accurate results than the other approaches, and a sustainable product was developed which could be easily updated in the future.

Additional benefits of the land use based approach for CCMP include the following:

- The land use based approach results in a greater accuracy. With greater model accuracy, there is less field work required to calibrate the model, and the system improvements resulting from the model analyses reflect more accurate conditions.

- This approach was based on the utilization of electronic maps and spreadsheets that graphically present the data developed and the assumptions made. This clear and revealing process ensures that future system updates could be based on updated data rather than on creating a new database. In addition, the electronic files can in the future be converted to different GIS and hydraulic model software, if needed.
- The land use based approach is a cost-effective method of providing realistic data when actual consumption records are incomplete or not available.
- Hydraulic models require spatially or geographically distributed demands to represent actual distribution system conditions. Only the land use based approach utilizes an efficient method which results in accurate, spatially distributed demands.
- Land uses have different consumption patterns that can be represented by applying the appropriate water use factors.
- This approach gives water purveyors an opportunity to check the assumptions (existing and projected land uses, boundaries, population densities, phasing of development, etc.) by reviewing maps.
- The resulting demands are presented in Table V1-3.1, Suez Existing and Projected Demands. The data developed, the assumptions made, and the resulting demands are described in the following sections.

3.2 Development of Existing Demands

Existing water demands were developed by identifying existing land uses and the associated water demands, and then applying water use factors to these areas. The demands were developed by nodal polygon areas assigned to specific hydraulic model nodes. These steps are described below.

3.2.1 Existing Land Uses

As described in Section 2, a list of land use categories was developed to reflect typical land use patterns within the study area. Similar water use areas were grouped and assigned to the appropriate categories. The land use categories are listed in Table V1-3.2, Suez Land Use Categories.

Residential land use categories were based on existing ranges of population densities per square kilometer within each qism or shiyakha. Industrial categories reflect typical water consumption requirements. For example, storage yards, warehousing, and distribution uses were grouped together because of their low water use; manufacturing has a higher use; and the highest industrial water users were individually identified based on high water user data provided by the SCA.

Table V1-3.1 - Existing and Projected Demands - Suez

Land Uses	Existing Area (km^2)	Existing Factors ($m^3/d/km^2$)	Existing Demands (m^3/d)	2020 Area (km^2)	2020 Factors ($m^3/d/km^2$)	2020 Demands (m^3/d)	Ultimate Area (km^2)	Ultimate Factors ($m^3/d/km^2$)	Ultimate Demands (m^3/d)
Residential - Very Low	1.28	4700	6,016	23.97	5170	123,925	16.56	5170	85,615
Residential - Low	7.50	7500	56,250	12.46	8250	102,795	20.96	8250	172,920
Residential - Medium	0.00	0	0	0.00	0	0	0.00	0	0
Residential - High	5.64	10450	58,938	5.69	12020	68,394	5.69	12020	68,394
Residential - Very High	0.00	0	0	0.00	0	0	0.00	0	0
Office and Government	4.79	2800	13,412	5.24	2800	14,672	5.57	2800	15,596
Tourism	0.22	1200	264	0.68	1440	979	0.68	1440	979
Industrial - Low Water Use	4.63	100	463	13.34	200	2,668	13.34	200	2,668
Industrial - Moderate	0.00	500	0	6.67	2500	16,675	6.67	2500	16,675
Military	9.44	100	944	9.45	100	945	9.45	100	945
Educational Facilities	0.90	700	630	0.85	700	595	0.82	700	574
Irrigated Parks/Open Space	1.72	1500	2,580	10.39	1500	15,585	10.45	1500	15,675
Unique Water Uses	5.89		20,320	5.89		20,320	5.89		20,320
Agricultural Land	0.42	0	0	1.64	0	0	1.64	0	0
Beach Set-back	0.64	0	0	0.57	0	0	0.57	0	0
Cemetery	0.25	0	0	0.55	0	0	0.55	0	0
Future Development	5.91	0	0	0.00	0	0	0.00	0	0
Water Bodies	0.00	0	0	0.22	0	0	0.22	0	0
Total Area	49			98			99		
Total Demands			**159,800**			**367,600**			**400,000**

67

Table V1-3.2 Suez Land Use Categories

Categories	Residential Population Density (p/km^2)
Residential – Very Low Density	(< 20,000)
Residential – Low Density	(20,000-30,000)
Residential – Medium Density	(30,000-45,000)
Residential – High Density	(45,000-65,000)
Residential – Very High Density	(> 65,000)
Office and Government	-
Tourism	-
Industrial – Low Water Use	-
Industrial – Moderate Water Use	-
Educational Facilities	-
Irrigated Parks and Open Spaces	-
Unique and High Water Users	-

Land use areas, or polygons, were identified based on a detailed review of land use and street maps as described in Section 2. An electronic map was prepared and the land use polygons were digitized and applied to the map. Areas with unique and high water uses were identified and polygons created for each individual use. Windshield surveys were conducted to confirm the land uses.

3.2.2 Existing Water Use Factors

Annual metered consumption data representing typical characteristics of several of the land use categories were provided by SCA in October 1998 for specific land areas. Where actual consumption data were not available, previous master plans were reviewed for historical water use. Water use factors were developed from the historical and available current data and adjusted to reflect existing land use categories with densities expressed on a per km^2 basis.

For example, most of the consumption data from previous studies were available on a per capita unit. The data were not disaggregated enough to use in a model to accurately represent system conditions. To correct the data for use in the model, billing information for representative residential accounts was obtained, the area of coverage for these accounts was determined, and the population information was obtained from CAPMAS and the Governorates. An estimate of consumption per person and per square kilometer was derived from this data for the various residential densities used for the mapping. For comparison, an analysis of consumption per person, using the above approach, applied to various residential densities[1] and income[2] levels, was also performed. There appeared to be a correlation between population density and income: the higher the income, the lower the density. Water

[1] Source: CAPMAS.

[2] Source: 1979 Canal Cities Master Plan.

use factors were then developed for the average density of each land use polygon and adjusted slightly to reflect income influences (e.g., the very low density residential use factor was proportionally higher than the high density residential use factor).

To provide greater accuracy for these average water use factors and for the distribution of existing demands, high water users were represented as unique uses. Actual consumption data for high water users were obtained; their locations were mapped and labeled individually as their own land use polygons. These annual consumption totals were removed from the average use factors, and utilized for each of the unique polygons.

3.2.3 Unaccounted-for Water Estimates

Unaccounted-for water (UFW) estimates represent distribution system leaks, hydrant use, main flushing, and other unmetered system uses. UFW typically represents the difference between water treatment plant production and total metered consumption. Most of the treated water flowmeters are not operational; therefore, an accurate comparison of treated water production with consumption is not possible. Also, some pumps are operated below their design heads so that they are actually pumping more than their rated capacities.

Previous reports reviewed for UFW estimates indicated that a difference of about 35 percent between production and consumption is typical, although the Central Accounting Agency estimates that only approximately 21 percent of the water produced is UFW. The 35 percent was used in developing water demands for this study. This UFW estimate was included in the development of water use factors for all land use categories, except high water users. The advantage of using the land use based approach is that there is no need for actual data indicating the UFW. The UFW is imbedded into the demands. If a lower UFW is used, then the water use factors would increase to match the production.

A leak detection program was conducted as part of this study. Approximately 10 percent of the water distribution network in each city was surveyed for leaks. Findings indicate that less than 2 percent of daily production is being lost through leakage. This observation leads to the assumption that the majority of UFW is due to leakage in the plumbing fixtures of residential and commercial buildings, unmetered uses in governmental and military buildings, and other public uses which are not metered.

3.2.4 Calibration of Derived Demands

Using GIS, the area of each land use polygon was calculated. Water use factors were applied to each land use polygon to determine total system demands. Water use factors for primary land uses were then adjusted until the derived demands matched the treatment production estimates. The resulting derived demands were calibrated to within 1 percent of the actual production records. The resulting water use factors are presented in Table V1-3.3, Suez Existing Water Use Factors.

Table V1-3.3 Suez Existing Water Use Factors

Land Use Category	$m^3/d/km2$
Residential – Very Low Density	4700
Residential – Low Density	5900
Residential – Medium Density	8000
Residential – High Density	10000
Office and Government	2800
Tourism	1200
Industrial – Low Water Use	100
Industrial – Moderate Water Use	500
Military	100
Educational Facilities	700
Irrigated Parks and Open Space	1500
Unique and High Water Users (1)	-

Notes:
(1) Each unique and high water user has its own use factor.

3.2.5 Distribution of Demands

As a part of the model development, distribution system demand nodes and nodal polygons representing the areal extent of demand distribution influence of each node were identified. Model demand nodes and their respective nodal polygons were defined by system characteristics such as piping configurations, high water users, and proximity to other nodal polygons. Using GIS, the nodal polygons were overlaid on the land use polygons to calculate the area of each land use within each nodal polygon. Water use factors were applied to the land use polygons to determine the total average daily demands (ADD) associated with each distribution system demand node. The data were then input to the hydraulic model.

3.3 Development of Future Demands

Development of future demands relied on identification of planned future land uses which have treated water demands, with a water use factor applied. Similar to the existing demands analysis, the future demands were summarized by nodal polygon areas, which were those areas assigned to specific hydraulic model nodes. Future demands were developed for 2020 and ultimate conditions, as described below.

3.3.1 Future Land Uses

Areas with development plans or development potential were identified and mapped. This included growth areas on the fringes of urban areas, large undeveloped lands surrounded by urban uses, and areas of anticipated increased densities and occupancy.

The land use categories identified in Table V1-3.2 were also utilized for future land uses. As described in Section 2, population projections were analyzed for their relationship to land use categories. The population estimates were first distributed according to a fuller utilization of existing dwelling units, followed by allocating the remaining population to new

development. Therefore, residential densities in some sections of each city are anticipated to increase in the future, resulting in a higher density land use category for future conditions.

Many newly developed residential areas are not expected to be fully occupied by year 2020. It was assumed that these new developments would be 70 percent occupied by 2020 and a new planning horizon of "ultimate" or "build-out" would reflect 100 percent occupancy. This new ultimate planning horizon was developed to reflect full build-out.

3.3.2 Future Water Use Factors

Water use factors for existing conditions, presented in Table V1-3.3, were reviewed and adjusted for future conditions: 2020 and ultimate. It was assumed that the existing residential use factors would decrease slightly, by about 5 percent, by 2020. The decrease is attributed to the implementation of water conservation programs, improved meter reading, leak detection and repair, and pipe replacements.

However, this decrease is offset by increased water consumption per land use category as the Egyptian economy continues to improve. Experience indicates that higher standard of living results in higher per capita water consumption. A 10 to 20 percent increase over existing demands was incorporated into the future demands to accommodate an increase in water using appliances and less sensitivity to cost. Some land uses, such as tourism and industry, are anticipated to increase consumption on a per square kilometer basis due to infill and increased densities resulting from urbanization. Table V1-3.4, Suez Future Water Use Factors (2020 and Ultimate), presents the future water use factors used for the demand projection analysis.

Table V1-3.4 Suez Future Water Use Factors (2020 and Ultimate)

Land Use Category	$m^3/d/km^2$
Residential – Very Low Density	5170
Residential – Low Density	6490
Residential – Medium Density	9600
Residential – High Density	11500
Residential – Very High Density	0
Office and Government	2800
Tourism	1440
Industrial – Low Water Use	200
Industrial – Moderate Water Use	2500
Military	100
Educational Facilities	700
Irrigated Parks and Open Space	1500
Unique and High Water Users (1)	-

Notes:
(1) Each unique and high water user has its own use factor.

3.3.3 Future Demands

Future demands were calculated in the same manner as existing demands. Using GIS, the area polygons were calculated for each future land use, and water use factors were applied to each set of land use areas to determine total system demands. These demands were also calculated on a nodal polygon basis for use in the hydraulic model. The results of the analysis of the 2020 and ultimate water demand projections by land use category are also presented in Table V1-3.1.

3.3.4 Phasing of Future Demands

It was assumed that the non-residential growth rate would parallel the population growth rate through year 2020. The residential growth curve was presented in Section 2. Applying this growth rate to the current demands results in 5-year incremental water demands to year 2020, presented as recommendations in Table V1-3.5, Suez Interim Water Demands.

Table V1-3.5 Suez Interim Water Demands

Year	Demands (m^3/day)
Current (1)	159,800
2000 (2)	188,600
2005 (2)	222,500
2010 (2)	262,600
2015 (2)	312,400
2020 (3)	367,600
Ultimate (3)	400,000

Notes:
(1) Estimated current (about 1997) system demands; distributed and calibrated based on an analysis of land uses and water use factors.
(2) Estimated from growth rate curve.
(3) Based on an analysis of future land use and water use factors.

These incremental demands were used in determining the timing of need and phasing, if required, of future water system facilities. The ultimate demands were used in sizing pipelines, hydraulic structures, treatment plant sites, and other related facilities.

This Master Plan analysis of demands provides future demands based on today's conditions and anticipated future conditions. Changed conditions which could increase the total future demands include additional intensification of land uses beyond that estimated here.

End of Chapter 3: Water Demands

4.0 Existing Water Treatment Facilities

The water treatment facilities and distribution systems in the City of Suez are owned and operated by the Suez Canal Authority (SCA). During the 1967 to 1973 hostilities, shelling destroyed much of the infrastructure of the City, including the water treatment and supply facilities. In 1979, a Water Facilities Master Plan was completed for the City. Since 1980, SCA has made significant improvements to the existing systems based primarily on the recommendations of the 1979 Water Facilities Master Plan. In general, SCA has succeeded in providing safe and adequate water to the ever-growing population in the City. SCA also has plans to expand the water treatment facilities and distribution systems to meet anticipated future demands.

4.1 Raw Water Supply

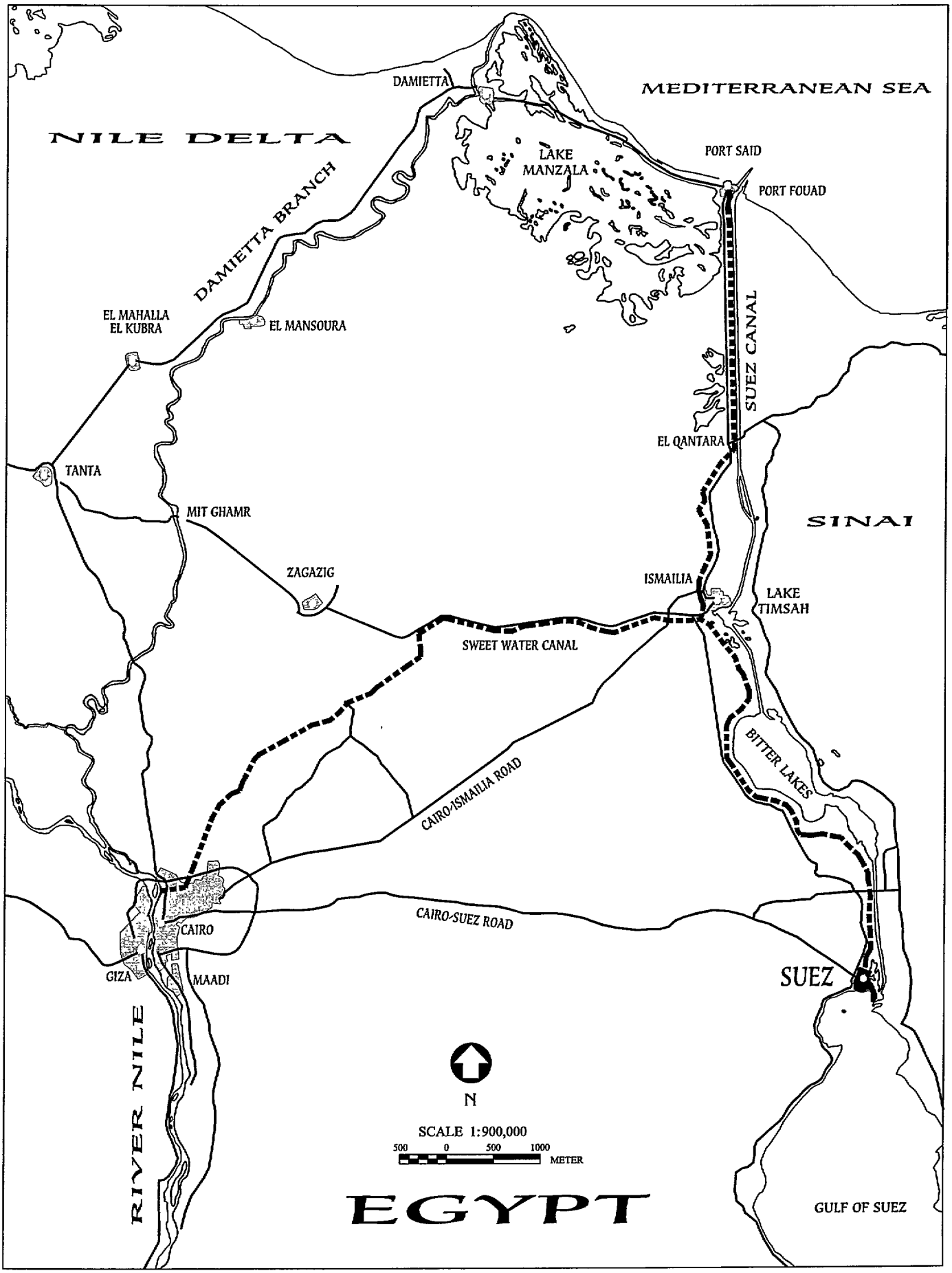
The City of Suez obtains its raw water supply from the Sweetwater Canal, which extends from the Nile River north of Cairo and flows northeasterly to Ismailia, a distance of about 135 km. A southerly branch of the Sweetwater Canal conveys water to Suez. The route of the canal is shown on Figure V1-4.1, Suez Raw Water Supply. Results of analyses on water samples taken from several points in the Ismailia, Port Said, and Suez branches of the Sweetwater Canal during January to June 1997, are included in Appendix V1-4.1.

The amount of water in the canal is controlled by releases from the Aswan Dam into the Nile River. The Ministry of Irrigation (MOI) controls the release of the water in accordance with irrigation needs. According to the MOI, the current total water allocation for the three canal cities for domestic use is 930,000 m^3/d, as follows: Ismailia – 330,000 m^3/d, Suez – 340,000 m^3/d, and Port Said – 260,000 m^3/d. According to the MOI, these allocations represent only 10 percent of the total water needs (potable, industrial, and irrigation) of the whole region, and MOI's first priority is to meet the domestic water needs of the three cities.

In a letter to the MOI, SCA indicated that the future potable water requirements of the three Canal Cities will be 1,205,000 m^3/d for year 2005 and 1,645,000 m^3/d for year 2017. A copy of this letter is included in Appendix V1-4.2. According to the MOI, the amount of water for domestic use allocated for the three cities through year 2017 is 1,900,000 m^3/d. This is about 16 percent more than the SCA 2017 water requirement of 1,645,000 m^3/d.

At present, the Suez Water Treatment Plant draws up to a maximum of 230,000 m^3/d of raw water during the summer months. This is well within the current water allocation for Suez of 340,000 m^3/d. Suez's future raw water requirements of 460,000 m^3/d in year 2005 and 600,000 m^3/d in year 2017 are also within the allocation.

However, SCA reports that for several days during summer, the water level in the Sweetwater Canal has fallen to the point where treatment plant production had to be reduced. In these cases, use from the canals by the SCA was significantly less than 230,000 m3/d. The



ARAB REPUBLIC OF **EGYPT** SUEZ CANAL AUTHORITY NATIONAL ORGANIZATION FOR POTABLE WATER AND SANITARY DRAINAGE	**USAID** CANAL CITIES WATER AND WASTEWATER MASTER PLAN	BLACK & VEATCH INTERNATIONAL IN ASSOCIATION WITH MONTGOMERY WATSON SABBOUR ASSOCIATES	SUEZ RAW WATER SUPPLY DATE: AUGUST 1999 FIGURE:V1-4.1

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eventual operation of Bamag 180 will increase the total raw water intake from the Sweetwater Canal by 200,000 m3/d. The capacity of the Sweetwater Canal to deliver water to Suez is limited both by its cross-sectional area and by culvert-type obstructions. These sections of the Suez branch of the Sweetwater Canal should be enlarged to increase its carrying capacity and provide the needed water to Suez.

CCMP projected water use by the Suez WTP is summarized in Table V1-3.5 and shown graphically on Figure V1-8.1, Treatment Capacity versus Water Demands.

4.2 Treatment Processes

The Suez Water Treatment Plant consists of four filtration trains: Bamag 90, Bamag 45, CTE (Group 4), and Bamag 180. The Bamag 180 is being commissioned. After Bamag 180 is operational, the CTE treatment train which was built by the French contracting firm of Compagnie Europeene de Traitement des Eaux (CTE), will be taken out of service for rehabilitation. Raw water enters each treatment train through individual intakes on the Sweetwater Canal. The existing plant site layout is shown on Figure V1-4.2, Suez Water Treatment Plant Site Layout. The four process trains are described below. Each treatment train functions independently from the others, each with its own raw water and treated water pumping stations. The chemical doses are the same for the three currently operating trains and will presumably be the same for Bamag 180. Alum dose is 30 mg/L. A chlorine dose of 4 mg/L is divided between pre-chlorination and post-chlorination at the inlet to the treated water storage tanks. Clarifier solids and spent filter backwash water are discharged to the local sewer system.

The old slow sand filtration trains, referred to as Group 1, Group 2, and Group 3, have been removed from service. Group 1 was removed from service approximately seven years ago, and some of the equipment is still in place. Its circular storage tank is used for storing treated water from the Bamag 45 treatment train. The Group 2 slow sand filters and circular storage tank have been replaced with two rectangular storage tanks for the Bamag 45 treatment train. The Group 3 circular storage tank is also used for storing treated water for the Bamag 45 treatment train. Other components of the Group 3 treatment train have been replaced with grass and garden areas.

A summary of the primary design parameters is given in Table V1-4.1, Primary Design Parameters – Suez Water Treatment Plant. The process trains are illustrated in Figure V1-4.3, Process Flow Diagram –Suez Water Treatment Plant.

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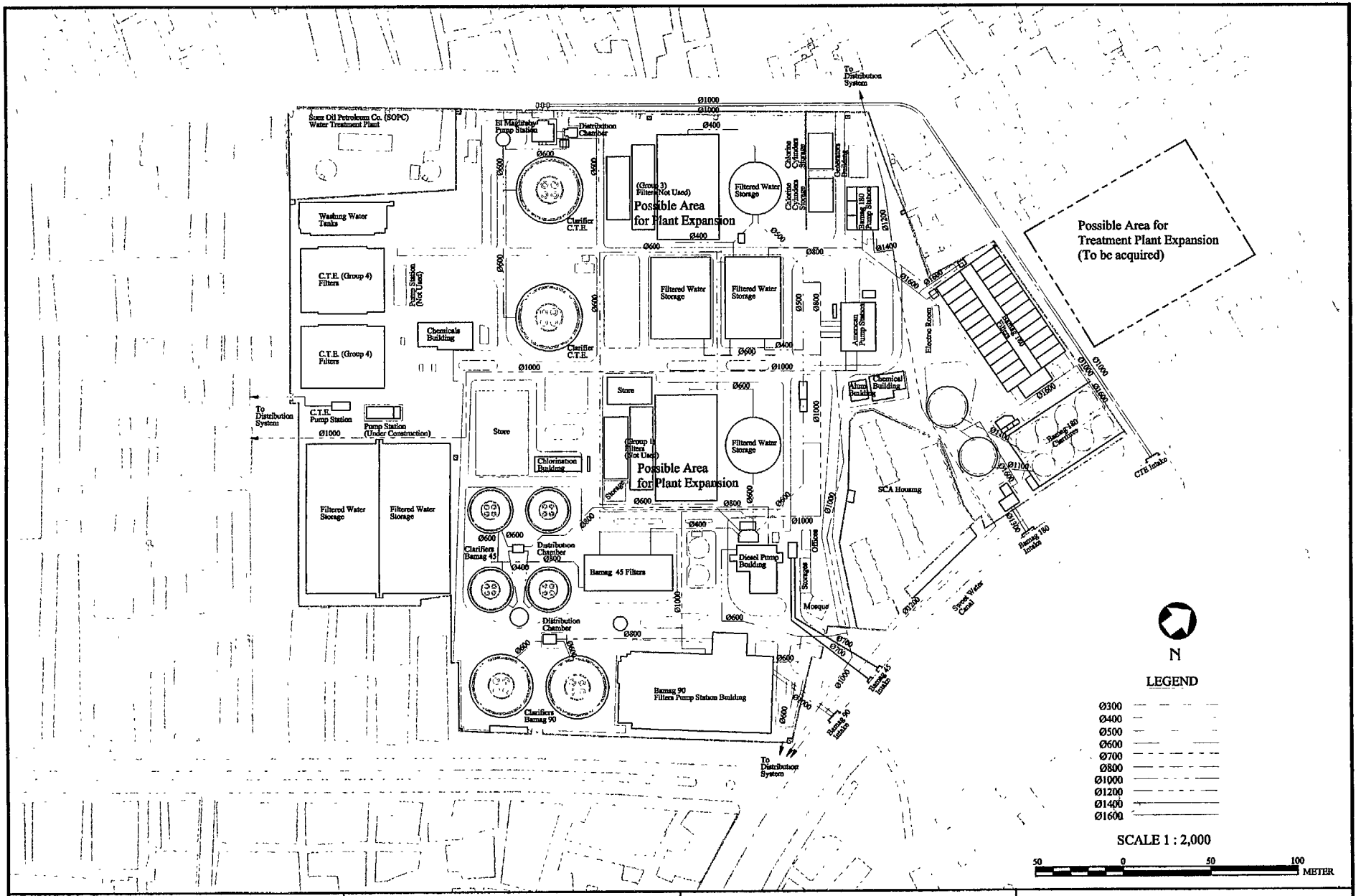

ARAB REPUBLIC OF **EGYPT** SUEZ CANAL AUTHORITY NATIONAL ORGANIZATION FOR POTABLE WATER AND SANITARY DRAINAGE	**USAID** CANAL CITIES WATER AND WASTEWATER MASTER PLAN	BLACK & VEATCH INTERNATIONAL IN ASSOCIATION WITH MONTGOMERY WATSON SABBOUR ASSOCIATES	**SUEZ** **WATER TREATMENT PLANT** **SITE LAYOUT** DATE: AUGUST 1999 FIGURE: VI-4.2

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Table V1-4.1 Primary Design Parameters-Suez Water Treatment Plant

Category	Design Value	Units	Type	Bamag 45	Bamag 90	CTE	Bamag 180
Circular Clarifier (Set 1) (1)							
Flocculator Detention Time	20	minutes	Typical	20	21.9	32	n/a
Loading Rate	44.0	m^3/m^2d	Maximum	51.9	28.9	31.0	n/a
Detention Time	2	hours	Typical	4.6	8.3	7.8	n/a
Weir Loading Rate	358	m^3/md	Maximum	326	149	126	n/a
Circular Clarifier (Set 2) (1)							
Flocculator Detention Time	20	minutes	Typical	37	8.8	n/a	n/a
Loading Rate	44.0	m^3/m^2d	Maximum	66	65	n/a	n/a
Detention Time	2	hours	Typical	1.8	1.9	n/a	n/a
Weir Loading Rate	358	m^3/md	Maximum	298	224	n/a	n/a
Tube Settler Clarifier							
Loading Rate	205	m^3/m^2d	Maximum	n/a	n/a	n/a	144
Detention Time	15	hours	Typical	n/a	n/a	n/a	50
Weir Loading Rate	304	m^3/md	Maximum	n/a	n/a	n/a	225
Filters							
Filter L/D ratio	1000		Minimum	1563	1563	729	938
Rapid Sand Filtration Rate	176	m^3/m^2d	Maximum	133	100	32	144
Treated Water Detention Time	30	minutes	Minimum	64	400	696	62

Notes:
(1) Flow from both Bamag plants is divided unequally to three clarifiers. Therefore, the detention times differ between sets.
n/a = not applicable.

4.2.1 Bamag 90 Treatment System

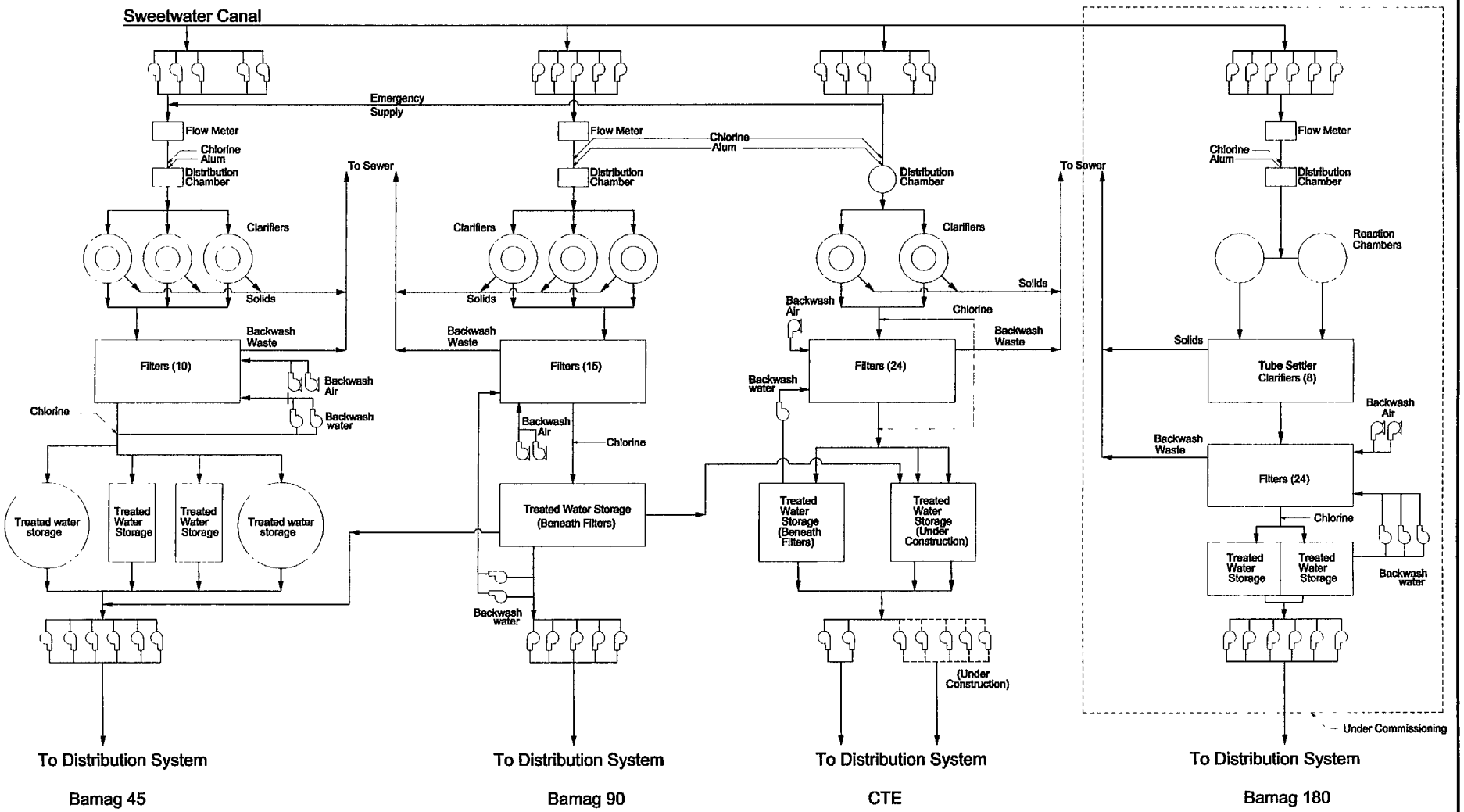
The Bamag 90 plant, built in 1981, consists of the process train shown in Figure V1-4.3. Raw water pumps draw water through the screened intakes on the Sweetwater Canal and send it to a flash mix chamber where alum and chlorine are added. (An orifice meter just ahead of the flash mix is currently not operating.) From the flash mix chamber, the flow is divided unequally among three reactor clarifiers, each with a center reaction chamber and a concentric outer clarification chamber, as indicated in Table V1-4.1.

Clarified water flows to 15 rapid sand filters. The filters do not have troughs. Water enters through an inlet channel, with a weir on one side of the filter. Spent backwash water discharges through an identical channel on the other side of the filter. Air and water are used simultaneously for backwashing the filters.

Filtered water is dosed with chlorine and flows to a single treated water storage tank below the filters and, from there, to the treated water pumping station. As an alternative, treated water from Bamag 90 can also be sent to Bamag 45 treated water pumping station and CTE storage tanks.

4.2.2 Bamag 45 Treatment System

The Bamag 45 treatment train was built in 1966. It is the only treatment train in the Canal Cities with diesel-powered raw water pumps. There are also two electric motor operated raw water pumps operating in parallel. As shown in Figure V1-4.2, raw water from the screened intake is pumped through a pipeline to a distribution tank where the flow is divided unequally



ARAB REPUBLIC OF EGYPT SUEZ CANAL AUTHORITY NATIONAL ORGANIZATION FOR POTABLE WATER AND SANITARY DRAINAGE	USAID CANAL CITIES WATER AND WASTEWATER MASTER PLAN	BLACK & VEATCH INTERNATIONAL IN ASSOCIATION WITH MONTGOMERY WATSON SABBOUR ASSOCIATES	SUEZ WATER TREATMENT PLANT PROCESS FLOW DIAGRAM DATE: AUGUST 1999 FIGURE: VI-4.3

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among three circular reactor-clarifiers, as indicated in Table V1-4.1. Raw water flow is measured with a venturi meter in the pipeline just upstream from the distribution tank.

Clarified water flows to ten rapid sand filters. As is typical of the Bamag treatment trains, there are no filter troughs. Backwashing is done by simultaneous application of air and water. Filtered water is dosed with chlorine and discharged to four treated water storage tanks and, from there, to the treated water pumping station.

4.2.3 CTE Treatment System

The CTE treatment train was built in the 1950s. As shown in Figure V1-4.2, the treatment train receives raw water through a screened inlet on the Sweetwater Canal. The water is sent to a flash mix tank where it is dosed with alum and chlorine and is divided evenly between two circular clarifiers. Each clarifier consists of a central flocculator zone with 12 vertical shaft flocculation stirrers. Solids are removed from the outer concentric sedimentation zone through eight manually valved withdrawal pipes.

Clarified water flows to 24 rapid sand filters, each of which is actually a pair of filters with a divider between them. Water enters the filter from the two exterior sides and backwash water enters through the center divider area and is distributed to both halves of the filter. The two filters in the pair must be operated and backwashed together. Problems with one filter can lead to imbalance in the flow of the raw water or backwash water. Filters are backwashed by simultaneous use of air and water. All valves must be individually and manually turned to take the filters from operation to backwashing and back to operation.

Filtered water flows to a treated water storage tank beneath the filters. The construction of two additional rectangular storage tanks for this treatment train is nearly completed. From storage, treated water is pumped to the distribution system. A new pumping station is being constructed to replace the one currently in use.

4.2.4 Bamag 180 Treatment System

The Bamag 180 treatment train is currently being commissioned. The design criteria are summarized in Table V1-4.1. As shown in Figure V1-4.2, the raw water pumping station draws water from the screened intake on the Sweetwater Canal and sends it to a flash mix system where alum and chlorine are added. The intake for this treatment train is the only one observed at any of the SCA treatment plants in the three Canal Cities with self-cleaning screens. From the flash mixer, the water flows to a pair of tangential inlet reactor chambers and, from there, to eight clarifiers with tube settlers. Rotating sludge scrapers are used to collect and remove sludge from the clarifiers.

