THE HASHEMITE KINGDOM OF JORDAN
MINISTRY OF WATER AND IRRIGATION (MWI)
WATER AUTHORITY OF JORDAN (WAJ)
YARMOUK WATER COMPANY (YWC)

PREPARATORY SURVEY
ON
THE PROJECT FOR URGENT IMPROVEMENT OF WATER SECTOR FOR THE HOST COMMUNITIES OF SYRIAN REFUGEES IN NORTHERN GOVERNORATES
PHASE 2
IN
THE HASHEMITE KINGDOM OF JORDAN

MAY 2017

JAPAN INTERNATIONAL COOPERATION AGENCY
TEC INTERNATIONAL CO., LTD.

GE
JR
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SUMMARY

1. Background of the Project

The population in Irbid governorate was 1.13 million in 2012 and increased to 1.31 million in 2014, 20% of which was Syrian refugees. As a result, poor water supply and demand imbalance has further worsened public water supply system cover9ing 97 % of the population in the northern governorates (Irbid, Mafraq, Jerash and Ajloun), where a large number of Syrian refugees is settled. Its water resources are mostly groundwater and amount of groundwater allocated to the northern governorates are limited due to transferring some amount of groundwater to Amman. The water supply system was of inadequate capacity, high leakage and of dilapidated one and cannot meet an increasing water demand. .

Under these circumstances, Jordanian government requested to Japanese government in October 2013 technical cooperation for development planning “the project for the study on water sector for the host communities of Syrian refugees in the northern governorates”. The study includes outline design of the high-priority project based on which Japan grant-aid assistance is to be implemented. In 2014 the first stage outline design was conducted and based on which the grant-aid project was being implemented as of March 2017 and will be completed soon.

Subsequently another outline design was conducted in 2016 for rehabilitation of pipes in Hawwara and Sarieh in Irbid city that was mostly studied in the first stage outline design but not implemented. This report contains the result of this outline design.

2. Overall Goal of the Project

Jordan formulated the “National Agenda 2006-2015,” a comprehensive national strategy that specifies issues the country should tackle and guidelines to resolve the challenges. Issues in the water sector include scarce water resources, inefficient distribution of water, inappropriate setting of water tariff, inadequate sewage treatment capacity and so on. One of the guidelines to resolve such issues is “to make operation and maintenance of facilities efficient and to reduce non-revenue water.”

- To reduce operating cost and non-revenue water by improving efficiency of the distribution network
- To secure and supply adequately safe drinking water
- To take immediate measures for the entire water sector and for economic development to cope with the increase in population and their water needs.

Furthermore, the Jordanian government has issued comprehensive guidelines in the “Water for Life: Water Strategy of Jordan 2008-2022.” The Project has the base on overall plans of the “National Agenda” and the “Water for Life”. The Project will contribute to the realization of the following targets from the guidelines and targets indicated in the overall plans.

The Project will meet the demands of water supply and sewerage systems of the host communities under the “National Resilience Plan”, thereby contributing to mitigation of the friction between host communities and refugees and lessen the impact of influx of Syrian refugees.

3. Issues on Water Sector to be Resolved

(1) Water Resource Scarcity

Annual rainfall is below 200 mm in Jordan where 75 % of land is desert. Jordan is one of the 10 poorest countries in the world in terms of water resources with available annual per capita water resources of only 120 - 145 m3, which is far below the internationally recognized water scarcity level of 500 m3. The increase in population and resulting water demand have caused enormous pressure on the limited water resources and created a chronic poor water supply and demand imbalance prevailing

in Jordan now.

(2) More Water Resource Scarcity due to Water Demand Increase of Syrian Refugees

Water resource scarcity in Jordan, especially in the northern governorates, has further worsened due to influx of Syrian refugees.

(3) High Leakage

A large number of aged pipes caused high leakage. Water issue is one of the important concerns in Jordan, and effective and fair use of water is the basic policy in Jordan. Hence, reduction of leakage is essential in Jordan.

(4) Inefficient Distribution System

The distribution systems were not developed properly to meet an increasing water demand. In addition cities were developed mostly in plateaus with large differences in ground elevations that cause water pressure differences within city. As a result water distribution was not efficient; creating some areas with low pressures or poor water supply and some areas with excessive pressures or high leakage.

