WATER AUTORITY OF JORDAN (WAJ)
THE HASHEMITE KINGDOM OF JORDAN

PREPARATORY SURVEY REPORT
ON
THE PROGRAMME
FOR
ENERGY CONSERVATION THROUGH UPGRADING WATER SUPPLY NETWORK
IN
THE HASHEMITE KINGDOM OF JORDAN

November 2009

JAPAN INTERNATIONAL COOPERATION AGENCY

KYOWA ENGINEERING CONSULTANTS CO., LTD.

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PREFACE

Japan International Cooperation Agency (JICA) conducted the preparatory survey on the Programme for Energy Conservation through Upgrading Water Supply Network in the Hashemite Kingdom of Jordan.

JICA sent to Jordan a survey team from April 4 to April 27, 2009 as the first stage survey, from June 14 to July 17, 2009 as the second stage survey.

The team held discussions with the officials concerned of the Government of Jordan, and conducted a field study at the study area. After the team returned to Japan, further studies were made. Then, a mission was sent to Jordan in order to discuss a draft outline design, and as this result, the present report was finalized.

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

I wish to express my sincere appreciation to the officials concerned of the government of Jordan for their close cooperation extended to the teams.

November 2009

Kikuo Nakagawa
Director General, Global Environment Department
Japan International Cooperation Agency

Letter of Transmittal

We are pleased to submit to you the preparatory survey report on the Programme for Energy Conservation through Upgrading Water Supply Network in the Hashemite Kingdom of Jordan.

This survey was conducted by Kyowa Engineering Consultants Co., Ltd., under a contract to JICA, during the period from February to November 2009. In conducting the survey, we have examined the feasibility and rationale of the project with due consideration to the present situation of Jordan and formulated the most appropriate outline design for the project under Japan's Grant Aid scheme.

Finally, we hope that this report will contribute to further promotion of the project.

Very truly yours,

Shigeo Otani
Project Manager,
Preparatory Survey Team on
the Programme for Energy Conservation
through Upgrading Water Supply Network in
the Hashemite Kingdom of Jordan
Kyowa Engineering Consultants Co., Ltd.

Summary

SUMMARY

The Hashemite Kingdom of Jordan (hereinafter referred to as "Jordan") has an area of 89,000 km^2. It is bordered by Israel (the West Bank in the Palestinian Territories), Syria, Iraq and Saudi Arabia on the west, north, east and southeast, respectively, and has a population of approx. 5.88 million. Despite its relatively high per capita GDP of approx. US$ 2,770, as it is a non-oil producing country and has no major source of acquisition of foreign currency, the international balance of payment continues to be in deficit. The population influx from neighboring countries continues to grow and the unemployment rate and poverty rate are high.

The territory of Jordan is divided into a mountainous area in the west and a desert area in the east. While the annual average precipitation reaches 660 mm in the western mountainous area, the corresponding figure in the eastern desert area is as low as 120 mm. Thus, 80% of the territory is either desert or wasteland. Evapotranspiration is extremely high and approx. 85% of the total 8.5 billion m^3 annual precipitation of the entire country is lost through evapotranspiration. The water resource potential of Jordan is one of the lowest in the world and the guarantee of a stable supply of potable water and water for agriculture is a significant issue for Jordan. The per capita water resource potential was 145 m^3/year in 2008. This figure is considerably lower than 500 m^3/year, which indicates the state of absolute water shortage.

Because of the water-scarce environment mentioned above, the Government of Jordan has adopted a "National Water Strategy" and is taking measures aimed at achieving an adequate supply of safe potable water and sustainable use of water resources by 2022. In the Intergovernmental Panel on Climate Change (IPCC) 4th evaluation report in 2007, it is stated that Middle East countries will suffer from decrease of water availability and consequently from shortage of potable water due to climate change. As a result, the Government of Jordan has raised measures against climate change to be an urgent task, and has indicated agreement with Japan's undertaking, the "Cool Earth Partnership", which supports countries working to stabilize climate by both reducing Green House Gas (hereinafter referred to as "GHGs") emission and economic growth.

Zarqa Governorate, in which the Programme is to be implemented, adjoins the northeastern part of the capital, Amman. The water supply area concerned is the urban area of Zarqa Governorate, which is the economic and industrial center of Jordan. Of the total population of approx. 900,000 of Zarqa Governorate, approx. 90%, or 800,000 people, live in the Zarqa Metropolitan Area. The residents of the area include many Palestinian refugees from the wars in the Middle East and refugees from the Iran-Iraq War and the Gulf War. The area has an elevation of between 450 and 700 m and an annual precipitation of approx. 200 mm, most of which is observed in the winter. The per capita water supply is low at approx. 140 lit/day. The ratio of non-revenue water, one of the reasons for the low water supply, is as high as 56%. Therefore, the Government of Jordan and several aid organizations are

taking measures to reduce non-revenue water.

Based on the recommendations in the master plan which was formulated in the development study, “Study on the Improvement of the Water Supply System for the Zarqa District”, which was implemented in 1994-1996, the Government of Japan has been implementing the grant aid project, “Project for Improvement of the Water Supply System for the Zarqa District”, in two phases, to support the reconstruction of the water supply system by installation of water distinct distribution zones aimed at equalization of the supply water pressure and reduction in water loss in the water distribution zones. As a result of this assistance for improvement of water transmission pipelines, reservoirs and main water distribution networks, modification of the main water supply facilities will be completed with a change from direct distribution by pump to the gravity flow from the service reservoirs at the core.

However, the water supply facilities in Zarqa District face problems of frequent breakdowns and declining water transmission and distribution capacity because of superannuated the pumping facilities, which transmit water from the source and the absence of operation and maintenance of the pumping facilities based on correct knowledge and techniques. Therefore, it is deemed necessary to take continuous measures in replacement of under-performing pumping facilities and further improvement in management of transmission and distribution pipelines for effective use of the limited water resources and stabilization of the water supply.

Because of the hilly terrain, many pumps are required in the water transmission and distribution systems in Zarqa District. Thermal power generation accounts for almost all power generated in Jordan. Therefore, operation of under-performing inefficient pump increases not only electricity consumption, but also GHGs emission. Deterioration by superannuated water supply facilities has resulted in continuous use of a significant amount of electricity in the water transmission and distribution and the cost of electricity accounts for approx. 60% of the expenses required for the operation and maintenance of the facilities excluding the investment in equipment related to construction of water supply facilities. Therefore, reduction in energy consumption for water transmission and distribution and stabilization of water transmission, in addition to the on-going transfer to an efficient system by gravity flow with maximum use of the main water supply facilities which have been constructed so far, are urgently required. .

In such a situation, in August 2008, the Government of Jordan made a request for grant aid for the Programme for Energy Conservation through Upgrading Water Supply Network (hereinafter referred to as “the Programme”) to the Government of Japan under Japan’s Grant Aid for Environment and Climate Change Programme (hereinafter referred to as “GAEC”) which was introduced as the new Grant Aid Scheme in the year 2008 as part of its assistance for measures to combat climate change, aiming at “saving energy use through improvement of efficiency in the transmission and distribution system (mitigation measures)” and “stabilization and increase of the water supply and promotion of

water resource conservation through reduction of water losses in the water supply system (adaptation measures)". The request consists of procurement of materials and equipment, including those for the replacement of the water transmission pump in the water supply system in Zarqa District, and technical assistance.

In response to the request, the Government of Japan decided to implement a preparatory survey on "The Programme for Energy Conservation through Upgrading the Water Supply Network" and the Japan International Cooperation Agency (hereinafter referred to as "JICA") dispatched the first field study team for the preparatory survey to Jordan from 4th to 27th April 2009 to verify the background and content of the request and to decide the programme content. The team held discussions with the implementing organization, the Water Authority of Jordan (hereinafter referred to as "WAJ"), confirmed the content of the request, implemented the field study and collected the relevant data. In the work in Japan after returning to Japan, the team verified the content of the request and the relevance of the programme, analyzed the problems in the sector concerned and finalized the framework of the cooperation programme. As a follow-up to the results of the first field study, JICA dispatched a second field study team to Jordan from 14th June to 17th July 2009.

After returning to Japan, the team held discussions on the appropriate programme scale and programme content, assuming that the requested programme is implemented under GAEC, and prepared a summary of the preparatory survey. JICA dispatched the mission to Jordan from 11th to 16th October 2009 to explain the summary to the relevant personnel in the Government of Jordan and hold discussions on the draft outline design with them. The outcome of the discussions is as described in this report.

The Programme consists of replacement of the main pumping facilities for water transmission, procurement of the materials and equipment for the water transmission pipelines and the water distribution networks, and technical assistance ("technical guidance" on operation and maintenance of the pumping facilities for water transmission and a "soft component" on operational management technology of pumping water transmission system) for the implementing organization, WAJ.

Because of the expected synergy with Japan's past and ongoing grant aid projects, such assistance will contribute not only to reduction in CO_2 emissions resulting from reduction in energy consumption, but also stabilization of water transmission and distribution in Zarqa District. The Programme was designed in accordance with the design policies described below, based on the results of the field studies.

1) Selection of the materials and equipment to be procured in the Programme

The three pumping stations at Azraq, Hallabat and Zarqa were selected as the main programme sites for replacement of the pumping facilities from the seven stations included in the request, taking into consideration the points described below. In addition, procurement of the water transmission pipes and

air valves for the transmission pipelines, which were effective in improving energy conservation relevant to the three pumping stations, and the valves and water flow meters required for controlling the flow rate were included in the Programme. Materials for the water distribution networks are also included in the Programme for their expected contribution to stabilization of the water supply.

- The Programme will maintain consistency with the grant aid project aimed at introduction of a water distribution system by gravity flow from reservoirs in accordance with the recommendations of the Development Study, “Study on the Improvement of the Water Supply System for the Zarqa District” prepared by JICA. Therefore, the Japanese side will not procure the equipment of pump intended for direct pumping into the distribution networks, which are included in the request. The specifications of the valves and water flow meters to be installed in the water distribution networks were decided on the assumption that they were to be used in the gravity flow system.

- Areas, materials and equipment included in the assistance projects of other donors will not be included in the assistance of the Japanese side. Therefore, Old Khaw Pumping Station (for water transmission to Amman and Southern Zarqa Water Distribution Zone) and Zarqa Reverse Osmosis (hereinafter referred to as “R/O”) Plant included in a project by Germany as a result of the Project for Improvement of Energy Efficiency (hereinafter referred to as “IEE”) by German Technical Cooperation (hereinafter referred to as “GTZ”), areas included in projects for improvement of water distribution networks and reduction in non-revenue water by the German Development Bank (hereinafter referred to as “KfW”), European Community (hereinafter referred to as “EC”) and China, and well facilities included in a study for a repair project by the Millennium Challenge Corporation (hereinafter referred to as “MCC”) of the USA were excluded from the assistance of the Japanese side.

2) Operational conditions for the pumping facilities

After examining the water allocation plans with other governorates and the water transmission and distribution plan in Zarqa District, the specifications for the requested materials and equipment were decided so that they would be appropriate for the design discharges agreed upon with WAJ. The design discharges of the proposed pumping facilities were set at appropriate figures derived from the records of yields from the existing well water sources and the capacity of the water transmission pipelines, instead of simply increasing the current discharges. A ban on simultaneous operation of the existing and proposed pump and control of facility operation by changing the number of pump in operation and their operating time were adopted as the operational conditions of the pumping facilities for the improvement of energy conservation and the number of pump required was decided under these conditions.

3) Power-receiving standards at the pumping facilities

The existing pumping stations use a low-voltage 400 V power supply as the standard supply.

However, it is recommended that the pumping facilities to be replaced in the Programme receive a medium-voltage 6.6 kV power supply because of their large capacity and scale and from the viewpoint of global market trends as well as from a technical viewpoint. After considering the distances from the nearest substations, the implementing capacity of the Jordanian side and the technical capacities of the maintenance engineers, it was decided to adopt a policy of switching from the current low-voltage receiving system to a medium-voltage receiving system at Azraq Pumping Station and maintaining the existing low-voltage power receiving systems at the other two stations.

4) Technical assistance (technical guidance, soft component)

Operation and maintenance personnel are assigned to the existing pumping stations and they carry out daily maintenance. However, their lack of precise knowledge and techniques not only impedes efficient operation of the facilities but is also one of the causes of the frequent breakdowns and premature deterioration. Therefore, it is necessary to provide both theoretical and practical technical guidance aimed at capacity development in appropriate techniques for operation and maintenance of the pumping facilities. It was decided to adopt a policy of implementing technical assistance in which operational guidance - “technical guidance” on electrical and mechanical equipment provided by a specialized engineer dispatched by the pump manufacturer - and the “soft component” in operation and management of the water transmission system provided by the consultant are combined.

5) Methods of material and equipment procurement

The materials and equipment to be procured in the Programme are classified into two lots, Lot 1 - “materials and equipment related to the water transmission pump and water flow meters” and Lot 2 - “materials and equipment for the water distribution networks.” Of the Lot 1 materials and equipment, the pumping facilities and water flow meters will be installed by the Japanese side. The remainder of the Lot 1 materials and equipment and the Lot 2 materials and equipment will be installed by the Jordanian side. At present, the grant aid project of Japan aimed at transfer to the gravity flow system is in progress. When the transfer to the gravity flow system has reached an advanced stage, the Lot 2 materials and equipment will be procured.

Tables S.1 and S.2 show the content and scale of the Programme.

(1) Procurement of materials and equipment

Table S.1 Components of Materials and Equipment to be Procured

Use	Requested Items			
	Pumping facility	Materials for pipelines	Water flow meter/Flow control valve	Lot No.
Transmission from major well water sources	Azraq Pumping Station			1
	Transformer 11kV/6.6kV, 6000kVA, 2 sets Multi-stage single suction centrifugal pump 5 sets (including 1 standby) Discharge: 425 m^3/h/set, Head 360m Air Valve Dia4", 1 set Transmission steel pipe: approx.40m	Air valves for pipeline to Khaw Dia.4": 40 nos.	Water flow meter at PS. -at inflow side: 2 sets -at discharge side: 1 set Flow control valve: 1 set	
	Hallabat Pumping Station			
	[For Khaw Reservoir] Transformer 33kV/400V, 1000kVA, 1 set Multi-stage single suction centrifugal pump:2 sets (including 1 standby) Discharge: 500 m^3/h/set, Head 135m Separation valve: 1 set	Air valves for pipeline to Khaw Dir.4": 15 nos.	Water flow meter at PS. -at inflow side: 2 sets -at discharge side.: 1 set Flow control valve: 1 set	
	[For Hallabat Village] Multi-stage single suction centrifugal pump:2 sets Discharge: 150 m^3/h/set, Head 150m	—	Water flow meter at PS. -at discharge side: 1 set Flow control valve: 1 set	
Transmission to Batrawi Reservoir	Zarqa Pumping Station			
	Multi-stage single suction centrifugal pump:3 sets (including 1 standby) Discharge rate: 400 m^3/h/set, Head 90m	Transmission pipeline to Batrawi Dir.600, approx. 2 km	Water flow meter at PS. -at discharge side: 1 set Flow control valve: 1 set	
	New Khaw Pumping Station			
	Gate valve, non-retaining valve and butterfly valve for existing pump station: 4 sets	—	Water flow meter at PS. -at inflow side: 2 sets -at discharge side: 1 set Flow control valve: 1 set	
Materials for water distribution networks in Zarqa District	—	—	Water flow meter at water transmission pipelines: 2 sets	
	—	- Gate valves Dia.4"-24", 343 nos. - Air valves Dia2": 15 nos.	—	2

(2) Technical assistance

Table S.2 Content of the Operation and Maintenance Technical Assistance

No.	Details of assistance	Activity	Recipients
1.Operation and maintenance technical guidance of pumping facilities by the Procurement Contractor			
1	Operation management technology	Training in operation management	Pump operators at the pumping stations assisted in this Programme
2	Maintenance technology: Preventive maintenance	Training in technology for inspection and maintenance	Maintenance managers at Zarqa GWA and Azraq Pumping Station
3	Maintenance technology: Maintenance after breakdown	Training in technology for repair	CWS maintenance managers
4	Safety management technology	Training in technology for safety	Safety managers at Zarqa CWS and Azraq Pumping Station
2. Soft component by the Consultant			
1	Appropriate operational management technology of pumping water transmission system	Training in drafting of an efficient water transmission plan Training in diagnosis of pumping operation efficiency	Water directorate managers at Zarqa GWA

The period required for implementation of the entire Programme is assumed at 36 months after conclusion of the Exchange of Notes (hereinafter referred to as "E/N"), consisting of two months for conclusion of the Grant Agreement (hereinafter referred to as "G/A"), Agent Agreement (hereinafter referred to as "A/A") and Consultant Contract, 25 months for completion of the work related to the Lot 1 materials and equipment (five months from detail design to conclusion of an agreement with a contractor, 14 months for procurement and six months for installation, commissioning and technical assistance) and lastly nine months from the tender for the Lot 2 materials and equipment to installation. The cost of implementation of the Programme borne by the Jordanian side is estimated at 1.1 million JD.

The outcomes expected from the implementation of the Programme are as follows.

1) Improvement in the operational efficiency of the pumping facilities for water transmission

The replacement of the pumping facilities at the three main water transmission facilities, Azraq, Hallabat and Zarqa Pumping Stations, in the Programme area, is expected to improve the operational efficiency of the pump and unit electricity consumption by 139% and 70%, respectively, on average.

Table S.3 Indices of the Outcomes Expected from Replacement of the Water Transmission Pumps

Pumping station	Destination of water	Operating number of pump	Existing pump station		Replacement pump station	
			Operation efficiency	Unit Electricity consumption	Operation efficiency	Unit Electricity consumption
			(%)	(kWh/m^3)	(%)	(kWh/m^3)
Azraq	Khaw Reservoir	4	57	1.89	68（119%）	1.58（83.6%）
Hallabat	Khaw Reservoir	1	57	0.62	68（119%）	0.52（83.8%）
Hallabat	Hallabat Village	2	34	1.20	65（191%）	0.63（52.5%）
Zarqa	Batrawi Reservoir	2	50	0.78	68（136%）	0.40（51.3%）

2) Reduction in energy consumption (Reduction in costs for electricity consumption)

A comparison of the electricity consumption after implementation of the Programme with consumption in the case where the existing pump are used to transmit water at the design discharge of the Programme at the Azraq, Hallabat and Zarqa Pumping Stations reveals a reduction of 8,687,000 kWh/year in electricity consumption after implementation of the Programme. Consequently, the cost of electricity will be reduced by 374,000 JD (approx. 18% of the total electricity cost at the three stations before implementation of the Programme) and this reduction will contribute to a reduction in the operation and maintenance costs of WAJ.

3) Reduction in CO_2 emissions

The reduction in electricity consumption in the water transmission system mentioned above is

expected to reduce CO_2 emissions by 5,386 tons-CO_2/year (8,687,000 kWh/year x 0.62 kg-CO_2/kWh). The Programme will contribute to alleviation of the effects of climate change through this reduction in GHGs emissions.

4) Increase in water transmission and distribution through stabilization of water transmission

At present, the water transmission system suffers from frequent breakdowns, which result in interruption of water transmission and declining water transmission capacity. The Programme will enable stable water transmission and increase water transmission by 1,900, 000 m^3/year. The increase in water transmission to reservoirs will lead to an increase in water distribution and, consequently, improve the water supply in the water distribution zones.

5) Improvement of the operation and maintenance system at the pumping stations for water transmission

Implementation of the Programme will establish the organizational system required for appropriate operation and maintenance of the pumping stations for water transmission. Implementation of technical assistance in the form of technical guidance by the procurement agent and the soft component by the consultant in the Programme will enable WAJ personnel to diagnose the operational condition of the pump and, consequently, enable efficient pump operation. In addition, strengthening of the capacity to operate and maintain the pumping facilities through implementation of the Programme will facilitate stabilization of water transmission and reduction in energy consumption.

6) Establishment of a discharge control system

The installation of water flow meters will enable accurate measurement of the amount of influx to and discharge from the pumping stations and the flow rate at the branching points in the main water transmission pipelines and enable appropriate discharge control in accordance with the operation plans of the pumping stations and the plans for water transmission. Consequently, it will be possible to carry out monitoring of the amount of water transmission, which will enable control of the amount of water transmission and water loss and diagnosis of the operational condition of the pump.

7) Appropriate condition of the water distribution networks

The replacement of materials in the water distribution networks with the materials (gate valves and air valves) to be procured in the Programme will improve the operational performance of the valves in the networks that is currently very poor because of superannuated valves, and enable appropriate operation and maintenance of the networks. In this way, the Programme will enable efficient use of water resources by adjusting the water distribution pressure within the water distribution zones to an appropriate level and by reducing water loss.

In addition to the many positive outcomes expected from the Programme as mentioned above, the Programme will contribute to improvement of the basic human needs (BHN) of the people in the Programme area and the technical capacity development of the staffs of WAJ who is the owner and operational body of the facilities. Moreover, the reduction of energy consumption in water transmission and distribution and the stabilization of water transmission and distribution realized through implementation of the Programme are expected to lead to improvement in financial management of the water supply project. For these reasons, the significance of implementing the Programme under grant aid is considered high. Meanwhile, effective and efficient implementation of the Programme will require attention to the following issues:

1) Implementation of appropriate operation and maintenance of the pumping facilities for water transmission

The Programme includes the provision of technical assistance to WAJ personnel in appropriate operation, preventive maintenance and maintenance after breakdown of the pumping facilities and operation of the water transmission system, in addition to replacement of the pumping facilities. Thus, the implementation of the Programme will create the conditions, in terms of both hardware and expertise, for stable, sustainable and long-term use of the pumping facilities and equipment procured in the Programme and for reduction in energy consumption. WAJ will be required to make full use of the hardware and expertise to implement appropriate operation and maintenance after completion of the Programme.

2) Implementation of monitoring and preparation of reports

To evaluate the reduction in energy consumption and to diagnose the operational condition of the pumping facilities, it is necessary to monitor the efficiency of the pumps and unit electricity consumption during daily operation and maintenance work. The measuring devices required for obtaining these parameters (equipment to measure the voltage, current, power factor, wattage, water pressure and flow rate) will be equipped in the Programme. WAJ will be required to implement daily monitoring, record and analyze the data obtained, and take measures against malfunctions when they occur and prepare reports.

3) Ripple effects of the outcomes of the Programme to operation and maintenance at other pumping stations

In the Programme, the pumping facilities will be replaced at three pumping stations, Azraq, Hallabat and Zarqa Pumping Stations, and technical assistance will be provided at these stations. Zarqa Branch Office of WAJ (Zarqa GWA) operates and maintains the water transmission and distribution pump station at 11 other stations. Although the Programme will not provide materials or equipment to these stations, it is desirable for WAJ to upgrade the operation and maintenance techniques at the other stations by implementing in-house training for the operators at these stations using the content of the training implemented and the manuals prepared in the technical guidance in the Programme. It is also

desirable for WAJ to improve the materials and equipment at the other stations with its own resources.

4) Switchover to gravity flow system in water distribution zones

Adoption of the gravity flow system in the water distribution networks enables leveling of the water distribution pressure and reduction in water loss. In addition, the adoption of the gravity flow system is expected to create synergy with the replacement of the water transmission pumps in the Programme and, thus, to have a significant effect on reduction of energy consumption.

However, some areas which the water distribution system has not yet been switchover from the direct pumping system to the gravity flow system remain in the distribution system which development of the main facilities has made steady progress by the grant aid project.

The following are considered to be the causes of the low progress of the switchover: 1) shortage of yield from the wells and the amount of water available from the water sources deriving from the water set aside for inter-governorate water-sharing including the water transmission to Amman, 2) non-realization of water transmission from Amman to Zarqa District, which was established as a precondition for the facility construction at the time of designing the grant aid project, 3) expansion of the water distribution zones and continued existence of areas with poor water distribution, and 4) poor performance of the pumping facilities for water transmission.

Therefore, WAJ will have to urgently formulate water allocation plans in Zarqa District and water distribution plan to the areas with poor water distribution after switchover to the gravity flow system, as the preparations for switchover from the direct pumping system currently practiced in the water distribution zones to the gravity flow system as originally planned.

5) Scenario for water-sharing

At present, only approxi. 80% of the design amount of water at the sources is available in Zarqa District. However, switchover to the gravity-flow water distribution system should be promoted strongly in the Northern Zarqa Water Distribution Zone, in which the Programme is to be implemented, since it has better conditions for water transmission and distribution than Rusaifa and Awajan Districts in the Southern Water Distribution Zone. For transfer to a full-scale gravity flow system, it will be necessary not only to transmit water to Rusaifa and Awajan Districts from Khaw Pumping Station, but also to receive distribution of excess water in Amman after the completion of the “Disi-Amman Conveyor Scheme,” a water resource development project for the supply of water to the Amman area.

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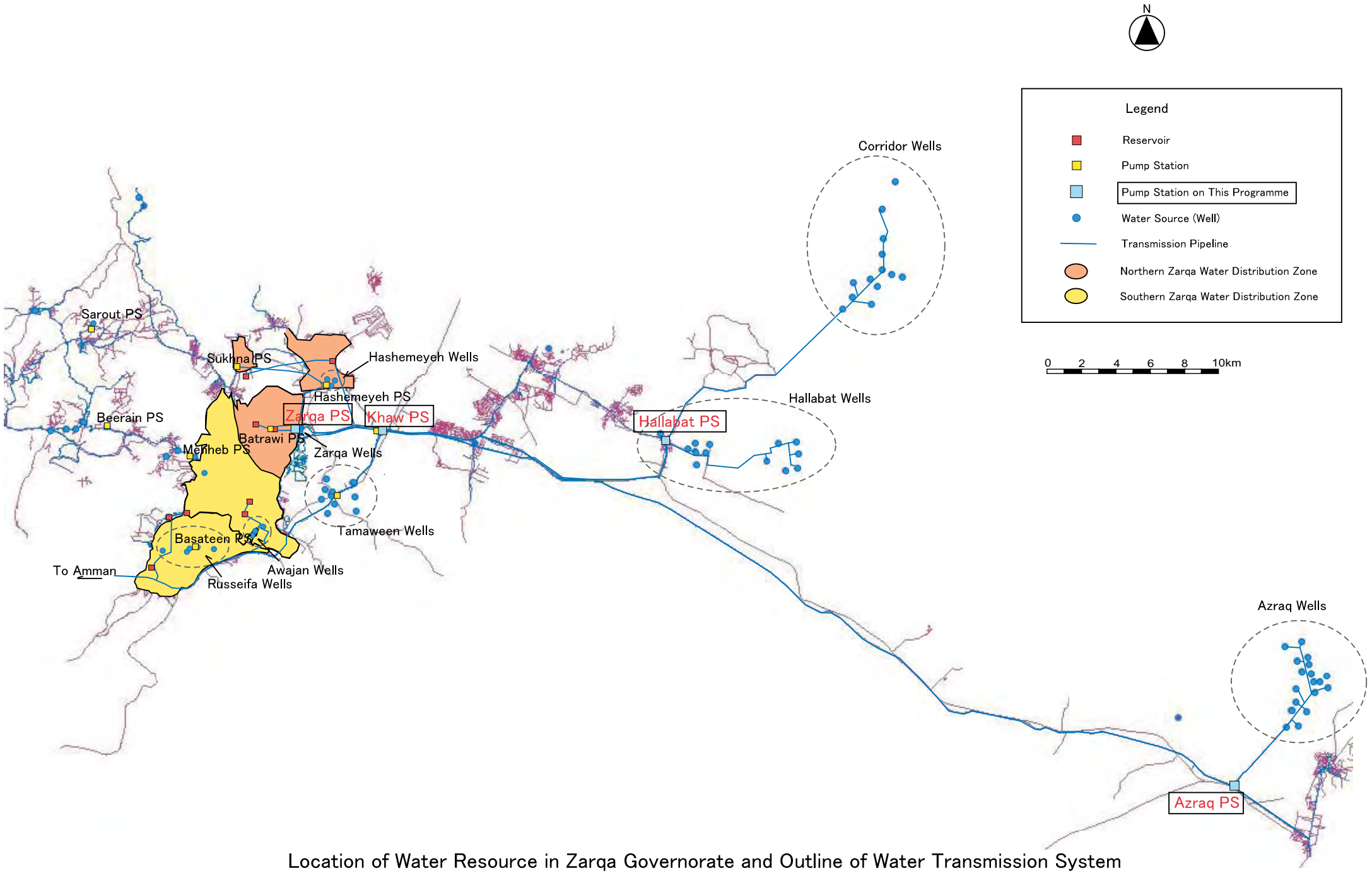

Location of Water Resource in Zarqa Governorate and Outline of Water Transmission System

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Abbreviations

A/A	Agent Agreement
B/A	Banking Arrangement
BDA	Blanket Disbursement Authorization
BHN	Basic Human Needs
COD	Central Operation Directorate
CWS	Central Work Shop

DAC	OECD Development Assistance Committee
DCIP	Ductile Cast-iron Pipe
EC	European Community
EDCO	Electricity Distribution Company
EIA	Environmental Impact Assessment
E/N	Exchange of Notes
EU	European Union
FIDIC	International Federation of Consulting Engineers
G/A	Grant Agreement
GAEC	Grant Aid for Environment and Climate Change Programme
GDP	Gross Domestic Product
GHGs	Green House Gas
GIS	Geographical Information System
GOJ	Government of Japan
GTZ	German Technical Cooperation Agency
GWA	Governorate Water Authority
IEE	Improving Energy Efficiency Project
IPCC	Intergovernmental Panel on Climate Change
IVA	Imposta sul Valore Aggiunto
JD	Jordan Dinar
JEPCO	Jordan Electric Power Company
JICA	Japan International Cooperation Agency
JICS	Japan International Cooperation System
KfW	Kreditanstalk fur Wiederaufban
MCC	Millennium Challenge Cooperation
NEPCO	National Electric Power Company
MOPIC	Ministry of Planning and International Cooperation
NRW	Non-Revenue Water
O&M	Operation and Maintenance
OECD	Organization for Economic Cooperation and Development
OJT	On-the -job-training
PDM	Programme Design Matrix
PS	Pump Station
R/O	Reverse Osmosis
USA	United States of America
USAID	United States Agency for International Development
VTC	Vocational Training Center
WAJ	Water Authority of Jordan
WTO	World Trade Organization

Chapter 1

Background of the Programme

Chapter 1 Background of the Programme

1.1 Background of the Request

The territory of Jordan is divided into a mountainous area in the west and a desert area in the east. Thus, 80% of the territory is either desert or wasteland. The water resource potential of Jordan is one of the lowest in the world and the guarantee of a stable supply of potable water and water for agriculture is a significant issue for Jordan. Because of the water-scarce environment, the Government of Jordan has adopted a "National Water Strategy" and is taking measures aimed at achieving an adequate supply of safe potable water and sustainable use of water resources by 2022. The per capita water resource potential was 145m^3/year in 2008. This figure is considerably lower than 500 m^3/year, which indicates the state of absolute water shortage.

The per capita water supply is low at approx. 140 lit/day. The ratio of non-revenue water, one of the reasons for the low water supply, is as high as 56% (WAJ data for 2008). Therefore, the Government of Jordan and several aid organizations are taking measures to reduce non-revenue water.

Based on the recommendations in the master plan which was formulated in the development study, "Study on the Improvement of the Water Supply System for the Zarqa District", which was implemented in 1994-1996, the Government of Japan implemented the grant aid project, "Project for Improvement of the Water Supply System for the Zarqa District", in two phases, to support the reconstruction of the water supply system by installation of water distinct distribution zones aimed at equalization of the supply water pressure and reduction in water loss in the water distribution zones. As a result of this assistance for improvement of water transmission pipelines, reservoirs and main water distribution networks, modification of the main water supply facilities will be completed with a change from direct distribution by pump to the gravity flow from the service reservoirs at the core.

However, the water supply facilities in Zarqa District face problems of frequent breakdowns and declining water transmission and distribution capacity because of superannuated the pumping facilities, which transmit water from the source and the absence of operation and maintenance of the pumping facilities based on correct knowledge and techniques.

In addition, deterioration by superannuated water supply facilities has resulted in continuous use of a significant amount of electricity in the water transmission and distribution and the cost of electricity accounts for approx. 60% of the expenses required for the operation and maintenance of the facilities excluding the investment in equipment related to construction of water supply facilities. Therefore, reduction in energy consumption for water transmission and distribution and stabilization of water transmission, in addition to the on-going transfer to an efficient system by gravity flow with maximum use of the main water supply facilities which have been constructed so far, are urgently required.

1.2 Contents of the Request

1.2.1 Original Request

The locations for use of materials and equipment were not indicated clearly in the original list of request. Therefore, Japanese side requested revised list of items with its number, specification, installation location and priority at the beginning of the First Field Survey, and the revised list was submitted at the end of the Field Survey. Programme description and revised list of the request from the Jordanian side are as shown in Table 1.2.1 and Table 1.2.2.

Table 1.2.1 Programme Description

Items	Contents
1) Overall goal	➢ To save energy use through rationalization of water transmission and distribution system, and to contribute mitigation of Climate Change ➢ To adapt to shortage of potable water and rainfall caused by climate change
2) Programme purpose	➢ To save energy use through rationalization of water transmission and distribution system (mitigation measure) ➢ To increase and stabilize water supply and secure water resources by reducing water losses (adaptation measure)
3) Expected effect	➢ To prepare appropriate distribution network plan and to rationalize distribution network ➢ To replace transmission and distribution pumps in inefficient use of energy ➢ To replace non suitable diameter pipes, fittings and accessories. (valves and meters) ➢ To establish the system to speed up repair of leakage points
4) Effectiveness indicators	➢ Reduction of CO_2 Emissions - reduction of electric power consumption as a result of replacement of pump and maintenance improvement - reduction of electric energy for transmission and distribution of the water equivalent to the reduction in water losses ➢ Water Losses Reduction (NRW Reduction)
5) Contents of the request	➢ Procurement of materials and equipment - Pumps (for the seven pumping stations, head 100-350m, 24 Nos) Pump means the unit includes “pump”, “all fittings on suction and delivery pipes”, ”electrical panel”, “cable” and “power distribution panel for the pump”. - Pipes (Within the water distribution networks: ductile iron pipes, diameter: 150 – 300mm, 14 km) - Water flow meters (for Azraq and Khaw Pumping Stations, 6 sets) - Various types of valve (Within the water distribution networks: gate valves, butterfly valves, non-retaining valves, water flow meters and air valves) 1,175 Nos ➢ Technical Assistance - Though Technical Assistance is not clearly requested in the Application Form, But, the items of preparation of appropriate distribution network plan and rationalization of the distribution network is described as the effect of the Programme.

Table1.2.2 Revised List of Requested Materials and Equipment at the First Field Survey

No.	Area/Station	Mark	Materials	Diameter (inch)	Place	PN(bar)	Unit	Quantity
1	New Azraq Station	GV	Gate Valve	8	Delivery Pipe	40	nos	4
2		GV	Gate Valve	12	Suction Pipe	16	nos	4
3		GV	Gate Valve	24	Pelving Pipe	40	nos	1
4		GV	Gate Valve	24	Pelving Pipe	25	nos	1
5		GV	Gate Valve	24	Suction Pipe	25	nos	1
6		NRV	Non-retaining Valve	8	on each pump delivery pipe	40	nos	4
7		NRV	Non-retaining Valve	24	Delivery Pipe	40	nos	1
8		WM	Water Meter (electronic)	24	on pipe from wells to reservoir	25	nos	1
9		WM	Water Meter (electronic)	24	on pipe from pump station to Khaw	40	nos	1
10	Old Azraq Station	V	Valve	10	Delivery Pipe	40	nos	7
11		V	Valve	12	Suction Pipe	25	nos	7
12		V	Valve	24	Delivery Pipe	40	nos	1
13		V	Valve	24	Suction Pipe	25	nos	1
14		NRV	Non-retaining Valve	10	on each pump delivery pipe	40	nos	7
15		NRV	Non-retaining Valve	24	Delivery Piper	40	nos	1
16	Khaw Station (Amman)	NRV	Non-retaining Valve	8	Delivery Pipe	40	nos	8
17		NRV	Non-retaining Valve	24	Delivery Pipe	40	nos	1
18		WM	Water Meter (electronic)	24	from Azraq pipeline	25	nos	1
19		WM	Water Meter (electronic)	24	to amman pipeline	40	nos	1
20	Khaw Station (Zarqa)	V	Valve	16	Delivery Pipe	40	nos	6
21		V	Valve	16	Suction Pipe	16	nos	6
22		V	Valve	24	Delivery Pipe	40	nos	2
23		NRV	Non-retaining Valve	16		40	nos	3
24		WM	Water Meter (electronic)	28	to Batrawi pipeline	25	nos	1
25		WM	Water Meter (electronic)	16	to Zarka pipeline	40	nos	1
26	Zarqa	P	Pump (Q=400m3/h、H=150m)		Zarqua station (to Zarka network)	15	nos	3
27		P	Pump (Q=200m3/h、H=150m)		Zarqua station (to Zarka network)	15	nos	2
28		P	Pump (Q=500m3/h、H=250m)		Zarqua station (to Rusaifa)	25	nos	3
29		P	Pump (Q=200m3/h、H=250m)		Zarqua station (to Rusaifa)	25	nos	2
30		P	Pump (Q=500m3/h、H=350m)		Azraq Station (to Khaw)	35	nos	2
31		P	Pump (Q=300m3/h、H=350m)		Azraq Station (to Khaw)	35	nos	2
32		P	Pump (Q=500m3/h、H=150m)		Halabat station (to Khaw)	15	nos	1
33		P	Pump (Q=300m3/h、H=150m)		Halabat station (to Halabat area)	15	nos	1
34		P	Pump (Q=100m3/h、H=350m)		Merheb station (to berein area)	35	nos	1
35		P	Pump (Q=200m3/h、H=100m)		Merheb station (to Awajan area)	10	nos	1
36		P	Pump (Q=500m3/h、H=50m)		treatment station (to Zarka PS)	5	nos	1
37		P	Pump (Q=50m3/h、H=350m)		Sokhneh station	35	nos	1
38		P	Pump (Q=500m3/h、H=350m)		Khaw station (to Amman)	35	nos	2
39		P	Pump (Q=300m3/h、H=350m)		Khaw station (to Amman)	35	nos	2

Note: pump includes pump+ all fittings on suction and delivery + electrical panel + cables+power distrubuation panel for the station

No.	Area/Station	Mark	Materials	Diameter (inch)	Place	PN(bar)	Unit	Quantity
40		GV	Gate Valve (with flange)	2	Zarqua network	16	nos	100
41		GV	Gate Valve (with flange)	2	Zarqua network+pump stations	25	nos	100
42		GV	Gate Valve (with stim)	2	Zarqua network+pump stations	40	nos	100
43		GV	Gate Valve	4	Zarqua network	16	nos	100
44		GV	Gate Valve	4	Zarqua network	25	nos	100
45		GV	Gate Valve	4	Zarqua network+pump stations	40	nos	100
46		GV	Gate Valve	6	Zarqua network+pump stations	16	nos	30
47		GV	Gate Valve	6	Zarqua network+pump stations	25	nos	30
48		GV	Gate Valve	6	Zarqua network+pump stations	40	nos	30
49		GV	Gate Valve	8	Zarqua network+pump stations	16	nos	30
50		GV	Gate Valve	8	Zarqua network+pump stations	25	nos	30
51		GV	Gate Valve	8	Zarqua network+pump stations	40	nos	30
52		GV	Gate Valve	12	Zarqua network+pump stations	25	nos	10
53		GV	Gate Valve	12	Zarqua network+pump stations	40	nos	10
54		BV	Butterfly Valve	12	Pump stations (merheb+Basatin+Tamwin+standby	25	nos	10
55		BV	Butterfly Valve	16	Pump stations (Zarqa+ standby)	25	nos	3
56		BV	Butterfly Valve	16	Pump stations (Zarqa (russaifa)+ standby)	40	nos	3
57		GV	Gate Valve	24	Zarqua network+pump stations	40	nos	2
58		BV	Butterfly Valve	24	Pump stations (Zarqa+ standby)	40	nos	2
59		NRV	Non-retaining Valve	4	Pump stations + wells	16	nos	20
60		NRV	Non-retaining Valve	4	Pump stations + wells	25	nos	20
61		NRV	Non-retaining Valve	4	Pump stations	40	nos	20
62		NRV	Non-retaining Valve	6	Pump stations + wells	16	nos	20
63		NRV	Non-retaining Valve	6	Pump stations	25	nos	20
64	**Zarqa**	NRV	Non-retaining Valve	6	Pump stations	40	nos	10
65		NRV	Non-retaining Valve	8	Pump stations + wells	16	nos	20
66		NRV	Non-retaining Valve	8	Pump stations	25	nos	20
67		NRV	Non-retaining Valve	8	Pump stations	40	nos	10
68		NRV	Non-retaining Valve	12	Pump stations (merheb+Basatin+Tamwin+standby)	25	nos	8
69		NRV	Non-retaining Valve	12	Pump stations (Zarqa+ standby)	40	nos	3
70		NRV	Non-retaining Valve	16	Pump stations (Zarqa+ standby)	25	nos	3
71		NRV	Non-retaining Valve	16	Pump stations (Zarqa (russaifa))	40	nos	3
72		NRV	Non-retaining Valve	24	Pump stations (Zarqa+ standby)	40	nos	2
73		WM	Water Meter	4	Wells	16	nos	20
74		WM	Water Meter	4	Pump stations	25	nos	10
75		WM	Water Meter	6	Wells	16	nos	25
76		WM	Water Meter	6	Pump stations	25	nos	20
77		WM	Water Meter	8	Wells	16	nos	20
78		WM	Water Meter	8	Pump stations	25	nos	10
79		WM	Water Meter	8	Pump stations	40	nos	10
80		WM	Water Meter (electronic)	12	Pump stations + line (merheb+Basatin+Tamwin+standby)	40	nos	5
81		WM	Water Meter (electronic)	16	Pump stations (Zarqa+ standby)	40	nos	4
82		WM	Water Meter (electronic)	24	Pump stations (Zarqa+ standby)	40	nos	2
83		AV	Air release valve	2	Zarqua network + Wells	25	nos	20
84		AV	Air release valve	4	Zarqua network + main lines	25	nos	20
85		AV	Air release valve	4	Zarqua network + main lines	40	nos	10
86		DIP	Ductile iron pipes	300mm	Zarqua network		meter	6000
87		DIP	Ductile iron pipes	200mm	Zarqua network		meter	6000
88		DIP	Ductile iron pipes	150mm	Zarqua network		meter	2000

1.2.2 Abstraction of the Requested Items for the Programme

The items in the revised list of materials and equipment requested for procurement submitted by the Jordanian side at the First Field Survey can be classified into six categories in accordance with use. With the aim of achieving the programme purposes and obtaining the expected effects, their relevance as materials and equipment for procurement and the priority of the materials and equipment were examined. Discussions were held with WAJ on the outcome of the examination at the beginning of the Second Field Survey. The Table 1.2.3 and Table 1.2.4 show the outcome of the discussions.

It was decided that, of the requested materials and equipment, those classified into Categories 1 to 4 would be provided in this Programme. This list is attached to the Minutes of Discussions signed on June 18, 2009). The materials and equipment in the list are classified into Categories 1 to 4 as proposed by the Japanese side and priorities 1 to 7. During the Second Field Survey, a survey was carried out of the materials and equipment included in this list.

Table 1.2.3 Classification of the Requested Components into Categories

Category	Use	Site	Materials/Equipment	Priority	Remarks
1	Water transmission from major well water sources	Azraq PS	Pumps for water transmission to reservoir at Khaw PS	1	
		Hallabat PS	Pumps for water transmission to reservoir at Khaw PS	2	
2	Water transmission to Batrawi Reservoir	Zarqa PS	Pumps for water transmission to Batrawi Reservoir	3	
		Between Zarqa PS. and Batrawi Reservoir	Change in the route of the existing transmission pipelines (φ400mm × 2) and installation of pipes (φ 600 mm, approx. 2 km)	3	Not included in the request list (Proposal)
		New Khaw PS	Valves for the pumps and water flow meters for water transmission	4	
		Zarqa R/O Plant	Pumps for water transmission to Zarqa Reservoir	5	GTZ survey
3	Water transmission to Awajan and Rusaifa Reservoirs	Old Khaw PS	Pumps for water transmission to Amman	Excluded	GTZ project adopted
		Merheb PS	Pumps for water transmission and distribution to Berein and Awajan Districts	6	
4	Materials for the water transmission and distribution networks in Zarqa District	Various locations in distribution zone	Water flow meters, gate valves and air valves for improvement of the water transmission and distribution network	7	
5	Water transmission and distribution to suburbs in Zarqa District	Sukhneh Distribution PS	Pumps for water distribution	Excluded	
6	Pumps, water flow meters and valves for distribution pumping stations and wells in Zarqa District	1) New Zarqa PS	Pumps not for water transmission to Batrawi Reservoir (for water distribution)	Excluded	
		2) Distribution network	Ductile Cast Iron distribution pipes	Excluded	KfW project adopted
		3) Distribution network	Water flow meters and valves for distribution pumping stations	Excluded	
		4) Wells	Water flow meters, non-retaining valves and air valves	Excluded	MCC project

PS: Pumping Station

Table 1.2.4 List of Request Agreed at the Beginning of the Second Field Survey

Category	Mark	Materials	Diameter (inch)	Location	PN(bar)	Unit	Quantity	Priority
1	P	Pump (Q=500m3/h、H=350m)	-	Azraq PS (to Khaw PS)	35	nos	2	1
	P	Pump (Q=300m3/h、H=350m)	-	Azraq PS (to Khaw PS)	35	nos	2	
	WM	Water Meter (Ultrasonic)	24	Azraq PS: Inlet pipeline from wells to reservoir	-	nos	1	
	WM	Water Meter (Ultrasonic)	24	Azraq PS: Outlet pipeline to Khaw PS	-	nos	1	
	WM	Water Meter (Ultrasonic)	24	Khaw Reservoir : Inlet pipeline from Azraq PS	-	nos	1	
	P	Pump (Q=500m3/h、H=150m)		Halabat station (to Khaw)	15	nos	1	2
	WM	Water Meter (Ultrasonic)	24	Hallabat PS: Inlet pipeline from wells to reservoir	-	nos	1	
	WM	Water Meter (Ultrasonic)	24	Hallabat PS: Outlet pipeline to Khaw PS	-	nos	1	
	WM	Water Meter (Ultrasonic)	24	Khaw Reservoir : Inlet pipeline from Hallabat PS	-	nos	1	
2	P	Pump (Q=400m3/h、H=100m)	-	Zarqa PS to Batrawi Reservoir	16	nos	3	3
	DIP	Ductile iron pipes	600mm	Transmission from Zarqa PS to Batrawi Reservoir	-	m	-	
	WM	Water Meter (Ultrasonic)	-	Zarqa PS: Outlet pipeline to Batrawi	-	nos	1	
	V	Valve	16	New Khaw PS: Delivery Pipeline	16	nos	6	4
	V	Valve	16	New Khaw PS: Suction Pipeline	16	nos	6	
	V	Valve	24	New Khaw PS: Delivery Pipeline	16	nos	2	
	NRV	Non-retaining Valve	16	New Khaw PS	16	nos	3	
	WM	Water Meter (electronic)	28	New Khaw PS: Outlet pipeline to Batrawi Reservoir	-	nos	1	
	WM	Water Meter (electronic)	16	New Khaw PS: Outlet pipeline to Zarqa PS	-	nos	1	
	DIP	Ductile iron pipes	Variable	New Khaw PS: Inside Connection Pipes	-	m	-	
	P	Pump (Q=500m3/h、H=50m)	-	Zarqa Treatment Plant: Outlet pipeline to Zarqa Reservoir	5	nos	1	5
3	P	Pump (Q=100m3/h、H=350m)	-	Merheb PS: To Berein Reservoir	35	nos	1	6
	P	Pump (Q=200m3/h、H=100m)	-	Merheb PS: To Awajan Reservoir	10	nos	1	
	WM	Water Meter (Turbin)	6	Merheb PS: Outlet pipeline to Berein	40	nos	1	
	WM	Water Meter (Turbin)	6	Merheb PS: Outlet pipeline to Awajan	10	nos	1	
4	GV	Gate Valve	2	Zarqa network	16	nos	100	7
	GV	Gate Valve	2	Zarqa network	25	nos	100	
	GV	Gate Valve	4	Zarqa network	16	nos	100	
	GV	Gate Valve	4	Zarqa network	25	nos	100	
	GV	Gate Valve	6	Zarqa network	16	nos	30	
	GV	Gate Valve	6	Zarqa network	25	nos	30	
	GV	Gate Valve	8	Zarqa network	16	nos	30	
	GV	Gate Valve	8	Zarqa network	25	nos	30	
	GV	Gate Valve	12	Zarqa network	16	nos	10	
	GV	Gate Valve	12	Zarqa network	25	nos	10	
	GV	Gate Valve	16	Zarqa network	16	nos	3	
	GV	Gate Valve	24	Zarqa network	25	nos	2	
	WM	Water Meter (Ultrasonic)	16	Transmission Line to Russeifa	-	nos	1	
	WM	Water Meter (Ultrasonic)	24	Khaw-Amman Pipiline: Awajan Junction	-	nos	1	
	AV	Air release valve	2	Zarqa network	25	nos	20	
	AV	Air release valve	4	Zarqa network	25	nos	20	

Note: The specification and quantity of the equipment and materials are subject to be modified by the study.