Clarified water flows to 24 rapid sand filters and to a treated water storage tank below the filters. Chlorine is added between the filters and the storage tank. The treated water pumping station pumps water to the distribution system.

4.3 Chemical Feed Systems

The only chemicals used in the Suez water treatment system are alum and chlorine. Each treatment train has its own separate chemical feed facilities. Alum is supplied and stored as a 50 percent solution and diluted to a 20 percent solution in mixing tanks located in the chemical feed areas. Bamag 180 has built-in storage for the concentrated alum; the older treatment trains have exterior circular metal storage tanks. The alum feed pumps are located in an adjacent room, lower than the bottom of the mixing tanks, so that they operate with flooded suction. The alum storage and feed area for the Bamag 90 treatment trains is located on the bottom floor of the administration building, which also houses the filters. Two positive displacement feed pumps are located on the floor below the alum mixing tanks.

Chlorine facilities consist of a ton cylinder storage area and an adjacent separate chlorinator and ejector room. Except for Bamag 180, only gaseous chlorine is used; there are no facilities for withdrawing and evaporating liquid chlorine. All chlorine storage buildings, except those at the CTE facility, are equipped with chlorine leak detectors, alarms, and vent fans. There are no chlorine scrubbers or any other chlorine neutralization equipment.

The chlorine facility has space for two rows of 1-ton chlorine cylinders. One row of four cylinders is for treated water; the other row of two cylinders (space for four) is for raw water. One pair of chlorinators feeds chlorine to the raw water and the other pair to filtered water.

The Bamag 45 chemical feed facility is located near the clarifiers. Three positive displacement pumps for alum are installed in a room adjacent to the mixing tanks. The elevation of the alum pumps is below the bottom elevation of the mixing tanks. The chlorine facility is in the same area and has space for storing 40 one-ton cylinders in two rows, with manifold connections for six cylinders on each row. There are six chlorinators in an adjacent room, three operating and three spares. Pre-chlorination for the CTE treatment train is also provided from this facility.

The CTE chemical feed facility is located near the filters and houses the alum feed and storage and the chlorine system in the same building. Eight alum feed pumps are available. The chlorine storage area has space for ten cylinders with one cylinder connected to the feed manifold. The other side of the manifold has three connections, but no cylinders were connected at the time it was observed. Two chlorinators in the adjacent chlorine feed room are available for post-chlorination of filtered water. There is no leak detector or vent system; however, plant staff indicate that bids will be tendered to replace the leak detection and vent system for all of the existing chlorine storage facilities at the plant, except the new Bamag 180. The leak detection and ventilation system will be added to the CTE chlorine facility at that time.

Alum feed for the Bamag 180 treatment train consists of built-in storage tanks, mixing tanks, and two double-headed positive displacement feed pumps. Chlorine storage is in a separate building and has a capacity for 14 one-ton cylinders, with seven cylinders connected to the manifold

on each of two rows. There are five chlorinators, two for pre-chlorination and two for post-chlorination of the filtered water, with one spare. There is also an evaporator, and plant staff indicates that, if it is used, liquid chlorine will be fed through the gas manifold connecting to the liquid taps on the cylinders instead of the gas taps.

4.4 Laboratory Facilities

A single laboratory, located in the administration building, is used for wet chemistry and bacteriological testing. A new laboratory room was built into the Bamag 180 filter building, but it is uncertain whether it will be utilized. Samples of treated water for bacteriological tests are taken once per day from each operating treatment train. Plant staff indicated that additional staff is needed to analyze distribution system samples.

4.5 Treated Water Storage and Pumping Stations

Four treated water pumping stations are located at the water treatment plant: American Pump Station, CTE Pump Station, Bamag 2 Pump Station, and the Bamag 180 Pump Station which is being commissioned. The American Pump Station serves Bamag 45 and has six pumps. It used to have eight pumps until recently when two of the pumps were transferred to the CTE replacement pumping station currently under construction. This replacement pumping station will also include all three pumps of the existing CTE Pump Station, so that when completed, it will have a total of five pumps. Bamag 90 has five pumps. All of the pumps in American, CTE and Bamag 90 pump stations are all rated at 1,000 m^3/h and 50 m head. Bamag 180 has its own pumping station with six pumps rated at 1,875 m^3/h at 52 m head.

All storage consists of ground storage tanks located at the water treatment plant. The existing distribution system storage capacity totals approximately 53,200 m^3 as shown in Table V1-4.2, Treated Water Storage Capacity. The estimated disinfection volume based on 30-minute chlorine contact time (Ct volume) is approximately 7,800 m^3. Therefore, the estimated remaining operational volume is approximately 45,400 m^3.

Table V1-4.2 Treated Water Storage Capacity

Treatment Train	Listed Production Capacity (m^3/d) (1)	No. of Tanks	Total Tank Capacity (m^3)	Estimated Disinfection Volume (m^3) (2)	Estimated Remaining Operational Volume (m^3) (3)
Bamag 45	45,000	3	12,500	938	11,563
Bamag 90	90,000	1	4,000	1,875	2,125
CTE (Group 4)	60,000	3	29,000	1,250	27,750
Bamag 180	180,000	2	7,700	3,750	3,950
Total	375,000		53,200	7,813	45,388

Notes:
(1) Based on reported design production, not actual production.
(2) Based on 30-minute contact time (WHO recommendations) at listed plant production capacity.
(3) Operational = (Total) - (Disinfection)

81

4.6 Water Quality

Raw and treated water quality is summarized in Table V1-4.3, Summary of Water Quality (Directly Affected by Treatment). The treated water values reported are for samples taken from a common water main located inside the plant that is fed from all treatment trains. The major water quality constituents affected by conventional water treatment are within the Egyptian and World Health Organization criteria. It may be possible to reach a treated water turbidity objective used in the US, that is aimed at controlling *Giardia* and *Cryptosporidium*. The U.S. turbidity limits are more stringent than the Egyptian and WHO standards. THMs are less than 0.1 mg/L; however, values in the distribution system are not reported.

Table V1-4.3 Summary of Water Quality (Directly Affected by Treatment)

Constituent	Treated Water Standards				Raw Water			Composite Treated Water		
	Egyptian	WHO	US EPA	Units	Minimum	Maximum	Average	Minimum	Maximum	Average
Turbidity	5	5(3)	0.3	NTU(1)	4.00	9.00	6.50	0.40	0.90	0.60
pH(2)	6.5 - 9.2	6.5 – 8.5	6.5 – 8.5		7.60	8.00	7.80	7.2	7.5	7.4
Iron(2)	0.3	0.3	0.3	mg/L	0.04	0.17	0.08	0.00	0.06	0.02
Manganese(2)	0.1	0.1	0.05	mg/L	0.001	0.009	0.004	0.000	0.007	0.002
Coliform Bacteria	3	0	Negative	per 100 ml	positive	positive	positive	negative	negative	negative

Notes:
(1) Egyptian standard is 5 JTU or equivalent. NTU is actually not interchangeable with JTU, but is used here as an approximation.
(2) Secondary Standard.
(3) For single sample. ≤ 1 NTU for median sample.

Chlorine residual is measured every hour at the treatment plant discharge, and the values are recorded in the Operation Logs. It is recommended that if it is not already measured, chlorine residual for the treated water be measured and reported with other water quality data. It is also recommended that chlorine residuals be measured in the field at the same time and the same place as distribution system bacteriological samples.

4.7 Observed Needs for Upgrades or Improvement

A number of problems with the current operating treatment trains were noted and discussed with the plant staff. Some of the problems affect day-to-day operation, others affect the efficiency and capacity of the treatment trains. The observed needs and recommendations are given below:

- Plant staff reported that the treated water flowmeters for Bamag 45 and Bamag 90 are not operational. ***The flowmeters should be examined and evaluated for calibration, rehabilitation, or replacement.***
- Except for the new Bamag 180, all the intake screens must be manually cleaned, and sometimes enough trash collects to necessitate hourly cleaning. This requires valuable operations manpower. ***It is recommended that self-cleaning screens be installed for all treatment trains.***

to properly backwash the filters as a result of problems with the underdrains. As stated earlier, all the valves on the filters must be manually and individually operated. ***It is recommended that SCA proceed with the rehabilitation of the entire CTE plant as soon as Bamag 180 is fully operational. The upgrading should include at least include the installation of rotating rakes and sludge hoppers with automatic valves for the clarifiers.***

- Sand is being lost from the Bamag 45 filters as a result of unexplained defects in the filter valves. ***The cause of this problem should be identified and appropriate corrective measures taken.***
- There is currently no reclamation system for spent washwater or clarifier solids for any of the treatment trains. Spent washwater and clarifier solids are discharged into a nearby sewer line. A general description of a disposal system is included in Appendix V1-4.3, Backwash and Clarifier Residuals Disposal. This is a major plant retrofit and requires detailed investigation of the plant's hydraulic grade line, multiple or a single centralized treatment unit alternatives and location(s), pipe sizes, lengths, alignments, etc. ***To reduce loadings to the wastewater system and meet environmental law requirements, it is recommended that a study for a filter backwash washwater and clarifier residuals disposal system be conducted, and a disposal system installed at the treatment plant in the near future.***

End of Chapter 4: Existing Water Treatment Facilities

5.0 Existing Water Distribution System

This section provides a description of the existing water distribution system, leak detection survey, and system pressure measurements.

5.1 General

The Suez potable water distribution system consists of approximately 695 km of pipes in diameters ranging from 100 mm to 1,200 mm. Pipe materials used include cast iron (CI), ductile iron (DI), asbestos cement (AC), and polyvinyl chloride (PVC).

The distribution system serves the built-up area of Suez, including the Ministry of Housing property located northeast of the city. The system also supplies the Suez Cement Company, located approximately 42 km south of the city, and the areas of Adabiya and Ain El Sokhna.

5.2 Primary Distribution System

The total length of distribution mains, 300 mm diameter and larger, is approximately 134 km. A summary of the distribution system pipe diameters, lengths, and materials is shown in Table V1-5.1, Inventory of Water Distribution Pipes. The general layout of the distribution system is shown in Figure V1-5.1, Suez Water Network.

Suez, like Port Said and Ismailia, has an ongoing program of replacing CI and AC pipes with DI and PVC. The program calls for replacing CI and AC pipes up to 300 mm in diameter with PVC and 400 mm and larger diameter pipes with DI. There are approximately 3 km of 100 mm CI house connections and 20 km of 150, 200, and 250 mm AC pipes that need to be replaced.

Table V1-5.1 Inventory of Water Distribution Pipes - 1998

Pipe Material	Diameter, mm													Total Length, m
	100	150	200	250	300	350	400	500	600	800	900	1000	1200	
CI	2,996	559	4,000	-	-	-	-	-	-	-	-	-	-	7,555
DI	-	4,441	7,000	-	6,000	-	19,709	2,000	13,000	3,000	21,000	4,855	17,584	98,589
AC	120,000	34,702	60,000	4,000	15,000	-	15,000	-	1,500	-	-	-	-	250,202
PVC	199,380	74,001	49,781	-	7,529	4,325	2,416	-	1,522	-	-	-	-	338,954
Total Length, m	322,376	113,703	120,781	4,000	28,529	4,325	37,125	2,000	16,022	3,000	21,000	4,855	17,584	695,300

5.3 Leak Detection Survey

In accordance with the CCMP Scope of Work, a water leakage survey of approximately 10 percent of the city's water distribution system was conducted. The objective was to gather data on the leakage and water losses for the existing potable

84

water system, evaluate possible causes of leakage, and provide recommendations on how to reduce or eliminate water losses. The survey also included training of maintenance staff in the use of leak detection and pipe/valve locating equipment by Heath Consultants, Inc., of Houston, Texas. At the conclusion of the program, one set of leak detection and pipe locating equipment was turned over to SCA.

5.3.1 Training

The training program consisted of both classroom and field training. The classroom training was attended by Department Heads and staff engineers of the SCA Network Department and the Water Treatment Plant Department as well as network maintenance technicians.

The field training in Suez was conducted parallel with the actual leak detection survey. Three SCA technicians and a coordinator from the SCA Network Department were trained in the hands-on use of the following equipment:

- Heath 300 Pipe Locator – For locating underground metallic pipes. It also allows the operator to find the depth of the pipe.
- Heath 300 valve box locator - For buried metallic valves.
- Pipe Finder Rod – For metallic and non-metallic pipes.
- Heath Aquascope System – For detecting the location and amount of leakage in buried pipes.

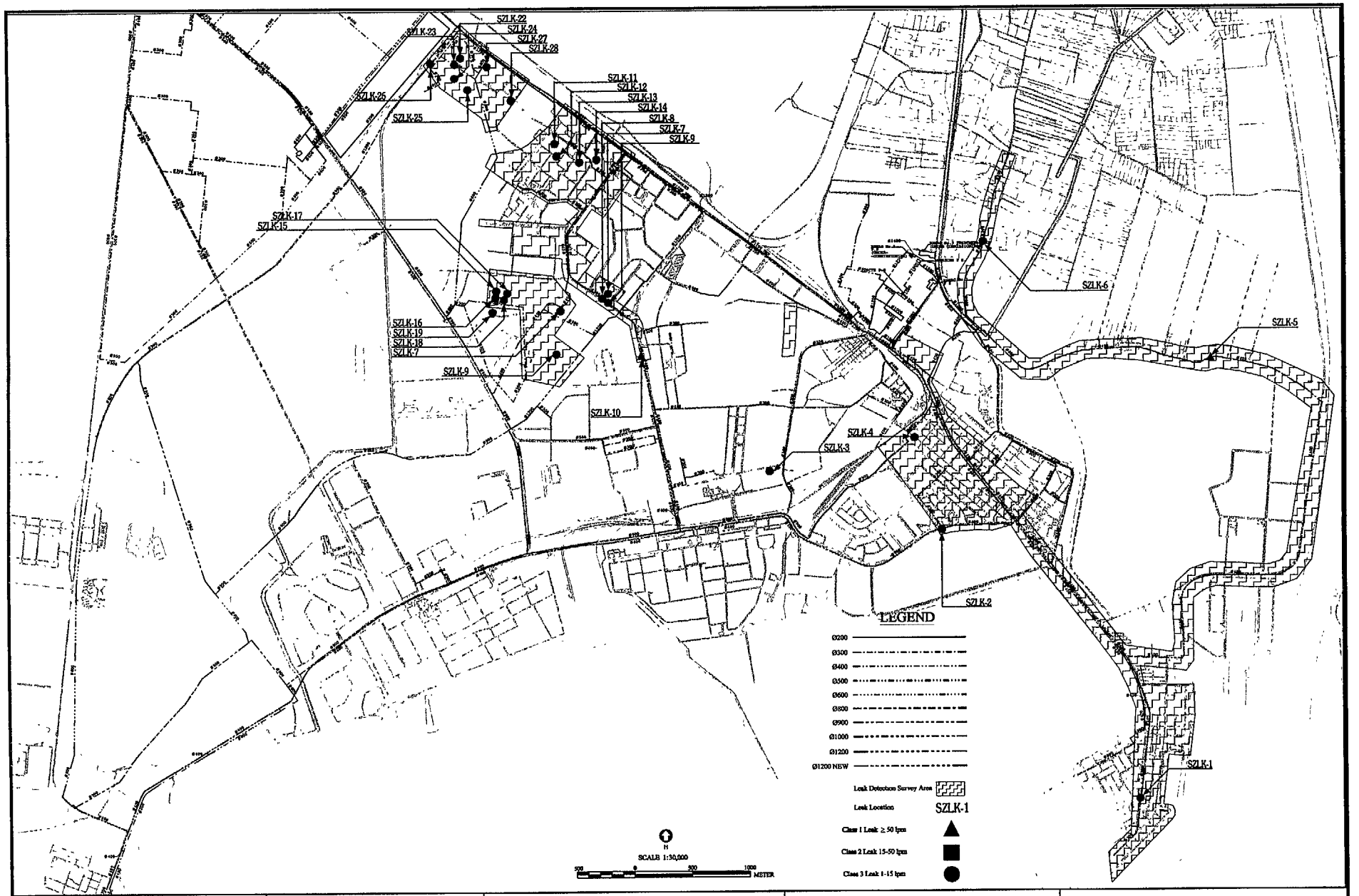
5.3.2 Leak Detection

Selected areas in the network were surveyed for leaks, as shown in Figure V1-5.2, Suez Water Leak Detection Survey Areas. Each area represented a different land use with different pipe age and water pressure. In accordance with the scope of work, approximately 71 km or a little over 10 percent of the pipelines were checked for leaks. A summary of the pipe inspected is given in Table V1-5.2, Summary of Pipes Inspected for Leakage.

Table V1-5.2 Summary of Pipes Inspected for Leakage

Pipe Material	Pipe Diameter, mm										Total Length, m
	100	150	200	250	300	400	600	900	1000	1200	
DI	-	-	900			5,700	1,750		400	1,000	9,750
AC	4,675	1,950	5,200	950	4,050	5900	2100	400			25,225
CI	850	-	1400	-	1000	-	-				3,250
PVC	15,025	8,350	7,925		1,000	300	500				33,100
Total Length, m	20,550	10,300	15,425	950	6,050	11,900	4,350	400	400	1,000	71,325

85



ARAB REPUBLIC OF **EGYPT** SUEZ CANAL AUTHORITY NATIONAL ORGANIZATION FOR POTABLE WATER AND SANITARY DRAINAGE	INTERNATIONAL ELLIPSOIDE - HAYFORD 1909 U.T.M. PROJECTION - ZONE 36 STEREOPLOTTING BASED ON GEODETIC TRIANGULATION OF EGYPTIAN SURVEY AUTHORITY	**USAID** CANAL CITIES WATER AND WASTEWATER MASTER PLAN	BLACK & VEATCH INTERNATIONAL IN ASSOCIATION WITH MONTGOMERY WATSON SABBOUR ASSOCIATES	**SUEZ WATER LEAK DETECTION SURVEY AREAS** DATE: AUGUST 1999 FIGURE: VI-5.2

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A summary of the locations and amounts of leakage is in Table V1-5.3, Summary of Detected Leaks. Leakage reports are on file with CCMP. The locations of the leakage points are also shown in Figure V1-5.2.

Table V1-5.3 Summary of Detected Leaks

Leak Location No. SZLK-	Class[1]	Location	Estimated Loss, lpm
1	3	service	1
2	3	valve	1
3	3	service	12
4	3	main	10
5	1	valve	50
6	3	valve	1
7	3	service	5
8	3	valve	15
9	3	valve	15
10	1	main	50
11	3	service	1
12	3	main	1
13	3	main	10
14	3	service	0.25
15	3	service	0.1
16	3	main	5
17	3	service	0.1
18	3	service	0.1
19	3	service	0.25
20	3	valve	1
21	3	hydrant	1
22	3	service	0.1
23	3	service	10
24	3	service	0.1
25	3	service	0.25
26	3	valve	10
27	3	service	0.25
28	3	service	2
Total Loss, lpm			202.5
Total Loss, m^3/d			47.2

1. Class 1 ≥ 50 lpm, Class 2 = 15 to 50 lpm, Class 3 = 1 to 15 lpm

The results of the leakage survey indicate that the Suez water network is a "tight" system. Leaks are classified as follows: Class 1 – 50 lpm or more, Class 2 – 15 to 50 lpm, and Class 3 – 1 to 15 lpm. Of the 71 km of pipe surveyed, only 28 leaks were found, most of which were Class 3 leaks. The total amount of detected leakage was estimated at 203 lpm, or 47.2 m^3/d. When extrapolated over the entire 695 km of pipe, the normalized leakage is about 1 percent of the total water production of 159,800 m^3/d.

87

The results of the leakage survey indicate that only a very small portion of the unaccounted-for water (UFW) is attributable to leaky pipe. The majority of it is believed to be due to unmetered domestic, commercial, and industrial usage, defective (under reading or non-functional) meters, hydrant use, main flushing, un-metered usage in governmental and military buildings and other public uses.

The following recommendations are offered to maintain a tight water system in Suez:

- SCA should continue its ongoing program of replacing old CI and CI pipes with DI and PVC.
- SCA should continue the leak detection survey of the remaining 90 percent of the system, using the equipment provided by the Master Plan, and should repair the leaks detected as soon as possible.
- The high quality of pipe installation workmanship was observed during the survey. This quality of pipe laying and pipe jointing practices should be maintained.

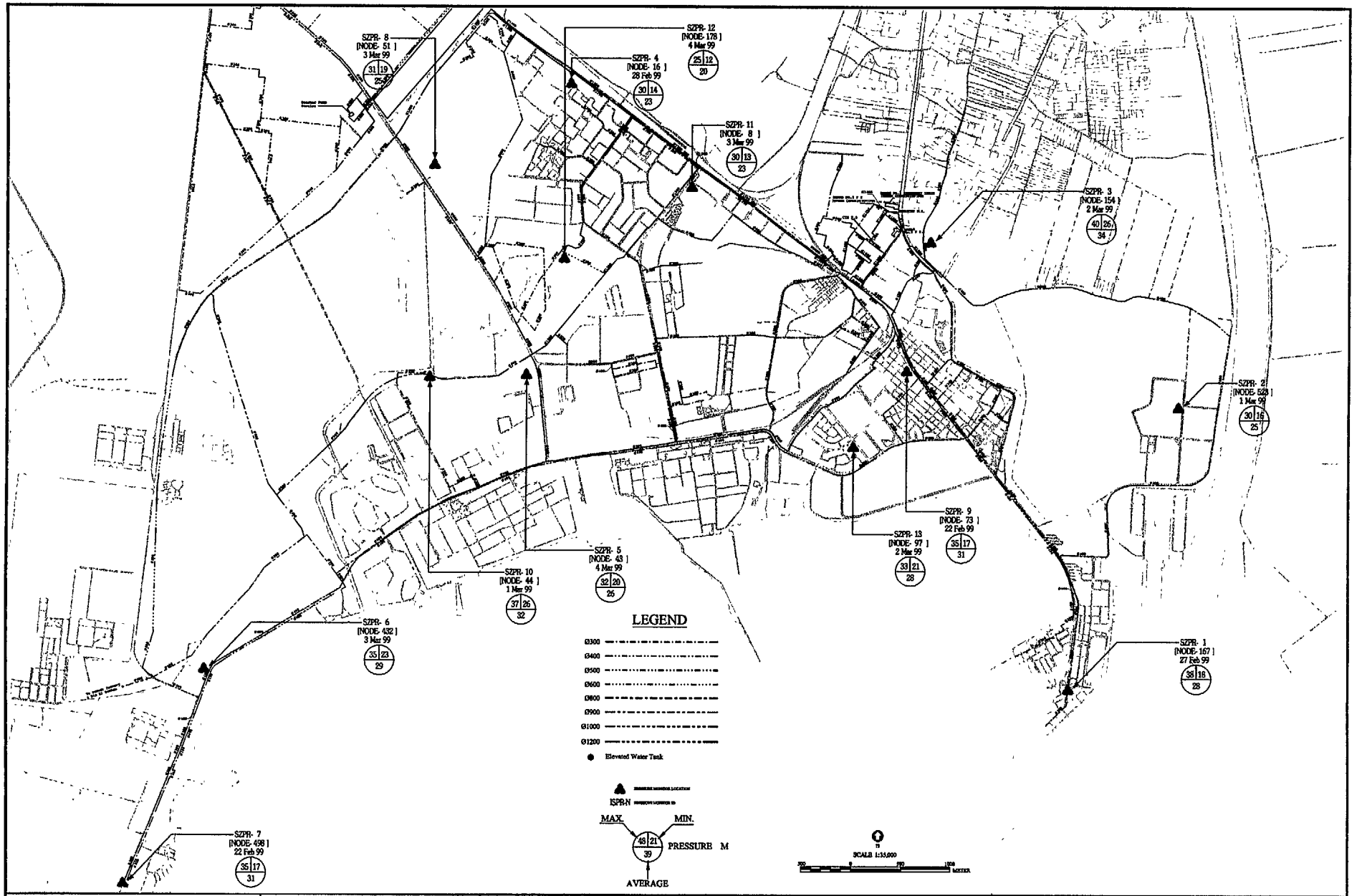
5.4 System Pressure Measurements

Pressure readings were taken at locations to determine general system pressures using pressure data loggers connected to fire hydrants. The fire hydrant locations were identified and located with the assistance of the SCA Network Department. Fire hydrant caps were made by the treatment plant department and fitted with adapters to connect the pressure data loggers. The data loggers were set to read and log pressures at 1-minute intervals for 24 hours.

A summary of the pressure readings and dates is in Table V1-5.4, Suez System Pressures. The pressure monitor locations, with the minimum, maximum, and average pressures, are shown in Figure V1-5.3, Suez Pressure Monitor Location. The pressure data were used to calibrate the system hydraulic model as discussed in Section 7, Water System Planning Criteria.

Table V1-5.4 Suez System Pressures

SZPR No.	Date	Pressure, m		
		Maximum	Minimum	Average
1	27-Feb-99	38	18	28
2	01-Mar-99	30	16	25
3	02-Mar-99	40	26	34
4	28-Feb-99	30	14	23
5	03-Mar-99	32	20	26
6	03-Mar-99	35	23	29
7	22-Feb-99	28	14	23
8	03-Mar-99	31	19	25
9	22-Feb-99	35	17	31
10	01-Mar-99	37	26	32
11	04-Mar-99	30	13	23
12	04-Mar-99	25	12	20
13	02-Mar-99	33	21	28



ARAB REPUBLIC OF **EGYPT** SUEZ CANAL AUTHORITY NATIONAL ORGANIZATION FOR POTABLE WATER AND SANITARY DRAINAGE	INTERNATIONAL ELLIPSOIDE - HAYFORD 1909 U.T.M. PROJECTION - ZONE 36 STEREOPLOTTING BASED ON GEODETIC TRIANGULATION OF EGYPTIAN SURVEY AUTHORITY	**USAID** CANAL CITIES WATER AND WASTEWATER MASTER PLAN	BLACK & VEATCH INTERNATIONAL IN ASSOCIATION WITH MONTGOMERY WATSON SABBOUR ASSOCIATES	**SUEZ** **PRESSURE MONITOR LOCATIONS** DATE: AUGUST 1999 FIGURE: V1-5.3

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5.5 Pump Performance Tests

Pump tests were conducted to determine capacity, head conditions, and shut-off head for each treated water pump. There are four treated water pump stations: American Pump Station, CTE Pump Station, Bamag 90 Pump Station, and Bamag 180 Pump Station.

The American Pump Station has six pumps. It used to have eight pumps until recently when two of the pumps were transferred to the CTE replacement pump station which is currently under construction. The pumps were tested on 7 March 1999. The CTE pump station originally had three pumps but one was transferred to the CTE replacement pump station. The remaining two CTE pumps were tested on 2 March 1999. The replacement CTE pump station when completed will include five pumps – two from the American and 3 from the CTE pump station. The Bamag 90 Pump Station has five treated water pumps. Pumps 1, 3, 4, and 5 were tested on 27 Feb 1999. Pump No. 2 was not tested because it was not operational. The new Bamag 180 pump station which serves the new Bamag 180,000 m^3/d plant has six pumps. These pumps were not tested because they are new and have just been tested by the manufacturer. Copies of the pump curves were obtained instead. All pumps in the three old pump stations are rated at 1000 m^3/h at 50 m head. The new pumps in the Bamag 180 are rated at 1875 m^3/d at 52 m head.

The pump flows were measured and logged using a "Quadrina" insertion turbine meter. Pump pressures were simultaneously recorded using a data logger that was connected to the pump pressure gage tap.

The pump pressure and flow readings were charted to prepare pump curves, which were used in the system hydraulic model as discussed in Section 7.

5.6 Other Water Systems

There are other water treatment and distribution systems within the CCMP Suez Study Area that are independent of the SCA system. These are described below.

5.6.1 Al Salam City Water System

The Central Agency for Development of the Ministry of Housing and Development owns, operates, and maintains a number of package-type water treatment plants within the Suez Governorate. These units are listed in Table V1-5.5, Package-Type Water Treatment Plants.

Table V1-5.5 Package-Type Water Treatment Plants

Location	No. of Treatment Units	Capacity, m^3/d
Al Ganayen	5	10,000
Al Shalofa	2	4,000
Kabreet	2	4,000
Genefa	2	4,000
West of A. Hamdy Tunnel	5	10,000
Total	16	32,000

In addition to these units, another government agency owns and operates a 34,750 m^3/d plant also located west of the Ahmed Hamdy tunnel. This plant supplies potable water to the southern part of Sinai, through two 500 mm water main crossings across the Suez Canal.

The package-type treatment units in Al Ganayen, Al Shalofa, Kabreet, and Genefa supply treated water to nearby villages. The five units located west of the Ahmed Hamdy tunnel, with a total capacity of 10,000 m^3/d, are planned to supply water to a new city that is being developed northwest of the City of Suez, just outside the existing SCA service area. However, this area, named Al Salam City, is located within the CCMP study area and is designated as residential growth area in the 2020 and ultimate land use plans. The current plan is to pump treated water from the treatment units through a 600 mm asbestos cement water main to a 5,000 m^3 ground storage reservoir/pumping station and to pump it again through a 600 mm water main to a 1,000 m^3 elevated storage tank. The maximum water level in the storage tank is at elevation 75 m. A total of 35,000 apartment units are planned to be built in Al Salam City.

The plan of supplying water to Al Salam City from the five package-type treatment units appears feasible under present conditions; however, when all the planned 35,000 apartment units are occupied, both the treatment capacity and the size of the 20-km long, 600 mm transmission main will be inadequate. In addition, a draft presidential decree of June 1999 is currently under consideration to form a single authority that will be in charge of the drinking water and sanitary drainage systems for the Suez, Ismailia, and Port Said Governorates. Based on these considerations, CCMP recommends that under future conditions, Al Salam City and the surrounding growth area be served by the larger SCA water system. The hydraulic model and the Master Plan include the Al Salam City demands, as supplying water from the SCA treatment plant is the most feasible means of service in the future. However, integration of the Al Salam City internal water distribution network with the existing SCA system will require reevaluation of the CCMP recommended future improvements.

5.6.2 Suez Oil Petroleum Company

The Suez Oil Petroleum Company (SOPC) operates its own water treatment and supply system for domestic and industrial uses. SOPC is also connected to the SCA system and could draw water from SCA when its own supply does not meet the demands, such as during equipment maintenance, breakdown, and/or increased demand in the summer.

The SOPC water treatment plant for domestic use is located in the southwest corner of the SCA water treatment plant as shown on Figure V1-4.2. It produces 2,400 m^3/d of potable water for domestic use of refinery employees as well as the residents of the housing units at the refinery site. The treatment plant draws raw water from the Sweetwater Canal through the same pipeline that supplies raw water to the CTE unit of the SCA treatment plant.

The major portion of the water used for industrial purposes in the SOPC refinery is treated at the plant site. For this purpose, SOPC draws about 36,000 m^3/d of raw water from the

Sweetwater Canal through an intake located a few meters north of the SOPC/SCA CTE raw water intake. The raw water is pumped through a 300 mm pipeline to the refinery where it is treated for use as boiler feed water and cooling water. Treatment consists of clarification and filtration by gravity sand filters. Alum is added for floc formation. Soda ash and lime are added for hardness reduction. For certain industrial processes, zeolite pressure filters are used.

5.6.3 El Nasr Fertilizer Company

The El Nasr Fertilizer Company is another industrial plant in Suez that has its own water treatment and distribution system. Raw water is drawn from the Sweetwater Canal through an intake located about 500 m north of the SOPC/SCA CTE intake. Approximately 22,500 m^3/d of raw water is pumped through two 300 mm water mains to the plant. Of this amount, about 15,000 m^3/d is treated for domestic use, 7,000 m^3/d is treated for industrial use, and about 500 m^3/d is used for yard irrigation. About 75 percent or 11,300 m^3/d of the potable water is used in the plant and in employee housing units. The remaining 25 percent is distributed to nearby industrial plants and employee housing units.

The treatment facilities are separated into those that treat water for industrial purposes and those that treat water for domestic use. Cooling water is dosed with alum for flocculation just before it enters a clarifier. Soda ash and lime are added after it leaves the clarifier and before it enters the settling basins. Filtration is accomplished by passing the water through anthracite pressure filters. Further hardness reduction for boiler feed water is accomplished by cation/anion exchange, degasification, and zeolite pressure filters. Treatment of potable water consists of flocculation with alum and polyelectrolyte, clarification, rapid sand filtration, ozonation, and post-chlorination.

5.6.4 North of Suez Gulf Industrial Area

The North of Suez Gulf Industrial Area (NSGIA) is an industrial development located approximately 8 km south of the CCMP study area boundary in the Ataqa area. This industrial area plans to have its own water treatment and distribution system. The plan is to take water from the Sweetwater Canal at El Omda and pump the raw water through a 900 mm water main to the industrial area where it will be treated for potable and industrial uses. Since the area is still under development, NSGIA has requested SCA to supply the industrial area with 30,000 m^3/d of treated water temporarily for a period of three years. SCA has agreed to supply the water through a 900 mm line located in the west part of Suez, near the power substation. NSGIA will construct a 50,000 m^3 storage tank with a booster pumping station to receive the treated water from SCA and to pump it to the industrial area. When the NSGIA water treatment and supply system is operational, SCA will cease to supply water to this area.

End of Chapter 5: Existing Water Distribution System

6.0 Regulations, Laws, and Treatment Criteria

This section presents a review of the drinking water quality standards for treated water and discharge regulations for treatment plant filter backwash and clarifier residuals disposal.

6.1 Water Quality Standards

Water quality standards are summarized in Table V1-6.1, Egyptian and U.S. Drinking Water Standards, World Health Organization and European Guidelines. Similar standards of the U.S. EPA and guidelines published by the World Health Organization (WHO) and European Union are also provided for comparison. WHO standards are followed in Egypt except where noted in the table. The Suez Canal Authority (SCA) follows the Egyptian standards in the operation of the water treatment plants in Port Said, Ismailia, and Suez.

6.2 Discharge Regulations

Responsibility for the environmental protection of Egypt is dispersed among many ministries and government agencies. Recent interest in the protection of the environment has led to the formation of the Ministry of State for Environmental Affairs (Ministry). To enforce environmental compliance, the Government of Egypt created the Egyptian Environmental Affairs Agency (EEAA) and empowered it to monitor and maintain the laws and decrees associated with the environment. Today, the Ministry and the EEAA are the central institutions concerned with environmental protection in Egypt. However, other ministries, including the Ministry of Health & Population and the Ministry of Public Works & Water Resources, play an important role in the protection of the environment by regulating the discharge of liquid wastes.

Discharge regulations affect the water treatment plants concerning the disposal of clarifier residuals and spent filter backwash water. The important regulations are discussed below.

