Chapter 3 National Water Control System

Chapter 4 Municipal Water Network Rehabilitation

CHAPTER 3
NATIONAL WATER CONTROL SYSTEM

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3.1 Basic Conditions

(1) Purpose of System Introduction

National Water Control System (hereinafter referred to as "NWCS") shall be established in order to realize an efficient distribution of limited water resources in Jordan through integrated operation and maintenance of water supply facilities located throughout the country

Computerized supervision and control system will be employed in Main Control Center at WAJ headquarters in Amman and Sub-Center at WAJ office in each Governorate to enable "efficient usage of water resources" or "reciprocal utilization among water supply facilities."

A stable water supply, reliable water quality, and the efficient management of water facilities can all be realized through this system.

(2) Scope of Pre-feasibility Study

The pre-feasibility study shall be conducted for the establishment of the Main Control Center in Amman and Sub-Center in 12 Governorates with SCADA system between control points and the Centers.

(3) System Outline

The system will consist of Main Control Center controlling water production and water supply related to inter-Governorate transfer lines and Sub-Center controlling water production and water supply in each Governorate with SCADA system.

The main functions of each facility are described in Table 3.1.1 and the conceptual figure for the whole system is shown in Fig.3.1.1-1.

Table 3.1.1-1 System Outline of National Water Control System

Facility for NWCS	Place to be established	Main Functions
Main Control Center	WAJ head office	Computerized supervisory and control system shall be installed in the Main Control Center. - To enable centralized supervision of water supply facilities related to the inter-Governorate water transfer. - To support the formulation of an optimum water allocation plan to the related Governorates, including daily water demand forecasts, optimum water transmission, and simulated action planning for emergency scenarios.
Sub-Center	WAJ office in each Governorate	Computerized supervisory and control system shall be installed in the Sub-Center. - To enable centralized supervision of water supply facilities in .the Governorate. - To support the formulation of an optimum water supply plan in the Governorate, including daily water demand forecasts, optimum water distribution, and simulated action planning for emergency scenarios. - To develop a database for operation and maintenance records of existing water supply facilities, including transmission and distribution pipeline drawings and to execute efficient operation and maintenance for water supply facilities.
SCADA System	From control points to the Centers	SCADA system for data acquisition and transmission from control points (pump stations, wells, reservoirs, etc.) to the above Centers shall be established.

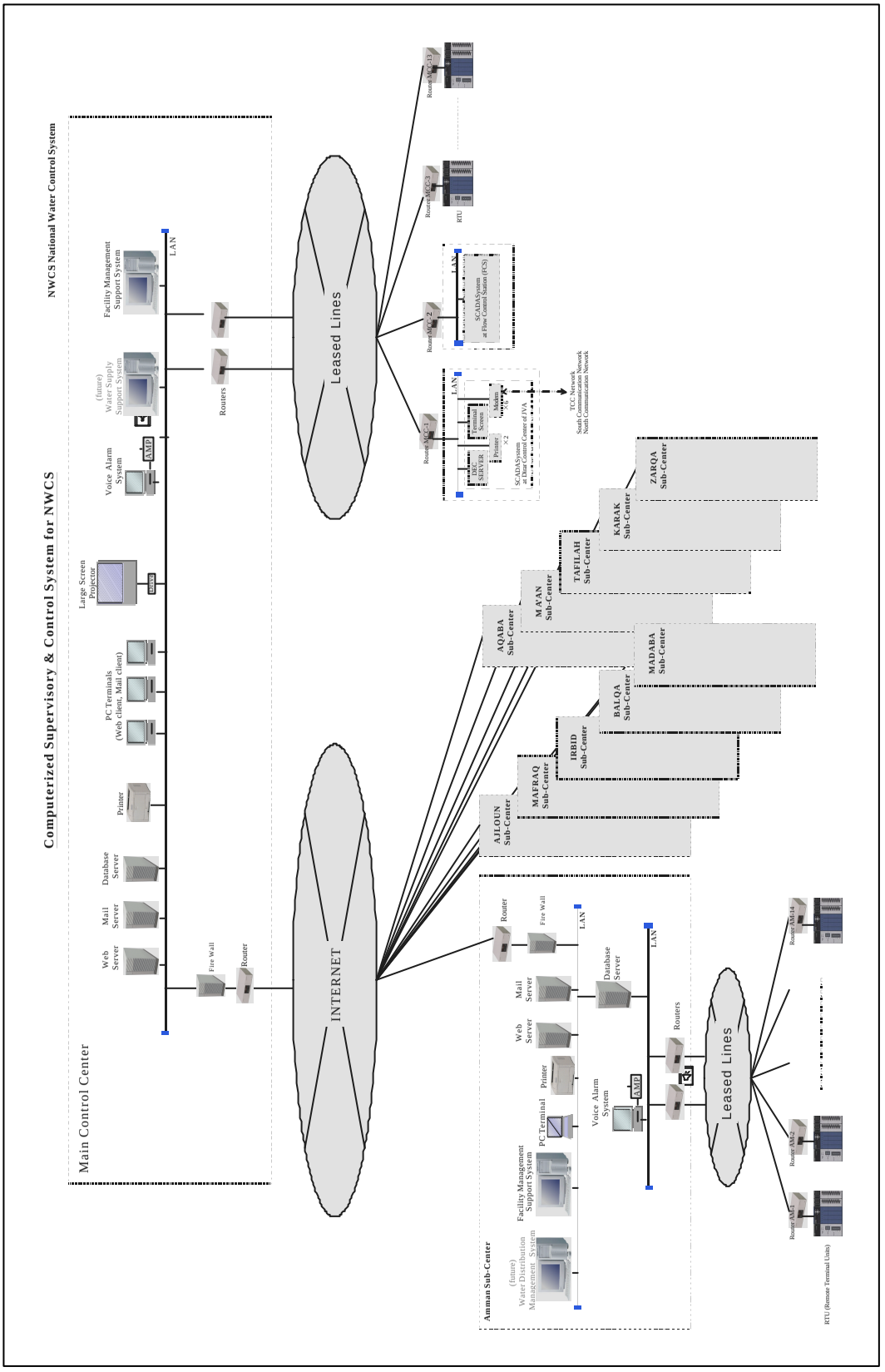

Fig.3.1.1-1 Conceptual Drawing for Computerized Supervisory System for NWCS

3.2 Current Situation of Control System

At present, water production and water supply have been monitored and controlled by the Central Control Room (CCR) in the WAJ headquarters for whole of Jordan and by LEMA for their service area in Amman Governorate. In each Governorate, there is no monitoring and control system. Nationwide SCADA (Supervisory Control and Data Acquisition) system has not yet been introduced.

(1) Monitoring and Control System by CCR

CCR takes the water production and water supply data from the related wells/springs, pumping stations and reservoirs in the whole country by hourly and daily through wireless and telephone. CCR summarizes these data at the end of the month and prepares a monthly report.

The locations and the data related to monitor and control for water production and supply by CCR are mentioned in Table 3.2.1-1 and 3.2.1-2.

(2) Monitoring and Control System by LEMA

LEMA is executing monitor and control for water production and water supply related to the Amman service area in the head office in Amman. All the information about water production and distribution are collected by either telephone or wireless radio and recorded in the paper form manually. Data collection has been done at the interval of every one hour for flow measurements and every 24 hours for bulk water and water sources. The data are collected from 6 external sources, 25 internal sources and 9 outputs as shown in Table 3.2.1-3. The summary of water supply is sent to WAJ monthly as a report. There is no line connection between WAJ and LEMA.

After current rehabilitating and restructuring projects in the Greater Amman areas by various donors are completed, 43 distribution zones and 250 distribution metered areas will be established.

Table 3.2.1-1 Measuring Points (Hourly) by Central Control Room of WAJ

No.	Name of Pumping Station	Governorate	Measuring Points	
			Pipeline From	Pipeline To
1	Zatary PS	MF	Aqeb wells	Khaw
			Zatary wells	Um Lulu
2	Khaldieh PS	MF	Khaldieh wells	Khaw
			Zatary wells	Delel Khaldieh
3	Azraq PS	ZA	Azraq wells	North & South Azraq
				Khaw
4	Khaw PS	ZA	Zatary/Khldieh	Amman
			Azraq	Zarqa
			Halabat	Hashemieh
5	Halabat PS	ZA	Halabat wells	Khaw
6	Zai PS	BA	King Abdullah Canal	Balqa
				Amman
7	Lib PS	MA	Waleh wells	Madaba
8	Muntazah PS	AM	Lib PS	Abu Alanda
			Yadodeh wells	Dabouq
9	Ain Ghazal PS	AM	Ain Ghazal wells	Marka
			Khaw PS	Hashemieh
			Zai PS	Shemesani
				Ras Ain
10	Qastal PS	AM	Qatraneh wells	Dhiban/Mad
			Swaqa wells	Naur
			Qastal wells	Amman
11	Tamween PS	ZA	Tamween wells	Khaw/Amman line
12	Qenaiah PS	ZA	Qenaiah spring	Mafraq
				Zarqa
13	Um Rummaneh PS	ZA	Birean wells	Jerash
			Um Rummaneh well	Balqa
			Muheb PS	Zarqa
14	Buweideh PS	MF	Um Lulu PS	Jerash
				Mafraq
15	Samad PS	IR	Hufa PS	Jerash
				Ajloun
16	Shoubak PS	TA	Shoubak wells	Shoubak
				Tafilah

Table 3.2.1-2 Measuring Points (Daily) by Central Control Center of WAJ

Governorate	Pump Station	No.	In/Out	Measuring Points
AMMAN		1	In	Zai PS No. 5
		2	In	Dabouq reservoir
		3	In	Ras Ain spring
		4	In	Muhajreen well
		5	In	Wadi Seer spring
		6	In	Taj wells
		7	In	Booster 22
		8	In	Booster 11
		9	In	Yajuz well 1
		10	In	Yajuz well 6
		11	In	Muaqer wells
		12	In	Yadodeh well
	Qastal PS	1	In	East wells
		2	In	West wells
		3	In	Qatranah wells
		4	In	Museitbeh/Qastal
		5	In	Qastal wells
		6	Out	Amman
		7	Out	Naur
	Wala PS	1	Out	Lib BPS
		2	Out	Muntazah PS
		3	Out	Dabouq reservoir
		4	Out	Abu Alanda reservoir
	Ain Ghazal PS	1	In	Khaw/Ain Ghazal
		2	In	Dabouq/Ain Ghazal
		3	Out	Line 600mm
		4	Out	Line 400mm
	To Karak	1	Out	Qatranah water meter
	To Madaba	2	Out	Shoubakiyeh/Dhiban
ZARQA		1	In	Azraq/Khaw
		2	In	Halabat/Khaw
		3	Out	Halabat town
		4	In	Hashemieh W2
		5	In	Hashemieh W2
		6	In	Hashemieh W5
		7	In	Refinary well 14, 14A
		8	In	Awajan W21
		9	In	Awajan W22
		10	In	Awajan W23