Category 1. Water transmission from major well water sources

1) Water transmission pumps in Azraq Pumping Station

The station concerned is a pumping station to transmit water lifted from Azraq well field with the highest yields of water resources in Zarqa Governorate, mainly to Khaw Pumping Station. Because of the importance of replacing the superannuated pumping facilities in the station to enhance the reliability and stability of water transmission, procurement of these pumps is of high priority. MCC is conducting a survey for a project to repair the well facilities at Azraq Wells. Cooperation between the two projects is expected to be mutually beneficial.

2) Water transmission pumps in Hallabat Pumping Station

The station concerned is a Pumping Station to transmit water lifted from Hallabat well field, mainly to Khaw Pumping Station. Because of the importance of replacing the superannuated pumping facilities in the station to enhance the reliability and stability of water transmission, procurement of these pumps is of high priority.

Category 2. Water transmission to Batrawi Reservoir

1) Water transmission pumps in Zarqa Pumping Station (for transmission to Batrawi Reservoir)

At Batrawi Reservoir, a new reservoir is being constructed with Japanese assistance, adjacent to the existing reservoir (4,000m^3). Completion of the construction of this reservoir will enable gravity-flow distribution to the Zarqa low-elevation distribution area, which is located in the center of Zarqa City. Since it will also serve as a reservoir for water to be pumped to Zarqa High Reservoir, it will be an important reservoir in the distribution system of Zarqa District as a whole. Water is transmitted to Batrawi Reservoir through two lines, one from Khaw Pumping Station and the other from Zarqa Pumping Station. The pumps in Zarqa Pumping Station are heavily superannuated. The procurement of new pumps for Zarqa Pumping Station for of water transmission to Batrawi Reservoir is of high priority because the pumps are needed to provide greater stability and reliability of the Programme effect of the grant aid project implemented by the Japanese side.

2) A new transmission pipeline between Zarqa Pumping Station and Batrawi Reservoir (φ600mm, approx. 2km)

Two pipelines with φ400mm ductile pipes are used for transmission from Zarqa Pumping Station to Batrawi Reservoir. These pipelines are also used as pipelines for direct distribution by pump. The route of the pipelines is not the shortest. It is an inefficient route, which passes through the city area. It is expected that the development of a new transmission pipeline, combined with the replacement of the pumping facilities for water transmission to Batrawi in Zarqa Pumping Station, will enable more reliable and efficient water transmission to Batrawi Reservoir.

3) Valves and water flow meters for the pumps in Khaw Pumping Station for transmission to Zarqa

Water Distribution Zone

In the water transmission line to Zarqa Water Distribution Zone, water is pumped to Batrawi and Hashmeyah Reservoirs. Because the water transmitted from New Khaw Pumping Station is the main water resource in Zarqa District, the improvement of this pumping station is of high priority.

4) Water transmission pumps in Zarqa Reverse Osmosis (R/O) Plant

Water from Zarqa Wells is transmitted to Batrawi Reservoir after being desalinated in Zarqa R/O Plant and mixed with water transmitted from Hashmeyah Wells and Khaw Pumping Station in Zarqa Reservoir. Replacement of the transmission pumps in the treatment station will enhance the efficiency of water transmission. GTZ was under conducting the study of IEE Project on Zarqa R/O Plant. The Plant will be excluded from the assistance list, in case German Government decides to provide assistance for it.

Category 3. Water transmission to Awajan and Rusaifa Reservoirs

1) Pumps in New Khaw Pumping Station to transmit water to Amman

Because of decision by German Government to assist new Khaw Pumping Station based on the result of IEE Project made by GTZ, New Khaw Pumping Station was excluded from the request list.

2) Pumps in Merheb Pumping Station

This station transmits water from six wells in the Merheb well field to Berein District in western Zarqa. On some days, the station transmits water to Awajan High Reservoir, which was constructed by the Japanese side.

Category 4: Materials for the water transmission and distribution networks in Zarqa Governorate

The procurement of water meters, gate valves (for approximately 530 locations) and air valves (for approximately 30 locations) is requested. Of these, clear indication of where they are to be used is given for only two water meters and 14 gate valves. Where the rest are to be used is not indicated, and they are considered to be spare materials for the improvement of the water distribution networks. Their place of installation is considered to be throughout the entire Zarqa Governorate. If the equipment and materials are to be used in such a way, they will be installed in scattered locations. This kind of use carries with it the risk of the effect of the Programme being diluted.

As three years is considered an appropriate period in which to complete installation of the equipment and materials, if such equipment and materials are to be procured, where they are to be installed, their use and quantities will have to be clearly stated.

Category 5: Water transmission and distribution to suburbs in Zarqa District

WAJ plans to abolish the existing Sukhneh distribution pumps and construct a new pumping station in

the grounds of the newly constructed Sukhneh Reservoir, and has requested the procurement of pumping facilities for this new station. Because of transmission to the outlying areas of Zarqa District, procurement of the equipment for this pumping station has low priority

Category 6: Pumps, water flow meters and valves for distribution pumping stations and wells in Zarqa District

1) Pumps in Zarqa Pumping Station (to other than Batrawi Reservoir)

Zarqa Pumping Station transmits and distributes water to the following destinations:

- Transmission to Batrawi Reservoir
- Distribution to the water distribution networks in central, western, northern and eastern Zarqa Water Distribution Zone
- Transmission to Basatin Reservoir in Rusaifa District and distribution to the water distribution networks on the way

Basatin Reservoir is located in the grounds of Basatin Pumping Station. It lifts water from the wells in nearby well field and pumps water to the water distribution networks in Rusaifa City. Water is also pumped to Rusaifa High Reservoir and Hutten Reservoir. In the plan so far set out by the Japanese side, the areas in which water is currently distributed directly from Zarqa Pumping Station are within the areas of the gravity-flow service from the reservoirs constructed by the Japanese side, with the exception of Eastern Zarqa Water Distribution Zone (a newly developed area). If it becomes possible to transmit water from Khaw and Zarqa Pumping Stations to Batrawi Reservoir and from the transmission pipeline between Khaw Pumping Station and Amman to Awajan and Rusaifa Reservoirs, as described in the original proposal, there will no longer be any need for Zarqa Pumping Station to pump water directly to Zarqa Water Distribution Zone. For these reasons, pumps that will not be used for transmitting water from Zarqa Pumping Station to Batrawi Reservoir are of low priority.

2) Ductile cast iron pipes (in distribution lines)

The pipes requested for water distribution (ductile pipes) are classified as follows.

a. Improvement of the distribution networks in Central Zarqa Water Distribution Zone (replacement and installation)
   The pipes are to be used within the pilot area of the NRW reduction project planned by KfW.

b. A new pipeline for distribution in Western Zarqa Water Distribution Zone
   The area in question is within the water distribution area from Awajan Low Reservoir, which was constructed by the Japanese side. Because of the shortage of discharge to the reservoir, direct distribution from Zarqa Pumping Station is required.

c. Replacement of the existing pipelines in Northern Zarqa Water Distribution Zone
   The area in question is within the water distribution area from Batrawi Reservoir, which is being constructed by the Japanese side. Because of frequent leakage from the existing

pipeline, replacement of the superannuated pipeline is requested.

Procurement for a. in this Programme is unadvisable because KfW has already begun its project. Use of b. will be temporary, until the use of the reservoir begins as intended. Therefore, there is no guarantee of continuous use in the future. Installation of the pipeline may inadvertently support continued pumping from Zarqa Pumping Station instead of the transfer to gravity-flow transmission from the reservoirs.

If water is available for direct pumping at Zarqa Station, the priority should be for water transmission to Awajan Reservoir via the water transmission pipeline from Khaw Pumping Station to Amman.

Procurement for c. is not advisable in this Programme, either. Improvement of the distribution pipelines should be considered after Batrawi Reservoir has been put into appropriate use. None of the above-mentioned a. - c. is of high priority for procurement in this Programme. For these reasons, procurement of the materials concerned is not advisable in this Programme.

3) Water flow meters, butterfly valves, gate valves and non-retaining valves for distribution Pumping Stations

At present, direct distribution to the distribution networks is performed by the Zarqa Pumping Station, Basatin Pumping Station, Sukhneh Pumping Station, Tamwin Pumping Station, Merheb Pumping Station and other stations (in Sarout, Qunayya, Al-Alouk, Tafeh and Un-Rumana in outlying areas). Zarqa, Sukhneh and Merheb Pumping Stations are listed in the request. The pumps at Basatin and Tamwin Pumping Stations will be used for direct distribution by pump and those in the other stations are for water distribution in outlying areas. Therefore, their procurement in this Programme is of low priority.

4) Water flow meters, non-retaining valves and air valves in wells

The EC has a plan to repair Awajan Wells, and the MCC is implementing a survey for the repair of 99 wells in Zarqa Governorate. As procurement of equipment in this Programme will have to be consistent with these plans, it is advisable that equipment and materials relevant to wells not be procured in this Programme.

1.3 Assistance Activities of Donors

(1) Japan

Based on the recommendations in the master plan which was formulated in the development study, “Study on the Improvement of the Water Supply System for the Zarqa District”, which was implemented in 1994-1996, the Government of Japan has been implementing the grant aid project, “Project for Improvement of the Water Supply System for the Zarqa District”, in two phases, to support the reconstruction of the water supply system by installation of water distinct distribution zones aimed at equalization of the supply water pressure and reduction in water loss in the water distribution zones. As a result of this assistance for improvement of water transmission pipelines, reservoirs and main water distribution networks, modification of the main water supply facilities will be completed with a change from direct distribution by pump to the gravity flow from the service reservoirs at the core.

(2) German Technical Cooperation (GTZ)

GTZ is implementing the Improving Energy Efficiency (IEE) Project at 11 pumping stations in three governorates in Central Jordan, Zarqa, Balqa and Madaba Governorates. In Zarqa Governorate, a survey was conducted at four pumping stations on water transmission (Azraq, Hallabat and Old Khaw Pumping Stations and Zarqa Reverse Osmosis Plant) to diagnose the pumping system at each station and to evaluate the possibility of improving the energy efficiency of the system and the cost saving expected from such efficiency improvement. Based on the results of the survey, GTZ decided that replacement of the facilities and equipment and their operation and maintenance were to be carried out in cooperation with private actors and selected two stations, Old Khaw Pumping Station and Zarqa Reverse Osmosis Plant, as the project sites for the German assistance project.

(3) German Development Bank (KfW)

KfW started the project for water management in the middle governorates including Zarqa and Madaba Governorates in Central Jordan in November 2008 for a planned period of two years. In Zarqa Governorate, the project has established a pilot area in the central part of Zarqa District and is providing assistance for non-revenue water reduction including reconstruction of the water distribution networks, repair and replacement of water meters and replacement of the connecting pipes to the water supply taps. KfW will conduct a comprehensive survey on customer research, customer management and water fee collection systems in order to reduce management losses.

(4) Millennium Challenge Corporation (MCC)

As an assistance project in the water supply sector in Zarqa Governorate, MCC is implementing a project to reduce non-revenue water by reconstructing and repairing the water supply system. In practice, the project consists of a project to repair the wells owned by WAJ (P1-A) and reconstruct/repair the water distribution networks (P1-B). In P1-A, a survey will be conducted on

repair of the 99 wells (pumps and associated equipment) owned by WAJ. In P1-B, preparation of a master plan and implementation of an improvement project aimed at gravity-flow water distribution in the entire Zarqa Governorate are planned.

(5) European Community (EC)

The EC provides assistance in the water supply sector in areas with concentrations of Iraqi refugees, with the particular aim of reducing water losses in water distribution networks. The project area is located in the central area in Zarqa Water Distribution Zone. In Awajan District, the project will improve well facilities and associated facilities. In order to improve the water distribution networks in Gwaireyeh District, reconstruction/repair of the water distribution networks, repair of the connecting pipes to the water supply taps, replacement of water meters and installation of water meter boxes will be implemented in the gravity-flow water distribution zones receiving water from Batrawi Reservoir.

(6) China

The Government of China provides grant aid assistance for a project in the water distribution zones in low Rusaifa area. The main component of the project is replacement of highly superannuated iron pipes and cast iron pipes and the aim of the project is reduction in water losses.

(7) Jordan

The Government of Jordan is implementing a project for improvement of the water distribution networks with the national budget through the “National Poverty Reduction Programme.” The project areas in Hashemeyeh and Sukhneh Cities are located within the Programme areas of the grant aid project of Japan, which is the target area of this survey.

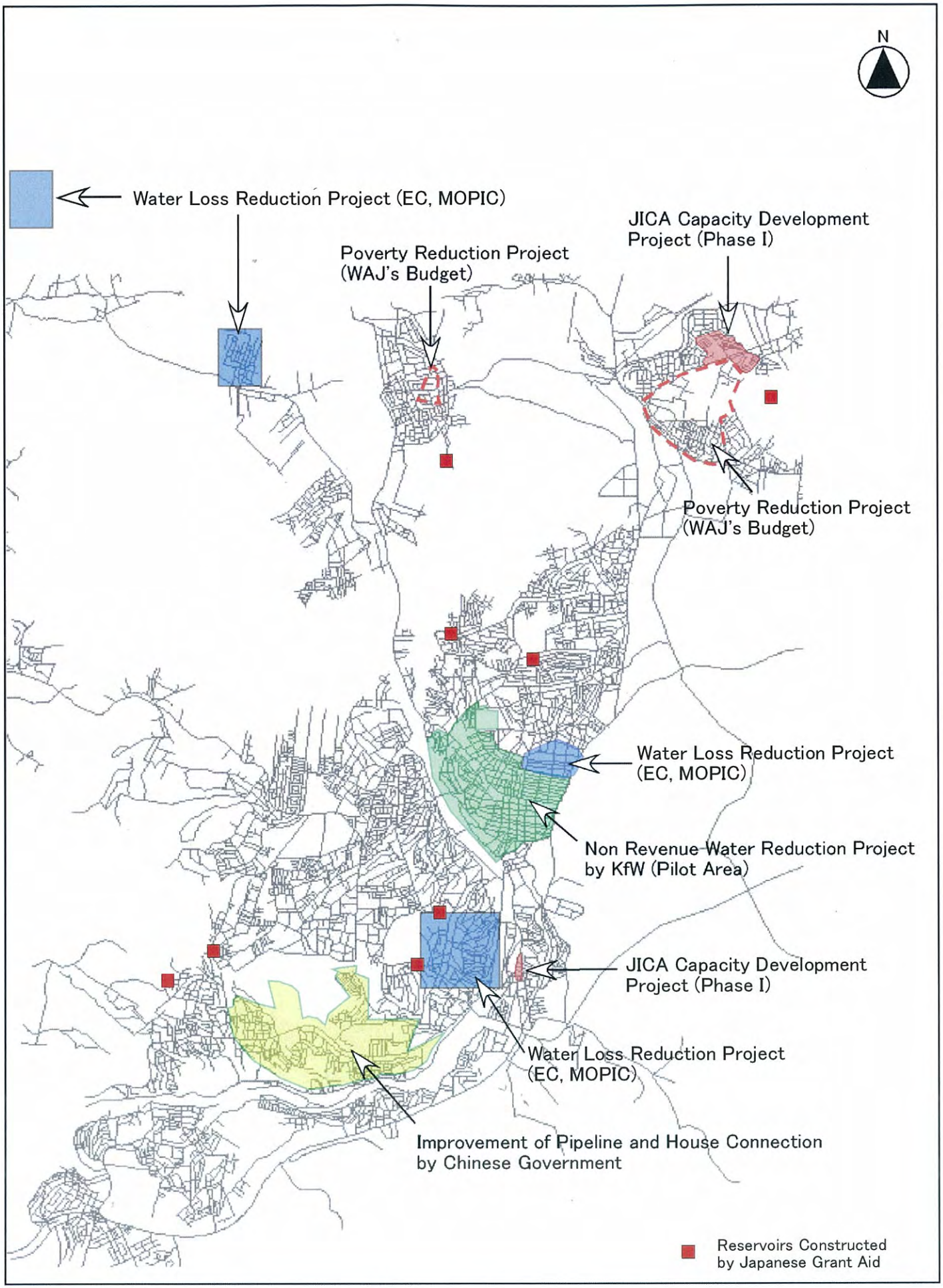


Figure 1.3.1 Sites of the Assistance Projects Implemented by Donors

1.4 Current Situations in the Water Transmission and Distribution Systems

1.4.1 Water Sources and Water Balance

(1) Water sources

All of the many water resources in Zarqa Governorate are wells. Of the major fields of wells, Azraq, Hallabat and Corridor are located in the desert east of Zarqa District. These three fields supply approximately 62% of the water used in Zarqa District. The four fields of wells in and around the city, Zarqa, Hashmeyah, Rusaifa and Awajan, supply approximately 33% of the water used in Zarqa District. In addition, the District receives water from wells in Mafraq Governorate and privately-owned wells. However, not all the water mentioned above can be used in Zarqa Governorate because WAJ distributes water, which is a scarce resource throughout Jordan, fairly among the governorates nationwide via its water supply service. Table 1.4.1 shows an overview of water distribution to and from Zarqa Governorate. Figure 1.4.1 shows the changes in the water balance in Zarqa Governorate over the past five years.

Table 1.4.1 Water Allocation in Zarqa Governorate (Unit: m^3)

Desctiption	Year 2007	Year 2008	Note
1. Internal water resource in ZarqGovernorate	49,259,657	50,408,381	
2. Imported water from other governorate	6,053,200	3,677,248	
From Mafraq	4,217,057	2,248,230	
From Private Wells	1,836,143	1,429,018	Summer Season Only(Jun-Nov)
3. Exported water to other governorates	10,682,525	9,249,120	
To Amman	8,331,868	7,047,988	
To Jerash	195,194	213,000	
To Balqa	65,823	59,027	
To Mafraq	77,900	124,350	
For Animal/Sheep	154,334	146,035	
To Azraq Wetlands	1,027,540	727,207	
Salty Water of R/O Plant of Zarqa	829,866	931,513	
Available water for Zarqa District	44,630,332	44,836,509	1+2-3
Average Daily Supply	122,275	122,840	

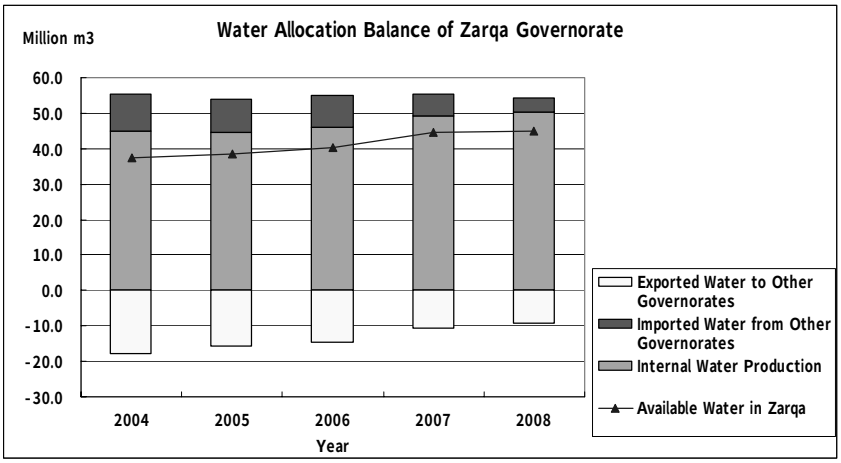


Figure 1.4.1 Water Allocation Balance in Zarqa Governorate

Records for the year 2008 show that the water resources in Zarqa Governorate yielded approxi. 50.4 million m^3/year of water, and that approxi. 3.6 million m^3/year of water was distributed from water resources in other governorates (influx). Because approxi. 9.2 million m^3/year of water was used for distribution to other governorates (efflux) and irrigation, approxi. 44.8 million m^3/year of water was available in the governorate.

Water transmission to the metropolitan Amman Area accounts for the largest proportion of distribution to other governorates. As a drastic increase in demand for water in Amman, caused by population growth, has increased demand for water resources, water resources for the city are being sought in other governorates. The water transmitted from Zarqa Governorate is one such water resource and it accounts for approxi. 7 million m^3/year.

Because of remarkable influx of population to Zarqa Governorate, water requirement of Zarqa Governorate has upword trend recently. Therefore, well yield has been increaseing with new wells development. On the other hand, the amount of transmission to Amman has been decreasing to 8.3 million m^3/year at 2008, 7.0 million m^3/year at 2009, respectively, from 16.4 million m^3/year at 2004. It is inferred that big factor of this trend was caused the completion of the Project of “the Mujib Zara, and Ma’en Water Desalination and Conveyance project in Balqa Governorate” with the aim of increasing the water supply amount to the Amman area.

At the time of basic design study on the “ Project for Improvement of the Water Supply System for the Zarqa District (Phase II)” implemented in 2004, the “Disi Water Conveyance Project” was planed for the water resource development project to the Amman area. This project is expected to be completed by 2015 and to enable surplus water born by the implementation of the project to transmit from Amman to the Zarqa District.

Table 1.4.2 and Table 1.4.3 shows “well yield in Zarqa Governorete” and “available water source for Zarqa Governorat”, respectively. Water allocation system in Zarqa Governorate is as shown in Figure 1.4.2.

Table 1.4.2 Well Yield in Zarqa Governorate

Unit: m^3/year

No.	Name of well/spring	2002	2003	2004	2005	2006	2007	2008
1	Al Azraq Wells	15,344,983	17,177,737	16,711,424	15,794,049	16,372,118	16,676,067	16,973,137
2	Qnayyah Spring	384,454	385,165	322,556	319,160	326,330	302,616	523,932
3	Sarout Spring	67,931	71,947	66,146	64,700	64,670	58,810	56,301
4	Al-Alouk Spring	36,913	54,164	47,833	41,177	39,500	39,729	33,617
5	Zarqa Well & Desalination ST	4,024,300	4,910,860	3,991,430	4,395,620	4,431,390	5,079,236	4,488,601
6	Hashemeyeh Wells	2,580,900	3,065,300	3,057,330	3,158,890	3,193,800	2,870,832	3,431,825
7	Awajan Wells	1,604,910	2,594,872	3,108,228	3,159,585	2,899,540	2,402,972	2,122,710
8	Ruseifa Wells	1,454,154	2,042,112	3,656,409	4,543,587	4,420,267	4,763,585	4,098,494
9	Hitteen Well	53,076	10,667	4,853	4,498	0	0	0
10	Marheb Wells	1,080,811	996,029	1,026,510	985,390	1,020,430	1,104,580	766,263
11	Hallabat Wells	3,761,500	2,962,180	2,641,480	2,288,350	1,777,935	3,992,525	6,241,567
12	Beerain Wells	291,927	402,776	432,163	424,280	566,783	619,497	755,821
13	Tamween Wells	1,045,581	992,779	886,883	1,152,050	2,394,000	2,710,834	2,488,068
14	Corridor Wells	9,459,600	9,392,588	8,829,664	8,083,707	8,617,806	8,458,516	8,261,617
15	Um-Rumana Well (2)	36,128	0	58,772	34,577	27,010	25,524	20,393
16	Desert Wells	0	0	0	0	0	154,334	146,035
Total		41,227,168	45,059,176	44,841,681	44,449,620	46,151,579	49,259,657	50,408,381

Table 1.4.3 Available Water Source for Zarqa Governorate

Year: 2008

単位:m^3

No.	Name of well/spring	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1	Al Azraq Wells	1,471,408	1,340,528	1,445,516	1,400,536	1,483,668	1,392,827	1,389,132	1,410,121	1,384,170	1,424,623	1,396,949	1,433,659	16,973,137
2	Qnayyah Spring	19,539	19,486	20,464	17,634	30,200	54,408	58,679	56,007	54,551	59,777	66,511	66,676	523,932
3	Sarout Spring	3,959	4,251	4,450	4,217	5,855	5,499	4,740	4,793	4,614	4,771	4,541	4,611	56,301
4	Al-Alouk Spring	2,500	2,498	2,205	2,199	4,037	3,174	3,002	2,752	2,999	3,236	2,564	2,451	33,617
5	Zarqa Wells	332,393	299,713	327,911	332,459	358,007	380,077	432,930	434,306	434,525	434,941	312,395	408,944	4,488,601
6	Hashemeyeh Wells	268,605	283,687	277,093	302,703	305,606	282,953	287,737	288,424	287,408	289,060	280,237	278,312	3,431,825
7	Awajan Wells	133,001	197,097	185,531	211,183	181,367	196,223	137,021	138,937	175,755	178,090	184,917	203,588	2,122,710
8	Ruseifa Wells	370,300	262,533	351,236	411,810	438,913	405,051	360,749	318,980	323,815	306,250	281,011	267,846	4,098,494
9	Hitteen Well	0	0	0	0	0	0	0	0	0	0	0	0	0
10	Merheb Wells	78,621	72,138	58,376	53,496	58,970	55,299	57,868	61,829	90,084	58,341	78,473	42,768	766,263
11	Al-Hallabat Wells	333,360	501,866	569,229	517,092	571,167	586,912	541,526	532,456	531,538	515,812	508,434	532,175	6,241,567
12	Beerain Wells	48,902	48,650	66,924	61,114	72,399	70,381	62,996	62,891	63,095	64,297	66,607	67,565	755,821
13	Tamween Wells	255,554	252,161	228,947	236,116	218,015	222,460	184,713	181,359	182,483	184,176	160,234	181,850	2,488,068
14	Corridor Wells	686,160	672,009	740,048	716,400	716,657	687,663	698,982	699,500	670,248	687,978	656,611	629,361	8,261,617
15	Um-Rumana Well (2)	53	4,659	3,277	2,710	2,404	2,399	2,427	2,429	35	0	0	0	20,393
16	Desart Wells	12,541	5,877	8,019	19,355	19,463	14,856	12,161	13,917	11,427	10,543	6,889	10,987	146,035
	Internal Water Source (Total)	4,149,897	4,164,250	4,474,757	4,500,207	4,648,095	4,556,405	4,234,663	4,208,701	4,216,747	4,221,895	4,006,373	4,130,793	50,408,381

※The above mentioned wells do not include the wells of Mafraq Governorate (Zatari Pumping Station).

Water Alocation Record (m^3)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	合計
① Internal Water Source in Zarqa Governa	4,149,897	4,164,250	4,474,757	4,500,207	4,648,095	4,556,405	4,234,663	4,208,701	4,216,747	4,221,895	4,006,373	4,130,793	50,408,381
② Imported Water	159,330	197,200	205,670	182,330	177,000	454,188	370,651	453,359	451,867	486,073	301,480	238,100	3,677,248
Import from Amman	0	0	0	0	0	0	0	0	0	0	0	0	0
From Khaw/Za'tari/Khaldieh Source	159,330	197,200	205,670	182,330	177,000	171,600	121,200	218,200	187,100	189,400	201,100	238,100	2,248,230
From Dhalil/Khaldieh Source	0	0	0	0	0	0	0	0	0	0	0	0	0
From Merae Zahram (Private Wells)	0	0	0	0	0	112,735	101,494	110,100	113,976	124,540	44,543	0	607,388
From Abu Hwedi (Private Wells)	0	0	0	0	0	104,088	87,832	72,739	93,091	108,376	41,274	0	507,400
From Harzalieh (Private Wells)	0	0	0	0	0	65,765	60,125	52,320	57,700	63,757	14,563	0	314,230
③ Exported Water	782,328	806,416	871,657	896,231	909,726	787,606	767,503	646,927	662,639	732,292	659,912	725,883	9,249,120
To Amman	590,382	633,854	678,622	733,398	732,897	620,256	586,059	469,296	481,697	512,178	504,967	504,382	7,047,988
To Jerash from Um Rumana	18,000	18,000	18,000	15,000	18,000	18,000	18,000	18,000	18,000	18,000	18,000	18,000	213,000
To Balqa from Um Rumana	6,482	7,354	10,155	3,059	6,669	6,227	4,273	3,836	2,000	2,000	4,551	2,421	59,027
To Mafraq from Ain Al Qinayyeh	5,710	5,490	5,190	5,670	6,420	11,120	11,480	12,300	14,660	13,920	13,940	18,450	124,350
To Animal Consume (Sheep)	12,541	5,877	8,019	19,355	19,463	14,856	12,161	13,917	11,427	10,543	6,889	10,987	146,035
To Azraq Reservation Area (Irrigation)	95,250	85,308	87,580	59,040	62,990	44,200	54,710	45,760	26,040	45,590	62,560	58,179	727,207
Treatment Plant Zarqa (RO)	53,963	50,533	64,091	60,709	63,287	72,947	80,820	83,818	108,815	130,061	49,005	113,464	931,513
Available Water Source ①+②-③	3,526,899	3,555,034	3,808,770	3,786,306	3,915,369	4,222,987	3,837,811	4,015,133	4,005,975	3,975,676	3,647,941	3,643,010	44,836,509
Average Daily Supply	113,771	122,587	122,864	126,210	126,302	140,766	123,800	129,520	133,533	128,248	121,598	117,516	122,840
Monthly Fluctuation	0.93	1.00	1.00	1.03	1.03	1.15	1.01	1.05	1.09	1.04	0.99	0.96	

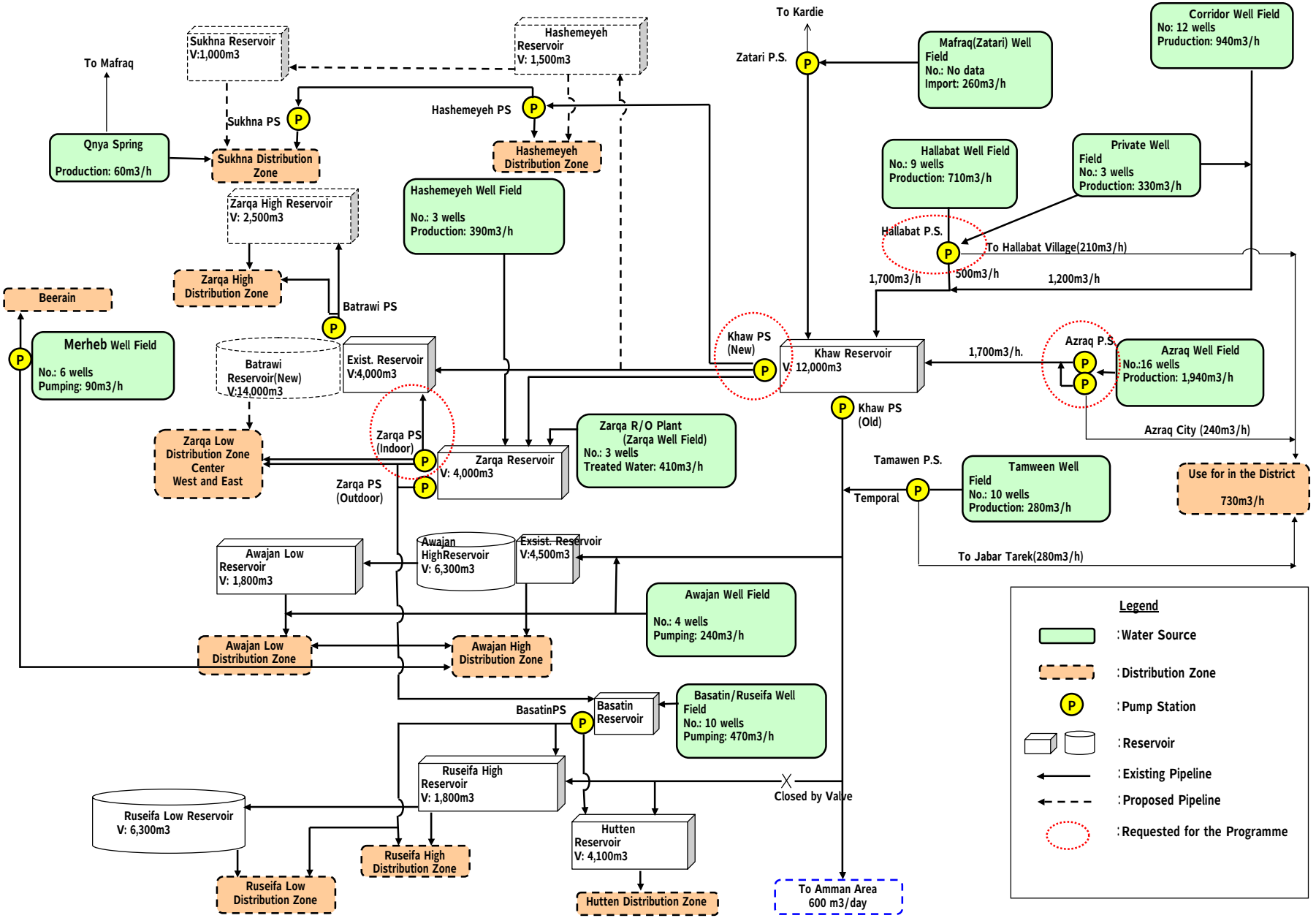


Figure 1.4.2 Water Allocation System in Zarqa Governorate

(2) State of Water Balance in Zarqa District

1) Water sources transmitted by Khaw Pumping Station

In Zarqa Governorate, the grant aid cooperation project, "The Project for Improvement of the Water Supply System for the Zarqa District (1st phase, 2nd phase)," has been implemented in two phases. During the implementation of the project, the future design water supply was estimated from the population projection deduced from the census data. In the water balance plan for 2010 assumed during the second phase of the grant aid project (as of 2006), the amount of water from water sources outside Zarqa District (eastern groundwater sources) was set at 120,190 m^3/day (5,008 m^3/h) and it was assumed possible to transmit 104,567 m^3/day (4,357 m^3/h) to Khaw Pumping Station after setting aside the supply to the villages near the water sources.

As of 2009, the amount of water from Zatari Well Field in Mafraq Governorate and Hallabat Well Field is significantly lower than the amount assumed in the plan and, despite the increase in supply from privately owned wells, the water supply from sources outside Zarqa District is only 99,953 m^3/day. Therefore, as of 2009, the amount of water influx at Khaw Pumping Station is 89,325 m^3/day (3,722 m^3/h). Since at least 12,000 m^3/day of water has to be set aside for transmission to Amman, the amount of water allocated to Zarqa District is 77,325 m^3/day (3,222 m^3/h).

Table1.4.4 Water Sources Transmitted by Khaw Pumping Station (Unit: m^3/day)

Items	Scenario of Water Allocation in Second Phase Grant Aid Project (year 2010)	Present Status of Water Allocation (year 2009)	Note
Water Sources outside of Zarqa Water Distribution Zone ①	120,190	99,953	
Azraq Well Field	45,785	46,375	
Hallabat Well Field	21,548	17,053	
Corodor Well Field	24,191	22,572	
Zatari Well Field	28,666	6,143	
Private Wells	-	7,810	
Water Consumption for the Villages in Water Source Area ②	15,623	10,628	
Azraq Village	15,623	5,575	-
Hallabat Village		5,053	
Incoming Discharge to Khaw Pumping Station (①-②)	104,567	89,325	
Allocation for Amman	17,102	12,000	
Allocation for Zarqa District	87,465	77,325	-11.6%

2) Water source available for Zarqa District

In addition to the water from eastern groundwater sources transmitted by Khaw Pumping Station shown in Table 1.4.5, water from sources within the district, such as sources in Zarqa and Hashemeyeh, is available for the water supply to Zarqa District. Table 1.4.6 shows the balance of water transmission

and distribution as of 2010 as assumed during the second phase of the grant aid cooperation project. The water from Tamawin Wells is not included in the calculation of the water resource volume in 2009 because it is not supplied to the water distribution zones in the original plan.

As of 2009, the water resource volume available to Zarqa District is 113,418 m^3/day. As shown in Table 1.4.5, the water resource volume available in Zarqa District guarantees only 80% of the design water supply. Recent population growth has led to the creation of residential areas outside the water distribution zones and the development of new residential areas. These facts indicate that the water resource volume is not sufficient to meet the requirements of the population to whom water should be supplied.

Table 1.4.5 Available Water Sources for Zarqa Water Distribution Zone (Unit: m^3/day)

Items	Scenario of Water Allocation in Second Phase Grant Aid Project (year 2010)	Present Status of Water Allocation (year 2009)	Note
Available Water Sources outside of Zarqa Water Distribution Zone ①	87,465	77,325	
Water Sources in Zarqa Water Distribution Zone ②	56,435	36,093	
Zarqa Well Field(R/O Plant)	10,935	9,719	
Hashemeyeh Well Field	8,376	9,376	
Awajan Well Field	26,330	5,800	
Rusaifa/Basatin Well Field		11,198	
Tamaween Well Field	10,794	-	
Sum of Available Water Sources (①+②)	143,900	113,418	
Planned Water Supply	143,900	142,200(*1)	
Water Source Ratio to Water Supply	100%	79.8%	

*1 Water to Balqa is not included in 2009, because of supplying from Beerain Well to Balqa.

Table 1.4.6 Daily Average Water Demand in Zarqa Water Distribution Zone (Unit: m^3/day)

Distribution Zone	Average Water Demand (year 2010)
Allocation to Balqa Govermorate	1,700
Sukhna	2,300
Hashemeyeh	3,200
Zarqa High	6,000
Zarqa Low	44,600
Awajan High	40,400
Awajan Low	6,500
Rusaifa High	6,500
Rusaifa Low	24,000
Hutten	8,700
Total	143,900

1.4.2 Water Transmission System by Khaw Pumping Station

Water supply facilities in Zarqa Governorate have been developed in densely populated urban areas and in rural villages mostly in sparsely populated desert areas. The urban areas in Zarqa Governorate consist of Hashemeyeh and Sukhneh Cities in the north and Zarqa and Rusaifa Cities in the central to southern part. In addition to Azraq and Hallabat, where major well fields are located, there are villages near small-scale water sources scattered around the Governorate. Many well fields have been developed in Zarqa Governorate and the water from these wells is distributed not only within Zarqa Governorate but also to the capital area of Amman and the adjacent Balqa and Mafraq Governorates. Therefore, the water distribution system in Zarqa Governorate is complex.

Khaw Pumping Station is pivotal to the water transmission system in Zarqa District. Khaw Pumping Station is considered to be the main base in a system in which water received from various well fields in northeastern Zarqa Governorate and water allocated from wells in Mafraq Governorate is distributed to Zarqa and Amman, as shown in Figure 1.4.2. Water is conveyed from well fields in Zarqa Governorate (Azraq, Hallabat and Corridor Well Fields), privately owned wells and Mafraq Well Fields. The average influx and discharge at Khaw Pumping Station are as shown in Figure 1.4.2. However, the influx changes as the yields from the water sources change. There exist several pipelines that diverge from the water transmission pipeline from Khaw Pumping Station to Amman, including the water transmission pipeline to Awajan in southern Zarqa District and the water distribution pipeline to the Central Workshop (CWS).

1) Azraq transmission system

Azraq Well Field is the largest well field located approx. 70 km east of Zarqa City and the yield from the wells in the field accounts for approx. 34% of the total well yield in Zarqa Governorate. Water pumped from each well is conveyed to Azraq Pumping Station and transmitted to Khaw Pumping Station and into the distribution network in Azraq City by pumping. The water conveyance pipeline was constructed using Dia. 600 mm iron pipes and construction of the pipeline from the wells to Khaw Pumping Station was completed in 1984. Use of one of the 17 wells constructed has been terminated, but the remaining 16 are in operation. The yield from the field in 2008 was 16,973,137 m^3/y (1,932 m^3/h). After deducting the amount of water transmitted to Azraq City, approx. 1,500 m^3/h of water is transmitted to Khaw Pumping Station.

2) Corridor transmission system

Corridor Well Field is located approx. 50 km northeast of Zarqa City near the border with Mafraq Governorate. Of the 15 wells constructed, 13 are in operation. The annual yield in 2008 is 8,261,617 m^3/y (941m^3/h). Water is pumped from each well directly into a water transmission pipeline, which joins the Hallabat Route water transmission pipeline (the pipeline from Hallabat Well Field to Khaw Pumping Station). The water from the Corridor Well Field is transmitted to Khaw Pumping Station via

this pipeline. Mafraq Well Fields refer to the well fields in Mafraq Governorate. In the past, the water from Mafraq Well Fields was transmitted to Khaw Pumping Station via Zatari Pumping Station using an independent pipeline. However, as of 2009, a new system in which the water from Mafraq Well Fields is discharged directly into the water transmission pipeline from Corridor Well Field has been adopted. In the calculation of the water balance by WAJ, the water from Mafraq Well Fields is included in the water received from other governorates. Because of the increase in water demand in the summer, the system increases the discharge to Khaw Pumping station with additional water received from privately owned wells.

3) Hallabat Transmission System

Hallabat Well Field is located approx. 30 km east of Zarqa City. The yield from the field accounts for approx. 12% of the total well yield in Zarqa Governorate. Water pumped from each well is conveyed to Hallabat Pumping Station and transmitted to Khaw Pumping Station and the distribution networks in Hallabat City by pumping. Use of four of the 13 wells owned by WAJ was terminated in 2009 because of a marked decrease in the yields of the four wells. At present, ten wells, including one privately owned well, are in operation. The yield in 2008 was 6,241,567 m^3/y (711 m^3/h). After deducting the amount of water transmitted to Hallabat City, approx. 500 m^3/h of water is transmitted to Khaw Pumping Station.

4) Water source transmission to Amman Area

At present, on average, 1,700 m^3/hour of water is transmitted from Khaw Pumping Station to Amman. On the way to Amman, 1,000 m^3/hour is diverted to Awajan and the remaining 700 m^3/hour is transmitted to Ain Ghazal Reservoir in Amman. In addition, because of the increase in water demand in Amman during the three or four summer months, water from Tamwin wells is transmitted to Amman together with water from Khaw Pumping Station.

An agreement between the water supply company in Amman, Miyahouna, and WAJ on water transmission to Amman provides that at least 500 m^3/hour of water is transmitted from Zarqa Governorate. This agreement sometimes affects discharge to Zarqa District depending on the amount of water available from the water sources in Zarqa District. Meanwhile, 2,300 m^3/hour is considered to be the upper limit of discharge from Khaw Station to Amman, taking into consideration the 600 mm diameter of the existing Khaw-Amman transmission pipeline, the capacity of the existing pumps and the hydraulic conditions along the pipeline.

As mentioned above, Khaw Pumping Station is an important facility, which controls water distribution in Zarqa District. Therefore, it is essential in drafting a future facility plan to decide on the scenario of a water transmission plan with Khaw Pumping Station at the core.

In the Basic Design Study for “The Project for Improvement of the Water Supply System for the Zarqa District” implemented in 2002, a construction plan was drafted on the basis of a scenario where completion of the water source development project around Amman District would enable distribution

of surplus water from Amman District to Zarqa District by 2005. Subsequently, in the survey for the second-phase grant aid cooperation project, a scenario for water transmission and distribution in 2010 was assumed as described below. However, transmission to Amman continues at present and, because of the water shortage, transmission to Awajan and Rusaifa is restricted.

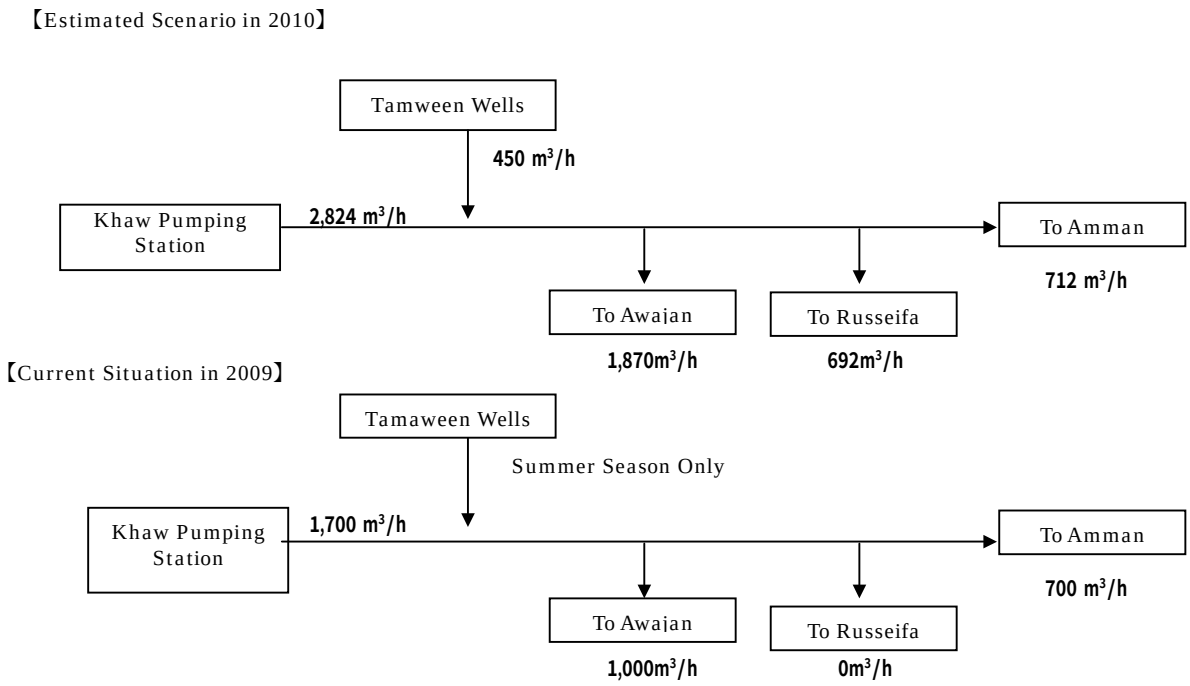


Figure 1.4.3 Scenario of Water Transmission on the Khaw-Amman Line

1.4.3 Water Distribution System

(1) The Japanese Grant Aid Project for the improvement of the water distribution system

The following improvement policies for the project for improvement of the water supply system in Zarqa District were established in the master plan formulated by JICA in 1994 -1996.

1) The objectives of the project are “an equitable water supply and reduction of NRW.”
2) To achieve the above objectives, “the equalization of water distribution pressure and the reduction of water losses” are to be achieved.
3) Eight water distinct distribution zones are to be established and gravity-flow systems from reservoirs are to be developed.

In line with these improvement policies, two phases of the “Project for Improvement of the Water Supply System for the Zarqa District” were implemented as a Japanese grant aid project, and main water transmission and distribution facilities were developed.

“The Project for Improvement of the Water Supply System for the Zarqa District - Phase 1” (Project

Areas: Rusaifa City and Awajan District in Zarqa City) has already been completed. “The Project for Improvement of the Water Supply System for the Zarqa District - Phase 2“ (Project Areas: Northern Districts in Zarqa City, Hashemeyeh City and Sukhneh City) is expected to be completed in March 2010. The completion of these two projects will lead to division of the target areas of the Project into nine water distribution zones and to improvement of the main facilities in the water transmission and distribution system, which will contribute significantly to improvement of the efficiency of water transmission and distribution. Figures 1.4.4 and 1.4.5 show the arrangement of the main facilities at the completion of these two projects and a schematic diagram showing the difference in elevation between reservoirs and distribution zones, respectively. Figure 1.4.6 shows the scenario of water source transmission schedule as of 2010. As is seen in this figure, almost the entire Zarqa District will be within the service area of the gravity-flow water distribution from reservoirs. The target distribution water pressure has been set at 2.5 to 7.0 bars in the plan.