6.2.1 Environmental Law No. 4 of the Year 1994

Environmental Law No. 4 of 1994 and the Prime Minister's Decree No. 338 of 1995 established the mandate of EEAA and provided clarification of discharge limits. Law No. 4 is the outcome of a long process that started with the formation in 1981 of ministerial and technical environmental committees reporting to the Prime Minister. These early initiatives led to the issuance of Presidential Decree No. 631 of 1982 establishing the formation of an Environmental Affairs Authority. The mandate of the Authority was limited; nevertheless, it issued Law No. 102 of 1983 for the protection of natural resources. In 1985, the Authority was reorganized with specialized divisions and technical staff positions added. However, its restricted operating scope led to the realization that there was a need for an organization with

Table V1-6.1 Egyptian and U.S. Drinking Water Standards, World Health Organization and European Union Guidelines

Parameter	Egyptian Ministry of Health Ministry Decree No. 52/1998 (Where Different from WHO)	World Health Organization Guidelines (1996)	EU Guide Levels	U.S. Environmental Protection Agency (Nov. 1998)
Microbials				
Bacteria			10/ml at 37°C 100/ml at 22°C	
Coliform Group	0/100 ml in 95% of samples per year; individual samples not more than 3/100 ml	Not detected in 100 ml	Not detected in 100 ml	Not present
E. coli	NS	Not detected in 100 ml		Not present
Giardia				99.9% removal/ inactivation
Viruses				99.99% removal/ inactivation
Cryptosporidium				99.99% removal/ inactivation (#)
Inorganics				
Ammonia (as Nitrogen	NS	1.5 mg/L as NH_3	1.5 mg/L as NH_4	
Antimony		0.005 mg/L (P)		0.006 mg/L
Arsenic	0.05 mg/L	0.01 mg/L (P)	0.05 mg/L *	0.05 mg/L
Asbestos				7 MFL
Barium	NS	0.7 mg/L		2 mg/L
Beryllium				0.004 mg/L
Boron		0.3 mg/L		
Cadmium	0.005	0.003 mg/L	0.005 mg/L *	0.005 mg/L
Chromium (Cr^{6+})		0.05 mg/L (P)	0.05 mg/L *	0.1 mg/L ***
Cyanide	0.05 mg/L	0.07 mg/L	0.05 mg/L *	0.2 mg/L
Fluoride	0.08 mg/L	1.5 mg/L	1.5 mg/L* 8-12°C 0.7 mg/L* 25-30°C	4.0 mg/L 2.0 mg/L **
Lead	0.05 mg/L at consumer's tap	0.01 mg/L	0.05 mg/L *	0.015 & treatment standards
Mercury		0.001 mg/L	0.001 mg/L*	0.002 mg/L
Molybdenum		0.07 mg/L		
Nitrate (as Nitrogen)	10 mg/L	50 mg/L as NO_3^-	25 mg/L as NO_3^-	10 mg/L
Nitrate + Nitrite (as Nitrogen)	Sum of ratio of concentration of each to its respective guideline should not exceed 1.0			10 mg/L
Nitrite (as Nitrogen)	0.005 mg/L	3 mg/L (P)		1 mg/L
Selenium		0.01 mg/L	0.01 mg/L*	0.05 mg/L
Thallium				0.002 mg/L
Organics				

Parameter	Egyptian Ministry of Health Ministry Decree No. 52/1998 (Where Different from WHO)	World Health Organization Guidelines (1996)	EU Guide Levels	U.S. Environmental Protection Agency (Nov. 1998)
1,1,1-Trichloroethane		2 mg/L (P)		0.2 mg/L
1,1,2-Trichloroethane	0.200 mg/L			0.005 mg/L
1,1-Dichloroethene	NS	0.003 mg/L		
1,1-Dichloroethylene	NS	0.03 mg/L		0.007 mg/L
1,2,4-Trichlorobenzene				0.07 mg/L
1,2-Dichloroethane				0.005 mg/L
1,2-Dichloropropane		0.02 mg/L		0.005 mg/L
1,3-Dichloropropene	NS	0.02 mg/L		
2,3,7,8-TCDD (Dioxin)				$3x10^{-8}$ mg/L
2,4,5-T		0.009 mg/L		
2,4,5-TP (Silvex)				0.05 mg/L
2,4-D	NS	0.03 mg/L		0.07 mg/L
2,4-DB		0.09 mg/L		
Acrylamide	NS	0.0005 mg/L		
Alachlor	NS	0.02 mg/L		0.002 mg/L
Aldicarb		0.01 mg/L		0.003 mg/L
Aldicarb sulfoxide				0.004 mg/L
Aldicarb sulfone				0.003 mg/L
Aldrin and Dieldrin		0.00003 mg/L		
Atrazine		0.002 mg/L		0.003 mg/L
Bentazone		0.03 mg/L		
Benzene		0.01 mg/L		0.005 mg/L
Benzo(a)pyrene		0.0007 mg/L		0.0002 mg/L
Carbaryl				
Carbofuran		0.005 mg/L		0.04 mg/L
Carbon tetrachloride		0.002 mg/L		0.005 mg/L
Chlordane		0.0002 mg/L		0.002 mg/L
Chlorotoluron		0.03 mg/L		
cis-1,2-Dichloroethylene				0.07 mg/L
Dalapon				0.02 mg/L
DDT		0.002 mg/L		
Di(2-ethylhexyl)adipate		0.080 mg/L		0.4 mg/L
Di(2-ethylhexyl)phthalate		0.008 mg/L		0.006 mg/L
Diazinon				
Dibromochloropropane (DBCP)	0.0012 mg/L	0.001 mg/L		0.0002 mg/L
Dichloromethane		0.02 mg/L		0.005 mg/L
Dichloroprop		0.100 mg/L		
Dinoseb				0.007 mg/L
Diquat				0.02 mg/L
Edetic acid (EDTA)		0.2 mg/L		
Endothall				0.1 mg/L
Endrin				0.002 mg/L
Epichlorohydrin		0.0004 mg/L		
Ethylbenzene	NS	0.3 mg/L		0.7 mg/L
Ethylene dibromide				0.00005 mg/L
Fenoprop		0.009 mg/L		

95

Parameter	Egyptian Ministry of Health Ministry Decree No. 52/1998 (Where Different from WHO)	World Health Organization Guidelines (1996)	EU Guide Levels	U.S. Environmental Protection Agency (Nov. 1998)
Phenitrothion				
Phenol			0.0005 mg/L *	
Picloram				0.5 mg/L
Polychlorinated biphenyl (PCB)				0.0005 mg/L
Propenil		0.02 mg/L		
Pyridate	NS	0.1 mg/L		
Simazine		0.002 mg/L		0.004 mg/L
Styrene	NS	0.020 mg/L		0.1 mg/L
Tetrachloroethylene		0.04 mg/L		0.005 mg/L
Toluene	0.100 mg/L (total hydrocarbons as toluene)	0.7 mg/L		1 mg/L
Toxaphene				0.003 mg/L
trans-1,2-Dichloroethylene				0.1 mg/L
Tributylin oxide		0.002 mg/L		
Trichlorobenzenes (total)		0.020 mg/L		
Trichloroethylene		0.07 mg/L		0.005 mg/L
Trifluralin		0.02 mg/L		
Vinyl chloride		0.005 mg/L		0.002 mg/L
Xylenes		0.5 mg/L		10 mg/L
Disinfectant By-Products				
Bromate		0.025 mg/L (P)		0.01 mg/L (#)
Chlorite		0.02 mg/L (P)		1.0 mg/L (#)
2,4,6-Trichlorophenol		0.2 mg/L		
Formaldehyde	NS	0.9 mg/L		
Bromoform	NS	0.1 mg/L		
Dibromochloromethane	NS	0.1 mg/L		
Bromodichloromethane		0.006 mg/L		
Chloroform		0.2 mg/L		
Total Trihalomethanes	0.1 mg/L			0.10 mg/L 0.08 mg/L (#)
Haloacetic acids				0.06 mg/L (#)
Dichloroacetic acid		0.5 mg/L (P)		
Trichloroacetic acid		0.1 mg/L (P)		
Trichloroacetaldehyde (chloral hydrate)		0.01 mg/L (P)		
Dichloroacetonitrile		0.09 mg/L (P)		
Dibromoacetonitrile		0.1 mg/L (P)		
Cyanogen chloride (as CN)		0.7 mg/L		
Disinfectants				
Monochloramine		3 mg/L		
Chloramine				4 mg/L as Cl (#)
Chlorine		5 mg/L		4 mg/L as Cl (#)
Radionuclides				
Radium-226 + Radium-228				5 pCi/L

96

Parameter	Egyptian Ministry of Health Ministry Decree No. 52/1998 (Where Different from WHO)	World Health Organization Guidelines (1996)	EU Guide Levels	U.S. Environmental Protection Agency (Nov. 1998)
Gross Alpha	NS	0.1 Bq/L		15 pCi/L
Beta particle & photon activity	NS	1.0 Bq/L		4 mRem/yr exposure
Materials Of Aesthetic Concerns				
Foaming Agents				0.5 mg/L **
Aluminum		0.2 mg/L	0.05 mg/L	0.05 – 0.2 mg/L **
Chloride	500 mg/L	250 mg/L	25 mg/L	250 mg/L **
Color[1]	20 – 30	15 TCU	1	15 CU**
Copper	1.0 mg/L at consumer's tap	1.0 mg/L	0.1 mg/L at outlet of work	1.3 mg/L ** & Treatment Standard
Hardness			>60 mg/L Ca	
Iron	0.3 mg/L (filtered water) 1.0 mg/L (artesian and mixed water)	0.3 mg/L	0.05 mg/L*	0.3 mg/L **
$KmnO_4$ Oxidizability			2 mg/L O_2	
Manganese	0.1 mg/L (filtered water) 0.5 mg/L (artesian and mixed water)	0.1 mg/L	0.02 mg/L *	0.05 mg/L **
pH	6.5 – 9.2	less than 8.0 for effective chlorination	6.5 – 8.5	6.5 – 8.5 **
Residue after evaporation		1000 mg/L	1500 mg/L	
Silver				0.1 mg/L **
Sodium		200 mg/L	20 mg/L	20 mg/L **
Sulfate	400 mg/L	250 mg/L	25 mg/L	250 mg/L **
Taste and Odor	nil	Should be acceptable	0 (dilution number)	3 Threshold Odor Number **
Total Dissolved Solids	1,200 mg/L			500 mg/L **
Turbidity[2]	5 JTU (filtered water) 10 JTU (artesian or mixed)	1 NTU (Median Sample) 5 NTU (Single Sample)	0.4 JU	0.5 NTU in 95% of samples per month (0.3 NTU in 95% of samples per month ##)
Zinc	5.0 mg/L	3 mg/L	0.1 mg/L at outlet of works	5 mg/L **

1. Platinum Cobalt Standard.
2. Standard for turbidity is Kaolin.

(P) Provisional value.
* Maximum Admissible Concentration
** Secondary Standard.
*** Total for all species.
\# Compliance required by 16 Dec. 2003
\## Compliance required by 16 Dec. 2001
NS – No Standard

97

much stronger authority and a clear mandate to protect the environment. This need was further recognized with the issuing of Ministerial Decrees Nos. 30 and 31 of 1991 to restructure and strengthen the Environmental Affairs Authority and with preparation of the Environmental Action Plan (EAP) in 1992. In 1994, Law No. 4 was authorized to deal with major environmental policy issues. Although it does not address all aspects of environmental protection, it covers the majority of the areas of concern including air, land, and marine environment. Details were left to be worked out by executive regulations and implementing ministerial decrees. Decree of the Prime Minister No. 338 of 1995 Promulgating the Executive Statutes of the Law on Environment provided the details. The main provisions of Law No. 4 and its Executive Regulations can be summarized as follows:

- Founding an agency with a clear mandate to protect the environment.
- Establishes and operates environmental information and monitoring networks to guarantee efficient implementation of the Agency's mandate. EEAA becomes the coordinating body responsible for the collection and dissemination of information.
- Establishes an Environmental Protection Fund with sufficient resources and well-defined expenditure items. The Fund's resources are devoted to research and technical analysis of the environment; environmental assessment studies; establishment of environmental networks; the removal of pollutants; and other activities aiming at environmental protection.
- Establishes the principles and procedures to be followed in the preparation of environmental impact assessments on new projects and on extensions to existing projects that have the potential to adversely affect the environment.
- Establishes an Environmental Affairs Department (EAD) in each Governorate to help coordinate and implement EEAA's mandate at the local level.

An important provision of Law No. 4 is Article 1. Article 1 states that the new law does not detract or weaken the provisions of Law No. 48 for the Year 1982 concerning the protection of the Nile River and the watercourses from pollution.

Annex No. 1 of Prime Minister Decree No. 338 of 1995 sets forth the criteria and specifications for certain materials when they are disposed of in a marine environment. Reference is made to the fact that the criteria and specifications also remain subject to the provisions of Law No. 48 of the Year 1982.

Annex No. 2 of Prime Minister Decree No. 338 of 1995 defines installations subject to the provisions of evaluation of environmental impacts. Item 6, under the heading "Installations Subject to Environmental Assessment Based on Site Activities," includes all infrastructure projects, including stations for sanitary drainage treatment and reuse of their waters.

98

6.2.2 Law No. 48 of the Year 1982

Law No. 48 for 1982 was established to protect the Nile River and its waterways from pollution. Details were provided through the Ministry of Irrigation Decree No. 8 of 1983. The Law is particularly focused on protecting fresh water resources for both potable and non-potable agricultural uses. Table V1-6.2, Waterways Protected by Law No. 48, provides a summary of waterways and sources of pollution defined by the Law and its Executive Regulations.

Table V1-6.2 Waterways Protected by Law No. 48

Waterway	Description
Nile River and its Two Branches	The main course of the Nile starting from the international border with Sudan to the mouth of Damietta and Rozetta branches in the Mediterranean Sea.
Bays	Side branches of the Nile, inside islands.
Feeders and Main Canals	Large canals conveying water from the downstream side of the Delta Barrage and feeding canal networks in Northern Egypt.
Canals	Large and small canals, with all their branches, up to field irrigation canals.
Side Channels	Parallel or adjacent distribution canals fed by main connecting canals carrying irrigation water.
Drainage and Drains	Large and small drainage canals, with all their branches, up to field drainage and covered drainage canals.
Lakes	Lakes connected with seas or closed.
Ponds	Closed water surfaces into which waterways discharge.
Closed Water Surfaces	Depressions filled with water and connected with waterways.
Oozes and Swamps	Low ground around lakes in which drainage channels discharge.
Underground Water Reservoirs	Underground water reservoirs inside Egyptian borders.
Solid Wastes	All solid materials, whether they are resulting from refuse, garbage, sweepings, dry rubbish, stone fractures, building and workshop scraps, or any solid material left by persons, housing buildings, and non-housing buildings – governmental or private, whether they were commercial, industrial, tourist, or public, as well as means of transportation.
Fluid Wastes	Wastes resulting from industrial shops and on which the standard measures regarding the industrial liquid wastes are applicable.
Human or Animal Waste	Waste resulting from sewerage purifying operations (sanitary drainage) or from their networks, or from real estate or other establishments, such as public, trading, industrial, and tourist shops, whether immovable, moveable, or floating.
Animal Fluid Wastes	Wastes resulting from slaughtering operations, abattoirs, slaughterhouses, poultry farms, hangers, and the like.
Establishment	All real estate shops, trading, industrial, or tourist structures – whether governmental or non-governmental.

97

The main provisions of Law No. 48 and its Executive Regulations can be summarized as follows:

- Defines waterway and pollutant sources.
- Establishes standard for treatment prior to discharge of marine vehicles in potable and nonpotable water sources.
- Establishes standards for treatment prior to discharge of industrial wastes into potable and nonpotable water sources.
- Establishes standards for sanitary drainage waters.

Table V1-6.3, Standards for Discharge of Licensed Fluid Wastes Into Non-Potable Water Sources, shows standards from Law No. 48 that apply to industrial fluid wastes, including water treatment plant washwater and solids discharges.

Table V1-6.3 Standards for Discharge of Licensed Fluid Wastes Into Non-Potable Water Sources

Description	Standard Measures and Specifications (1)
Temperature	Not more than 5 C over prevailing rate
Dissolved Oxygen	Not less than 4 mg/L at any time
Hydrogen Exponent (pH)	Not less than 7 and not more than 8.5
Industrial Detergents	Not more than 0.5 mg/L
Phenol	Not more than 0.005 mg/L
Sediment	Not more than 50 units
Dissolved Solid Substances	Not more than 650 mg/L
Probable Counting in Colon Group in 100 cm^3	Not more than 5,000

(1) Law No. 48 limits as defined in Article 68 of Decree No. 8 of the Year 1983

End of Chapter 6: Regulations, Laws, and Treatment Criteria

100

7.0 Water System Planning Criteria

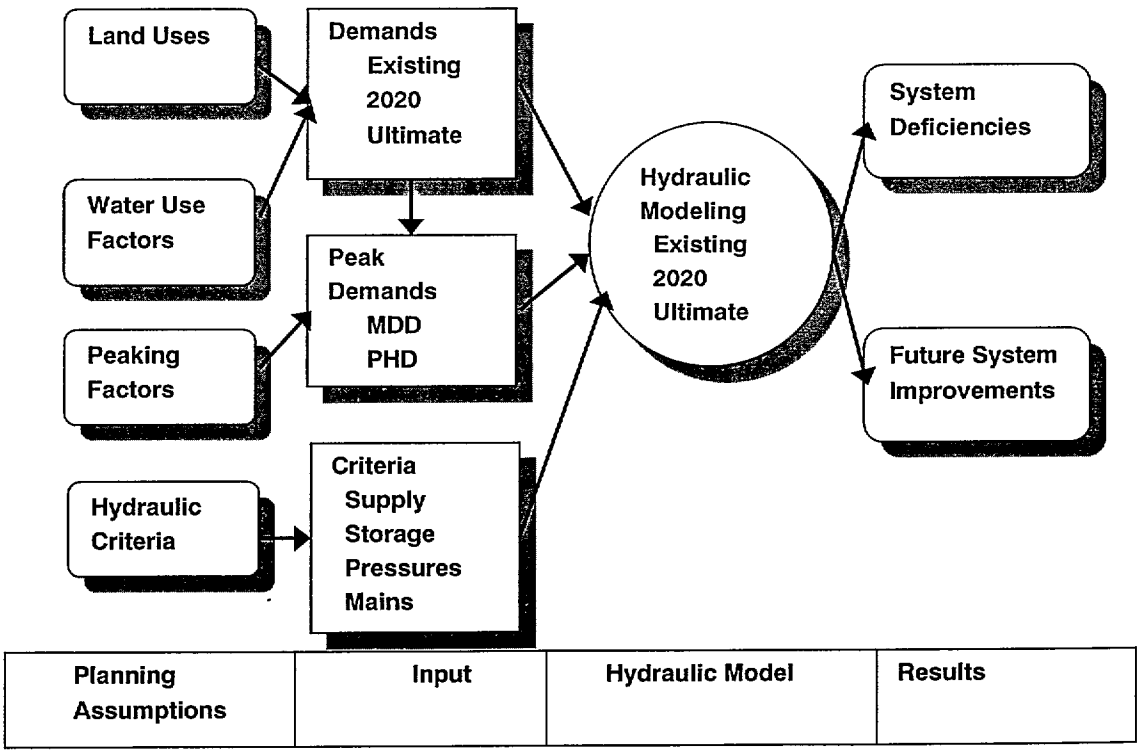
This section presents the design criteria established for evaluation of the existing water system facilities, and for planning and sizing future facilities; the purpose and development of the computer network models; and hydraulic analysis of the City's water distribution system. The output from the hydraulic simulations is used to evaluate the water system and to identify system deficiencies.

7.1 Methodology for Water System Planning Criteria

As described in Section 3, Water Demands, a land use based approach was used in this project to develop and distribute the existing and future water demands that were used in the hydraulic model to analyze the distribution system. The water demands are based on existing and future land uses that were developed in Section 2, Physical Conditions, Land Use and Population. A water use factor was developed for each existing and future land use, and applied to land use polygons using MapInfo, a GIS software. MapInfo was also used to calculate water demands for each water nodal polygon. The water nodal polygons are areas assigned to specific nodes in the hydraulic model. The nodal water demands were then entered in the hydraulic model. The development of the hydraulic criteria and the water system model is described below.

Figure V1-7.1, Overview of Water System Planning Process, provides an overview of the methodology used in establishing and utilizing water system planning criteria.

Figure V1-7.1 Overview of Water System Planning Process



191

7.2 Development of System Hydraulic Criteria

Water system criteria are established for assessing the performance of the water systems, as simulated by the computer hydraulic models, and for sizing future facilities. The recommended criteria considers specific guidelines recommended by the *Egyptian Code for Water and Wastewater Networks*, Suez Canal Authority operations, and accepted industry standards. The intent of these criteria is to plan and operate water systems with sufficient capacity to satisfy both daily and maximum demand conditions.

Computer models developed for each city were used to identify existing deficiencies and to determine future improvements that are needed to accommodate future growth. Facility deficiencies were be identified through observing the water system performance under various modeling scenarios. Specific system segments that influence operating conditions include the following:

- Water Supply Facilities
- Storage
- Service Pressures
- Distribution Mains
- Water Demand Peaking Factors

A summary of the system hydraulic criteria is shown in Table V1-7.1, System Hydraulic Criteria.

7.2.1 Water Supply Facilities

In determining the adequacy of the water supply facilities, the source of supply must be sufficient to meet the various demand conditions and also be able to meet demand during emergency conditions such as power outages and natural or man-created disasters. A water system's source of supply must be capable, at a minimum, of meeting maximum day demands (MDD) for all aspects, including raw water conveyance, treatment, and treated water pumping. Peak Hour Demand (PHD) can be accommodated by pumping from operational storage, but MDD conditions can occur for several consecutive days.

The raw water and treated water pumping facilities within each water system will be evaluated for their ability to meet MDD conditions.

7.2.2 Storage

The principal function of storage is to provide a reserve supply of water for (1) operational equalization, (2) fire reserve, and (3) emergency needs. Operational storage is directly related to the amount of water necessary to meet peak demands. The intent of operational storage is to supply the difference in quantity between the peak demands and the available supply. Fire storage is the volume of water that is kept in storage at all times to suppress fires. The volume of water allocated for emergency uses is the owner's decision that is typically based on the historical record of emergencies, on the amount of time expected to lapse before the

107

emergency can be corrected, and on the degree of inconvenience to the customers that the purveyor is willing to allow.

Table V1-7.1 System Hydraulic Criteria

System Segment	System Hydraulic Criteria	
Source of Supply	The Sweetwater Canal source is assumed to be physically and contractually available to provide adequate MDD supply	
	Raw water intake and pumping; treatment facilities; and treated water pumping will be evaluated using MDD criteria	
Storage	Operational storage will be equivalent to 15% MDD	
	Fire storage will be based on land use and will provide for 160 l/s with a 4 h duration to an industrial area	
	Emergency storage will be equivalent to 15% MDD	
Service Pressures	Maximum pressure	55 m
	Minimum pressure, during peak hour	28 m
	Minimum pressure, during fires	14 m
Distribution Mains	Sized to meet the greater of:	PHD
		MDD + Fire Flow
	Maximum desirable pipeline velocity	2.0 m/s
	Maximum desirable head loss, 300 mm and smaller	10 m/1000m
	Maximum desirable head loss, 400mm and larger	3 m/1000m
Fire Flow	Residential	80 l/s
	Commercial	100 l/s
	Industrial	160 l/s
Water Demand Peaking Factors	Maximum Day Demand (MDD)	1.3 x ADD
	Peak Hour Demand (PHD)	2.0 x ADD

7.2.2.1 Operational Storage

Operational storage is the amount of water stored in a system to regulate fluctuations in demand so that extreme variations will not be imposed on the source of supply. If there is no operational storage, the source of supply must be capable of meeting the PHD condition. Operational storage is normally provided, since the increased cost of providing treatment and pumping facilities capable of meeting PHD conditions is usually not cost-effective. With operational storage, system pressures are improved and stabilized to better serve customers throughout the service area. If data is unavailable, operational storage is often estimated to be 20 to 25 percent of the total maximum day demand. Available data for the Canal Cities appears to indicate that a lesser amount of operational storage will suffice. For the CCMP, 15 percent of maximum day demand is recommended.

7.2.2.2 Fire Storage

Fire storage is the amount of water required when the capacity of the production facilities is insufficient to meet the maximum day demand plus fire flow demands for a certain duration. Several approaches maybe used to develop fire storage provisions. The *Egyptian Code for Design of Treatment Plants* recommends a fire flow of 50 L/s for cities with

population over 200,000; however, no duration is specified. If a duration of 4 hours is assumed, the required fire storage would be 720 m^3. The Cairo East Bank Water System Master Plan Update, completed in January 1998, adopted a fire storage criterion of 120 m^3 for every 10,000 people in a service area. Applied to Suez, this would amount to 6,000 m^3.

An alternative approach that is compatible with the land use approach used for developing demand factors was selected for the CCMP. This approach considers different fire flow requirements for different land uses. Typically, the flows required to suppress a fire in an industrial area are greater than those needed in a residential area. This must be balanced with the fact that most of the fire hydrants in the Canal Cities are supplied by 100 mm pipes capable of only limited flow. For the CCMP, fire flow and duration requirements will be based on the values presented in Table V1-7.2, Fire Flow Factors. The resulting fire storage for each system will be 2,304 m^3.

Table V1-7.2 Fire Flow Factors

Land Use	Fire Flow, l/s	Duration, h
Residential	80	2
Commercial	100	2
Industrial	160	4

7.2.2.3 Emergency Storage

Emergency storage is the volume of water needed to meet demand during emergency situations such as electric power outages, natural disasters, pipeline failures, major trunk line failures, or pump failures. The amount of emergency storage within a particular water distribution system is the owner's option, based on an assessment of risk and the desired degree of system dependability. Guidelines and policies for emergency storage vary widely. Often the amount of storage required is expressed as a percentage of the total amount of water supplied for an average day, and guidelines range from 15 to 100 percent. Other guidelines suggest that the reservoir storage at the treatment plant should never fall below mid-depth, which means that emergency storage and fire flow reserve should be equal to the amount of storage used for system operation. This would result in an emergency storage requirement of 15 percent of maximum day demand.

7.2.3 Service Pressures

Differences in service pressures in water distribution systems are a function of consumption and production, condition and type of pipe, and distance in the system from the pump stations or reservoirs. It is essential that the water pressure at the consumer's tap be neither too high nor too low. Low pressures cause annoying flow reductions when more than one water-using appliance is used. High pressures may cause faucets to leak and valve seats to wear out quickly. Additionally, high pressures usually result in wasted water and higher water utility bills.

104

Distribution systems should be capable of supplying the current and planned demands for residential, commercial, and industrial water users at all times, as well as providing the necessary capacity for fire protection. Individual distribution mains should be of the most economical size that will satisfy these requirements and result in the lowest total cost, including the costs of construction, operation, and maintenance.

The minimum service pressure head considered acceptable is 28 m. This should be adequate to supply water-consuming appliances on the sixth floor of a building. Higher buildings will need to provide individual booster pumps, a common practice in the Canal Cities and throughout Egypt. The minimum service pressure of 28 m should be provided during PHD conditions.

The second minimum service pressure head criterion relates to the capability of the distribution system to provide the required fire flows and maintain an adequate residual pressure near the fire. Given that the occurrence of a fire during MDD is very possible, these adopted criteria should apply during MDD. A 14 m residual pressure at the nodes near the fire is recommended for evaluation of the Canal Cities systems. This pressure should be available during a fire and at MDD conditions.

A maximum service pressure criterion is not considered critical in the Canal Cities. The normal shutoff head for the treated water pumps is around 65 m and should not damage distribution system piping. Nevertheless, for good planning and efficient operation, 55 m is recommended for evaluation.

7.2.4 Distribution Mains

Treated water transmission mains are generally sized to carry the greater of (1) the peak hour demand, or (2) the maximum day demand plus fire flow. Other criteria related to the distribution piping include the maximum and minimum velocities and maximum allowable friction losses.

Velocity and unit head losses at peak flow rates are indicators of overloaded water mains. Velocities should generally be less than 2.0 m/s, although velocities of up to 3 m/s are acceptable in certain instances, such as short runs and inside pump stations. Allowing high velocities in long piping segments could result in water hammer problems. Unit head loss at maximum flow rate generally should not exceed 10 m/1000 m, or in the case of larger piping (400 mm or larger), 3 m/1000 m should be the appropriate upper limit. The hydraulic models will compute this head loss for each pipe under each demand scenario.

The roughness coefficients for calculating headloss in pipes will be based on industry standards for similar pipe materials and service age. The roughness coefficients are presented in Table V1-7.3, Table of Roughness Coefficients.

Table V1-7.3 Table of Roughness Coefficients

Pipe Material	Age (Years)						
	0	5	10	20	30	40	50
Asbestos Cement	140	136	133	130	126	123	120
Cast Iron	130	120	111	96	87	80	60
Ductile Iron	130	120	111	96	87	80	60
Plastic (PVC)	150	148	146	144	142	141	140
Steel	125	115	106	91	82	75	65

7.2.5 Water Demand Peaking Factors

Peaking factors represent the increase above the average day demand (ADD) experienced during a specified time period. The various peaking conditions are statistical concepts or numerical values obtained from historical data and, at times, tempered by engineering judgment. Peaking conditions that are of particular significance to hydraulic analysis of the water system include the maximum day demand (MDD), and the peak hour demand (PHD). Peaking factors used in expressing these demands as a function of the ADD were developed based on the demand patterns within the study area boundary.

MDD is the highest expected water demand during a 24-hour period of the year. MDD peaking factors are expressed as a multiplier applied to the average day demand. A water system is customarily tested in the hydraulic model under maximum day plus fire flow conditions.

Maximum day demands plus fire flows stress the water system in the specific area of the fire and often show existing deficiencies, if any, in the general area of the fire. To evaluate the effect of maximum day plus fire flow throughout a system, the fire has to be simulated at various critical areas of the system. This condition also demonstrates the performance of supply sources, booster pumps, and storage tanks operating under stressful conditions. Table V1-7.4, Historical Peaking Factors, presents a summary of the historical peaking factors analyzed.

Table V1-7.4 Historical Peaking Factors

Demand Condition	(m^3/d)	Peaking Factor
Average Day ADD[1]	159,800	1.00
Maximum Day MDD[2]	199,300	1.25
Peak Hour PHD[3]	264,000	1.65

Notes:
1. The total annual water demand divided by 365.
2. The highest water demand during any 24-hour period of the year.
3. The highest water demand during any one-hour period of the year.

Available water production records indicate that for the study area, the maximum day to average day ratio was about 1.2 to 1.3. *The Egyptian Code for Water Networks recommends a maximum day flow of 1.6 to 1.8 times greater than the average annual demand.* However, a

factor of 1.3 was used to evaluate the water systems of the study area since this factor represents actual conditions.

Maximum Day Demand = 1.3 x Average Day Demand

The PHD is the highest expected water demand during any one-hour period of the year. PHD is expressed as a multiplier applied to the average annual demand. Peak hour flow simulates high flows throughout the system during peak demands and identifies areas of low pressures in the water system. This condition is similar to maximum day plus fire flow, only in this case the entire system is exposed to stress.

Historical records indicate that the peak hour demand in the study area has been 1.6 to 1.7 times greater than the average day demand. *The Egyptian Code for Water Networks recommends a peak factor of 2.5.* However, recent data from the pressure and flow monitoring in this study indicates that peak flows of 1.8 times higher than average flow were attained during January 1999. Given that peak flows during the summer will normally be higher than in the winter (as verified by sewer flow records), a factor of 2.0 is considered appropriate and was used for evaluating the water system for the study area.

Peak Hour Demand = 2.0 x Average Day Demand

7.3 Water System Model

7.3.1 Overview

Hydraulic network analysis is used in all aspects of water distribution planning, design, operation, management, emergency response, system reliability, fire-flow capacity, and most recently water quality. A critical element in preparing the Canal Cities Water Master Plans was the development of a computer model of each city's distribution system to assist in evaluating the adequacy of both present and future facilities.

Modeling water distribution systems with computers is a proven, effective, and reliable technology for simulating and analyzing system behavior under a wide range of hydraulic conditions. The network model is represented by a collection of pipe lengths interconnected in a specified topological configuration by node points, where water can enter and exit the system. Computer models utilize laws of conservation of mass and energy to determine pressure and flow distribution throughout the network. Conservation of mass dictates that for each node the algebraic sum of flows must equal zero. Conservation of energy requires that along each closed loop the accumulated energy loss must be zero. These laws can be expressed as nonlinear algebraic equations in terms of either pressures (node formulation) or volumetric flow rates (loop and pipe formulation). The non-linearity reflects the relationship between pipe flow rate and the pressure drop along its length. Due to the presence of non-linearity in these equations, numerical solution methods are iterative. Initial estimated values of pressure or flow are repeatedly adjusted until the difference between two successive

iterates is within an acceptable tolerance. Several numerical iterative solution techniques have been suggested, from which the Newton method is the most widely used.

Because of the widespread use of microcomputers during the last two decades, network modeling has taken on new dimensions. Engineers today rely on computer models to solve a variety of hydraulic problems. The use of interactive on-screen graphics to enter and edit network data and to color-code and display network maps, attributes, and analysis results has become commonplace in the water industry. This makes it much easier for the engineer to construct, calibrate, and manipulate the model and visualize what is happening in the network under various situations such as non-compliance with system performance criteria. The engineer is now able to spend more time thinking and evaluating system improvements and less time on flipping through voluminous pages of computer printouts, thus leading to improved operation and design recommendations. The new generation of computer models has greatly simplified the formidable task of collecting and organizing network data and comprehending massive results.

7.3.2 Hydraulic Model Selection

There are several network analysis software packages available with a variety of features and capabilities. The selection of a particular model generally depends on user preferences and the operational requirements of the water system. Many of the available software packages offer additional capabilities beyond standard hydraulic modeling, such as water quality assessment (both conservative and reactive species), multi-quality source blending, travel time determination, energy and power cost calculation, leakage and pressure management, fire flow modeling, surge (transient) analysis, system head curve generation, automated network calibration, real-time simulation, and network optimization.

To select an appropriate model, it is essential to develop evaluation criteria that are based on the needs of the system being modeled. These criteria should be developed based on the project objectives. For the CCMP these objectives include hydraulic analysis capabilities, availability of support, graphics output types, model capacities, simulation characteristics, ease of use, input formats, possibly water quality tracing capabilities in the future, and cost. After considering these specific objectives, a computer program called EPANet was selected for the CCMP.

In March 1993, the U.S. Environmental Protection Agency released a water hydraulic model, which runs in the user-friendly environment of Microsoft Windows. The model, known as EPANet, quickly became popular with public utilities and consultants, as it supplemented the modeling capabilities of previously available models with ease of use and higher processing speed. EPANet is a sophisticated model that can accommodate a wide range of water system components including pressure reducing valves, pressure sustaining valves, flow control valves, fixed and variable speed pumps, cylindrical and variable cross-sectional area tanks, variable head reservoirs, multiple inlet/outlet tanks and fixed surface

elevation reservoirs. EPANet functions in a steady-state analysis mode or will perform extended period simulations of the system. It also contains a very sophisticated water quality analysis "engine" that allows analysis of the distribution of conservative chemical components that do not react with the water or reactive chemicals such as chlorine that decay or react over time. EPANet is public domain software, available free of charge from the U.S. Environmental Protection Agency. Its modeling power and ease of use made it an ideal choice for the CCMP project.

7.3.3 Development of a System Model

Computer modeling requires gathering detailed numerical information on the physical characteristics of the modeled water system, such as pipe sizes (diameters), lengths, and system geometry. Operational characteristics such as pump curves, historical average and peak water consumption, and system controls are also needed. EPANet requires the compilation of a computer input file that contains network and operational data necessary for the analysis.