Governorate	Pump Station	No.	In/Ou	Measuring Points
ZARQA (continued)		11	In	Murheb wells
		12	In	Tamween W3
		13	In	Tamween W5, W4
	Khaw PS	1	In	Zatary/Khaldieh
		2	In	Azraq/Khaw
		3	In	Halabat/Khaw
		4	Out	Amman
		5	Out	Zarqa
		6	Out	Hashemieh
		7	Out	Army
	Qenia PS	1	Out	Zarqa
		2	Out	Mafraq
KARAK		1	In	Sultani
		2	In	Ain Sarah
		3	In	Guwir 1
		4	In	Guwir 2, 3
TAFILAH		1	In	Zabdah wells
		2	In	Qadiseyeh reservoir
MAFRAQ	Zartary PS	1	In	Aqeb 24
		2	In	Aqeb 16
		3	In	Zatary 1, 2
		5	Out	Khaw 1 (MM)
		6	Out	Khaw 2 (UM)
		7	Out	Um Lulu 1 (MM)
		8	Out	Um Lulu 2 (UM)
		9	Out	Booster 111
		10	Out	Booster 134
		1	In	Muketfeh
		2	In	Suilmeh
	Khaldieh PS	1	In	Khaldieh W17
		2	In	Khaldieh W16
		3	Out	Khaldieh/Khaw
		4	In	Treated 1 (MM)
		5	In	Treated 2 (UM)
	Sumaiyah PS	1	In	Sumaiyah wells
		2	Out	Mafraq
		3	Out	Sarhan
	Um Lulu BPS	1	Out	Line 24"

Governorate	Pump Station	No.	In/Ou	Measuring Points
MAFRAQ (continued)	Um Lulu BPS (continued)	2	Out	East
		3	Out	West
		4	Out	Husha
		5	Out	Border 24
		6	Out	University
		7	Out	Bouydah
		8	Out	Abu Iyad
IRBID		1	In	Wadi Arab wells
		2	In	Tabqat fahal
		3	Out	To North Shouneh
		4	Out	Samad PS
JERASH		1	In	Qerawan PS
		2	In	Gadeer spring
		3	In	Shawahed wells
		4	In	Deer well
AJLOUN		1	In	Tanoor
		2	In	Quaytra
BALQA		1	In	Bqriyeh spring
		2	In	Shrayeh spring
		3	In	Hazeer spring
		4	In	Um Atiyeh well
		5	In	Baladieh 2
		6	In	Baladieh 7
		7	In	Yazidiyeh 1A
		8	In	Yazidiyeh 2, 3
		9	In	Yazidiyeh 5
		10	In	Yazidiyeh 7, 8
		11	In	Subaihi
AQABA		1	In	Disi

Note : "In" means water sources of the Governorate and "Out" means the output from the measuring points.

Table 3.2.1-3 Monitoring and Control Points by LEMA

	No.	Name
External Source	1	Water pumped from ZAI WTP
	2	Fuheis/Balqa to Dabouq
	3	Khaw PS/Zarqa to Ein Ghazal
	4	Zarqa distribution to Marka
	5	Khaw PS/Zarqa to Marka housing
	6	Wala-Hidan/Madaba to Muntazah
Internal Source	1	Muhajereen well
	2	Ras El Ain Spring
	3	Taj wells
	4	Booster 22
	5	Ruseifa wells DN400
	6	Ruseifa wells DN600
	7	Booster 11
	8	Yajouz well 1
	9	Yajouz well 1
	10	Qastal wells
	11	Suwaqa East wells
	12	Suwaqa West wells
	13	Qatraneh wells
	14	Manhona well
	15	Wadi Qattar well
	16	Ras El Ain well 1
	17	Ras El Ain well 2
	18	Wadi Saqra well
	19	Muwaqqar wells
	20	Musaitbeh wells
	21	Wadi Sir spring
	22	Abdoun well
	23	Yadudeh well
	24	Um Basateen
	25	Irainbeh well
Output (export to other service area)	1	ZAI/Dabouq to Masara
	2	ZAI/Dabouq to Yazidieh
	3	ZAI/Dabouq to Baqaa/Sarw
	4	ZAI/Dabouq to Fuheis
	5	ZAI/Dabouq to Zaatari
	6	ZAI/Dabouq to Um Joza
	7	Abu Nuseir network to Abu Nuseir village
	8	Shoubakeyeh meter (to Dhiban)
	9	Qatrana PS to Qatrana village

3.3 Description of the System

3.3.1 Main Control Center

Proposed layout for Main Control Center (MCC) is shown in Fig. 3.3.1-1 and Inter-Governorate Water Transfer System controlled by Main Control Center is shown in Fig. 3.3.1-2.

Expected functions of MCC are described as follows.

(1) Prediction of Inter-Governorate Water Supply and Formulation of Water Supply Plan

According to the past data collected from each Sub-Center (SC), Inter-Governorate water transfer volume will be predicted. Based on the prediction, water sources allocation plan in the Inter-Governorate water transfer system will be prepared.

In the next step, the allocation plan will be divided into hours for 24-hour period. The plan will be transmitted by telephone, fax or e-mail to each SC.

When SCs examine this plan and they request some modifications to MCC, MCC will reformulate the allocation plan for the related Governorates and inform the SCs of the revised target value.

(2) Monitoring of Operating Conditions for the Facilities

Information received from the field operator on water level, flow rate, water quality, operating condition of pumps (on/off), opening ratio of valves, power consumption, conditions of equipment, etc. will be input into the database of Data Server in MCC.

At PC Terminal connected with Web Server by LAN, whether there is deviation or not between the planned values and collected data from RTU and Router such as water level at reservoir, outlet flow rate, ON/OFF of pumps, serious or minor trouble, discharge head of pumps, etc. will be monitored by the graphic or trend screen.

(3) Adjustment of Gap between Planned and Actual Water Supply

MCC will reformulate the water allocation plan when the following cases happen.

- SC can not adjust the gap between the planned and actual water supply and requests MCC to reformulate the planned value.
- MCC judges to modify the plan during the monitoring.

(4) Measures against Accident and Emergency

When MCC receives information about troubles or emergency cases from field operators or citizens or SCs, MCC will examine the countermeasures and give instructions to each SC.