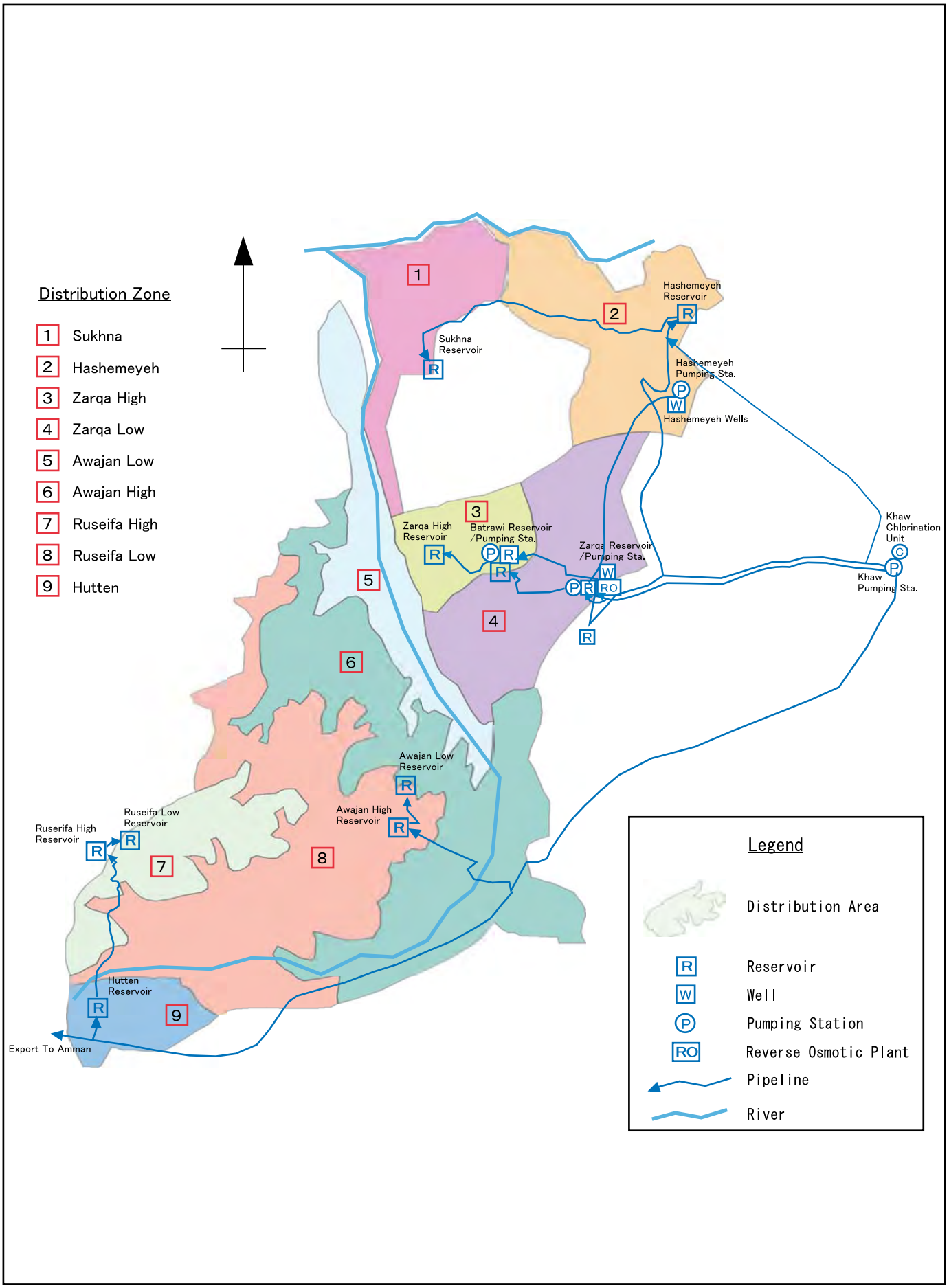


Figure 1.4.4 Location of the Main Facilities of the Japanese Grant Aid Project

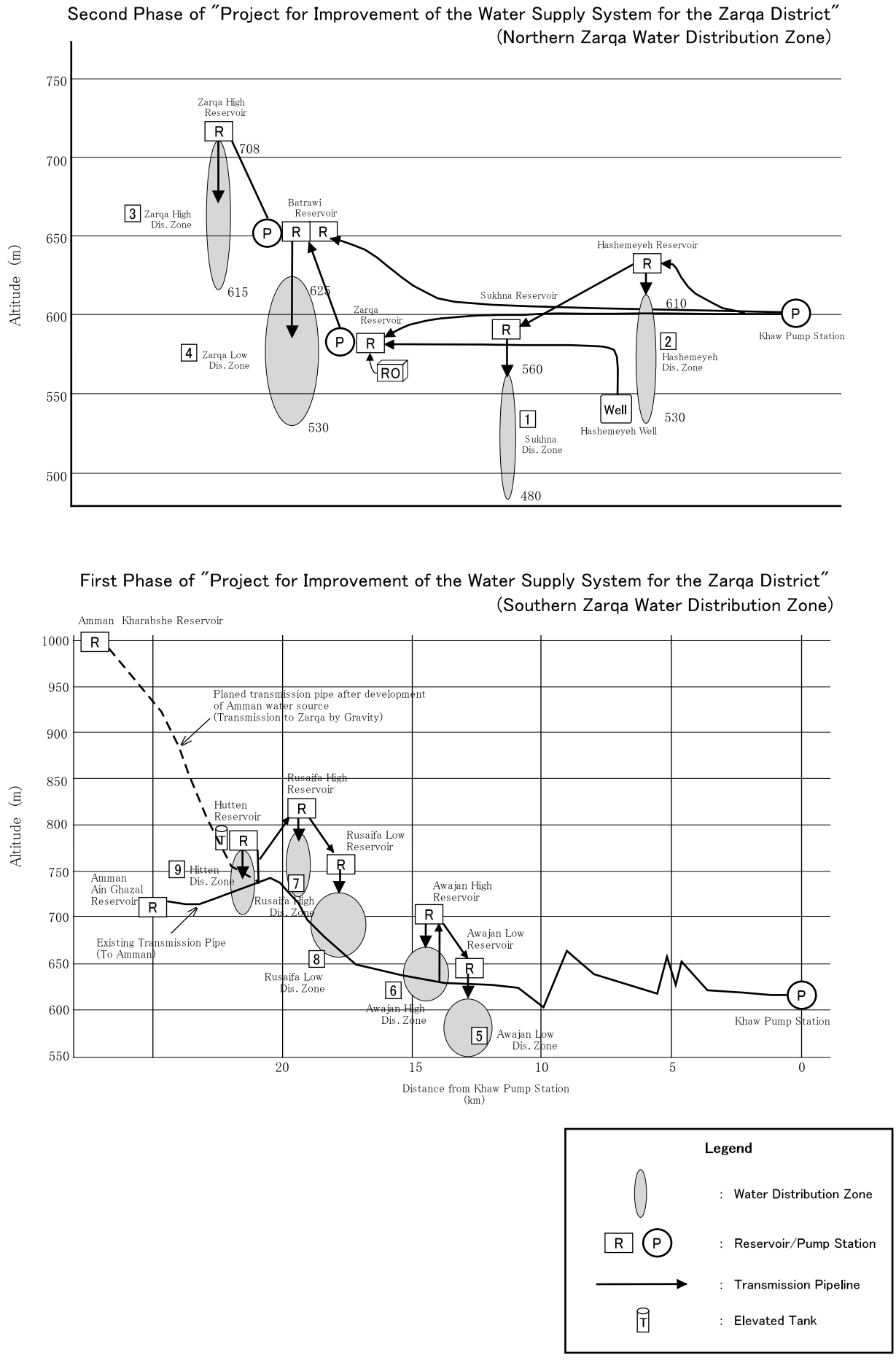
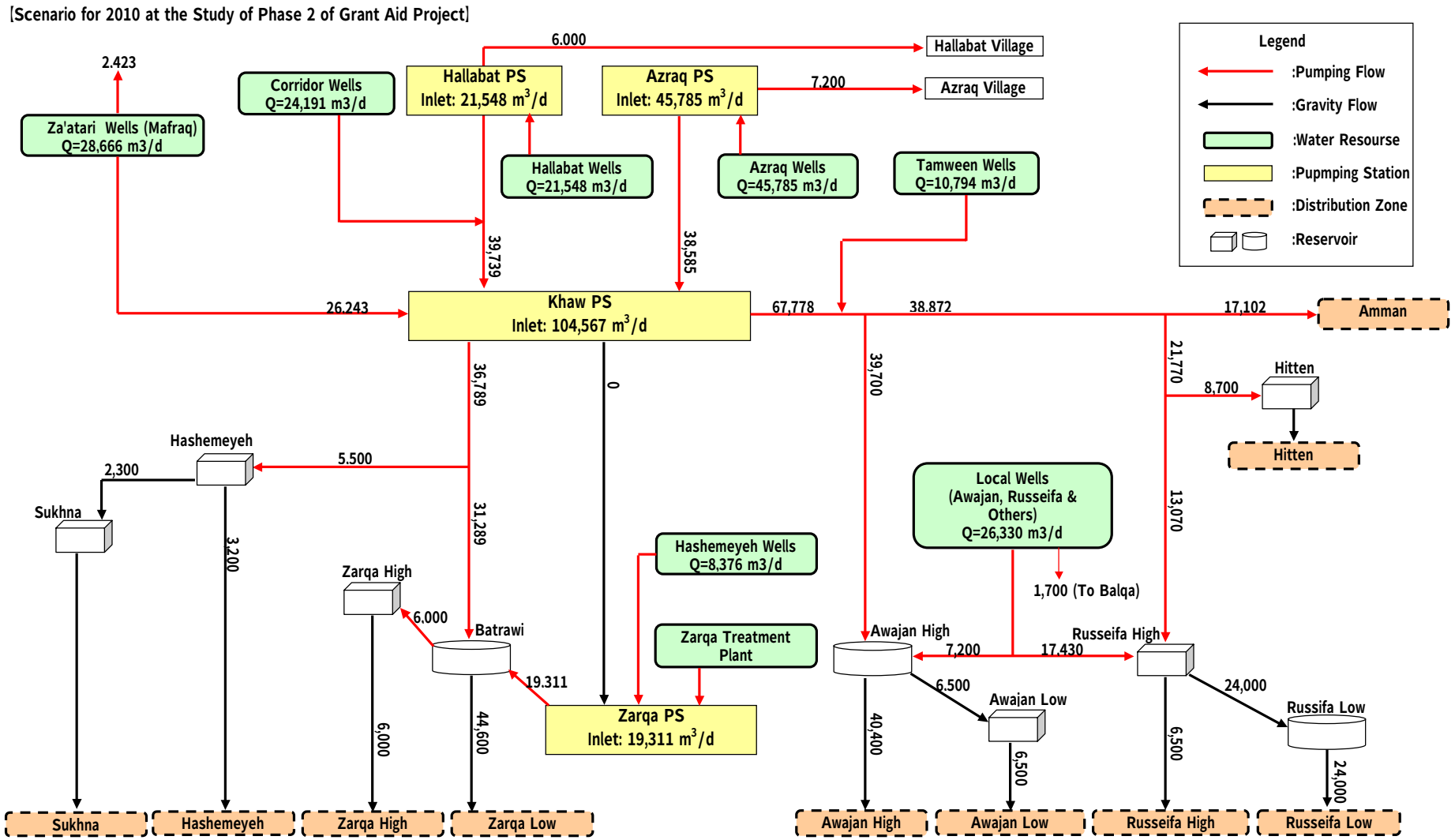


Figure 1.4.5 Profile of the Distribution Zones and Reservoir



Year	Demand /Suupply	Distribution Zone									
		Sukhna	Hashemeyeh	Zarqa High	Zarqa Low		Awajan High	Awajan Low	Russeifa High	Russeifa Low	Hitten
2010	Demand (m^3/d)	2,300	3,200	6,000	44,600		40,400	6,500	6,500	24,000	8,700
	Supply (m^3/d)	2,300	3,200	6,000	44,600		40,400	6,500	6,500	24,000	8,700
	Satisfaction (%)	100.0	100.0	100.0	100.0		100.0	100.0	100.0	100.0	100.0
2015	Demand (m^3/d)	2,700	3,700	7,500	50,000		47,600	7,900	7,600	28,500	10,100
	Supply (m^3/d)	2,300	3,200	6,000	44,600		40,400	6,500	6,500	24,000	8,700
	Satisfaction (%)	100.0	100.0	100.0	100.0		100.0	100.0	100.0	100.0	100.0

Figure 1.4.6 Scenario of Water Source Transmission Schedule as of 2010

(2) Problem of the distribution system

1) Direct distribution of water to areas served by the water distribution networks

As mentioned above, it is expected that the Japanese grant aid project will enable water distribution to most parts of Zarqa District through gravity-flow systems. However, at present, direct distribution by pump on a set rotational basis is being used for water distribution to most parts of Zarqa District. Such a direct distribution by pump requires excessive water pressure because a week's supply of water has to be distributed within a few days. Such a system of operation not only requires heavy energy consumption to operate the system, but also causes water losses in the distribution networks.

[Northern Zarqa Water Distribution Zone in Zarqa District]

The construction of reservoirs and water transmission/distribution pipelines was completed in March 2008 and March 2009, respectively, in the high-elevation areas of Zarqa, Hashmeyah and Sukhneh Cities as part of the on-going grant aid project in the second phase of the Project for Improvement of the Water Supply System for the Zarqa District. At present, Batrawi Reservoir, a facility for the low-elevation areas of Northern Zarqa Water Distribution Zone, is being constructed. The work will be completed in March 2010. Switchover to the gravity-flow system is expected to begin when the work has been completed. Therefore, direct distribution by pump to most parts of Northern Zarqa Water Distribution Zone will have to be continued until 2010.

However, the conditions for the switchover to the gravity-flow system are going to be satisfied by rather high reliability of water source transmission in Northern Zarqa Water Distribution Zone than that of Southern Zarqa Water Distribution Zone. The movement of switchover to the gravity-flow system will be more accelerated after transmission of water resource in the east Zarqa District became stable and condition for the transmission to Batrawi reservoir was improved through this Programme.

[Southern Zarqa Water Distribution Zone in Zarqa District]

In Russeifa and Awajan Water Distribution Zone, located in the south of Zarqa District, four reservoirs and water transmission and distribution pipelines were constructed as part of the Japanese grant aid project in March 2005. However, because of the unsatisfied condition of water allocation from Amman, the distribution zone with gravity-flow is limited. This situation has resulted in the need for direct distribution by pump from Zarqa Pumping Station toward Russeifa and Awajan.

If the Disi Fossil Water Project, currently in the planning stage, is launched, the work is expected to be completed by 2015. After the completion of the project, it is expected that revision of the water allocation plan between Amman and Zarqa District will bring to an end the pumping of water from Zarqa District toward Amman and also lead to the transmission of surplus water from Amman toward Zarqa District through a gravity-flow system, as depicted in the original scenario.

2) Expansion of city areas and remaining areas with insufficient water distribution

The significant improvement of the road network in Zarqa District in recent years has been accompanied by the development of new city areas. This development is at its height and development work is still continuing in the vast area in which Tamween Well Field is located. The original plan at the time of the development of the well field in 2005 was to transmit the water from the wells toward Amman. However, it is being used mostly to supply water to the neighbouring city areas.

It is expected that there will continue to be areas in some residential areas on hillsides and in the peripheries of the distribution areas, which cannot be served by the gravity-flow systems from reservoirs. Therefore, in some cases direct distribution by pump will have to be continued for the time being.

1.5 Environmental Impact Assessment

Implementation of environmental impact assessment (EIA) in Jordan is provided in EIA Bylaw No. 37/2005 and the EIA Directorate in the Ministry of Environment is the competent authority for EIA.

This Programme includes replacement (relocation at Zarqa Pumping Station) of the electric pumping facilities at the existing water transmission pumping stations, replacement of the equipment for the relevant water transmission pipelines and procurement of valves for the existing water distribution networks. There is no need for development of new water sources or purchase of land. In addition, the planned site of New Zarqa Pumping Station is on the same premises as the Zarqa Desalination Plant owned by WAJ. The route of the Zarqa-Batrawi Water Transmission Pipeline follows the roads under which the existing pipeline is installed.

In principle, no official procedures with regard to environmental and social concerns are required for facility improvement in the water sector in Jordan. Such reports are prepared at the request of the donor country. As EIA procedures were not necessary for the Grand Aid for General Projects (first and second phases) being implemented in Zarqa Governorate, similar conditions are considered applicable to the implementation of this Programme.

Chapter 2

Contents of the Programme

Chapter 2 Contents of the Programme

2.1 Basic Concept of the Programme

2.1.1 Objective of the Programme

The Programme is within the framework of the "National Water Strategy" adopted by the Government of Jordan and aims at an adequate supply of safe potable water and sustainable use of water sources. The National Water Strategy also includes measures against climate change in accordance with the recommendations of the Intergovernmental Panel on Climate Change (IPCC) as an urgent task. To achieve these goals, WAJ adopted contribution to the mitigation of climate change by reduction in energy consumption through rationalization of the water transmission and distribution system and adaptation to the decline in precipitation and availability of potable water caused by climate change as the aims of improvement of the water supply system. In accordance with WAJ's policy, the Programme aims at reduction in energy consumption and stabilization of water transmission and distribution through improved efficiency of water transmission and distribution in Zarqa District.

2.1.2 Outline of the Programme

To achieve the above-mentioned goals, the Programme will replace the major pumping facilities for water transmission, procure materials and equipment for the water transmission pipelines and water distribution networks and provide the implementing organization, WAJ, with technical assistance (guidance in operation of the pumping facilities for water transmission and a "soft component" on operation and management of the water transmission system). The Programme is also expected to create synergy with past and on-going grant aid projects of the Government of Japan. Therefore, the Programme will contribute not only to reduction in CO_2 emissions through reduction in energy consumption, but also to stabilization of the water supply in Zarqa District. Table 2.1.1 shows the programme design matrix (PDM) of the Programme.

The table below shows the programme design matrix of this Programme.

Table 2.1.1 Programme Design Matrix (PDM)

Narrative summary	Objectively verifiable indicators	Means of verification	Assumptions
Overall Goals 1. To contribute to mitigation of climate change by reducing energy consumption through rationalization of the water transmission and distribution systems 2. To adapt to shortfall of potable water and rainfall caused by climate change	1. CO_2 emissions 2. Unit water supply	Records of electricity consumption	Electricity is supplied without any problem
Programme Purposes 1. Energy consumption for water transmission and distribution is reduced (mitigation measure)	1. Consumption of electricity for pump operation is reduced by 8,687MWh/year at the design flow rate	1. Records of electricity consumption	WAJ operates and maintains the water transmission facilities appropriately

<table>
<tr><td>2. Water transmission and distribution to the water supply area is stabilized (adaptation measure)</td><td>2-1. Amount of water transmission to Zarqa District increases by 1,900,000m^3/year
2-2. Efficient water transmission and distribution systems are constructed</td><td>2. Records of amount of water transmission and distribution</td><td></td></tr>
<tr><td><u>Outputs</u>
1. Efficiency of energy consumption of the pumping facilities is improved

2. Efficiency of the water transmission and distribution systems in the target area are improved</td><td>1. Consumption of electricity per unit water transmission is reduced at the target pumping stations
2-1. Amount of inflow and outflow is monitored accurately at the target pumping stations and the water transmission and distribution pipelines are managed appropriately
2.2 Water transmission pipeline between Zarqa Pumping Station and Batrawi Reservoir is improved
2-3. Distribution networks are operated and maintained appropriately</td><td>Records of electricity consumption
Records of amount of water transmission and distribution

Records of facility operation</td><td>WAJ will construct New Zarqa Pumping Station in Fiscal 2010

WAJ will install the equipment and materials (water transmission pipes, gate and air valves) procured by the Japanese side

Participants in technical training in O&M Technical Guidance and Soft Component receive technical training</td></tr>
<tr><td rowspan="2">Activities
<u>Japanese side</u>
1. Procurement and installation of pumping facilities at Azraq, Hallabat and Zarqa Pumping Stations (12 pumps)
2. Procurement of valves and other materials for Khaw Pumping Station (1 set)
3. Procurement and installation of water flow meters (13 sets)
4. Procurement of water transmission pipes (approx.2km)
5. Procurement of gate and air valves (343 and 15 pieces, respectively)
6. Implementation of O&M Technical Guidance and Soft Component in operation and maintenance of the water transmission pumps
<u>Jordanian side</u>
1. Construction of building and improvement of transformers and water transmission pipelines in Zarqa Pumping Station
2. Installation of transmission pipelines
3. Construction of water flow meter chambers and valve chambers
4. Installation of valves, etc. at Khaw Pumping Station
5. Installation of gate and air valves in the distribution networks
6. Repair of existing facilities
7. Participation in O&M Technical Guidance and Soft Component</td><td colspan="2">Inputs</td><td rowspan="2">Works in the scope of the Jordanian side are implemented

<u>Pre-condition</u>:
Operators, technicians, engineers, etc. of WAJ are appointed to participate in O&M Technical Guidance and Soft Component</td></tr>
<tr><td><u>Japanese side</u>
【Materials and equipment】
Pumping equipment for water transmission, transformers, transmission pipes, water flow meters, gate valves and air valves
【Human resources】
Engineers and technical advisors
【Programme costs】
Costs of procurement of materials and equipment and removal and installation of equipment and costs of O&M Technical Guidance and Soft Component, detailed design and procurement supervision</td><td><u>Jordanian side</u>
【Materials and equipment】
Materials for water flow meter chambers and installation of pipelines
【Human resources】
Engineers, technicians, operators and laborers
【Programme costs】
Costs of installation of equipment and repair and improvement of existing facilities and operation and management costs</td></tr>
</table>

2.2 Outline Design of the Japanese Assistance

2.2.1 Design Policy

The basic policies for selecting the materials and equipment to be assisted are as follows:

(1) Consistency with past and on-going grant aid projects

The Master Plan prepared by JICA from 1994 to 1996 provided the following improvement policies for the project for improvement of the water supply system in Zarqa District.

- The objectives of the project are "an equitable water supply and reduction of NRW."
- To achieve the above objectives, "the equalization of water distribution pressure and the reduction of water losses" are to be realized.
- Eight water distinct distribution zones are to be established and gravity flow systems from reservoirs are to be developed.

In line with these improvement policies, "The Project for Improvement of the Water Supply System for the Zarqa District" has been implemented in two phases as grant aid projects of Japan and improvement of the main water transmission and distribution facilities is in progress. It is expected that this grant aid project of Japan will enable gravity flow water distribution to most of the distribution zones. Under such circumstances, the following basic policies have been confirmed in this Programme after discussion with WAJ to maintain consistency with the basic purpose.

1) Materials and equipment to be assisted should be selected on the assumption of switchover to the gravity flow system. Procurement of pumps for direct pumping to distribution areas is inconsistent with the concept of gravity flow distribution from reservoirs in past and on-going grant aid projects. In addition, it is expected that the pumps will become redundant once the switchover to the gravity flow system is completed. For these reasons, the Japanese side will not procure such pumps.

   However, the pumps for direct distribution to Hallabat Village were included in the survey items for the following reasons: The pumps concerned are not part of the planned gravity flow system mentioned above. Improvement in energy efficiency is expected from replacement of the pumps. No other donor is providing, planning or considering providing assistance to the pumps concerned.

2) The specifications of the valves and water flow meters requested for installation in the distribution networks will be decided on the assumption that they are to be used in the gravity flow system. Despite a design pressure of 2.5 -7.0 bars in the distribution areas under the gravity flow system, the pressure specifications of some of the requested materials and equipment are too high at 25 bars or 40 bars. Therefore, the pressure specifications of all the valves, etc. to be procured will be the lowest specification, that is, 16 bars. The Japanese side will not procure

replacement valves for the distribution pumps because they are for direct pumping to the distribution areas.

(2) Coordination of content of assistance with other donors

Areas, equipment included in projects being implemented and to be implemented by other donors should not be included in the Programme.

In Zarqa District, German Technical Cooperation (GTZ) has implemented a project to improve the energy efficiency of the water transmission pumps, and Reconstruction Credit Institute (KfW) of Germany, China, the EC and Millennium Challenge Corporation (MCC) funded by the U.S.A. are implementing projects for NRW reduction in the distribution networks.

Both this Preparatory Survey and the GTZ survey included the pumps for water transmission to Amman at Old Khaw Pumping Station and the transmission pumps at Zarqa R/O Plant as survey items. However, since GTZ has decided to provide assistance to these facilities in their project, these facilities were excluded from this Japanese Programme. Materials and equipment for the distribution networks in the areas where KfW and other donor agencies are implementing projects has been excluded from this Programme.

1) Pumps for water transmission to Amman at Old Khaw Pumping Station

The GTZ survey for "Improvement of Energy Efficiency (IEE) Project" reveals that the amount of investment (1,282,000 JD) required for improvement of the operating efficiency of the pumps to 68% (WAJ's target; the current efficiency is 70% and 45%, respectively) can be recovered in about four years through reduction in electricity consumption (7.01 million kWh/year or 302,000 JD/year). It is GTZ's policy that, if investment in a project can be recovered in a short period of four years, it recommends private investment in the project and does not provide financial assistance to the project. Therefore, GTZ intends to urge WAJ to utilize private investment to improve the operating efficiency. In accordance with the intentions of GTZ, WAJ, GTZ and Japanese side has agreed to exclude the pumps concerned from this Programme.

2) Water transmission pumps at Zarqa R/O Plant

GTZ has decided to provide financial assistance for the pumps concerned after carefully studying the final report of the IEE Project (completed at the end of June 2009).

3) Materials and equipment in the water distribution zones

With assistance from KfW, a pilot project for improvement of the water distribution network is being implemented in Zarqa District. The survey team has confirmed KfW that there is no duplication between Japanese and KfW's Projects, after having explained that 1) the KfW's pilot area should be excluded from the target area of the Japanese Programme, and 2) materials and equipment for the distribution zones should be installed after the gravity flow system has been

established. Similarly, it has been decided to exclude the areas where other donors such as EC, China, etc. are to improve the distribution network from this Programme.

4) Materials and equipment for wells

Since MCC is studying the possibility of implementing a project to repair well facilities in Zarqa District, procurement of materials and equipment for wells will not be included in the assistance of the Japanese side.

(3) Scenario of the water source transmission schedule in Zarqa Governorate

After confirming the inter-governorate water transmission plans and the water transmission and distribution plan for the Zarqa District, the specifications of the requested materials and equipment (pumping discharge rate, number of pumps, etc.) will be decided in accordance with the design discharge of transmission agreed with WAJ.

1) Water reception and discharge at Khaw Pumping Station

On the basis of data on the well yield and transmission discharge to Khaw Pumping Station from each well group in 2008, daily-average design water flow rates were established as follows:

Inflow discharge at Khaw Pumping Station:	89,325 m^3/day (3,722 m^3/hour)
Outflow discharge to Amman:	12,000 m^3/day (500 m^3/hour)
Amount of water available for Zarqa District:	77,325 m^3/day (3,222 m^3/hour)

The water inflow at Khaw Station depends on the yield from each water source. Since the yields have been stable for the past few years, no significant change in inflow is expected in future. Meanwhile, since the agreement with Miyahouna provides at least 500 m^3/hour of discharge to Amman, the rest of inflow at Khaw Pumping Station can be used in Zarqa District.

2) Water distribution to Zarqa District

Zarqa District is divided into the Northern Area and the Southern Area. The Northern Area consists of Zarqa City, Hashmeyah City and Sukhneh City, while the Southern Area consists of Awajan and Rusaifa Cities. Each district has groundwater sources. The sum total of the yields from these sources can be considered as the amount of water available for water supply. Table 2.2.1 summarizes the results of a comparison between the design water supply of each distribution zone and the available water sources in each area.

Table 2.2.1 Design Water Supply and Yields from Water Sources within the District (unit: m^3/day)

Items	Distribution Area					Total
	Area of Phase 1 Grant Aid Project		Area of Phase 2 Grant Aid Project			
	Northern Zarqa Water Distribution		Southern Zarqa Water Distribution Zone			
	Awajan	Russeifa/Hitten	Sukhna	Hashemeyeh	Zarqa(Low/High)	
Daily Average Water Supply ①						
Year 2010	46,900	39,200	2,300	3,200	50,600	142,200
Year 2015	55,500	46,200	2,700	3,700	57,500	165,600
Groundwater Resourse ②						
Zarqa Reverse Osmotic Plant	-	-	-	-	9,719	-
Hashemeyeh Wells	-	-	-	-	9,376	-
Awajan Wells	5,800	-	-	-	-	-
Russeifa/Basateen Wells	-	11,198	-	-	-	-
Water Balance (①-②)						
Year 2010	41,100	28,002	2,300	3,200	31,505	106,107
Year 2015	49,700	35,002	2,700	3,700	38,405	129,507
Total of Water Supply						
Year 2010	69,102		37,005			106,107
Year 2015	84,702		44,805			129,507

As shown in the table above, the available water source flow rates differ from distribution zone to distribution zone. Areas with low water supply have to be provided with water supplied through Khaw Pumping Station. However, a limited amount of water can be supplied to areas such as Awajan and Rusaifa, where water has to be diverted from the water transmission pipelines to Amman.

Because of the problem of water quality, water from Hashmeyah wells has to be diluted with good-quality water from Zarqa Reservoir and, thus, cannot be supplied directly to Hashmeyah District. As an alternative, a diversion pipeline from Khaw-Batrawi transmission pipeline has been established and water is supplied to Hashmeyah and Sukhneh via Khaw Pumping Station.

3) Discharge distribution plan

As shown in Table 2.2.1, assuming that the level of yield from the water sources in Zarqa District can be maintained at the 2008 level, the amount of water from water sources outside Zarqa District (amount of water transmitted via Khaw) required to meet the design water supply in the district is estimated at 106,107 m^3/day and 129,507 m^3/day for the year 2010 and year 2015, respectively.

However, the actual available discharge from water sources outside Zarqa District is 77,325 m^3/day, which is the amount of water that can be supplied through Khaw Pumping Station. It is necessary to establish a scenario for distribution of this discharge before preparing energy efficiency improvement measures at the pumping stations. Establishment of such a scenario is a precondition for improvement measures. The following are the distribution policies considered feasible at present.

As described in Chapter1, 1.4.1(2) 2), comparison between the current water demand in the entire Zarqa Water Distribution Zone and the available water source reveals that the latter meets approx. 80% of the water demand. The poorest water supply is found in Southern Zarqa Water Distribution

Zone, where Rusaifa and Awajan Districts are located.

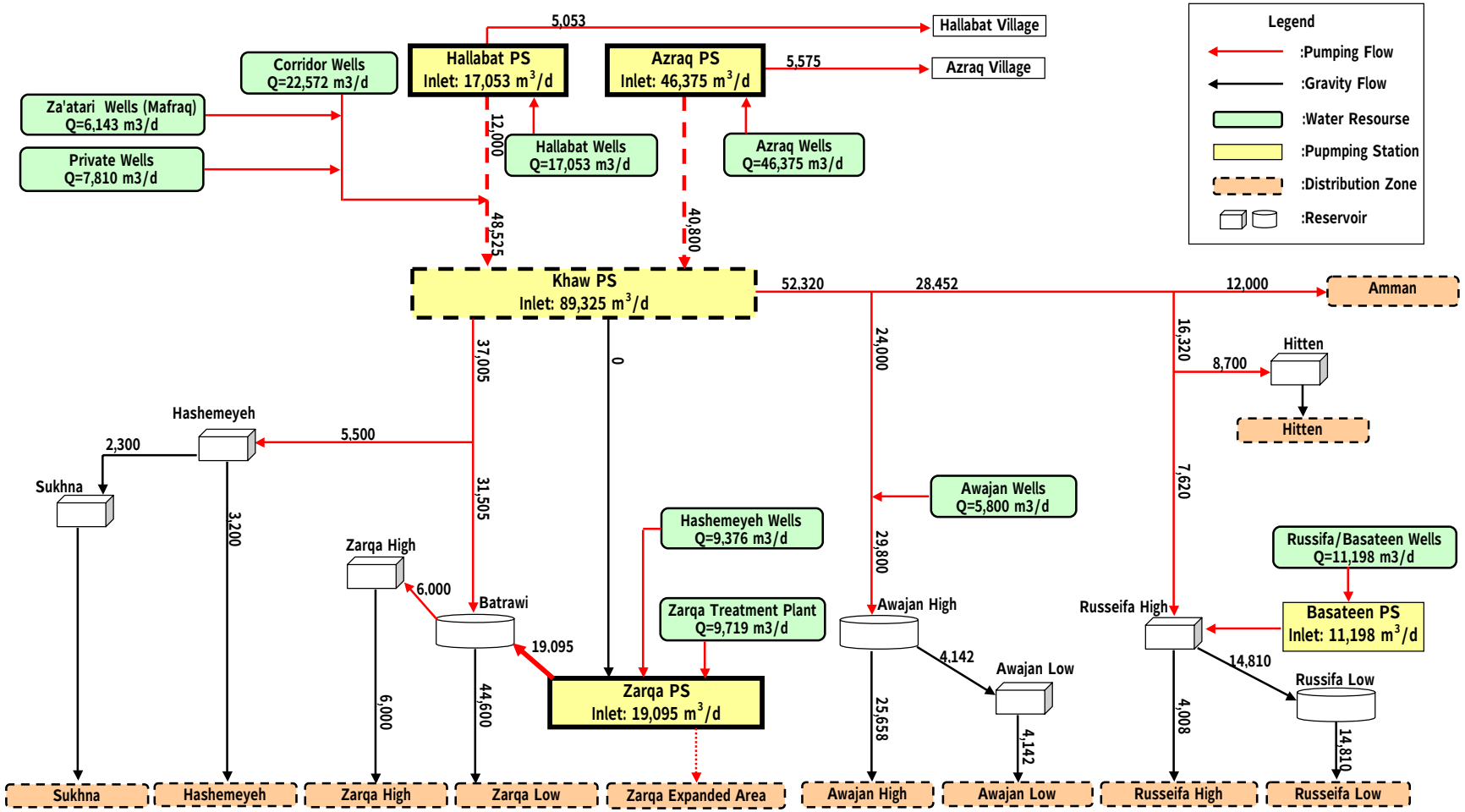
【Scenario】

Priority is given to satisfying demand in Northern Zarqa (Sukhneh, Hashmeyah and Zarqa) and whatever water is left after satisfying such demand is distributed to Southern Zarqa (Figure 2.2.1).

The above-mentioned scenario is the closest to the scenario in the on-going second-phase grant aid project. In this scenario, priority is given to satisfying the design water supply to Northern Zarqa Water Distribution Zone and the surplus water is distributed to Southern Zarqa Water Distribution Zone and to Amman Area.

This scenario allows a discharge of 37,005m^3/day (1,542 m^3/hour) and 52,320 m^3/day (2,180 m^3/hour) to Northern Zarqa Water Distribution Zone and Amman, respectively. It is possible to transmit water from Khaw Pumping Station via the Khaw-Amman transmission pipeline, which has a hydraulic coefficient of flow velocity of 120, to Rusaifa Reservoir at a flow rate of up to 2,300 m^3/hour with the existing pump at Khaw Pumping Station, which has a pumping head of 350 m.

In this case, the discharge to Awajan and Rusaifa Districts will be below the design water supply. However, this shortage is considered beyond our control because it arises from the location, yield and geographical constraints at the water sources. From a technical viewpoint, in particular, it is thought that water should be distributed from Amman to Awajan and Rusaifa areas instead of supplying water to these areas from Zarqa District. Water transmission to Amman will have to be terminated and water from Amman will have to supplement the discharge to these districts. Further promotion of the on-going project for development of water sources for Amman is required.



Year	Demand /Suupply	Distribution Zone									
		Sukhna	Hashemeyeh	Zarqa High	Zarqa Low	Expanded Area	Awajan High	Awajan Low	Russeifa High	Russeifa Low	Hitten
2010	Demand (m^3/d)	2,300	3,200	6,000	44,600		40,400	6,500	6,500	24,000	8,700
	Supply (m^3/d)	2,300	3,200	6,000	44,600		25,658	4,142	4,008	14,810	8,700
	Satisfaction (%)	100.0	100.0	100.0	100.0		63.5	63.7	61.7	61.7	100.0
2015	Demand (m^3/d)	2,700	3,700	7,500	50,000		47,600	7,900	7,600	28,500	10,100
	Supply (m^3/d)	2,300	3,200	6,000	44,600		25,658	4,142	4,008	14,810	8,700
	Satisfaction (%)	85.2	86.5	80.0	89.2		53.9	52.4	52.7	52.0	86.1

Note: The quantity of water above mentioned is based on the Average Water Demand ped day.

Figure 2.2.1 Proposed Scenario of the Water Source Transmission Schedule
(Discharge via Khaw Station is preferentially distributed to meet demand in the Northern Zarqa Distribution Area)

(4) Operational condition of the pumping facilities

The current state of and plan for water distribution have been discussed in the preceding section. However, the above-mentioned scenario will not significantly affect the design condition of the pumping stations to be assisted in this Programme. The reason is that, since the pumping stations concerned transmit water only to Khaw Pumping Station and Batrawi Reservoir, they do not directly affect the amount of water distributed via Khaw Pumping Station. In other words, the design discharge from these stations is decided in accordance with the yield of the existing water sources. Because replacement of the pumping facilities is planned under Programme Grant Aid for Environment and Climate Change (GAEC), their operational condition will have to be established with emphasis on improvement of energy efficiency.

Replacement of the pumping facilities will be implemented under the following conditions.

1) Prohibition of simultaneous operation with existing pumps

At present, many pumping stations are equipped with pumping facilities with different specifications, heads, capacities, etc. In particular, if motors with different outputs or different types of pumps are operated simultaneously, the difference in the performance of the equipment may impede efficient operation of the pumps. In principle, the pumping facilities procured in this Programme, including standbys, will not be operated simultaneously with pumps with different specifications.

2) Efficient power receiving system under the local power transmission system

In general, medium voltage power receiving is the global standard for large-capacity pumps such as those to be provided in this Programme. However, all the pumping stations in Zarqa District use low voltage power receiving systems. This is because the operation and maintenance system of WAJ is not capable of handling medium voltage power receiving and because the existing conditions of the substations and the transmission lines for the pumping stations are incompatible with medium voltage power receiving.

Since losses associated with power receiving and transmission are less in a medium voltage power receiving system than in a low voltage power receiving system, the former contributes to improvement of overall efficiency. Taking this into consideration, the possibility of pump operation with medium voltage power receiving will be examined in this Programme. However, there may be cases in which it is inevitable to continue using the existing low voltage power receiving system because of the condition of the power transmission lines and substation facilities at the locations.

3) Control by number of pumps in operation and operation with adjustment of operating time

The transmission pumps to be provided in this Programme will be used for transmitting water from the pumping stations in the water source areas to the reservoirs of the distribution zones through transmission pipelines. When operation discharge has to be changed by water level of the reservoirs or

water demand, the number of pumps in operation or the operating time will be adjusted accordingly.

(5) General procurement conditions

The main products to be procured in this Programme commercially available in Jordan are imported from the EC, Eastern Europe, Turkey, Saudi Arabia, China, etc. Because of the relatively small size of the domestic market for water supply materials and equipment, foreign manufactures conduct sales activities by concluding agency agreements with local dealers instead of having directly managed agents. Therefore, only domestic dealers participate in tenders for domestic procurement of materials and equipment. In exceptional cases, WAJ deals directly with foreign companies when procuring products not handled by domestic dealers such as water quality analyzers and reagents.

(6) Local dealer

In general, the contractual obligations of local dealers in procurement of water supply materials and equipment end when they have delivered the products to the purchaser. Therefore, when WAJ plans to install a pump, WAJ has to entrust the manufacturing and installation of high-voltage switches, switchboards, power distribution panels, etc. to electric and mechanical engineering companies and the installation of pumping equipment to a plumbing company separately. Of the electric and mechanical engineering companies, some general engineering companies are able to manufacture and install electric facilities themselves with materials and equipment directly procured from the manufacturers. These companies have accumulated results mainly in the private sector.

(7) Technical assistance by Operation & Maintenance Guidance and Soft Component

In this Programme, technical assistance through Operation & Maintenance Guidance and Soft component will be provided immediately after the installation of the equipments in order to transfer appropriate technology in operation and maintenance management of pumping facilities and operational management of water transmission pumping system.

(8) Policies on deciding the grades of equipment and materials

The materials and equipment to be procured in the Programme will be pumping facilities, power source facilities and piping materials and equipment. Since these materials and equipment are in principle for replacement of existing facilities, the Programme will not include upgrading of equipment which requires special maintenance techniques. The basic policies on deciding the grade of the equipment are as follows:

- The effects of suspension of pump operation at the time of breakdowns and inspections shall be minimized.
- The installation space in the existing pump rooms shall be used effectively.
- New equipment shall be arranged in such a manner that its installation does not impede the operation of existing pumps.

- Maximum and minimum discharges shall be adjustable by changing the number of pumps in operation.
- Since the pumps to be procured are for water transmission, the absence of significant change in the amount of water transmission shall be a precondition.
- Compatibility of consumables and spare parts shall be enhanced by installing pumps with the same capacity wherever possible.
- The main bodies of pumps and motors shall be of waterproof and dust-proof specifications compatible with use in desert areas.
- When selecting such general-use products as power source facilities and piping materials, locally available products shall be selected so that there will be no problem in procuring consumables and replacement parts.

(9) Lot classification of the materials and equipment to be procured

The materials and equipment to be procured in this Programme are classified into "materials and equipment for water transmission pumps" and "materials and equipment for water distribution networks."

Of the materials and equipment for water transmission pumps, the pumping facilities are classified into Lot 1 because the Japanese side will be responsible for their installation. Because the water flow meters are precision machinery and, thus, their installation and adjustment requires expertise, WAJ has requested the Japanese side to accept responsibility up to their installation and adjustment. Therefore, the water flow meters have been included in Lot 1.

The specifications of the materials and equipment for water distribution networks (valves and air valves) will be designed for their assumed use in a gravity-flow system. WAJ will install the valves. Since Japan and other donors are implementing and preparing projects for the switchover to a gravity-flow system, the equipment in Lot 2 will be procured when the switchover has been completed with such donors' assistance. The table below summarizes the lot classification.

Table 2.2.2 Summary of the Lot Classification

Item	Lot 1 (Materials and equipment mainly for water transmission pumps)	Lot 2 (Materials and equipment for water distribution networks)
Details of equipment	Water transmission pumps, Transmission pipelines, Water flow meters	Gate valves, Air valves
Time of installation	After delivery of the equipment for the pumping facilities to the sites	After installation of the Lot 1 equipment After the switchover to a gravity-flow system
Scope of works	To be installed by the Japanese side. However, the Jordanian side is to construct the concrete chambers for the water flow meters and install the transmission pipelines.	To be installed by the Jordanian side.

2.2.2 Final List of Requested Materials and Equipment

At the end of the Second Field Survey, WAJ and the study team held discussions on the results of the field surveys conducted so far and the technical design policies and agreed on the content of the requested equipment as shown in the table below and Table 2.2.4 (attached to the Memorandum of the Second Field Survey).

Table 2.2.3 List of Selected Requested Materials and Equipment

Procurement Lot	Category	Use	Site	Materials/Equipment
Lot 1	1	Water transmission from major well water sources	Azraq P. S.	Pumps for water transmission to reservoir at Khaw P.S.
			Hallabat P.S.	Pumps for water transmission to reservoir at Khaw P. S.
	2	Water transmission to Batrawi Reservoir	Zarqa P.S.	Pumps for water transmission to Batrawi Reservoir
			Between Zarqa P. S. and Batrawi Reservoir	Change in the route of the existing transmission pipelines (Dia.400mm × 2) and installation of transmission pipes (Dia.600mm, approx. 2 km)
			New Khaw P.S.	Valves for the pumps and water flow meters for water transmission
	3	Water distribution from major well water sources	Hallabat P. S.	Pumps for water distribution to Hallabat Village
	4	Transmission and distribution pipelines in Zarqa District	Various locations in distribution zone	Water flow meters for improvement of the water transmission and distribution network
Lot 2	4	Transmission and distribution pipelines in Zarqa District	Various locations in distribution zone	Gate valves and air valves for improvement of the water transmission and distribution network

The major changes from the agreement reached in the Minutes of Discussions during the Second Field Survey (Table 1.2.4) are as follows:

1) Classification

- The pumping equipment, materials related to transmission pipeline and materials to be installed by the Japanese side have been classified into “Lot 1”. The gate valves and air valves to be installed in the distribution networks by WAJ have been classified into “Lot 2”.
- Since the installation and adjustment of the water flow meters requires professional technology, at the request of WAJ they have been included in “Lot 1” as equipment to be installed by the Japanese side.
- Since the air valves (Dia.4”) are to replace those on the transmission pipelines from Azraq and Hallabat Stations and, thus, are preferably replaced simultaneously with the pumps, they have been included in “Lot 1.”

2) Exclusion

- Pumps for Zarqa R/O Plant have been excluded from the request as GTZ assistance has been confirmed.

・The discharge from Merheb Pumping Station is smaller than the discharge from the other stations. Direct pumping is also used at this station for water distribution to the distribution network. Therefore, water transmission, a precondition for verification of the indicators of the effects, is unstable. The reduction in energy consumption expected from the replacement of the pumps is smaller than at the other stations. For these reasons, Merheb Pumping Station has been excluded from the Programme.

3) Addition

・Replacement of the pumping facilities for water distribution to Hallabat Village was included in the original request. Although the facilities are for direct distribution to the distribution network, WAJ requested again. Replacement of this equipment is independent of the switchover to the gravity flow system in Zarqa District. Other donors do not have projects concerning these facilities. For these reasons, the pumping facilities for water distribution to Hallabat Village were included in the survey items.

4) Quantities

・The capacity and number of pumps have been determined so that they are sufficient to achieve the design discharge.

・On the basis of the results of the field survey, the required number of valves and water flow meters at the sites of pumping station has been determined.

・The required number of various valves was requested by WAJ on the basis of conditions in the existing water distribution network.

Table 2.2.4 Final list of Requested Materials and Equipment

Category	Equipment	Dia. (inch)	Location	PN(bar)	Unit	Quantity
	I. Procurement Lot 1					
1	1. Azraq Pumping Station					
	Pump (Q=425m^3/h、H=360m)	-	Azraq P.S. to Khaw P.S.	36	nos	5
	Water Meter	24	Inlet pipeline from wells to reservoir	-	nos	2
	Water Meter	24	Outlet pipeline to Khaw P.S.	-	nos	1
	Water Meter	24	Khaw Reservoir : Inlet pipeline from Azraq P.S	-	nos	1
	2. Hallabat Pumping Station (to Khaw)					
	Pump (Q=500m^3/h、H=135m)	-	Hallabat station to Khaw	14	nos	2
	Water Meter	16	Inlet pipeline from wells to reservoir	-	nos	1
	Water Meter	12	Inlet pipeline from wells to reservoir	-	nos	1
	Water Meter	24	Outlet pipeline to Khaw P.S.	-	nos	1
	Water Meter	24	Khaw Reservoir : Inlet pipeline from Hallabat P.S	-	nos	1
2	3. Zarqa Pumping Station					
	Pump (Q=400m^3/h、H=100m)	-	Zarqa P.S. to Batrawi Reservoir	16	nos	3
	Ductile iron pipes	20	Transmission from Zarqa P.S. to Batrawi Reservoir	16	km	2.2
	Water Meter	20	Zarqa P.S.: Outlet pipeline to Batrawi	-	nos	1
	4. Khaw New Pumping Station					
	Valve	16	Delivery Pipeline	16	nos	4
	Valve	16	Suction Pipeline	16	nos	4
	Valve	28	Delivery Pipeline	16	nos	1
	Non-retaining Valve	16	Delivery Pipeline	16	nos	4
	Water Meter	28	Outlet pipeline to Batrawi Reservoir	-	nos	1
3	5. Hallabat Pumping Station (to Hallabat Village)					
	Pump (Q=200m^3/h、H=148m)	-	Hallabat station to Hallabat Village	15	nos	2
	Water Meter	8	Outlet pipeline to Hallabat Village	-	nos	1
4	6. Air release valve on Transmission Pipe to Khaw and Water Meter				nos	
	Air release valve	4	Transmission Line from Azraq to Khaw	-	nos	40
	Air release valve	4	Transmission Line from Hallabat to Khaw	-	nos	15
	Water Meter	16	Transmission Line to Russeifa	16	nos	1
	Water Meter	24	Khaw-Amman Pipeline: Awajan Junction	25	nos	1
	II. Procurment Lot 2					
	7. Transmission and Distribution Network					
	Gate Valve	4	Zarqa network	16	nos	222
	Gate Valve	6	Zarqa network	16	nos	69
	Gate Valve	8	Zarqa network	16	nos	32
	Gate Valve	12	Zarqa network	16	nos	13
	Gate Valve	16	Zarqa network	16	nos	5
	Gate Valve	24	Zarqa network	16	nos	2
	Air release valve	2	Zarqa network	16	nos	15

2.2.3 Basic Plan

2.2.3.1 Component of the Programme

The Programme is composed of the procurement of materials and equipment described in the table below and Soft Component.