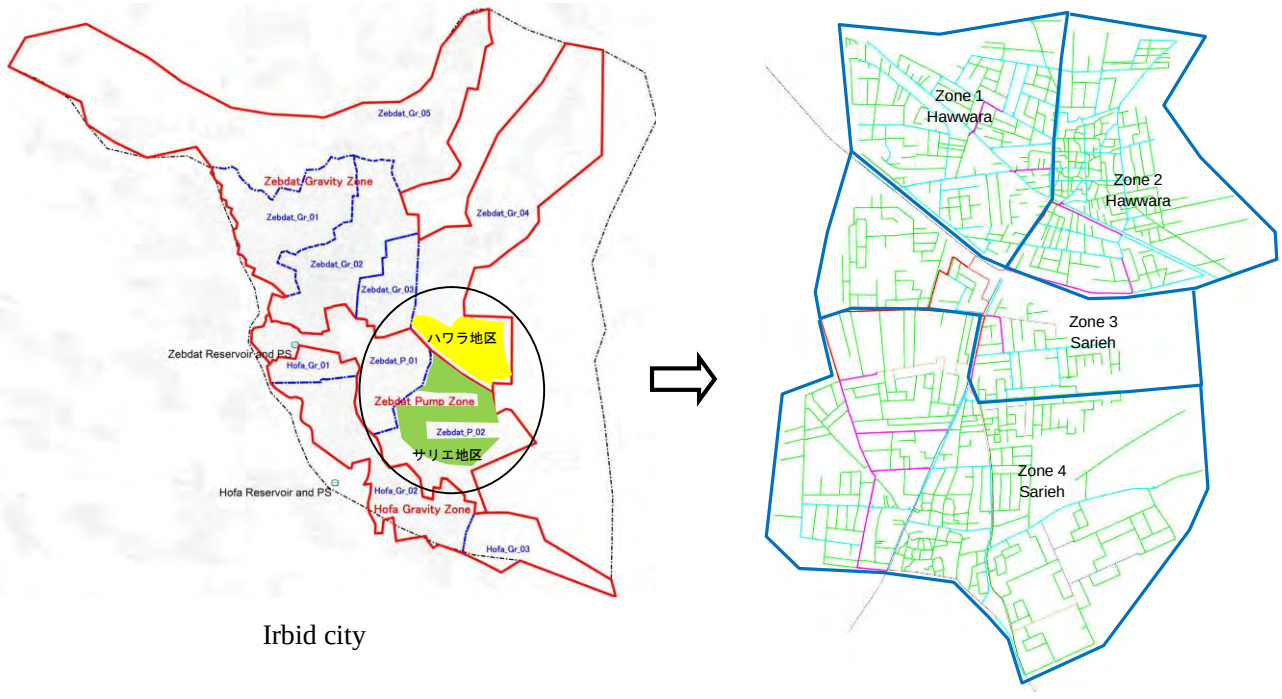
(5) Water Supply Management

Water Authority of Jordan (WAJ) and Yarmouk Water Company (YWC) are financially deficit and have being subsidized by the government. Water tariff increase to decease financial deficit seems difficult in Jordan to keep stabilization of the lives of the general public. Hence, assistance from the central government and donor agencies will continue to solve water issues.

4. Outline of the Project

(1) Project Area

The study was conducted for Hawwara and Sarieh in Irbid city. The study area is divided into 4 zones as shown in the following figure. As a result of the study, zones 1 to 3 were selected as the Project area.



Irbid city

Study Area (zones 1 to 4) and Project Area (Zones 1 to 3)

(2) Project Component

The Project consists of the following components.

- Setting of 4 zones in the study area
- Installation of pressure reducing valves for adequate service pressure
- Replacement of aged pipes
- Supply and installation of new pipes
- Installation of service pipes and water meters by Jordanian side

(3) Objectives of the Project

The objectives of the Project are to resolve water unserved areas by means of adequate water supply pressure and equitable water distribution, eliminate water unserved area and reduce leakage. The following table shows issues and measures planned in the Project.