(5) Storage of Data and Preparation of Record

(6) Preparation of Daily/Monthly/Annual Report

(7) Preparation of Statistical Data

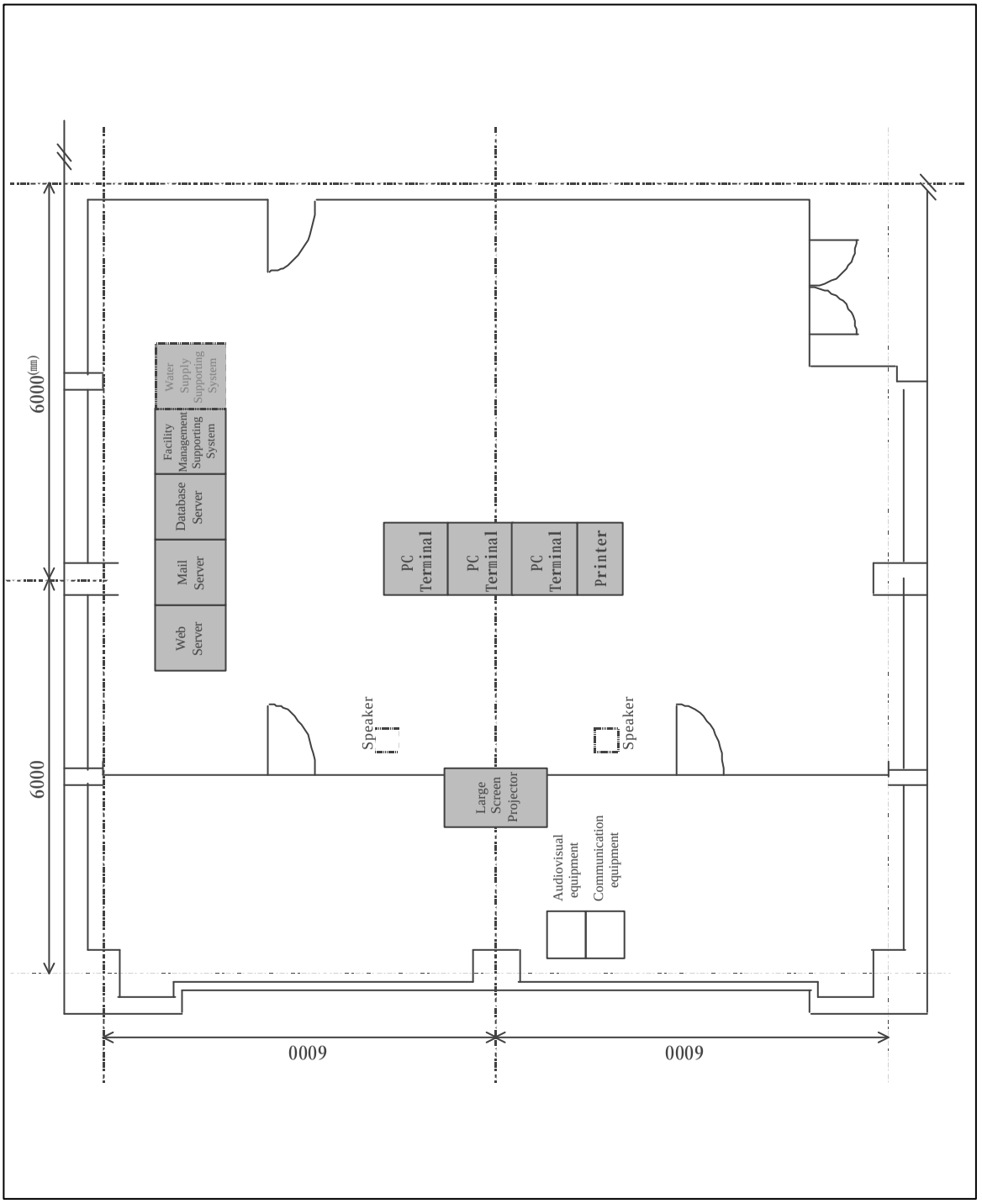

Fig. 3.3.1-1 Proposed Layout for Main Control Center

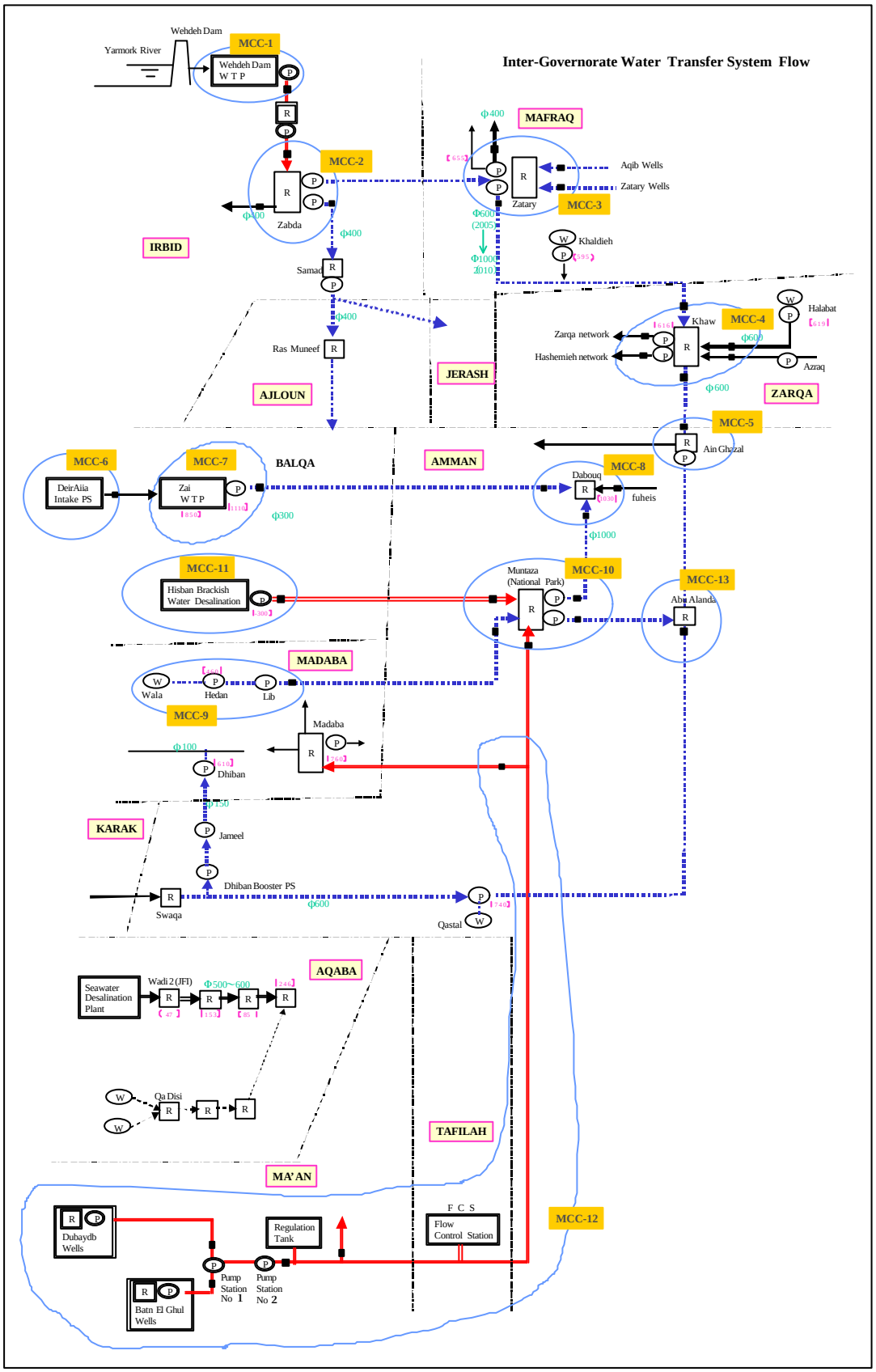

Fig. 3.3.1-2 Inter-Governorate Water Transfer System Controlled by Main Control Center

3.3.2 Sub-Center

Proposed layout for Sub-Center is shown in Fig. 3.3.2-1 and Water Transfer System in the Governorate to be controlled by SC is shown in Fig. 3.3.2-2 to 3.3.2-6.

(1) Prediction of Water Supply and Formulation of Water Sources Utilization Plan

Based on the prediction of water supply volume in the Governorate and water sources utilization plan for 24-hour period transmitted from MCC, utilization plan for water supply in the Governorate will be formulated.

When planned water supply is needed to be changed, it will be informed to MCC. In case that the volume of water sources becomes insufficient to the water demand and the water reservoir can not cover the shortage, plan for suspension or restriction on water supply will be formulated in SC.

(2) Monitoring of Operating Conditions for the Facilities

Information received from the field operator on water level, flow rate, water quality, operating condition of pumps (on/off), opening ratio of valves, power consumption, conditions of equipment, etc. will be input into the database of Data Server in SC.

At PC Terminal connected with Web Server by LAN, whether there is deviation or not between the planned values and collected data from RTU such as water level at reservoir, outlet flow rate, ON/OFF of pumps, serious or minor trouble, discharge head of pumps, etc. will be monitored by the graphic or trend screen.

(3) Instruction for Operation of Equipment

Based on the plan formulated in Item-(1) above, the Center will give instruction to the field operator for opening/closing of valves and starting/stopping of pumps.

(4) Adjustment of Gap between Planned and Actual Water Supply

When the actual water supply becomes deviated from the planned water supply, the Center will give instruction to the field operator to adjust by water reservoir, etc. When he can not adjust the gap between the planned and actual water supply, the Center will request MCC to re-formulate water supply plan for each Governorate.

(5) Measures against Accident and Emergency

When the Center receives reports on accidents and emergency cases from field operator or citizen, the Center examines the measures and gives instructions to the field operator at Site. If required, the Center will inform of this matter to MCC and consult the matter.

(6) Storage of Data and Preparation of Record

(7) Preparation of Daily/Monthly/Annual Report

(8) Preparation of Statistical Data

(9) Supporting Management Work for Facilities and Equipment

Civil/building drawings, pipeline drawings, equipment inventory, inspection records, etc. of the facilities inside the Governorate (pipelines, pumps, valves, reservoirs, RTU, instrumentation equipment, and power receiving facility) will be input into Facility Management Supporting System.

(10) Analysis for UFW

After comparison between metered water supply and collected water supply data from control points, physical losses, illegal connection, defective equipment, etc. shall be analyzed.

(11) Water Distribution Management System (Future)

Simulation for water pressure in the network will be done using this system to get an optimum valve opening, pump revolution and operating unit so that they can be reflected to performance indicators.

Simulation for water suspension and water quality will be done and the results will be utilized for public relations.

Simulation for temporary water network will be done and the results will be used for formulation of future water network.