Pipes and nodes represent the physical elements in describing the water network. A node represents a location in the network where a demand can be applied or water supplied to the system; a pipe segment represents the actual transmission or distribution pipe itself. For ease of identification, a numbering system was established, first for the nodes, and then for the pipe segments. Each node was assigned a unique number and was located geographically by assigning northing and easting coordinates (for computer graphical plotting). Each pipe was also assigned a unique pipe number and listed with pipe diameter, length, and roughness coefficient. Most pipe diameters, pipe lengths, and pipe materials were obtained from record drawings furnished by SCA. Node elevations were determined from available contour maps.

Development of the nodal demands normally involves distributing the average day flow throughout the system in proportion to land use. This is commonly accomplished by determining a demand area for selected nodes, measuring the area of each different land use within the demand area, multiplying the area of each land use within the demand area by its respective average day water use factor, summing the water demand for each land use within the demand area, and applying the sum at the node. The GIS software, MapInfo, was used to develop the nodal demands. The demand areas and the land uses were mapped in separate layers in the GIS software. The GIS software capability of "polygon processing" intersected the different layers and computed the land use sums within the various demand areas. When the water use factors developed for each land use were multiplied by their respective land use, the result was the average day system demand, proportioned to each selected node by land use. The water system computer model was then used to apply appropriate global peaking factors as determined from the water use history. Development of the land use water factors is discussed in Section 3.

Figure V1-7.2, Nodal Polygon Development, is a sample illustration showing the water demand polygon, demand nodes, and pipelines.

A computer model was developed for each of the CCMP cities. All pipes 300 mm and larger were included in the models.

Pump performance curves are an important element of the CCMP water system models since the pump curves are needed to accurately simulate the hydraulic conditions in the water system. Pump performance curves consist of the head versus capacity (H-Q) relationships plotted as a smooth curve for a specific speed. The pump head (H), expressed in meters, refers to the height the water is lifted (or pumped), while the capacity (Q), expressed in liters per second, refers to the corresponding flow.

CCMP pump performance curves were established in pump tests conducted at each city by Heath Consultants as a part of the CCMP project. In a few isolated cases, it was not possible to test an existing pump due to mechanical or electrical problems when adjacent pumps were tested or the pump test data appeared flawed. If this occurred, data from adjacent pumps was used. If the pumps had been installed within the past year, the factory certified pump curves were used. The pump test data incorporated into the computer models is contained in Appendix V1-7.1.

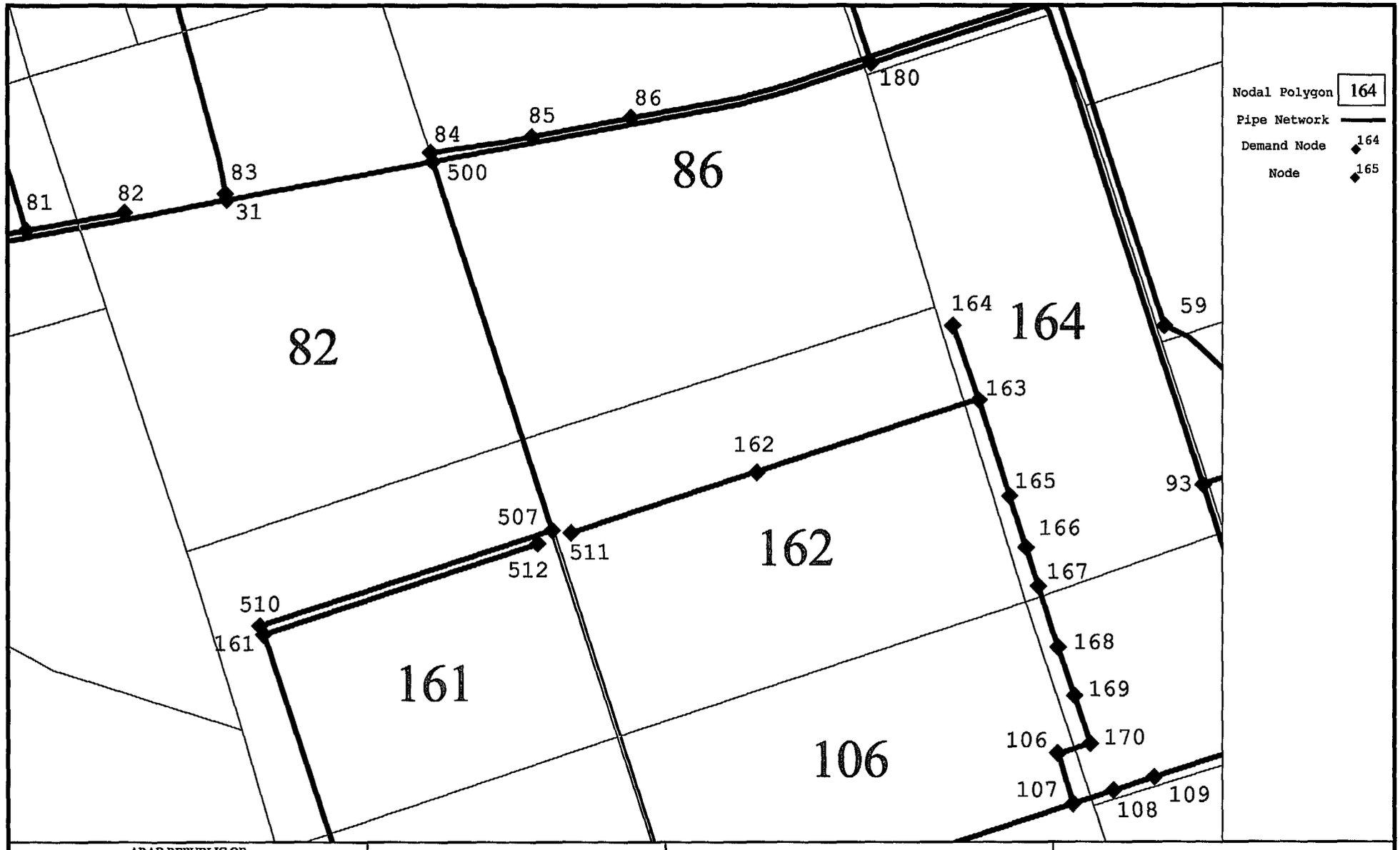
The EPANet input and map files for existing and year 2020 are contained in Appendix V1-7.2. The modeled water distribution system is shown in Appendix V1-7.3.

7.3.4 Model Calibration

Each of the CCMP hydraulic models was calibrated to establish a level of confidence in the pressures and flows it simulates. The calibrated models served as an established benchmark for further analysis and evaluation. Pressure and flow values from future analysis scenarios were compared to the benchmark model. The future analyses consisted of modifications to the calibrated models to simulate other water consumption patterns, operating scenarios, and additional facilities.

Calibration of a water system computer model is often complicated by the fact that some data are known and unchanging, some are variable over time, and others are estimated. Pipe information such as diameter, length, and location is known. Operating data vary with time of day, season, and total number of customers. For instance, pumping rates and discharge pressures vary over time to respond to variations in consumption. All of these issues were addressed in the calibration of the CCMP models.

The calibration involved primarily comparison of the flows and pressures predicted by the model to measured flows and pressures. During January, February, and March, Heath Consultants collected pressure data at several locations in each Canal City using data logger equipment which gave continuous pressure readings throughout one day for each location.



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IN ASSOCIATION WITH
MONTGOMERY WATSON SABBOUR ASSOCIATES

NODAL POLYGON
DEVELOPMENT

DATE: AUGUST 1998 FIGURE: VI-7.2

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SCA then furnished data listing the pumps that were running for each hour throughout corresponding days. The model input file was adjusted to reflect the appropriate pump operation and the resulting pressure compared to the measured pressure. To accomplish the model calibration, the global peaking factor was adjusted in successive model runs until representative results were obtained.

Table V1-7.5, Hydraulic Model Calibration Summary, presents the calibration results. The table provides comparisons for pressures and flows between the recorded system measurements and the model predicted simulations. As the table illustrates, the model predicted pressures, given the record flow conditions, matched very favorably with the recorded pressures. In some cases, as seen in the table, it was impossible to match recorded pressures without "closing" some lines in the model, while for other pressure locations, the model quite accurately simulated actual system performance. This is a strong indication that there are some closed valves in the distribution system, and finding and opening these valves is recommended as an improvement to the system.

The calibrated model was used to determine recommended improvements to the existing system as well as to determine improvements that will be required to accommodate growth to the year 2020.

Table V1-7.5 Suez Calibration Summary
Average Daily Flow = 1843.85 L/s

22 February 1999

Time of Day	Pumps Running	Peaking Factor	Flow L/s	Pressure, M: Location No. 7 (Model Node No. 498) Recorded	Pressure, M: Location No. 7 (Model Node No. 498) Model	Pressure, M: Location No. 9 (Model Node No. 73) Recorded	Pressure, M: Location No. 9 (Model Node No. 73) Model	Comments
12:30 to 13:30	Bamag90 3, 4 Amer. - 0 - CTE 2 Bamag180 3, 6	1.55	2857.97	21	27 w/pipes closed. 30 w/pipes open.	34	34	Pipes 577 & 584 closed to develop close correlation with recorded pressures. All pumps operating well right of design head.
16:00 to 17:00	Bamag90 3, 4 Amer. - 0 - CTE 2 Bamag180 3, 6	1.55	2857.97	26	26 w/pipes closed. 29 w/pipes open.	32	32	Pipes 577 & 584 closed to develop close correlation with recorded pressures. All pumps operating well right of design head.
21:30 to 22:30	Bamag90 3, 5 Amer. - 0 - CTE - 0 - Bamag180 1, 3	1.37	2526.07	23	23 w/pipes closed. 26 w/pipes open.	30	30	Pipes 577 & 584 closed to develop close correlation with recorded pressures. All pumps operating well right of design head.

27 February 1999

Time of Day	Pumps Running	Peaking Factor	Flow L/s	Pressure, M: Location No. 1 (Model Node No. 167) Recorded	Pressure, M: Location No. 1 (Model Node No. 167) Model	Comments
14:15 to 15:15	Bamag90 3, 5 Amer. 2 CTE - 0 - Bamag180 3, 6	1.37	2526.07	27	27	All pumps well right of design head.
16:30 to 17:30	Bamag90 1, 5 Amer. - 0 - CTE 2 Bamag180 3, 6	1.40	2581.39	31	31	All pumps well right of design head.
23:00	Bamag90 1 Amer. - 0 - CTE 2 Bamag180 2, 6	1.24	2286.37	29	29	All pumps well right of design head.
23:10	Bamag90 1 Amer. - 0 - CTE 2 Bamag180 2	0.89	1641.03	22	22	All pumps extremely right of design head.

113

Table V1-7.5 Suez Calibration Summary (Continued)

Average Daily Flow = 1843.85 L/s

28 February 1999

Time of Day	Pumps Running	Peaking Factor	Flow L/s	Pressure, M Location No. 4 (Model Node No. 16) Recorded	Pressure, M Location No. 4 (Model Node No. 16) Model	Comments
17:00 to 18:00	Bamag90 3, 5 Amer. - 0 - CTE - 0 - Bamag180 2, 4	1.18	2175.74	25	25	All pumps well right of design head.
19.00 to 20.00	Bamag90 5 Amer. - 0 - CTE - 0 - Bamag180 2, 4	0.97	1788.53	24	24	All pumps well right of design head.
21:45 to 22.45	Bamag90 3, 5 Amer. - 0 - CTE 2 Bamag180 2	0.88	1622.59	20	20	All pumps well right of design head.

01 March 1999

Time of Day	Pumps Running	Peaking Factor	Flow L/s	Pressure, M Location No. 2 (Model Node No. 523) Recorded	Pressure, M Location No. 2 (Model Node No. 523) Model	Pressure, M Location No. 10 (Model Node No. 44) Recorded	Pressure, M Location No. 10 (Model Node No. 44) Model	Comments
	Bamag90 Amer. CTE Bamag180							
	Bamag90 Amer. CTE Bamag180							
	Bamag90 Amer. CTE Bamag180							

Pump and pressure data does not look correct for this day. For example, pump records show only 2 pumps running during peak hour. There are several other inconsistencies.

Table V1-7.5 Suez Calibration Summary (Continued)

Average Daily Flow = 1843.85 L/s

02 March 1999

Time of Day	Pumps Running	Peaking Factor	Flow L/s	Pressure, M: Location No. 3 (Model Node No. 154) Recorded	Location No. 3 (Model Node No. 154) Model	Location No 13 (Model Node No. 97) Recorded	Location No 13 (Model Node No. 97) Model	Comments
13 30 to 14.30	Bamag90 1, 4, 5 Amer. 2, 3, 6 CTE 2 Bamag180 - 0 -	1.45	2673.58	36	35	27	31	All pumps well right of design head.
17:00 to 18:00	Bamag90 1, 4, 5 Amer. 2, 3, 5, 6 CTE 2 Bamag180 - 0 -	1.64	3023.91	37	36	29	31	All pumps well right of design head.
21:00 to 22:00	Bamag90 1, 4, 5 Amer 2, 3, 5 CTE 2 Bamag180 - 0 -	1.25	2304.81	35	33	29	30	All pumps well right of design head.

03 March 1999

Time of Day	Pumps Running	Peaking Factor	Flow L/s	Pressure, M: Location No 5 (Model Node No. 8) Recorded	Location No 5 (Model Node No. 8) Model	Location No. 6 (Model Node No. 432) Recorded	Location No. 6 (Model Node No. 432) Model	Location No. 8 (Model Node No. 51) Recorded	Location No. 8 (Model Node No. 51) Model	Comments
13:30 to 14:30	Bamag90 1, 3, 4, 5 Amer. 2, 3, 6 CTE 2 Bamag180 - 0 -	1.70	3154.55	25	25	28	30 w/pipes closed. 31 w/pipes open.	25	23	Pipes 577 & 584 closed to develop close correlation with recorded pressures. All pumps operating well right of design head
16:30 to 17:30	Bamag90 1, 4, 5 Amer. 2, 3, 5, 6 CTE 2 Bamag180 - 0 -	1.75	3226.74	21	21	25	25 w/pipes closed. 29 w/pipes open.	20	19	Pipes 577 & 584 closed to develop close correlation with recorded pressures. All pumps operating well right of design head.
0:00 to 1:00	Bamag90 3, 4 Amer. 2, 3, 5, 6 CTE 2 Bamag180 - 0 -	1.25	2304 81	28	26	31	33 w/pipes closed. 35 w/pipes open.	26	25	Pipes 577 & 584 closed to develop close correlation with recorded pressures. All pumps operating well right of design head.

04 March 1999

Time of Day	Pumps Running	Peaking Factor	Flow L/s	Pressure, M: Location No. 11 (Model Node No. 43) Recorded	Location No. 11 (Model Node No. 43) Model	Location No. 12 (Model Node No. 178) Recorded	Location No. 12 (Model Node No. 178) Model	Comments
13:30 to 14:30	Bamag90 1, 3, 4, 5 Amer. 2, 3, 6 CTE 2 Bamag180 - 0 -	1.81	3337.37	25	27	20	19	All pumps well right of design head.
17:00 to 18 00	Bamag90 3, 4, 5 Amer 2, 3, 6 CTE 2 Bamag180 - 0 -	1.61	2968.60	24	26	19	18	All pumps well right of design head
0.00 to 1.00	Bamag90 1, 3, 4 Amer. 2, 3 CTE 2 Bamag180 - 0 -	1.33	2452.32	25	29	23	21	All pumps well right of design head

115

8.0 Water System Evaluation

This section presents an assessment of the existing conditions in the Suez water treatment facilities and distribution system and identifies the existing or anticipated deficiencies during the present (year 2000) and projected (year 2020) demand conditions. Recommended improvements are also presented.

8.1 Existing (Year 2000)

8.1.1 Water Treatment Facilities

The general condition and hydraulic capacity of the treatment trains of the Suez Water Treatment Plant have been discussed in Section 4, Existing Water Treatment Facilities.

The listed production capacity for the Suez Water Treatment Plant is summarized in Table V1-8.1, Suez Water Treatment Plant Production.

Table V1-8.1 Suez Water Treatment Plant Production

Treatment Train	Listed Production Capacity (m^3/d) [1]	Evaluated Capacity
Bamag 45	45,000	45,000
Bamag 90	90,000	90,000
CTE	60,000	60,000
Sub total	195,000	195,000
Bamag 180 (under commissioning)	180,000	180,000
Total (Year 2000 capacity)	375,000	375,000

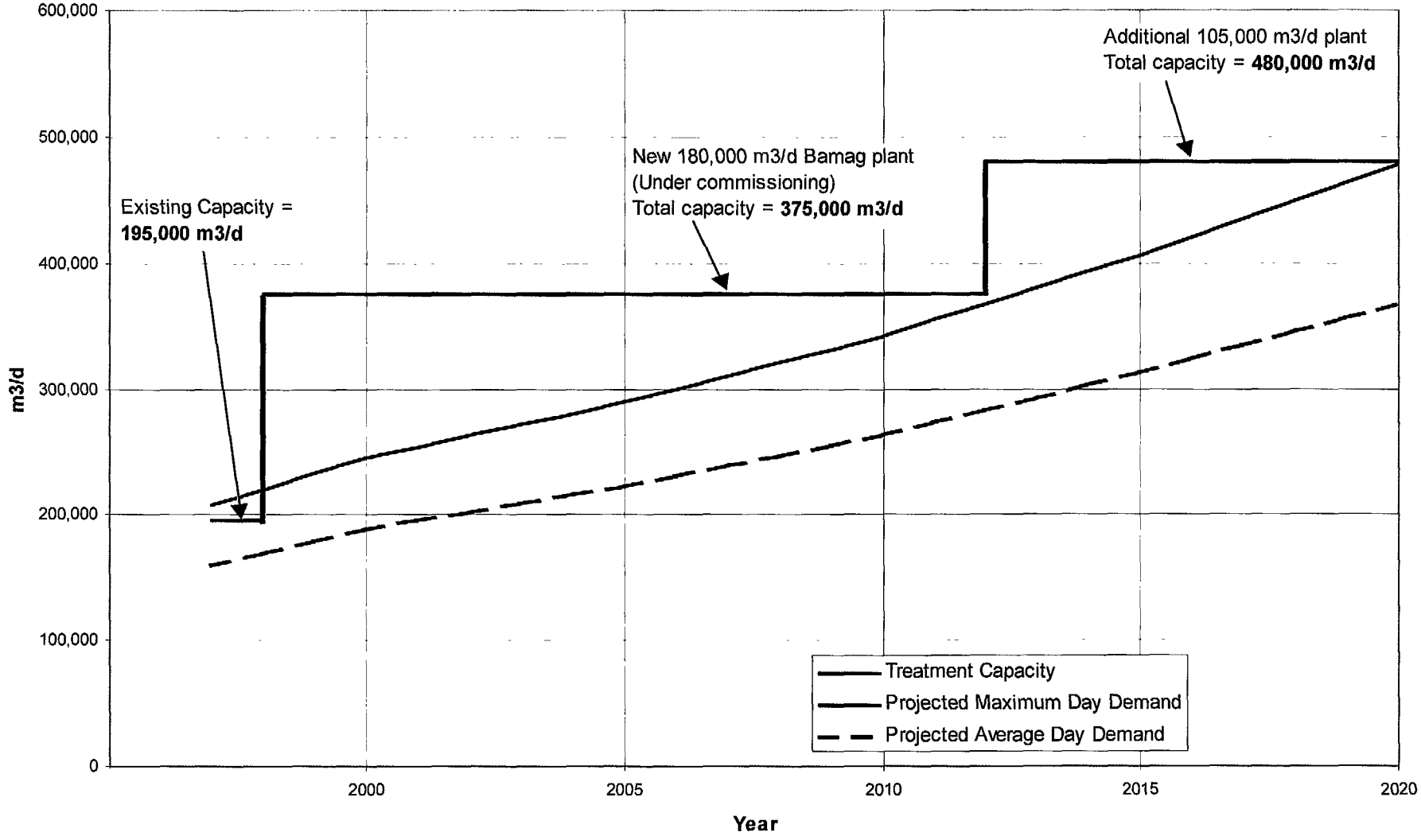
[1] Based on reported design production.

The existing capacity of the Suez Water Treatment Plant is listed at 195,000 m^3/d. The CTE treatment train will be rehabilitated as soon as the Bamag 180 treatment train is in full-time operation. Therefore, for planning purposes, both trains are included in the total production capacity. When the Bamag 180 treatment train is in operation, the total production capacity of the Suez Water Treatment Plant will be 375,000 m^3/d. A tender for rehabilitating the entire CTE plant will be issued as soon as the Bamag 180 is fully operational.

Capacity requirements for water treatment plants are based on meeting maximum day demands (MDD). Figure V1-8.1, Suez Treatment Capacity Vs Projected Water Demands, shows a plot of the existing and projected MDDs versus treatment capacity.

Figure V1-8.1 indicates that the existing Suez treatment plant capacity of 195,000 m^3/d is not adequate to meet the current MDD. After the Bamag 180 is operational and the CTE treatment train has been rehabilitated, the plant will be able to supply enough treated water to meet the MDD requirement until year 2012. After that time, another 105,000 m^3/d plant will be needed to meet the demands until year 2020. The former locations of Group 1 and Group

116



ARAB REPUBLIC OF EGYPT SUEZ CANAL AUTHORITY NATIONAL ORGANIZATION FOR POTABLE WATER AND SANITARY DRAINAGE	USAID CANAL CITIES WATER AND WASTEWATER MASTER PLAN	SUEZ TREATMENT CAPACITY VS PROJECTED WATER DEMANDS	BLACK & VEATCH INTERNATIONAL IN ASSOCIATION WITH MONTGOMERY WATSON SABBOUR ASSOCIATES DATE: AUGUST 1999 FIGURE: V1-8.1

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3 slow sand filtration trains are possible sites for this expansion. If necessary, an adjacent vacant lot northeast of the water treatment plant could be purchased and used for the expansion.

8.1.2 Water Distribution System

8.1.2.1 Pipelines

When compared to the pressure recording data, the hydraulic modeling strongly indicated that a few valves near the extreme westerly part of the system are closed which results in reduced pressures. It is recommended that all valves along the westerly portion of the system be inspected to verify that they are not closed. The existing system was analyzed assuming that there were no closed valves on the west side of the system.

A section in the south-central portion of Suez is subject to chronic low pressures. This can be easily corrected by two cross connections. A 400-mm connection (Pipe No. 1000) should be made from Node No. 423 to Node No. 512, solving a dead-end section. Another 400-mm connection (Pipe No. 1002) should be made from Node No. 423 to Node No. 430, tying the existing 400-mm line to the adjacent 900-mm line. The node locations are given in Appendix V1-4.3.

These recommended pipeline improvements are listed in Table V1-8.2, Year 2000 Recommended Pipeline Improvements.

Table V1-8.2 Year 2000 Recommended Pipeline Improvements

Pipe No.	Diameter, mm	Approximate Length, m	Description
1000	400	40	New cross connection near canal
1002	400	20	New cross connection near canal
Total Length, m		60	

8.1.2.2 Pumping and Storage

As discussed in Section 4, Existing Water Treatment Facilities, the existing storage, not including the disinfection storage, is 45,388 m^3. The required operational storage according to the analysis criteria, is 15 percent of MDD, which equates to 31,065 m^3. The emergency storage requirement is the same amount as the operational storage. Fire flow storage adds another 2,300 m^3 for a total required storage of 64,430 m^3. Therefore, the existing storage deficit is 19,100 m^3.

However, when combined with future storage requirements as discussed for 2020 conditions, a reasonable recommended improvement to the existing system would be to install a storage reservoir that provides one-third of the 2020 deficit of 100,210 m^3, or 33,400 m^3. A 2160 m^3/h booster pump station is recommended to pump into the system through the 1200 mm line near the north end of the existing system. (This has been modeled to be near Node 20.) A reservoir of this capacity would be approximately 60 m in diameter and 14 m high

with 2 m of freeboard. The ground surface in this area is at elevation 25. As a result of the higher elevation, pressures in this area are lower than in the lower portions of the system. A booster pump would tend to locally increase pressures and also cause the pumps at the water treatment plant to operate more efficiently.

Emergency storage will be available during loss of power only if standby power is provided. Standby power could be provided at the new ground storage reservoir and booster pump installation, but the reservoir will also be providing operational storage and the required amount of emergency storage cannot be guaranteed at all times. Therefore, it is recommended that standby power be provided at the new booster pump station and at one of the existing pump stations. This would provide emergency storage at two locations in the system. If the standby power is adequate to power enough pumps to supply approximately 850 L/s (approximately 46 percent of average flow), flow from emergency storage can be provided for around 10 hours.

8.1.2.3 Control Systems

The existing system has no automatic controls. Pumps are manually turned on and off based on observed pressures at the plant or on the basis of operating experience. At a minimum, the pumps should operate automatically by means of pressure switches. Optimally, a computer-based Supervisory Control and Data Acquisition (SCADA) system is recommended. Such a system would not only operate the system automatically but would also provide the operators a continuous view of system conditions and allow easy adjustment of system operation.

8.2 Year 2020

8.2.1 Water Treatment Facilities

Figure V1-8.1 shows that assuming the growth in Suez follows the demand projections, a new 105,000 m^3/d treatment plant will be needed to meet the MDD in year 2012. This new treatment capacity will be adequate to meet the demands until year 2020.

A site adjacent to the Bamag 180 treatment train, on the northeast side of the plant, may be available for this additional treatment train. Alternatively, the sites of the abandoned Group 1 and Group 3 slow sand filters could be used.

8.2.2 Water Distribution System

In accordance with the analysis for the existing system, the 2020 peak hour analysis was conducted using a peak hour factor of 2.0 times the average day flow. The 2020 analysis assumes that all recommended improvements to the existing system are in place.

8.2.2.1 Pipelines

Results of the hydraulic analysis indicate the need for several pipeline improvements such as cross connections, parallel lines, and pipe size enlargement, to meet 2020 demands and to provide adequate system pressures. Pipeline extensions are also needed to extend water service to new areas that will develop between years 2000 and 2020. A total of approximately 40 km of pipeline improvements and extensions needed to meet 2020 demands are listed in Table V1-8.3, Year 2020 Recommended Pipeline Improvements.

Table V1-8.3 Year 2020 Recommended Pipeline Improvements

Pipe No.	Diameter, mm	Approximate Length, m	Description
566	300	469	Pipe replacement with 400 mm
570	300	716	Pipe replacement with 400 mm
574	300	459	Pipe replacement with 400 mm
10000	400	805	New extension
10002	400	1,864	New extension
10004	600	2,376	New extension
10006	800	248	New extension
10008	800	1,087	New extension
10010	800	330	New extension
10012	800	1,620	New extension
10014	800	797	New extension
10016	800	674	New extension
10018	800	1,663	New extension
10020	1200	1,813	New extension
10022	1200	1,073	New extension
10024	1200	1000	New extension
10026	1200	689	New extension
10028	1200	1,442	New extension
10030	1200	2,103	New extension
10032	1200	1,178	New extension
10034	800	1,281	New extension
10036	800	1,652	New extension
10038	800	936	New extension
10040	800	1,160	New extension
10042	800	2,228	New extension
10044	900	337	New extension
10046	900	595	New extension
10048	600	958	New extension
10050	600	850	New extension
10052	600	523	New extension
10054	600	1,253	New extension
10056	300	227	New extension
10058	300	347	New extension
10060	600	1,383	New extension
10062	600	1,194	New extension
10064	600	704	New extension
10066	400	473	New extension
10068	400	21	New extension
10070	1200	20	New extension
10072	300	20	New cross connection in southwest
10074	400	20	New cross connection in south
10076	400	530	New parallel line in southwest
10078	400	20	New cross connection in southwest
10080	400	459	New parallel line in southwest
Total Length, m		39,597	

Due to the large change of ground elevation from the south to the north, it was necessary to establish two pressure zones for the 2020 system. Pressure sustaining valves PSV 6001, PSV 6002, and PSV 6003 will be required on the higher pressure zone to maintain pressure on the upstream side. At a pressure of 28 m, the valves will release water to the lower pressure zone.

8.2.2.2 Pumping and Storage

Existing storage, not counting required disinfection storage, is 45,388 m^3. The required operational storage per the analysis criteria is 15 percent of MDD, or 71,649 m^3. According to the analysis criteria, the emergency storage requirement is the same amount as the operational storage. Fire flow adds another 2,300 m^3, for a total storage of 145,598 m^3. An additional 100,210 m^3 will be required to meet the 2020 storage requirements.

The 100,210 m^3 of 2020 storage will need to be properly divided between the two pressure zones. The 2020 average day flow rate to the upper zone is 2,960 m^3/h. The amount of storage that should be available to the upper zone is therefore 39,416 m^3.

As mentioned in the preceding section, a 33,400 m^3 storage reservoir near Node 20 is recommended for existing conditions. Depending on growth, the recommendation for 2010 would be to install a second 33,400 m^3 reservoir to be tied with the first reservoir near Node 20. Two booster pump stations will be required to accommodate 2020 flows. One of these should pump into the upper zone at Node No. 10062. During PHD, this pump station will need to pump 3,960 m^3/h to the upper zone. The other pump station, pumping into the lower zone at Node No. 20, will be an expansion of the 2,160 m^3/h station recommended as an improvement to the existing system. At PHD, this station will need to pump 3,750 m^3/h to the lower zone. The booster pump stations will be so installed that both can draw from the same reservoir(s). A flow control valve (FCV 6000) will control flow into the reservoir(s).

The recommended 2020 improvements would consist of installation of the last 33,400 m^3 reservoir at the WTP and expansion of the two booster pump stations to their ultimate capacities. The 2,160 m^3/h booster pump station will be expanded to 3,750 m^3/h, while the 3,960 m^3/h booster pump station will be expanded to 7,920 m^3/h. This would provide a total of approximately 100,200 m^3 of storage, which closely approximates the projected deficit.

End of Chapter 8: Water System Evaluation

9.0 Implementation Plan

9.1 Introduction

This section presents the Implementation Plan, which includes recommendations for the water distribution system, pump stations, reservoirs, and water treatment facilities for Suez. These recommendations were grouped into Capital Improvements Projects (CIP). The Implementation Plan was prepared using information from water system inventory, growth and development projections, pressure and flow monitoring surveys, computer modeling, and information provided by SCA officials and staff. The plan addresses requirements for 300 mm and larger pipelines and includes the following components:

9.1.1 Phase 1 Improvements

- Interconnection of existing distribution system pipelines to correct hydraulic deficiencies.
- Construction of new concrete reservoir and new booster pump station.
- Improvements and/or upgrading of the existing water treatment facilities to increase the hydraulic capacity and treatment efficiency.

9.1.2 Phase 2 Improvements

- Construction of extension pipelines to serve areas currently without water service.
- Construction of new concrete reservoir.
- Construction of new booster pumping stations and expansion of existing stations.
- Construction of new water treatment plant

Figure V1-9.1, Suez Water System Recommended Improvements, shows the facilities included in the implementation plan. The pipe interconnection details are shown on Figures V1-9.2, Suez CIP Details 1; Figure V1-9.3, Suez CIP Details 2; and Figure V1-9.4, Suez CIP Details 3. The recommended improvements are grouped into two priorities. Phase 1 improvements are needed to address immediate or near-term deficiencies and should be constructed within the next 5 years. Phase 2 improvements consist of additional facilities which are needed by year 2020. Phase 2 improvements should be reviewed prior to implementation based on the actual growth and water demand patterns.

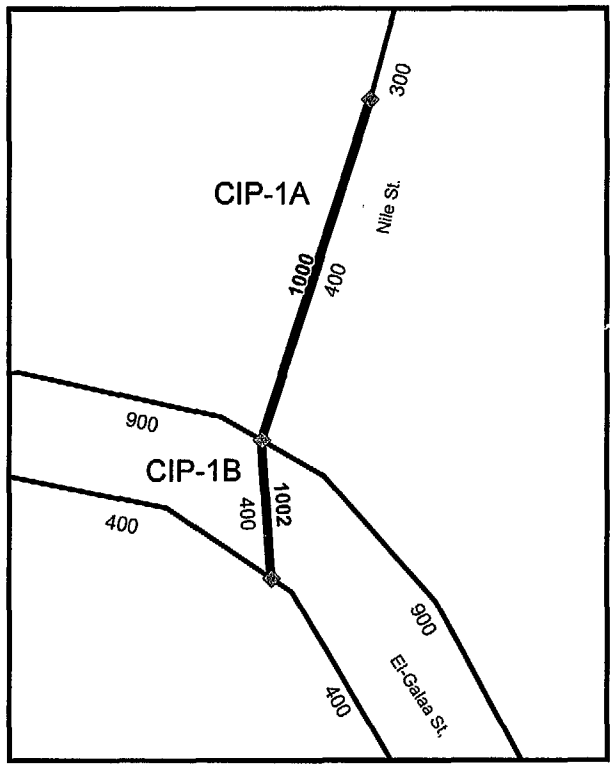
Opinions of costs have been prepared for construction of the water system facilities for each phase.