Table 2.2.5 Components of Materials and Equipment to be Procured

Use	Requested item			
	Pumping facility	Materials for pipelines	Water flow meter/Flow control valve	Lot No.
Transmission from major well water sources	Azraq Pumping Station			1
	Transformer 11kV/6.6kV, 6000kVA, 2 sets Multi-stage single suction centrifugal pump 5 sets (including 1 standby) Discharge: 425 m^3/h/set, Head 360m Air Valve Dia4", 1 set Transmission steel pipe: approx.40m	Air valves for pipeline to Khaw Dia.4": 40 nos.	Water flow meter at P.S. -at inflow side: 2 sets -at discharge side: 1 set Flow control valve: 1 set	
	Hallabat Pumping Station			
	[For Khaw Reservoir] Transformer 33kV/400V, 1000kVA, 1 set Multi-stage single suction centrifugal pump:2 sets (including 1 standby) Discharge: 500 m^3/h/set, Head 135m Separation valve: 1 set	Air valves for pipeline to Khaw Dir.4": 15 nos.	Water flow meter at P.S. -at inflow side: 2 sets -at discharge side.: 1 set Flow control valve: 1 set	
	[For Hallabat Village] Multi-stage single suction centrifugal pump:2 sets Discharge: 150 m^3/h/set, Head 150m	—	Water flow meter at P.S. -at discharge side: 1 set Flow control valve: 1 set	
Transmission to Batrawi Reservoir	Zarqa Pumping Station			
	Multi-stage single suction centrifugal pump:3 sets (including 1 standby) Discharge rate: 400 m^3/h/set, Head 90m	Transmission pipeline to Batrawi Dia.600, approx. 2 km	Water flow meter at P.S. -at discharge side: 1 set Flow control valve: 1 set	
	New Khaw Pumping Station			
	Gate valve, non-retaining valve and butterfly valve for existing pumps: 4 sets	—	Water flow meter at P.S. -at inflow side: 2 sets -at discharge side: 1 set Flow control valve: 1 set	
Materials for water distribution networks in Zarqa District	—	—	Water flow meter at water transmission pipelines: 2 sets	
	—	Gate valves Dia.4" - 24", 343 nos., Air valves Dia2": 15 nos.	—	2

Table 2.2.6 Content of the Operation and Maintenance Technical Guidance

No.	Details of assistance	Activity	Recipients
1.Operation and maintenance technical guidance of pumping facilities by the Procurement Contractor			
1	Operation management technology	Training in operation management	Pump operators at the pumping stations assisted in this Programme
2	Maintenance technology: Preventive maintenance	Training in technology for inspection and maintenance	Maintenance managers at Zarqa GWA and Azraq Pumping Station
3	Maintenance technology: Maintenance after breakdown	Training in technology for repair	CWS maintenance managers
4	Safety management technology	Training in technology for safety	Safety managers at Zarqa CWS and Azraq Pumping Station
2. Soft component by the Consultant			
1	Appropriate operational management technology of pumping water transmission system	Training in drafting of an efficient water transmission plan Training in diagnosis of pumping operation efficiency	Water directorate managers at Zarqa GWA

2.2.3.2 Design Capacity of the Proposed Pumps

(1) Azraq Pumping Station

1) Hydraulic condition of pipeline

Prior to designing the pumping facility, the velocity coefficient (Roughness Value of Pipe) of the existing pipeline was calculated from measurements of the flow and pressure in the pipeline from the pumping station. The highest point of the pipeline is located 51.6km from the pumping station. The water pressure inside the pipeline at this point was measured at 0. This means that water flows by gravity from the highest point to the reservoir at Khaw Pumping Station.

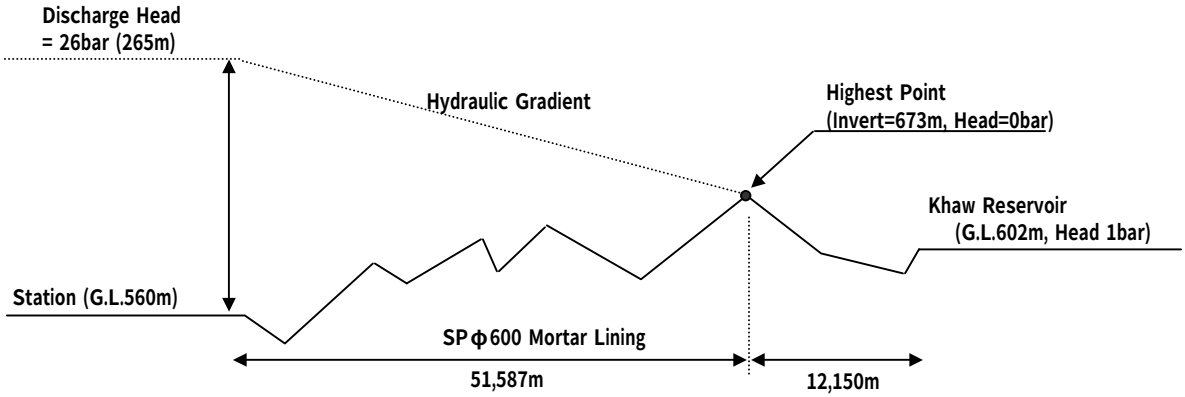


Figure 2.2.2 Profile of Azraq-Khaw Water Transmission Pipeline

Table 2.2.7 Measurement of the Flow in Azraq-Khaw Pipeline

Description	Discharge (m^3/h)	Remarks
Discharge Point at Azraq Station	1,512	By existing electromagnetic flow meter
Ditto	1,470	By ultrasonic meter (NRW of Zarqa GWA)
Inlet Point of Khaw Reservoir	1,400	By ultrasonic meter (NRW of Zarqa GWA)

*Date 22 June 2009

An electromagnetic flow meter is installed on the water transmission pipeline from the pumping station to Khaw. However, the readings were unstable and approx. 3% higher than the readings obtained with an ultrasonic flow meter. Since the meter is not protected in a pit, the sensor part is exposed to the wind and rain. This exposure is a cause of the inaccurate readings.

A survey conducted by GTZ in April 2009 revealed that the minimum and maximum flows in the pipeline were 1,500 m^3/h (when three pumps were operated) and 1,700 m^3/h (when four pumps were operated), respectively. At the time of the JICA survey, three pumps were operated and the flow at the discharge point of the pumping station was measured at approx. 1,500 m^3/h.This observation confirmed the previous observation. The flow of the water reaching Khaw Pumping Station is lower than the flow of the transmitted water because water is diverted for use by nomads (Bedouins), Hashemeyeh University and a chlorine plant on the way to Khaw. Assuming the flow in the transmission pipeline is 1,400 m^3/h, the coefficient of velocity was calculated.

[Hazen-Williams Formula]

$I = 10.666 \times C^{-1.85} \times D^{-4.87} \times Q^{1.85} \rightarrow C = 3.5903 \times Q \times D^{-2.63} \times I^{-0.54}$

Table 2.2.8 Hydraulic Condition of Azraq Pipeline

Description	From: Azraq Station To: Highest Point	From: Highest Point To Khaw Reservoir
Discharge	0.389 m^3/sec	0.389 m^3/sec
Inside Diameter of Pipe	0.587 m	0.587 m
Pipe Friction Loss (h)	(560+265)-(673+0)=152 m	(675+0)-(602+10)=63 m
Hydraulic Gradient (I=h/L)	152/51,587=0.00295	63/12,150=0.00519
Coefficient of Velocity (C)	132	97
Weighted Average (Cave)	125	

Because the pipeline is made of cement mortar-lined steel pipes and is used for transmission of good quality water from wells as a water source, the decrease in the velocity coefficient (Roughness Value) resulting from years of use is expected to be small. The coefficient of velocity in the case of cement mortar-lined cast-iron pipes and coated steel pipes are as follows:

Table 2.2.9 Coefficients of Velocity of the Pipeline

Condition	Coefficient
When losses at curves, bends and valves are included	110
When losses at curves and bends are excluded	130

Because the pipeline is mostly straight, it is considered possible to use a relatively high coefficient of velocity despite the years of use. Therefore, a figure of 125 has been adopted as the coefficient of velocity of the pipeline as a whole.

2) Design discharge

The design discharge from Azraq Pumping Station has been established on the basis of the yield of the existing wells. The average yield of the wells was 46,375 m^3/day (1,932 m^3/h) in 2008. From this yield, 200-300 m^3/h is always distributed to Azraq Village. Therefore, the discharge from the station to Khaw is approx. 1,700 m^3/h at maximum.

On the basis of the above-mentioned, the inlet and discharge flow rates at the pumping station have been set as follows:

- Yield of water source at Azraq Pumping Station: 1,900 m^3/h
- Maximum discharge to Khaw: 1,700 m^3/h
  (200 m^3/h to Azraq Village is deducted from the source yield)
- Minimum discharge to Khaw: 1,500 m^3/h (flow velocity of 1.54 m /sec)
  (Result of actual measurement at the site)

3) Establishment of number of pumps

- Relevant issues

When establishing the number of pumps, attention is to be paid to the following:

- To reduce the risk of damage caused by sudden stopping of the pumps (water hammer)
- To use the available space in the existing new pumping house
- To control discharge by switching on/off of pumps, not by valve throttling
- To standardize the pumps to the same discharge flow and head for flexible maintenance

- Space for installation

Five existing pumps (Pumps Nos.3-7) in the new pumping station will be removed and the foundation work for and installation of the new pumps will be implemented. Of the existing pumps in the new pumping house, while Pumps Nos. 1 and 3 are in operation, Pumps Nos. 4-8 are out of order because of mechanical problems. The following are the advantages of this installation plan:

- Removal of Pumps Nos. 4-8 will not impede operation of the other existing pumps.
- The minimum required flow during the work will be ensured by operating Pump No.1 and the old pumping station.
- Continued use of the existing collecting pipes on the discharge side.

It is also possible to install the new pumps where an unused generator is currently installed, after removing the generator. However, this plan will require not only removal of the huge generator, but also extension of the inlet and discharge pipelines. Such additional work will not contribute to improving the operational efficiency of the pumping station. Figure 2.2.3 shows the new layout plan.

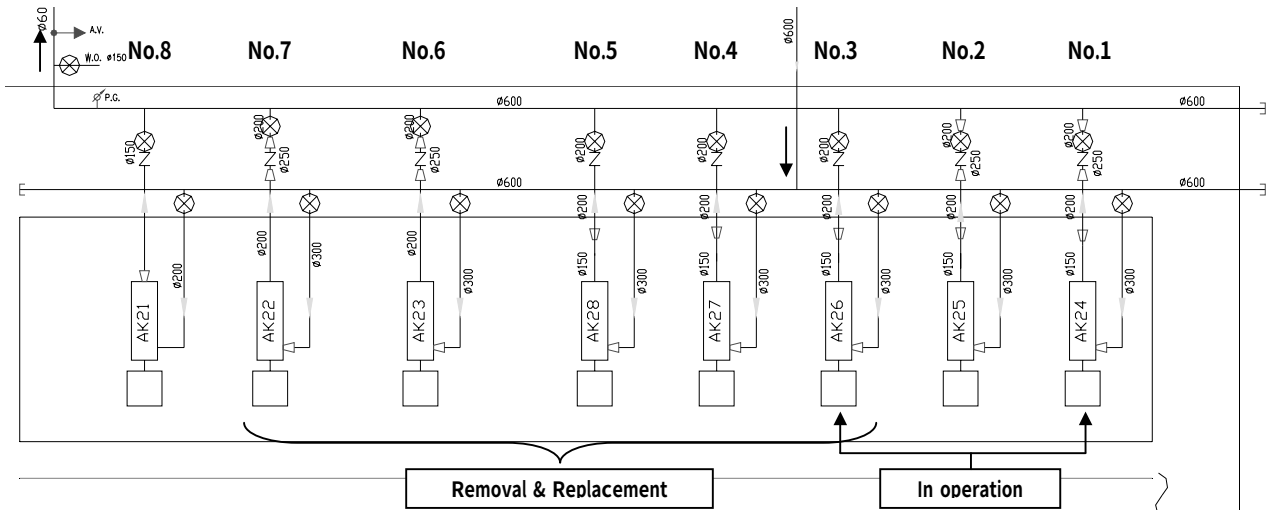


Figure 2.2.3 New Layout Plan of Azraq Pumping Station

- Number of pumps

The original request presented by WAJ includes two 500 m^3/h capacity pumps and two 300 m^3/h capacity pumps. The characteristics of the water transmission system imply that there is little need for significant change in the discharge under this system. Therefore, it is considered efficient to install a

sufficient number of pumps with the same capacity.

For the reason mentioned above and for effective use of the space vacated by removal of the five existing pumps, five new pumps with the same capacity, four for daily operation and one as a backup, will be installed. The 1,700 m^3/h design discharge of the station means that each pump must have a capacity of 425 m^3/h.

4) Establishment of total head

Hydraulic calculations were conducted to determine the pumping head required to avoid negative pressure inside the pipeline at the highest point (L = 52 km).

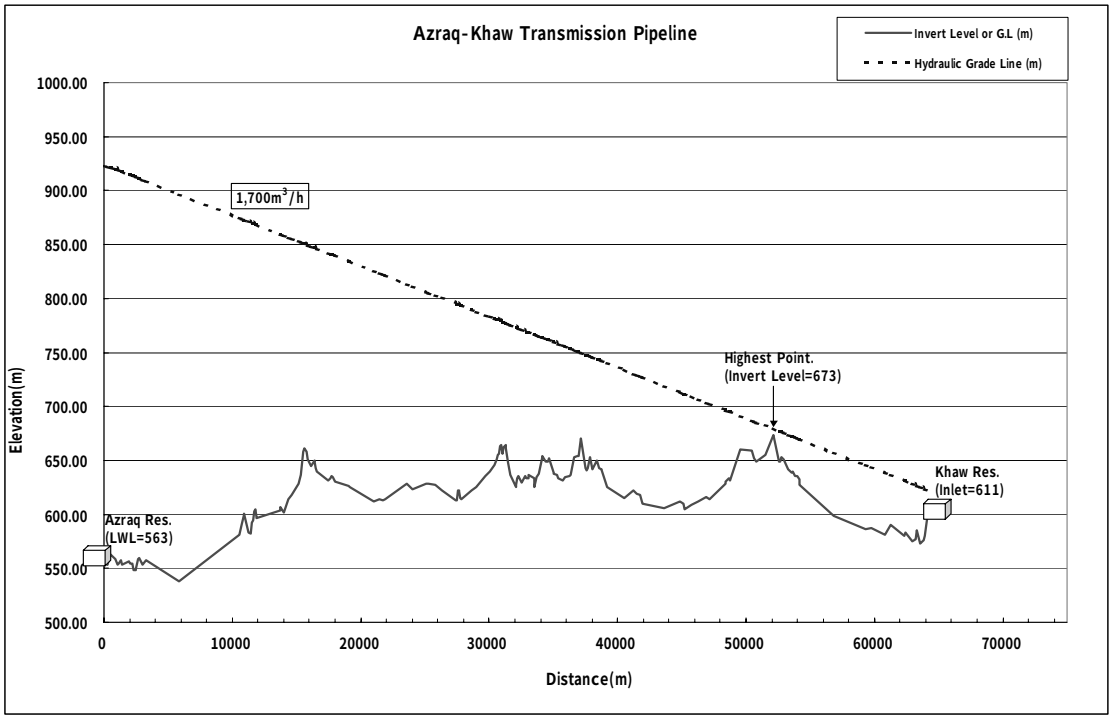


Figure 2.2.4 Hydraulic Gradient of the Azraq Water Transmission System

Table 2.2.10 Hydraulic Calculation of the Azraq Water Transmission System

Description	Data
Discharge	0.472 m^3/sec
Inside Diameter of Pipe	0.587 m
Velocity	1.75 m/sec
Coefficient of Velocity (C)	125
Hydraulic Gradient (I) *1)	0.00470
Distance from Azraq Reservoir to New Pumping Station	250 m
Distance from New Pumping Station to Initial Point of Pipeline	270 m
Distance from Initial Point to Highest Point	51,587 m
Total Distance	52,107 m
Difference in Elevation between Azraq Reservoir (LWL) and Highest Point	110.3 m
Friction Head Loss (h)	0.00470×52,107=244.9m
Required Total Head	110.3+ 244.9 = 355.2 m
Design Total Head	360 m

5) Pumping system curve

Figure 2.2.5 shows the system curves when four pumps transmit 1,700 m^3/h of water. As the pumping capacity curve for three pumps intersects with the resistance curve, stable and appropriate operation can be achieved with operation of three of the four pumps, while operation of the remaining pump is suspended. In this case, the discharge will be approx.1, 500 m^3/h. In other words, it will be possible to ensure the minimum discharge with three pumps.

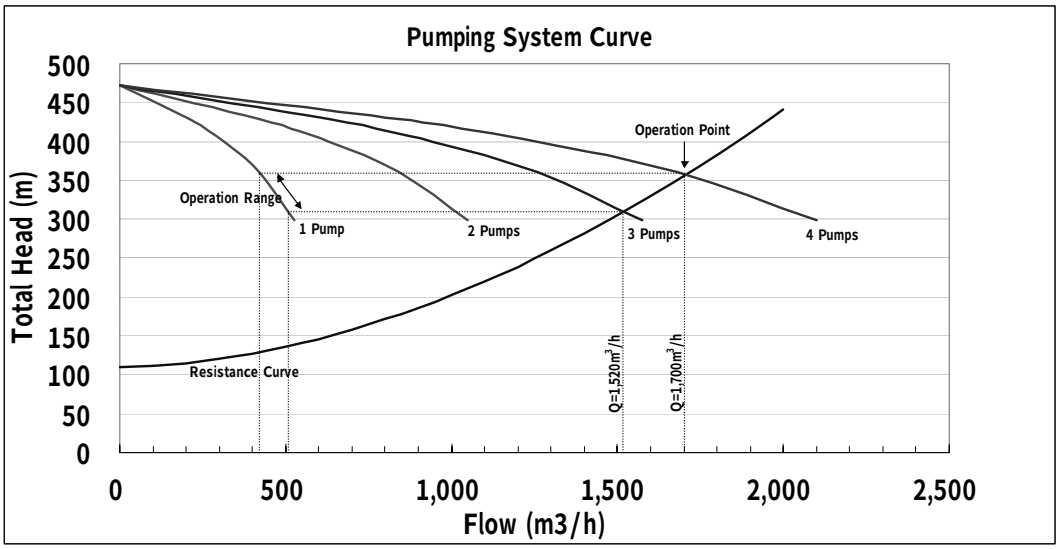


Figure 2.2.5 Pumping System Curve with Four Pumps in Azraq

Figure 2.2.6 shows the system curves when three pumps transmit 1,700 m^3/h of water. In this case, since each pump has to discharge a larger amount of water than in the case of four-pump operation, the pumping capacity curve may not intersect with the resistance curve of the pipeline when operation of one of the pumps is suspended. Therefore, two pumps will have to be operated simultaneously with the valves on the discharge sides partially closed. However, the current minimum discharge will not be achieved with such operation. It also contradicts the purpose of the program to improve energy efficiency, since operation with the valves partially closed impedes efficient pump operation.

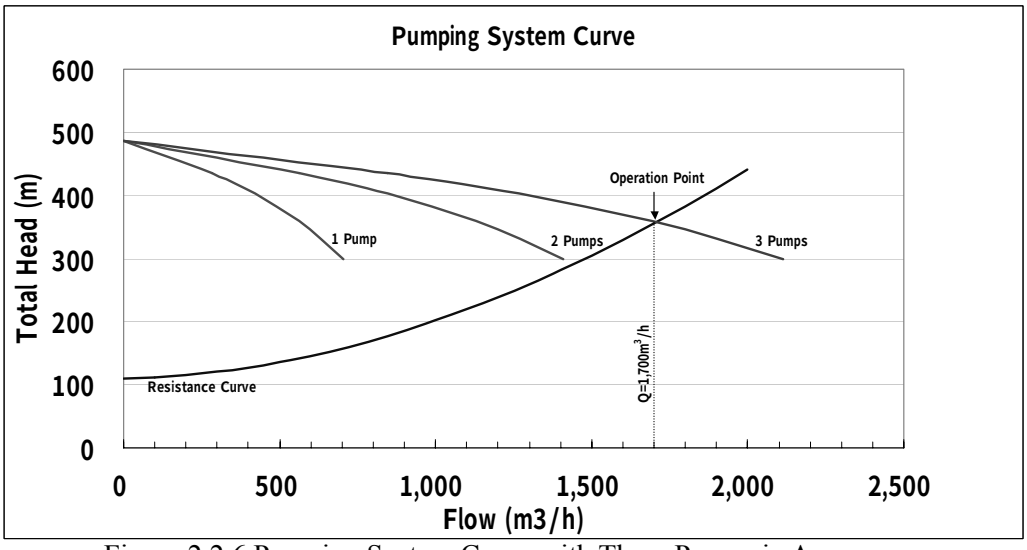


Figure 2.2.6 Pumping System Curve with Three Pumps in Azraq

(2) Hallabat Pumping Station

1) Hydraulic condition of pipeline

In the same way as in the case of Azraq Pumping Station, the velocity coefficient of the existing pipeline was calculated as described below. This pipeline merges with the water transmission pipeline from Corridor Wells 840 m from Hallabat Pumping Station. From a point 8 km from the station to Khaw, the pipeline runs parallel with the transmission pipeline from Azraq Pumping Station. The pumping head should be determined from the results of the field survey so as to avoid negative water pressure inside the pipeline at the highest point.

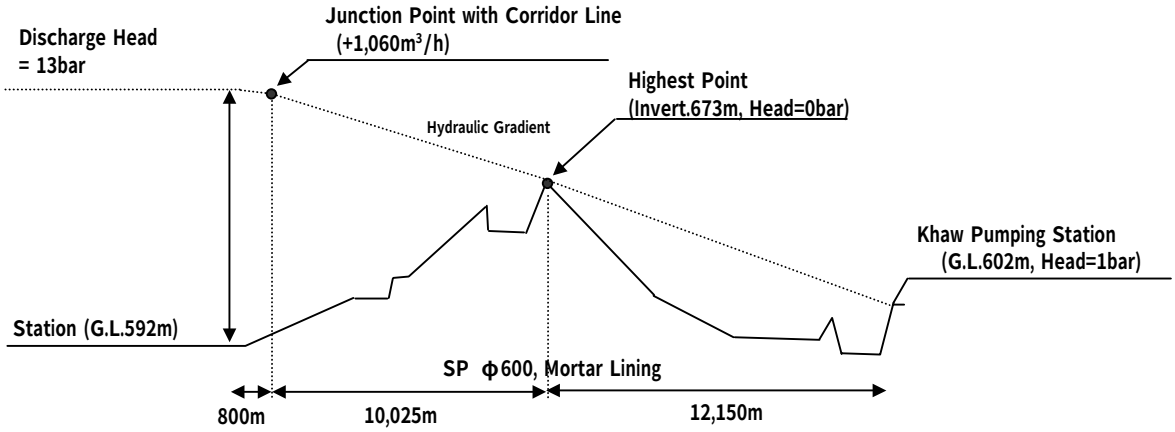


Figure 2.2.7 Profile of Hallabat-Khaw Water Transmission Pipeline

Table 2.2.11 Flows in Hallabat-Khaw Transmission Pipeline

Description	Result 1	Result 2	Remarks
Discharge from Hallabat Station	380 m^3/h	530 m^3/h	By ultrasonic meter
Inlet from Corridor Line	1,060 m^3/h	1,043m^3/h	-
Head at Corridor Junction	119 m	126 m	-
Total Discharge	1,440 m^3/h	1,573 m^3/h	By ultrasonic meter

* Source: Data provided by WAJ, measurements taken on 5 May 2009

The water transmission pipeline from the station merges with that from Corridor Wells approx. 900 m from the station. The flow rates of distribution from Hallabat to Khaw and from Corridor Wells to Khaw are 500 m^3/h and 900-1,000 m^3/h, respectively. In the summer, water from privately owned wells temporarily merges with the water from Hallabat and Corridor. Therefore, the flow at the inlet of Khaw Pumping Station varies within a range of 1,400-1,900 m^3/h.

Using the above-mentioned actual measurements, the velocity coefficient of the pipeline between the junction with the Corridor Line and Khaw Pumping Station was calculated.

[Hazen-Williams Formula]

$$I = 10.666 \times C^{-1.85} \times D^{-4.87} \times Q^{1.85} \rightarrow C = 3.5903 \times Q \times D^{-2.63} \times I^{-0.54}$$

Table 2.2.12 Hydraulic condition of Hallabat Line

Description	Data	
Discharge	0.400 m^3/sec	0.437 m^3/sec
Inside Diameter of Pipe	0.587 m	0.587 m
Friction Head Loss (h)	(594+119)-(678+0)=35 m	(594+126)-(678+0)=42 m
Hydraulic Gradient (I=h/L)	35/9,763=0.00358	42/9,763=0.00430
Coefficient of Velocity (C)	122.1	122.2

In accordance with the table above, a figure of 122 has been adopted as the velocity coefficient of the transmission pipeline.

2) Design discharge

The design discharge from Hallabat Pumping Station was established on the basis of the yield of the existing wells. The average yield of the wells was 17,053 m^3/day (711 m^3/h) in 2008. From this yield, 100-250 m^3/h is always distributed to Hallabat Village. In addition to the discharge of approx. 500 m^3/h from Hallabat Pumping Station, there is an inlet of 900-1,000 m^3/h from the Corridor Line and there are additional discharges from privately owned wells to the pipeline during the summer. In total, the average and maximum flows to Khaw are approx. 1,700 m^3/h and 1,900 m^3/h, respectively. As is the case with the Azraq Line, this pipeline is made of Dia. 600 mm cement mortar-lined steel pipes. The flow velocity is 1.95 m/s at a flow rate of 1,900 m^3/h in such a pipeline. Because the standard velocity desirable for a pumping water transmission pipeline is 1.2-1.8 m/s and to reduce the risk from water hammer pressure, it is desirable to set the maximum discharge at 1,700 m^3/h, the same as at Azraq Pumping Station.

Available Water Resources in Hallabat:	700 m^3/h (from production records)
Maximum Discharge to Khaw:	500 m^3/h
Minimum Discharge to Khaw:	450 m^3/h
Maximum Inlet from Corridor Line:	1,200 m^3/h
Minimum Inlet from Corridor Line:	900 m^3/h
Maximum Flow to Khaw:	1,700 m^3/h (V=1.74 m/s)
Minimum Flow to Khaw:	1,350 m^3/h (V=1.39 m/s)

3) Establishment of number of pumps

- Relevant issues

The issues requiring attention when deciding the number of pumps are the same as in the case of Azraq Pumping Station.

- Space for installation

Two pumps, Pump No. 1 (for discharge to Khaw) and Pump No.4 (for discharge to Hallabat), are currently in use and the other two are not used. At first, Pump No.1 will be relocated to the place from

which Pump No.3 has been removed in order not only to ensure that Pumps Nos. 1 and 4 are available for operation at any time, but also to create space to install the new pumps. Then, the foundation work and installation of the new pumps will be carried out where Pumps Nos. 1 and 2 are currently located. Continued use of the existing collecting pipes on the discharge side after the installation of the new pumps will not affect the installation work significantly. However, since the discharge pipelines to Khaw and to Hallabat must be completely separated, the bypass pipeline and relevant valves will be removed.

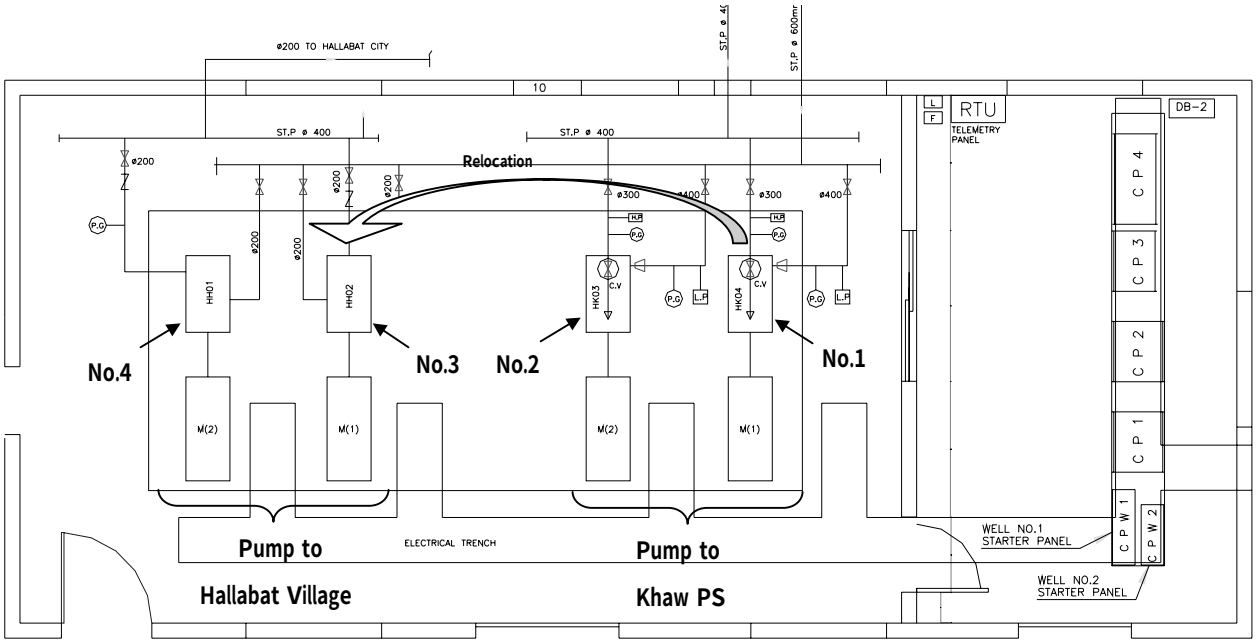


Figure 2.2.8 New Layout Plan of Hallabat Pumping Station

- Number of pumps

One 500 m^3/h-capacity pump was included in the original request. The above-mentioned discussion suggests that this discharge capacity is appropriate. The characteristics of the transmission system imply that there is little need for significant change in the discharge under this system. Therefore, two pumps with the same capacity, one for daily operation and the other as a backup, will be installed.

4) Establishment of total head

Hydraulic calculations were conducted to determine the pumping head required to avoid negative pressure inside the pipeline at the highest point (L = 10 km).

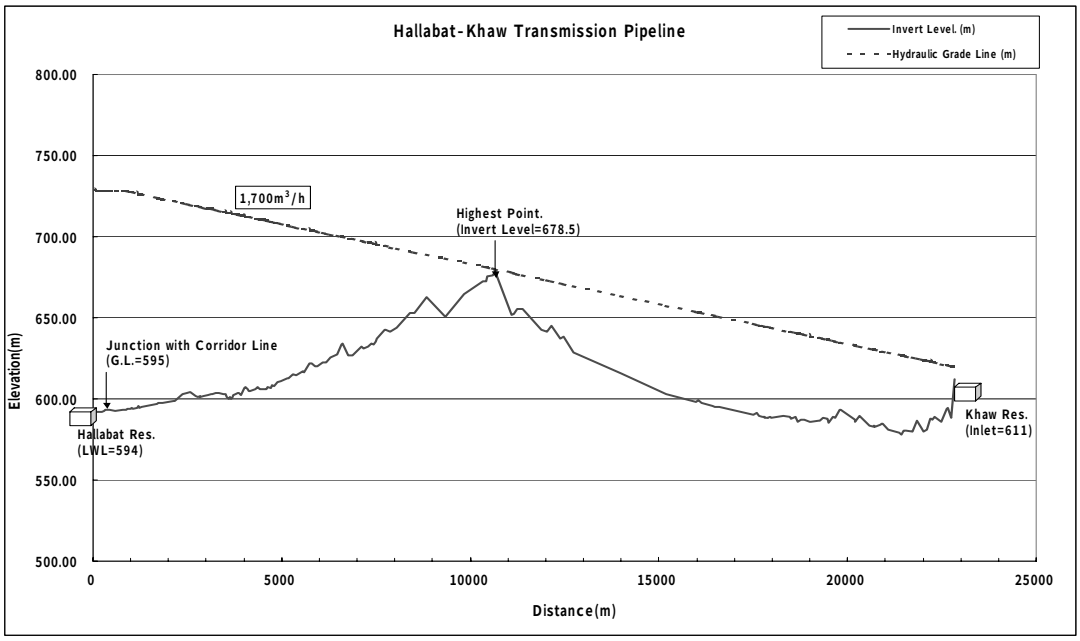


Figure 2.2.9 Hydraulic Gradient of the Hallabat Water Transmission System

Table 2.2.13 Hydraulic Calculation of the Hallabat Water Transmission System

Description	Figure
Coefficient of Velocity (C)	122
From Corridor Junction to Highest Point	
Discharge	0.472 m^3/s
Inside Diameter of Pipe	0.587 m
Hydraulic Gradient (I) *1)	0.004913
Distance from Corridor Junction to Highest Point	9,763 m
Difference in Elevation between Corridor Junction and Highest Point (Invert)	85 m
Friction Head Loss (h)	0.004913×9,763=48m
Necessary Head at Corridor Junction	85+ 48 = 133 m
From Hallabat Station to Corridor Junction	
Discharge	0.139 m^3/s
Inside Diameter of Pipe	0.587 m
Hydraulic Gradient (I) *1	0.000512
Distance from Pumping Station to Corridor Junction	900 m (including suction pipe)
Difference in Elevation between Hallabat Reservoir (LWL) and Corridor Junction GL	0.3 m
Friction Head Loss (h)	0.000512×900=0.5 m
Required Total Head	0.3+0.5+133 = 133.8 m
Design Total Head	135 m

5) Pumping system curve

Figure 2.2.10 shows the system curves when the pump is operated at the design discharge of 500 m^3/h. The resistance curve was obtained on the assumption that a flow of 1,200 m^3/h from the Corridor Line was maintained when the discharge from the pump at Hallabat Pumping Station was 0. Therefore, in the case of a rapid decrease in the flow from the Corridor Line, the decrease will affect the operating condition of the pump at Hallabat Pumping Station. If the flow from the Corridor Line is less than the minimum flow of 700 m^3/h, the resistance curve will be outside the range of the pump capacity. In such a case, the flow rate will have to be adjusted by a flow control valve.

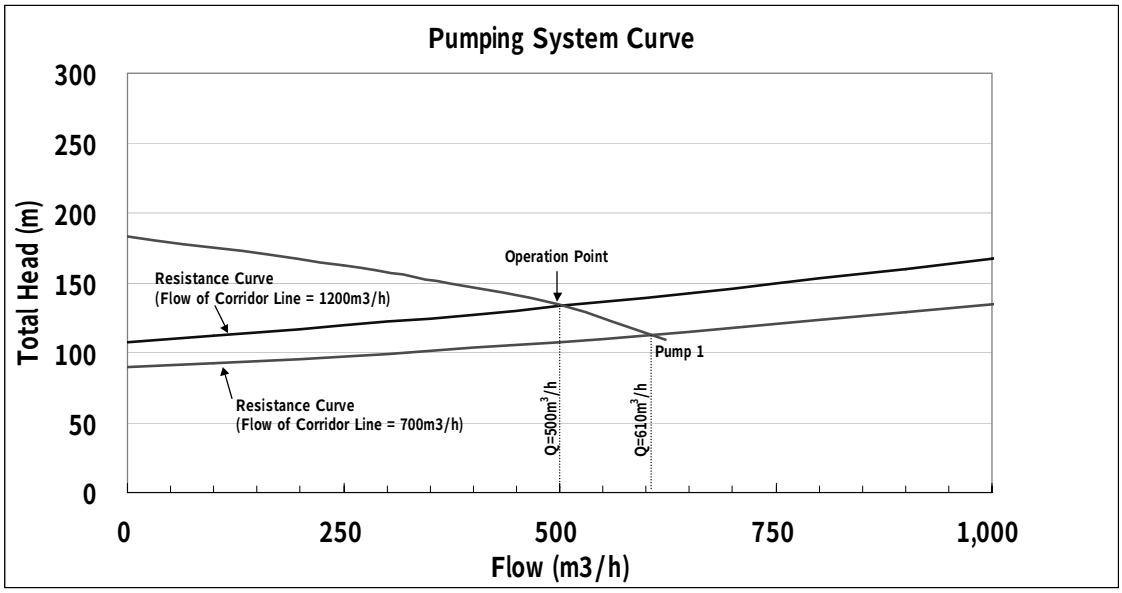


Figure 2.2.10 Pumping System Curves at Hallabat Pumping Station

(3) New Zarqa Pumping Station

1) Hydraulic Condition of Pipeline

The New Zarqa Pumping Station will be constructed on the premises of the existing R/O plant. The shortest route of the new transmission pipeline from Zarqa Pumping Station to Batrawi Reservoir is approx.2.2km. The installation route will be the same as the existing Khaw-Batrawi Water Transmission Pipeline (Dia.700 mm, constructed in 2002). On the basis of the cross section of the Khaw-Batrawi Water Transmission Pipeline, the elevation at each point and the distances between points have been established as shown below.

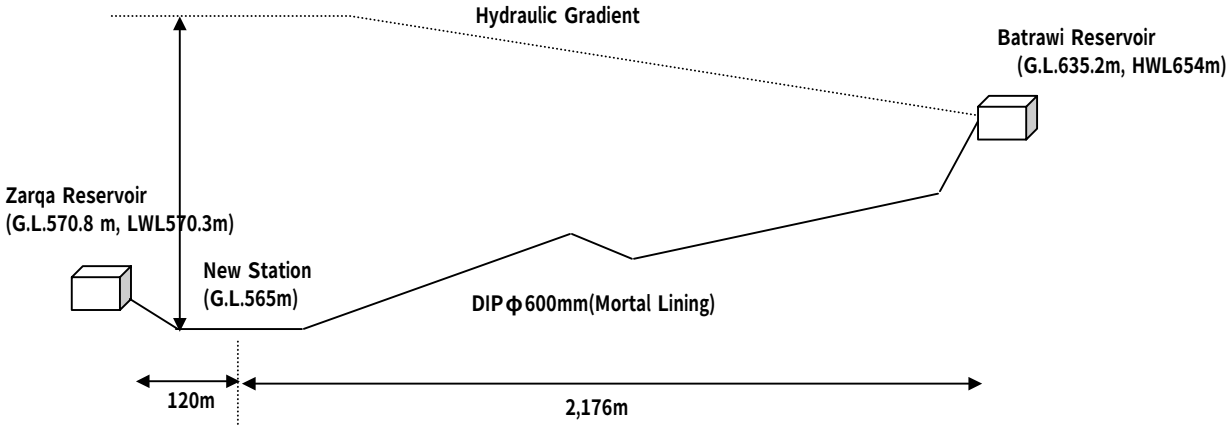


Figure 2.2.11 Profile of Zarqa-Batrawi Water Transmission Pipeline

Pipes with an inner diameter of 450 mm and 500 mm are not commercially available in Jordan. Adoption of such pipes will result in maintenance problems because it is difficult to procure valves and fittings for these pipes in Jordan. Therefore, considering WAJ's request, pipes with an inner

diameter of 600 mm will be adopted, despite the small extra capacity in flow velocity. The adoption of Dia. 600 mm pipes will be advantageous because it will reduce the friction head losses and, thus, reduce the pumping head required for the pipeline. A figure of 110 has been adopted as the velocity coefficient in the hydraulic calculations.

2) Design discharge

The design discharge from Zarqa Pumping Station to Batrawi Reservoir has been decided on the basis of the yields of the Zarqa Wells (water treated at the R/O Plant) and Hashemeyeh Wells.

The scenario of water transmission in the existing project assumes that water from Zarqa and Hashemeyeh Wells is transmitted to Batrawi Reservoir, where it will be mixed with good-quality water from Khaw Pumping Station, and the mixed water will be distributed.

At present, Batrawi Reservoir is under construction. For the period until the completion of construction in March 2010, the following water transmission plan is proposed:

Average daily water supply to Zarqa (High and Low Elevation Zones)	50,600 m^3/day (2,108 m^3/h)
Discharge from Khaw to Batrawi:	31,453 m^3/day (1,310 m^3/h)
Discharge from Zarqa Pumping Station to Batrawi:	19,147 m^3/day (798 m^3/h)

Because of the need to divert water from the Khaw-Batrawi Water Transmission Pipeline to Hashemeyeh and Sukhneh (5,500 m3/day), the total discharge from Khaw Pumping Station will be 36,953 m3/day. Zarqa GWA will have to prepare an operation plan for Khaw Pumping Station to ensure the above-mentioned discharge from Khaw Pumping Station. In particular, at the branch point to Hashemeyeh on the Khaw-Batrawi Transmission Pipeline, the flow will have to be distributed appropriately between the two lines by adjusting the valve.

Figure 2.2.12 shows the monthly average flow from Hashemeyeh Wells and the monthly average discharge of treated water from Zarqa R/O Plant in 2008. The figure shows little change in the flow throughout the year and an annual average of 796 m^3/h, which corresponds well to the daily average discharge (798 m^3/h) in the above-mentioned scenario. WAJ is negotiating with a company, which is contracted to operate Zarqa R/O Plant concerning improvement of the treatment capacity. At present, the volume of wastewater corresponds to approx. 21 % of the yield of the wells. Reduction of this percentage by improvement of the treatment capacity will increase the amount of water suitable for drinking.

However, the yield of Zarqa Wells in 2008 was 4,488,601 m^3/year, or 512 m^3/h. Even if the proportion of wastewater is reduced to 10 %, the combined flow from the R/O plant and Hashemeyeh Wells will merely increase to 850 m^3/h. Therefore, the design discharge from Zarqa to Batrawi has been set at 800 m^3/h for the design of the pumps.

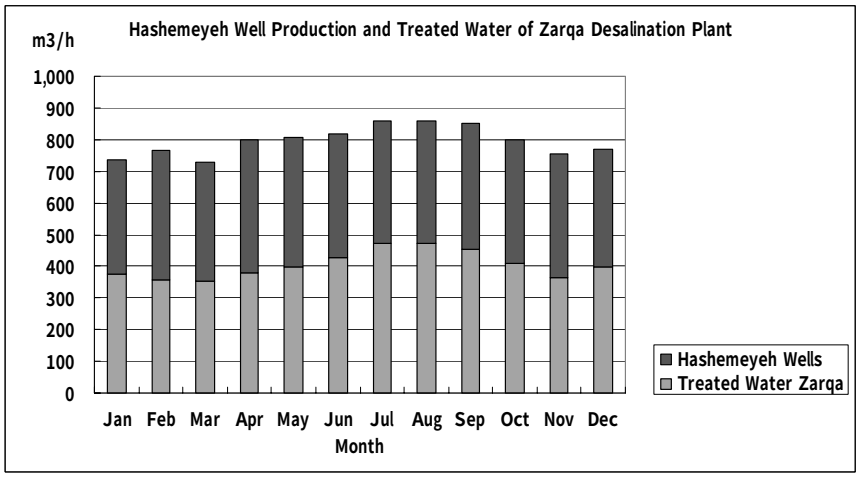


Figure 2.2.12 Frow of Treated Water of Zarqa R/O Plant and Hashemeyeh Wells

3) Number of pumps

There will be few restrictions on the layout of the pumping station to be designed because the number of pumps required is the only factor to be considered. Meanwhile, the transmission pipeline to Batrawi Reservoir will be installed exclusively for water transmission to the reservoir and no connection with other transmission pipelines will be allowed.

Since the design discharge is high (800 m^3/h), three 400 m^3/h-capacity pumps, two for daily operation and one as a backup, will be installed.

4) Establishment of total head

Hydraulic calculations were conducted to determine the required pumping head under the conditions of the planned transmission pipeline as mentioned below.

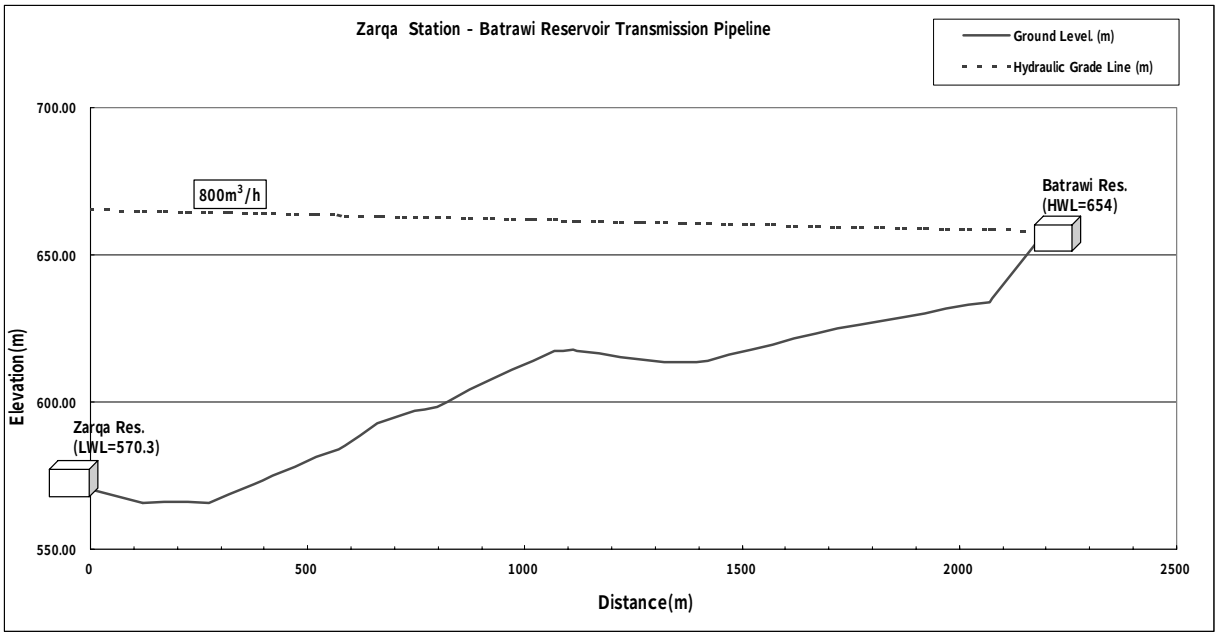


Figure 2.2.13 Hydraulic Gradient of Zarqa-Batrawi Water Transmission Pipeline

Table 2.2.14 Hydraulic Calculation of Zarqa-Batrawi Water Transmission Pipeline

Description	Data
Discharge	0.222 m^3/sec
Inside Diameter	0.603 m
Coefficient of Velocity (C)	110
Hydraulic Gradient (I)	0.00129
Distance of Pipeline	2,176 m
Friction Head Loss (h)	0.00129×2,176=2.8 m
Difference in Elevation between Zarqa Reservoir (LWL) and Batrawi Reservoir (HWL)	83.7 m
Required Total Head	2.8 + 83.7 = 86.5 m
Design Total Head	90 m

5) Hydraulic condition of pipeline

The system curve when two pumps transmit the design discharge of 800 m^3/h is shown in Figure 2.2.14.

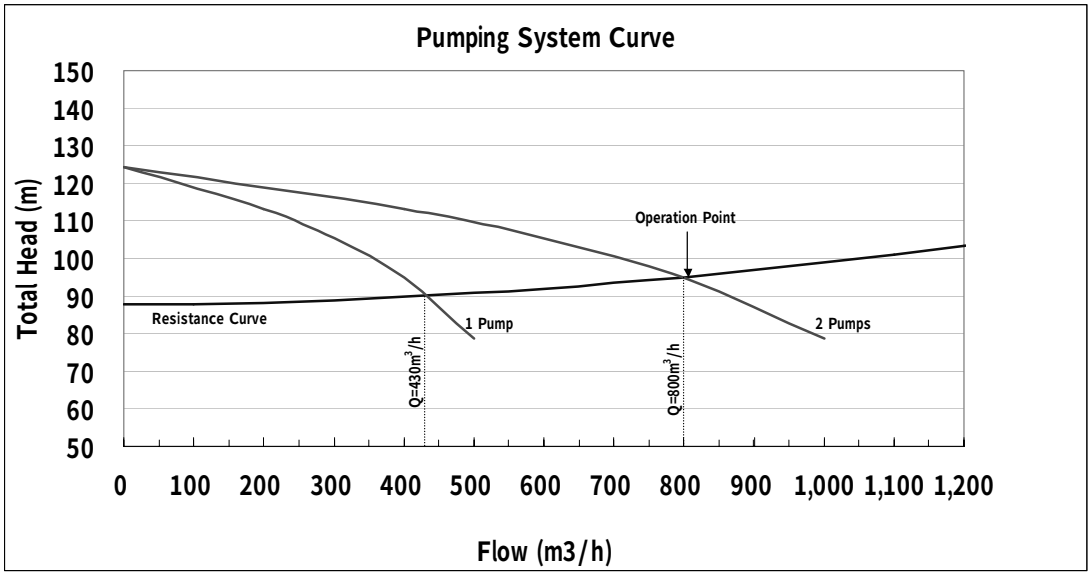


Figure 2.2.14 Pumping System Curves of the Zarqa-Hallabat Water Transmission Pumps

(4) Pump installation plan

When installing the new pumps, the space currently occupied by unusable pumps and pumps with no future use will be utilized effectively. The pumps to be installed will be connected to the existing discharge and suction pipes by steel pipes and valves.

- A gate valve to stop the water flow will be installed on the suction pipe of the pumps.
- A check valve and a butterfly valve will be installed on the discharge pipe of the pumps.
- The foundations of the pumps will be a concrete structure with sufficient strength to withstand the load and vibration of the pumps.
- A compound gauge and a pressure gauge will be installed on the suction and discharge sides, respectively, of the pumps.

2.2.3.3 Electric Power Receiving Plan

(1) State and problems in the current power receiving system

While a 660V power source is supplied to some pumping stations under the jurisdiction of WAJ for operation of pumping facilities, a low voltage 400V power source is standard. However, with recent technological developments and current market trends, continued sole dependence on a low voltage power source may lead to problems in future. In this Programme, the possibility of a switchover to medium voltage power receiving was examined.

(2) Availability of equipment on the Jordanian market

It is standard in most developed countries, including Japan, Europe and the U.S.A., to adopt medium voltage of 6.6kV as the power source for motors of 200-300kW-class or higher output. Although large-capacity motors for low voltage power receiving are available from multiple manufacturers in Jordan, they are not common on the global market. It has been confirmed that it is possible to procure a motor of 700kW-class output, which is required in this Programme for replacement at Azraq Pumping Station, from one company, while it is almost impossible to procure such a motor manufactured in Japan, Europe or the U.S.A.

The switchover to a medium voltage power receiving system is taking place in private companies in Jordan and the number of manufacturers of power source facilities with the technical capability to handle such systems seems to be increasing. There is no guarantee in future of the availability of specialized low-voltage/large capacity component parts (switches, circuit breakers, etc.) for the auxiliary electric equipment.