Issues and Measures planned in the Project

Problem	Cause	Condition	Countermeasures	Purpose
Low water supply per capita 62 Lpcd for Hawwara (1) 54 Lpcd for Sarieh (1)	・Limited water resources ・Increase of water demand by rapid influx of Syrian refugees	Increase in water resources by Disi groundwater development and eastern well fields development	・Utilization of new water resources ・Decrease in leakage	Increase in water supply amount
Lots of water unserved areas (0.11-0.5MPa) (2)	・Limited water resources ・Improper arrangement of distribution network ・A large elevation difference		・Adequate pipe arrangement and pipe size ・Setting of distribution zones ・Installation of pressure reducing valves (PRVs)	Elimination of water unserved areas (equitable water supply/adequate water pressure)
water unserved area	・No pipe		・Installation of new pipe	・Elimination of water unserved areas
High leakage ratio	・Lots of aged pipes ・High water supply pressure in low elevation area		・Replacement of aged pipes ・Adequate water pressure by zoning and installation of PRVs	Decrease in leakage

Note) (1) estimated value from the data of JICA Water Supply Master Plan
(2) Measured by JICA study team

(4) Design Policy

1) Target Year

Year 2020, 1 year after expected year 2019 of project completion

2) Project Area

Project area is Hawwara (zones 1 and 2) and Sarieh (zone 3) although zone 4 (Sarieh) was studied.

3) Served Population

Served population in 2020 as shown below includes the estimated Jordanian population in 2020 and number of Syrian refugees in 2013.

Served Population in 2020 (Target Year)

Area	Jordanian Population	Syrian Refugees	Total	Served Population	
				Study Area	Project Area
				Zone 1 - 4	Zone 1 - 3
Hawwara	18,333	3,298	21,631	21,631 (*1)	21,631
Sarieh	27,615	4,968	32,583	32,583	6,333 (*2)
Total	45,946	8,266	54,214	54,214	27,964

Note) (*1) 10,008 for Zone 1 and 11,623 for Zone 2 obtained from the ratio of household numbers
(*2) Obtained from the household ratio of Zone 4 to the total households in Hawwara and Sarieh

4) Distribution facilities corresponding to change of transmission of water resource

The Project assumes additional water resource from the east; firstly by the improvement of the eastern wellfields and secondly by construction of the National Corridor conveying Disi fossil water. Subsequently, additional water will be brought from the west by the Wadi Arab 2nd stage project. Depending on these projects, Hawwara and Sarieh will receive additional water from different reservoirs with distribution methods of pumping or gravity. Accordingly, the proposed distribution pipe in these areas is planned so that distribution network will be utilized regardless of whether it is transmitted from the eastern or the western water resources.

Distribution System in Hawwara

- Current: Pumping ;from Zebdat reservoir
- Disi fossil water and Hofa – Bait Ras pipe ;Gravity flow from Hofa reservoir
- Wadi Arab 2nd phase ;Gravity flow from Zebdat reservoir

Distribution System in Sarieh

- Current and Disi fossil water and Hofa – Bait Ras pipe : Gravity flow from Hofa reservoir
- Wadi Arab 2nd phase (and distribution pipe From Zebdat reservoir according to JICA water master plan) : Pumping from Zebdat reservoir

5) Scope of Project

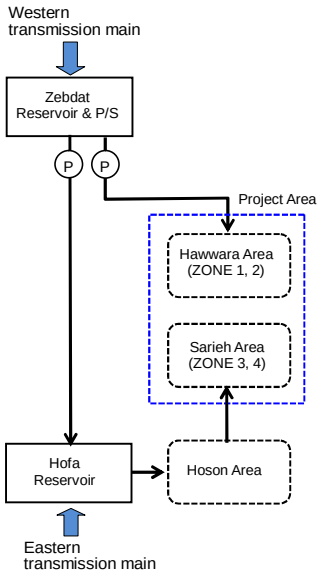
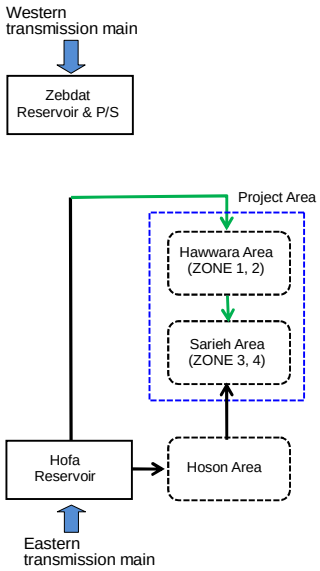
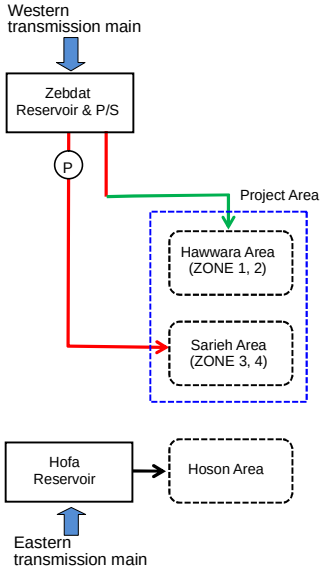
- New and Replacing pipe in zone 1 : 35.2km
- New and Replacing pipe in zone 2 : 42.7km
- New and Replacing pipe in zone 2 : 27.9km
- Total (Pipe diameter 63 to 300 mm) : 105.8km