9.2 Opinion of Cost

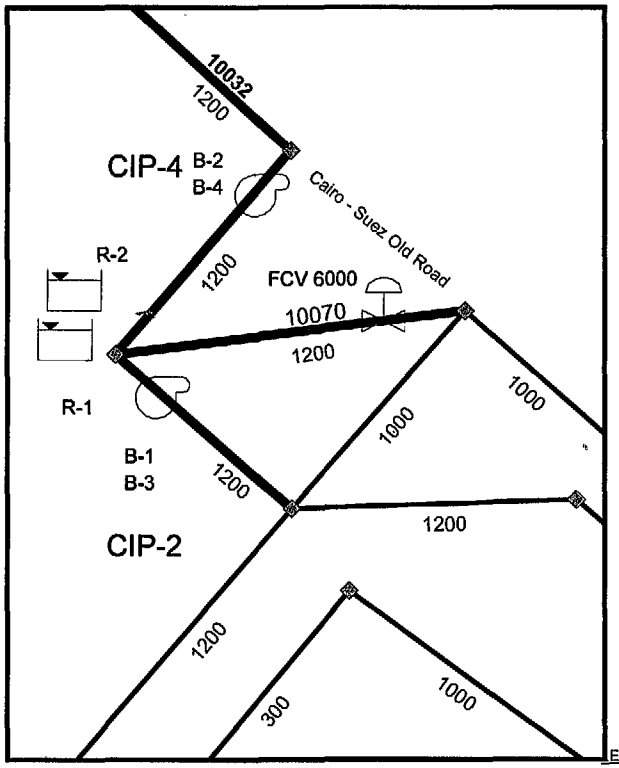
9.2.1 Estimating Guidelines

The cost estimate is to be considered a Budget Level Estimate, or a Class "C" estimate as defined by the AACE (American Association of Cost Engineering). The estimate is based on

182



CIP-1A & CIP-1B

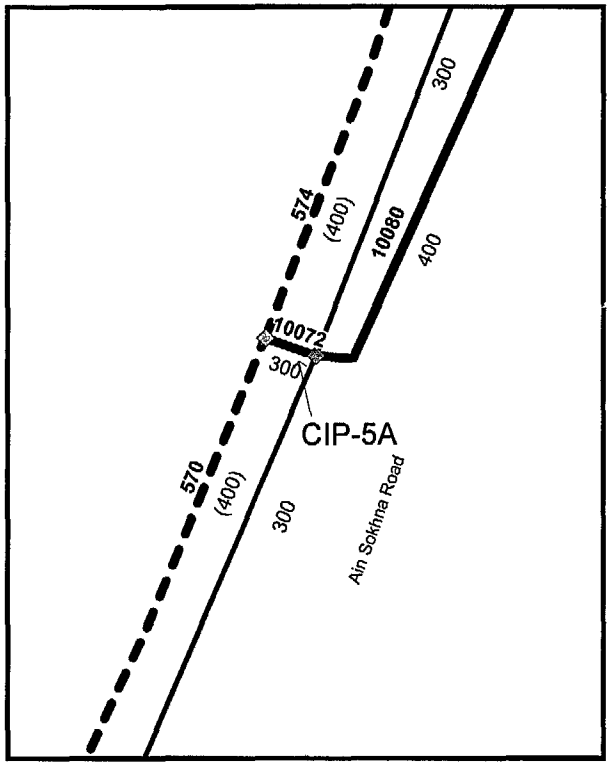


CIP-2 & CIP-4

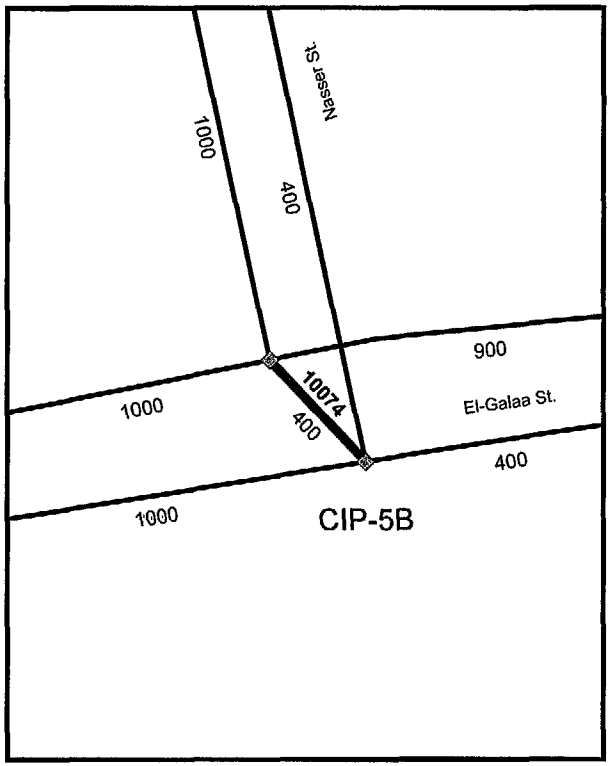
LEGEND

- Existing Main
- Phase 1 Main
- Phase 2 Main
- 994 / 1000 — Pipe ID / Pipe Diameter
- Reservoir
- Booster Pump
- Flow Control Valve

ARAB REPUBLIC OF EGYPT SUEZ CANAL AUTHORITY NATIONAL ORGANIZATION FOR POTABLE WATER AND SANITARY DRAINAGE	USAID CANAL CITIES WATER AND WASTEWATER MASTER PLAN	BLACK & VEATCH INTERNATIONAL IN ASSOCIATION WITH MONTGOMERY WATSON SABBOUR ASSOCIATES	SUEZ WATER CIP DETAILS 1 DATE: August 1999 FIGURE:V1-9.2



CIP-5A



CIP-5B

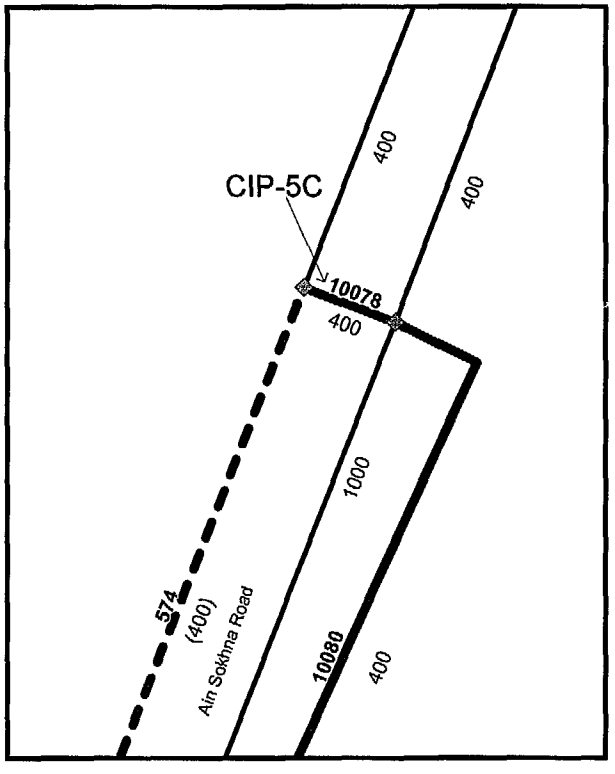
N

LEGEND

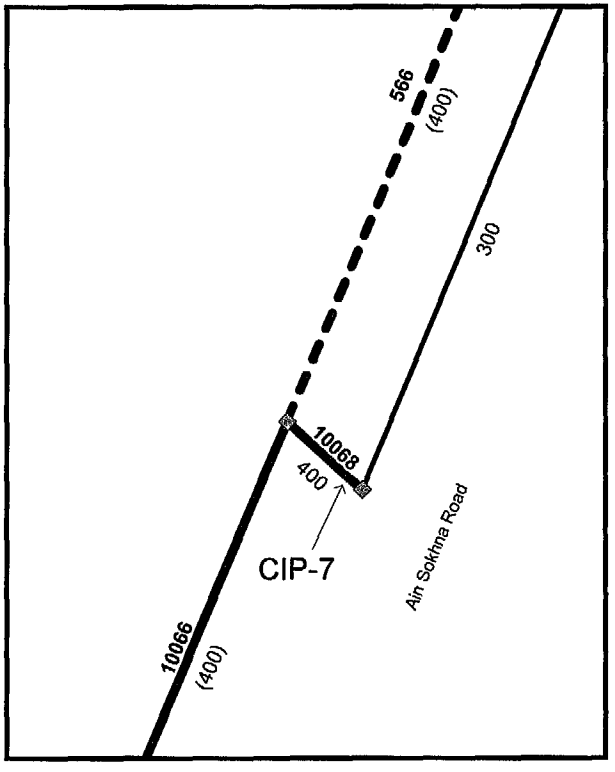
- Existing Main
- Phase 1 Main
- Phase 2 Main
- 994 / 1000 — Pipe ID / Pipe Diameter
- (400) — Pipe Size Enlargment

ARAB REPUBLIC OF EGYPT SUEZ CANAL AUTHORITY NATIONAL ORGANIZATION FOR POTABLE WATER AND SANITARY DRAINAGE	USAID CANAL CITIES WATER AND WASTEWATER MASTER PLAN	BLACK & VEATCH INTERNATIONAL IN ASSOCIATION WITH MONTGOMERY WATSON SABBOUR ASSOCIATES	SUEZ WATER CIP DETAILS 2 DATE: August 1999 FIGURE:V1-9.3

124



CIP-5C



CIP-7

N

LEGEND

- Existing Main
- Phase 1 Main
- Phase 2 Main
- 994 / 1000 — Pipe ID / Pipe Diameter
- (400) — Pipe Size Enlargment

ARAB REPUBLIC OF EGYPT SUEZ CANAL AUTHORITY NATIONAL ORGANIZATION FOR POTABLE WATER AND SANITARY DRAINAGE	USAID CANAL CITIES WATER AND WASTEWATER MASTER PLAN	BLACK & VEATCH INTERNATIONAL IN ASSOCIATION WITH MONTGOMERY WATSON SABBOUR ASSOCIATES	SUEZ WATER CIP DETAILS 3 DATE: August 1999 FIGURE:V1-9.4

125

the combined use of construction cost curves for unit processes, unit price models, and quantities. This type of estimate is the Initial Construction Budget developed to conform to project-specific design criteria. The framework of this estimate usually is based upon quantities and unit price models developed from assumptions from the design criteria, site layout, soils reports, and other relevant information. In this effort the estimate was originated from cost curves for the different unit process and construction components and then trended with the use of unit cost and quantities. As defined by the AACE the expected accuracy of this type of estimate is +30 percent to –20 percent of the actual cost of construction. These costs are based on use of international contractors, management and inspection. These costs should be updated during detailed design to represent current costs based on the inflation index and methods of construction.

9.2.2 Basis of Assumptions

This project involves the installation of approximately 40 km of new water pipelines in diameters ranging from 300 mm to 1200 mm. The pipeline work includes all earthwork, trench shoring, and pipe laying and dewatering, as well as valves, fittings, blow-off assemblies, imported bedding material, compacted backfill, surface restoration, disposal of excavated material, and traffic controls.

Dewatering is assumed to be necessary for all trench depths, and no hazardous materials are expected to be encountered. The assumption was made that 100 percent of the pipe bedding material will be imported and that the excavated material is suitable for backfilling the pipe and trench zones and is assumed to be compacted to 95 percent (Standard Proctor). Excess excavated material will be hauled off-site to a distance of 3 km or less.

The work also includes the construction of new booster pump stations, aboveground concrete reservoirs, new water treatment facilities, and modifications and upgrades to the existing water treatment plant.

9.2.3 Construction Contingency

A contingency of 20 percent has been included in the cost estimates.

9.2.4 Escalation to Mid-Point of Construction

No increase in the construction cost due to price escalation has been added to the current estimated cost.

9.3 General Recommendations

The following are general recommendations to provide sustainability to the Master Plan. These recommendations could be implemented by SCA without or with minimal help from outside contractors.

9.3.1 Leak Detection and Repair

A number of technicians of the Suez SCA Network Department were field-trained on the use of leak detection equipment. As part of this project, a set of leak detection equipment was provided to SCA by USAID for use in Suez. However, the scope of the CCMP study made it possible to inspect only 10 percent of the water distribution system for leakage. SCA should continue and expand the leak survey to cover the remaining 90 percent of the system.

9.3.2 Replacement of Old CI and AC Pipes

SCA should continue the ongoing program of replacing old CI and AC pipes with PVC and DI pipes. This will further strengthen and reduce leaks in the system. There are approximately 3 km of 100 mm CI house connections and 20 km of 150, 200, and 250 mm AC pipes that need to be replaced.

9.3.3 Closed Valve Inventory

The distribution system contains hundreds of valves, most of which are open. However, there appear to be a few valves that could have been inadvertently left closed. As part of this project, pipe and valve locating equipment were also provided by USAID to SCA. This equipment could be used to locate the closed valves.

9.3.4 Replacement of Distribution System Valves

There are approximately 300 gate valves in the distribution system that need to be replaced. These valves are old and most of them are difficult to operate. Most of the valves are not contained in valve boxes. Power-actuated butterfly valves contained in valve boxes should be considered as replacement.

9.3.5 GIS Mapping and Hydraulic Modeling

A set of computers, printers, and digitizing equipment with GIS mapping and hydraulic modeling capability was provided by USAID to SCA as part of this project. The GIS mapping is critical in the ability to update the land use plans and to estimate the water demands at the water demand polygon level in the hydraulic model. The CCMP project will also provide training to the appropriate SCA personnel. SCA should continue to make use of the GIS capability and to use the hydraulic model to reflect changes in land use and in the distribution system.

Recommendations for further studies or preliminary design include the following:

- **Plant Hydraulics Study.** A study of the hydraulic grade line of the different hydraulic components of the treatment plant should be conducted to identify measures to increase the capacity of the components to their design capacities.
- **Pump Rehabilitation and Replacement Study.** This is a detailed study of the raw and treated water pumps to develop a pump rehabilitation and replacement program.

This study includes a physical inspection of the pumps, vibration and other tests, and review of operating and maintenance records.

- **Safety Improvement Study.** CCMP noted various safety needs, especially in the pump stations, and the need for safety equipment, e.g., gas masks, etc. This is strongly recommended for the near future.
- **Alternative Treatment Process Evaluation and Preliminary Design.** Alternative treatment processes should be evaluated to determine the most feasible system components for future treatment plants.
- **Filter Backwash and Clarifier Residuals Disposal Preliminary Design.** A preliminary design should be done in the near future for a disposal system for the water treatment plant filter backwash and clarifier residuals This system is a major plant retrofit and requires investigation of the plant's hydraulic grade line, multiple or a single centralized treatment unit alternatives and location(s), pipe sizes, lengths, alignment, etc., as outlined in Appendix V1-4.3.

9.4 Phase 1 Recommended Capital Improvement Projects

9.4.1 CIP-1 Pipe Interconnections and Replacement

CIP-1 is planned to provide interconnections between existing distribution system pipelines to improve low pressures and provide improved system hydraulic operations. Details for these interconnections (CIP-1A and CIP-1B) are shown in Figure V1-9.2. CIP-1 also includes replacement of 23 km of 100, 150, 200, and 250 mm CI and AC pipes with PVC. The total capital cost for these improvements is estimated to be approximately US $3 million as shown in the following tabulation:

CIP-1 Pipe Interconnections and Replacement

CIP	Pipe No.	Diameter, mm	Approximate Length, m	Unit Cost, $/LM	Total Cost, US $
1A	1000	400	40	313	13,000
1B	1002	400	20	313	6,000
Replacement of 23 km of 100, 150, 200, and 250 mm CI and AC pipes					2,114,000
				Construction Cost Subtotal	$2,133,000
				Construction Contingency 20%	427,000
				Subtotal	$2,560,000
				Engineering and Administration 20%	512,000
				Total Capital Improvement Cost	**$3,072,000**

9.4.2 CIP-2 Pipe, Reservoir, and Booster Pumping Station

CIP-2 is planned to provide additional operational and emergency storage to meet the analysis criteria of 15 percent of MDD for each. Meeting the 2000 peak hour demands and residual pressure criteria will require the construction of a 33,400 m^3 ground storage reservoir

128

and installation of a new 2160 m^3/h pump station expandable to 3750 m^3/h in 2020. The total cost of these improvements is estimated to be approximately US $6.6 million as shown in the following tabulation:

CIP-2 Pipe, Reservoir and Booster Pumping Station

Pipe	Diameter, mm	Approx. Length, m	Unit Cost, $/LM	Total Cost, US $
10070	1200	20	1128	23,000
Pipe Subtotal				23,000
R-1	Ground Storage Reservoir, 33,400 m^3 capacity @ Node 20 (including Flow Control Valve)			2,822,000
B-1	Booster Pumping Station, 2160 m^3/h (including standby generator) @ Node 20			1,741,000
			Construction Cost Subtotal	$4,586,000
			Construction Contingency 20%	917,000
			Subtotal	$5,503,000
			Engineering and Administration 20%	1,101,000
			Total Capital Improvement Cost	**$6,604,000**

9.4.3 CIP-3 Water Treatment Plant Improvements

CIP-3 is planned to provide improvements to the Suez Water Treatment Plant. These improvements will increase the overall treatment efficiency and provide monitoring of flows in each treatment train. Improvements will include rehabilitation of the CTE treatment train; installation of self-cleaning screens on all raw water intakes, except Bamag 180 which already has one; and replacement of treated water flowmeters for Bamag 45 and Bamag 90. It is assumed that the CTE flowmeter will be replaced as part of the plant rehabilitation. The total cost of these improvements is estimated to be approximately US $15.2 million as shown in the following tabulation.

CIP-3 Water Treatment Plant Improvements

Item	Description	Total Cost, US $
T-1	Rehabilitation of CTE Treatment Train	10,000,000
T-2A	Replace two treated water flowmeters (Bamag 45 and Bamag 90)	65,000
T-2B	Install eight self-cleaning screens	500,000
	Construction Cost Subtotal	$10,565,000
	Construction Contingency 20%	2,113,000
	Subtotal	$12,678,000
	Engineering and Administration 20%	2,536,000
	Total Capital Improvement Cost	**$15,214,000**

9.5 Phase 2 Recommended Capital Improvement Projects

9.5.1 CIP-4 Reservoir and Booster Pumping Station

CIP-4 is planned to provide additional operational and emergency storage by year 2010 near Node No. 10062. Meeting the year 2010 peak hour demands will require the

construction of a new 33,400 m^3 ground storage reservoir and installation of a 3,960 m^3/h booster pumping station expandable to 7,920 m^3/h in 2020. The total cost of these improvements is estimated to be approximately US$9.2 million as shown in the following tabulation.

CIP-4 Reservoir and Booster Pumping Station

CIP No.	Description	Total Cost, US $
R-2	Ground Storage Reservoir, 33,400 m^3 @ Node 10062	2,680,000
B-2	Booster Pumping Station , 3960 m^3/h (including standby generator) @ Node 10062	3,725,000
	Construction Cost Subtotal	$6,405,000
	Construction Contingency 20%	1,281,000
	Subtotal	$7,686,000
	Engineering and Administration 20%	1,537,000
	Total Capital Improvement Cost	**$9,223,000**

9.5.2 CIP-5 Pipeline Interconnections, Parallel Pipes, and Pipe Replacement

CIP-5 is planned to provide parallel pipes and pipeline interconnections between existing distribution system pipelines which would otherwise experience hydraulic constraints at year 2020 flows. These interconnections and parallel pipes will provide hydraulic capacity of the area pipeline network and improve the low pressures which would otherwise result due to hydraulic constraints. Details for these interconnections (CIP-5A, 5B, and 5C) are shown in Figure V1-9.3. CIP-5 also includes the replacement of approximately 1.6 km of old 300 mm AC pipe with 400 mm DI pipe. The total cost of these improvements is estimated to be approximately US$1.2 million, as shown in the following tabulation.

CIP-5 Pipeline Interconnections

CIP Detail	Pipe No.	Diameter, mm	Approximate Length, m	Unit Cost, $/LM	Total Cost, US $
5A	10072	300	20	127	3,000
5B	10074	400	20	313	6,000
5C	10078	400	20	313	6,000
-	10076	400	530	313	166,000
-	10080	400	459	313	144,000
	566	400	469	313	147,000
	570	400	716	313	224,000
	574	400	459	313	144,000
				Construction Cost Subtotal	$840,000
				Construction Contingency 20%	168,000
				Subtotal	$1,008,000
				Engineering and Administration 20%	202,000
				Total Capital Improvement Cost	**$1,210,000**

9.5.3 CIP-6 Pipes and Pressure Sustaining Valves

CIP-6 is planned to supply treated water to the Al Salam City which is currently under development. Al Salam City is a new residential development located northwest of Suez City. The proposed 800 mm, 900 mm, and 1200 mm pipelines will be approximately 17.5 km in length. The sizes and alignments of these proposed pipelines should be re-evaluated if and when the Al Salam City internal water distribution network is integrated with the SCA water system. Two pressure sustaining valves, one on Pipe No. 6001 (800 mm) and one on Pipe No. 6002 (900 mm) will be installed to maintain pressure in the upper pressure zone.

The total cost of these improvements is estimated to be approximately US$24 million as shown in the following tabulation.

CIP-6 Pipes and Pressure Sustaining Valves

Pipe No.	Diameter, mm	Approximate Length, m	Unit Cost, $/LM	Total Cost, US $
10020	1200	1,813	1158	2,099,000
10022	1200	1,073	1158	1,243,000
10024	1200	1,000	1158	1,158,000
10026	1200	689	1158	798,000
10028	1200	1,442	1158	1,670,000
10030	1200	2,103	1158	2,435,000
10032	1200	1,178	1158	1,364,000
10034	800	1,281	687	880,000
10036	800	1,652	687	1,135,000
10038	800	936	687	643,000
10040	800	1,160	687	797,000
10042	800	2,228	687	1,531,000
10044	900	337	771	260,000
10046	900	595	771	459,000
Pipe Subtotal		17,487		16,472,000
PSV 6001 & 6002	Two (2) Pressure Sustaining Valves (800 mm and 900 mm)			120,000
			Construction Cost Subtotal	$16,592,000
			Construction Contingency 20%	3,318,000
			Subtotal	$19,910,000
			Engineering and Administration 20%	3,982,000
			Total Capital Improvement Cost	**$23,892,000**

9.5.4 CIP-7 Pipes and Pressure Sustaining Valve

CIP-7 is planned to supply treated water to a new light industrial area and educational facilities southwest of Suez, in the vicinity of the wastewater treatment facilities. Pipelines will consist of 400 mm, 600 mm, and 800 mm pipe, and will be approximately 12 km in

length. One pressure sustaining valve will be installed on Pipe No. 6003 (400 mm) to maintain pressure in the upper pressure zone.

The total cost of these improvements is estimated to be approximately US $9.5 million as shown in the following tabulation.

CIP-7 Pipes and Pressure Sustaining Valve

Pipe No.	Diameter, mm	Approximate Length, m	Unit Cost, $/LM	Total Cost, US $
10000	400	805	313	252,000
10002	400	1,864	313	583,000
10004	600	2,376	498	1,183,000
10006	800	248	687	170,000
10008	800	1,087	687	747,000
10010	800	330	687	227,000
10012	800	1,620	687	1,113,000
10014	800	797	687	548,000
10016	800	674	687	463,000
10018	800	1,663	687	1,142,000
10066	400	473	313	148,000
10068	400	21	313	7,000
Pipe Subtotal		11,958		6,583,000
PSV-6003	One Pressure Sustaining Valve (400 mm)			30,000
			Construction Cost Subtotal	$6,613,000
			Construction Contingency 20%	1,323,000
			Subtotal	$7,936,000
			Engineering and Administration 20%	1,587,000
			Total Capital Improvement Cost	**$9,523,000**

9.5.5 CIP-8 Pipes

CIP-8 is planned to provide treated water to a light industrial area north of Suez. Part of this area is presently being provided with water by the Governorate. It is recommended that SCA serve this area in the future. The proposed pipelines will consist of 300 mm and 600 mm diameter pipes and will be approximately 3 km in length. The sizes and alignments of the proposed pipelines should be reevaluated when the internal water network for this area is integrated with the SCA system.

The total cost of this improvement is approximately US $2.7 million as shown in the following tabulation.

CIP-8 Pipes

Pipe No.	Diameter, mm	Approximate Length, m	Unit Cost, $/LM	Total Cost, US $
10048	600	958	498	477,000
10050	600	850	498	423,000
10052	600	523	498	260,000
10054	600	1,253	498	624,000
10056	300	227	127	29,000
10058	300	347	127	44,000
			Construction Cost Subtotal	$1,857,000
			Construction Contingency 20%	371,000
			Subtotal	$2,228,000
			Engineering and Administration 20%	446,000
			Total Capital Improvement Cost	**$2,674,000**

9.5.6 CIP-9 Pipes

CIP-9 is planned to supply treated water to a new residential development area on the east side of Suez. Between the Suez branch of the Sweetwater Canal and the Suez Canal. Pipelines will consist of 400 mm and 600 mm pipes and will be approximately 3.8 km in length.

The total cost of this improvement is approximately US $2.4 million as shown in the following tabulation.

CIP-9 Pipes

Pipe No.	Diameter, mm	Approximate Length, m	Unit Cost, $/LM	Total Cost, US $
10060	600	1,383	498	689,000
10062	600	1,194	498	595,000
10064	600	704	498	351,000
			Construction Cost Subtotal	$1,635,000
			Construction Contingency 20%	327,000
			Subtotal	$1,962,000
			Engineering and Administration 20%	392,000
			Total Capital Improvement Cost	**$2,354,000**

9.5.7 CIP-10 Water Treatment Plant

CIP-10 is planned to provide a new 105,000 m^3/d water treatment plant to meet the MDDs in year 2020. A new 33,400 m^3 concrete reservoir and a new 4375 m^3/h booster pumping station will also be constructed at the water treatment plant site to deliver the treated water to the distribution system.

The total cost of these improvements is estimated to be approximately US $39 million as shown in the following tabulation.

CIP-10 Water Treatment Plant

CIP No.	Description	Total Cost, US $
T-3	Water Treatment Plant, 105,000 m^3/d (including pump station)	24,326,000
R-3	Treated water reservoir – 33,400 m^3	2,680,000
	Construction Cost Subtotal	$27,006,000
	Construction Contingency 20%	5,401,000
	Subtotal	$32,407,000
	Engineering and Administration 20%	6,481,000
	Total Capital Improvement Cost	**$38,888,000**

9.5.8 CIP-11 Booster Pumping Station Expansion

CIP-11 is planned to increase the capacity of two existing booster pump stations. The booster pump station constructed under CIP-2 will be expanded from 2160 m^3/h to 3750 m^3/h, and the booster pump station constructed under CIP-4 at Node 20 will be expanded from 3960 m^3/h to 7920 m^3/h.

The total cost of these improvements is estimated to be approximately US $3.4 million as shown in the following tabulation.

CIP-11 Booster Pumping Station Expansion

CIP No.	Description	Total Cost, US $
B-3	B-1 Booster Pump Station Expansion from 2160 m^3/h to 3750 m^3/h.	697,000
B-4	B-2 Booster Pump Station Expansion from 3960 m^3/h to 7920 m^3/h (including expansion of standby generator)	1,655,000
	Construction Cost Subtotal	$2,352,000
	Construction Contingency 20%	470,000
	Subtotal	$2,822,000
	Engineering and Administration 20%	564,000
	Total Capital Improvement Cost	**$3,386,000**

9.5.9 Summary

A summary of the Phase 1 and Phase 2 probable capital costs for Suez is presented in Table V1-9.1, Summary of Probable Capital Improvement Costs.

Table V1-9.1 Summary of Probable Capital Improvement Costs

CIP No.	Construction Cost, US$	Total Capital Cost, US$
Year 2000		
CIP-1 – Pipe Interconnections and Replacement	2,560,000	3,072,000
CIP-2 – Pipe, Reservoir and Booster Pumping Station	5,503,000	6,604,000
CIP-3 – Water Treatment Plant Improvements	12,678,000	15,214,000
Total Capital Improvement Cost - Year 2000	**20,741,000**	**24,890,000**
Year 2010		
CIP-4 – Reservoir and Booster Pumping Station	7,686,000	9,223,000
Total Capital Improvement Cost - Year 2010	**7,686,000**	**9,223,000**
Year 2020		
CIP-5 – Pipe Interconnections, Parallel and Replacement Pipes	1,008,000	1,210,000
CIP-6 – Pipes and Pressure Sustaining Valves	19,910,000	23,892,000
CIP-7 – Pipes and Pressure Sustaining Valves	7,936,000	9,523,000
CIP-8 – Pipes	2,228,000	2,674,000
CIP-9 – Pipes	1,962,000	2,354,000
CIP-10 – Water Treatment Plant and Storage Reservoir	32,407,000	38,888,000
CIP-11 – Booster Pumping Stations Expansion	2,822,000	3,386,000
Total Capital Improvement Cost - Year 2020	**68,723,000**	**81,927,000**

Construction Cost includes 20 percent construction contingency
Total Capital cost includes construction cost and 20 percent engineering and administration cost

End of Chapter 9: Implementation Plan

APPENDICES

APPENDIX V1-4.1

esults of Analysis of Sweetwater Canal Water Samples

Appendix V1-4.1 Results of Analysis of Sweetwater Canal Water Samples

January-June 1997

Canal Name	Month	Site	pH	Dissolved Oxygen, mg/L	COD mg/L	BOD mg/L	Solid Materials mg/L	Total Alkalinity mg/L	CN mg/L	NO_3 mg/L	NH_3 mg/L	Fe mg/L	Mn mg/L
Ismailia	January	El Tell El Kebir	8	*	11	*	350	180	0	*	0	0.1	0
		El Zahereya	8.3	*	12.5	*	467	170	0	*	0	0.05	0
		El Sabaa Abar											
		before mixing	7.7	*	12	*	550	170	0	*	0.05	0	0
		after mixing	7.7	*	12	*	700	170	0	*	0.08	0	0
	February	El Tell Kebir	8	*	12.5	*	240	180	0	*	0	0.07	0
		El Zahereya	8.2	*	*	*	240	175	0	*	0	0.05	0
		El Sabaa Abar											
		before mixing	8.5	16	*	*	278	170	0	*	0	0.05	0
		after mixing	8.5	16	*	*	282	170	0	*	0	0.04	0
	March	El Zahereya	8	10	*	*	372	140	0	*	0.05	0.05	0
	April	El Tell El Kebir	7.9	12.5	*	*	*	134	0	0	0	0	0
		El Zahereya	8.2	12 5	*	*	*	130	0	0	0	*	*
		El Sabaa Abar											
		before mixing	8	5	*	*	*	140	0	0	0	*	*
		after mixing	8	5	*	*	*	140	0	0	0	*	*
	May	El Tell El Kebir	8	10	*	*	*	136	0	0	0.1	0	0
		El Zahereya	8	12	*	*	*	*	0	0	0.05	0	0
	June	El Tell El Kebir	7 9	11.5	*	*	*	130	0	0	0.1	0.1	0
		El Zahereya	8 2	9	9	6 2	*	140	0	0	0.1	0.05	0
		El Sabaa Abar											
		before mixing	8	9 5	9.5	7.5	332	120	0	0	0	0.05	0
		after mixing	7.9	*	*	*	553	170	0	0	0	0.1	0
Port Said	January	Qantara West	7.6	*	11.5	*	560	180	0	*	0	0	0
	March	Qantara West	8	13	*	*	336	160	0	*	0	0.02	0
	April	Qantara West	8.3	10	*	*	*	140	0	0	0.25	0	0
	June	Qantara West	8	11	12.5	8	494	120		0	0.2	0.1	
Suez	January	Fayed	7 7	*	11	*	400	180	0	*	0	0.05	0
	February	Fayed	8.2	*	*	*	236	160	0	*	0	0.07	0
	March	Fayed	8.5	9.5	*	*	420	150	0	*	0	0.02	0
	April	Fayed	8.2	12	*	*	*	150	0	*	0	0	0
	May	Fayed	8 2	12	*	*	*	140	0	*	0	0	0
Fresh Water Standards, Article 60, Law 48/1982			7-8.5	> 4	<10	<6	500	20-150	0.1	45	0.5	1	0.5

* No analysis results

Source: Sustainable Development Project - The Environmental Profile of Ismailia Governorate, prepared by Ismailia Sustainable Development Project Unit of Ismailia Governorate, published by UNDP and Ismailia Governorate, October 1997.

APPENDIX V1-4.2

SCA Letter to the Ministry of Irrigation
Re: Water Requirements

Ismailia July 1998
Department of Public Works

Fax No. 064/321188

Eng. Chairman of the Central Department
Of the Canal Governorates
Ministry of Public Works & Water Resources

Dear Messrs.,

Referring to your letter No. 328 dated on 23/5/98 regarding the water needs for the three Canal Cities through year 2017.

We would like to inform you that the water needs for the three canal cities through year 2017 are as follows:

City	Year 2005	Year 2017
Port Said	360,000 m^3	525,000 m^3
Ismailia	385,000 m^3	520,000 m^3
Suez	460,000 m^3	600,00 m^3
Total	1205,000 m^3	1,645.000 m^3

Sincerely Yours

Department of Public Works, Manager

Eng. Nabil Lotfi Ali

م ع/ن ع/١

الاسماعيلية - يونيه ٩٨
الاشغـــــال
م/١٠

فاكس رقم ٣٢١١٨٨/٠٦٤

السيد المهندس/ رئيس الادارة المركزية لمحافظة القناة
(وزارة الاشغال العامة والموارد المائية)

تحية طيبة وبعد ...

بالاحالة لكتاب سيادتكم رقم ٣٢٨ في ٢٣/٥/٩٨ بخصوص الاحتياجات المائية لمدن القناة الثلاث حتى سنة ٢٠١٧

نتشرف بأن نفيد سيادتكم باحتياجات مدن القناة الثلاث للمياه حتى سنة ٢٠١٧ طبقا للجدول الآتي :

المدينة	سنة ٢٠٠٥	سنة ٢٠١٧
بورسعيد	٣٦٠ ألف م٣	٥٢٥ ألف م٣
الاسماعيلية	٣٨٥ ألف م٣	٥٢٠ ألف م٣
السويس	٤٦٠ ألف م٣	٦٠٠ ألف م٣
الاجمالي	١٢٠٥ ألف م٣	١٦٤٥ ألف م٣

والسلام عليكم ورحمة الله وبركاته ...

مدير ادارة الاشغال
مهندس

(نبيل لطفي طه)

141

APPENDIX V1-4.3

Filter Backwash and Clarifier Residuals Disposal

Appendix V1-4.3
Backwash And Clarifier Residuals Disposal

General

Law 48 was established in 1982 to protect the Nile River and its waterways from pollution. Article 11 of the Ministry of Irrigation (MOI) Decree No. 8/1983 promulgating the Executive Regulations of Law 48/1982, specifically requires that backwash water and other wastes from potable water purification stations (plants) must not be discharged into water surfaces without treatment. The receiving water standards for non-potable water surfaces are listed under Article 8 of the MOI Decree No. 8/1983.

In order to comply with the above-mentioned regulations, all three water treatment plants in Port Said, Ismailia, and Suez should provide treatment of the washwater and clarifier residuals before discharge into the receiving water. This discussion is presented to develop the basic concept for a washwater and clarifier residuals treatment system and define a detailed study that will provide design information and capital cost estimates.

Basic Residuals Disposal Concept

The basic concept for residual solids disposal into a sewer system is to send all clarifier and filter backwash solids to the local wastewater treatment plant, as shown in Figure 1.

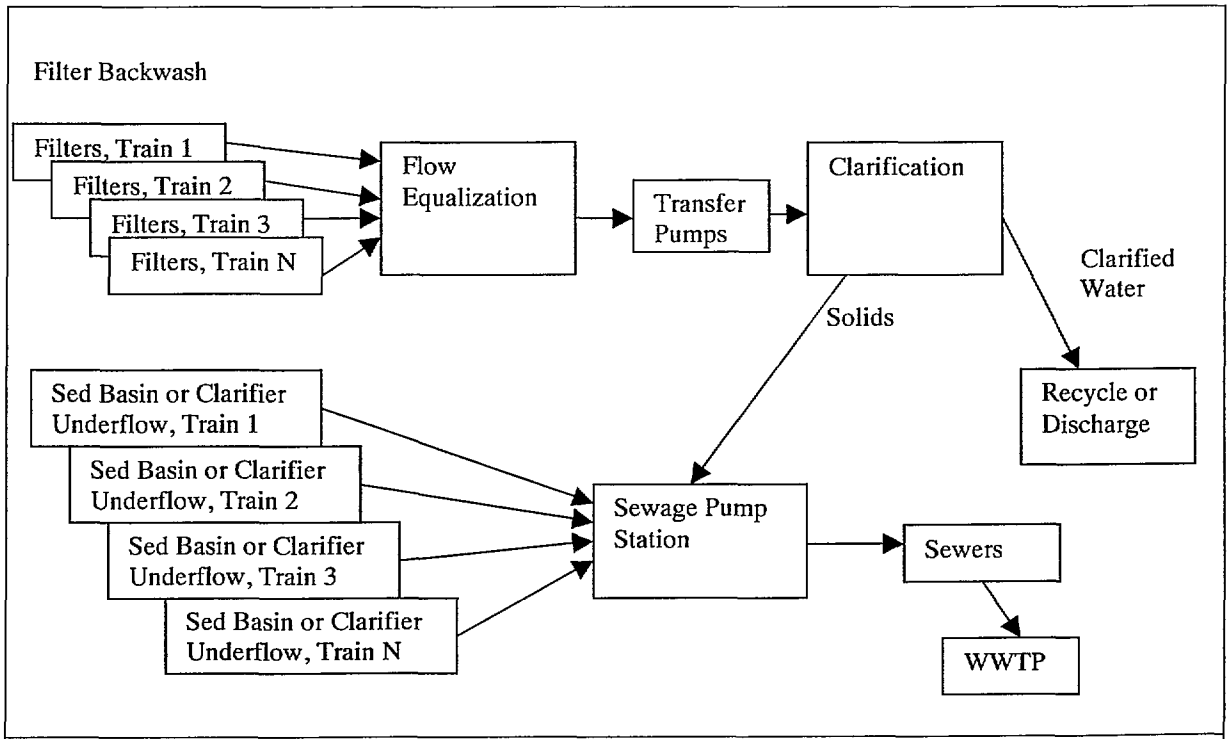


Figure 1. Residual Solids Disposal Concept
(With Discharge to Sewer System)

Waste filter backwash water would be collected and subjected to a clarification step to reduce the total volume of water and to concentrate the solids. The basic system would consist of flow equalization basins and clarifiers. The solids underflow from the backwash clarifiers would be sent to a sewage pumping station which would pump the solids out of the water treatment plant and into the sewers and ultimately to the wastewater treatment plant. Underflow from sedimentation basins and clarifiers in each of the water treatment trains would also be sent to the sewage pumping station. The clarified water can be either recycled for treatment or discharged into a receiving water, if it meets discharge requirements.