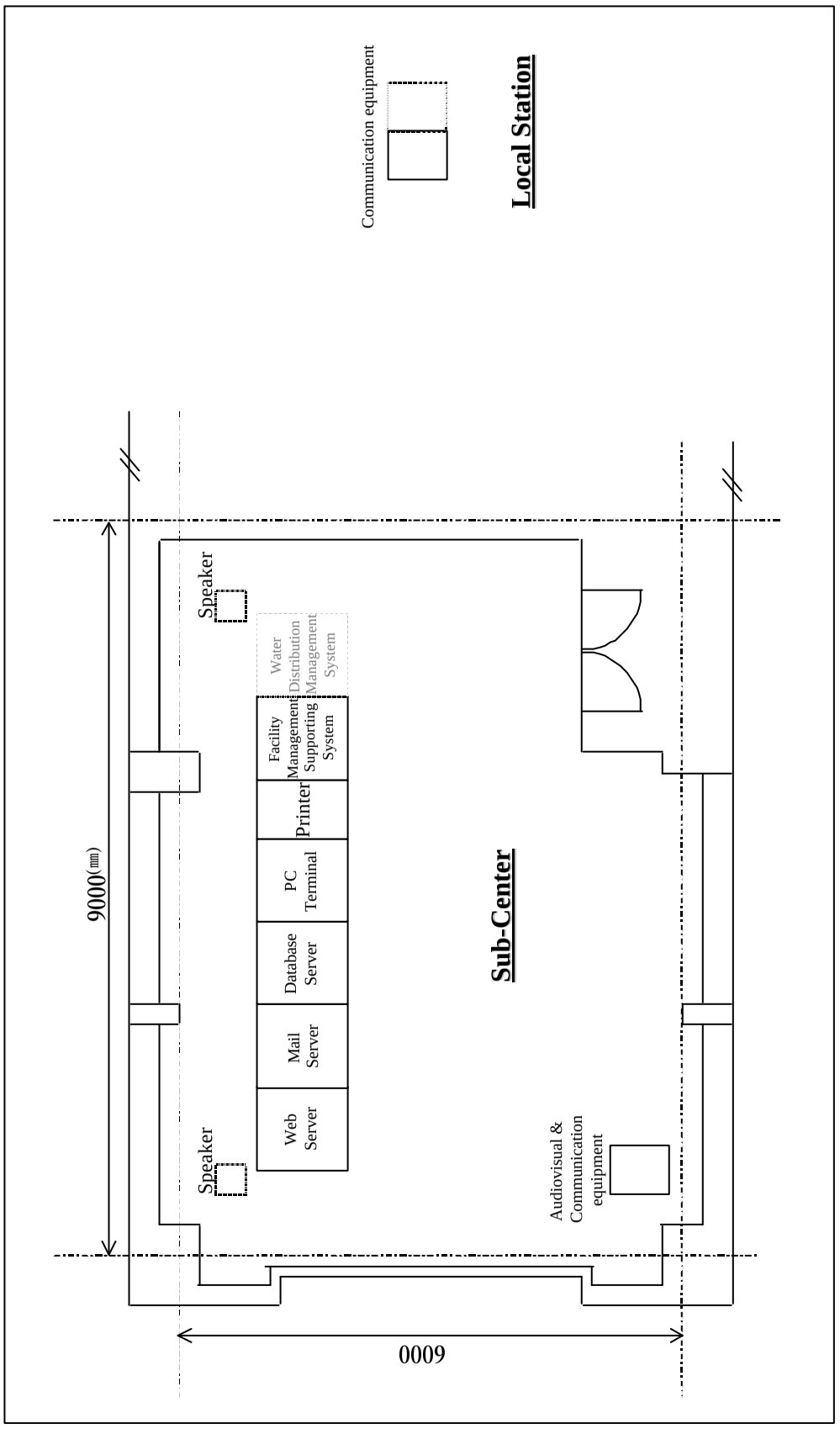

Fig. 3.3.2-1 Proposed Layout for Sub-Center

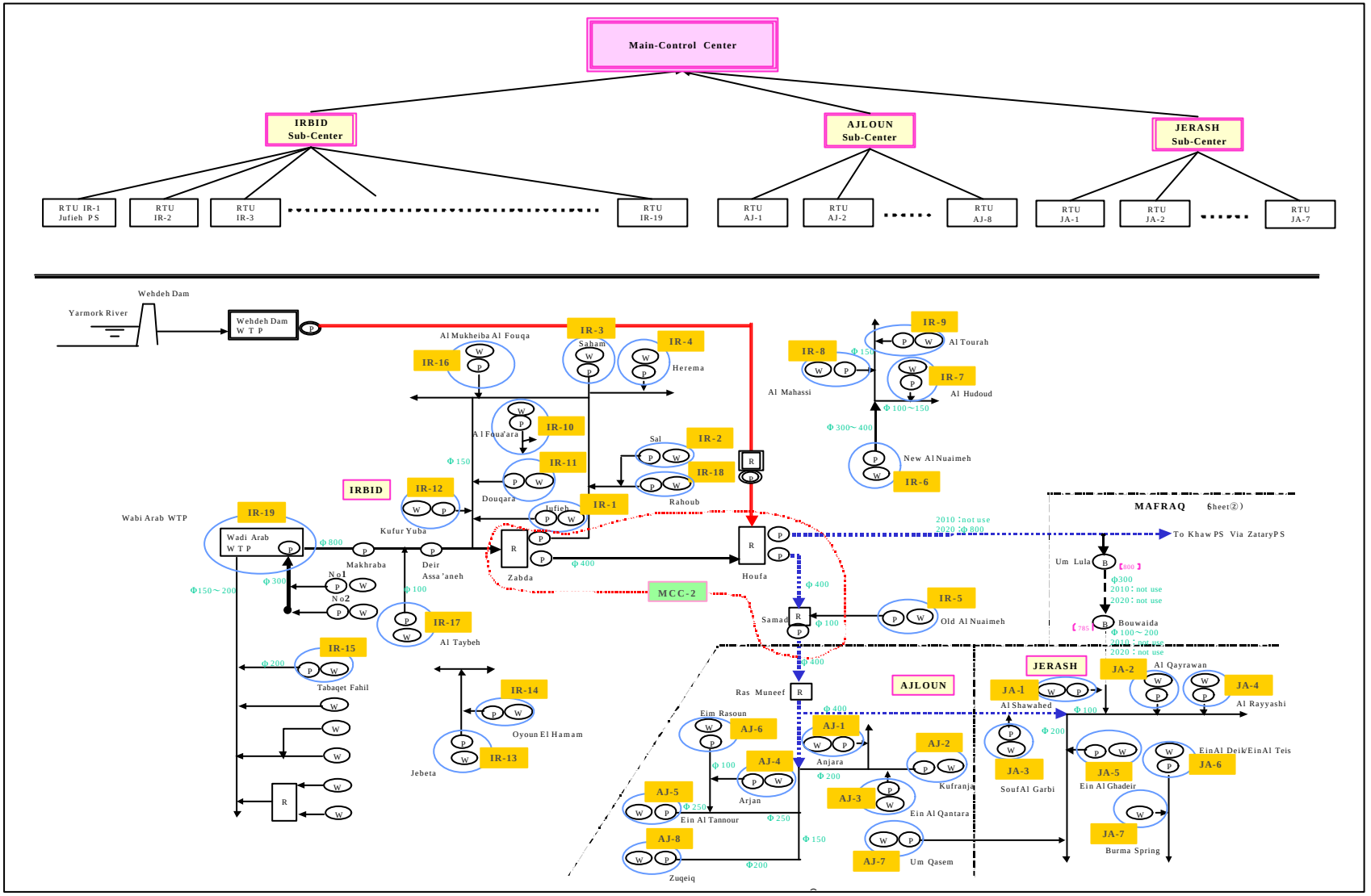

Fig. 3.3.2-2 Water Transfer System in Irbid - Ajloun - Jerash Governorates Controlled by Sub-Center

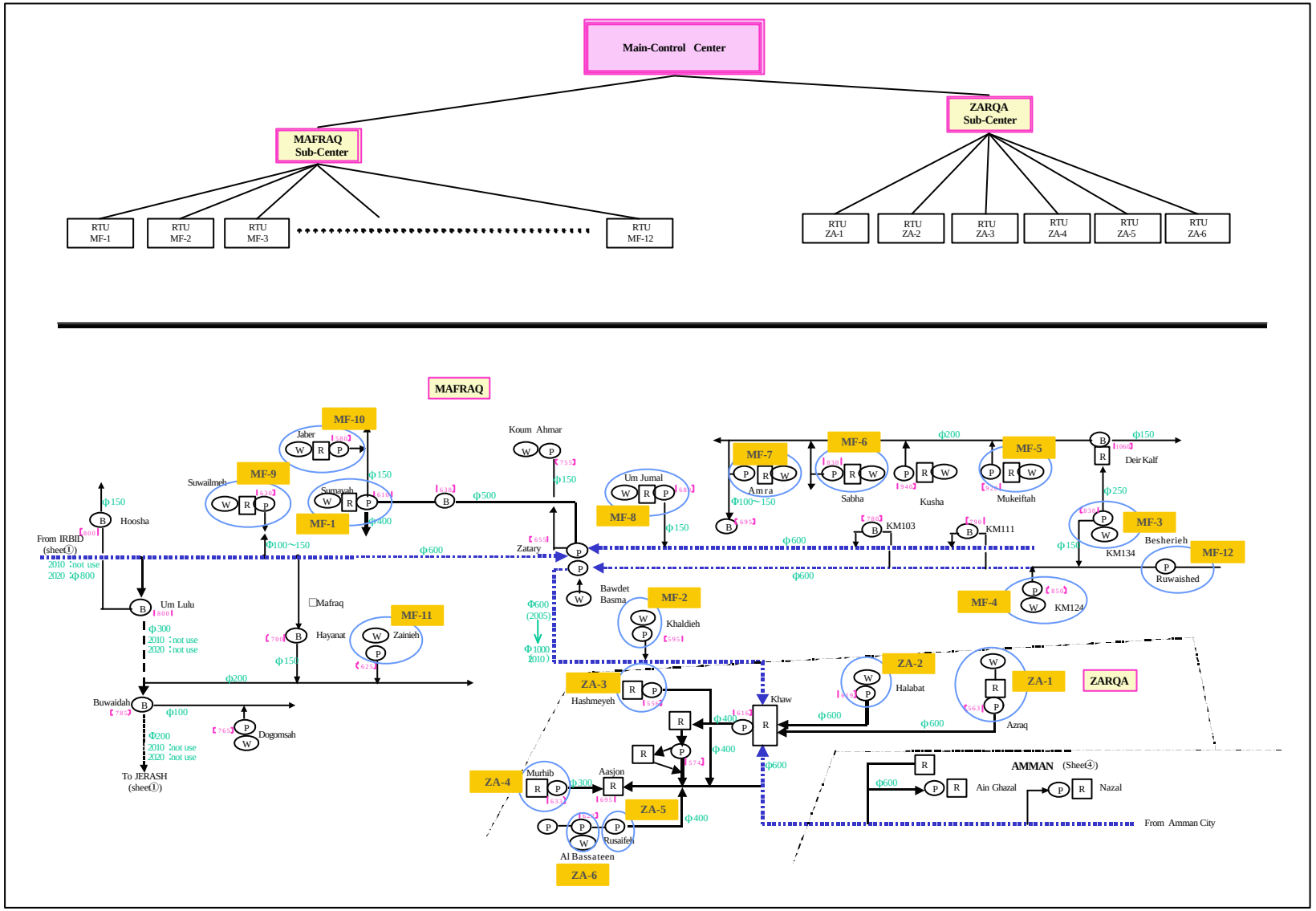

Fig. 3.3.5 Water Transfer System in Mafraq - Zarqa Governorates Controlled by Sub-Center