6) Project Cost by Jordanian Side

- Water and Chlorine : JD15,000 (JY 2.6 million)
- Service Pipe and House Meter : JD 834,000 (JY 143.7 million)
- Banking Arrangement Fee and Authorization-to-pay charges : JD 5,000 (JY 0.95 million)
- Total : JD 854,000 (JY 4,362 million)

Exchange Rate: JD 1=JY 172.24

Transition of Water Distribution System in the Project Area

	At Present (2016)	Case A (2018 -) Completion of Disi Groundwater Transmission System in 2018	Case B (2020 -) Completion of Wadi Arab 2nd Stage in Year 2020
Schematic Flow Diagram			
Improvement of Distribution System in Irbid		Completion of Hofa - Bait Ras pipeline (1st stage grant-aid project) in year 2017	Improvement of distribution system ・ Water can reach Hawwara (Zone 1 and 2) by KfW and AFD financing in around 2018. ・ Water can reach Sarieh (Zone 3 and 4) by improvement of Zebdat pumps and installation of pipelines from the pump station to Zone 4 (have not started).
Hawwara	From Zebdat Reservoir by pumping	From Hofa reservoir via Hofa – Bait Ras pipeline by gravity	From Zebdat reservoir by gravity
Sarieh	From Hofa reservoir via Hoson area by gravity	・ From Hofa reservoir to Zone 3 through Bait Ras pipeline by gravity ・ From Hofa reservoir to Zone 4 via Hoson area by gravity	From Zebdat reservoir by pumping

5. Project Evaluation

(1) Relevance

- Beneficiaries and its number
  Beneficiaries will be inhabitants in Hawwara and Sarieh including Syrian refugees and its number will be 21,631 persons for Zone 1 and Zone 2 of Hawwara, and 6,333 persons in Zone 3 of Sarieh, totaling 27,964 persons in 2020.
- Project target and BHN
  Water pressures in the Project area will be improved from the current value of 0.11 - 0.50 MPa to the target value of 0.25 - 0.75 MPa. This will be able to eliminate poor water supply areas and such, contribute to satisfying BHN.
- Improvement of life environment and stabilization of the people's livelihood
  A number of Syrian refugees have been flowing into Hawwara and Sarieh. The implementation of the Project will improve the water supply service such as optimization of the service pressure and increase in water supply amount because of reduction of leakage. This will contribute to improving the water

supply service and thereby improving the life environment of both Jordanian and Syrian refugees. Accordingly, tensions between them will be eased.

- Contributing to realization of targets of medium and long-term development plans
  The "National Water Strategy" which is Jordan's medium to long-term plan has the policy of effectively using limited water sources to the maximum extent. This project will contribute to the realizing the targets of the medium to long-term plan through reduction in water leakage and non-revenue water.
- Conformity with Japan's assistance policy
  Japan announced in the Supporting Syria and the Region Conference London, February 2016 that Japan would extend new assistance of approximately 350 million US dollars to Syria, Iraq and neighboring countries. One of the principles Japan expressed is to alleviate the burden on the host countries. Thus, the implementation of the Project is in conformity with the above Japan's assistance policy.