In case a sewer system is not available for disposal, additional treatment of the backwash and clarifier solids inside the water treatment plant, such as solids thickening and mechanical dewatering with landfill disposal offsite, should be considered. This is shown in Figure 2. Lagooning with landfill disposal of sun-dried sludge can also be considered; however, the land requirement, even for an arid climate, could be very extensive. The clarified water can be either recycled for treatment or discharged into a receiving water if it meets discharge requirements.

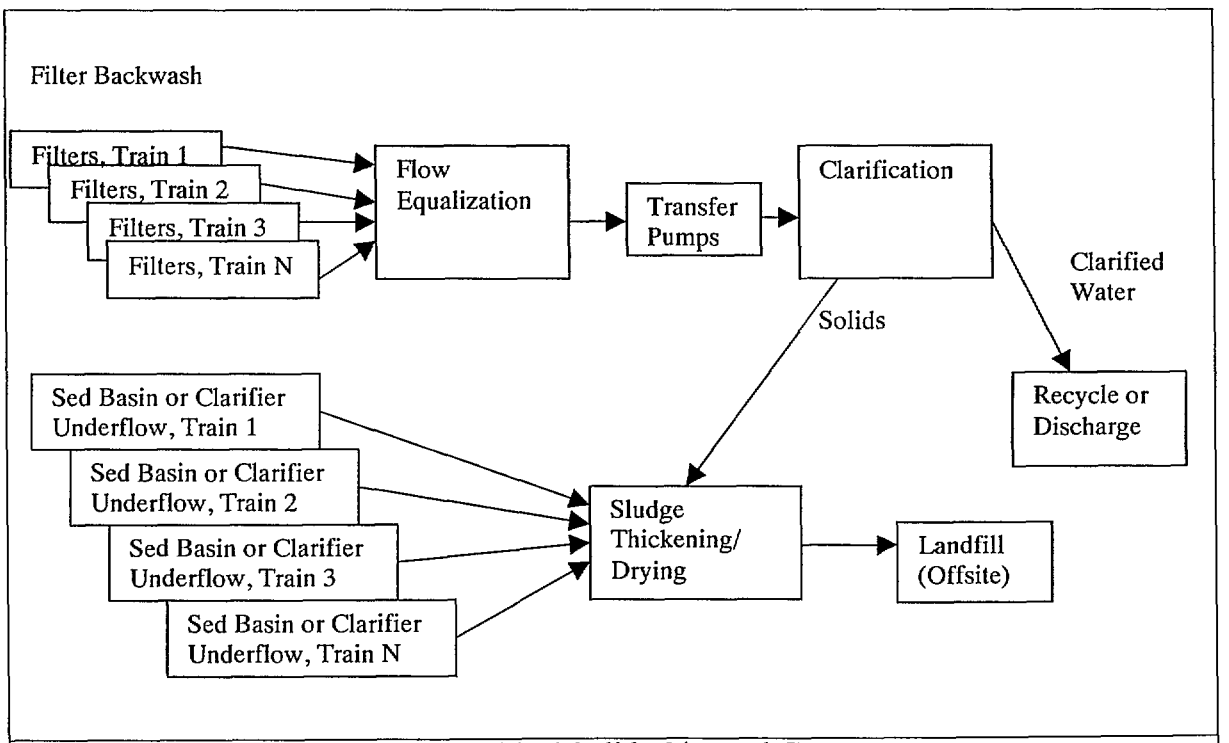


Figure 2. Residual Solids Disposal Concept
(Without Discharge to Sewer System)

Planning And Feasibility Study

The planning and feasibility study that would be required to estimate the costs of disposing of residual solids consists of the following tasks:

Task 1 - Field Investigation. A retrofit of a residual solids disposal system requires an accurate map of the plant site, which includes accurate locations of the relevant pipelines. Several data issues must be resolved:

a) The available spaces within the plant property or adjacent areas must be defined and the ground contour elevations identified.
b) The water surface elevations in the filters and sedimentation/clarifiers of all treatment trains must be accurately identified.
c) The location, sizes of, and invert elevations of all filter backwash waste pipelines and sedimentation/clarifier solids underflow pipelines must be mapped from beginning to end of each pipeline.

Because many of the treatment trains are several decades old, it is assumed that design drawings are not available. Therefore, a site survey with potholing of the above named pipelines will be necessary. The end product of this task is a scaled site map showing the plant property with elevations, locations of all structures and major pipeline (especially those named above). Available property nearby the plant should also be mapped. In addition, a profile diagram showing the above named water surface elevations must also be included.

Task 2 - Preliminary Alternatives Analysis. A preliminary comparison of advantages and disadvantages of basic residual solids disposal alternatives will identify one alternative for further consideration. Alternatives include sludge lagoons and landfill disposal, backwash clarification with sewage disposal, backwash clarification with thickening and mechanical dewatering and landfill disposal, etc.

Task 3 – Development of Alternatives. Location and piping alternatives for the selected alternative should be identified, including the need for a centralized equalization and pumping unit or a number of these units distributed around the plant due to the number of treatment trains and hydraulic limitations. Also, alternative processes should be identified; e.g., conventional flocculation and sedimentation, reactor clarifiers, or solids contact clarifiers (Actiflow). A recommended process selection should be made and location and pipeline routes determined.

Task 4: Cost Estimate. Estimate costs based on the defined treatment alternative.

145

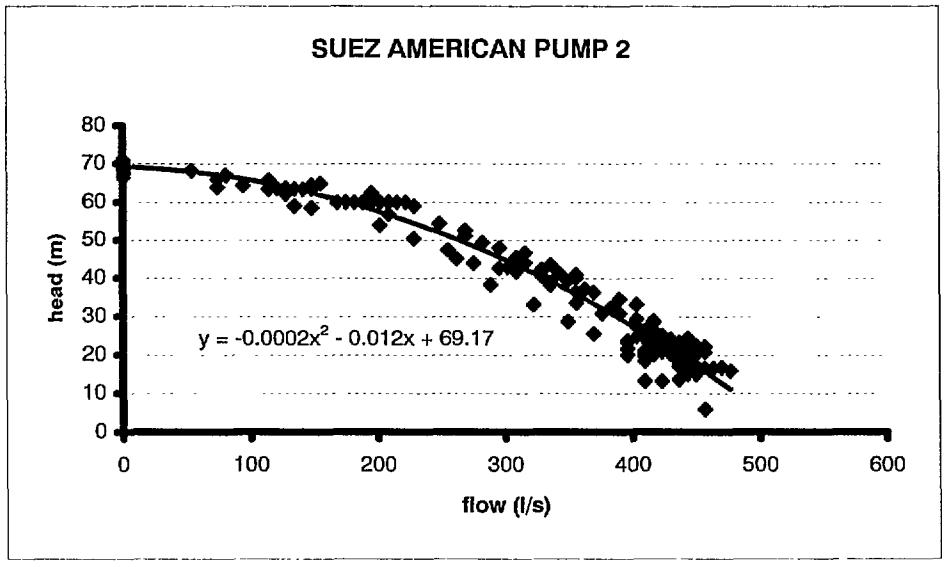
APPENDIX V1-7.1

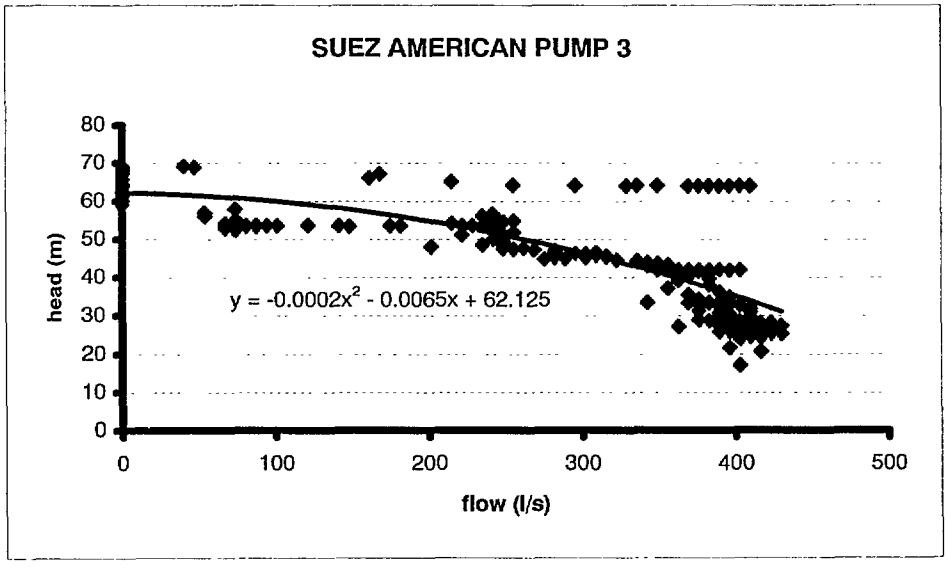
Pump Curves

Suez American Pump Station
Pump Curve Summary

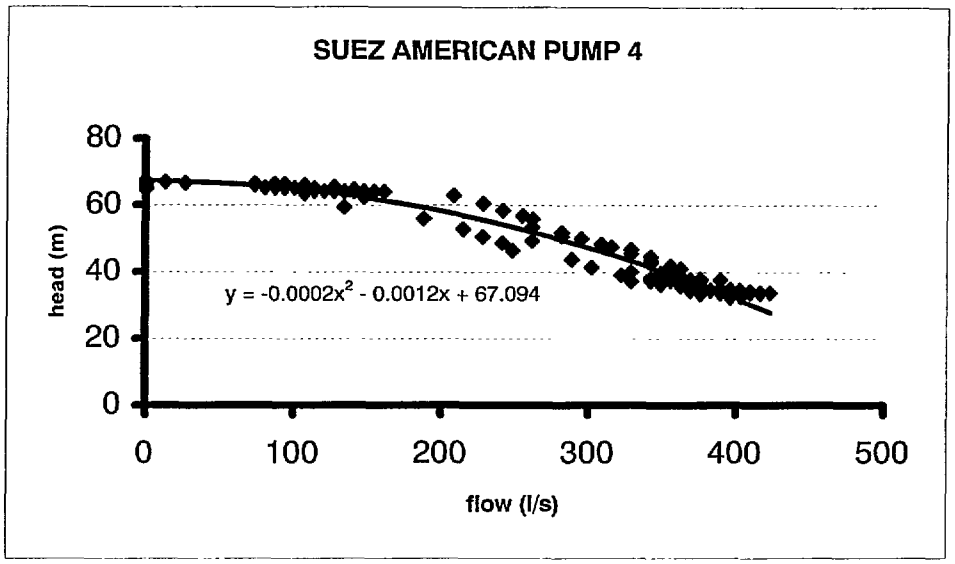
Raw Data											
Pump No. 2		Pump No. 3		Pump No. 4		Pump No. 5		Pump No. 6		Pump No. 7	
Flow	Pressure	Flow	Pressure	Flow	Pressure	Flow	Pressure	Flow	Pressure	Flow	Pressure
l/s	M	l/s	M	l/s	M	l/s	M	l/s	M	l/s	M
0	69.17	0	62.125	0	67.094	0	67.939	0	67.569	0	67.796
100	65.97	100	59.475	100	64.974	100	65.539	100	66.829	100	65.516
200	58.77	200	52.825	200	58.854	200	59.139	200	62.089	200	59.236
300	47.57	250	48.0	300	48.734	250	54.439	250	58.219	250	54.596
400	32.37	350	35.35	400	34.614	300	48.739	300	53.349	300	48.956
450	23.27	400	27.525	450	26.054	350	42.039	350	47.479	400	34.676
500	13.17	500	8.875	500	16.494	400	34.339	450	32.739	450	26.036
						450	25.639	500	23.869		

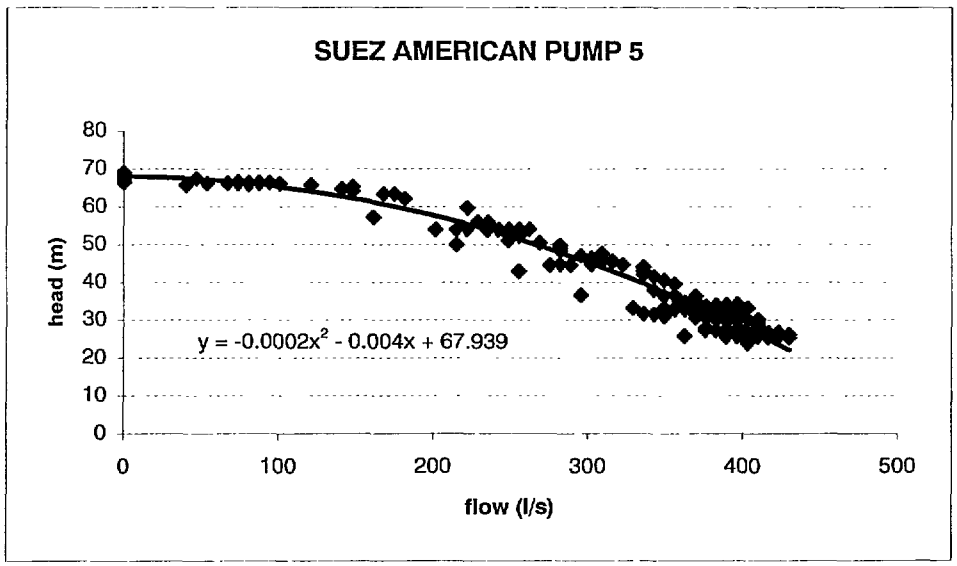
Model Entries											
Pump No. 2		Pump No. 3		Pump No. 4		Pump No. 5		Pump No. 6		Pump No. 7	
Flow	Pressure	Flow	Pressure	Flow	Pressure	Flow	Pressure	Flow	Pressure	Flow	Pressure
l/s	M	l/s	M	l/s	M	l/s	M	l/s	M	l/s	M
0	69.2	0	62.1	0	67.1	0	67.9	0	67.6	0	67.8
300	47.6	250	48.0	300	48.7	300	48.7	350	47.5	300	49.0
450	23.3	400	27.5	450	26.1	450	25.6	500	23.9	450	26.0



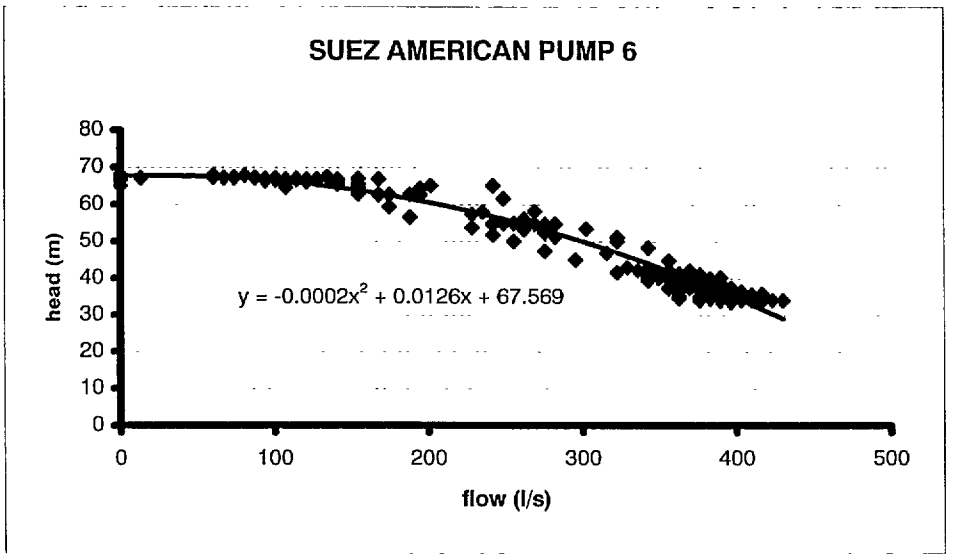


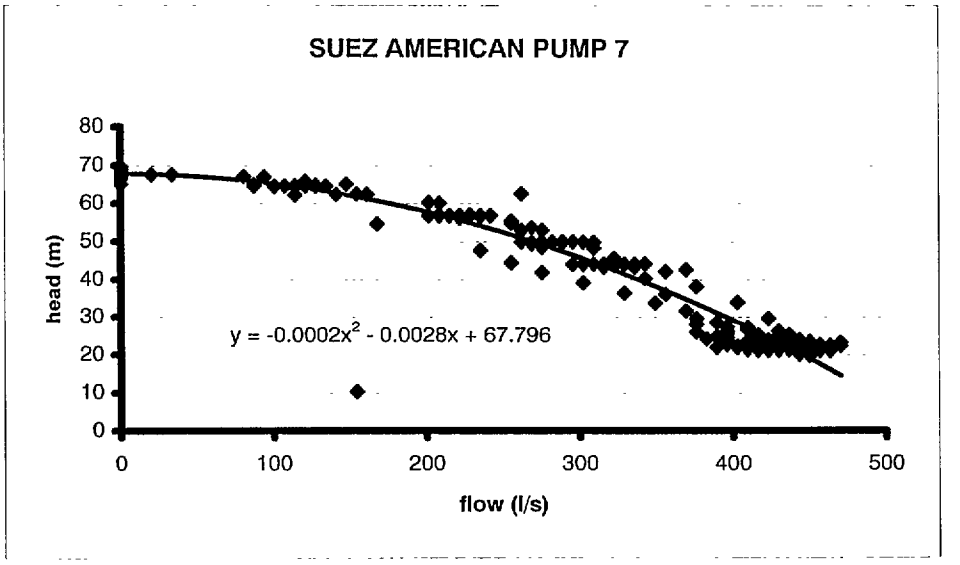
Suez American pump tests.xls





Suez American pump tests.xls





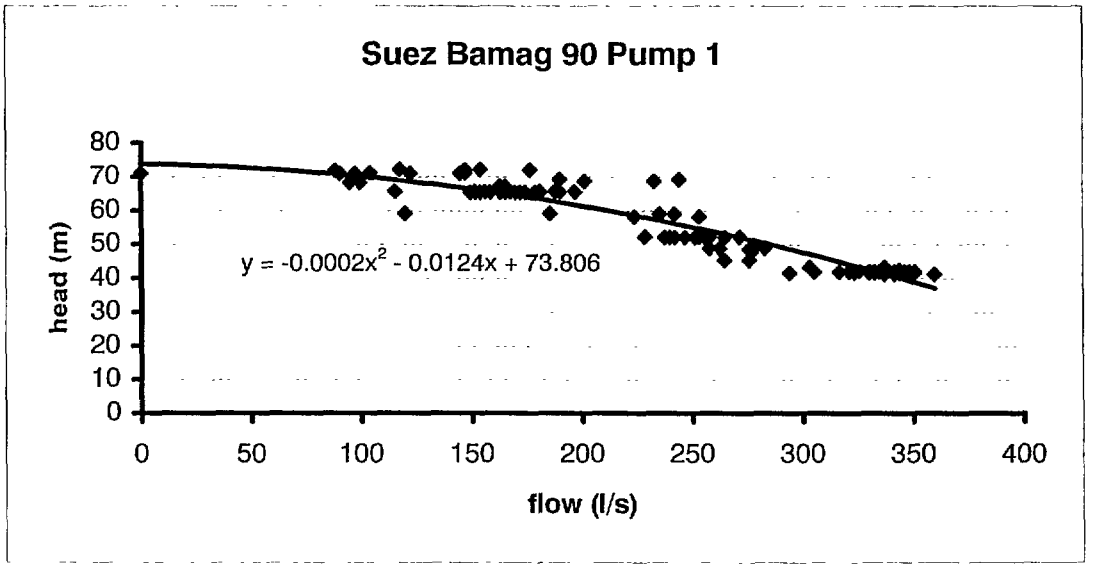
Suez American pump tests.xls

Suez Bamag Pump Station
Pump Curve Summary

Raw Data									
Pump No. 1		Pump No. 2		Pump No. 3		Pump No. 4		Pump No. 5	
Flow	Pressure	Flow	Pressure	Flow	Pressure	Flow	Pressure	Flow	Pressure
l/s	M	l/s	M	l/s	M	l/s	M	l/s	M
0	73.806			0	71.031	0	73.686	0	73.632
100	70.566	Pump not tested due		100	71.611	100	73.596	100	74.572
200	63.326	to mechanical		200	68.191	200	67.506	200	67.512
300	52.086	problems. Pump		300	60.771	250	62.211	250	60.982
350	44.966	curve estimated from		400	49.351	300	55.416	300	52.452
450	27.726	other pump curves at		450	42.141	350	47.121	350	41.922
500	17.606	this pump station.		550	24.721	400	37.326	400	29.392
						450	26.031	450	14.862

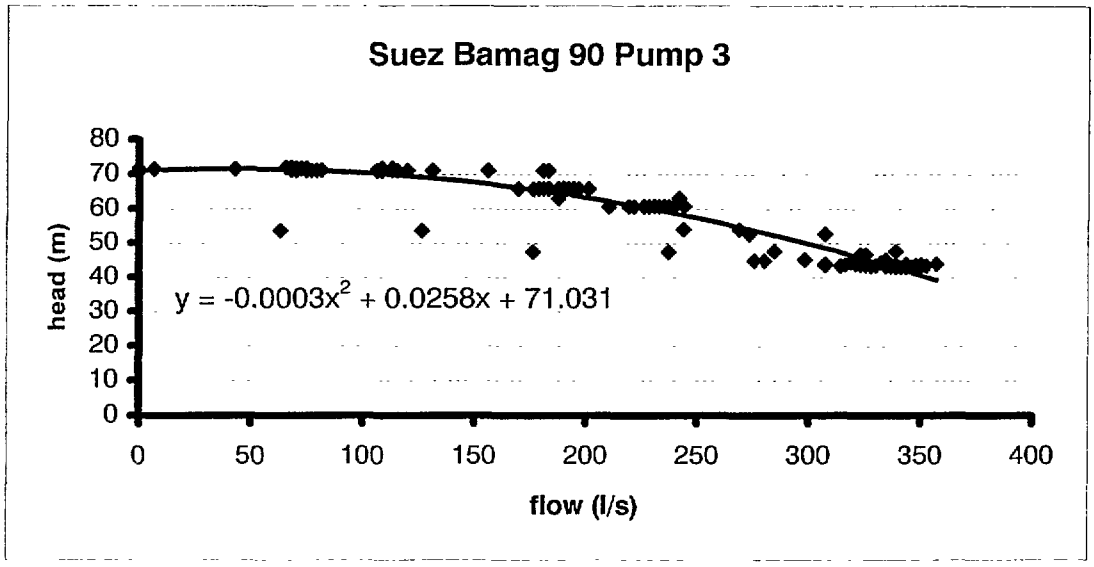
Model Entries									
Pump No. 1		Pump No. 2		Pump No. 3		Pump No. 4		Pump No. 5	
Flow	Pressure	Flow	Pressure	Flow	Pressure	Flow	Pressure	Flow	Pressure
l/s	M	l/s	M	l/s	M	l/s	M	l/s	M
0	73.8	0	73.8	0	71.0	0	73.7	0	73.6
350	45.0	350	45.0	450	42.1	350	47.1	350	41.9
450	27.7	450	27.7	550	24.7	450	26.0	400	29.4

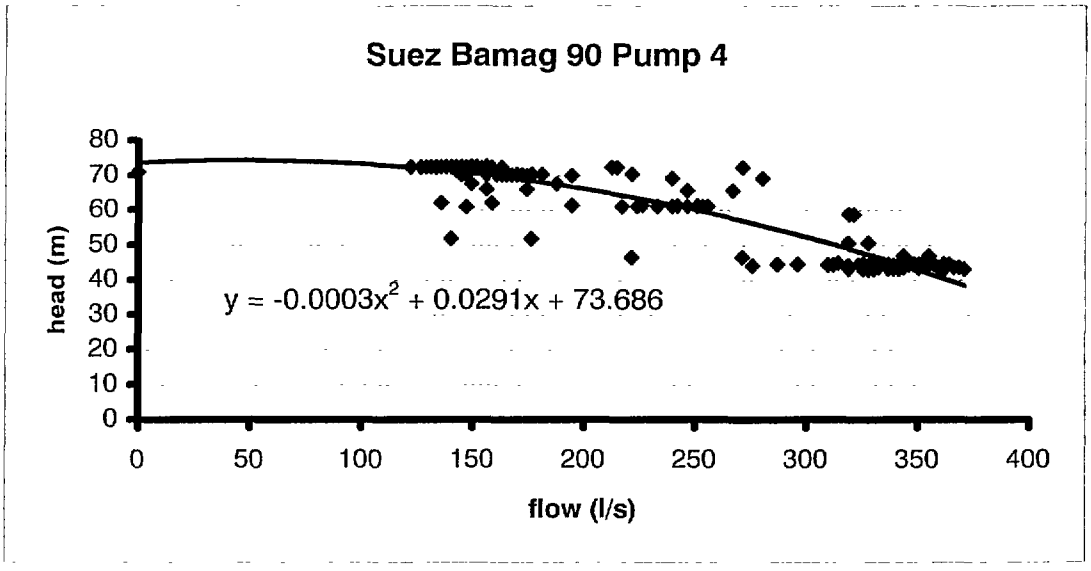
151

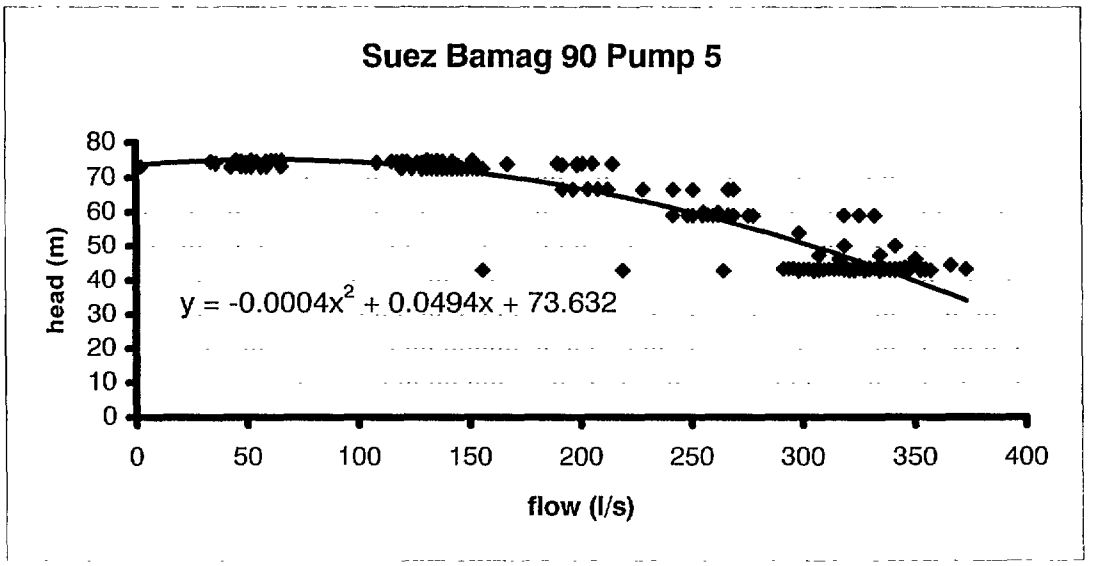


Suez Bamag 90 Pump 2

No tests done. Pump not operational.


Suez Bamag 90 Pump 3
head (m)
80
70
60
50
40
30
20
10
0
y = -0.0003x2 + 0.0258x + 71.031
0
50
100
150
200
250
300
350
400
flow (l/s)

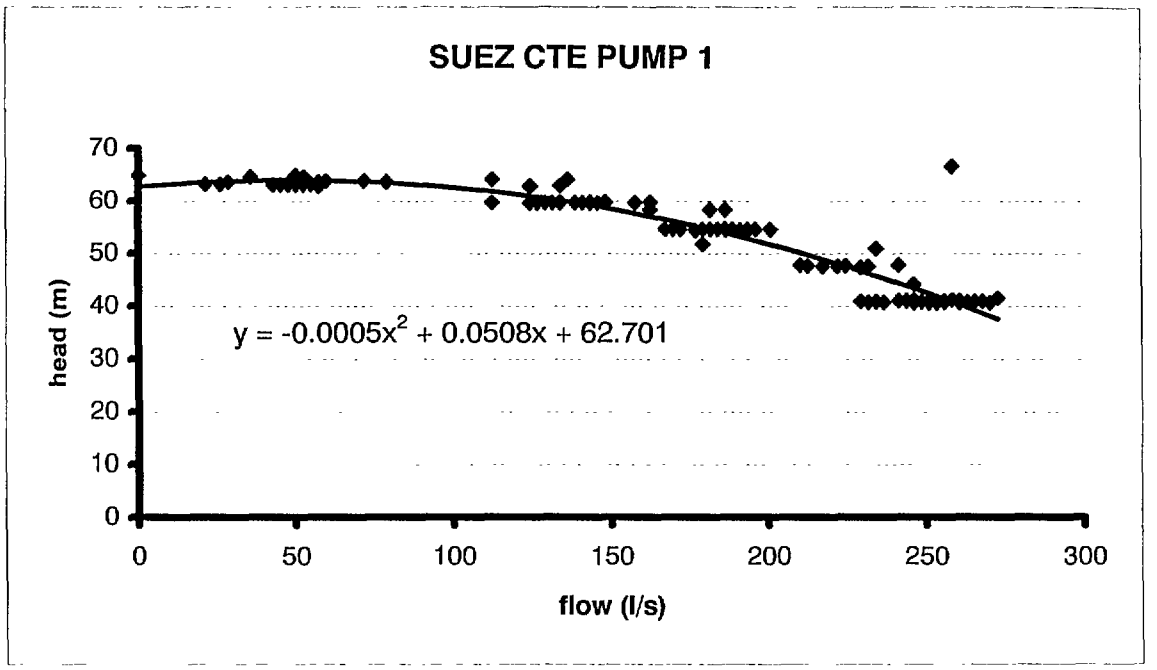

Suez Bamag 90 Pump 4
head (m)
80
70
60
50
40
30
20
10
0
y = -0.0003x2 + 0.0291x + 73.686
0
50
100
150
200
250
300
350
400
flow (l/s)

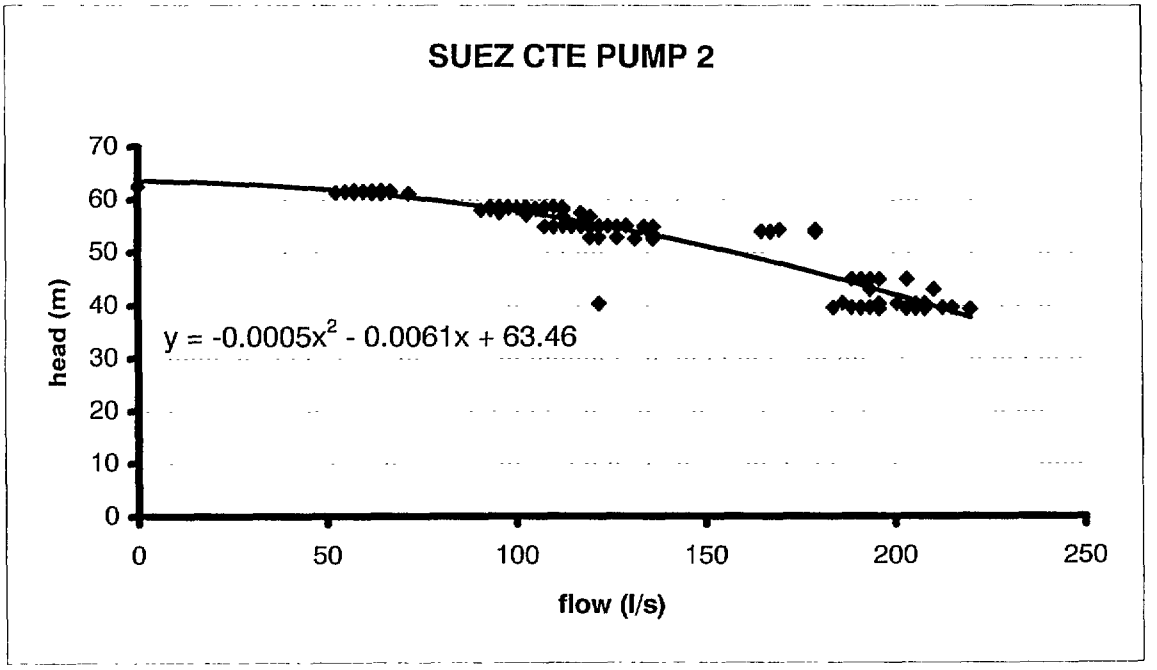

Suez Bamag 90 Pump 5
head (m)
80
70
60
50
40
30
20
10
0
y = -0.0004x² + 0.0494x + 73.632
0
50
100
150
200
250
300
350
400
flow (l/s)

Suez CTE Pump Station
Pump Curve Summary

Raw Data			
Pump No. 1		Pump No. 2	
Flow	Pressure	Flow	Pressure
l/s	M	l/s	M
0	62.701	0	63.46
100	62.781	100	57.85
200	52.861	200	42.24
250	44.151	250	30.685
300	32.941	300	16.63
350	19.231	350	0.075

Model Entries			
Pump No. 1		Pump No. 2	
Flow	Pressure	Flow	Pressure
l/s	M	l/s	M
0	62.7	0	73.6
250	44.2	200	42.2
300	32.9	300	16.6


SUEZ CTE PUMP 1
head (m)
flow (l/s)
y = -0.0005x2 + 0.0508x + 62.701
0
10
20
30
40
50
60
70
0
50
100
150
200
250
300


SUEZ CTE PUMP 2
head (m)
flow (l/s)
y = -0.0005x2 - 0.0061x + 63.46
0
10
20
30
40
50
60
70
0
50
100
150
200
250

APPENDIX V1-7.2

EPANet Input Files – Existing and Year 2020

[TITLE]
Suez Improved Existing System

Existing Land Uses - December 1998
; Average Day Demand - 1843.85 L/s
; Peaking Factors - See PATTERNS Section
; New reservoir and booster pump station at Node No. 18
; New cross connections in downtown area to complete loops
; All lines assumed to be open

[JUNCTIONS]