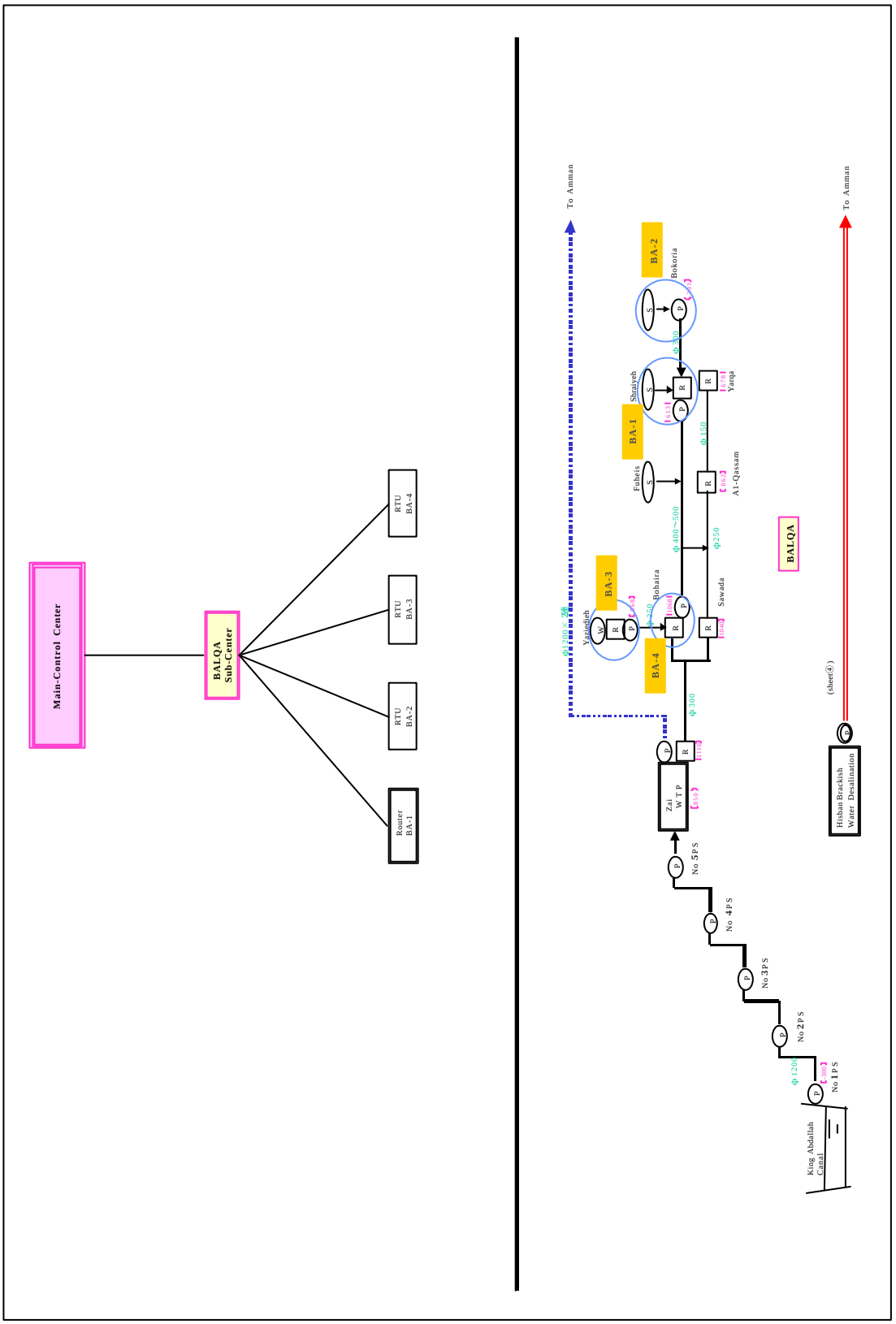

Fig. 3.3.2-4 Water Transfer System in Balqa Governorate Controlled by Sub-Center

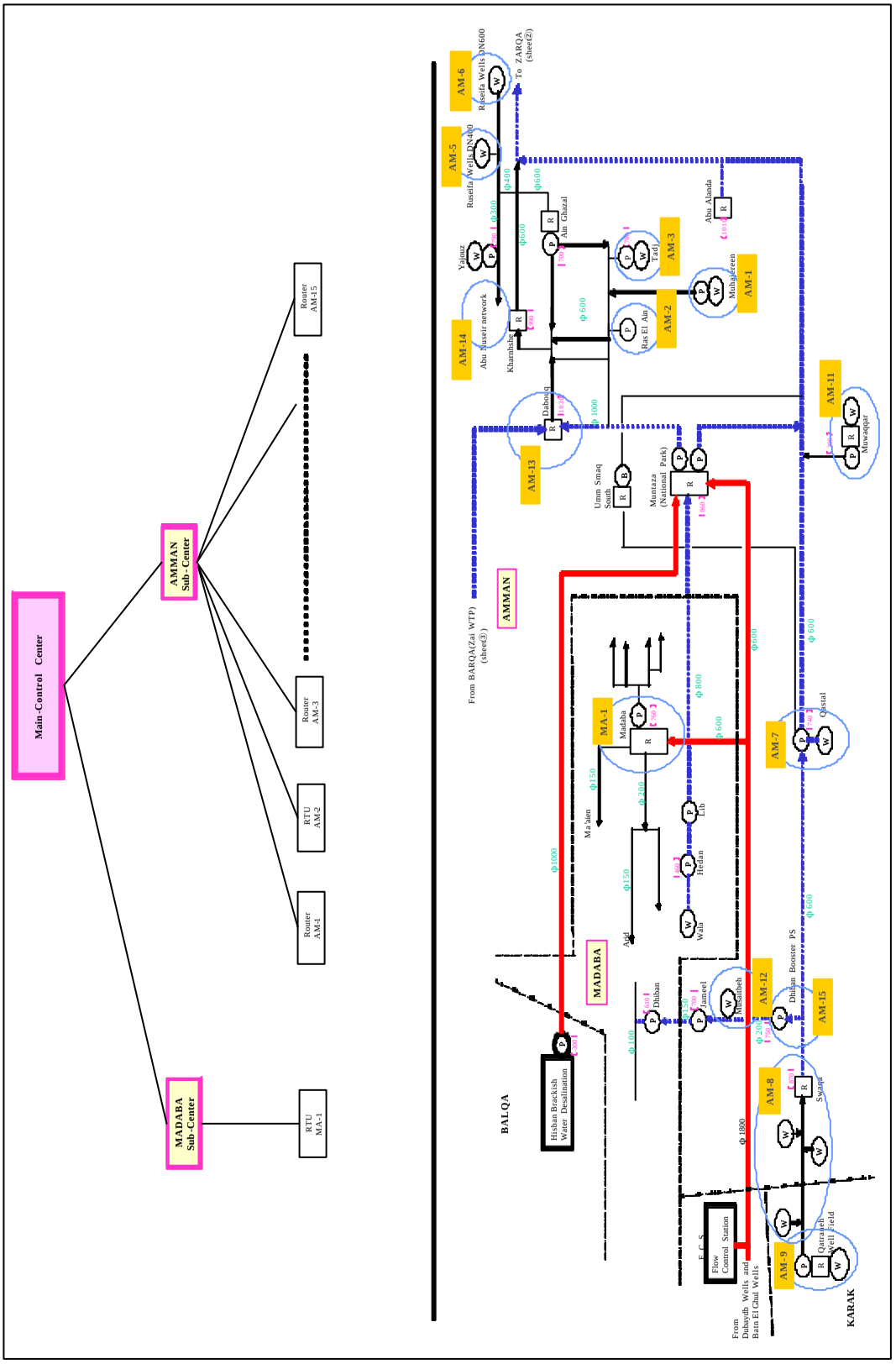

Fig. 3.3.2-5 Water Transfer System in Madaba - Amman Governorates Controlled by Sub-Center

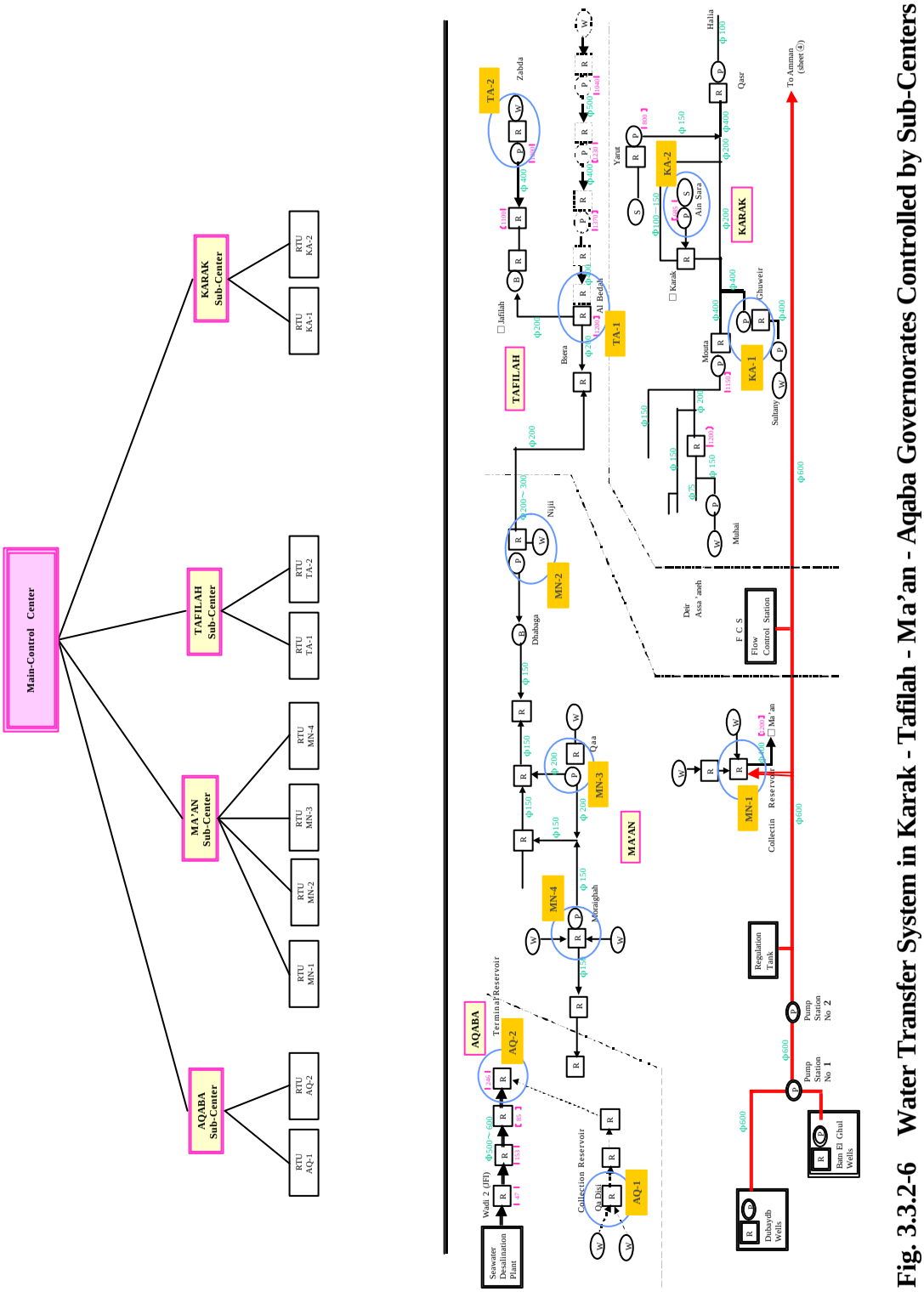

Fig. 3.3.2-6 Water Transfer System in Karak - Tafilah - Ma'an - Aqaba Governorates Controlled by Sub-Centers

3.3.3 Equipment for the Centers

(1) Remote Terminal Unit (RTU)

1) Data acquisition and processing

a. Periodical acquisition: periodically acquires analog quantities from the pump stations and reservoirs, such as quantity of flow, water level and water pressure, and stores data into memory.

Data acquisition points are as shown in Fig. 3.3.3-1.

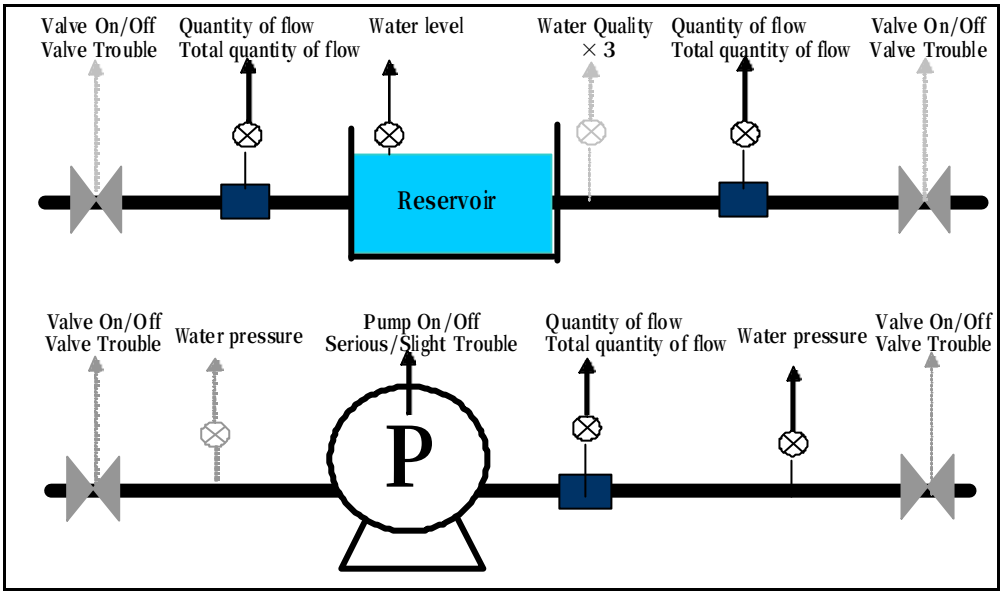

Fig. 3.3.3-1 Data Acquisition Points for Facilities

b. Overrun checking: checks measured values of analog quantities against their overrun limits. If any value exceeds its limit, an alarm sounds.

2) Digital quantity acquisition and processing

a. Acquires data periodically, checks status and updates database

3) Communicates with the database server in the Sub-Center (or Main Control Center)

a. Sends acquired data to the database server periodically.

b. Sends data to the database server in response to calls from the Sub-Center (or Main Control Center).

c. Sends event information to the database server if any event signals and alarms occur.

(2) Voice Alarm System

Automatically activates all event signals and alarms at the pump station and the reservoirs

(3) Database Server

1) Communicates with RTUs

a. Receives acquired data from RTUs periodically.

b. Receives data from RTUs in response to calls from the Sub-Center (or Main Control Center).

c. Receives event information from RTUs, if any event signals and alarms occur.

2) Stores acquired data

a. Stores received data from RTUs.

b. Stores the data input by operators, such as quantity of flow, water level and water pressure at pump stations and reservoirs with no RTUs.

(4) Web Server

1) Provides content, such as trend graphs, station diagrams, daily reports, etc., to the web browser

2) Requires user authorization by entering a valid user ID and password to log-on

(5) PC Terminals

1) Has access to the required Web Server of Main Control Center or Sub-Center with Internet Browser and enables to do graphic supervision of monitored data, show trend graphs, search for alarm in operation and monitored data, etc.

2) Data not collected in RTU will be measured manually by field operators and stored to Database through manual input at PC Terminal.

(6) Printer

Prints out daily, monthly and yearly reports

(7) Mail Server

1) Sends alarms as E-mail: Some event signals and alarms at the pump station and reservoirs shall be converted into E-mail and sent to the Main Control Center, Sub-Centers and defined people.

2) Sends E-mail among Sub-Centers and Main Control Center

(8) Firewall

1) Keeps hostile visitors out and protects NWCS internal information

2) Keeps employees in, usually a means of discouraging people from playing games or visiting recreational sites on business time.

(9) Facility Management Support System

Converts documents, ledgers and drawings related to the facility and its operations into the database to efficiently manage the facility

(10) Water Distribution Management System (Future)

1) Develop an integrated property inventory management database, including conduct and service pipe routing maps and drawings, to efficiently and effectively maintain and manage waterworks equipment and facilities
2) Acquire changes in water distribution conditions in real time and manage water distribution information (quantity, quality)
3) Control valves in the water supply and distribution lines to optimize distribution pressure to equalize pressure at service ends and minimize water leakage

(11) Large Screen Projector

1) Displays the flow of the water transfer system nationwide, so that many people understand the present state and can make decisions in the case of emergencies
2) Shows VTR during visitors' tours

(12) Water Supply Support System (Future)

Provide supports aids that support planning activities, including daily water-demand forecasts, optimum water supply and distribution, and simulated action planning for emergency scenarios

3.4 Control Points of the System

(1) Main Control Center

Main Control Center (MCC) shall monitor and control the water production and water supply related to the Inter-Governorate water transfer lines.