(2) Effectiveness

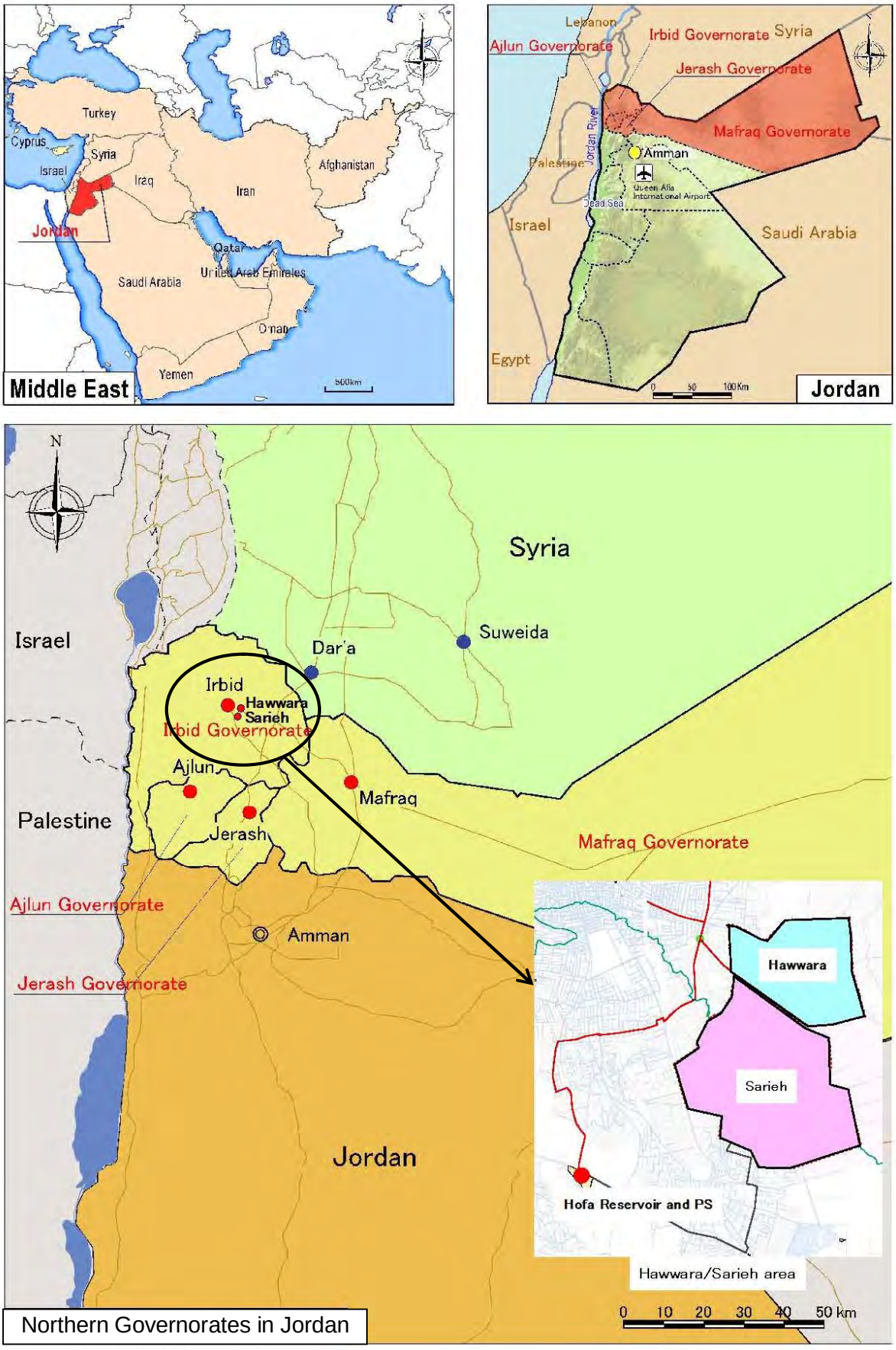
1) Quantitative effect
Water will be distributed in the Project area with adequate water pressure ranging from 0.25 to 0.75 MPa.