;ID	Elev. m	Demand lps	Pattern
1	7	0	1
2	7	0	1
3	7	0	1
4	7	0	1
5	9	12.89	1
6	11	3.15	1
7	11.3	5.44	1
8	12	22.28	1
9	14.1	0	1
10	15.5	0	1
11	15.5	0	1
12	15.7	5.19	1
13	16.8	0	1
14	18.8	0	1
15	19.4	5.01	1
16	21	0	1
17	21	19.14	1
18	24.5	2.14	1
19	25	0	1
20	25.5	-600	99
21	23	0	1
22	24.5	0	1
23	19.2	1.89	1
24	18.2	2.12	1
25	10	14.49	1
26	8	46.3	1
27	3	0	1
28	0.5	0	1
29	3.3	1.03	1
31	4.5	0	1
32	4.3	0	1
33	6.7	0	1
34	5.5	0	1
35	6.3	0	1
36	6.3	0	1
37	4.5	0	1
38	10	28.44	1
39	9.9	0	1
40	9	0	1
41	8.5	3.5	1
42	3.8	0	1
43	3.8	6.17	1
44	6	7.17	1
45	6.8	0	1
46	5.7	0	1
47	5	0	1

48	8	0	1
49	14	0	1
50	15.7	0	1
51	13.5	0	1
52	10.3	0	1
53	5.1	17.63	1
54	3.7	0	1
55	3.7	0	1
56	3.7	0	1
57	3.5	8.47	1
58	3	0	1
59	2.7	5.59	1
60	2.5	3.25	1
61	3.5	5.32	1
62	3	4.42	1
63	3	0.73	1
64	3.5	2.88	1
65	3.5	0	1
66	3.6	0	1
67	3.6	0	1
68	3.7	0	1
69	3.7	0	1
70	3.8	0	1
71	3.8	128.9	1
72	3.9	0	1
73	4	0	1
74	4	0	1
75	4	0	1
76	4.1	2.78	1
77	4.1	2.69	1
78	3.5	9.44	1
79	3.5	0	1
80	3.5	0	1
81	3.6	0	1
82	3.7	8.94	1
83	3.8	0	1
84	3.9	0	1
85	4	8.6	1
86	4	0	1
87	4	3.72	1
88	4.1	0	1
89	4.1	0	1
90	4.1	0	1
91	4.1	0	1
92	3.5	17.43	1
93	3.5	0	1
94	3.6	0	1
95	3	12.65	1
96	3	5.3	1
97	3	13.22	1
98	4	1.64	1
99	3.7	5.38	1
100	3.3	8.56	1
101	3.3	0	1
102	3	0	1
103	3.1	0.62	1
104	2.5	0.02	1
105	2.5	0	1
106	1.5	5.81	1
107	1.4	0	1
108	0.5	0	1
109	0	0.11	1

110	10	2.25	1
111	9	0	1
112	2.8	0	1
113	2	0.57	1
114	3.3	0	1
115	3.3	0	1
116	3.3	6.96	1
117	3.3	3.35	1
118	3.3	0	1
119	3.3	0	1
120	3.3	0	1
121	3.4	0	1
122	3.5	0	1
123	3.6	0	1
124	6	1.89	1
125	6.9	0	1
126	8.5	0	1
127	10.2	0	1
128	6.7	0	1
129	6.6	0	1
130	6.6	0	1
131	6.6	5.92	1
132	7	11.94	1
133	4.1	11.78	1
134	5	0	1
135	5.6	2.89	1
136	4.6	0	1
137	7.1	7.11	1
138	9	10.91	1
139	6.1	41.97	1
140	3.3	0.72	1
141	6.6	7.78	1
142	9.5	0	1
143	9.6	16.68	1
144	10.5	1.32	1
145	11	0	1
146	9.5	0	1
147	8.5	8.41	1
153	3	0	1
154	3	44.72	1
155	6	10.46	1
156	3.5	0	1
157	2.7	0	1
158	3.5	0	1
159	2	0	1
160	2.6	10.06	1
161	4.5	9.88	1
162	2.8	1.17	1
163	2.8	7.99	1
164	2.8	0	1
165	2.5	6.58	1
166	2.5	0	1
167	7.2	0	1
168	2.8	1.83	1
169	2.5	0	1
170	2.3	0	1
171	2.3	3.35	1
172	1	0.29	1
173	14.2	0	1
174	14.6	0	1
175	13	14.19	1
176	12	4.95	1

178	12	0	1
179	5	0	1
180	3.7	14.1	1
181	3.7	7.19	1
183	10	12.29	1
184	7.4	8.09	1
185	10.5	0	1
186	12.3	5.59	1
187	13.5	31.66	1
188	15.7	0	1
189	16.2	36.01	1
190	17.2	0	1
191	18.2	0	1
192	18.7	0	1
193	20.5	0	1
194	21.2	0	1
195	21.2	0	1
196	23	16.23	1
197	23	0	1
400	6.3	0	1
401	6.7	4.78	1
402	6.7	0	1
403	6.7	0	1
404	6.7	0	1
405	4.5	0	1
406	4.5	0	1
407	4.5	19.14	1
408	5.8	0	1
409	6.3	0	1
410	3.4	0	1
411	3.4	0	1
413	6.7	0	1
414	12	23.34	1
415	9.9	16.87	1
416	9	0	1
417	9	0	1
418	6	21.04	1
420	6	0	1
421	3.6	0	1
422	3	0	1
423	5	0	1
424	4	2.26	1
425	4	57.83	1
426	4	0	1
427	4.1	0	1
428	4.3	11.74	1
429	3.7	0	1
430	5	0.01	1
431	2.5	17.67	1
432	2	0	1
433	8.5	0	1
434	4.5	13.28	1
435	2.5	0	1
436	9	0	1
437	10.2	19.33	1
438	10.2	0	1
439	8.5	63.26	1
441	6.6	0	1
442	5	0	1
443	7.3	21.33	1
444	3.4	0	1
445	3.4	0	1

446	15.1	0.26	1
447	12.5	0	1
448	12	0	1
449	12	0	1
450	10	6.47	1
451	4.5	7.43	1
452	1.8	0	1
453	1.8	0	1
454	1.8	160.33	1
455	5.5	4.77	1
456	15.5	20.95	1
457	14.2	11.76	1
458	12	0	1
459	6.5	0	1
460	6	0	1
461	6.2	0	1
462	7	13.3	1
463	25	0	1
464	6.5	0	1
465	6.7	0	1
466	6.7	0	1
467	6.7	0	1
468	6.7	0	1
469	6.7	18.25	1
470	6.3	0	1
471	6.3	0	1
472	6.3	0	1
475	4.5	12.04	1
476	25	0	1
477	25.5	0	1
478	25.7	0	1
479	23	0	1
480	23	0	1
481	22	0	1
482	22	4.49	1
483	10.3	0	1
484	10.3	0	1
485	17	0	1
486	16.3	0	1
487	3	0	1
488	0.5	0	1
489	0	9.23	1
490	0	0.12	1
491	0	0.06	1
492	2	0	1
493	10	0	1
494	10	0	1
495	3.5	0.69	1
496	3.5	0	1
497	4	0.12	1
498	4	0.27	1
499	3	0	1
500	3.7	0	1
501	8	0	1
502	8	0	1
503	1	2.92	1
504	1	4.45	1
505	1.1	3.59	1
506	6	0	1
507	6	0	1
508	6	0	1
509	2.3	5.9	1

510	5	9.64	1
511	4.8	4.18	1
512	4.5	2.06	1
513	1.4	9.04	1
514	1.4	0	1
515	1.2	15.67	1
516	1.2	6.08	1
517	6.7	43.07	1
518	8.2	23.33	1
520	15.7	18.22	1
521	18	9.33	1
522	2.2	19.54	1
523	2.6	0	1
524	5.5	15.06	1
525	7.8	8.97	1
526	2.5	43.68	1
527	1.7	43.65	1
528	15.6	0	1
529	14.3	6.35	1
530	13.7	17.15	1
531	9	17.22	1
532	2.5	48.84	1
533	6	0.27	1
534	6	1.62	1
535	2.5	1.55	1
536	1.2	0.14	1
537	2.5	6.92	1
538	7	0	1
540	12	0	1
541	1.6	0	1
542	6.1	0	1
543	9	0	1
544	9	0	1
545	9	0	1
546	13	0	1
547	7.2	0	1
548	11.3	0	1
549	6.7	0	1
1161	3.3	3.08	1
1162	2.9	0	1
1163	2.5	8.52	1
1531	3	0	1
1551	4.3	10.08	1
2801	2.6	5.24	1
3501	3.7	0	1
4101	4	0	1
8301	3.8	6.54	1

```
[TANKS]
;-----------------------------------------------------------------
;          Elev.     Init.     Min.      Max.      Diam.
;ID        m         Level     Level     Level     m
;-----------------------------------------------------------------
     5000          6.3 ; Bamag No. 2 Pump Station
     5001          5.5 ; American Pump Station
; 5002              6.7 ; CTE Pump Station
     5003          6.7 ; Bamag No. 3 Pump Station

[PIPES]
;-----------------------------------------------------------------
;          From      To        Length    Diam.     Rough.
;ID        Node      Node      m         mm        Coeff.
```

;----------

2	1	2	57	1200	111
4	2	3	42	1200	111
6	3	4	148	1200	111
8	4	5	681	1200	111
10	5	6	311	1200	111
12	6	7	176	1200	111
14	7	8	404	1200	111
16	8	458	21	1200	111
17	458	9	420	1200	111
18	9	10	395	1200	111
20	10	11	12	1200	111
22	11	12	35	1200	111
24	12	13	125	1200	111
26	13	14	197	1200	111
28	14	15	124	1200	111
30	15	16	258	1200	111
32	16	17	15	1200	111
34	17	18	687	1200	111
36	18	19	300	1200	111
38	19	20	60	1200	111
40	20	21	343	1200	111
42	21	22	551	1200	111
43	528	529	1105	600	111
44	22	23	659	1200	111
45	529	530	557	600	111
46	23	24	2435	900	111
47	530	531	1332	600	111
48	24	528	726	600	111
49	531	25	369	600	111
50	25	501	110	600	111
51	501	26	29	600	111
52	26	500	450	900	111
53	500	499	1147	900	111
54	27	28	488	900	111
55	499	487	504	900	111
56	28	527	610	900	111
57	487	27	32	900	111
58	2801	29	1332	900	111
59	527	2801	1792	900	111
60	29	423	946	900	111
61	423	424	285	900	111
62	77	31	545	900	111
64	31	32	415	900	111
66	32	33	199	1200	111
67	33	402	89	1000	111
68	402	401	30	1000	111
69	401	34	228	1000	111
70	34	35	236	1000	111
72	35	36	7	1000	111
74	36	37	644	1000	111
75	37	472	117	1000	111
76	472	538	56	1000	111
77	538	1	57	1200	111
78	8	414	13	1200	111
79	414	38	637	1200	111
80	38	39	122	1200	111
82	39	415	25	1200	111
83	415	40	336	1200	111
84	40	416	46	1200	111
85	416	417	59	1200	111
86	417	41	192	1200	111

87	41	4101	780	1200	111
88	4101	42	304	1200	111
90	42	43	24	900	111
91	43	2801	1083	500	111
92	43	418	389	900	111
93	418	44	741	900	111
94	44	420	308	900	111
95	420	45	373	900	111
96	45	46	570	900	111
98	46	47	148	900	111
100	47	48	574	900	111
101	48	487	511	600	111
102	48	49	966	900	111
104	49	50	651	900	111
106	50	24	503	900	111
108	23	51	773	800	111
110	51	52	677	800	111
112	52	483	20	800	111
113	483	53	750	800	111
114	53	42	344	800	111
116	35	3501	358	600	111
117	3501	54	8	400	111
118	54	55	109	400	111
119	3501	429	168	600	111
120	55	56	67	400	111
121	429	1531	33	600	111
122	56	57	367	400	111
124	57	58	475	400	111
126	58	59	54	400	111
127	59	84	364	400	111
128	59	60	150	400	111
130	60	421	565	400	111
131	421	61	303	400	111
132	61	62	535	400	111
134	62	422	93	400	111
135	422	63	19	400	111
136	63	64	467	600	111
138	64	65	21	600	111
140	65	66	130	600	111
142	66	67	28	600	111
144	67	68	39	600	111
146	68	69	78	600	111
148	69	70	91	600	111
150	70	71	73	600	111
152	71	72	175	600	111
154	72	73	206	600	111
156	73	74	95	600	111
158	74	75	29	600	111
160	75	76	157	600	111
162	76	427	75	600	111
164	427	77	88	600	111
166	427	89	23	400	111
168	422	78	453	400	111
170	78	79	13	400	111
172	79	80	21	400	111
174	80	81	135	400	111
176	81	82	52	400	111
178	82	83	169	400	111
180	83	8301	94	400	111
182	8301	84	182	400	111
184	84	85	105	400	111
186	85	86	99	400	111

188	86	87	190	400	111
190	87	88	78	400	111
192	88	89	67	400	111
194	89	90	80	400	111
196	90	91	154	400	111
198	91	428	49	400	111
199	428	92	399	400	111
200	92	93	49	400	111
201	92	54	172	400	111
202	93	94	48	400	111
204	94	56	112	400	111
206	64	95	531	400	111
208	95	96	104	400	111
210	96	97	695	400	111
212	97	98	586	400	111
214	98	99	169	400	111
216	99	430	113	400	111
217	430	100	931	400	111
218	100	101	91	400	111
220	101	102	600	400	111
222	102	103	285	400	111
224	103	104	514	400	111
226	104	105	46	400	111
228	105	106	115	400	111
229	432	110	368	400	111
230	106	503	430	400	111
231	503	107	297	400	111
232	107	536	363	400	111
233	536	431	746	400	111
234	431	108	337	400	111
235	108	109	116	400	111
236	109	491	728	400	111
237	491	432	636	400	111
238	40	433	140	600	111
239	433	111	99	600	111
240	111	112	820	600	111
241	111	518	419	300	111
242	112	113	109	600	111
244	113	114	646	600	111
246	114	115	60	600	111
248	115	29	91	600	111
250	4101	434	156	500	111
251	434	116	191	500	111
252	116	1161	444	500	111
253	1161	112	483	500	111
254	60	435	9	300	111
255	435	117	459	300	111
256	117	118	53	300	111
257	435	8301	406	300	111
258	118	119	120	300	111
260	119	120	33	300	111
261	120	61	230	300	111
262	120	121	161	300	111
264	121	122	96	300	111
266	122	123	49	300	111
268	123	78	49	300	111
270	124	125	259	300	111
272	125	126	102	300	111
274	126	436	101	300	111
275	436	127	164	300	111
276	33	128	45	900	111
278	128	413	14	600	111

279	413	129	125	600	111
280	129	130	27	400	111
282	130	441	40	400	111
283	441	131	34	400	111
284	131	127	299	400	111
286	2	132	40	400	111
288	132	133	288	400	111
290	133	442	363	400	111
291	442	134	83	400	111
292	134	135	103	400	111
293	135	455	365	400	111
294	133	136	196	300	111
296	136	137	150	300	111
298	137	525	188	300	111
299	525	138	485	300	111
300	134	136	289	300	111
302	135	137	329	300	111
304	138	517	379	300	146
305	517	139	822	400	146
306	139	541	688	400	111
307	541	140	271	400	111
308	140	100	111	400	111
309	139	542	83	400	111
310	132	443	512	300	111
311	443	138	522	300	111
312	4	141	69	400	111
314	141	142	498	400	111
316	142	143	75	400	111
318	143	144	318	400	111
320	144	145	147	400	111
322	145	146	336	400	111
324	146	147	153	400	111
325	147	38	445	400	111
330	153	1531	53	400	111
332	1531	444	101	400	111
333	444	156	418	400	111
334	156	157	1037	400	111
336	157	158	641	400	111
338	158	159	1071	400	111
339	159	523	722	400	111
340	523	522	323	400	111
341	522	160	424	400	111
342	160	161	943	400	111
344	161	162	633	400	111
346	162	163	482	400	111
348	62	163	968	400	111
350	163	164	402	400	111
352	164	168	28	400	111
354	63	168	1454	400	111
356	164	165	111	400	111
358	165	166	179	400	111
360	166	537	349	300	111
361	537	167	497	300	111
362	168	169	250	400	111
364	169	170	138	300	111
366	170	171	55	300	111
368	171	172	554	300	111
369	167	547	285	300	111
374	11	446	266	600	111
375	446	447	345	600	111
376	447	173	275	600	111
377	173	174	67	600	111

378	174	175	277	600	111
380	175	176	124	600	111
382	176	448	146	400	146
383	448	449	127	400	146
384	449	178	98	400	146
386	178	179	367	400	146
387	179	53	486	400	146
400	52	185	124	600	111
402	185	186	214	600	111
404	186	187	328	600	111
406	187	188	167	600	111
412	188	189	150	600	111
414	189	190	279	600	111
416	190	191	133	600	111
418	191	192	69	600	111
420	192	193	296	600	111
422	193	194	69	600	146
424	194	195	188	600	146
426	195	196	145	600	146
428	196	197	59	600	146
429	196	478	354	300	146
430	197	18	181	600	146
432	197	476	294	300	111
434	476	477	99	300	111
436	477	478	226	300	111
438	478	479	112	300	111
440	479	480	27	300	111
442	479	21	26	300	111
444	480	481	159	300	111
446	481	482	148	300	111
500	424	524	568	900	111
502	524	425	652	900	111
504	425	426	38	900	111
506	426	77	427	900	111
508	541	513	131	300	111
510	513	514	60	300	111
512	514	515	256	300	111
514	514	516	179	300	111
516	113	453	35	400	111
518	453	452	32	300	111
520	453	454	34	300	111
522	452	1163	449	300	111
524	454	1162	450	300	111
526	1163	1162	81	300	111
528	1162	1161	61	400	111
530	185	183	81	300	111
532	183	450	60	300	111
534	450	184	475	300	111
536	184	180	600	300	111
538	180	181	236	300	111
540	181	451	306	300	111
542	451	183	631	300	111
544	483	484	23	400	111
546	484	485	929	400	111
548	485	486	210	300	111
550	44	508	15	300	111
552	508	507	273	300	111
554	507	506	99	300	111
556	506	526	537	300	111
558	526	505	634	300	111
560	505	504	246	300	111
562	504	503	135	300	111

564	497	534	462	300	111
566	498	533	469	300	111
568	534	535	723	300	111
570	533	532	716	300	111
572	535	495	456	300	111
574	532	496	459	300	111
576	495	493	246	400	111
577	493	494	19	400	111
578	496	494	251	400	111
580	493	492	531	400	111
582	494	110	175	400	111
584	110	502	535	400	111
586	502	501	14	400	111
590	492	490	634	400	111
592	490	489	728	400	111
594	109	489	22	400	111
596	489	488	169	400	111
597	488	28	164	600	111
598	10	456	10	300	111
600	456	457	872	300	111
602	446	521	607	300	111
604	447	520	641	300	111
606	457	546	335	300	111
608	546	543	567	300	111
610	543	544	23	300	111
612	544	545	19	300	111
616	41	178	498	600	111
618	4	462	12	1200	111
620	462	548	1169	1200	111
622	548	7	12	1200	111
624	548	540	423	1200	111
626	540	458	16	1200	111
628	540	463	2612	1200	111
630	463	20	55	1200	111
632	456	414	836	300	111
634	138	510	571	300	111
636	510	511	177	300	111
638	511	512	123	300	111
640	85	509	532	300	111
642	509	96	352	300	111
644	462	461	86	1200	111
646	461	460	147	1200	111
648	460	464	220	1200	111
650	464	459	45	1200	111
652	459	407	431	1200	111
654	407	406	87	1200	111
655	406	405	18	1400	111
656	406	408	175	1200	111
658	408	409	165	1200	111
660	409	35	9	1200	111
662	409	410	175	1200	111
664	410	411	29	1000	111
666	411	445	423	1000	111
668	445	444	21	600	111
670	153	154	94	400	111
672	154	155	676	400	111
674	155	1551	779	300	111
676	127	437	19	300	111
678	437	438	31	300	111
680	438	439	643	300	111
682	471	124	135	300	111
684	1	471	54	600	111

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     686     471     470      30     600     111
     688     470     469     172     600     111
     690     469     468      24     600     111
     692     468     467      34     600     111
     694     467     549     123     600     111
     696     549     413     165     600     111
     698     128     404      14     600     111
     700     404     403      31     600     111
     702     467     466      58    1000     111
     704     466     465      35    1000     111
     706     465     464     293    1000     111
     708      36     400      49     600     111
     710      37     475      28    1000     111
     712     475     428     413     400     111
     714      31     538     140     600     111
    1000     423     512      40     300     148 ; Added connection near canal
    1002     423     430      20     400     148 ; Added connection near canal

[PUMPS]
;-----------------------------------------------------------
; Pump    From    To      H0      H1      Q1      H2      Q2
; ID      Node    Node    M       M       L/S     M       L/S
;-----------------------------------------------------------
; 5001    5000    400     73.8    45      350     27.7    450 ; Bamag No. 2 Pump No. 1
; 5002    5000    400     73.8    45      350     27.7    450 ; Bamag No. 2 Pump No. 2
  5003    5000    400     71      42.1    450     24.7    550 ; Bamag No. 2 Pump No. 3
  5004    5000    400     73.7    47.1    350     26      450 ; Bamag No. 2 Pump No. 4
; 5005    5000    400     73.6    41.9    350     29.4    400 ; Bamag No. 2 Pump No. 5
  5102    5001    34      69.2    47.6    300     23.3    450 ; American Pump No. 2
  5103    5001    34      62.1    48      250     27.5    400 ; American Pump No. 3
; 5104    5001    34      67.1    48.7    300     26.1    450 ; American Pump No. 4
; 5105    5001    34      67.9    48.7    300     25.6    450 ; American Pump No. 5
  5106    5001    34      67.6    47.5    350     23.9    500 ; American Pump No. 6
; 5107    5001    34      67.8    49      300     26      450 ; American Pump No. 7
; 5201    5002    403     62.7    44.2    250     32.9    300 ; CTE Pump No. 1
; 5202    5002    403     73.6    42.2    200     16.6    300 ; CTE Pump No. 2
; 5203    5002    403     62.7    44.2    250     32.9    300 ; CTE Pump No. 3 (No Test)
; 5204    5002    403     67      48      300     25      450 ; CTE Pump No. 4 (American)
; 5205    5002    403     67      48      300     25      450 ; CTE Pump No. 5 (American)
  5301    5003    405     70      52.5    500     36      750 ; Bamag No. 3 Pump No. 1
; 5302    5003    405     70      52.5    500     36      750 ; Bamag No. 3 Pump No. 2
; 5303    5003    405     70      52.5    500     36      750 ; Bamag No. 3 Pump No. 3
; 5304    5003    405     70      52.5    500     36      750 ; Bamag No. 3 Pump No. 4
; 5305    5003    405     70      52.5    500     36      750 ; Bamag No. 3 Pump No. 5
  5306    5003    405     70      52.5    500     36      750 ; Bamag No. 3 Pump No. 6

[REPORT]
        STATUS   YES

[STATUS]
;-----------------------------------------------------------
;
;       Link     Status
;-----------------------------------------------------------
;          5000 CLOSED
;          5001 CLOSED
;          5002 CLOSED
;          5003 CLOSED
;           577 CLOSED   ; Cross Connection in SW section
;           584 CLOSED   ; Cross Connection in SW section

[PATTERNS]
```

```
;-----------------------------------------------------------------
;                    1          1 ; Average Day Demand
;                    1        1.3 ; Max. Day Demand
                     1          2 ; Peak Hour Demand
                    99          1 ; Unique Users Fixed Demand
;                    1        1.5 ; Calibration Factor