(3) Current state of similar facilities

At the "Zai System pumping station for raw water transmission," which was repaired with Japan's grant aid cooperation, and "Wadi Ma'in, Zara & Mujib Water Treatment Plants" constructed with assistance from USAID, the 6.6 kV medium voltage power receiving system was adopted because the output of the pump motors at these facilities was 2,000 kW-class. At these facilities, management and operation systems corresponding to medium voltage power receiving, including appointment of a full-time manager and introduction of a safety management system, have been adopted. It is expected that, with the implementation of these projects, the need for such medium voltage power receiving systems be expected to increase gradually.

(4) Advantages of the medium voltage power receiving system

The power distribution voltage is usually determined after examining the electric characteristics and load distribution and taking into consideration economic factors and energy conservation in accordance with the scale of the facilities. Economic benefit is expected from a reduction in power loss by increasing the voltage in accordance with the increased capacity of the motors and the scale of

the buildings. Medium voltage power receiving enables a stable power source supply because the voltage drop is smaller than the low voltage power receiving. Adoption of medium voltage power reception will enable use of cables with a smaller cross section, which will facilitate wiring work. Thus, it will be possible to use cable trays installed on walls and ceilings for wiring instead of trenches as seen in the existing pumping stations. This change will bring advantages in maintenance of the facilities because it will enable detection of abnormalities at an early stage.

(5) Policies on the power receiving plan

If the procurement and installation of transformers is entrusted to a power distribution company, the transformers will be maintained by the power distribution company free of charge for 20 years and then transferred to the power distribution company as assets. If WAJ installs the transformers, it will be WAJ's responsibility to maintain them. Possible changes in the power distribution voltage systems are as follows:

1) Azraq Pumping Station

A substation of National Electric Power Company (NEPCO) is located adjacent to the pumping station premises and the distance between the substation and the existing transformers at Azraq Station (11kV/0.4 kV, two units) is relatively short. Electricity Distribution Company (EDCO) is responsible for power distribution.

If a medium voltage power receiving system is adopted at Azraq Station, it will be necessary to replace the existing transformers with transformers for medium voltage power receiving and also to replace part of the power distribution cable. The total length of the distribution cable from the substation to the planned installation site of the new transformers will be 318 m. Since new cable will be installed for 275 m, no replacement will be required for this part. It will be necessary to replace the old cable for the remaining 43 m. Because of the close proximity of the substation and the pumping station, there will be no need to increase the power transmission voltage from 11kV to 33kV. Estimation reveals that a 6,000kVA-capacity 11kV/6.6kV transformer will be required for the assumed capacity of the pumps at present. Since Azraq Pumping Station is an important facility for water transmission from the water sources, two transformers, including one standby, for medium voltage power receiving will be installed.

The cost of replacement of the distribution cable associated with this replacement is approx. 7,000 JD. Since this amount will not be a major burden on WAJ, WAJ has agreed to change to medium voltage power receiving at Azraq Station.

2) Hallabat Pumping Station

The existing transmission cable carries 33kV electricity and the station has two 1,000kVA transformers. The existing station building does not have sufficient space to install pumps. The superannuated building will pose problems for the wiring for medium voltage power receiving.

Since the pump operators will be the only full-time operation and maintenance personnel at the station, it will be difficult to change the station to a medium voltage power receiving facility because of concerns over safety management. Therefore, the existing low voltage power receiving system will remain in operation. Since the capacity of the existing transformers is not sufficient for the starting current of the pumps, one 1,000 kVA transformers will be procured in the Programme. This transformer will be used with existing two 1,000 kVA transformers. JEPCO is responsible for power distribution.

3) Zarqa Pumping Station

Zarqa Pumping Station is connected via an 11kV underground transmission line and equipped with 11kV/0.4kV transformers. Because of the limited capacity of the line, it is impossible to divert a power receiving line from it. Jordan Electric Power Company (JEPCO) is responsible for power distribution. According to JEPCO, switchover to a medium voltage power receiving system will require replacement of a 10 km stretch of the existing overhead transmission line with 33kV cables because of the existence of other demand, and this replacement will cost approx. 250,000 JD. In addition, there will be a need to install 33kV/6.6kV or 33kV/3.3kV transformers. Because the cost of replacement of the transmission cables will be too heavy a burden on WAJ and because a long work period will be required for the replacement, it will be difficult to introduce a medium voltage power receiving system in this pumping station.

An examination of the required electric power after the replacement of the equipment has revealed that operation of the three pumps to be procured by the Japanese side in this Programme will require 1,200 kVA of electricity. Since the capacity of the existing transformers is 3,000 kVA, these transformers can accommodate the power demand arising from this Programme. However, if an increase in transformer capacity becomes necessary for the installation of pumps for water distribution to the distribution network by WAJ, independent of this Programme, the cost of the required works will be borne by WAJ.

On the basis of the above discussion, of the pumping stations at which the pumping facilities will be replaced in this Programme, the medium voltage power receiving system will be introduced in Azraq Pumping Station and the other stations, Hallabat and Zarqa Pumping Stations, will continue using the current low voltage power receiving system.

2.2.3.4 Major Specifications of the Materials and Equipment

(1) Types of pumps

Table 2.2.15 Specifications of the Pumps

Pumping station	Type of pump	Quantity	Discharge rate	Pump head
		unit	m^3/h	m
Azraq	Multi-stage single suction centrifugal pump	5 (including 1 standby)	425	360
Hallabat (to Khaw Station)	Multi-stage single suction centrifugal pump	2 (including 1 standby)	500	135
Hallabat (to Halabat Village)	Multi-stage single suction centrifugal pump	2	150	150
Zarqa	Multi-stage single suction centrifugal pump	3 (including 1 standby)	400	90

(2) Auxiliary facilities

At the existing pumping stations, the valves on the discharge side are not operated when starting or stopping the pump. Therefore, there is fear of accidents such as impact of the water hammer and overloaded operation of the pumps and motors and non-operational valves. A possible underlying cause of such accidents is that high water pressure on the discharge part makes manual opening/closing of the valves difficult. Therefore, to ensure appropriate valve operation and to prevent damage to the equipment, powered valves will be installed on the discharge side of the pumps to link their operation with starting/shutdown of the pumps. Not only to detect any abnormality during pump operation, but also to prevent breakdown of the pumps and motors, protection circuits (against high pressure, high temperature and overloading, for 3E relays, etc.) will be installed.

(3) Types of motors

Three-phase squirrel-cage induction motors like those currently in use will be adopted. A comparison of the different types of motors is shown below.

Table 2.2.16 Comparison of Induction Motors

Type	Characteristics	Installation
Squirrel-cage Induction Motor	Simple structure endures long continuous operation and requires little maintenance. Highly stable against changes in power source voltage and frequency.	Can be installed without significantly changing arrangement of equipment at existing pumping facilities. However, new foundation has to be constructed.
Winding Induction Motor	Can change starting characteristics and rotational velocity with secondary resistor. Can be started without large current, and velocity can be controlled.	Larger than squirrel-cage induction motor and rearrangement of equipment may be required. Needs space to install starting resistor.

In the existing facilities, “Korndorfer (auto-transformer) starting” and “liquid resistance starting (a type of reactor starting)” is commonly used for low-to-medium output motors (50-300kW) and high-output motors (500-850kW), respectively. In this Programme, “Korndorfer starting”, “reactor

starting" etc. will be adopted to reduce the starting current and the impact on the facilities and equipment.

(4) General specifications for pump

The general specifications of the component equipment of the pumping facilities are as follows:

Table 2.2.17 Specification of Pump Equipment of Azraq Pumping Station

Item	Type	Specification	Accessories
Transmission Pump	Horizontal Single Suction Multistage Centrifugal Pump	Discharge: 425m^3/h Pump head: 360m Main body material: Cast Iron Shaft seal: gland packing Quantity：5sets（including 1 standby）	Motor operated butterfly valve, Gate valve, Non-return valve, Air valve, Compound gauge, Pressure gauge, Piping Base concrete for pump
Electric Motor	Three Phase Squirrel-cage Induction Motor	Current source: ACϕ3, 50Hz, 6.6kV, Enclosure：dust-proof, water-jet-proof type Insulation：F Type	
Electric Panel (Medium Voltage)	Medium Voltage Incoming Panel, Low Voltage Power Transformer & Feeder Panel, Pump Control Panel	Indoor type 6.6kV, Metal-enclosed Switchgear, VCB Indoor type 6.6kV/400-230V, MCCB Starter: Soft start Motor protection relays: Phase failures, overload, temperature, suction/discharge pressure, etc. Discharge valve motor control	Volt/Ampere/Watt-hour/Power factor meters Indication lamps

Table 2.2.18 Specification of Pump Equipment of Hallabat Pumping Station

Item	Type	Specification	Accessories
Transmission Pump for Khaw Reservoir	Horizontal Single Suction Multistage Centrifugal Pump	Discharge: 500m^3/h Pump head: 135m Main body material: Cast Iron Shaft seal: gland packing Quantity：2sets（including 1 standby）	Motor operated butterfly valve, Gate valve, Non-return valve, Air valve, Compound gauge, Pressure gauge, Piping Base concrete for pump
Transmission Pump for Hallabat Village	Horizontal Single Suction Multistage Centrifugal Pump	Discharge: 150m^3/h Pump head: 150m Main body material: Cast Iron Shaft seal: gland packing Quantity：2sets	Motor operated butterfly valve, Gate valve, Non-return valve, Air valve, Compound gauge, Pressure gauge, Piping Base concrete for pump
Electric Motor	Three Phase Squirrel-cage Induction Motor	Current source: ACϕ3, 50Hz, 400V, Enclosure：dust-proof, water-jet-proof type Insulation： F Type	
Electric Panel (Low Voltage)	Incoming/Distribution Panel, Pump Control Panel	Indoor type 400V, Metal-enclosed Switchgear, MCCBs Starter: Soft start Motor protection relays: Phase failures, overload, temperature, suction/discharge pressure, etc. Discharge valve motor control	Volt/Ampere/Watt-hour/power factor meters Indication lamps

Table 2.2.19 Specification of Pump Equipment of Zarqa Pumping Station

Item	Type	Specification	Accessories
Transmission Pump	Horizontal Single Suction Multistage Centrifugal Pump	Discharge: 400m^3/h Pump head: 90m Main body material: Cast Iron Shaft seal: gland packing Quantity：3sets（including 1 standby）	Motor operated butterfly valve, Gate valve, Non-return valve, Air valve Compound gauge, Pressure gauge, Piping Base concrete for pump
Electric Motor	Three Phase Squirrel-cage Induction Motor	Current source: ACϕ3, 50Hz, 400 V, Enclosure：dust-proof, water-jet-proof type Insulation：F Type Flywheel: 87kgf/m^2	
Electric Panel (Low Voltage)	Incoming/Distribution Panel, Pump Control Panel	Indoor type 400V, Metal-enclosed Switchgear, MCCBs Starter: Soft start Motor protection relays: Phase failures, overload, temperature, suction/discharge pressure, etc. Discharge valve motor control	Motor operated butterfly valve, Gate valve, Non-return valve, Air valve, Compound gauge, Pressure gauge, Piping Base concrete for pump

Table 2.2.20 Other Main Materials and Equipment

Place	Specification	Quantity	Use
a. Main power transformer			
Azraq P.S.	11kV/6.6kV, 50Hz, 6000kVA	2	Medium voltage use
Hallabat P.S.	33kV/400V, 50Hz, 1000kVA	1	Low voltage use
b. Motor operated butterfly valve for discharge pipe of pump			
Azraq P.S.	DN200, PN40, valve seat SUS403,	5	pump operation
Hallabat P.S. (for Khaw reservoir)	DN300, PN16, valve seat SUS403	2	pump operation
Hallabat P.S. (for Hallabat village)	DN200, PN16, valve seat SUS403	2	pump operation
Zarqa P.S.	DN250, PN16, valve seat SUS403	3	pump operation
c. Flow control valve			
Azraq P.S.	Butterfly valve, DN600, PN40, valve seat SUS403	1	flow control
Hallabat P.S. (for Khaw reservoir)	Butterfly valve, DN600, PN16, valve seat SUS403	1	flow control
Hallabat P.S. (for Hallabat village)	Butterfly valve, DN200, PN16, valve seat SUS403	1	flow control
Zarqa P.S.	Butterfly valve, DN600, PN16, valve seat SUS403	1	flow control
d. Water flow meter			
Inlet and outlet of Pumping Station	Ultrasonic Flow Meter, clamp-on and two course type of traverse, 1 ϕ AC100-240V, 50Hz,	13	measurement of the transmission discharge

(5) Materials and equipment for the distribution zones

As for the equipment to be installed in the distribution zones, procurement of gate and air valves is requested. In the distribution zones, pipes installed 30 to 35 years ago have deteriorated by aging and many of the valves are not functioning. The valves controlling the rotation of water distribution among the nine blocks in Zarqa Water Distribution Zone and the ten blocks in Rusaifa Distribution Zone suffer from not only deterioration by aging, but also reduced performance resulting from repeated and frequent opening/closing operation.

According to WAJ Zarqa GWA, replacement of superannuated valves is required at 141 places and 68 places in Zarqa Water Distribution Zone (excluding the project area of the KfW pilot project) and Rusaifa Water Distribution Zone (excluding the proposed project area of Chinese assistance), respectively. In addition, 134 valves are requested as spares for a two-year period. These figures add up to 343 valves to be procured as shown in the table below. Fifteen air valves have also been requested.

The materials (valves and air valves) for the water distribution zones are included in Lot-2 procurement and their procurement assumes their use in distribution networks in the gravity flow system from reservoirs. Therefore, after conducting the tender for the Lot-1 equipment and confirming the progress of the switchover to the gravity flow system, the target areas for installation will have to be confirmed and the number of materials will have to be re-confirmed.

Table 2.2.21 Number of Requested Valves in Water Distribution Zones

Equipment	Diameter (inch)	Requested Quantity			
		Zarqa Area	Rusaifa Area	Spares	Total
Gate valve	4	100	22	100	222
	6	15	39	15	69
	8	15	2	15	32
	12	5	4	4	13
	16	4	1	0	5
	24	2	—	0	2
	Total	141	68	134	343
Air valve	2	10	—	5	15

2.2.4 Outline Design Drawings

Installation of the materials and equipment is as shown in the following drawings.

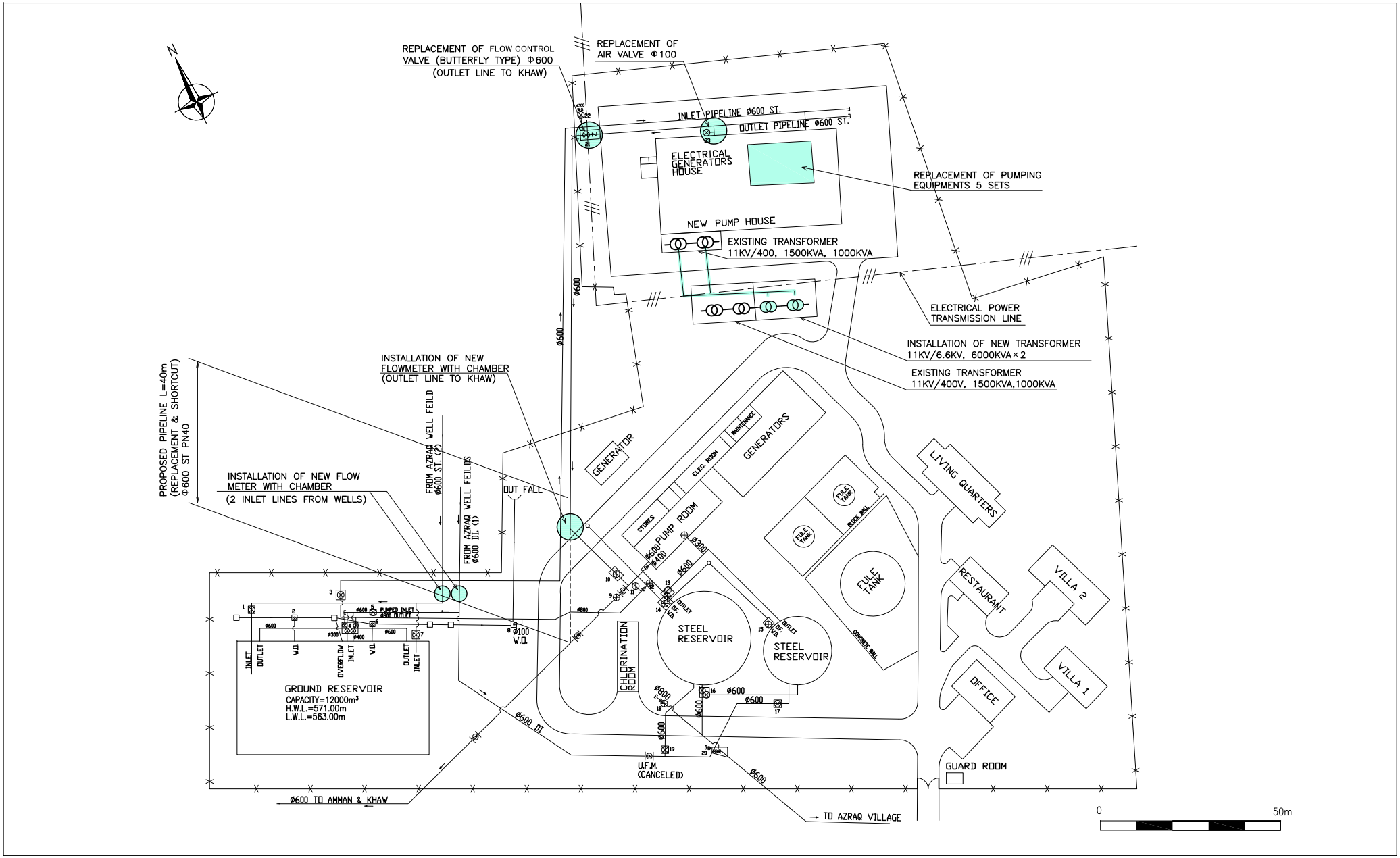


Figure 2.2.15 General Plan of Azraq Pumping Station

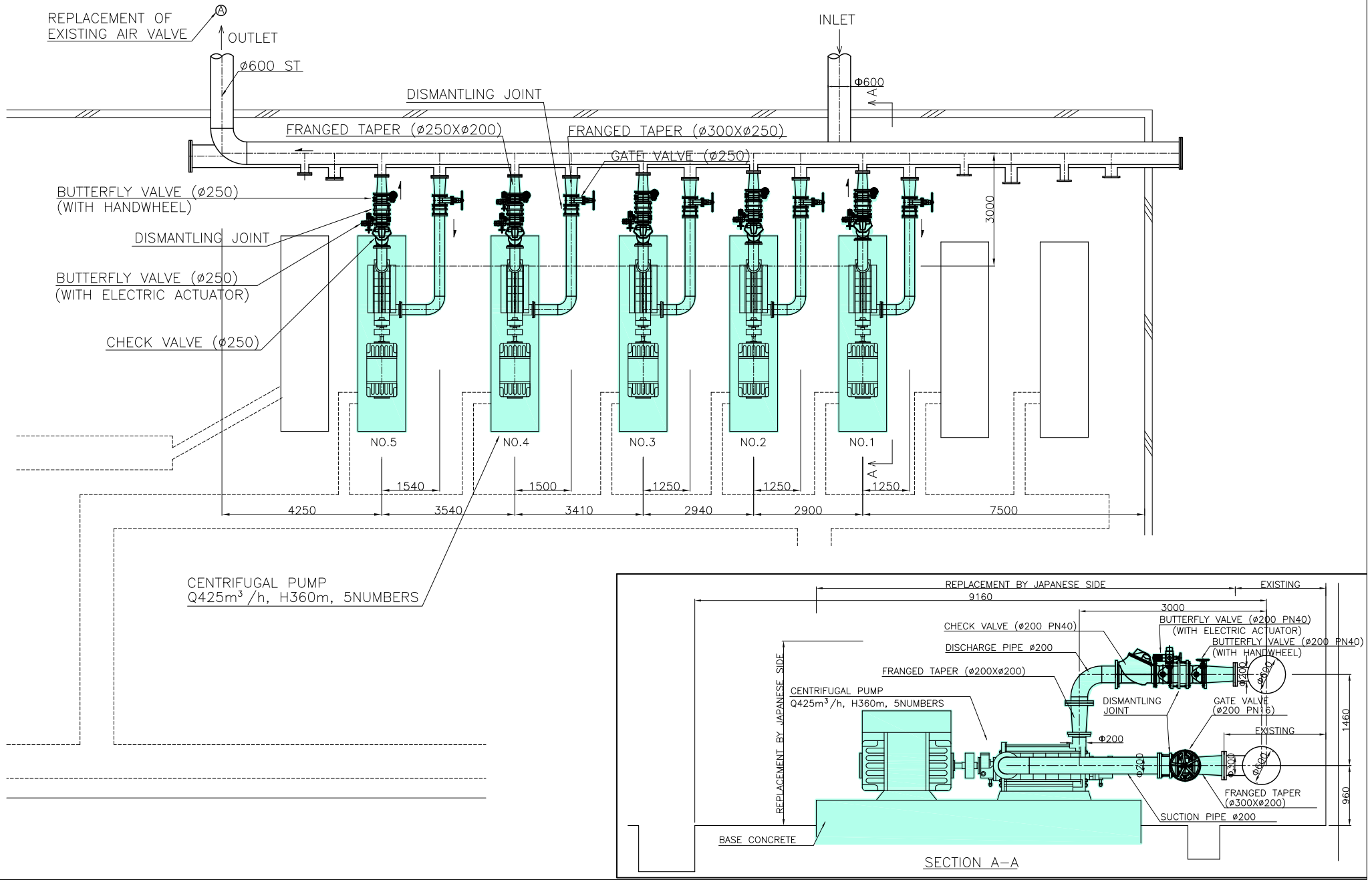


Figure 2.2.16 Installation Plan of Pumping Equipment for Azraq Pumping Station

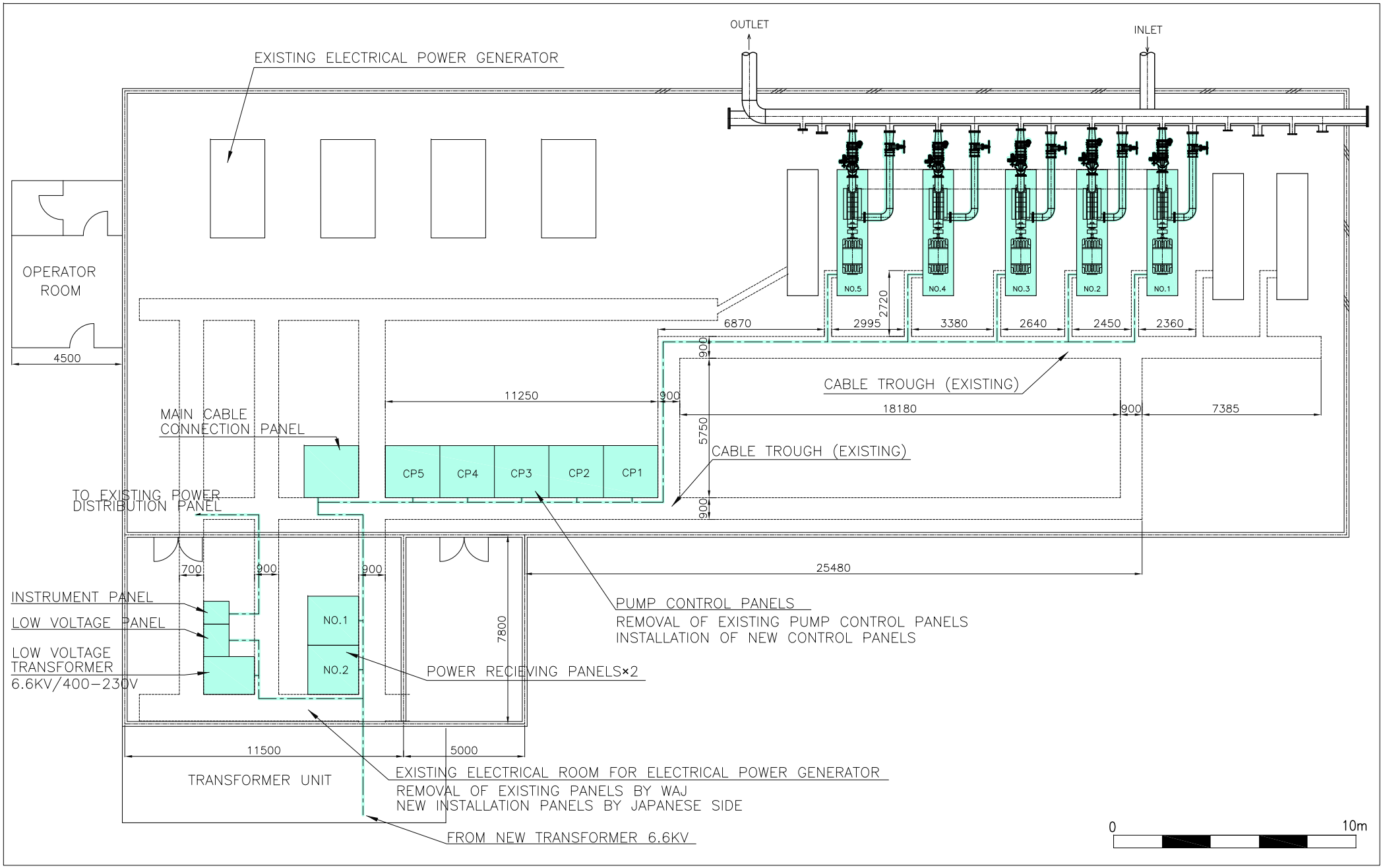


Figure 2.2.17 Installation Plan of Electrical Equipment of Azraq Pumping Station

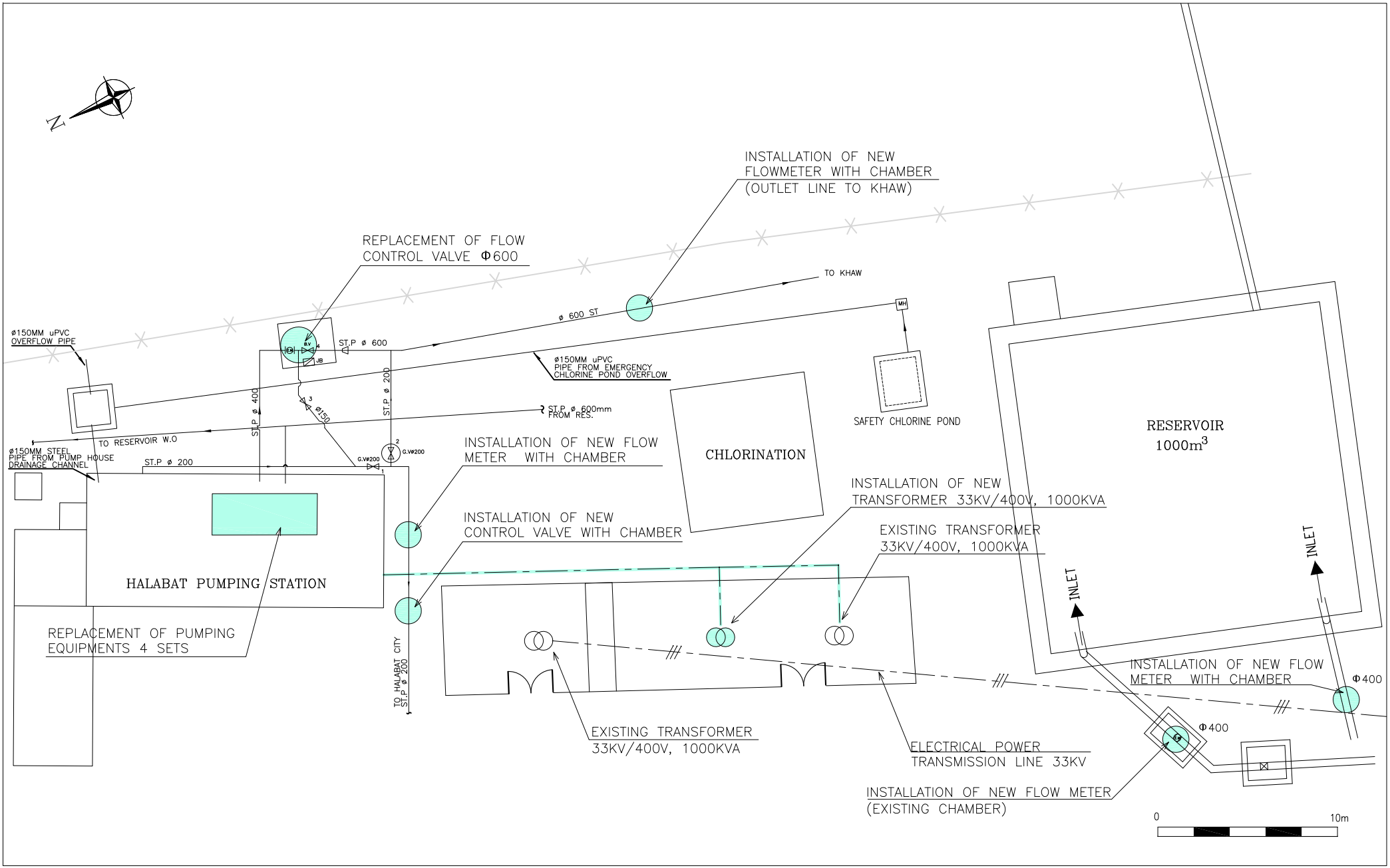


Figure 2.2.18 General Plan of Hallabat Pumping Station

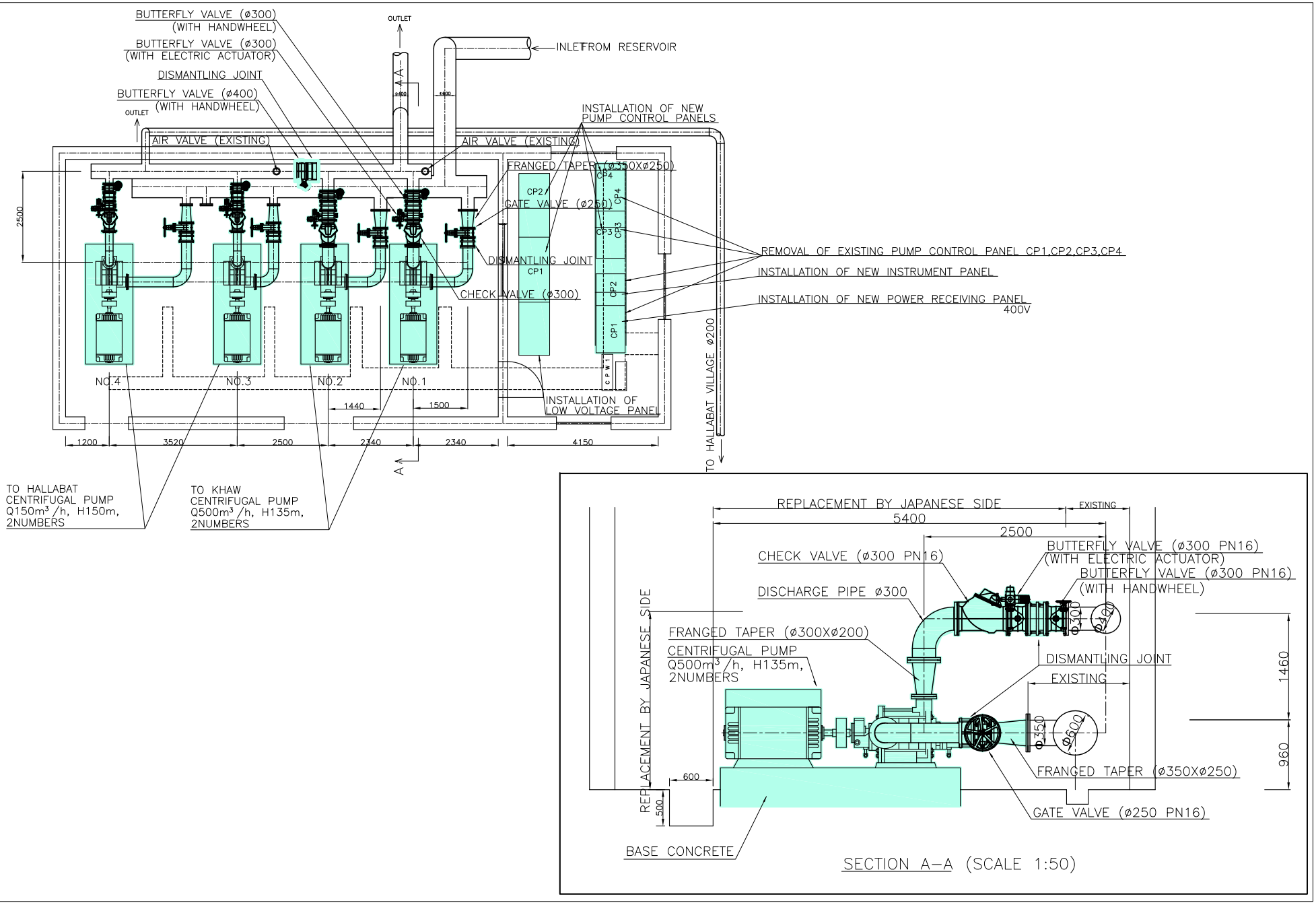


Figure 2.2.19 Installation Plan of Pumping Equipment for Hallabat Pumping Station

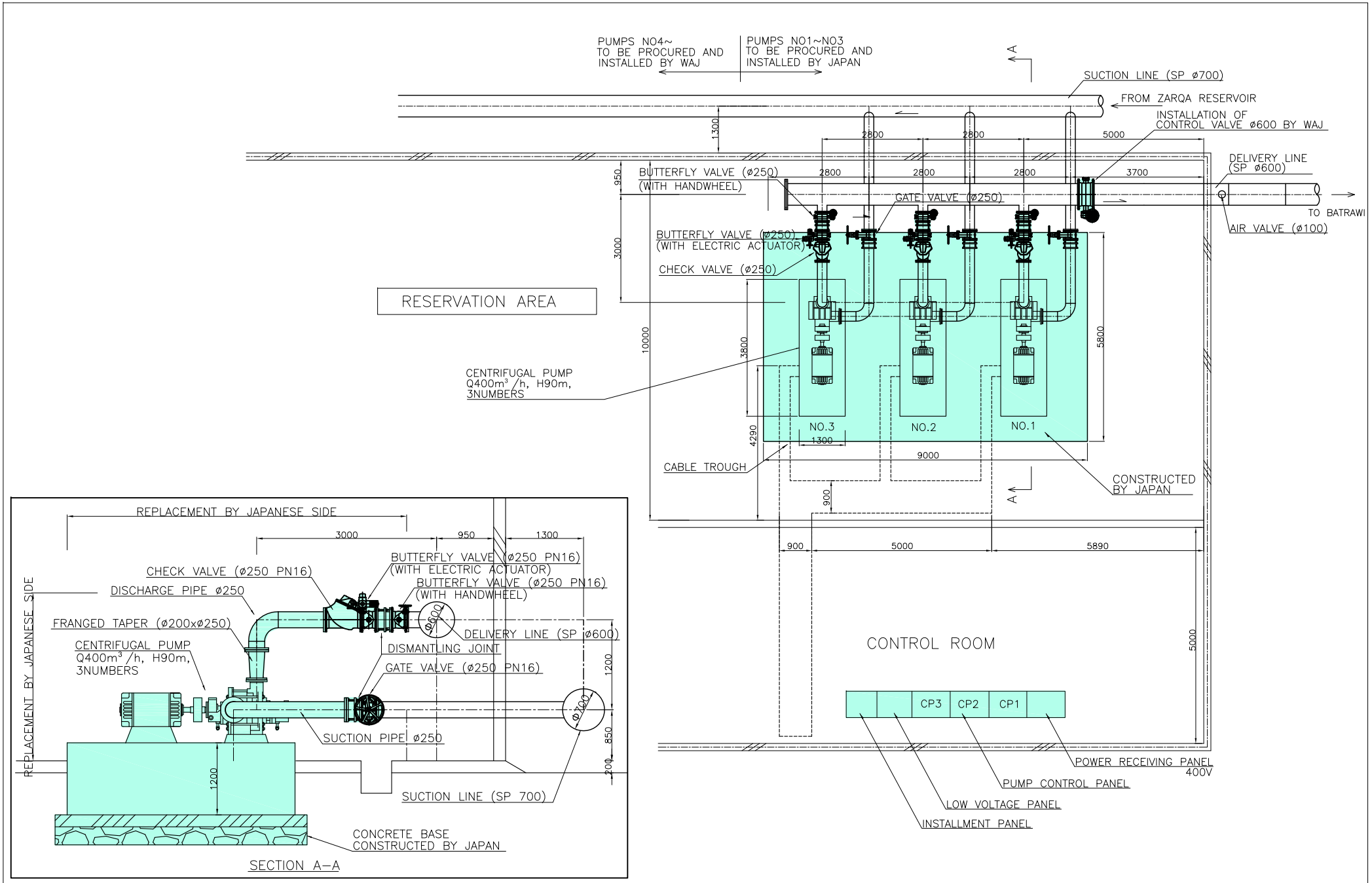


Figure 2.2.20 Installation Plan of Pumping Equipment of Zarqa Pumping Station

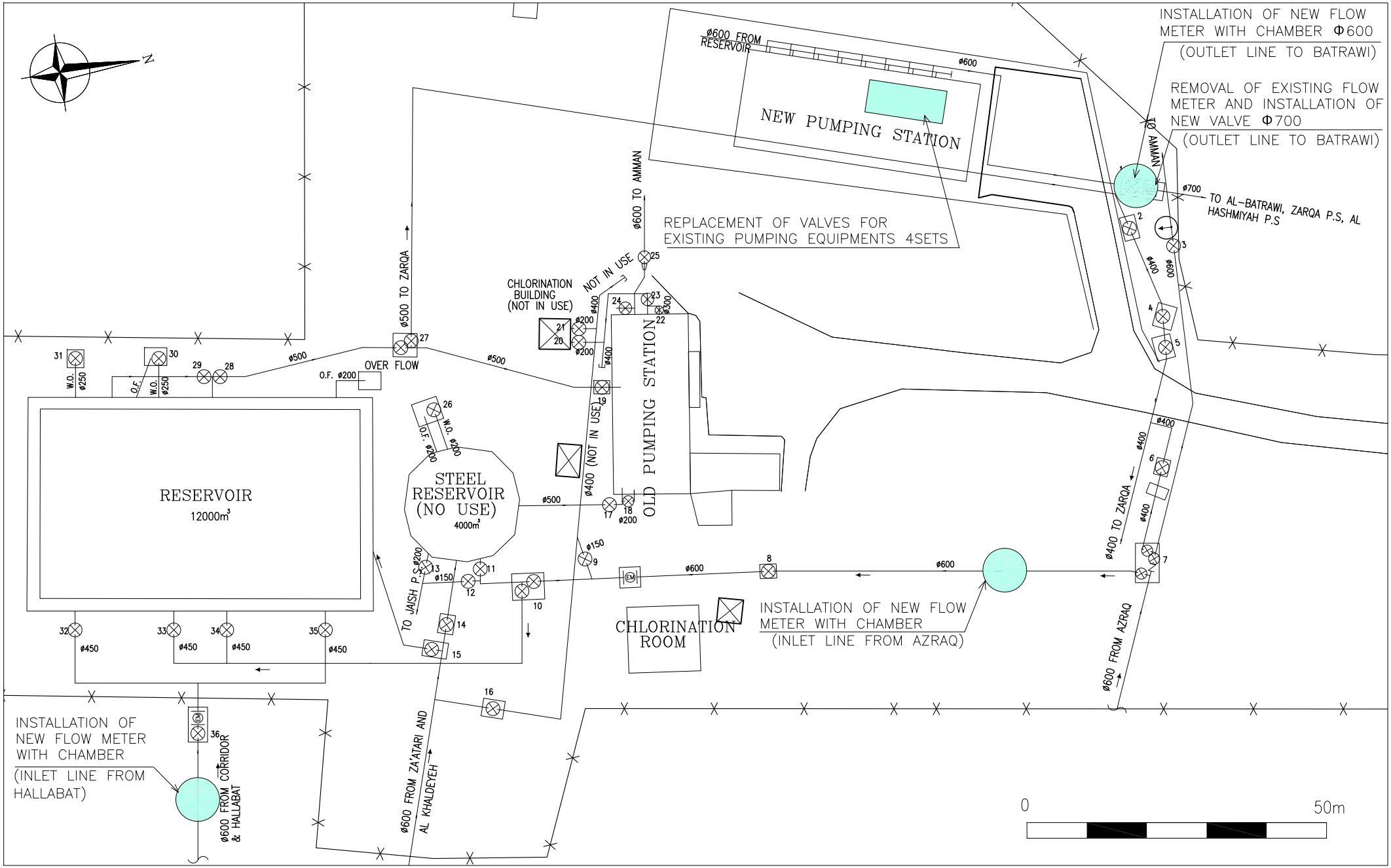
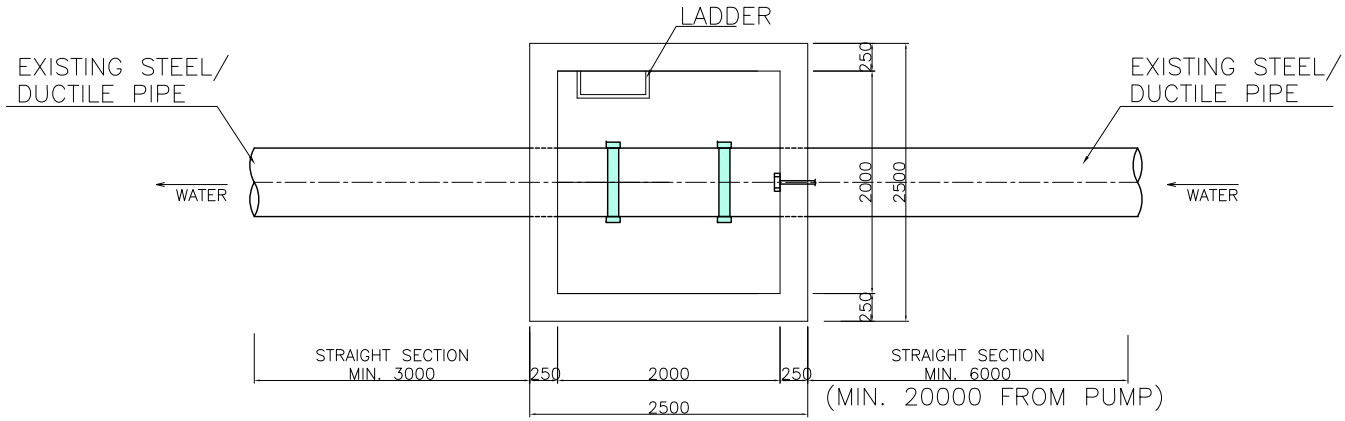
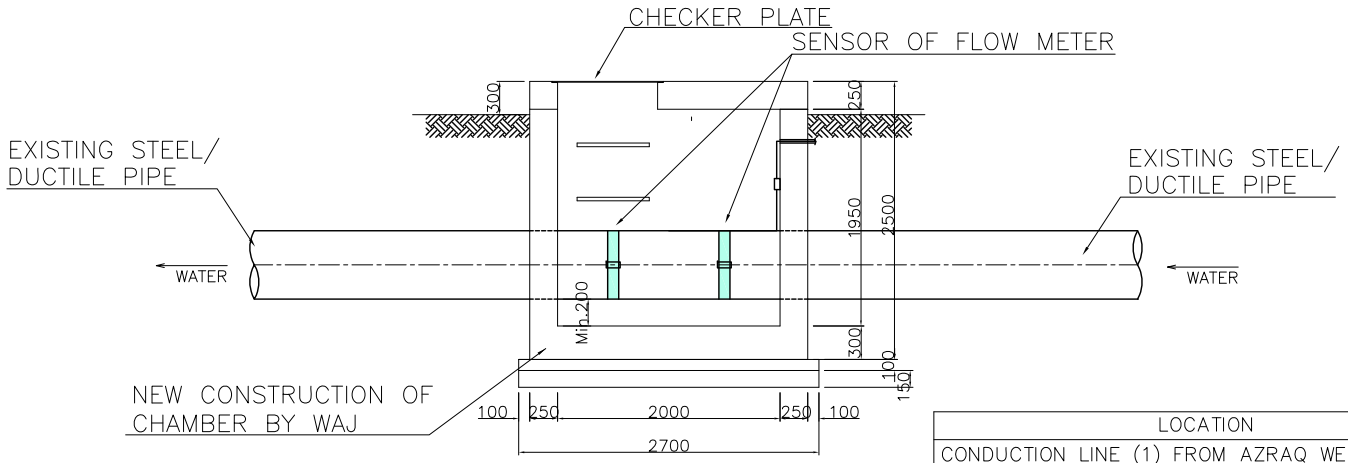


Figure 2.2.21 General Plan of Khaw Pumping Station



PLAN

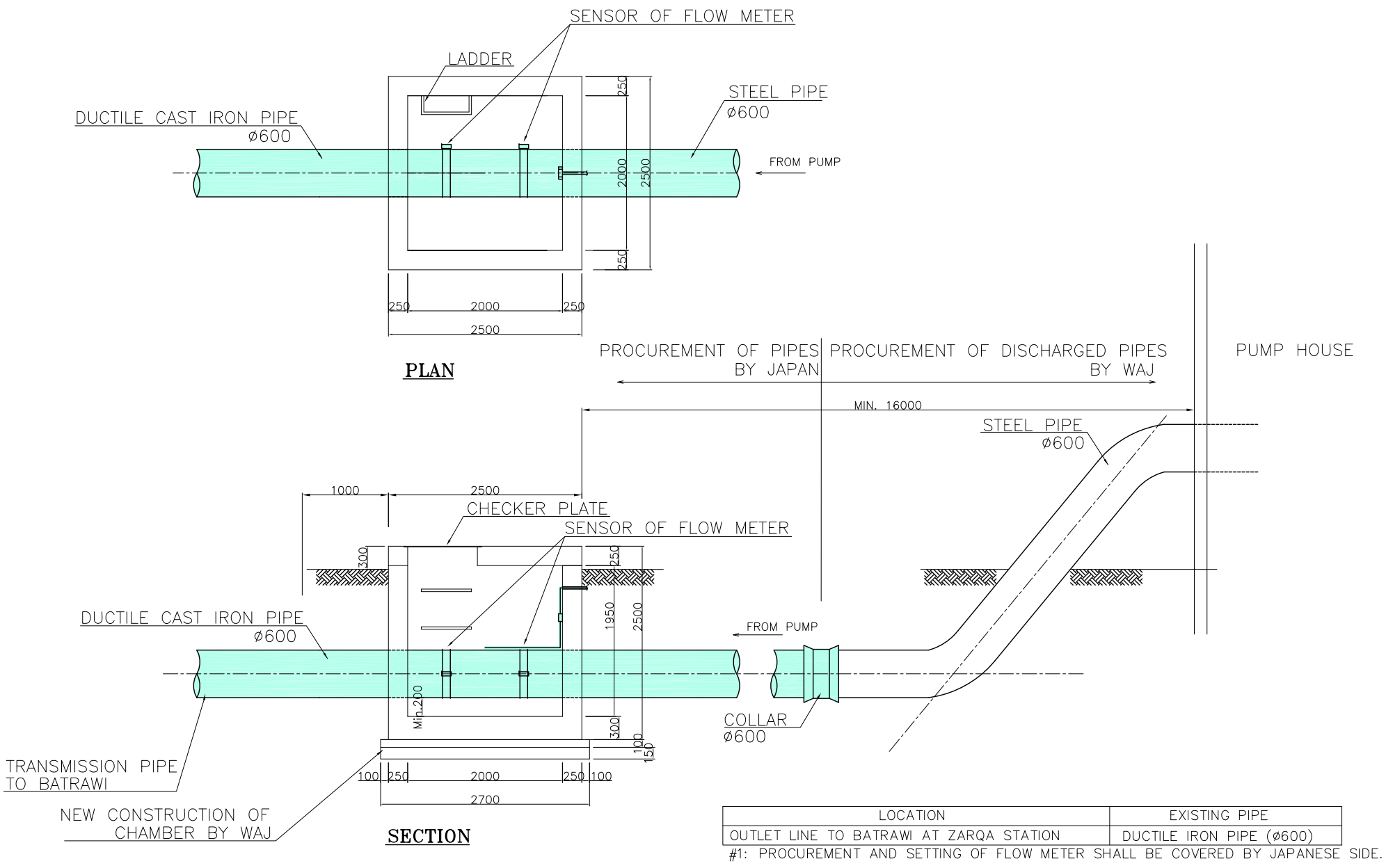


SECTION

NOTE: FLOW METER WILL BE PROCURED AND INSTALLED BY JAPAN
CHAMBER WILL BE CONSTRUCTED BY WAJ

LOCATION	EXISTING PIPE
CONDUCTION LINE (1) FROM AZRAQ WELL	EXIST. DUCTILE IRON PIPE (ø600)
CONDUCTION LINE (2) FROM AZRAQ WELL	EXIST. STEEL PIPE (ø600)
OUTLET LINE TO KHAW AT AZRAQ STATION	NEW STEEL PIPE (ø600)
CONDUCTION LINE (1) FROM HALLABAT WELL	EXIST. STEEL PIPE (ø400)
CONDUCTION LINE (2) FROM HALLABAT WELL	EXIST. STEEL PIPE (ø400)
OUTLET LINE TO KHAW AT HALLABAT STATION	EXIST. STEEL PIPE (ø600)
OUTLET LINE TO HALLABAT VILLAGE AT HALLABAT STATION	EXIST. STEEL PIPE (ø200)
INLET LINE FROM AZRAQ AT KHAW RESERVOIR	EXIST. STEEL PIPE (ø600)
INLET LINE FROM HALLABAT AT KHAW RESERVOIR	EXIST. STEEL PIPE (ø600)
TRANSMISSION LINE IN WATER DISTRIBUTION AREA TO AWAJAN	EXIST. STEEL PIPE (ø600)
TRANSMISSION LINE IN WATER DISTRIBUTION AREA TO RUSEIFA	EXIST. STEEL PIPE (ø400)

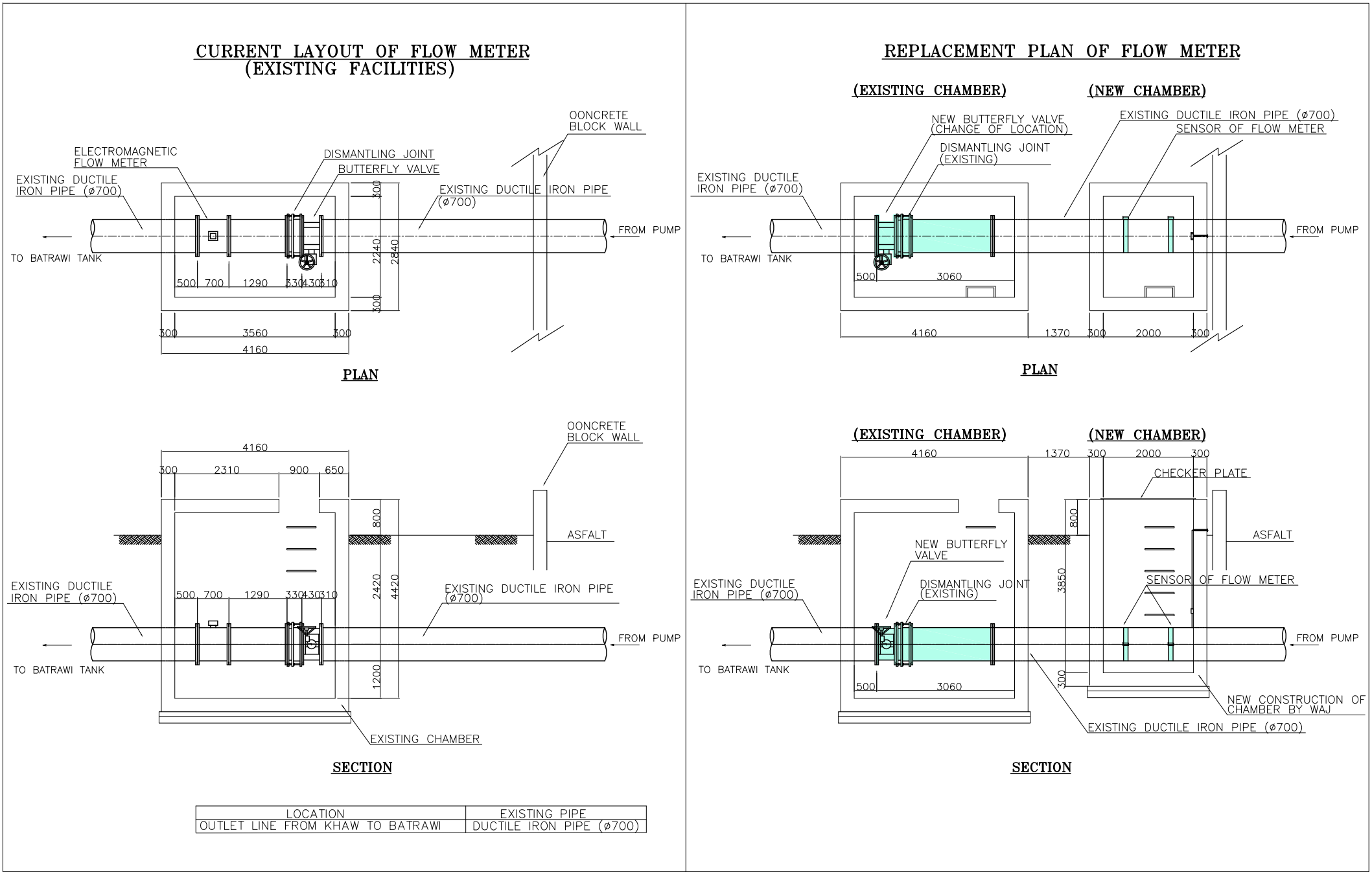
Figure 2.2.22 Installation of Water Flow Meter



LOCATION	EXISTING PIPE
OUTLET LINE TO BATRAWI AT ZARQA STATION	DUCTILE IRON PIPE (ø600)

#1: PROCUREMENT AND SETTING OF FLOW METER SHALL BE COVERED BY JAPANESE SIDE.