2) Qualitative effect

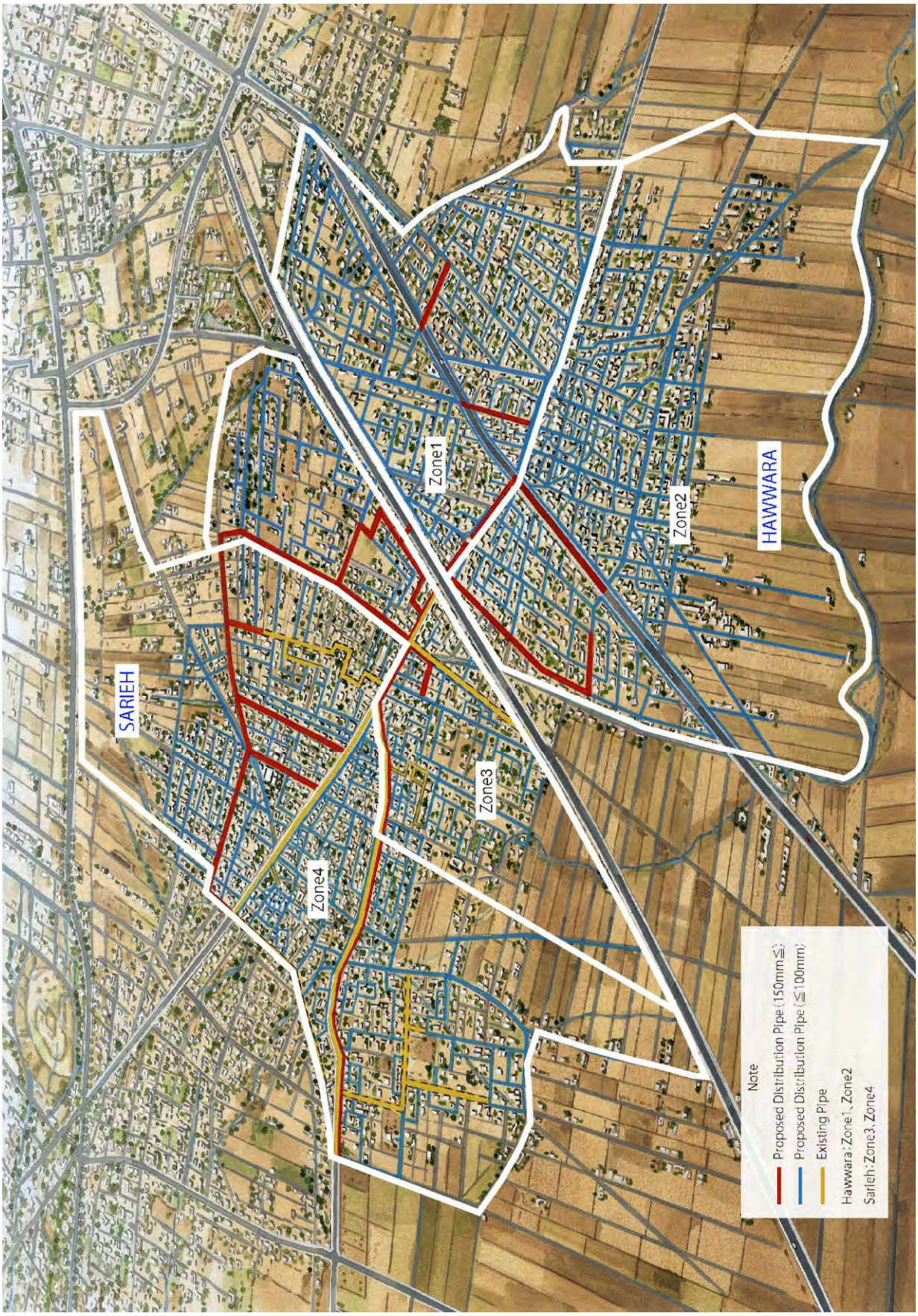
- Leakage will be reduced by pipe rehabilitation.
- Water served area will be expanded due to additional pipes in un-served areas.
- Poor water supply area will be narrowed due to additional available water amount.
- Water supply duration will be increased due to additional available water amount.

(3) Conclusion

The Project will have the abovementioned relevance and effects; therefore, implementation of the Project is adequate to be implemented under Japan's grant aid assistance.