The control points for MCC shall be installed at the main facilities and these points are listed in Table 3.4.1-1 and shown in Fig. 3.4.1-1 respectively.

Table 3.4.1-1 Proposed Control Points for Main Control Center

Inter-Governorate System	Facility	No. of Control Point	Control Point
Wehda-Irbid Conveyor	Transmission PS at WTP	1	Outlet of PS
	Zabda reservoir	1	Inlet at the reservoir for the conveyor
Zabda-Irbid-Ajloun/Jerash line	Zabda reservoir	2	Outlet to Ajloun/Jerash
			Outlet to Irbid city network
Zatary-Khaw line	Zatary PS	4	Inlet at the reservoir from Agib wells
			Inlet at the reservoir from Zatary wells
			Outlet to Khaw PS
			Outlet to Mafraq network
Khaw-Ain Ghazal line	Khaw PS	6	Inlet at the reservoir from Zatary PS
			Inlet at the reservoir from Halabat PS
			Inlet at the reservoir from Azraq PS
			Outlet to Ain Ghazal PS
			Outlet to Zarqa network
			Outlet to Hashemieh network
	Ain Ghazal PS	1	Inlet at the reservoir from Khaw PS
Deir Alla Intake-Zai-Dabouq line	Deir Alla Intake PS	(1)	Outlet to Zai WTP (#1)
	Transmission PS at Zai WTP	1	Outlet to Dabouq reservoir
	Dabouq reservoir	3	Inlet from Zai WTP
			Inlet from Fuheis
			Inlet from Muntazah PS
Wala/Hidan-Muntazah line	Wala PS	1	Outlet to Muntazah PS
	Muntazah PS	3	Inlet from Wala-Hidan
			Outlet to Abu Alanda reservoir
			Outlet to Dabouq reservoir
Hisban Desali Plant-Muntazah PS	Transmission PS at Desali Plant	1	Outlet to Qastar PS
	Muntazah PS	1	Inlet from Desali Plant
Disi-Amman Conveyor	Transmission PS at Disi	5	Inlet from Disi wells (2 points)
			Outlet at Transmission PS
			Branch line for Ma'an
			Branch line for Madaba
	Flow Control Station	(1)	Outlet at Flow Control Station (#2)
	Muntazah PS	1	Inlet from Disi conveyor
	Abu Alanda reservoir	1	Inlet from Disi conveyor
Total		32	

Notes 1. Data will be transferred to MCC from Dirar Control Center of JVA
2. Data will be transferred to MCC from Flow Control Station to be installed on Disi-Amman Conveyor

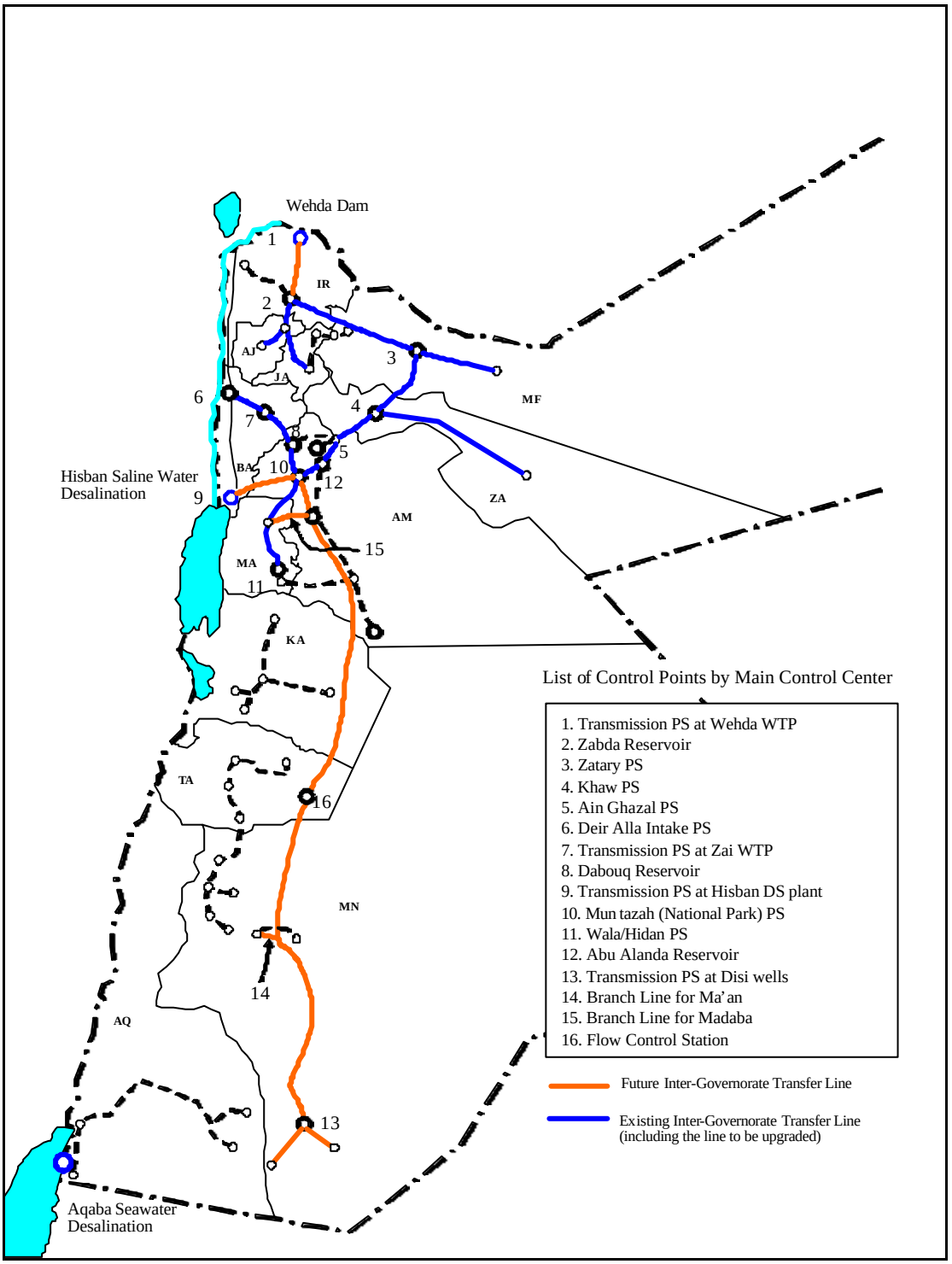

Fig. 3.4.1-1 Location of Control Points for Main Control Center

(2) Sub-Center

Sub-Center (SC) shall monitor and control the water production and supply in each Governorate.

However, for the time being, the control points for SC in each Governorate shall be mainly provided at the outlet of the related main pump stations and reservoirs which account for the most part of the water supply volume in each Governorate.

The data from other pump stations and reservoirs, where the control points are not provided, will be reported to the Sub-Center by the operator with telephone or wireless as applied at present. The control points for these facilities will be set up at the future stage (after the completion of the proposed projects in this study), on condition that all the water meters are to be installed or replaced for those facilities (pump stations, wells, springs, etc.) by each Governorate.

The control points shall be determined taking into account the existing control points by WAJ Central Control Room and LEMA.

The control points for the water production volume shall be set up at the future stage. Therefore, the water production data shall be reported to the Sub-Center by the operator with telephone or wireless as applied at present.

The control points, which have been selected taking into account the current situation of control system in Jordan, are listed in Table 3.4.1-2.

Table 3.4.1-2 List of Control Points by Sub-Centers (1 of 2)

Governorate	Pump Station/Reservoir	No. of Control Point	Control Point
Amman	Muhajereen Well	1	Outlet of reservoir
	Ras El Ain Spring	1	Outlet of reservoir
	Taj Reservoir	1	Outlet
	Ruseifa Wells DN400	1	Outlet
	Ruseifa Wells DN600	1	Outlet
	Qastal PS	4	Outlet to Amman
			Outlet to Madaba
			Inlet from Qastal Wells
	Swaqa Reservoir	4	Inlet from Swaqa East Wells
			Inlet from Swaqa West Wells
			Inlet from Qatraneh Wells
			Outlet to Qastal PS
	Qatraneh PS	2	Outlet to Swaqa Reservoir
			Outlet to Qatraneh village
	Ras El Ain PS	1	Outlet
	Muwaqqar PS	1	Outlet
	Musaitbeh Wells	1	Outlet of reservoir
	Dabouq Reservoir	7	Outlet to Amman
			Outlet to Masara
			Outlet to Yazidieh
			Outlet to Baqaa/Sarw
			Outlet to Fuheis
			Outlet to Zaatary
			Outlet to Um Joza
	Abu Nuseir network	1	Outlet to Abu Nuseir village
	Dhiban Booster	1	Outlet to Madaba
	Total	**27**	
Zarqa	Azraq PS	1	Outlet to Khaw PS
	Halabat PS	2	Outlet to Khaw PS
			Outlet to Khaldieh PS
	Hashmeyeh PS	4	Inlet from Khaw PS
			Outlet to Zarqa PS
Zarqa (continued)	Hashmeyeh PS (continued)		Outlet to Sukhna Reservoir
			Outlet to Hararieh Reservoir
	Murhib PS	1	Outlet to Awjan Reservoir
	Booster 18 PS	1	Outlet
	Al Bassateen Booster PS	1	Outlet
	Total	**10**	
Irbid	Jufieh PS	1	Outlet
	Sal PS	1	Outlet
	Saham PS	1	Outlet
	Herema PS	1	Outlet
	Old Al Nuaimeh PS	1	Outlet
	New Al Nuaimeh PS	1	Outlet
	Al Hudoud PS	1	Outlet
	Al Mahassi PS	1	Outlet
	Al Tourah PS	1	Outlet
	Al Foua'ara PS	1	Outlet
	Douqara PS	1	Outlet
	Kufur Yuba PS	1	Outlet
	Jebeta PS	1	Outlet
	Oyoun El Hamam PS	1	Outlet
	Tabaqet Fahil PS	1	Outlet
	Al Mukheiba Al Fouqa PS	1	Outlet
	Al Taybeh PS	1	Outlet
	Rahoub PS	1	Outlet
	Wadi Arab WTP PS	1	Outlet to Zabda Reservoir
	Total	**19**	
Mafraq	Sumayah PS	1	Outlet
	Khaldieh PS	1	Outlet
	Besherieh PS	1	Outlet
	KM 124	1	Outlet
	Mukeiftah PS	1	Outlet
	Sabha PS	1	Outlet

Table 3.4.1-2 List of Control Points by Sub-Centers (2 of 2)