Figure 2.2.23 Installation of Water Flow Meter for Zarqa Pumping Station



LOCATION	EXISTING PIPE
OUTLET LINE FROM KHAW TO BATRAWI	DUCTILE IRON PIPE (ø700)

Figure 2.2.24 Installation of Flow Control Valve and Water Flow Meter for Khaw Pumping Station

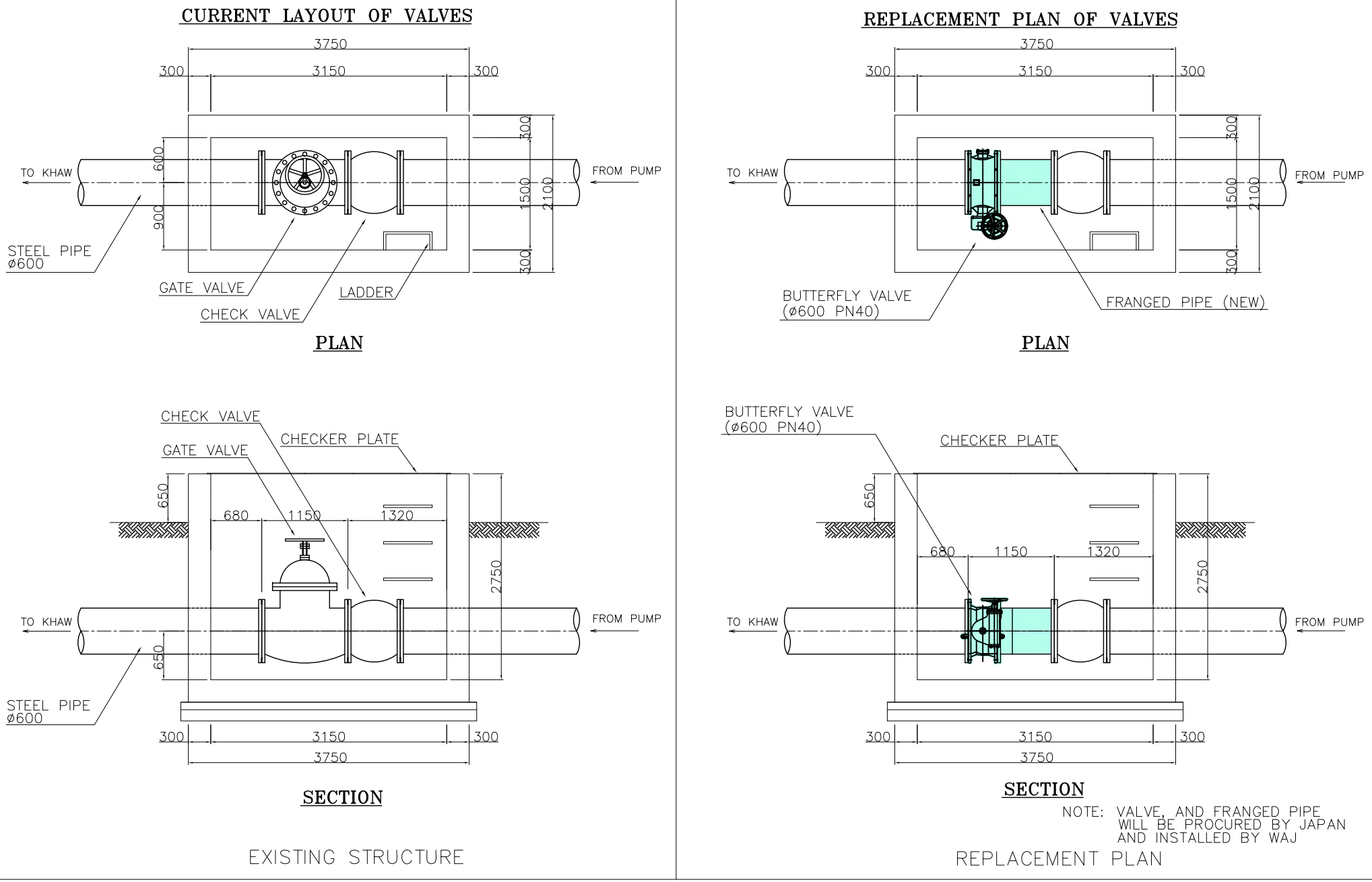


Figure 2.2.25 Installation of Flow Control Valve for Azraq Pumping Station

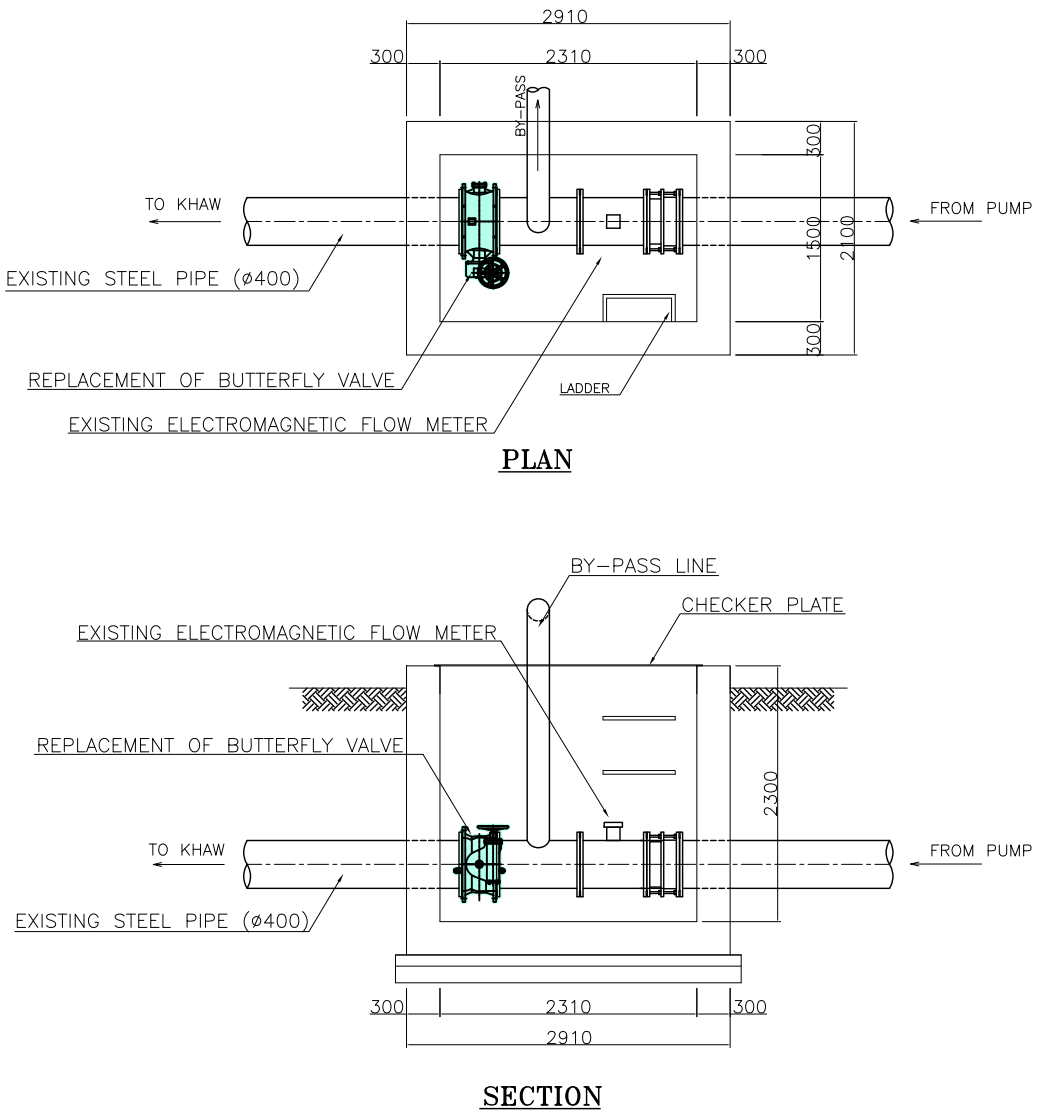


Figure 2.2.26 Installation of Flow Control Valve for Hallabat Pumping Station

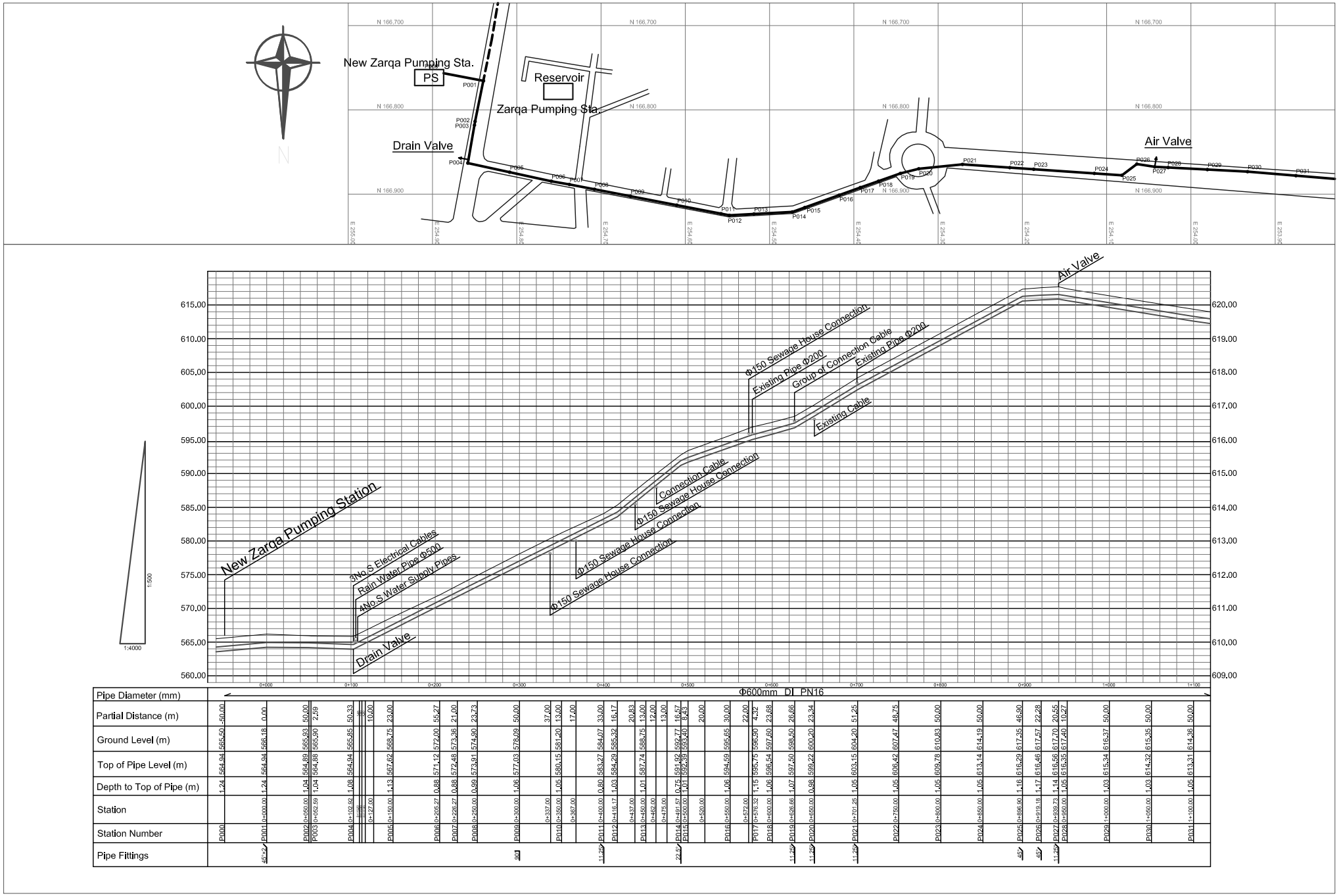
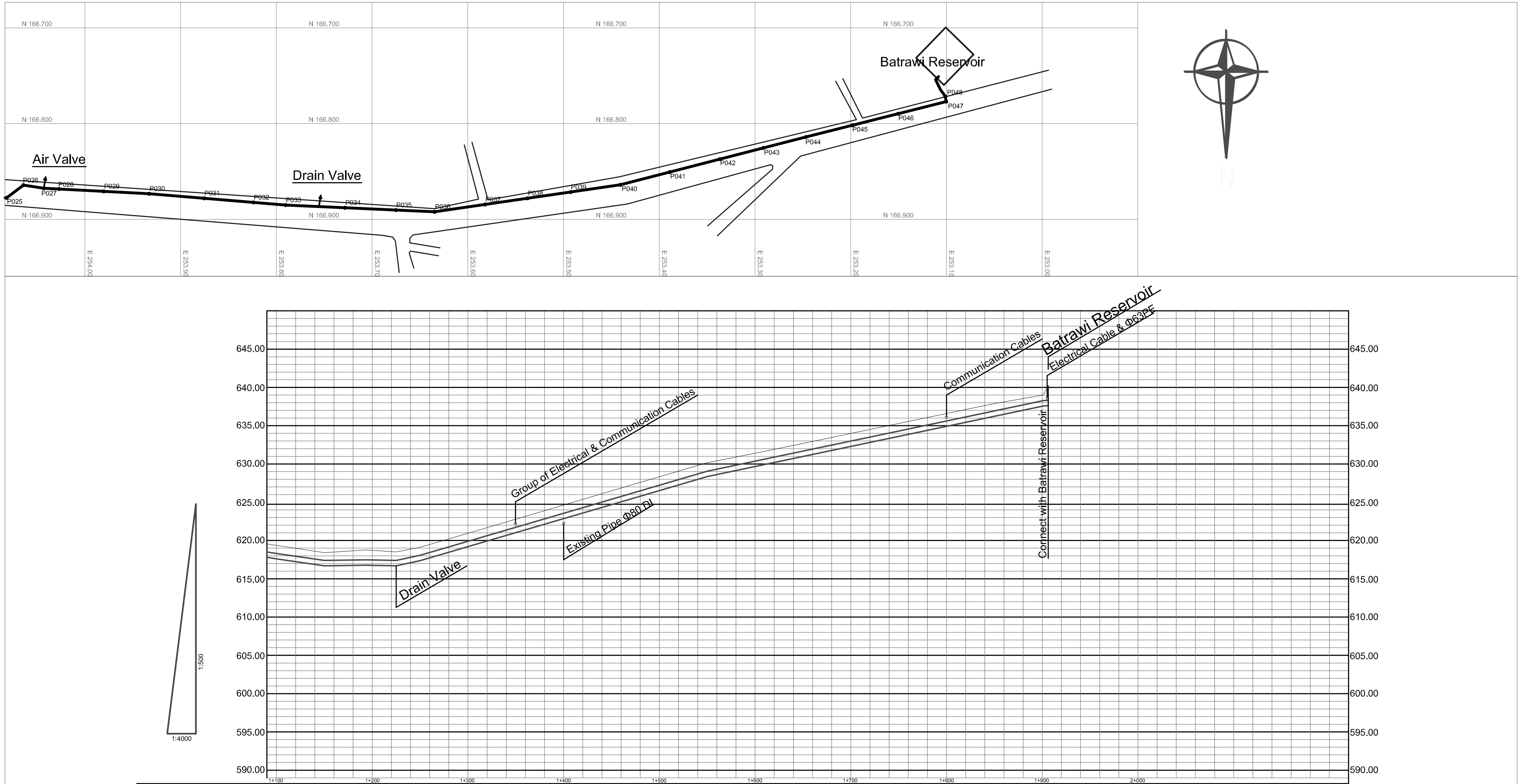


Figure 2.2.27 (1) Profiles of Transmission Pipeline between Zarqa Pumping Station and Batrawi Reservoir (1/2)



Pipe Diameter (mm)	Φ600mm DI PN16									
Partial Distance (m)	50.00	50.00	44.25	30.75	25.00	50.00	50.00	50.00	50.00	50.00
Ground Level (m)	614.36	613.41	613.77	613.51	614.11	615.93	617.80	619.64	621.48	623.33
Top of Pipe Level (m)	613.31	612.40	612.48	612.40	613.07	614.90	616.73	618.56	620.39	622.22
Depth to Top of Pipe (m)	1.05	1.01	1.29	1.10	1.04	1.03	1.07	1.08	1.09	1.11
Station	1+100.00	1+150.00	1+194.25	1+225.00	1+250.00	1+300.00	1+350.00	1+400.00	1+450.00	1+500.00
Station Number	P031	P032	P033		P034	P035	P036	P037	P038	P039
Pipe Fittings							11.25°			

Pipe Diameter (mm)	Φ600mm DI PN16								
Partial Distance (m)	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.85	5.40
Ground Level (m)	625.17	626.40	627.70	628.97	630.28	631.59	632.90	634.00	635.20
Top of Pipe Level (m)	624.06	625.37	626.68	627.99	629.30	630.62	631.93	633.26	633.32
Depth to Top of Pipe (m)	1.11	1.03	1.02	0.98	0.98	0.97	0.97	0.74	1.88
Station	1+550.00	1+600.00	1+650.00	1+700.00	1+750.00	1+800.00	1+850.00	1+900.85	1+906.25
Station Number	P040	P041	P042	P043	P044	P045	P046	P047	P048
Pipe Fittings	11.25°							90°	

Figure 2.2.27 (2) Profiles of Transmission Pipeline between Zarqa Pumping Station and Batrawi Reservoir (2/2)

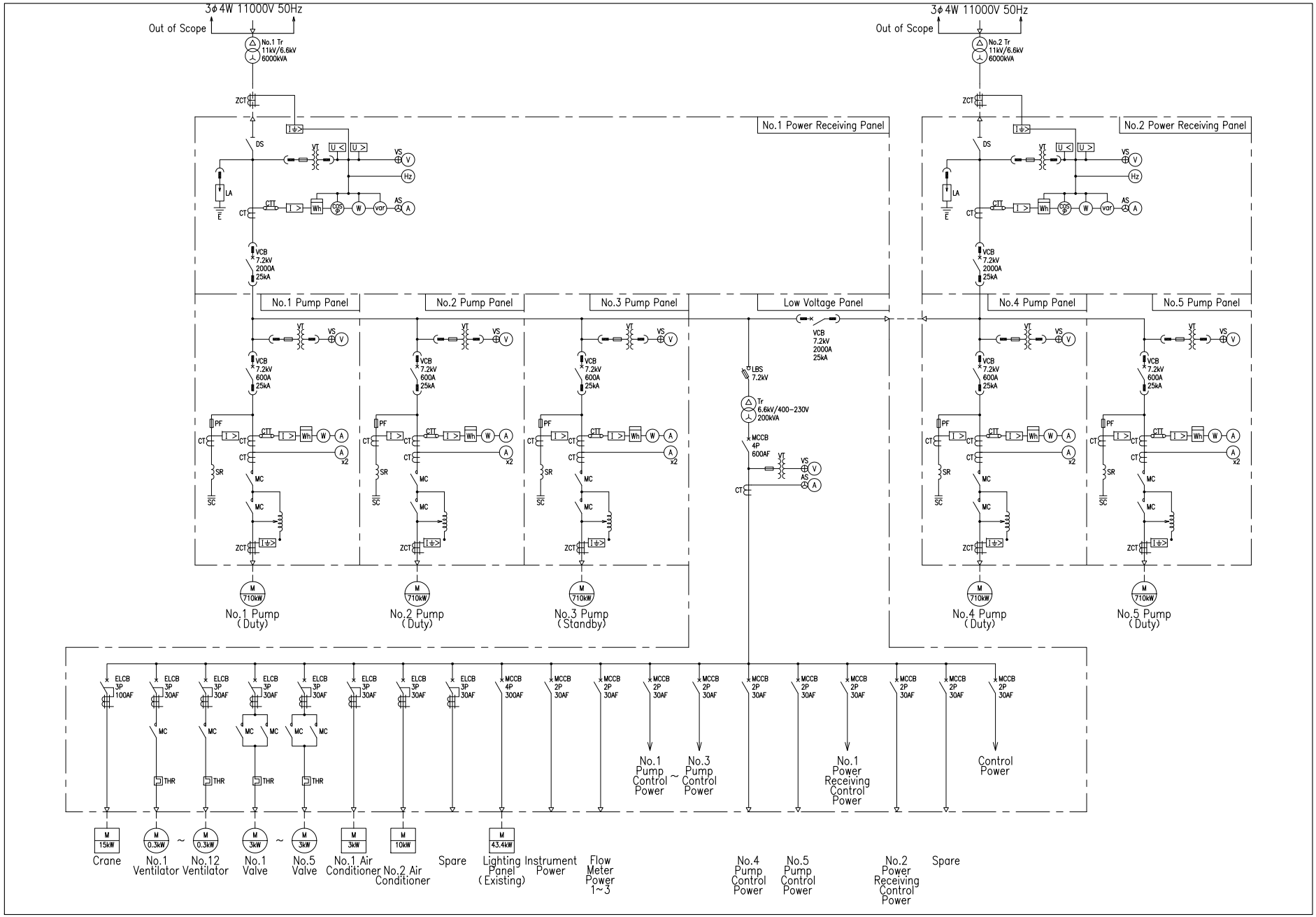


Figure 2.2.28 Electrical Single Line Diagramme of Azraq Pumping Station

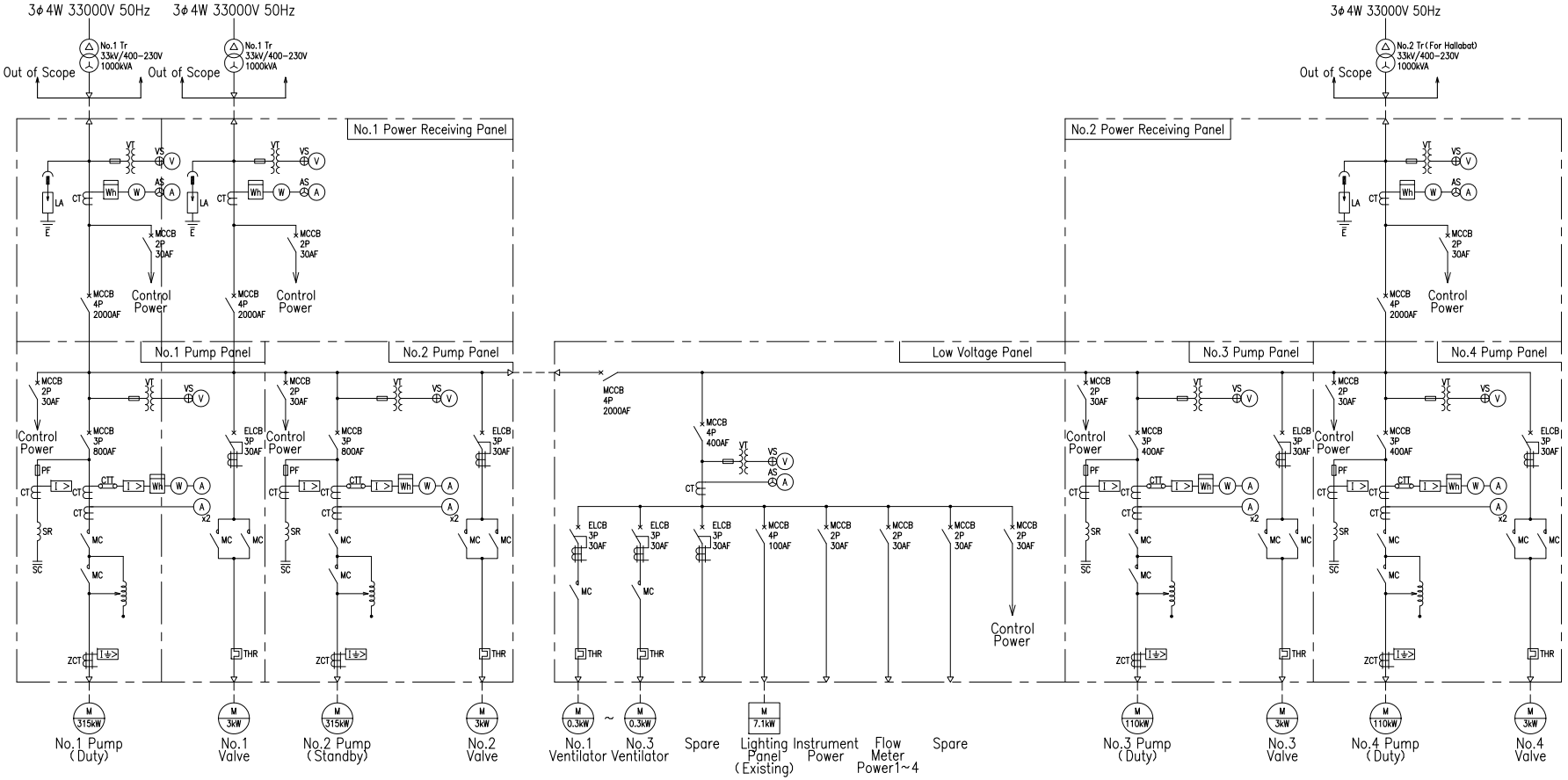


Figure 2.2.29 Electrical Single Line Diagramme of Hallabat Pumping Station

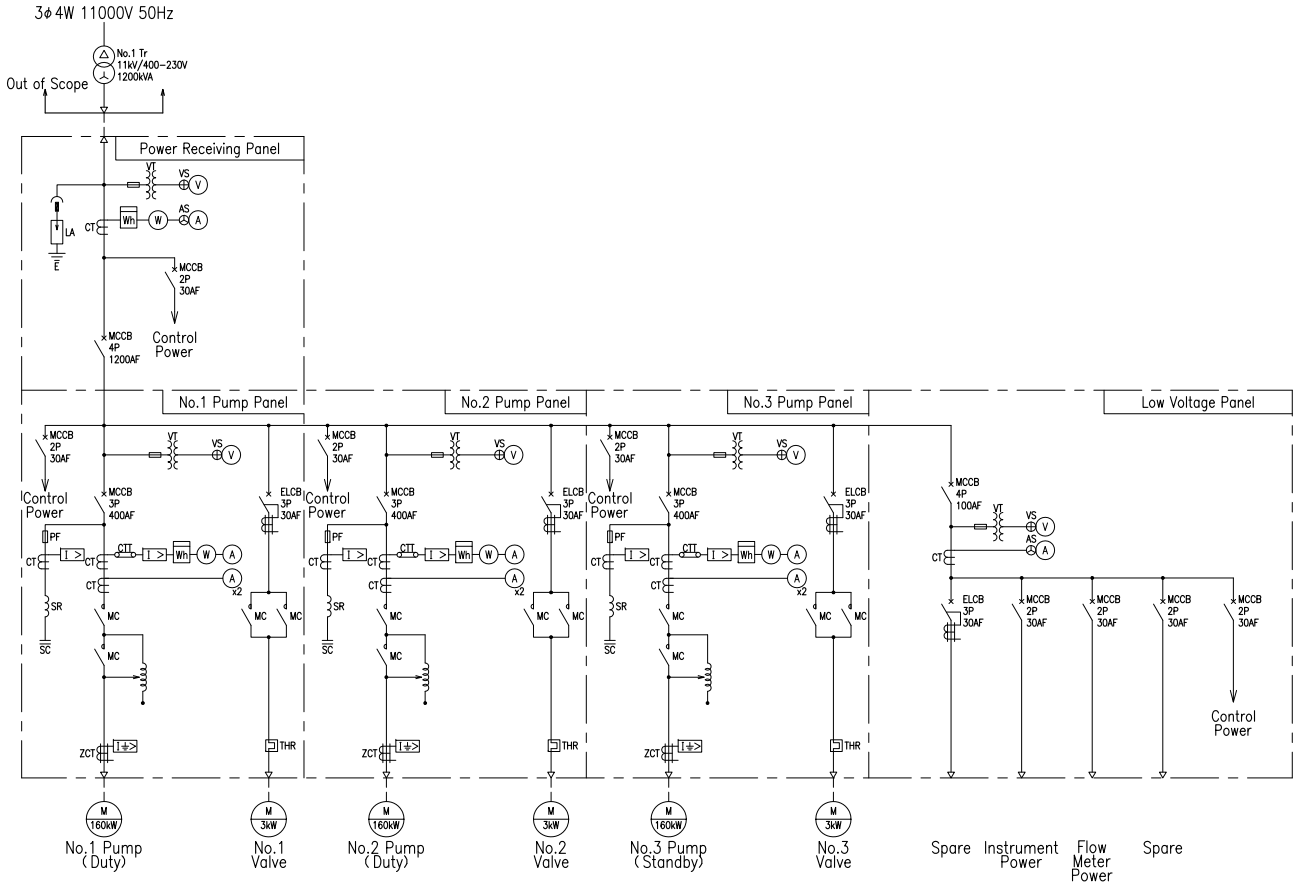


Figure 2.2.30 Electrical Single Line Diagramme of Zarqa Pumping Station

2.2.5 Procurement Plan

2.2.5.1 Implementation Organization

(1) Implementing organizations

The initial step in this Programme is establishment of an international commitment between the Government of Jordan and the Government of Japan with the conclusion of an Exchange of Notes (E/N). After conclusion of the E/N, the Government of Jordan and JICA, the supervisor of Programme implementation, will conclude a Grant Agreement (G/A) and the Programme will be implemented within the frameworks of the E/N and the G/A. A Consultative Committee consisting of governmental organizations representing the respective Governments will be established to discuss issues related to the content of the assistance and issues arising during the implementation stage.

This Programme will adopt the Procurement Agent System, in which a Procurement Management Agent of the Government of Jordan will procure the materials, equipment and services and manage the funds on behalf of the Government of Jordan. Japan International Cooperation System (JICS) is expected to be the Procurement Management Agent for the Programme. JICS will conclude an Agent Agreement with the Government of Jordan.

Since WAJ will be responsible for asset management of the equipment to be procured in the Programme and for operation/maintenance of the equipment after the procurement, WAJ will be the implementation organization on the Jordanian side.

The Programme consists of the following five components: four components to be implemented by the Japanese side; i.e. 1) supervision of procurement of the materials, equipment and services, and financial supervision, 2) detail design and supervision of procurement and installation, 3) procurement and installation of the equipment, and 4) technical assistance; and 5) works to be implemented by the Jordanian side including installation of the equipment. Of the five components, components 1) to 4) will be assisted with Grant Aid Cooperation of the Government of Japan and component 5) will be funded by the Government of Jordan.

The Procurement Management Agent, a Japanese consultant, a contractor for procurement of equipment, the consultant and the contractor, and WAJ will implement components 1) to 5), respectively. The table below shows the actual works of each implementation organization.

Table 2.2.22 Actual Works of the Implementing Organizations

Implementation organization	Actual works
WAJ	Implementation of the works in the scope of the Jordanian side (see Table 2.3.1) and asset management and operation/maintenance of the procured equipment
Procurement Management Agent	Consultancy contract, preparation of tender documents, process of selecting a contractor (pre-qualification, bidding and evaluation), agreement with the contractor for procurement of equipment, supervision of delivery of equipment, supervision of Programme implementation, final inspection and fund management/payment
Consultant	Detail design, preparation of reference materials for preparation of tender documents, supervision of procurement of equipment (pre-shipping, pre-loading and pre-delivery inspections, etc.), supervision of installation of equipment, supervision of the Operation and Maintenance Technical Guidance of pumping facilities provided by the contractor and Technical Assistance by Soft Component (operational management technology of pumping water transmission system)
Contractor for procurement of materials and equipment	Manufacture, procurement, installation and commissioning of equipment, Operation and Maintenance Technical Guidance of pumping facilities (operation, maintenance and safety control)

(2) Consultative committee

The Consultative Committee will be established for prompt and appropriate implementation of the Programme. The Jordanian members of the committee will be as follows:

- Representatives of the Ministry of Planning and International Cooperation (MOPIC)
- Representatives of WAJ
  - President (Chairperson)
  - Head of the NRW Reduction Section/Director in charge of work evaluation and benchmarking
  - Director of Planning and Design
  - Director of Zarqa GWA
- Representatives of the Procurement Management Agent
- Representatives of JICA Jordan Office

Figure 2.2.31 shows the “Flow of Funds and Implementation of the Programme” and Figure 2.2.32 shows the “Organization Chart for Implementation of the Programme”, respectively.

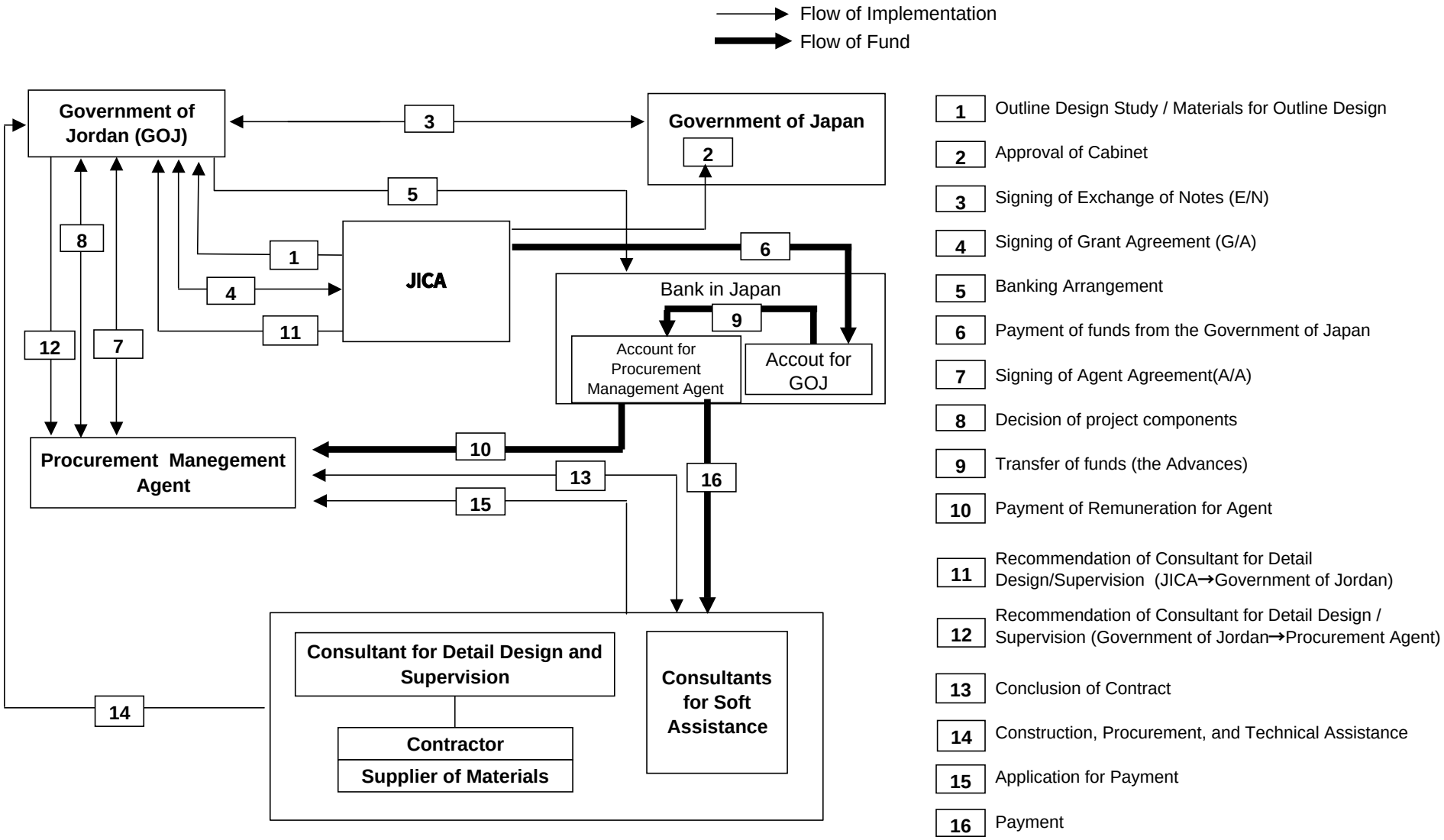
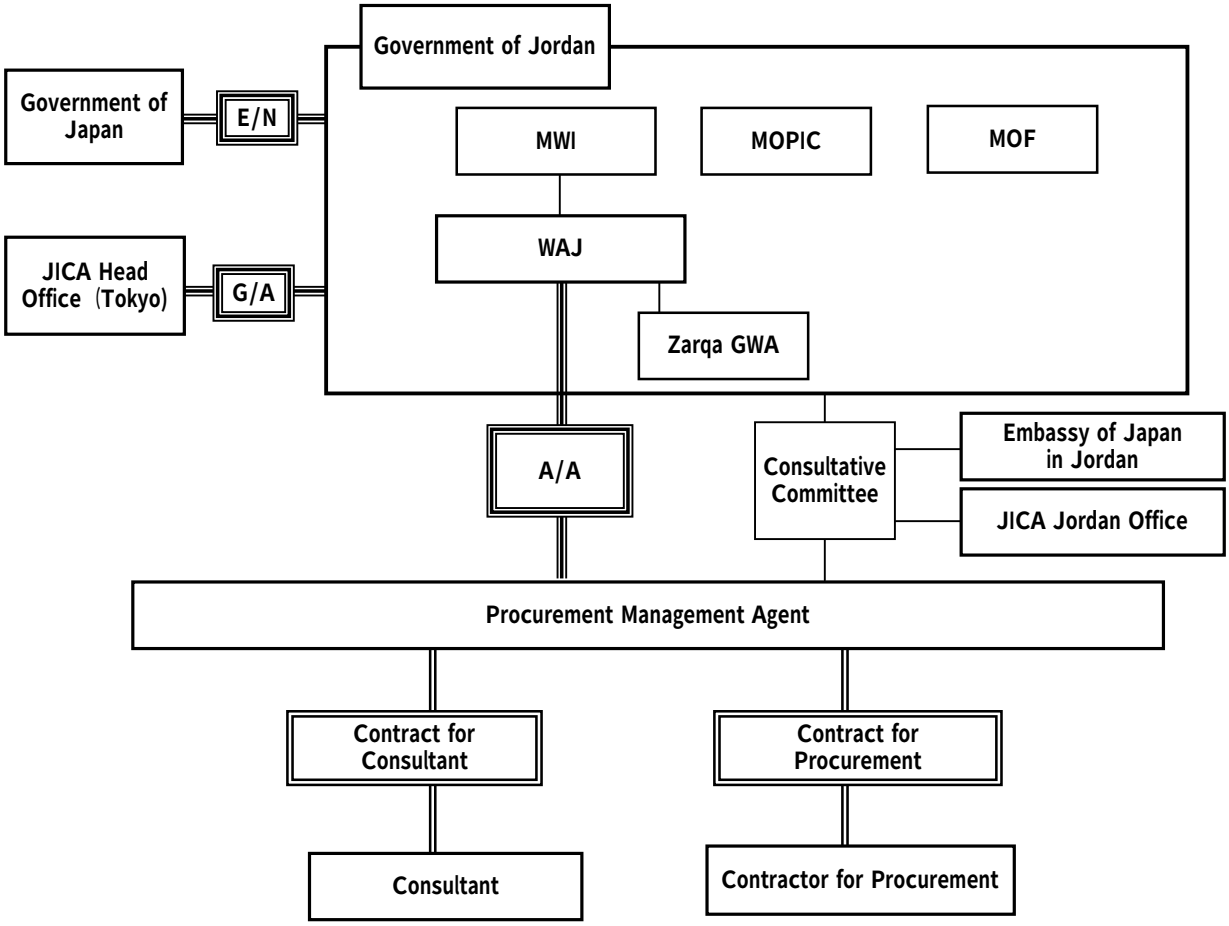


Figure 2.2.31 Flow of Funds and Implementation of the Programme



Legend:

═══	:Contract (Jordan－Japan)
═══	:Contract(Procurement Agent－Firms & Consultants)
———	:Report･Supervision･Cordination
E/N	:Exchange of Notes
G/A	:Grant Agreement
A/A	:Agent Agreement
MWI	:Ministry of Water and Irrigation
MOPIC	:Ministry of Planning and International Cooperation
MOF	:Ministry of Finance
WAJ	:Water Authority of Jordan
Zarqa GWA	:Zarqa Governorate Water Authority
JICA	:Japan International Cooperation Agency
JICS	:Japan International Cooperation System

Figure 2.2.32 Organization Chart for the Implementation of the Programme

2.2.5.2 Procurement Conditions

(1) Eligible source countries for procurement of materials and equipment

The materials and equipment to be procured in this Programme are for pumping facilities, power source facilities and piping. Products made in various countries including European countries are commercially available for such use in Jordan. In the Programme, materials and equipment of good quality, which satisfy international standards, should be used so that they will contribute to the achievement of the objectives of the Programme, improvement in energy conservation and stabilization of water transmission and distribution. However, products of inferior quality have become widely distributed in recent years because of their low price.

With regard to the quality of products, products manufactured in the Develop Assistance Committee of OECD (DAC) member countries are highly reliable and adequate after-sales services are available for these products. For these reasons, WAJ has requested procurement of products manufactured in the DAC member countries. Since DAC has 22 members as of January 2009, restricting the countries of origin of the materials and equipment to DAC member countries will not compromise the competitiveness of the tender.

Jordanian electric and mechanical engineering companies produce electric equipment including electrical panels, switchboards and control boards locally and they have a record of delivering their products to domestic clients and clients in neighboring countries. Some of them have a record of delivering their products in the grant aid project of Japan, "The Project for Improvement of the Water Supply System for the Zarqa District." Therefore, no problems are expected from using these local engineering companies in the Programme.

For the reasons mentioned above, the DAC member countries and Jordan have been designated as eligible source countries for the procurement of both Lot 1 and Lot 2 materials and equipment in this Programme on the basis of guarantee of quality.

(2) Bidders

WAJ has requested bidding for procurement of the Lot 1 equipment to be restricted to Japanese companies not only to guarantee the quality of pump installation and maintenance, but also for smooth installation well-timed with the procurement. However, it is considered possible to guarantee the quality of pump installation without using Japanese contractors by providing the detailed specifications of the installation work in the tender documents and by the procurement supervisor enforcing strict implementation management. Therefore, there will be no restriction on the nationality of bidders.

Since no expertise is required for the installation of the Lot 2 valves for the distribution networks, the Jordanian side will install the valves. As procurement of the equipment concerned is part of WAJ's ordinary work, there will be no problem if there is no restriction on the nationality of the bidders.

2.2.5.3 Attention for the Procurement

(1) Tax-exemption procedures

Since officially joining WTO in April 2000, Jordan has revised its domestic laws governing customs duties, sales tax, measurement standards, intellectual property rights, etc. Domestic customs duties are to be reduced to less 30% in principle by 2010. However, according to the local agents interviewed, tariff rates of 100%, 40% and 30% are applicable to imported machinery including pumps and motors, valves, and pipes, respectively, and 0.2%, 16% and 2% of the commission for customs clearance, sales tax, and domestic tax, respectively, are added to the sales prices.

Costs of procurement of materials and equipment and construction works are tax-exempt in projects under Programme Grant Aid for Environment and Climate Change (GAEC) as is the case with projects under General Grant Aid. To obtain tax-exemption status, WAJ will have to submit an application to request tax exemption for each of the above-mentioned taxes, including customs duties and sales tax, to the Ministry of Finance and obtain approval for the tax exemption from the ministry.

(2) Marine and land transport

The port of discharge in Jordan is the Port of Aqaba located at the southern end of the country on the Red Sea coast. Products imported by sea from DAC countries are transported overland to dealers' warehouses after being cleared at Aqaba. Meanwhile, imports from neighboring countries are transported overland and cleared at the border.