[OPTIONS]
;-----------------------------------------------
UNITS     SI
MAP       SZ_EXIST.MAP

[END]
```

Suez Existing Map

[COORDINATES]
SUEZ WATER DISTRIBUTION SYSTEM

;----------
;Node X-Coord. Y-Coord.
;----------

1	455951	316446
2	455905	316481
3	455864	316488
4	455754	316587
5	455209	316996
6	454961	317185
7	454820	317290
8	454489	317523
9	454136	317789
10	453818	318024
11	453807	318032
12	453779	318052
13	453678	318127
14	453519	318244
15	453418	318317
16	453208	318469
17	453194	318464
18	452639	318872
19	452407	319062
20	452347	319060
21	452122	318799
22	451763	318380
23	451414	317823
24	449574	316259
25	448907	312527
26	449009	312432
27	450555	313863
28	450853	313476
29	454267	314806
31	456113	316333
32	456355	316669
33	456194	316787
34	456351	317064
35	456519	316904
36	456515	316898
37	456128	316382
38	454071	317023
39	453993	316928
40	453752	316666
41	453541	316469
42	452811	315676
43	452790	315663
44	451725	315472
45	451129	315202
46	450766	314766
47	450659	314663
48	450247	314264
49	449908	315161
50	449709	315781
51	451863	317196
52	452248	316639
53	452645	315979
54	456707	316602

[COORDINATES]
SUEZ WATER DISTRIBUTION SYSTEM

;----------
;Node X-Coord. Y-Coord.
;----------

55	456787	316527
56	456841	316486
57	457020	316165
58	457022	315690
59	457027	315634
60	457152	315554
61	457614	315004
62	457483	314487
63	457456	314490
64	457168	314857
65	457155	314875
66	457073	314975
67	457055	314998
68	457030	315028
69	456980	315089
70	456924	315157
71	456876	315218
72	456767	315356
73	456641	315519
74	456591	315600
75	456579	315627
76	456516	315771
77	456451	315922
78	457190	314857
79	457181	314868
80	457169	314885
81	457083	314990
82	457050	315031
83	456945	315163
84	456772	315379
85	456708	315464
86	456647	315543
87	456560	315712
88	456534	315787
89	456509	315850
90	456480	315925
91	456418	316065
92	456643	316447
93	456683	316476
94	456729	316487
95	456642	314823
96	456542	314797
97	455935	314475
98	455392	314689
99	455263	314796
100	454288	314784
101	454197	314770
102	453603	314683
103	453320	314651
104	452815	314554
105	452770	314541
106	452660	314503
107	451986	314230
108	450885	313333
109	450787	313275
110	449475	312228

[COORDINATES]
SUEZ WATER DISTRIBUTION SYSTEM

;----------
;Node X-Coord. Y-Coord.
;----------

111	453901	316496
112	454076	315695
113	454100	315587
114	454235	314955
115	454248	314896
116	453161	315577
117	457520	315311
118	457496	315263
119	457439	315157
120	457423	315129
121	457317	315006
122	457254	314933
123	457221	314894
124	455927	316572
125	455739	316753
126	455759	316852
127	455724	317027
128	456158	316814
129	456046	316897
130	456044	316925
131	456016	316972
132	455874	316454
133	456063	316238
134	456248	315884
135	456186	315800
136	456018	316053
137	455900	315961
138	455261	315842
139	454064	315832
140	454264	314894
141	455718	316527
142	455272	316750
143	455211	316791
144	454947	316972
145	454829	317060
146	454617	316800
147	454465	316822
153	456820	316559
154	456753	316628
155	456901	317261
156	457240	316169
157	458248	316342
158	458861	316253
159	459829	315865
160	459548	314441
161	458645	314284
162	458607	313666
163	458128	313668
164	458289	313299
165	458321	313193
166	458306	313012
167	458198	312172
168	458261	313296
169	458270	313046
170	458151	312976
171	458179	312928

[COORDINATES]
SUEZ WATER DISTRIBUTION SYSTEM

;----------
;Node X-Coord. Y-Coord.
;----------

172	457692	312665
173	453288	317312
174	453291	317246
175	453315	316971
176	453288	316850
178	453096	316694
179	452875	316401
180	452939	316116
181	452832	315908
183	452404	316727
184	452917	316718
185	452323	316737
186	452342	316949
187	452371	317276
188	452385	317444
189	452459	317574
190	452597	317817
191	452663	317933
192	452699	317995
193	452619	318281
194	452600	318348
195	452549	318529
196	452509	318668
197	452541	318718
400	456476	316929
401	456220	316878
402	456245	316860
403	456192	316807
404	456166	316826
405	456312	317121
406	456324	317135
407	456243	317164
408	456484	317069
409	456525	316912
410	456601	316751
411	456630	316745
413	456146	316822
414	454480	317512
415	453968	316924
416	453723	316631
417	453665	316617
418	452458	315458
420	451423	315426
421	457655	315300
422	457471	314502
423	455201	314919
424	455391	314715
425	456254	315548
426	456227	315575
427	456487	315841
428	456442	316108
429	456839	316499
430	455204	314891
431	451060	313623
432	449618	312569
433	453871	316589

[COORDINATES]
SUEZ WATER DISTRIBUTION SYSTEM

;----------
;Node X-Coord. Y-Coord.
;----------

434	453161	315769
435	457146	315547
436	455660	316875
437	455732	317045
438	455762	317039
439	455919	317656
441	456006	316939
442	456289	315954
443	455379	316343
444	456935	316458
445	456921	316441
446	453649	317817
447	453445	317538
448	453291	316735
449	453172	316747
450	452445	316771
451	452629	316137
452	454073	315548
453	454065	315580
454	454058	315613
455	455975	315502
456	453812	318016
457	453302	317310
458	454472	317536
459	455982	316819
460	455932	316559
461	455822	316658
462	455760	316597
463	452384	319102
464	455973	316774
465	456215	316609
466	456193	316580
467	456147	316616
468	456127	316587
469	456108	316603
470	456010	316469
471	455986	316487
472	456034	316454
475	456113	316359
476	452440	318985
477	452359	319042
478	452214	318869
479	452142	318783
480	452125	318762
481	452204	318624
482	452069	318563
483	452260	316622
484	452240	316609
485	451713	317375
486	451537	317258
487	450529	313843
488	450945	313341
489	450799	313255
490	450173	312882
491	450163	312898
492	449632	312549

[COORDINATES]
SUEZ WATER DISTRIBUTION SYSTEM

;----------
;Node X-Coord. Y-Coord.
;----------

493	449430	312058
494	449411	312065
495	449340	311828
496	449319	311831
497	448708	310312
498	448686	310312
499	450129	313535
500	449404	312651
501	448985	312448
502	448997	312460
503	452265	314334
504	452203	314455
505	451982	314347
506	451441	315386
507	451453	315485
508	451725	315487
509	456339	315083
510	455176	315276
511	455242	315114
512	455224	314991
513	454335	315187
514	454322	315247
515	454572	315304
516	454283	315422
517	454885	315863
518	454313	316562
520	452872	317751
521	453198	318202
522	459666	314831
523	459711	315151
524	455739	315160
525	455748	315849
526	451690	314910
527	451340	313844
528	449228	315625
529	449091	314765
530	449041	314211
531	449012	312878
532	449144	311405
533	448867	310744
534	448887	310738
535	449166	311405
536	451664	314062
537	458263	312666
538	455997	316411
540	454482	317548
541	454207	315159
542	454047	315914
543	453794	316652
544	453779	316634
545	453762	316645
546	453330	316977
547	457998	311971
548	454828	317300
549	456049	316688
1161	453605	315587

[COORDINATES]
SUEZ WATER DISTRIBUTION SYSTEM

;----------
;Node X-Coord. Y-Coord.
;----------

1162	453616	315527
1163	453635	315448
1531	456860	316525
1551	457119	318006
2801	452951	314602
3501	456711	316609
4101	453041	315870
8301	456886	315237
5000	456466	316917
5001	456356	317071
5002	456202	316817
5003	456299	317131

[LABELS]
;----------
;X-COORDY-COORD.LABEL
;----------

456536	316937	Bamag No. 2 P.S.
456406	317071	American P.S.
456252	316817	CTE P.S.
456299	317231	Bamag No. 3 P.S.

[END]

[TITLE]
Suez 2020 System

; Peak Hour Demand - 8505.32 L/s
; Peaking Factors - See PATTERNS Section
; New cross connections in downtown area to complete loops
; All lines assumed to be open
; New reservoir and booster pumps near Node No. 20

[JUNCTIONS]

;ID	Elev. m	Demand lps	Pattern	
1	7	0	1	
2	7	0	1	
3	7	0	1	
4	7	0	1	
5	9	15.77	1	
6	11	3.8	1	
7	11.3	6.54	1	
8	12	0	1	
9	14.1	0	1	
10	15.5	32.29	1	
11	15.5	0	1	
12	15.7	7.25	1	
13	16.8	0	1	
14	18.8	0	1	
15	19.4	7	1	
16	21	0	1	
17	21	27.06	1	
18	24.5	30.5	1	
19	25	0	1	
20	25.5	0	1	
21	23	0	1	
; 22	24.5	0	1	; Replaced by new node 10022
23	19.2	3.16	1	
24	18.2	2.52	1	
25	10	16.3	1	
26	8	46.3	1	
27	3	0	1	
28	0.5	0	1	
29	3.3	3.51	1	
31	4.5	0	1	
32	4.3	0	1	
33	6.7	0	1	
34	5.5	0	1	
35	6.3	0	1	
36	6.3	0	1	
37	4.5	0	1	
38	10	34.17	1	
39	9.9	0	1	
40	9	0	1	
41	8.5	17.73	1	
42	3.8	0	1	
43	3.8	8.64	1	
44	6	13.14	1	
45	6.8	0	1	
46	5.7	0	1	
; 47	5	0	1	; Replaced by new node 10011
; 48	8	0	1	; Replaced by new node 10010

179

49	14	0	1	
; 50	15.7	0	1	; Replaced by new node 10013
51	13.5	0	1	
52	10.3	0	1	
53	5.1	23.69	1	
54	3.7	0	1	
55	3.7	0	1	
56	3.7	0	1	
57	3.5	9.81	1	
58	3	0	1	
59	2.7	7.59	1	
60	2.5	4.34	1	
61	3.5	6.29	1	
62	3	5.41	1	
63	3	0.73	1	
64	3.5	3.42	1	
65	3.5	0	1	
66	3.6	0	1	
67	3.6	0	1	
68	3.7	0	1	
69	3.7	0	1	
70	3.8	0	1	
71	3.8	4.22	1	
72	3.9	0	1	
73	4	0	1	
74	4	0	1	
75	4	0	1	
76	4.1	3.78	1	
77	4.1	3.38	1	
78	3.5	13.19	1	
79	3.5	0	1	
80	3.5	0	1	
81	3.6	0	1	
82	3.7	10.54	1	
83	3.8	0	1	
84	3.9	0	1	
85	4	11.19	1	
86	4	0	1	
87	4	4.82	1	
88	4.1	0	1	
89	4.1	0	1	
90	4.1	0	1	
91	4.1	0	1	
92	3.5	21.47	1	
93	3.5	0	1	
94	3.6	0	1	
95	3	12.65	1	
96	3	6.64	1	
97	3	16.44	1	
98	4	1.64	1	
99	3.7	5.43	1	
100	3.3	8.93	1	
101	3.3	0	1	
102	3	0	1	
103	3.1	1.41	1	
104	2.5	0.06	1	
105	2.5	0	1	
106	1.5	6.98	1	
107	1.4	0	1	
108	0.5	0	1	
109	0	0.23	1	
110	10	3.19	1	

111	9	0	1	
112	2.8	0	1	
113	2	0.78	1	
114	3.3	0	1	
115	3.3	0	1	
116	3.3	9.81	1	
117	3.3	4.64	1	
118	3.3	0	1	
119	3.3	0	1	
120	3.3	0	1	
121	3.4	0	1	
122	3.5	0	1	
123	3.6	0	1	
124	6	0	1	
125	6.9	2.27	1	
126	8.5	0	1	
127	10.2	0	1	
128	6.7	0	1	
129	6.6	0	1	
130	6.6	0	1	
131	6.6	7.12	1	
132	7	14.35	1	
133	4.1	14.09	1	
134	5	0	1	
135	5.6	3.34	1	
136	4.6	0	1	
137	7.1	8.39	1	
138	9	20.66	1	
139	6.1	50.38	1	
140	3.3	1.44	1	
141	6.6	9.37	1	
142	9.5	0	1	
143	9.6	20.05	1	
144	10.5	1.35	1	
145	11	0	1	
146	9.5	7.38	1	
147	8.5	10.1	1	
153	3	0	1	
154	3	53.8	1	
155	6	12.66	1	
156	3.5	0	1	
157	2.7	0	1	
158	3.5	0	1	
; 159	2	0	1	; Replaced by new node 10028
160	2.6	10.26	1	
161	4.5	12.62	1	
162	2.8	2.35	1	
163	2.8	14.24	1	
164	2.8	0	1	
165	2.5	8.54	1	
166	2.5	0	1	
167	7.2	0	1	
168	2.8	2.46	1	
169	2.5	0	1	
170	2.3	0	1	
171	2.3	4.73	1	
172	1	0.57	1	
173	14.2	0	1	
174	14.6	0	1	
175	13	19.84	1	
176	12	6.73	1	
178	12	0	1	

	179	5	0	1
	180	3.7	20.56	1
	181	3.7	10.05	1
	183	10	17.15	1
	184	7.4	11.32	1
	185	10.5	0	1
	186	12.3	8.58	1
	187	13.5	46.11	1
	188	15.7	0	1
	189	16.2	60.77	1
	190	17.2	0	1
	191	18.2	0	1
	192	18.7	0	1
	193	20.5	0	1
	194	21.2	0	1
	195	21.2	0	1
	196	23	26.14	1
	197	23	0	1
	400	6.3	0	1
	401	6.7	4.9	1
	402	6.7	0	1
	403	6.7	0	1
	404	6.7	0	1
	405	4.5	0	1
	406	4.5	0	1
	407	4.5	23	1
	408	5.8	0	1
	409	6.3	0	1
	410	3.4	0	1
	411	3.4	0	1
	413	6.7	0	1
	414	12	30.2	1
	415	9.9	23.18	1
	416	9	0	1
	417	9	0	1
	418	6	25.41	1
	420	6	0	1
	421	3.6	0	1
	422	3	0	1
	423	5	0	1
	424	4	2.95	1
	425	4	3.07	1
	426	4	0	1
	427	4.1	0	1
	428	4.3	14.12	1
	429	3.7	0	1
	430	5	0.61	1
	431	2.5	23.88	1
; 432		2	0	1 ; Replaced by new node 10006
	433	8.5	0	1
	434	4.5	18.15	1
	435	2.5	0	1
	436	9	0	1
	437	10.2	23.24	1
	438	10.2	0	1
	439	8.5	76.03	1
	441	6.6	0	1
	442	5	0	1
	443	7.3	25.64	1
	444	3.4	0	1
	445	3.4	0	1
	446	15.1	0.52	1

	447	12.5	0	1
	448	12	0	1
	449	12	0	1
	450	10	8.81	1
	451	4.5	10.39	1
	452	1.8	0	1
	453	1.8	0	1
	454	1.8	172	1
	455	5.5	6.1	1
	456	15.5	27.12	1
	457	14.2	16.28	1
	458	12	0	1
	459	6.5	0	1
	460	6	0	1
	461	6.2	0	1
	462	7	16.15	1
	463	25	0	1
	464	6.5	0	1
	465	6.7	0	1
	466	6.7	0	1
	467	6.7	0	1
	468	6.7	0	1
	469	6.7	21.92	1
	470	6.3	0	1
	471	6.3	0	1
	472	6.3	0	1
	475	4.5	14.47	1
	476	25	0	1
	477	25.5	0	1
	478	25.7	0	1
	479	23	0	1
	480	23	0	1
	481	22	0	1
	482	22	6.63	1
	483	10.3	0	1
; 484		10.3	0	1 ; Replaced by new node 10015
	485	17	0	1
	486	16.3	0	1
	487	3	0	1
	488	0.5	0	1
	489	0	10.33	1
	490	0	5.35	1
	491	0	0.15	1
	492	2	0	1
	493	10	0	1
	494	10	0	1
	495	3.5	0.04	1
	496	3.5	0	1
	497	4	0.8	1
	498	4	0.53	1
; 499		3	0	1 ; Replaced by new node 10007
; 500		3.7	0	1 ; Replaced by new node 10004
	501	8	0	1
	502	8	0	1
	503	1	2.94	1
	504	1	5.82	1
	505	1.1	4.66	1
	506	6	0	1
	507	6	0	1
	508	6	0	1
	509	2.3	6.6	1
	510	5	26.3	1

511	4.8	3.97	1	
512	4.5	2.18	1	
513	1.4	10.86	1	
514	1.4	0	1	
515	1.2	21.14	1	
516	1.2	7.31	1	
517	6.7	59.19	1	
518	8.2	28.06	1	
520	15.7	25.47	1	
521	18	12.8	1	
522	2.2	28.82	1	
523	2.6	0	1	
524	5.5	19.66	1	
525	7.8	10.77	1	
526	2.5	51.67	1	
527	1.7	60.5	1	
528	15.6	0	1	
529	14.3	1.56	1	
; 530	13.7	0	1	; Replaced by new node 10017
531	9	20.14	1	
532	2.5	49.18	1	
533	6	0.55	1	
534	6	1.69	1	
535	2.5	0.72	1	
536	1.2	4.48	1	
537	2.5	9.74	1	
538	7	0	1	
540	12	0	1	
541	1.6	0	1	
542	6.1	0	1	
543	9	0	1	
544	9	0	1	
545	9	0	1	
546	13	0	1	
547	7.2	0	1	
548	11.3	0	1	
549	6.7	0	1	
1161	3.3	3.2	1	
1162	2.9	0	1	
1163	2.5	11.78	1	
1531	3	0	1	
1551	4.3	11.95	1	
2801	2.6	28.71	1	
3501	3.7	0	1	
4101	4	0	1	
8301	3.8	8.78	1	
10000	20.5	68.6	1	
10001	33	72.29	1	
10002	4	71.07	1	
10003	38.5	9.36	1	
10004	3.7	17.91	1	; Replaces Node 500
10005	30	10.61	1	
10006	2	29.85	1	; Replaces Node 432
10007	3	78.43	1	; Replaces Node 499
10008	31	5.12	1	
10009	23	7.05	1	
10010	8	190.77	1	; Replaces Node 48
10011	5	63.81	1	; Replaces Node 47
10012	20.1	121.82	1	
10013	15.7	170.16	1	; Replaces Node 50
10014	19.2	121.06	1	
10015	10.3	11.18	1	; Replaces Node 484

10016	27.2	107.89	1
10017	13.7	31.9	1 ; Nodes 10017+530=12.99+18.91=31.90
10018	29.5	76.94	1
10019	32.5	129.35	1
10020	33.5	171.99	1
10021	29	159.1	1
10022	24.5	44.58	1 ; Replaces Node 22
10023	34.5	23.02	1
10024	27.3	138.35	1
10027	5	92.07	1
10028	2	7.36	1 ; Replaces Node 159
10029	9.5	59.7	1
10050	3.5	0	1
10051	31.9	0	1
10052	26	0	1
10054	32.4	0	1
10055	23.6	0	1
10056	18.7	0	1
10057	11.5	0	1
10058	10	0	1
10059	9.5	0	1
10060	10	0	1
10061	11.5	0	1
10062	25	0	1
10063	19.2	0	1
10064	18.2	0	1
10065	20.5	0	1
10066	25	0	1

[TANKS]

; ID	Elev. m	Description
5000	6.3	; Bamag No. 2 Pump Station
5001	5.5	; American Pump Station
5002	6.7	; CTE Pump Station
5003	6.7	; Bamag No. 3 Pump Station
5004	35.0	; New Reservoir near Node No. 20

[PIPES]

;ID	From Node	To Node	Length m	Diam. mm	Rough. Coeff.
2	1	2	57	1200	111
4	2	3	42	1200	111
6	3	4	148	1200	111
8	4	5	681	1200	111
10	5	6	311	1200	111
12	6	7	176	1200	111
14	7	8	404	1200	111
16	8	458	21	1200	111
17	458	9	420	1200	111
18	9	10	395	1200	111
20	10	11	12	1200	111
22	11	12	35	1200	111
24	12	13	125	1200	111
26	13	14	197	1200	111
28	14	15	124	1200	111
30	15	16	258	1200	111
32	16	17	15	1200	111

34	17	18	687	1200	111
36	18	19	300	1200	111
37	10014	24	1438	900	111
38	19	20	60	1200	111
40	20	21	343	1200	111
42	21	10022	551	1200	111
43	528	529	1105	600	111
44	10022	23	659	1200	111
45	529	10017	557	600	111
46	23	10014	997	900	111
47	10017	531	1332	600	111
48	24	528	726	600	111
49	531	25	369	600	111
50	25	501	110	600	111
51	501	26	29	600	111
52	26	10004	450	900	111
53	10004	10007	1147	900	111
54	27	28	488	900	111
55	10007	487	504	900	111
56	28	527	610	900	111
57	487	27	32	900	111
58	2801	29	1332	900	111
59	527	2801	1792	900	111
60	29	423	946	900	111
61	423	424	285	900	111
62	77	31	545	900	111
64	31	32	415	900	111
66	32	33	199	1200	111
67	33	402	89	1000	111
68	402	401	30	1000	111
69	401	34	228	1000	111
70	34	35	236	1000	111
72	35	36	7	1000	111
74	36	37	644	1000	111
75	37	472	117	1000	111
76	472	538	56	1000	111
77	538	1	57	1200	111
78	8	414	13	1200	111
79	414	38	637	1200	111
80	38	39	122	1200	111
82	39	415	25	1200	111
83	415	40	336	1200	111
84	40	416	46	1200	111
85	416	417	59	1200	111
86	417	41	192	1200	111
87	41	4101	780	1200	111
88	4101	42	304	1200	111
90	42	43	24	900	111
91	43	2801	1083	500	111
92	43	418	389	900	111
93	418	44	741	900	111
94	44	420	308	900	111
95	420	45	373	900	111
96	45	46	570	900	111
98	46	10011	148	900	111
100	10011	10010	574	900	111
101	10010	487	511	600	111
102	10010	49	966	900	111
104	49	10013	651	900	111
106	10013	24	503	900	111
108	23	51	773	800	111
110	51	52	677	800	111

112	52	483	20	800	111
113	483	53	750	800	111
114	53	42	344	800	111
116	35	3501	358	600	111
117	3501	54	8	400	111
118	54	55	109	400	111
119	3501	429	168	600	111
120	55	56	67	400	111
121	429	1531	33	600	111
122	56	57	367	400	111
124	57	58	475	400	111
126	58	59	54	400	111
127	59	84	364	400	111
128	59	60	150	400	111
130	60	421	565	400	111
131	421	61	303	400	111
132	61	62	535	400	111
134	62	422	93	400	111
135	422	63	19	400	111
136	63	64	467	600	111
138	64	65	21	600	111
140	65	66	130	600	111
142	66	67	28	600	111
144	67	68	39	600	111
146	68	69	78	600	111
148	69	70	91	600	111
150	70	71	73	600	111
152	71	72	175	600	111
154	72	73	206	600	111
156	73	74	95	600	111
158	74	75	29	600	111
160	75	76	157	600	111
162	76	427	75	600	111
164	427	77	88	600	111
166	427	89	23	400	111
168	422	78	453	400	111
170	78	79	13	400	111
172	79	80	21	400	111
174	80	81	135	400	111
176	81	82	52	400	111
178	82	83	169	400	111
180	83	8301	94	400	111
182	8301	84	182	400	111
184	84	85	105	400	111
186	85	86	99	400	111
188	86	87	190	400	111
190	87	88	78	400	111
192	88	89	67	400	111
194	89	90	80	400	111
196	90	91	154	400	111
198	91	428	49	400	111
199	428	92	399	400	111
200	92	93	49	400	111
201	92	54	172	400	111
202	93	94	48	400	111
204	94	56	112	400	111
206	64	95	531	400	111
208	95	96	104	400	111
210	96	97	695	400	111
212	97	98	586	400	111
214	98	99	169	400	111
216	99	430	113	400	111

187

217	430	100	931	400	111
218	100	101	91	400	111
220	101	102	600	400	111
222	102	103	285	400	111
224	103	104	514	400	111
226	104	105	46	400	111
228	105	106	115	400	111
229	10006	110	368	400	111
230	106	503	430	400	111
231	503	107	297	400	111
232	107	536	363	400	111
233	536	431	746	400	111
234	431	108	337	400	111
235	108	109	116	400	111
236	109	491	728	400	111
237	491	10006	636	400	111
238	40	433	140	600	111
239	433	111	99	600	111
240	111	112	820	600	111
241	111	518	419	300	111
242	112	113	109	600	111
244	113	114	646	600	111
246	114	115	60	600	111
248	115	29	91	600	111
250	4101	434	156	500	111
251	434	116	191	500	111
252	116	1161	444	500	111
253	1161	112	483	500	111
254	60	435	9	300	111
255	435	117	459	300	111
256	117	118	53	300	111
257	435	8301	406	300	111
258	118	119	120	300	111
260	119	120	33	300	111
261	120	61	230	300	111
262	120	121	161	300	111
264	121	122	96	300	111
266	122	123	49	300	111
268	123	78	49	300	111
270	124	125	259	300	111
272	125	126	102	300	111
274	126	436	101	300	111
275	436	127	164	300	111
276	33	128	45	900	111
278	128	413	14	600	111
279	413	129	125	600	111
280	129	130	27	400	111
282	130	441	40	400	111
283	441	131	34	400	111
284	131	127	299	400	111
286	2	132	40	400	111
288	132	133	288	400	111
290	133	442	363	400	111
291	442	134	83	400	111
292	134	135	103	400	111
293	135	455	365	400	111
294	133	136	196	300	111
296	136	137	150	300	111
298	137	525	188	300	111
299	525	138	485	300	111
300	134	136	289	300	111
302	135	137	329	300	111

304	138	517	379	300	146
305	517	139	822	400	146
306	139	541	688	400	111
307	541	140	271	400	111
308	140	100	111	400	111
309	139	542	83	400	111
310	132	443	512	300	111
311	443	138	522	300	111
312	4	141	69	400	111
314	141	142	498	400	111
316	142	143	75	400	111
318	143	144	318	400	111
320	144	145	147	400	111
322	145	146	336	400	111
324	146	147	153	400	111
325	147	38	445	400	111
330	153	1531	53	400	111
332	1531	444	101	400	111
333	444	156	418	400	111
334	156	157	1037	400	111
336	157	158	641	400	111
338	158	10028	1071	400	111
339	10028	523	722	400	111
340	523	522	323	400	111
341	522	160	424	400	111
342	160	161	943	400	111
344	161	162	633	400	111
346	162	163	482	400	111
348	62	163	968	400	111
350	163	164	402	400	111
352	164	168	28	400	111
354	63	168	1454	400	111
356	164	165	111	400	111
358	165	166	179	400	111
360	166	537	349	300	111
361	537	167	497	300	111
362	168	169	250	400	111
364	169	170	138	300	111
366	170	171	55	300	111
368	171	172	554	300	111
369	167	547	285	300	111
374	11	446	266	600	111
375	446	447	345	600	111
376	447	173	275	600	111
377	173	174	67	600	111
378	174	175	277	600	111
380	175	176	124	600	111
382	176	448	146	400	146
383	448	449	127	400	146
384	449	178	98	400	146
386	178	179	367	400	146
387	179	53	486	400	146
400	52	185	124	600	111
402	185	186	214	600	111
404	186	187	328	600	111
406	187	188	167	600	111
412	188	189	150	600	111
414	189	190	279	600	111
416	190	191	133	600	111
418	191	192	69	600	111
420	192	193	296	600	111
422	193	194	69	600	146

424	194	195	188	600	146
426	195	196	145	600	146
428	196	197	59	600	146
429	196	478	354	300	146
430	197	18	181	600	146
432	197	476	294	300	111
434	476	477	99	300	111
436	477	478	226	300	111
438	478	479	112	300	111
440	479	480	27	300	111
442	479	21	26	300	111
444	480	481	159	300	111
446	481	482	148	300	111
500	424	524	568	900	111
502	524	425	652	900	111
504	425	426	38	900	111
506	426	77	427	900	111
508	541	513	131	300	111
510	513	514	60	300	111
512	514	515	256	300	111
514	514	516	179	300	111
516	113	453	35	400	111
518	453	452	32	300	111
520	453	454	34	300	111
522	452	1163	449	300	111
524	454	1162	450	300	111
526	1163	1162	81	300	111
528	1162	1161	61	400	111
530	185	183	81	300	111
532	183	450	60	300	111
534	450	184	475	300	111
536	184	180	600	300	111
538	180	181	236	300	111
540	181	451	306	300	111
542	451	183	631	300	111
544	483	10015	23	400	111
546	10015	485	929	400	111
548	485	486	210	300	111
550	44	508	15	300	111
552	508	507	273	300	111
554	507	506	99	300	111
556	506	526	537	300	111
558	526	505	634	300	111
560	505	504	246	300	111
562	504	503	135	300	111
564	497	534	462	300	111
566	498	533	469	300	111
568	534	535	723	300	111
570	533	532	716	300	111
572	535	495	456	300	111
574	532	496	459	300	111
576	495	493	246	400	111
577	493	494	19	400	111
578	496	494	251	400	111
580	493	492	531	400	111
582	494	110	175	400	111
584	110	502	535	400	111
586	502	501	14	400	111
590	492	490	634	400	111
592	490	489	728	400	111
594	109	489	22	400	111
596	489	488	169	400	111

190

597	488	28	164	600	111	
598	10	456	10	300	111	
600	456	457	872	300	111	
602	446	521	607	300	111	
604	447	520	641	300	111	
606	457	546	335	300	111	
608	546	543	567	300	111	
610	543	544	23	300	111	
612	544	545	19	300	111	
616	41	178	498	600	111	
618	4	462	12	1200	111	
620	462	548	1169	1200	111	
622	548	7	12	1200	111	
624	548	540	423	1200	111	
626	540	458	16	1200	111	
628	540	463	2612	1200	111	
630	463	20	55	1200	111	
632	456	414	836	300	111	
634	138	510	571	300	111	
636	510	511	177	300	111	
638	511	512	123	300	111	
640	85	509	532	300	111	
642	509	96	352	300	111	
644	462	461	86	1200	111	
646	461	460	147	1200	111	
648	460	464	220	1200	111	
650	464	459	45	1200	111	
652	459	407	431	1200	111	
654	407	406	87	1200	111	
655	406	405	18	1400	111	
656	406	408	175	1200	111	
658	408	409	165	1200	111	
660	409	35	9	1200	111	
662	409	410	175	1200	111	
664	410	411	29	1000	111	
666	411	445	423	1000	111	
668	445	444	21	600	111	
670	153	154	94	400	111	
672	154	155	676	400	111	
674	155	1551	779	300	111	
676	127	437	19	300	111	
678	437	438	31	300	111	
680	438	439	643	300	111	
682	471	124	135	300	111	
684	1	471	54	600	111	
686	471	470	30	600	111	
688	470	469	172	600	111	
690	469	468	24	600	111	
692	468	467	34	600	111	
694	467	549	123	600	111	
696	549	413	165	600	111	
698	128	404	14	600	111	
700	404	403	31	600	111	
702	467	466	58	1000	111	
704	466	465	35	1000	111	
706	465	464	293	1000	111	
708	36	400	49	600	111	
710	37	475	28	1000	111	
712	475	428	413	400	111	
714	31	538	140	600	111	
1000	423	512	40	300	148	; Added connection near canal
1002	423	430	20	400	148	; Added connection near canal

```
 10000    10065    10050     805     400     148
 10002    10050    10002    1864     400     148
 10004    10000    10001    2376     600 148 ; Reduced from 1200
 10006    10001    10051     248     800 130 ; Reduced from 1200
 10008    10051    10052    1087     800 130 ; Reduced from 1200
 10010    10052    10003     330     800 130 ; Reduced from 1200
 10012    10003    10005    1620     800 130 ; Reduced from 1200
 10014    10005    10008     797     800 130 ; Reduced from 1200
 10016    10008    10009     674     800 130 ; Reduced from 1200
 10018    10009    10012    1663     800 130 ; Reduced from 1200
 10020    10012    10016    1813    1200     130
 10022    10016    10018    1073    1200     130
 10024    10018    10019     999    1200     130
 10026    10019    10020     689    1200     130
 10028    10020    10023    1442    1200     130
 10030    10023    10024    2103    1200     130
 10032    10024    10062    1178    1200     130
 10034    10020    10054    1281     800     130
 10036    10054    10055    1652     800     130
 10038    10055    10063     936     800     130
 10040    10054    10021    1160     800     130
 10042    10021    10056    2228     800     130
 10044    10056    10064     337     900     130
 10046    10012    10056     595     900     130
 10048      540    10060     958     600     148
 10050    10060    10061     850     600     148
 10052    10061    10057     523     600     148
 10054    10057    10058    1253     600     148
 10056    10058    10059     227     300     148
 10058    10059      439     347     300     148
 10060      445    10027    1383     600     148
 10062    10027    10029    1194     600     148
 10064    10029      523     704     600     148
 10066      498    10002     473     400     148
 10068      497      498      21     400     148
 10070    10066     5004      20    1200     130
 10072      532      535      20     300 148 ; New cross connection in southwest
 10074       29      100      20     400 148 ; New cross connection in south
 10076       26      110     530     400 148 ; New parallel line in southwest
 10078      495      496      20     400 148 ; New cross connection in southwest
 10080      495      532     459     400 148 ; New parallel line in southwest
  6001       23    10063      10     900     130 CV ; Cross connection to upper zone
  6002       24    10064      10     900     130 CV ; Cross connection to upper zone
  6003    10065    10000      10     900     130 CV ; Cross connection to upper zone

[PUMPS]
;-----------------------------------------------------------------------------------------------------------------
; Pump     From     To       H0       H1       Q1       H2       Q2
; ID       Node     Node     M        M        L/S      M        L/S
;-----------------------------------------------------------------------------------------------------------------
    5001     5000      400     73.8       45      350     27.7 450 ; Bamag No. 2 Pump No. 1
    5002     5000      400     73.8       45      350     27.7 450 ; Bamag No. 2 Pump No. 2
    5003     5000      400       71     42.1      450     24.7 550 ; Bamag No. 2 Pump No. 3
    5004     5000      400     73.7     47.1      350       26 450 ; Bamag No. 2 Pump No. 4
; 5005         5000      400     73.6     41.9      350     29.4 400 ; Bamag No. 2 Pump No. 5
    5102     5001       34     69.2     47.6      300     23.3 450 ; American Pump No. 2
    5103     5001       34     62.1       48      250     27.5 400 ; American Pump No. 3
    5104     5001       34     67.1     48.7      300     26.1 450 ; American Pump No. 4
    5105     5001       34     67.9     48.7      300     25.6 450 ; American Pump No. 5
; 5106         5001       34     67.6     47.5      350     23.9 500 ; American Pump No. 6
; 5107         5001       34     67.8       49      300       26 450 ; American Pump No. 7
    5201     5002      403     62.7     44.2      250     32.9 300 ; CTE Pump No. 1
```

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; 5202      5002    403    73.6    42.2    200    16.6 300 ; CTE Pump No. 2
; 5203      5002    403    62.7    44.2    250    32.9 300 ; CTE Pump No. 3 (No Test)
; 5204      5002    403      67      48    300      25 450 ; CTE Pump No. 4 (American)
    5205    5002    403      67      48    300      25 450 ; CTE Pump No. 5 (American)
    5301    5003    405      70    52.5    500      36 750 ; Bamag No. 3 Pump No. 1
    5302    5003    405      70    52.5    500      36 750 ; Bamag No. 3 Pump No. 2
    5303    5003    405      70    52.5    500      36 750 ; Bamag No. 3 Pump No. 3
    5304    5003    405      70    52.5    500      36 750 ; Bamag No. 3 Pump No. 4
    5305    5003    405      70    52.5    500      36 750 ; Bamag No. 3 Pump No. 5
; 5306      5003    405      70    52.5    500      36 750 ; Bamag No. 3 Pump No. 6

; 5400      5004  10062      50      40    600      25 900  ; Booster to upper zone 1 pump
; 5400      5004  10062      50      40   1200      25 1800 ; Booster to upper zone 2 pumps
; 5400      5004  10062      50      40   1800      25 2700 ; Booster to upper zone 3 pumps
    5400    5004  10062      50      40   2400      25 3600 ; Booster to upper zone 4 pumps
; 5400      5004  10062      50      40   3000      25 4500 ; Booster to upper zone 5 pumps
; 5500      5004     20      35      25    250      10 400  ; Booster to lower zone 1 pump
; 5500      5004     20      35      25    500      10 800  ; Booster to lower zone 2 pumps
    5500    5004     20      35      25    750      10 1200 ; Booster to lower zone 3 pumps
; 5500      5004     20      35      25   1000      10 1600 ; Booster to lower zone 4 pumps
; 5500      5004     20      35      25   1250      10 2000 ; Booster to lower zone 5 pumps

[VALVES]
;-----------------------------------------------------------------------------------------
; Valve    From     To      Diam                  Pressure
; ID       Node     Node    mm        Type        Setting
;-----------------------------------------------------------------------------------------
    6000     463    10066   1200 FCV              300


[REPORT]
          STATUS   YES

[STATUS]
;-----------------------------------------------------------------------------------------
;
;          Link     Status
;-----------------------------------------------------------------------------------------
;                5000 CLOSED
;                5001 CLOSED
;                5002 CLOSED
;                5003 CLOSED
;                 577 CLOSED  ; Cross Connection in SW section
;                 584 CLOSED  ; Cross Connection in SW section
                  630 CLOSED

[PATTERNS]
;-----------------------------------------------------------------------------------------
;                   1        1 ; Average Day Demand
;                   1      1.3 ; Max. Day Demand
                    1        2 ; Peak Hour Demand
;                  99        1 ; Fixed Demand or Inflow
;                   1      1.5 ; Calibration Factor

[OPTIONS]
;-----------------------------------------------
UNITS     SI
MAP       SZ_2020.MAP

[END]
```

Suez 2020 Map

[COORDINATES]
SUEZ WATER DISTRIBUTION SYSTEM

;Node	X-Coord.	Y-Coord.
1	455951	316446
2	455905	316481
3	455864	316488
4	455754	316587
5	455209	316996
6	454961	317185
7	454820	317290
8	454489	317523
9	454136	317789
10	453818	318024
11	453807	318032
12	453779	318052
13	453678	318127
14	453519	318244
15	453418	318317
16	453208	318469
17	453194	318464
18	452639	318872
19	452407	319062
20	452347	319060
21	452122	318799
;22	451763	318380
23	451414	317823
24	449574	316259
25	448907	312527
26	449009	312432
27	450555	313863
28	450853	313476
29	454267	314806
31	456113	316333
32	456355	316669
33	456194	316787
34	456351	317064
35	456519	316904
36	456515	316898
37	456128	316382
38	454071	317023
39	453993	316928
40	453752	316666
41	453541	316469
42	452811	315676
43	452790	315663
44	451725	315472
45	451129	315202
46	450766	314766
;47	450659	314663
;48	450247	314264
49	449908	315161
;50	449709	315781
51	451863	317196
52	452248	316639
53	452645	315979
54	456707	316602
55	456787	316527

[COORDINATES]
SUEZ WATER DISTRIBUTION SYSTEM

;----------
;Node X-Coord. Y-Coord.
;----------

56	456841	316486
57	457020	316165
58	457022	315690
59	457027	315634
60	457152	315554
61	457614	315004
62	457483	314487
63	457456	314490
64	457168	314857
65	457155	314875
66	457073	314975
67	457055	314998
68	457030	315028
69	456980	315089
70	456924	315157
71	456876	315218
72	456767	315356
73	456641	315519
74	456591	315600
75	456579	315627
76	456516	315771
77	456451	315922
78	457190	314857
79	457181	314868
80	457169	314885
81	457083	314990
82	457050	315031
83	456945	315163
84	456772	315379
85	456708	315464
86	456647	315543
87	456560	315712
88	456534	315787
89	456509	315850
90	456480	315925
91	456418	316065
92	456643	316447
93	456683	316476
94	456729	316487
;95	456642	314823
96	456542	314797
97	455935	314475
98	455392	314689
99	455263	314796
100	454288	314784
101	454197	314770
102	453603	314683
103	453320	314651
104	452815	314554
105	452770	314541
106	452660	314503
107	451986	314230
108	450885	313333
109	450787	313275
110	449475	312228
111	453901	316496

[COORDINATES]
SUEZ WATER DISTRIBUTION SYSTEM

;----------
;Node X-Coord. Y-Coord.
;----------

112	454076	315695
113	454100	315587
114	454235	314955
115	454248	314896
116	453161	315577
117	457520	315311
118	457496	315263
119	457439	315157
120	457423	315129
121	457317	315006
122	457254	314933
123	457221	314894
124	455927	316572
125	455739	316753
126	455759	316852
127	455724	317027
128	456158	316814
129	456046	316897
130	456044	316925
131	456016	316972
132	455874	316454
133	456063	316238
134	456248	315884
135	456186	315800
136	456018	316053
137	455900	315961
138	455261	315842
139	454064	315832
140	454264	314894
141	455718	316527
142	455272	316750
143	455211	316791
144	454947	316972
145	454829	317060
146	454617	316800
147	454465	316822
153	456820	316559
154	456753	316628
155	456901	317261
156	457240	316169
157	458248	316342
158	458861	316253
;159	459829	315865
160	459548	314441
161	458645	314284
162	458607	313666
163	458128	313668
164	458289	313299
165	458321	313193
166	458306	313012
167	458198	312172
168	458261	313296
169	458270	313046
170	458151	312976
171	458179	312928
172	457692	312665

[COORDINATES]
SUEZ WATER DISTRIBUTION SYSTEM

;----------
;Node X-Coord. Y-Coord.
;----------

173	453288	317312
174	453291	317246
175	453315	316971
176	453288	316850
178	453096	316694
179	452875	316401
180	452939	316116
181	452832	315908
183	452404	316727
184	452917	316718
185	452323	316737
186	452342	316949
187	452371	317276
188	452385	317444
189	452459	317574
190	452597	317817
191	452663	317933
192	452699	317995
193	452619	318281
194	452600	318348
195	452549	318529
196	452509	318668
197	452541	318718
400	456476	316929
401	456220	316878
402	456245	316860
403	456192	316807
404	456166	316826
405	456312	317121
406	456324	317135
407	456243	317164
408	456484	317069
409	456525	316912
410	456601	316751
411	456630	316745
413	456146	316822
414	454480	317512
415	453968	316924
416	453723	316631
417	453665	316617
418	452458	315458
420	451423	315426
421	457655	315300
422	457471	314502
423	455201	314919
424	455391	314715
425	456254	315548
426	456227	315575
427	456487	315841
428	456442	316108
429	456839	316499
430	455204	314891
431	451060	313623
;432	449618	312569
433	453871	316589
434	453161	315769

[COORDINATES]
SUEZ WATER DISTRIBUTION SYSTEM

;----------
;Node X-Coord. Y-Coord.
;----------

435	457146	315547
436	455660	316875
437	455732	317045
438	455762	317039
439	455919	317656
441	456006	316939
442	456289	315954
443	455379	316343
444	456935	316458
445	456921	316441
446	453649	317817
447	453445	317538
448	453291	316735
449	453172	316747
450	452445	316771
451	452629	316137
452	454073	315548
453	454065	315580
454	454058	315613
455	455975	315502
456	453812	318016
457	453302	317310
458	454472	317536
459	455982	316819
460	455932	316559
461	455822	316658
462	455760	316597
463	452384	319102
464	455973	316774
465	456215	316609
466	456193	316580
467	456147	316616
468	456127	316587
469	456108	316603
470	456010	316469
471	455986	316487
472	456034	316454
475	456113	316359
476	452440	318985
477	452359	319042
478	452214	318869
479	452142	318783
480	452125	318762
481	452204	318624
482	452069	318563
483	452260	316622
;484	452240	316609
485	451713	317375
486	451537	317258
487	450529	313843
488	450945	313341
489	450799	313255
490	450173	312882
491	450163	312898
492	449632	312549
493	449430	312058

198

[COORDINATES]
SUEZ WATER DISTRIBUTION SYSTEM

;----------
;Node X-Coord. Y-Coord.
;----------

494	449411	312065
495	449340	311828
496	449319	311831
497	448708	310312
498	448686	310312
;499	450129	313535
;500	449404	312651
501	448985	312448
502	448997	312460
503	452265	314334
504	452203	314455
505	451982	314347
506	451441	315386
507	451453	315485
508	451725	315487
509	456339	315083
510	455176	315276
511	455242	315114
512	455224	314991
513	454335	315187
514	454322	315247
515	454572	315304
516	454283	315422
517	454885	315863
518	454313	316562
520	452872	317751
521	453198	318202
522	459666	314831
523	459711	315151
524	455739	315160
525	455748	315849
526	451690	314910
527	451340	313844
528	449228	315625
529	449091	314765
530	449041	314211
531	449012	312878
532	449144	311405
533	448867	310744
534	448887	310738
535	449166	311405
536	451664	314062
537	458263	312666
538	455997	316411
540	454482	317548
541	454207	315159
542	454047	315914
543	453794	316652
544	453779	316634
545	453762	316645
546	453330	316977
547	457998	311971
548	454828	317300
549	456049	316688
1161	453605	315587
1162	453616	315527

[COORDINATES]
SUEZ WATER DISTRIBUTION SYSTEM

;----------
;Node X-Coord. Y-Coord.
;----------

1163	453635	315448
1531	456860	316525
1551	457119	318006
2801	452951	314602
3501	456711	316609
4101	453041	315870
8301	456886	315237
5000	456460	316910
5001	456365	317085
5002	456205	316825
5003	456287	317135
5004	452306	319098
10000	446788	308635
10001	447138	310985
10002	448552	309993
10003	447310	312046
10004	449404	312651
10005	447453	313661
10006	449618	312569
10007	450129	313535
10008	447523	314453
10009	447595	315123
10010	450247	314264
10011	450659	314663
10012	448652	316410
10013	449709	315781
10014	450758	317074
10015	452240	316609
10016	447947	318080
10017	449041	314211
10018	447848	319141
10019	448203	320061
10020	448691	320547
10021	449493	318526
10022	451763	318380
10023	449931	321283
10024	451507	319891
10027	457949	315515
10028	459829	315865
10029	458968	314892
10030	455934	314182
10050	447560	308414
10051	447382	310953
10052	447636	312009
10054	449633	319679
10055	450873	318588
10056	449241	316314
10057	455862	318916
10058	455366	317773
10059	455572	317674
10060	455107	318256
10061	455363	319070
10062	452343	319140
10063	451410	317827
10064	449565	316261
10065	446795	308634

200

```
[COORDINATES]
SUEZ WATER DISTRIBUTION SYSTEM

;-----------------------------------------------------------------
;Node       X-Coord.   Y-Coord.
;-----------------------------------------------------------------
    10066     452345     319100

[LABELS]
;-----------------------------------------
;X-COORDY-COORD.LABEL
;-----------------------------------------
   456380     316895 Bamag No. 2 P.S.
   456365     317070 American P.S.
   456170     316855 CTE P.S.
   456230     317118 Bamag No. 3 P.S.
;452280       319122 New Reservoir

[END]
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