Governorate	Pump Station/Reservoir	No. of Control Point	Control Point
Mafraq (continued)	Amra PS	1	Outlet
	Um Jumal PS	1	Outlet
	Suwailmeh PS	1	Outlet
	Jaber PS	1	Outlet
	Zainieh PS	1	Outlet
	Ruwaished PS	1	Outlet
	Total	**12**	
Ajloun	Anjara PS	1	Outlet
	Kufranja PS	1	Outlet
	Ein Al Qantara PS	1	Outlet
	Arjan PS	1	Outlet
	Ein Al Tannour PS	1	Outlet
	Ein Rasoun PS	1	Outlet
	Um Qasem PS	1	Outlet
	Zuqeiq PS	1	Outlet
	Total	**8**	
Jerash	Al Shawahed PS	1	Outlet
	Al Qayrawan PS	1	Outlet
	Souf Al Garbi PS	1	Outlet
	Al Rayyashi PS	1	Outlet
	Ein Al Ghadeir PS	1	Outlet
	Ein Al Deik/Ein Al Teis PS	1	Outlet
	Burma Spring	1	Outlet
	Total	**7**	
Balqa	Shaiyeh PS	2	Outlet
	Bokoria PS	2	Outlet
	Yazidieh PS	1	Outlet
	Bohaira PS	3	Outlet
	Total	**8**	
Madaba	Madaba PS	1	Inlet
		2	Outlet
	Total	**3**	
Karak	Ghuweir PS	1	Inlet
		3	Outlet
	Ain Sara Spring	1	Outlet
	Total	**5**	
Tafilah	Al Bedah Reservoir	1	Inlet
		1	Outlet
	Zabda PS	1	Outlet
	Total	**3**	
Ma'an	Collection Reservoir	1	Outlet to Ma'an City
	Nijii PS	2	Outlet to Tafilah
			Outlet
	Qaa PS	2	Outlet
	Moraighah	2	Outlet
	Total	**7**	
Aqaba	Collection Reservoir	2	Inlet from Disi wells
		1	Outlet to Aqaba
	Terminal Reservoir No.1	1	Inlet from Collection Reservoir
		1	Outlet to T/R No.2
	Total	**5**	

3.5 Implementation Plan

The plan for establishing NWCS shall be implemented in two stages, that is, Phase-1 and Phase-2 as shown in Table 3.5.1.

Phase-1 shall cover the construction of Main Control Center to be located in the head office of WAJ in Amman for supervising and controlling the water transmission volume among the related Governorates.

Phase-1 shall also include the construction of Sub-Center for biggest 4 Governorates in water supply (Amman, Zarqa, Irbid and Mafraq) where the water supply accounts for about 70% of the whole Jordan.

Phase-2 shall cover the construction of Sub-Center for the remaining 8 Governorates.

Proposed implementation plan and schedule are shown in Table 3.5.1-1 and Table 3.5.1-2.

Table 3.5.1-1 Proposed Implementation Plan

Project Name	Outline	Expected Schedule
Project for Establishment of National Water Supply Control System (Phase-1) [Short Term Plan]	• Construction of Main Control Center • Construction of Sub-Centers of 4 northern Governorates (Amman, Zarqa, Irbid and Mafraq) • Establishment of SCADA system including installation of flow meters	Year 2003～2004
Project for Establishment of National Water Supply Control System (Phase-1) [Mid Term Plan]	• Construction of Sub-Centers of 8 southern Governorates. • Establishment of SCADA system including installation of flow meters.	Year 2006～2008

Table 3.5.1-2 Proposed Implementation Schedule

Project Name	2005	2010	2015	2020
Project for Establishment of National Water Supply Control System (Phase-1)				
Project for Establishment of National Water Supply Control System (Phase-2)				

3.6 Cost Estimate

The cost estimation has been done for the establishment of National Water Control System (NWCS) in Jordan. The following assumptions and conditions are applied for the estimation.

- Main Control Center shall be established in the existing building of WAJ head office in Amman. and Sub-Center shall be established in the existing building of WAJ branch office in each Governorate.
- Hardware, software and other equipment shall be imported from outside of Jordan.
- Cost for telecommunication in the operation such as telephone charge, internet connection fee, etc. is not included in O & M cost.
- Public telephone line shall be used for telecommunication between Sub-Centers and each RTU.

Table 3.6.1-1 Cost Estimate for National Water Control System

	Facilities for NWCS		Total Investiment Cost (JD)	Annual (2005) O&M Cost (JD/a)	Annual (2010) O&M Cost (JD/a)
Phase-1	Main Control Center	hardware	430,000	114,000	114,000
		software	887,000	0	0
		Sub-total	1,317,000	114,000	114,000
	Sub-Center (4 nos.)	hardware	906,000	403,000	403,000
		software	1,641,000	0	0
		Sub-total	2,547,000	403,000	403,000
	Local Stations (RTU, flow meters, etc.)	hardware	2,474,000	170,000	170,000
		software	722,000	0	0
		Sub-total	3,196,000	170,000	170,000
	Engineering Services & Contingency		254,000	0	0
	Phase 1 - Total		7,314,000	687,000	687,000
Phase-2	Main Control Center		0	0	0
			0	0	0
			0	0	0
	Sub-Center (8 nos.)	hardware	1,813,000	0	793,000
		software	2,614,000	0	0
		Sub-total	4,427,000	0	793,000
	Local Stations (RTU, flow meters, etc.)	hardware	1,109,000	0	240,000
		software	320,000	0	0
		Sub-total	1,428,000	0	240,000
	Engineering Services & Contingency		211,000	0	0
	Phase 2 - Total		6,066,000	0	1,032,000
Grand Total			13,380,000	687,000	1,719,000

Estimation conditions:
1. Operator of Main Control Station : 5 persons x 2 shifts/day = 10 persons/day
2. Operator of Sub-Center : 5 persons x 2 shifts/day = 10 persons/day
3. Maintenance staff for local stations : 3 persons/Sub-Center
4. O&M cost : 2.0% x (hardware + software)
5. Sub-Center for Phase-1 : Amman, Irbid, Zarqa and Mafraq
   Sub-Center for Phase-2 : Ajloun, Jerash, Balqa, Madaba, Karak, Tafilah, Ma'an and Aqaba

3.7 Economic and Financial Analysis

3.7.1 Socio-Economic Conditions

(1) Population

Population and its Growth in the Past

Item	1979 Census	1994 Census	Inter-Censual Growth Rate/a
Jordan	2,149,177	4,139,458	4.5%

Source: Department of Statistics

The 1994 population of Jordan was 4,139,458 according to the population census conducted by the Department of Statistics. It grew during the inter-censual 15 years 1979 to 1994 at the average annual rate of 4.5%, resulting in nearly double figures compared with the 1979 population as shown in the above table.

(2) Employed Persons

Employed Persons 15 Years of Age & More by Economic Activity

Item	1979	1994	Inter-Censual Growth Rate/a
Primary Sector	46,049 (11%)	66,900 (8%)	2.5%
Secondary Sector	104,506 (26%)	195,780 (23%)	4.3%
Tertiary Sector	255,514 (63%)	592,670 (69%)	5.8%
Total	406,069 (100%)	855,350 (100%)	5.1%

Source: Department of Statistics

The employed persons in the whole country in 1994 were 855,350, the primary, secondary and tertiary sectors accounting for 8%, 23% and 69% respectively. It grew during the inter-censual 15 years 1979 to 1994 at the average annual rate of 5.1%, resulting in more than two times increase compared with the 1979 figures as shown in the above table.

The fact that the growth rate of employed persons is greater than that of population may mean that the economic activities of the country are being accelerated. And the tendency is more pronounced in the tertiary sector as shown in the above table.

3.7.2 Economic and Financial Analysis

The system aims for managing the conditions of the nation-wide water supply mains by automatically and continuously monitoring the water flows and pressures in the mains through electronic systems to be set up in the sub-centers in the 12 governorates as well

as in the main control center. Any irregularities in the water flows and pressures caught in the sub-centers/main center will give rise to the efforts for the identification of the causes and for the taking of remedial steps. The causes may be varied such as the breakage of pipes and reservoirs, breakdowns of pumps, illegal connections, water theft, intermittent water supply, direct water supply from the pumping stations to the end users. (The latter two causes concern the shortcomings of the existing systems which cannot be rectified on the spot or in a short term.)

The system also has an important function of accurately and automatically recording the production, transportation (exportation and importation) and supply of water in each of the 12 governorates. Thus, the system will contribute to accurately grasping the reality of UFW (especially physical loss) on one hand and reducing it on the other on the governorate as well as national basis.

In view of the actual situation where over 50% of water produced disappears in the dark without fulfilling its central objective of supplying the life line to the beneficiaries with due financial/economic returns, the importance and the necessity of the project cannot be overemphasized.

Although the cost estimation of the project can be done in the standard way, there is virtually no way to accurately forecast the economic/financial benefits the project will bring about. However, the actual situation of UFW is more or less known and the target level of UFW can be set.

No one can accurately project how much the project is going to be involved in attaining the target level of UFW. But, one can employ the sensitivity analysis by assuming the contribution rate of the project in the attainment of the target level setting several instances. By so doing one can quantitatively estimate the financial/economic benefits in each assumed instance.
In this way, one can eventually perform financial/economic analysis of the project.

(1) Methodology

1) Financial Analysis

(a) Preparation of cost benefits streams

a) Project life for financial analysis was set at 30 years.

b) Preparation of cost streams
The estimated initial cost of the project was spread over the implementation period. Also, the annual recurrent cost for the operation and maintenance (O & M) of the facilities was entered annually after the implementation up to the end of the project life.

c) Estimation of water stream
The quantity of urban water to be annually supplied in the whole nation after the implementation up to the end of the project life was estimated.

d) Estimation of UFW reduction in the with project case
The ratio of UFW in the without project case was estimated by dividing the quantity of urban water billed by that of urban water supplied in recent years.

Out of it, the extent to which UFW will be reduced through the implementation of the project was estimated by setting several assumed instances.

e) Estimation of water stream to be saved and billed in the with project case
From items c) and d), in each assumed instance of UFW reduction, the quantity of urban water to be annually saved and billed in the with project case was determined up to the end of the project life.

f) Estimation of the unit value of water
The financial value of the unit quantity of urban water was estimated based on the existing water tariffs and future needs for raising them.

g) Preparation of benefits stream
From items e) and f), for each assumed instance, the benefits stream was worked out up to the end of the project life.

(b) Calculation of Financial Criteria and Financial Evaluation

a) The discount rate was assumed as 5%.

b) Using the cost benefits streams, for each assumed instance, FIRR, NPV and the water price were calculated.

c) Based on the values of financial criteria, taking into consideration qualitative factors as well, the judgment on the financial feasibility of the project was passed.

2) Economic Analysis

(a) Preparation of cost benefits streams

a) Project life
(Same as in financial analysis)

b) Preparation of cost streams
The estimated initial cost was divided into foreign and local components. The standard conversion factor was applied to the local components, except land acquisition cost, which will be annualized based on land rent.
The initial cost of the project was spread over the implementation period. Also, the annual recurrent cost for the operation and maintenance (O & M) of the facilities was entered annually after the implementation up to the end of the project life.

c) Estimation of water stream
(Same as in financial analysis)

d) Estimation of UFW reduction in the with project case
The ratio of UFW in the without project case was estimated by dividing the quantity of urban water billed by that of urban water supplied in recent years.
Out of it, the extent to which physical loss will be reduced through the implementation of the project was estimated by setting several assumed instances.

e) Estimation of water stream to be saved in the with project case
From items c) and d), in each assumed instance of physical loss reduction, the quantity of urban water to be annually saved in the with project case was determined up to the end of the project life.

f) Estimation of the unit value of water
The economic value of the unit quantity of municipal water was worked out by considering the affordability of a household to pay for water supply and the water demand per household. The economic value of the unit quantity of industrial water was surmised from the industrial gross output, industrial water demand and the contribution of water in realizing industrial output.

g) Preparation of benefits stream
From items e) and f), for each assumed instance, the benefits stream was worked out up to the end of the project life.