The equipment to be procured in this Programme is divided into two lots. Each lot is delivered in one batch and delivery of the two lots will be made on different dates. Each piece of equipment will be transported to the place of installation at the time of installation. Therefore, WAJ's Central Warehouse in Ain Ghazal in Amman will be used to store the procured equipment from delivery to installation. The materials and equipment to be procured throughout this Programme will be transported overland to the place of delivery, the Central Warehouse, after having been cleared. Zarqa GWA has a warehouse. However, since it is for storage of small, light equipment for distribution pipelines, the storage space is not very big. Because it is impossible for a crane to enter the warehouse, it is not possible to store equipment for pumping facilities or heavy valves there. Therefore, it cannot be used as a delivery warehouse for the materials and equipment in this Programme.

(3) Current state of installation works

There are more than 1,000 construction companies in Jordan. The Ministry of Public Works and Housing classified them into five ranks in the five fields shown in the table below in accordance with their scale in terms of contracts awarded per year, number of engineers and employees, etc. Medium- to large-scale general contractors are registered in more than one field.

Table 2.2.23 Ranking of Jordanian Construction Companies

Ranking	Road	Construction	Water supply and sewerage	Electric and mechanical	Others
1st Class	11	49	26	33	2
2nd Class	10	42	13	20	8
3rd Class	18	72	19	35	2
4th Class	69	320	49	0	8
5th Class	50	235	89	0	0
Total	158	718	196	88	20

Source: Data of JCCA (Jordan Construction Contractors Association)

There are 196 registered construction companies in the field of water supply and sewerage and each is engaged in work in accordance with its scale. WAJ conducts 120 to 140 tenders for construction works per year and companies in the higher classes win contracts for construction works worth hundreds of thousands to millions of JD.

WAJ conducts tenders in accordance with FIDIC Conditions of Contracts for Construction. After opening the tender, the tender evaluation team (consisting of several members of the Construction Design and Construction Tender Departments) scrutinizes the technical content (specifications) and proposed prices and selects the winner within 20 days.

The records of past construction works reveal that, though no serious problems have been found in contractors' implementing capacity, there have been several cases of lax implementation management and low accuracy in management.

(4) Installation conditions (site, waste and permission/approval)

Since installation of the pumps is the only construction work involved in this Programme and all the work sites are inside the existing pumping stations of WAJ, there will be no need to obtain permission/approval from any other ministry, agency or local government. However, before commencing electric work such as installation of transformers, an application will be submitted to the power distribution company and the company will then conduct a study of the conditions on the ground. After the absence of problems has been confirmed, the electric work will commence. Such procedures are required because the equipment will have to be maintained by the power distribution company after installation and the installation will affect other electric facilities near the station.

In this Programme, the foundations for the pumps will have to be reconstructed at Azraq and Hallabat Pumping Stations after the existing pumps have been removed. Any removed materials and equipment including pumps, motors, valves and pipes that can be reused will be transported to WAJ's Central Workshop and reused. Meanwhile, waste such as concrete from the removed foundations will be disposed of at land reclamation sites or waste disposal plants. Although Jordan has not developed any laws for waste disposal, industrial waste is disposed of by private companies at 21 land reclamation sites in the country.

2.2.5.4 Obligations of Both Countries

The Japanese side will be responsible for procurement of the equipment, installation of part of the equipment and provision of Technical Assistance regarding the pumping facilities, while the Jordanian side will be responsible for storage of the equipment until installation and installation of the equipment. The scope of equipment installation works shall be as follows:

The Japanese side will be responsible for installation of the equipment for the pumping facilities (pumps, motors, electrical panels, pipes and valves for the pumps and electrical cables). While the Japanese side will be responsible for procurement and installation of the transformers, the actual work shall be entrusted to local power distributing companies.

It is difficult to install and adjust water flow meters. Therefore, WAJ will take responsibility for installation of the concrete chambers and pipes, and installation of the electric cables at the planned water flow meter installation sites and the Japanese side will be responsible for installation and adjustment of the flow meters (detector and indicator).

WAJ will be responsible for installation of other equipment (water transmission pipes, flow control valves, air valves and various valves in the distribution networks).

As WAJ will construct a new building at Zarqa Pumping Station, installation of the lead-in pipes from the reservoir and the discharge pipes inside the building will be under the responsibility of WAJ. The Japanese side will be responsible for the piping and the installation of valves for the pumps.

Tables 2.2.24 and 2.2.25 show the obrigations of both countries for Implementation in the Programme. The scope of works in the installation of the materials and equipment at Azraq, Hallabat and Zarqa Pumping Station is summarized in Figures 2.2.33 – 2.2.35.

Tale 2.2.24 Obligations of Both Countries for Implementation in the Programme

Obligations of the Japanese Side	Obligations of the Jordanian side
・Procurement of the Equipment ・packing, marine transportation, insurance ・inland transportation of Jordan ・Inspections ・Installation of pump, commissioning, Operation and Maintenance Technical Guidance of pumping facilities ・Installation and adjustment of water flow meter, ・Procurement and installation of transformer at Azraq and Hallabat pumping stations ・Soft Component	・Installation of the Equipment（excluding pumping facility and water flow meter） ・Construction of concrete chamber for valve and flow meter ・Acquisition of land for chamber of water flow meter at water transmission pipe from Hallabat to Khaw reservoir ・Construction of pump house at Zarqa station, arrangement of piping and transformer ・Maintenance contract with private company for medium voltage system ・Storage of materials and spare parts ・Appointment of trainees for Operation and Maintenance Technical Guidance of pumping facilities, payment of required allowance for the trainees

Table 2.2.25 Obligations for Procurement and Installation of the Materials and Equipment

Facility	Equipment	S/W of the Japanese side	S/W of the Jordanian side
A. Equipment for Azraq Pumping Station			
1. Improvements inside the station			
Power receiving facility	Replacement of approx. 50m of 11 kV transmission cables	—	Procurement and aerial installation (entrusted to the power distribution company)
	2 transformers; 11 kV/6.6 kV, 6,000 kVA	Procurement and installation (entrusted to the EDCO)	Removal of the existing transformers
	Underground lead-in cables on the secondary side of the transformers	Procurement and wiring	—
Pumping facility	5 sets of pumps, motors, pipes for the pumps, valves and electric cables	Procurement and installation	—
	Medium- and low-voltage electrical panels, power distribution panels (for five pumps), and converters for water flow meters	Procurement and installation	—
	Foundations of the existing pumps	Removal	Relocation of Pump No.3 in the new pumping station
	Electrical panels and control boards for the existing pumps	Removal	—
	Electrical panels for the existing generators	Removal	—
	Foundations for the replacement pumps	Installation	—
	Trenches for the electric cables	Partial extension	—
	Connection to the existing distribution boards in the station	Wiring	—
Water flow meter	2 sets (Dia.600mm) at the inflow side of the reservoir, electric cables	Procurement, installation and adjustment	Construction of Chamber, installation of wiring
	1 set (Dia.600mm) at the discharge side of the pumping station, electric cables	Procurement, installation and adjustment	Construction of Chamber, installation of wiring
Water transmission pipe	Replacement of approx. 40m of transmission pipes SP Dia.600mm)	Procurement	Installation
Flow control valve	1 set of butterfly valves (Dia.600mm)	Procurement	Repair of Valve Chamber and installation of valves
Air valve	1 set (Dia.100mm)	Procurement	Installation
2. Improvements outside the station			
Air valves for the transmission pipeline	40 air valves (Dia.100mm) for the water transmission pipeline to Khaw	Procurement	Repair of Air Valve Chamber and installation of air valves
Water flow meter	1 set (Dia.600mm) at the inflow side of Khaw Reservoir, electric cables	Procurement, installation and adjustment	Construction of Chamber, installation wiring

Facility	Equipment	S/W of the Japanese side	S/W of the Jordanian side
B. Equipment for Hallabat Pumping Station			
1. Improvements inside the station			
Pumping station building	Existing	—	Repair
Power receiving facility	1 transformer 33 kV/400V, 1,000kVA	Procurement and installation of a new one (entrusted to the power distribution company)	—
	Underground lead-in cables on the secondary side of the transformer	Procurement and wiring	—

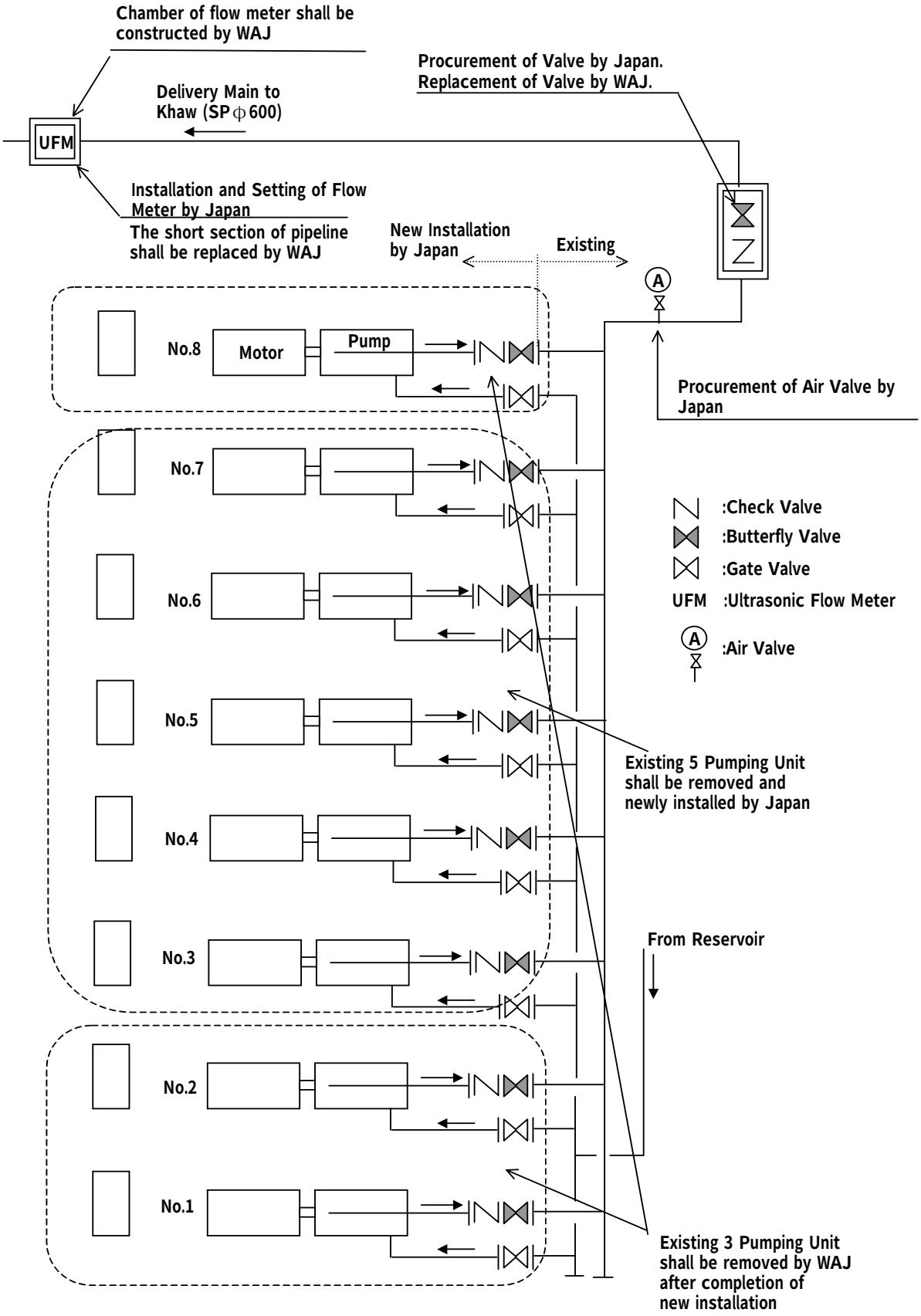
Facility	Equipment	S/W of the Japanese side	S/W of the Jordanian side
Pumping facility	(Discharge to Khaw) 2 sets of pumps, motors, pipes for the pumps, valves and electric cables	Procurement and installation	—
	(Discharge to Hallabat Village) 2 sets of pumps, motors, pipes for the pumps, valves and electric cables	Procurement and installation	—
	1 set of isolation valves and butterfly valves (Dia.400mm) for the pumps for discharge to Khaw and the village	Procurement and installation	—
	Electrical panels, power distribution panels (for four pumps), and converters for water flow meters	Procurement and installation	—
	Existing pumps and foundations	Removal	Relocation of Pump No.1
	Electrical panels and control boards for the existing pumps	Removal	—
	Foundations for the replacement pumps	Installation	—
	Trenches for electric cables in the station	Improvement	—
	Connection to the existing distribution boards in the station	Wiring	—
Water flow meter	1 set (Dia.400mm) at the inflow side of the reservoir, electric cables	Procurement, installation and adjustment	Construction of Chamber, installation of wiring
	1 set (Dia.400mm) at the inflow side of the reservoir, electric cables	Procurement, installation and adjustment	Rehabilitation of Chamber, installation of wiring
	1 set (Dia.600mm) in the pumping station for discharge to Khaw, electric cables	Procurement, installation and adjustment	Construction of Chamber, installation of pipes and wiring
	1 set (Dia.200mm) in the pumping station for discharge to the village with pipes and electric cables	Procurement, installation and adjustment	Construction of Chamber, installation of pipes and wiring
Flow Control Valve	1 set of butterfly valves (Dia.600mm) for the transmission pipeline to Khaw	Procurement	Construction of Chamber, installation of valve
	1 set of butterfly valves (Dia.200mm) for water distribution to the village	Procurement	Construction of Valve Chamber, installation of valve
Bypass pipe	Bypasses between the transmission pipelines to Khaw and the village	—	Improvement
2. Improvements outside the station			
Air valve for water transmission pipeline	15 air valves (Dia.100mm) for the transmission pipeline to Khaw	Procurement	Repair of Chamber and installation of air valves
Water flow meter	1 set (Dia.600mm) at the inflow side of Khaw Reservoir, electric cables	Procurement, installation and adjustment	Land acquisition, construction of Chamber, installation of wiring

Facility	Equipment	S/W of the Japanese side	S/W of the Jordanian side
C. Equipment for Zarqa Pumping Station			
1. Improvements inside the station			
Pumping station building	Construction	—	Improvement
Power receiving facility	1 transformer: 11 kV/400 kV, 1,200 kVA or above	—	Arrangement of the existing transformer
	Lead-in cables on the secondary side of the transformer	—	Procurement and wiring
Auxiliary pipes in the	Inflow pipes from the reservoir (Dia.600)	—	Improvement

Facility	Equipment	S/W of the Japanese side	S/W of the Jordanian side
pumping station	Discharge pipes from the pumping station (Dia.600)	—	Improvement
Pumping facility (to Batrawi)	3 sets of pumps, motors, pipes for the pumps, valves and electric cables	Procurement and installation	—
	Electrical panels, power distribution panels (for three pumps) and converters for water flow meters	Procurement and installation	—
	Foundations for the new pumps	Installation	—
	Trenches for the electric cables in the station	—	Improvement
Water flow meter	1 set (Dia.600mm) at the discharge side of the pumping station with electric cables	Procurement, installation and adjustment	Construction of Chamber and wiring
Flow control valve	1 set of butterfly valves (Dia.600mm)	Procurement	Installation of valve
2. Improvements outside the station			
Transmission pipeline (to Batrawi)	Approx. 2km of transmission pipeline (Dia.600) to Batrawi (including accessories such as valves and air valves)	Procurement	Installation

Facility	Equipment	S/W of the Japanese side	S/W of the Jordanian side
D. Equipment for New Khaw Pumping Station			
Pumping facility	4 sets of valves	Procurement	Installation
Flow control valve	1 set of butterfly valves (Dia.700mm)	Procurement	Removal of the existing valves and water flow meters, repair of Chamber and installation of valves
Water flow meter	1 set (Dia.600) at the discharge side of the pumping station with a converter for the water flow meter, electric cables	Procurement, installation and adjustment	Construction of Chamber, installation of wiring

Facility	Equipment	S/W of the Japanese side	S/W of the Jordanian side
E. Equipment for the distribution networks			
Water flow meter	1 set (Dia.400mm) on the transmission pipeline to Rusaifa, with an outdoor panel for the converter for the water flow meter, electric cables	Procurement, installation and adjustment	Provision of power source, construction of Chamber, improvement of Converter Shed, installation of wiring
	1 set (Dia.600mm) on the transmission pipeline to Awajan, with an outdoor panel for the converter for the water flow meter, electric cables	Procurement, installation and adjustment	Provision of power source, construction of r Chamber, improvement of Converter Shed, installation of wiring
Gate valve	222 gate valves (Dia.100mm)	Procurement	Installation
	69 gate valves (Dia.150mm)	Procurement	Installation
	32 gate valves (Dia.200mm)	Procurement	Installation
	13 gate valves (Dia.300mm)	Procurement	Installation
	5 gate valves (Dia.400mm)	Procurement	Installation
	2 gate valves (Dia.600mm)	Procurement	Installation
Air valve	15 air valves (Dia.50mm)	Procurement	Installation



PLAN

Figure 2.2.33 Responsibility of Both Countries in the Azraq Pumping Station

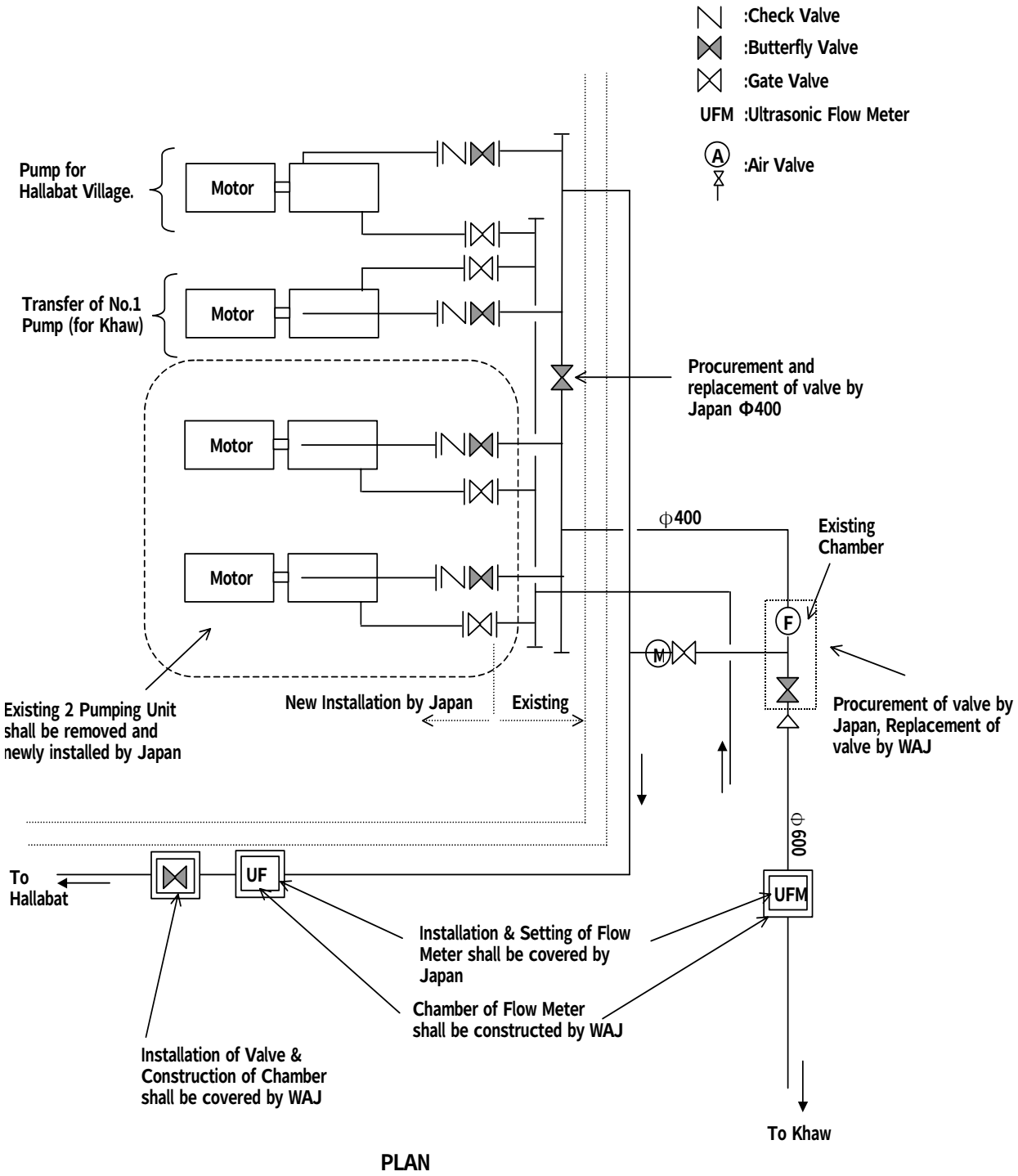


Figure 2.2.34 Responsibility of Both Countries in the Hallabat Pumping Station

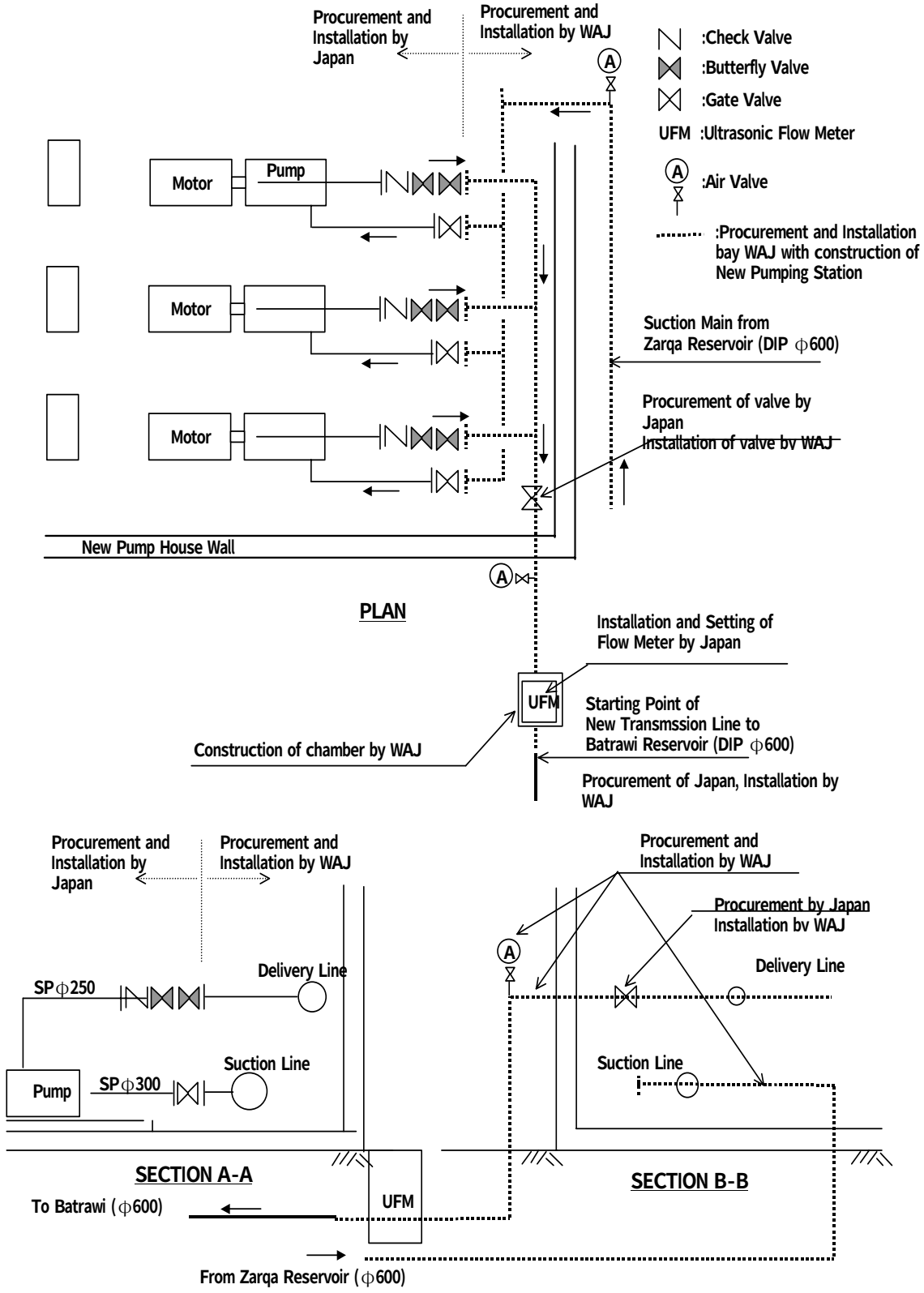


Figure 2.2.35 Responsibility of Both Countries in the New Zarqa Pumping Station

2.2.6 Consultant Supervision

The Procurement Management Agent, under contract with the Jordanian governmental organization, will supervise the procurement in this Programme.

The obligations of the procurement contractor on the Japanese side include installation and adjustment of the water flow meters, as well as installation of the procured pumping and power source facilities. It is expected that these works will be implemented, in practice, by local construction companies/distributors under the control of the procurement contractor, who is under contract with the Procurement Management Agent. There is concern that installation of the pumps under the sole control of the procurement contractor may lead to unsatisfactory performance of the procured equipment because of inadequate guarantee of the quality of the work. Therefore, the consultant, who is under contract with the Procurement Management Agent, will supervise the installation of the procured equipment to guarantee the quality of the installation work.

In order to ensure trouble-free procurement and installation of the materials and equipment, the consultant will fulfill the following obligations:

(1) Relevant issues

The consultant shall:

- Adhere to the provisions of the E/N and G/A to be concluded between the Government of Jordan and the Government of Japan and JICA, respectively,
- Confirm the details of the obligations of the Jordanian side and coordinate them with the implementation schedule of the Japanese side,
- Confirm the progress of processes concerning customs clearance, tax-exemption, etc, of the imported equipment, and
- Control the quality of the work by shop inspection, pre-loading inspection, acceptance inspection, installation inspection, etc.

(2) Details of the obligations

[At the detailed design stage]

1) Field Survey

- Confirmation of the progress of the preparations, including the Programme implementation system, and budgetary measures of the Jordanian side
- Confirmation of the progress of the preparations for the works in the scope of the Jordanian side and coordination between such works and the works in the scope of the Japanese side
- Confirmation of the state of water distribution after the outline design stage
- Confirmation of the condition of the equipment storage site and the workshop of the

implementation organization

・Confirmation in detail of the layout of the existing equipment in the pumping stations

・Investigation for detailed design of the installation of the equipment

・Arrangement with the power distribution companies for installation of the transformers

・Survey of the route of the water transmission pipeline between Zarqa Pumping Station and Batrawi Reservoir

2) Detailed design

・Preparation of reference materials for the tender documents

・Preparation of equipment installation drawings

・Preparation of detailed specifications of the equipment to be procured and specifications of the installation work and revision of the number of equipment items

・Preparation of Installation Plan

・Revision of Programme costs

[At the procurement supervision stage]

・Approval for manufacture of the equipment, pre-loading inspection, pre-shipping inspection and acceptance inspection

[At the installation supervision stage]

・Approval of Installation Plan

・Supervision of the installation work by the procurement contractor

[At the Technical Assistance stage]

・ Management of the Technical Assistance by the procurement contractor

・Preparation and implementation of technical assistance

2.2.7 Quality Control Plan

Quality control of the pumping facilities and equipment shall be implemented through verification of shop drawings and pre-shipment inspection of equipment and materials. The pre-shipment inspection shall include examination of the performance of the equipment, confirmation of the raw materials and standards used and inspection of the external finishing. For other equipment and materials, conformity to the specifications shall be confirmed.

When verifying the quality of the materials and equipment for the pump installation work and the completed work, a quality control plan shall be prepared and quality inspection shall be implemented for construction materials, earthwork, concrete work, etc.

2.2.8 Country Origin of the Materials and Equipment

According to the policy described in 2.2.5.2 (1), the country origin of the materials and equipment to be procured in the Programme are as shown in the table below.

Table 2.2.26 Country Origin of the Materials and Equipment

Items	Country Origin			Note
	Jordan	Japan	Third country	
Transformer			○	DAC member
Pump, Motor		○		
Electric Panels	○			
Ultrasonic flow meter		○		
Ductile cast iron pipe			○	DAC member
Gate valve			○	DAC member
Non retaining valve			○	DAC member
Air valve			○	DAC member

2.2.9 Technical Guidance

(1) Necessity of the Technical Guidance

Improvement of the water transmission pipelines, reservoirs and main water distribution networks is in progress with the implementation of the two phases of the Grant Aid Project of Japan, "The Project for Improvement of the Water Supply System for the Zarqa District," based on the master plan for improvement of the water supply system in Zarqa District drafted by JICA. The implementation of the project is expected to improve efficiency of water distribution and thus reduce energy consumption for water distribution.

In this Programme, the pumping facilities at the existing main water transmission pumping stations (Azraq, Hallabat and Zarqa Pumping Stations) will be replaced to improve water transmission efficiency and reduce energy consumption for water transmission. Implementation of this Programme will create synergy with the above-mentioned Grant Aid Project and enable more stable water distribution in Zarqa District and reduced operation and maintenance costs.

Full-time operators and mechanical and electrical maintenance technicians are assigned to each pumping station in Zarqa Governorate. However, the existence of many problems in the operation and maintenance of the pumping facilities not only impedes efficient operation of the facilities, but also causes frequent breakdowns and premature deterioration of the facilities. Therefore, the effectiveness of implementation of the Programme is likely to be compromised because of lack of appropriate operation and maintenance even after the replacement of the pumping facilities.

Under such circumstances, establishment of the effectiveness of Programme implementation will require not only procurement of equipment for water transmission, but also provision of technical

assistance in the form of Operation and Maintenance Technical Guidance and Soft Component, both in theory and in practice, to develop the capacity to operate and maintain the improved pumping facilities for water transmission appropriately and to improve energy efficiency in water transmission system.

The following are the problems found in the operation and maintenance of the pumping facilities:

1) Operation management-related problems

・Operators do not have correct knowledge of pump operation, including procedures and timing of starting and shutdown of pumps.

2) Maintenance-related problems

・Repairs are not implemented promptly even when an abnormality or damage to the equipment has been detected.
・Because of inadequate daily inspection, damage is not repaired while still minor.
・Except for regular application of oil and grease to the sliding parts of the rotating machinery such as pumps and motors, no preventive maintenance work is carried out.
・The only entries in the Operation and Maintenance Records are the daily discharge and operation hours. Because of the lack of records concerning maintenance/inspection and replacement of equipment, it is impossible to know the time of occurrence and type of damage or abnormality.

3) Safety management-related problems

・Understanding of safety management is poor and technology for accident prevention and crisis management is lacking.
・Experience in medium voltage power receiving is lacking.

4) Problems related to management organization and training in management

・As the number of engineers and technicians for maintenance is not sufficient, employment of additional personnel is required. As a medium voltage power receiving system is to be introduced, someone to be in charge of handling medium voltage electric equipment will have to be appointed.
・There is no systematic operation/maintenance manual and operation and maintenance depend solely on the experience of the operators and technicians.
・No systematic technical training is provided to engineers, technicians and operators. Although ad hoc training is provided at the Vocational Training Centre (VTC) and Central Workshop (CWS), the content is either conceptual or fragmental.
・Only limited operation records are kept (ID numbers of operated pumps, pump discharge, discharge pressure, water level in reservoirs and amount of chlorine input) and such records are not sorted, analyzed or used.

5) Problems in managing the water transmission system

- Each pumping station is operated either for fixed hours or according to the water level in the reservoir to which the station supplies water. An operation system that takes into consideration water distribution in the entire water transmission and distribution system has not been adopted.
- The diagnosis of the operational condition of the pump facility based on water transmission efficiency, efficiency of electricity consumption and pump efficiency has not considered.
- Pump operation and procurement of equipment are implemented without consideration for reduction in energy consumption.

The measure of Operation and Maintenance Technical Guidance of pumping facilities provided by the contractor will be taken for the problems 1), 2), 3) and 4) at immediately after installation of the equipments at each pumping station. For the problem of 5), the measure of Technical Assistance by Soft Component provided by the Consultant will be taken. These technical assistances shall be acted in cooperation between the contractor and the consultant.

(2) Objective of the Operation and Maintenance Technical Guidance of Pumping Facilities

Implementation of the Technical Guidance will provide the operators and maintenance personnel at the pumping stations with the technical knowledge required for operation and maintenance of the pumping facilities, thus leading to appropriate operation and maintenance of the pumping facilities improved in this Programme. Long-term stable maintenance of the performance of the mechanical and electrical facilities will require appropriate operation and continuous rational maintenance of the facilities and equipment.

Systematic integration of various inspections of the pumping facilities, including daily inspection before operation, regular inspection as a preventive maintenance measure and emergency inspection in the event of abnormality, and implementation of maintenance and inspection in accordance with a manual will contribute to extension of the service life and efficient operation of the pumping facilities and equipment.

Taking the above-mentioned into consideration, the objectives of the Technical Guidance in this Programme have been summarized as follows:

1) Appropriate operation management will enable safe and stable operation of the facilities and, thus, lead to extension of their service life.
2) Appropriate maintenance with preventive intervention will reduce facility breakdowns and, if breakdowns occur, will keep damage to the minimum. It will also contribute to shortening of the time required for repair of the facilities and improvement of the accuracy of the repairs.
3) Appropriate safety management will enable prevention of work-related accidents including those caused by contact with high voltage electricity.

(3) Effects of the Technical Guidance

The following direct effects (capacity development in operation and maintenance of the pumping facilities) can be expected from implementation of the Technical Guidance:

1) Appropriate operation management
   Operators at the pumping stations will understand the method of pump operation and be able to perform appropriate operation management. They will also be able to record data on operation and monitoring.
2) Appropriate maintenance
   Maintenance personnel (technicians) at Zarqa GWA will be able to inspect and maintain the facilities appropriately. CWS maintenance personnel (technicians) will be able to carry out appropriate repair work. They will be able to keep maintenance records.
3) Appropriate safety management
   Safety Managers at Zarqa GWA will be able to perform safety management of the pumping facilities.

(4) Means of verification of achievement of the effects

Goals will be set for each training subject. The instructor in each subject will evaluate the degree of understanding of the transferred technology in the final confirmation. In the final confirmation, each trainee will carry out the work independently and the instructor will evaluate their performance. Evaluation will include the technical achievements of the trainees and suggestions for further training.

Table 2.2.27 Goals of the Operation and Maintenance Technical Guidance

Training subject	Goals
1.peration management	To master appropriate operation procedures in accordance with the Operation Management Manual To record operation and monitoring work in accordance with the Operation Record Form To finalize the Operation Management Manual and the Operation Record Form
1-1 Maintenance (inspection and maintenance)	To master appropriate inspection and maintenance procedures in accordance with the Maintenance Manual To master daily and regular inspections in accordance with the Maintenance Record Form To finalize the Maintenance Manual and the Maintenance Record Form
1-2 Maintenance (repair)	To master appropriate repair technology in accordance with the Maintenance Manual To master repair procedures in accordance with the Maintenance Record Form To finalize the Maintenance Manual and the Maintenance Record Form
2. Safety management	To master appropriate safety management procedures in accordance with the Safety Management Manual To record management work in accordance with the Safety Management Record Form To finalize the Safety Management Manual for Pumping Facilities

(5) Technical Guidance Activities (Input Plan)

The recipients of the Technical Guidance will be the Director of the Water Supply Department, who supervises operation of the water transmission systems, the head and staff members (engineers and technicians) of the Pump Section, pump operators and maintenance managers (mechanical/electrical technicians) at the pumping stations assisted by this Programme and repair technicians (mechanical/electrical technicians) at CWS, where repair of the facilities is to be conducted. In addition, operators of other pumping stations and VTC training lecturers will also be invited to participate in the Technical Guidance.

In addition to the practical training given at each pumping station in Zarqa assisted by this Programme, the possibility of providing technical assistance to personnel from other pumping stations in Zarqa, VTC lecturers and CWS personnel by conducting classroom training in VTC training rooms will be considered.

Table 2.2.28 Content of the Operation and Maintenance Technical Guidance

No.	Details of assistance	Activity	Recipients
1	Pumping facility operation management technology	Training in operation management of the pumping facilities	Pump operators at the pumping stations assisted in this Programme (Zarqa: 6, Azraq: 13, Hallabat: 4)
2	Pumping facility maintenance technology (inspection and maintenance) Preventive maintenance	Training in technology for inspection and maintenance of the pumping facilities	Maintenance managers at Zarqa GWA (mechanical facility technicians: 2, electrical facility technicians: 2) Azraq Pumping Station (Technician: 1, Assistant Technician: 1)
3	Pumping facility maintenance technology (repair) Maintenance after breakdown	Training in technology for repair of the pumping facilities	CWS maintenance managers (pump, motor and control panel maintenance technicians)
4	Pumping facility safety management technology	Training in technology for safety management of the pumping facilities	Safety managers at Zarqa GWA and Azraq Pumping Station

(6) Resources required for implementation of the Operation and Maintenance Technical Guidance

Expertise and experience in electrical and mechanical engineering are required of the technical training instructors in operation and maintenance of the pumping facilities. Therefore, it is desirable to have engineers from the pump manufacturer as instructors. Operation management and maintenance technology, in particular, are closely related to the initial training for the procured pumping facilities and, therefore, the contractor will have to get the manufacturer to dispatch highly competent engineers for the Technical Guidance.

Effective implementation of training in operation management and maintenance of pumping facilities requires continuous implementation of the work series from preparation of various manuals to implementation of seminars and OJT. The manuals will have to be prepared in Arabic. Since such work as holding of seminars and revision of and addition to the prepared manuals will be required at the sites, a local assistant capable of communication in Arabic will have to be employed. The

personnel to be dispatched for the Technical Guidance will be as follows:

[Personnel to be dispatched for the Technical Guidance]

Procurement Contractor: Operation, maintenance and safety management of the pumping system
Mechanical facility engineer: 1
Electrical facility engineer : 1

Each of the procurement contractor's engineers will confirm achievement of the capacity development of the technical personnel of the implementation organization and prepare a report on such achievement.

(7) Implementation schedule of the Operation and Maintenance Technical Guidance

The contractor will implement commissioning of the facilities at Azraq, Hallabat and Zarqa pumping station immediately after installation of the pumping facilities. Technical Guidance in management of operation, maintenance and safety control will be implemented following the commissioning. Theoretical training will be provided at VTC and practice will be conducted on-site at each pumping station. Because WAJ is the implementation organization of this Programme, the Technical Guidance will be implemented after discussion on the implementation methods and content with WAJ. While technical assistance will be provided at each pumping station assisted in the Programme, arrangements prior to implementation and reporting upon conclusion of the Technical Guidance will be made in Zarqa GWA. The consultant will supervise the activity of the Technical Guidance by the contractor.

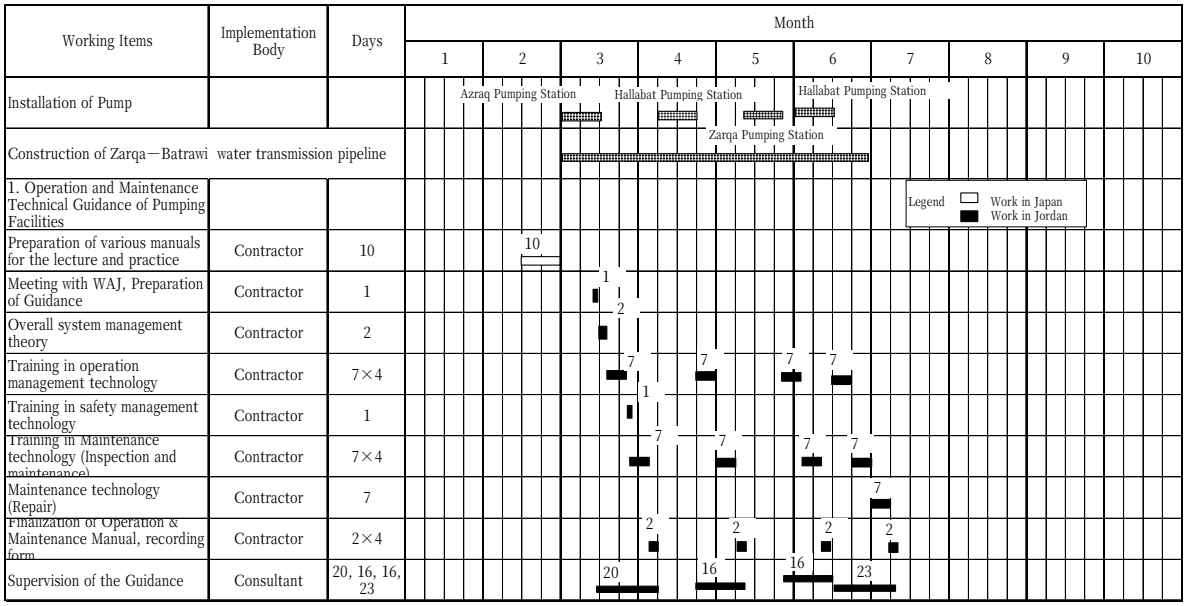
Table 2.2.29 shows the activities under the Technical Guidance and the number of working days and Table 2.2.30 shows the dispatch plan.

Table 2.2.29 Activities and number of working days of the Technical Guidance

Activity	Details of activity	Number of days
Work in Japan	Drafting of lecture and practice plans and preparation of various manuals and reference materials for the lecture and practice plans	10
Field Activity 1: (For relevant personnel at Zarqa GWA and the pumping stations)	1) Explanation of the Technical Guidance implementation plan to WAJ and preparation for implementation	1
	2) Overall system management theory System composition, introduction to operation and maintenance, confirmation of accompanying documents such as operation manuals for the equipment and drawings, confirmation of the content of the (draft) manuals and (draft) operation and maintenance records, and clarification of the division of duties	2
	3) Training in operation management technology (for operators) Understanding of the facility components (parts, structure, functions and maintenance methods of the machinery), operation theory/operation practice, field practice in monitoring, inspection and record keeping, entry in Operation Record and practice in operation	7
	4) Training in safety management technology	1
	5) Maintenance technology (Inspection and maintenance) Theory of preventive maintenance, practice in regular inspection of pumps, motors and control boards, practice in inspection and maintenance records and practice in maintenance	7
	6) Finalization of Operation and Maintenance Manual, recording form	2

Field activity 2: (For relevant personnel at CWS)	7) Maintenance technology (Repair) Pumps: Overhaul, dismantling and inspection of major parts, replacement of worn parts, adjustment of alignment, *etc*. Motors: Overhaul, dismantling and inspection of major parts, replacement of parts, adjustment methods, *etc*. Panels: Dismantling and inspection of electrical panels, switchboards and power distribution panels, adjustment and repair methods, *etc*. Practice in maintenance records	7
	8) Finalization of Operation and Maintenance Manual, recording form	2

Table 2.2.30 Implementation plan of Technical Guidance of Pumping Facilities



(8) Outputs of the Operation and Maintenance Technical Guidance

The table below shows the outputs of the Technical Guidance activities. The outputs will be written in English and Arabic.

Table 2.2.31 Outputs of the Technical Guidance

No.	Subject	Outputs
1	Pumping facility operation management technology	Operation management Manual Operation Management Record Sheet
2	Pumping facility maintenance technology (inspection and maintenance)	Maintenance Manual (Inspection and Maintenance) Maintenance Record Sheet
3	Pumping facility maintenance technology (repair)	Maintenance Manual (Repair) Maintenance Record Sheet
4	Pumping facility safety management technology	Safety Management Manual Safety Management Record Sheet

(9) Responsibilities of the recipient country

In order to enhance and sustain the effects of the Technical Guidance activities and to facilitate the activities, the Jordanian side should take responsibility for the following:

- Appointment of a counterpart for the Technical Guidance for the Programme
- Additional appointment of personnel for operation management, maintenance and safety

management at the assisted pumping stations

- Appointment of participants in the seminars and OJT from unassisted pumping stations
- Purchase of two personal computers for sorting and analysis of the operation/maintenance records
- Payment of allowance for attendance at the above-mentioned seminars and OJT to the relevant personnel
- Reservation of lecture rooms suitable for seminars
- Contact and coordination with the relevant organizations to facilitate implementation of the Technical Guidance
- Monitoring and follow-up for sustainable operation and maintenance of the facilities after implementation of the Technical Assistance

2.2.10 Soft Component

(1) Background to planning the Soft Component

For the following problem mentioned previously as 5) in clause 2.5.6, the measure of Soft Assistance by Soft Component provided by the Consultant will be taken.

Problems in managing the water transmission system

- Each pumping station is operated either for fixed hours or according to the water level in the reservoir to which the station supplies water. An operation system that takes into consideration water distribution in the entire water transmission and distribution system has not been adopted.
- The diagnosis of the operational condition of the pump facility based on water transmission efficiency, efficiency of electricity consumption and pump efficiency has not considered.
- Pump operation and procurement of equipment are implemented without consideration for reduction in energy consumption.

(2) Objective of the Soft Component

Appropriate operational management of the water transmission system will make water transmission efficient and stable by enabling water transmission in accordance with demand for water distribution (demand at distribution reservoirs). It will reduce energy use in water transmission system by enabling efficient operational management.

Diagnosis of the operational condition by collecting and analyzing the operation records on pumping discharge, voltage and current and electricity consumption of pump facilities will contribute to efficient pump operation and reduction in energy consumption.

(3) Effects of the Soft Component

The engineers who are engaged in operation of water supply system at Zarqa GWA will be able to carry out comprehensive water transmission management and operation of the pumping facilities with

conscious of energy efficiency. Also, they will be able to do maintenance management based on the efficiency of pumping facility.

(4) Means of verification of achievement of the effects

Goals will be set for each training subject. The instructor in each subject will evaluate the degree of understanding of the transferred technology in the final confirmation. In the final confirmation, each trainee will carry out the work independently and the instructor will evaluate his/her performance.

Table 2.2.32 Goals of the Soft Component

Training subject	Goals
Operational management technology of pumping water transmission system	To prepare a pump operation plan in accordance with the water transmission and distribution plan To analyze the operation management records and evaluate the efficiency of pump operation To finalize the management manual of pumping water transmission system

(5) Soft Component activities (Input Plan)

The recipients of the Soft Component will be the Director of the Water Directorate, who supervises operation of the water transmission systems, the head and staff members (engineers and technicians) of the Pump Section.

Table 2.2.33 Content of the Soft Component

Details of assistance	Activity	Recipients
Operational management technology of pumping water transmission system	Training in drafting of an efficient water transmission plan Training in drafting of a pumping station operation plan Management by procurement contractor	Water directorate managers at Zarqa GWA (Director of Water Directorate: 1, Head of Pump Section: 1, mechanical facility engineer: 1, electrical facility engineer: 1) Azraq (senior manager: 1), Technician: 6

Table 2.2.34 Activities and Number of Working Days of the Soft Component

Activity	Details of activity	Number of days
Work in Japan	Drafting of lecture and practice plans and preparation of manual and reference materials for the lecture and practice plan	5
Field activity 3: (For system managers)	1) Water transmission system operation technology Theory of water transmission by pump, operation and maintenance record, analysis of the record, diagnosis of operation condition, practice of preparation of report 2) Diagnosis technology of efficiency of pumping facilities: evaluation of operational efficiency, unit electricity consumption per pumping discharge, electricity consumption of pump 3) Practice at Azraq, Hallabat and Zarqa pumping stations	3
	Preparation of Final Report on Soft Component, advice on management and finalization of the manuals	2
	Report to WAJ	1

(6) Resources required for implementation of the Soft Component

The consultant, who is familiar with the concept of the water supply system, to provide technical assistance both in preparation and in implementation of the operational plans for the pumping stations. Personnel to be dispatched for the Soft Component is a Japanese engineer of operational management of pumping water transmission system.

(7) Implementation schedule of the Soft Component

The contractor will implement commissioning and Operation and Maintenance Technical Guidance of pumping facilities at Azraq, Hallabat and Zarqa pumping station immediately after installation of the equipments.

The consultant will provide technical assistance under the Soft Component after completion of all technical guidance provided by the contractor and at the time when new pumping facilities replaced in the Programme became in the operational condition.

Because WAJ is the implementation organization of this Programme, the Soft Component will be implemented after discussion on the implementation methods and content with WAJ and in the presence of WAJ training personnel.

Table 2.2.35 Implementation plan of Soft Component.