(b) Calculation of Economic Criteria and Economic Evaluation

a) Opportunity cost of capital was assumed as 10%.
b) Using the cost benefit streams, for each assumed instance, EIRR, NPV and the water price were calculated.
c) Based on the values of economic criteria, taking into consideration qualitative factors as well, the judgment on the economic feasibility of the project was passed.

(2) Preconditions

1) Water to be Produced (Unit: M m^3/year)

Year	2005	2010
Water to be Produced	340.670	453.040

2) Investment Costs (Unit: M JD)

Investment Costs	Local Components		Foreign Components	
13.380	0%	0	100%	13.380

3) Implementation Schedule

2003	2004	2005	2006	2007	2008

4) O & M Costs (Unit: M JD)

Year	2005	2010
O & M Costs	0.687	1.719

5) Water Tariffs

(a) Municipal Water (Unit: Fils/m^3)

2003	2004	2005	2006	2007	2008	2009	2010
341	341	351	362	373	384	395	407

(b) Industrial/Touristic Water (Unit: Fils/m^3)

2003	2004	2005	2006	2007	2008	2009	2010
1,000	1,000	1,030	1,061	1,093	1,126	1,159	1,194

Starting in 2005, the average water tariffs per m^3 were assumed to be increased at the annual rate of 3% up to 2010.

6) Assumed Reduction of UFW

Percentage of Reduction	Water to be Saved in 2010 (M m3/a)
0.8% (physical 0.5%, administrative 0.3%)	3.624
0.9% (physical 0.5%, administrative 0.4%)	4.077
1.0% (physical 0.5%, administrative 0.5%)	4.530

7) Unit Benefits of Urban Water
   (a) Municipal Water: 735 Fils/m^3
   (b) Industrial Water : 2,740 Fils/m^3

(3) Results of Financial Analysis

Percentage of Reduction	NPV (M JD)	FIRR (%)	Unit Water Price (Fils)
0.8%	-3.106	0.0%	598
0.9%	0.297	5.4%	532
1.0%	3.701	10.0%	479

Note: Discount Rate=5%
The one percentage reduction of UFW was adopted.

(4) Results of Economic Analysis

EIRR	NPV (M JD)	Unit Water Price (Fils)
13.0%	1.434	1,048

Note: Discount Rate=10%
The 0.5 percent reduction of physical loss is assumed.

(5) Evaluation

This project is financially feasible with the FIRR of 10.0%, NPV of 3.701 million JD and the unit water price of 479 fils per m^3. It is also economically feasible with the EIRR of 13.0%, NPV of 1.434 million JD and the unit water price of 1,048 fils per m^3.

The above results hinge on two major assumptions as mentioned above. One is that the average water tariffs go up at the annual rate of 3% up to the year 2010, and another is that the reduction of UFW through the implementation of this project will be one percent, of which 0.5% will be that of physical loss and another 0.5% that of administrative loss.

It seems that these assumptions are appropriate and reasonable. Therefore, the project can be judged to be sufficiently worthwhile and suitable for implementation.

3.7.3 Preparation of Projected Financial Statements

(1) Preconditions

The projected financial statements, namely the income statement, the funds statement and the balance sheet were prepared.

In preparing projected financial statements, the following preconditions were set:

Item	Values, etc.
Financing resources	80% : External; 20%: Local
Financing terms	Repayment period: 30 years
	Grace period: 5 years
	Annual interest rate: 4%
Inflation rate	2%/a
Executing Entity	Public
Corporate Tax	0%

(2) Evaluation of Projected Financial Statements

The financial statements for the national water control system project shown in Table 3.7.3-1 are summarized by the representative managerial indices as follows:

(Unit: %)

Projects	Profit/Revenues	Working Capital/ Revenues	Profit/ Liabilities and Capital
	Up to 2020	Up to 2020	Up to 2020
National Water Control System	24.9	10.7	4.0

For the sake of comparison analysis, it can be stated that the standard level would be 10% for the profit to revenues ratio, 10% for the working capital to revenues ratio, and 5% for the profit to liabilities and capital ratio.

Regarding the profit to revenues ratio, this project has been found to be perfectly OK with the calculated value more than two times the standard level. With regard to the working capital to revenues ratio also, the project is sustainable with the value more than the desired level.

With respect to the profit to liabilities and capital ratio, the project would not be up to the standard level. However, this point should not be overemphasized because this undertaking of social nature is essentially not profit-oriented and, therefore, the estimated value should be regarded as acceptable.

In conclusion, it can be stated that the project would be financially sufficiently sustainable under the afore-mentioned preconditions.

Table 3.7.3-1 Finacial Statements of National Water Control System Project

(Unit : Million JD at Current Prices)

Item	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
(1) Income Statement																		
Revenues	0.000	1.570	1.725	1.912	2.120	2.351	2.607	2.835	2.835	2.835	2.835	2.835	2.835	2.835	2.835	2.835	2.835	2.835
O & M Cost	0.000	0.000	0.715	0.729	0.743	0.758	0.773	1.936	1.936	1.936	1.936	1.936	1.936	1.936	1.936	1.936	1.936	1.936
Depreciation	0.000	0.000	0.000	0.000	0.401	0.110	0.110	0.000	0.061	0.061	0.061	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Interest Payment	0.146	0.293	0.293	0.373	0.454	0.535	0.514	0.492	0.471	0.450	0.428	0.407	0.385	0.364	0.343	0.321	0.300	0.278
Expenditures	0.146	0.293	1.007	1.102	1.599	1.403	1.397	2.428	2.468	2.446	2.425	2.343	2.321	2.300	2.279	2.257	2.236	2.214
Profit Before Tax	-0.146	1.278	0.718	0.810	0.521	0.947	1.210	0.407	0.368	0.389	0.411	0.493	0.514	0.535	0.557	0.578	0.600	0.621
Tax	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Profit After Tax	-0.146	1.278	0.718	0.810	0.521	0.947	1.210	0.407	0.368	0.389	0.411	0.493	0.514	0.535	0.557	0.578	0.600	0.621
	(up to 2020)																	
Average Profit Before Tax to Revenues Ratio	24.9%																	
Average Profit After Tax to Revenues Ratio	24.9%		49.3%															
(2) Funds Statement																		
Profit After Tax	-0.146	1.278	0.718	0.810	0.521	0.947	1.210	0.407	0.368	0.389	0.411	0.493	0.514	0.535	0.557	0.578	0.600	0.621
Loans+Budget	3.657	3.657	0.000	2.022	2.022	2.022	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Depreciation	0.000	0.000	0.000	0.000	0.401	0.110	0.110	0.000	0.061	0.061	0.061	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Sources	3.511	4.935	0.718	2.832	2.944	3.079	1.320	0.407	0.428	0.450	0.471		0.514	0.535	0.557	0.578	0.600	0.621
Capital Works	3.657	3.657	0.000	2.022	2.022	2.022	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Payment of Principal	0.000	0.000	0.000	0.000	0.000	0.535	0.535	0.535	0.535	0.535	0.535	0.535	0.535	0.535	0.535	0.535	0.535	0.535
Working Capital	-0.146	1.278	0.718	0.810	0.922	0.522	0.785	-0.128	-0.107	-0.085	-0.064	-0.043	-0.021	0.000	0.022	0.043	0.064	0.086
Applications	3.511	4.935	0.718	2.832	2.944	3.079	1.320	0.407	0.428	0.450	0.471	0.493	0.514	0.535	0.557	0.578	0.600	0.621
	(up to 2020)																	
Average Working Capital to Revenues Ratio	10.7%																	
(3) Balance Sheet																		
Liabilities	2.926	5.485	5.485	6.901	8.316	9.196	8.661	8.126	7.591	7.056	6.520	5.985	5.450	4.915	4.380	3.844	3.309	2.774
Capital	0.585	2.960	3.678	5.094	6.222	7.776	8.986	9.393	9.760	10.149	10.560	11.053	11.566	12.102	12.659	13.237	13.836	14.457
Liabilities and Capital	3.511	8.445	9.163	11.995	14.538	16.972	17.647	17.519	17.351	17.205	17.080	17.038	17.017	17.017	17.038	17.081	17.146	17.232
Current Assets	-0.146	1.131	1.849	2.659	3.581	4.103	4.888	4.760	4.653	4.567	4.503	4.461	4.439	4.440	4.461	4.504	4.569	4.654
Fixed Assets	3.657	7.314	7.314	9.336	10.957	12.869	12.759	12.759	12.698	12.638	12.577	12.577	12.577	12.577	12.577	12.577	12.577	12.577
Assets	3.511	8.445	9.163	11.995	14.538	16.972	17.647	17.519	17.351	17.205	17.080	17.038	17.017	17.017	17.038	17.081	17.146	17.232
	(up to 2020)																	
Average Profit Before Tax to Liabilities and Capital Ratio	4.0%																	

3.8 Project Evaluation

As a result of sensitivity analysis, a very interesting result has been found: supposing it were succeeded through the implementation of the national water control system to reduce the UFW by one percent, then the project would be financially successful with the FIRR of 10%. Supposing the reduction rate were 0.9%, still the project would be OK with the FIRR of 5.4%. One percent reduction of UFW means in absolute terms the saving of 4.5 MCM in 2010. Further, supposing the reduction by 0.5% of physical loss were realized, then the project would be economically feasible, resulting in the EIRR of 13%.

In performing financial analysis, it was premised at the beginning that the average municipal water tariff would be gradually raised from the current 341 fils per m^3 ultimately to 407 fils in 2010. In the same way, the industrial water tariff will be raised from 1,000 fils to 1,194 fils.

In performing financial analysis also, the discount rate was set at 5% in anticipation of the provision of a kind of soft loans for the implementation of the project.

The summary of the economic and financial analysis of the project is as follows:

Economic/Financial Criteria

Project	UFW Reduction (%)	FIRR (%)	Unit Water Price	EIRR (%)
National Water Control System	1.0 (physical: 0.5)	10.0	479	13.0

Note: Discount Rate: Financial=5%, Economic=10%

Managerial Indices (Unit: %)

Project	Profit/Revenues*	Working Capital/Revenues**	Profit/Liabilities and Capital***
National Water Control System	24.9	10.7	4.0

Note: Standard Levels:*=10%, **=10%, ***=5%

It seems that the assumptions regarding UFW reduction are appropriate and reasonable. If that is the case, as the above table shows, the project is financially feasible with the FIRR twice as high as the discount rate, and also economically feasible with the EIRR substantially above the OCC. In terms of managerial indices, profitability is excellent and liquidity is on a par with the standard level, attesting to the sufficient financial sustainability of the project.

In conclusion, the national water control system project can be said to have enough potential to be financially as well as economically feasible, and therefore fully recommended as a solid candidate for implementation.

It is very obvious that the construction of the control center will not be accompanied with any environmental negative impacts.