Working Items	Implementation Body	Days	Month 1	2	3	4	5	6	7	8	9	10
Installation of Pump			Azraq Pumping Station		Hallabat Pumping Station			Hallabat Pumping Station				
Construction of Zarqa－Batrawi water transmission pipeline							Zarqa Pumping Station					
1. Operation and Maintenance Technical Guidance of Pumping Facilities									Legend: Work in Japan / Work in Jordan			
Preparation of various manuals for the lecture and practice	Contractor	10		10								
Meeting with WAJ, Preparation of Guidance	Contractor	1			1							
Overall system management theory	Contractor	2			2							
Training in operation management technology	Contractor	7×4			7	7		7	7			
Training in safety management technology	Contractor	1				1						
Training in Maintenance technology (Inspection and maintenance)	Contractor	7×4				7	7		7	7		
Maintenance technology (Repair)	Contractor	7								7		
Finalization of Operation & Maintenance Manual, recording form	Contractor	2×4				2	2	2	2			
Supervision of the Guidance	Consultant	20, 16, 16, 23			20		16	16	23			
2. Soft Component												
Preparation of manual for the lecture and practice	**Consultant**	5						5				
Training in water transmission system operation technology	**Consultant**	3							3			
Preparation of Final Report on Soft Component	**Consultant**	2							2			
Report to WAJ	**Consultant**	1							1			

(8) Outputs of the Soft Component

The table below shows the outputs of the Soft Component activities. These outputs will be compiled into the Soft Component Report to be submitted to WAJ. The outputs will be written in English

- Pumping Water Transmission System Management Manual
- Reference materials for the lecture and practice
- Completion report of soft component

(9) Responsibilities of the recipient country

In order to enhance and sustain the effects of the Soft Component activities and to facilitate the activities, the Jordanian side should take responsibility for the following:

- Appointment of a counterpart for the Soft Component
- Monitoring and follow-up for sustainable operation and maintenance of the facilities after implementation of the Soft Component

2.2.11 Implementation Schedule

Table 2.2.36 show the implementation schedule of this Programme. As mentioned earlier, the materials and equipment will be procured in two lots, Lot 1 for water transmission pumping facilities and Lot 2 for water distribution networks.

After the conclusion of E/N, a consultant contract will be concluded and detailed design will be conducted. Subsequently, the Procurement Management Agent will prepare the tender documents and conduct the tender to select a contractor for procurement of Lot 1. After concluding a contract with the contractor, manufacture and procurement of the equipment will commence. Because this Programme, which consists of procurement of equipment and O&M Technical Guidance and Soft Component, is complex in nature and because the pumps to be procured are special equipment, pre-qualification of the bidders and deliberate evaluation of the bids will be required. Therefore, it has been decided that the tender process will be carried out in Japan.

Approximately five months will be required to implement detailed design for the implementation design, tendering and conclusion of a contract with the contractor for Lot 1. The subsequent period from manufacture to delivery of the equipment is expected to be approx. 14 months. Then, it is expected to take approx. six months to complete the installation and commissioning of the pumping facilities and the O&M Technical Guidance.

The Lot 2 materials and equipment will be procured when switchover to the gravity-flow system has advanced. Because the progress of the switchover depends on the resolve of WAJ, it is unknown when the switchover will be completed. Therefore, it will be necessary to monitor the condition of the

distribution zones to decide when to procure the Lot 2 materials and equipment. This schedule assumes that the tender process for the Lot 2 equipment commences after discussion at a meeting of the Consultative Committee to be held after installation of the pumping facilities for water transmission in this Programme has been completed and stable water transmission has been established.

The detailed design and preparation of the reference materials for the tender documents for Lot 2 will be carried out simultaneously with those for Lot 1 immediately after the conclusion of E/N. However, revision will be required when the time to commence the Lot 2 work has been decided. The Lot 2 equipment consists of gate valves and air valves for the water distribution networks. Since these valves are not special equipment and their procurement is the only component of the work, the tender for Lot 2 will be conducted in Jordan. It is expected to take four months from the detail design to the tender and conclusion of a contract with the contractor and three months from manufacture to delivery of the equipment. After the delivery, WAJ will install the equipment.

Since it is not acceptable for each pumping station concerned to stop pumping water for a long period during Lot 1 pump installation, removal and installation will have to be implemented without interrupting water transmission by the existing pumps. In order to stabilize the water transmission at an early stage, installation at Azraq Pumping Station, which has the largest discharge, will be conducted first, followed by work at Hallabat Pumping Station. Installation of the pumping facilities at Zarqa Pumping Station will be implemented in such a way that completion will coincide with completion of the installation of the water transmission pipeline to Batrawi Reservoir, which is to be implemented by WAJ.

Installation of the Lot 1 equipment and the Technical Assistance will be implemented in the following order:

(1) Azraq Pumping Station

1) The period required for installation of the pumping equipment is expected to be 2.5 months, consisting of 2.0 months for removal of the existing pumping facilities, demolition of the pump foundations and casting and curing of the foundation concrete for the new pumps, and 0.5 month for installation of the pumping facilities.

2) While the existing pumping facilities are being removed, Pump No. 3 currently in operation will be moved to the location of Pump No. 2, which is not operating. It will then be operated with Pump No. 1 to ensure sufficient discharge during the installation. In addition, the transmission cables will be replaced and the new transformers will be installed for the switchover from a low to a medium voltage power receiving system during the period of removal of the existing pumping facilities and installation of the new facilities. During this period, the existing Pumps Nos. 1 and 2 will be operated using the low voltage system.

3） During the above period, it will be necessary to complete installation of the water flow meters, water transmission pipes, flow control valves and air valves on the premises of the pumping station and installation of the air valves on the water transmission pipeline to Khaw Reservoir outside the station.

4） After installation of the five new pumping facilities has been completed, the power receiving voltage has been changed and test operation has proven the absence of any problems, full-scale operation of the new facilities will commence. Upon completion of the subsequent removal of the remaining old pumping facilities and transformers for low voltage power receiving, the installation work at Azraq Pumping Station will be completed.

5） Following test commissioning of the facilities, O&M Technical Guidance will be provided by the procurement contractor and the consultant.

(2) Hallabat Pumping Station

1） After replacement of the pumping facilities has been completed at Azraq Pumping Station and water transmission from the station has stabilized, installation of the pumping facilities will commence at Hallabat Pumping Station. Of the four pumps to be replaced, two each for discharge to Khaw and to Hallabat Village, the pumps for Khaw will be replaced in the Programme. In the beginning, one of the existing pumps will be relocated (Pump No. 1 will be moved to the location of Pump No. 3) in order not to interrupt discharge during the installation work.

2） While the series of work from removal of the existing pumping facilities, demolition of the existing pump foundations, and casting and curing of the foundation concrete for the new pumps to installation of the new pumping facilities is being implemented, the existing low-voltage transformers will be replaced.

3） During the same period, installation of the water flow meters and flow control valves at the inflow side of the reservoir and for discharge to Khaw inside the premises and installation of the air valves on the transmission pipeline outside the premises will be completed.

4） After installation of the pumping facilities for discharge to Khaw has been completed, the O&M Technical Guidance of the facilities will be conducted followed by the commissioning of the facility.

5） After installation of the pumping facilities for discharge to Khaw has been completed, installation of the pumping facilities to Hallabat Village will commence. At the same time, installation of the water meters and flow control valves for discharge to the village will be completed.

6） For emergency use, a bypass pipeline will be installed between the transmission pipelines to

Khaw and to Hallabat Village and isolation valves will be installed on the discharge pipes.

7) Since there is no indoor crane in the Hallabat Pumping Station building and there is little extra space for pump installation, the removal and installation work will have to be implemented carefully. It is expected to take five months to complete installation of all the equipment.

8) After installation of the pumping facilities for discharge to Hallabat Village has been completed, the O&M Technical Guidance and Soft Component of the facilities will be conducted followed by the commissioning of the facility

(3) Zarqa Pumping Station

1) At Zarqa Pumping Station, once construction of the new pumping station building has been completed, it will be possible to install the new pumping facilities at any time after the arrival of the equipment.

2) Since the inflow and discharge pipes for the pumping facilities will be installed with the construction of the new building, the Japanese side will take responsibility for the work including the foundation work for the new pumps, installation of the pumping facilities and connection to the installed pipes.

3) During the above work, installation of the water flow meters and flow control valves inside the premises and the water transmission pipeline to Batrawi Reservoir outside the premises will be completed.

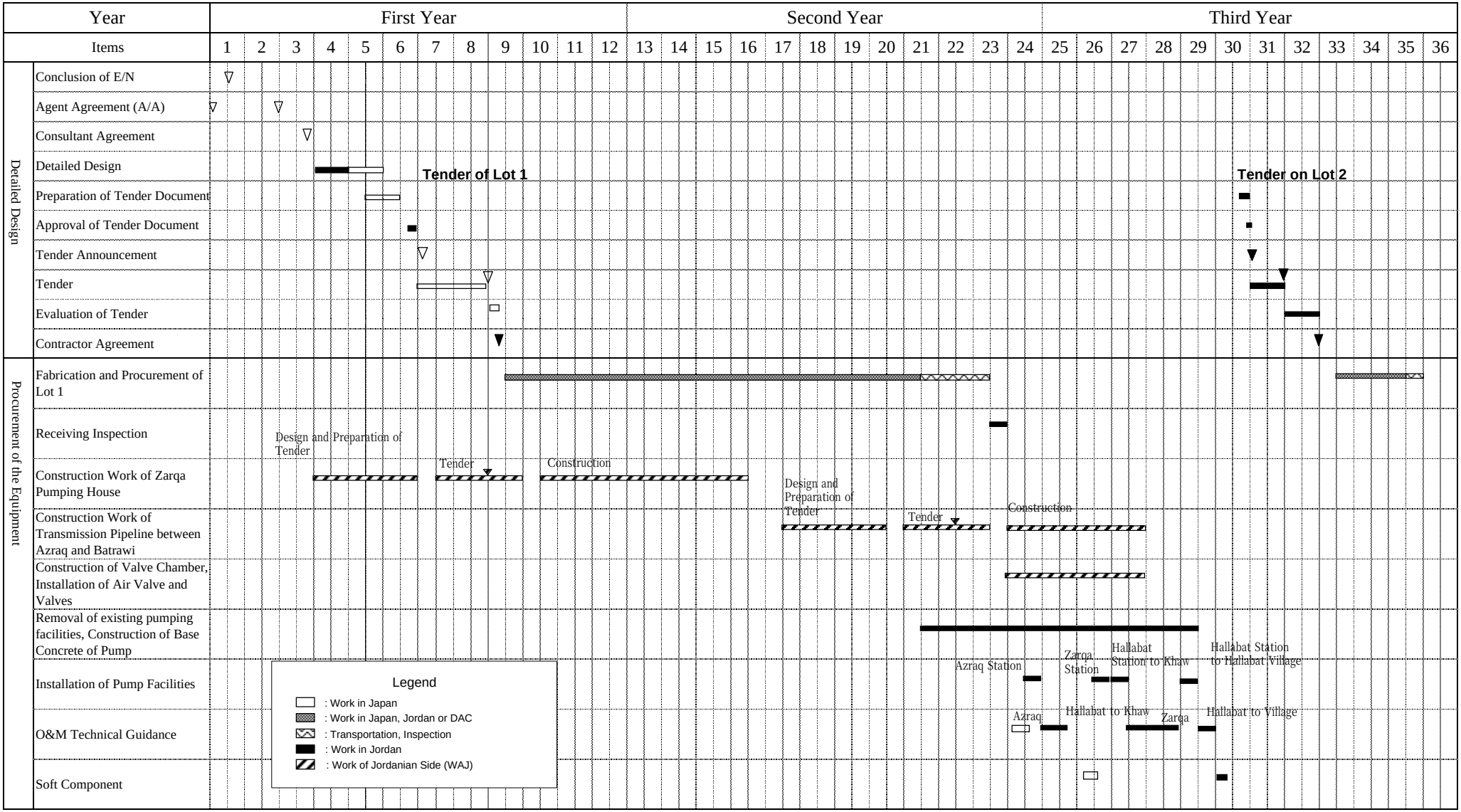
4) WAJ will be responsible for improvement of the transformers and installation of the electric cables to the electrical panel for the electric power consumed by the pumping facilities to be procured by the Japanese side, the pumping facilities procured by WAJ and for other uses in the pumping station.

5) After installation of the pumping facilities has been completed, commissioning of the facilities will be conducted followed by the O&M Technical Guidance.

(4) Khaw Pumping Station

Before completion of the installation work at Hallabat Pumping Station, the valves for the pumps will be replaced and the flow control valves and water flow meters (at two places on the inflow side of the reservoir and at one place on the discharge side of the pumping station) will be installed.

Table 2.2.36 Implementation Schedule of the Programme



2.3 Obligations of Recipient Country

The Jordanian side will have to perform its obligations in pace with the progress of the procurement of materials and equipment by the Japanese side. The table below shows the obligations of the Jordanian side.

Table 2.3.1 Obligations of the Jordanian Side

Item	Obligations of the Jordanian side
1. General matters	・Application for and acquisition of permission/approval relevant to Programme implementation from the organizations concerned ・Banking procedures including Banking Arrangement (B/A) and Blanket Disbursement Authorization (BDA) ・Payment of commission for opening the B/A account, commission for BDA notification and other bank commissions ・Guarantee of unloading and customs clearance at the port of disembarkation and domestic transportation of the equipment to be procured in this Programme ・Arrangement for exemption from internal taxes including customs duties and IVA and other fiscal charges on the equipment and services to be procured in this Programme ・Assistance to employees of the consultant and the procurement contractor involved in Programme implementation for their entry into, exit from and stay in Jordan ・Implementation of environmental impact assessment and acquisition of permission for installation of the equipment from the Ministry of Environment, if necessary ・Guarantee of the safety of the activities for Programme implementation
2. Content and schedule of Programme implementation	・Discussion on the content of the Lot 2 equipment after conclusion of the contract for the procurement of Lot 1 (at the Consultative Committee) ・Discussion on when to implement the process of selecting the contractor for the procurement of Lot 2 (at the Consultative Committee) ・Selection of areas in which installation of Lot 2 is to be implemented (at the Consultative Committee)
3. Preparation for procurement of equipment	・Reservation and improvement of storage area for equipment and spare parts (at Ain Ghazal Central Warehouse)
4. Preparation for installation of equipment	<u>Azraq Pumping Station</u> ・Necessary arrangements with the power distribution company for switchover of the power distribution system (from low to medium voltage power receiving) ・Partial replacement of distribution cables (for switchover to the medium voltage power receiving system) ・Removal of the existing transformer at the new pumping station ・Relocation of Pump No.3 to the new pumping station (for installation of the procured equipment) ・Removal of existing electric panels for generators in the electric room <u>Hallabat Pumping Station</u> ・Repair of the existing station building ・Relocation of Pump No.1 (for installation of the procured equipment) <u>Zarqa Pumping Station</u> ・Construction and furnishing of the new pumping station building ・Arrangement of transformer facilities (1,200 kVA transformer for the transmission pumps procured by the Japanese side and transformer for the distribution pumps

Item	Obligations of the Jordanian side
	procured by the Jordanian side) ・Installation of inflow pipeline at the new pumping station (from Zarqa Reservoir) ・Installation of outflow pipelines from the new pumping station (for the transmission pumps procured by the Japanese side and the distribution pumps procured by the Jordanian side) ・Installation of trenches for wiring in the station (for the transmission pumps procured by the Japanese side and the distribution pumps procured by the Jordanian side) <u>Khaw Pumping Station</u> ・Approval of constructing a flow meter chamber to be constructed at the inflow pipeline from Hallabat
5. Installation of equipment	<u>Azraq Pumping Station</u> ・Construction of water flow meter chambers and installation of cables for water flow meters (three places) ・Installation of pipes for partial replacement of the transmission pipeline on the premises of the station (Dia.600mm, approx.. 40 m) ・Repair of existing valve chamber for flow control valve and installation of valve(Dia.600mm, one place) ・Installation of air valve on the discharge pipe of the water transmission pump (one place) ・Installation of air valves and repair of existing air valve chambers on the water transmission pipeline to Khaw Reservoir (40 places) <u>Hallabat Pumping Station</u> ・Construction of water flow meter chambers and installation of cables for water flow meters (three places) ・Repair of water flow meter chamber and installation of cables for water flow meter (one place) ・Construction of valve chambers for flow control valves and installation of valve (Dia.600mm, Dia.200mm, one each) ・Connection of bypass pipeline (between the transmission pipeline to Khaw and the distribution pipeline to the village) ・Installation of air valves and repair of existing air valve chambers on the transmission pipeline to Khaw Reservoir (15 places) <u>Zarqa Pumping Station</u> ・Installation of lead-in cables on the secondary side of the transformer to the electrical board for the water transmission pumps procured by the Japanese side ・Construction of water flow meter chamber and installation of cables (one place: Pipes are to be installed as part of the discharge pipeline from the new pumping station) ・Construction of valve chamber for flow control valve and installation of valve (Dia.600mm, one place: Pipes are to be installed as part of the discharge pipeline from the new pumping station) ・Installation of water transmission pipeline to Batrawi Reservoir (Dia.600mm, approx.2 km) <u>Khaw Pumping Station</u> ・Installation of valves for the pumps (Dia.400mm, 4 sets) ・Construction of water flow meter chambers and installation of pipes and cables for water flow meters (three places) ・Repair of valve chamber for flow control valve, removal of existing valve and water flow meter, and installation of flow control valve and pipes (Dia.700mm, one place) <u>In the distribution networks</u>

Item	Obligations of the Jordanian side
	・Construction of water flow meter chambers, installation of cables, supply of power source and construction of converter sheds for water flow meters (two places) ・Installation of gate valves (Dia.100 – 600 mm, 343 valves) ・Installation of air valves (Dia.50, 15 valves) <u>Miscellaneous</u> ・Measures to ensure water distribution in the case of temporary shortage of discharge during installation of the equipment
6. Operation and Maintenance Technical Guidance of Pumping Facilities, Soft Component	・Appointment of a counterpart for the Technical Guidance and Soft Component ・New and additional appointment of personnel in charge of operation management, maintenance / safety management at the assisted pumping stations ・Appointment of personnel from unassisted pumping stations to attend the seminars and OJT ・Purchase of two personal computers for sorting and analysis of the operation/maintenance records ・Payment of allowance for attendance at the above-mentioned seminars and OJT to the relevant personnel ・Reservation of lecture rooms suitable for seminars (at VTC) ・Contact and coordination with the relevant organizations to facilitate implementation of the Technical Guidance and Soft Component ・Monitoring and follow-up for sustainable operation and maintenance of the facilities after implementation of the Technical Guidance and Soft Component
7. Organization	<u>Azraq Pumping Station</u> ・Appointment of a safety manager for the medium voltage power receiving system <u>Zarqa Pumping Station</u> ・Additional appointment of an electrical facility engineer, mechanical facility engineer and electrical facility technician <u>Khaw Pumping Station</u> ・Appointment of a senior manager for the pumping station ・Additional appointment of a technician in chlorine management
8. Operation and maintenance of equipment	・Implementation of appropriate operation management, maintenance / safety management of the procured equipment ・Implementation of appropriate management of the operation of the water transmission system ・Implementation of appropriate inventory and procurement management of spare parts ・Maintenance contract for the medium voltage power receiving system with a private company

2.4 Programme Operation Plan

This Programme has the goals of improving the transmission efficiency and reducing the transmission energy consumption of the water supply system in Zarqa District and stabilizing water distribution in the distribution zones, in cooperation with Grant Aid Cooperation of Japan under "The Project for Improvement of the Water Supply System for the Zarqa District." To achieve these goals, the pumping facilities at the existing main transmission pumping stations, Azraq, Hallabat and Zarqa Stations, will be replaced and the relevant valves in the pumping facilities at Khaw Pumping Station and the valves in the water distribution networks will be improved. Since this Programme is aimed at improvement of the equipment in part of the existing facilities within the entire water transmission and distribution systems in Zarqa District, the existing operation and maintenance system will remain in use after the completion of this Programme.

However, even though an operation and maintenance system exists, there is no manual for operation and maintenance of the pumping facilities. Sufficient training in operation and maintenance has not been provided to the relevant personnel either. Therefore, this Programme aims at improving the capacity to operate and maintain the pumping facilities appropriately by providing technical guidance under O&M Technical Guidance and Soft Component. Table 2.4.1 shows the job standards in operation and maintenance.

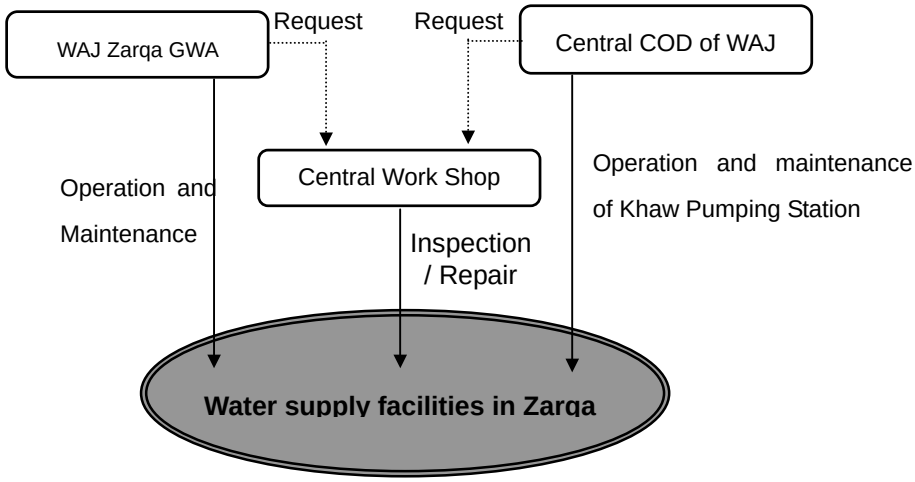


Figure 2.4.1 Operation and maintenance system of WAJ

Table 2.4.1 Proposed Operation and Maintenance System

No.	Operation/maintenance item	Person in charge
1	Operation of the pumping facilities	Operators of the target pumping stations
2	Inspection and maintenance of the pumping facilities	Maintenance personnel of Zarqa GWA and COD (Mechanical and electrical facilities technicians)
3	Repair of the pumping facilities	1) All pumping stations except Azraq Station (facilities with low voltage power reception) Maintenance personnel of Central Repair Shop will handle the repairs (Technicians specialized in pumps, motors and control panels) 2) Azraq Pumping Station (facilities with medium voltage power reception) Outsourcing of inspections and repairs to private companies
4	Safety management of the pumping facilities	Safety management personnel of Zarqa GWA and COD
5	Management of the operation of the water transmission system (Transmission management)	Water supply system managers of Zarqa GWA and COD (Director of the Department of Water Supply, Head of the Pump Section, engineers and technicians)

COD: COD is the central management department of WAJ's headquarters, which currently has control only over Khaw Pumping Station.

In the existing operation and maintenance system, while the number of operators is sufficient to operate the pumping facilities, the number of engineers and technicians is insufficient to maintain the facilities appropriately. The Pumping Facility Section of Zarqa GWA has two engineer-level workers for mechanical facilities and Rusaifa District has only one engineer in civil engineering. Neither has an electrical facilities engineer. There is one mechanical facilities technician and one electrical facilities technician at Zarqa Pumping Station, two general facilities technicians at Azraq Pumping Station and two mechanical facilities technicians and one electrical facilities technician at Khaw Pumping Station. The two at Zarqa Pumping Station are in their late fifties and close to retirement. In addition, since they are responsible for 12 pumping stations including Zarqa Pumping Station and a group of wells, they are unable to attend to all these facilities under the current conditions.

Therefore, if pumping facilities are to be procured in this Programme, Zarqa Pumping Station, which oversees and manages all the stations, will require reinforcement of its personnel, *i.e.* one electrical facilities engineer and one mechanical and one electrical facilities technician each, in order to maintain the pumping facilities appropriately.

2.5 Programme Cost Estimation

2.5.1 Initial Cost Estimation

(1) Costs borne by the Jordanian side

In this Programme, the Japanese side will install the pumping facilities and water flow meters, while

the Jordanian side will install the transmission pipes and valves procured by the Japanese side, construct the water flow meter chambers and flow control valve chambers and install the valves in the distribution networks.

The costs borne by the Jordanian side is estimated at about 1.1 million JD.

Table 2.5.1 Costs Borne by the Jordanian Side

Item	Cost (JD)
Construction of New Zarqa Pumping Station building and installation of transmission pipelines within the site of station	400,000
Improvement of the power distribution cables for medium voltage power reception at Azraq Pumping Station	7,300
Installation of transmission pipeline in the site of Azraq Pumping Station	8,800
Installation of transmission pipeline to Batrawi reservoir from Zarqa Pumping Station	500,000
Arrangement of transformer and installation of secondary power line for the new pumping facility of Zarqa Pumping Station	2,500
Repair of pump house of Hallabat Pumping Station	10,000
Installation of valves for existing pumps in Khaw Pumping Station	2,000
Movement of existing pump (Azraq, Hallabat)	13,000
Installation of concrete chambers for water flow meters (at each pumping station)	48,000
Construction of concrete chambers for the control valves on the transmission pipelines (at each pumping station)	13,000
Installation of air valves for transmission pipelines (Azraq, Hallabat)	29,000
Construction of concrete chambers and indicator house for water flow meters in the distribution network, supply of electricity	13,000
Commission related to banking arrangement, etc.	8,800
Allowance of the participants of WAJ for Technical Guidance, etc.	7,300
Installation of gate valves and air valves in the distribution networks	2,900
Total	1,065,600

(2) Estimation conditions

1) Time of estimation: End of June 2009

2) Foreign exchange rates: 1 US$=¥96.59
1EUR=¥128.92
1 JD=¥136.65

3) Period of procurement: The periods of detail design and procurement are as shown in the Implementation Schedule.

4) Miscellaneous Estimation shall be carried out in accordance with the Grant Aid Cooperation scheme of the Government of Japan.

2.5.2 Operation and Maintenance Cost

Implementation of this Programme will affect the electricity costs, personnel costs and revenue from water charges.

(1) Personnel costs

Appropriate operation and maintenance of the facilities will require reinforcement of the personnel by one electrical facilities engineer and one mechanical and one electrical facilities technician each. The annual costs for the additional personnel will be (1,500 + 715 × 2) × 12 = 35,000 JD.

(2) Revenue from water charges

The replacement of the pumps will stabilize the amount of water transmission. The increase in revenue from the water charges resulting from this increased amount of water distribution is expected to be 1,900,000 m^3 /year x 50% of the proportion of revenue water x 4,422 JD/20 m^3 of water charges = 210,000 JD.

(3) Electricity costs

In order to compare the electricity consumption between before and after implementation of the Programme, calculation was made in following three cases as shown in the Table 2.5.3- Table 2.5.5.

Case 1: Comparison of electricity consumption between in actual amount of water transmission before the Programme and in planned amount of water transmission after the Programme

(The water distribution condition after the Programme is still direct pumping from Zarqa PS to Northern Zarqa Distribution Zone.)

Case 2: Same as Case 1

(Pumping operation from Zarqa PS to Northern Zarqa Distribution Zone is canceled and gravity flow condition is realized.)

Case 3: Comparison of electricity consumption based on planned amount of water transmission between before and after the Programme

(The water distribution condition after the Programme is still direct pumping from Zarqa PS to Northern Zarqa Distribution Zone.)

Table 2.5.3 shows that the replacement of the pumping facilities at Azraq, Hallabat and Zarqa Stations will increase the annual electricity costs at the three stations by 123,000 JD from 1,573,000 JD before Programme implementation to 1,696,000 JD after implementation. The increase corresponds to approx. 2.3% of the 5,439,000 JD electricity costs of the entire WAJ Zarqa GWA in Fiscal 2008.

The cause of the increase is that, because of the improved efficiency of the pumps resulting from the replacement of the transmission pumps, annual transmission will increase by 5.4%, from 14,117,000 m^3 to 14,892,000 m^3, and 22%, from 5,007,000 m^3 to 6,132,000 m^3, at Azraq and Hallabat Pumping Stations, respectively. The combined increase of 1,900,000 m^3 per year will increase electricity consumption by 2,862,000 kWh after Programme implementation.

However, the above comparison was made under the assumption that the current pumping of water to most of the water distribution zones in Zarqa District from Zarqa Pumping Station continues. If the system is switched over to the gravity flow system using the reservoirs constructed with Japanese grant aid and direct pumping from Zarqa Pumping Station to the Northern Zarqa Water Distribution Zone is terminated, the annual electricity consumption and electricity costs will be reduced by 1,891,000 kWh and 82,000JD, respectively, as shown in Table 2.5.4.

If Zarqa Pumping Station continues using the current system of direct pumping distribution, the net annual reduction in electricity consumption and costs at the design flow rate, which will increase after implementation of this Programme, will be 8,687,000 kWh and 374,000 JD, respectively, as shown in Table 2.5.5.

The table below summarizes the changes in annual revenue and expenditure in the format of the statement of profits and losses of Zarqa GWA. The calculations were made under the assumption that direct pumping distribution from Zarqa Pumping Station is to continue for the time being after the completion of this Programme.

Despite the increases in the electricity costs and personnel costs, because of the increase in revenue from the water charges, though deficit operation continues, the balance between operational revenue and operational expenditure is expected to improve by 52,000 JD/year.

Table 2.5.2 Balance of Revenue and Expenditure of Zarqa GWA

Item	Before Programme implementation (Fiscal 2008)	After Programme implementation	Increase (decrease)	Increased (decreased) item
Revenue				
1. Revenue from water charges	8,745,546	8,955,546	210,000	Increase in water transmission
2. Revenue from sewerage charges	1,761,749	1,761,749	0	
3. Non-operating revenue	1,819,287	1,819,287	0	
Total revenue	12,326,582	12,536,582	210,000	Reinforcement in maintenance personnel
Expenditure				
1. Personnel costs	2,150,952	2,185,952	35,000	
2. Water transportation	4,086,524	4,086,524	0	
3. Electricity costs	3,303,532	3,426,532	123,000	Replacement of transmission pumping facilities
4. Sewerage treatment	2,615,154	2,615,154	0	
5. Repair and fuel	1,387,535	1,387,535	0	
6. Miscellaneous	1,262,033	1,262,033	0	
Total expenditure	14,805,730	14,963,730	158,000	
Balance of revenue and expenditure	-2,479,148	-2,427,148	52,000	

Table 2.5.3 Comparison of Electricity Consumptions before and after the Programme (Case 1)

(The water distribution condition after the Programme is still direct pumping from Zarqa PS to Northern Zarqa Distribution Zone.)

Pumping Station		Before Implementation of the Programme (Actual in 2008)					After Implementation of the Programme (Proposed)					
Station	Destination of Water	Pump Efficiency	Unit Electricity Consumption	Water Transmission Amount	Electricity Consumption	Electricity Cost	Pump Efficiency	Unit Transmission Discharge	Water Transmission Amount	Unit Electricity Consumption	Electricity Consumption	Electricity Cost
		%	kWh/m^3	m^3/y	kWh/y	JD/y	%	m^3/h	m^3/y	kWh/m^3	kWh/y	JD/y
Azraq	Khaw Reservoir	57	1.250	14,116,880	17,434,610	749,688	68	1,700	14,892,000	1.582	23,559,144	1,013,043
Hallabat	Khaw Reservoir	57	0.620	3,587,739	3,927,342	168,876	68	500	4,380,000	0.520	2,277,600	97,937
	Hallabat Village	34	1.200	1,419,120			65	200	1,752,000	0.628	1,100,256	47,311
Zarqa	Distribution Area	50	0.782	19,450,620	15,218,700	654,596	50	–	12,442,620	0.782	9,730,129	418,396
	Batrawi Reservoir						68	800	7,008,000	0.396	2,775,168	119,332
Total				38,574,359	36,580,652	1,573,160			40,474,620		39,442,297	1,696,019
Balance between Before and After Programme									1,900,261		2,861,645	122,859

Note 1: Unit electricity consumption is based on actual measurement of existing pump except Zarqa Pumping Station.

Note 2: Total electricity consumption of Azraq Pumping Station 28,589,623kWh (Transmission pump:17,646,100kWh, Well pumps:10,943,523kWh)

Note 3: Unit Electricity Charge 0.043JD/kWh

Table 2.5.4 Comparison of Electricity Consumptions before and after the Programme (Case 2)

(Pumping operation from Zarqa PS to Northern Zarqa Distribution Zone is canceled and gravity flow condition is realized.)

Pumping Station		Before Implementation of the Programme (Actual in 2008)					After Implementation of the Programme (Proposed)					
Station	Destination of Water	Pump Efficiency	Unit Electricity Consumption	Water Transmission Amount	Electricity Consumption	Electricity Cost	Pump Efficiency	Unit Transmission Discharge	Water Transmission Amount	Unit Electricity Consumption	Electricity Consumption	Electricity Cost
		%	kWh/m^3	m^3/y	kWh/y	JD/y	%	m^3/h	m^3/y	kWh/m^3	kWh/y	JD/y
Azraq	Khaw Reservoir	57	1.250	14,116,880	17,434,610	749,688	68	1,700	14,892,000	1.582	23,559,144	1,013,043
Hallabat	Khaw Reservoir	57	0.620	3,587,739	3,927,342	168,876	68	500	4,380,000	0.520	2,277,600	97,937
	Hallabat Village	34	1.200	1,419,120			65	200	1,752,000	0.628	1,100,256	47,311
Zarqa	Distribution Area	50	0.782	19,450,620	15,218,700	654,596	–	–	–	–	–	–
	Batrawi Reservoir						68	800	7,008,000	0.396	2,775,168	119,332
New Khaw	Batrawi Reservoir								12,442,620	0.400	4,977,048	214,013
Total				38,574,359	36,580,652	1,573,160			40,474,620		34,689,216	1,491,636
Balance between Before and After Programme									1,900,261		-1,891,436	-81,524

Table 2.5.5 Comparison of Electricity Consumptions before and after the Programme (Case 3)

(The water distribution condition after the Programme is still direct pumping from Zarqa PS to Northern Zarqa Distribution Zone.)

Pumping Station		Before Implementation of the Programme (Actual in 2008)					After Implementation of the Programme (Proposed)					
Station	Destination of Water	Pump Efficiency	Unit Electricity Consumption	Water Transmission Amount	Electricity Consumption	Electricity Cost	Pump Efficiency	Unit Transmission Discharge	Water Transmission Amount	Unit Electricity Consumption	Electricity Consumption	Electricity Cost
		%	kWh/m^3	m^3/y	kWh/y	JD/y	%	m^3/h	m^3/y	kWh/m^3	kWh/y	JD/y
Azraq	Khaw Reservoir	57	1.887	14,892,000	28,101,204	1,208,352	68	1,700	14,892,000	1.582	23,559,144	1,013,043
Hallabat	Khaw Reservoir	57	0.620	4,380,000	2,715,600	116,771	68	500	4,380,000	0.520	2,277,600	97,937
	Hallabat Village	34	1.200	1,752,000	2,102,400	90,403	65	200	1,752,000	0.628	1,100,256	47,311
Zarqa	Distribution Area	50	0.782	12,442,620	9,730,129	418,396	50	–	12,442,620	0.782	9,730,129	418,396
	Batrawi Reservoir	50	0.782	7,008,000	5,480,256	235,651	68	800	7,008,000	0.396	2,775,168	119,332
Total				40,474,620	48,129,589	2,069,572			40,474,620		39,442,297	1,696,019
Balance between Before and After Programme									0		-8,687,292	-373,554

Note: Unit electricity consumption of Azraq Station 1.88 kWh/m3 is assumed from proposed one. Because operation point of the existing pump is too much different with proposed one.

2.6 Other Relevant Issues

(1) Operation and maintenance personnel

In the existing operation and maintenance system, while the number of operators is sufficient to operate the pumping facilities, the number of engineers and technicians is insufficient to carry out appropriate maintenance. Therefore, if pumping equipment is to be procured in the Programme, it is necessary to assign an additional electrical facility engineer, mechanical facility technician and electrical facility technician to Zarqa Pumping Station which supervises and controls the entire pumping facilities, to rationalize the operation and maintenance of the pumping facilities. These personnel will have to be assigned to the station before completion of the installation of the equipment in order for them to attend the technical training in operation and maintenance of the water transmission pumps in the technical assistance provided by the Japanese side. In order to sustain appropriate operation and maintenance, every possible measure shall be taken to guarantee the permanent and exclusive assignment of such personnel who have received the technical training.

(2) Installation of the materials in distribution network system

Use in the water distribution networks in the gravity-flow system from reservoirs is a precondition for the materials for the water distribution networks (gate and air valves) to be procured in the Programme. Therefore, it will be necessary to select the distribution zones for the installation of the materials and to reconfirm their specifications and required number after confirming the progress of the transfer to the gravity-flow system.

Chapter 3

Programme Evaluation and Recommendations

Chapter 3 Programme Evaluation and Recommendations

3.1 Programme Effects

This Programme aims at saving energy use through improvement of efficiency in the transmission and distribution system (mitigation measures) and stabilization and increase of the water supply and promotion of water resource conservation through reduction of water losses in the water supply system (adaptation measures). Furthermore, the Programme will contribute to reduce CO_2 emissions resulting from reduction in energy consumption by synergy with Japan's past and ongoing grant aid projects. The table below shows the current state and problems of the transmission and distribution system and the effects expected from implementation of the Programme.

(1) Programme effect table

Table 3.1.1 Programme Effects

Current problem	Content of cooperation Programme	Direct Effects of cooperation Programme	Indirect Effects of cooperation Programme
Operational efficiency and electricity consumption efficiency of the pumps are low, because of deterioration of the superannuated pumps and inappropriate specifications of the equipment.	Replacement of the pumping facilities at three pumping stations (Azraq, Hallabat and Zarqa)	- Operation efficiency of the Pump will be improved and unit electricity consumption will be reduced. - Net annual reduction of 8,687 MWh/year of electricity worth 374,000JD will be achieved. - Thus, net reduction in CO_2 emissions of 5,386 ton/year will be expected.	- Reduction in GHGs emissions will contribute to alleviation of the effects of climate change. - Reduction of the cost of electricity will be contributed to improvement of financial management of WAJ.
Water cannot be transmitted stably because of frequent breakdowns and low operational efficiency of superannuated pumps.	Replacement of the pumping facilities at three pumping stations (Azraq, Hallabat and Zarqa)	- Stabilization of water transmission will increase the amount of water transmission by 1,900,000 m^3/year (approx. 9 %) to the Zarqa water distribution zone.	- The increase in water transmission to reservoirs will lead to an increase in water distribution and, consequently, improve the water supply in the water distribution zones.
The amount of inflow to and discharge from the pumping stations and the flow rates at the branching points on the main transmission pipelines are not accurately monitored.	Installation of water flow meters on the transmission pipelines at four pumping stations (Azraq, Hallabat, Zarqa and Khaw) and a reservoir (Khaw Pumping Station)	- Appropriate water transmission management will be realized at the pumping stations to be assisted in the Programme. - Effective transmission system will be constructed.	- Monitoring of the amount of water transmission will be realize, and it will enable control of the amount of water transmission and water loss, and diagnosis of the operational condition of the pumps.
Because the existing transmission pipeline between Zarqa Pumping Station and Batrawi Reservoir used to be a distribution pipeline that has been converted to a transmission pipeline, there are maintenance-related problems arising from deterioration by aging, transmission losses and places of installation.	Change in the route of the transmission pipeline and installation of new pipes	- An efficient water transmission system will be constructed between the facilities concerned. - Water loss will be reduced in transmission line. - Energy consumption will be reduced by the reduction of required pump head for transmition of water. - Maintenance of the pipeline will be easier.	- Reduction of the cost of electricity will be contributed to improvement of financial management of WAJ.

Deterioration by aging of the valves in the distribution networks has resulted in poor operation and function.	Replacement of valves and air valves in the distribution networks	- The water distribution networks will be operated and maintained appropriately in the water distrib ution zone.	- Adjusting the water distribution pressure within the water distribution zones to an appropriate level and reduction of water loss will enable efficient use of water resources.
The low capacity in operation and maintenance of the pumping facilities is impeding efficient operation.	Technical assistance for appropriate operational management technology of pumping water transmission system (Technical Guidance of Pumping Facilities)	- Capacity development in operation and maintenance of the pumping facilities will facilitate stabilization of water transmission and reduction in energy consumption.	- Appropriate maintenance will enable long-term use of the pumping facilities
An operation system that takes into consideration water distribution in the entire water transmission and distribution system has not been adopted.	Technical assistance on operational management technology of pumping water transmission system (Soft Component)	- Appropriate operational management of the water transmission system will make water transmission efficient and stable by enabling water transmission in accordance with demand for water distribution.	- The assistance will enable WAJ personnel to diagnose the operational condition of the pumps and, consequently, enable efficient pump operation.

(2) Programme effects

The outcomes expected from the implementation of the Programme are as follows.

1) Improvement in the operational efficiency of the pumping facilities for water transmission

The replacement of the pumping facilities at the three main water transmission facilities, Azraq, Hallabat and Zarqa Pumping Stations, in the Programme area, is expected to improve the operational efficiency of the pumps and unit electricity consumption by 139% and 70%, respectively, on average.

Table 3.1.2 Indices of the Outcomes Expected from Replacement of the Pumps

Pumping station	Destination of water	Operating number of pump	Existing pumps		Replacement pumps	
			Operation efficiency	Unit Electricity consumption	Operation efficiency	Unit Electricity consumption
			(%)	(kWh/m^3)	(%)	(kWh/m^3)
Azraq	Khaw Reservoir	4	57	1.89	68（119%）	1.58（83.6%）
Hallabat	Khaw Reservoir	1	57	0.62	68（119%）	0.52（83.8%）
Hallabat	Hallabat Village	2	34	1.20	65（191%）	0.63（52.5%）
Zarqa	Batrawi Reservoir	2	50	0.78	68（136%）	0.40（51.3%）

* The efficiency of the replacement pumps is target figure and, to achieve the target, the pumps must be operated and maintained appropriately.

2) Reduction in energy consumption (Reduction in costs for electricity consumption)

A comparison of the electricity consumption after implementation of the Programme with consumption in the case where the existing pumps are used to transmit water at the design discharge of

the Programme at the Azraq, Hallabat and Zarqa Pumping Stations reveals a reduction of 8,687,000 kWh/year in electricity consumption after implementation of the Programme. Consequently, the cost of electricity will be reduced by 374,000JD (approx. 18% of the total electricity cost at the three stations before implementation of the Programme) and this reduction will contribute to a reduction in the operation and maintenance costs of WAJ. (Close2-5-2, Case 3)

3) Reduction in CO_2 emissions

The reduction in electricity consumption in the water transmission system mentioned above is expected to reduce CO_2 emissions by 5,386 ton-CO_2/year (8,687,000 kWh/year x 0.62 kg-CO_2/kWh). The Programme will contribute to alleviation of the effects of climate change through this reduction in GHGs emissions.

The CO_2 emission coefficient of 0.62kg-CO_2/kWh proposed in the JICA Project Research Progress Report for the "Project Study on Quantification of Greenhouse Gases (GHGs) Reduction Effectiveness, December 2008" is used as the coefficient in Jordan for calculating CO_2 emissions.

4) Increase in water transmission and distribution through stabilization of water transmission

At present, the water transmission system suffers from frequent breakdowns, which result in interruption of water transmission and declining water transmission capacity. The Programme will enable stable water transmission and increase water transmission by 1,900,000m^3/year. The increase in water transmission to reservoirs will lead to an increase in water distribution and, consequently, improve the water supply in the water distribution zones.

5) Improvement of the operation and maintenance system at the pumping stations for water transmission

Implementation of the Programme will establish the organizational system required for appropriate operation and maintenance of the pumping stations for water transmission. Implementation of technical assistance in the form of technical guidance by the procurement agent and the soft component by the consultant in the Programme will enable WAJ personnel to diagnose the operational condition of the pumps and, consequently, enable efficient pump operation. In addition, strengthening of the capacity to operate and maintain the pumping facilities through implementation of the Programme will facilitate stabilization of water transmission and reduction in energy consumption.

6) Establishment of a discharge control system

The installation of water flow meters will enable accurate measurement of the amount of influx to and discharge from the pumping stations and the flow rate at the branching points in the main water transmission pipelines and enable appropriate discharge control in accordance with the operation plans of the pumping stations and the plans for water transmission. Consequently, it will be possible to carry

out monitoring of the amount of water transmission, which will enable control of the amount of water transmission and water loss and diagnosis of the operational condition of the pumps.

7) Appropriate condition of the water distribution networks

The replacement of materials in the water distribution networks with the materials (gate valves and air valves) to be procured in the Programme will improve the operational performance of the valves in the networks, which is currently very poor because of superannuated valves, and enable appropriate operation and maintenance of the networks. In this way, the Programme will enable efficient use of water resources by adjusting the water distribution pressure within the water distribution zones to an appropriate level and by reducing water loss.

3.2 Recommendations

1) Implementation of appropriate operation and maintenance of the pumping facilities for water transmission

The Programme includes the provision of technical assistance to WAJ personnel in appropriate operation, preventive maintenance and maintenance after breakdown of the pumping facilities and operation of the water transmission system, in addition to replacement of the pumping facilities. Thus, the implementation of the Programme will create the conditions, in terms of both hardware and expertise, for stable, sustainable and long-term use of the pumping facilities and equipment procured in the Programme and for reduction in energy consumption. WAJ will be required to make full use of the hardware and expertise to implement appropriate operation and maintenance after completion of the Programme.

2) Implementation of monitoring and preparation of reports

To evaluate the reduction in energy consumption and to diagnose the operational condition of the pumping facilities, it is necessary to monitor the efficiency of the pumps and unit electricity consumption during daily operation and maintenance work. The measuring devices required for obtaining these parameters (equipment to measure the voltage, current, power factor, wattage, water pressure and flow rate) will be equipped in the Programme. WAJ will be required to implement daily monitoring, record and analyze the data obtained, and take measures against malfunctions when they occur and prepare reports.

3) Ripple effects of the outcomes of the Programme to operation and maintenance at other pumping stations

In the Programme, the pumping facilities will be replaced at three pumping stations, Azraq, Hallabat and Zarqa Pumping Stations, and technical assistance will be provided at these stations. Zarqa Branch Office of WAJ (Zarqa GWA) operates and maintains the water transmission and distribution pumps at

11 other stations. Although the Programme will not provide materials or equipment to these stations, it is desirable for WAJ to upgrade the operation and maintenance techniques at the other stations by implementing in-house training for the operators at these stations using the content of the training implemented and the manuals prepared in the technical guidance in the Programme. It is also desirable for WAJ to improve the materials and equipment at the other stations with its own resources.

4) Switchover to gravity flow system in water distribution zones

Adoption of the gravity flow system in the water distribution networks enables leveling of the water distribution pressure and reduction in water loss. In addition, the adoption of the gravity flow system is expected to create synergy with the replacement of the water transmission pumps in the Programme and, thus, to have a significant effect on reduction of energy consumption.

However, some areas which the water distribution system has not yet been switchover from the direct pumping system to the gravity flow system remain in the distribution system which development of the main facilities has made steady progress by the grant aid project.

The following are considered to be the causes of the low progress of the switchover: 1) shortage of yield from the wells and the amount of water available from the water sources deriving from the water set aside for inter-governorate water-sharing including the water transmission to Amman, 2) non-realization of water transmission from Amman to Zarqa District, which was established as a precondition for the facility construction at the time of designing the grant aid cooperation project, 3) expansion of the water distribution zones and continued existence of areas with poor water distribution, and 4) poor performance of the pumping facilities for water transmission.

Therefore, WAJ will have to urgently formulate water allocation plans in Zarqa District and water distribution plan to the areas with poor water distribution after switchover to the gravity flow system, as the preparations for switchover from the direct pumping system currently practiced in the water distribution zones to the gravity flow system as originally planned.

5) Scenario for water sharing

At present, only approxi. 80% of the design amount of water at the sources is available in Zarqa District. However, switchover to the gravity-flow water distribution system should be promoted strongly in the Northern Zarqa Water Distribution Zone, in which the Programme is to be implemented, since it has better conditions for water transmission and distribution than Rusaifa and Awajan Districts in the Southern Water Distribution Zone. For transfer to a full-scale gravity flow system, it will be necessary not only to transmit water to Rusaifa and Awajan Districts from Khaw Pumping Station, but also to receive distribution of excess water in Amman after the completion of the “Disi-Amman Conveyor Scheme,” a water resource development project for the supply of water to the Amman area.

6) Cooperation wit another Project

a. Technical cooperation project

A technical cooperation project to strengthen the capacity to manage water distribution networks being implemented by Japan, “Capacity Development Project for Non Revenue Water Reduction in Jordan,” will be completed in August 2011. Installation of the Lot 2 materials for the water distribution networks in the Project is scheduled for 2012. Therefore, it will be possible to utilize the knowledge from the technical cooperation project in deciding the installation locations and the specifications of the materials in the Project.

b. Project of other donor

GTZ has implemented the Improving Energy Efficiency (IEE) Project. The outcome of the project was used for selecting Old Khaw Pumping Station and Zarqa Reverse Osmosis Plant as the sites for a German assistance project. The said assistance project aims at reducing the energy consumption of the pumping facilities for water transmission as the Programme. Therefore, it will be desirable to coordinate with GTZ regarding technical guidance to WAJ on operation and management of the facilities.

KfW, EC and China are implementing projects for improvement of the water distribution networks and reduction in non-revenue water in the central part of Zarqa District and Rusaifa District in the Zarqa Water Distribution Zone. These projects are scheduled to be completed in 2011 and early 2012. Therefore, it will be desirable to refer to the knowledge obtained from the outcomes of these projects when deciding the installation locations and the specifications of the materials for the water distribution network in the Programme.

MCC is planning to conduct a survey on repair of the 99 wells owned by WAJ with the focus on Azraq Well Cluster and to prepare a master plan for realization of gravity-flow water distribution in the entire Zarqa Governorate. Since the principal pumping station in the Programme is Azraq Pumping Station, it will be necessary to pay attention to the outcomes of this survey.