Location Map



Perspective of the Project Area

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Perspective of the Project Area
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ABBREVIATION

DCIP/DCI pipe	Ductile Cast Iron Pipe
DMA	District Metered Area
DN	Nominal Diameter
DOS	Department of Statistics
E/N	Exchange of Notes
EIA	Environmental Impact Assessment
EIB	European Investment Bank
G/A	Grant Agreement
GDP	Gross Domestic Product
GNI	Gross National Income
GRDP	Gross Regional Domestic Product
HCSP	Host Community Support Platform
HDPE	High Density Polyethylene
ID	Internal Diameter
IEE	Initial Environmental Examination
JICA	Japan International Cooperation Agency
JIS	Japanese Industrial Standards
JWWA	Japan Water Works Association
JD	Jordanian Dinar
KfW	Kreditanstalt für Wiederaufbau
Lpcd	Liters per capita per day (L/capita/day)
MCM	Million cubic meter
MCM/y	Million cubic meter per year
MD	Minutes of Discussion
MP	Master Plan
MOE	Ministry of Environment
MPa	Mega Pascal (N/mm^2)
MPWH	Ministry of Public Works and Housing
MOTA	Ministry of Tourism and Antiquities
MWI	Ministry of Water and Irrigation
OD	Outside Diameter
O & M	Operation & Maintenance
PE	Polyethylene
PMU	Programme Management Unit of WAJ
PN	Nominal Pressure
PRV	Pressure Reducing Valve
ROU	Regional Operation Unit
RSCN	Royal Society for the Conservation of Nature
TOR	Terms of Reference
UNHCR	United Nations High Commissioner for Refugees
USAID	United States Agency for International Development
WAJ	Water Authority of Jordan
WASH	Water, Sanitation & Hygiene
WLRP	Water Loss Reduction Program
WWTP	Wastewater Treatment Plant
YWC	Yarmouk Water Company

CHAPTER 1 BACKGROUND OF THE PROJECT

CHAPTER 1 BACKGROUND OF THE PROJECT

1.1 Background, Transition and Overview of Grant Aid Cooperation

In Jordan the water problem has been getting more strained due to a large number of Syrian refugees flowing into Jordan since Syrian crisis happened in 2011. In some host community, friction between Jordanian habitants and Syrian refugees has been caused because of worsening water service by sharing limited water.
Water service coverage in northern governorates is 97%, and its resource is mostly groundwater. Amount of groundwater allocated to the northern governorates are limited partly due to transferring some amount of groundwater to Amman. The water supply system was of inadequate capacity, high leakage and of dilapidated one and cannot meet an increased water demand. .
Under these circumstances, Jordanian government requested Japan in October 2013 technical cooperation for development planning "the project for the study on water sector for the host communities of Syrian refugees in the northern governorates". The study includes outline design of the high-priority project based on which Japan grant-aid assistance is to be implemented. In 2014 first stage outline design was conducted and based on which the grant-aid project was being implemented as of March 2017 and will be completed soon.
Subsequently another outline design was conducted in 2016 for pipes rehabilitation in Hawwara and Sarieh in Irbid city that was mostly studied in the first stage outline design but not implemented. This report contains the result of this outline design.

1.2 Natural Conditions

(1) Topography

Hawwara and Sarieh are located on a plateau with projecting elevations of 400-700 m. A catchment boundary lies at the center and slightly to the east of Irbid urban area, while the river basin of Wadi Arab, the tributary of the Jordan river lies on the western side. The river basin of Wadi Shallalah, the tributary of the Yarmouk river lies on the eastern side.
The Hofa reservoir, which is the distribution base is situated at an elevation of 780 m, while the Zebdat reservoir is at an elevation of 625 m. The Zebdat reservoir is located within the city, so distribution of water to the city is convenient. The Hofa reservoir is situated at the highest elevation in the project area; it is at an elevation suitable for distributing water by gravity flow to Irbid City and Hawwara. Since there is a level difference in the study area, the plan for distribution facilities should consider elevation aspects appropriately.

(2) Geology

The geology of surface layers in the project area consists mainly of a distribution of Paleogene strata from the Cretaceous upper strata, and consists of limestone, Dolomite type limestone, and chalk. According to test boring study results, the pipe laying route has gravel mixed with limestone (silt and sand) and limestone ground (soft rock). From the geological status, the ground has adequate bearing capacity to resist structures, and generally, no foundation work is required.

(3) Hydrogeology

Figure 1.1 shows the hydrogeological unit distribution of Jordan, while Table 1.1 shows the hydrogeological unit stratigraphic table. Table 1.2 shows the major aquifer layers that form the intake for production wells in the four northern governorates. The wells in the four northern governorates mainly take in water from the B2/A7 aquifers (Barqa group, Wadi Amman formation/ Ajloun group, Wadi Sir formation: Paleogene- Palaeocene period/ upper part of the Cretaceous Period).

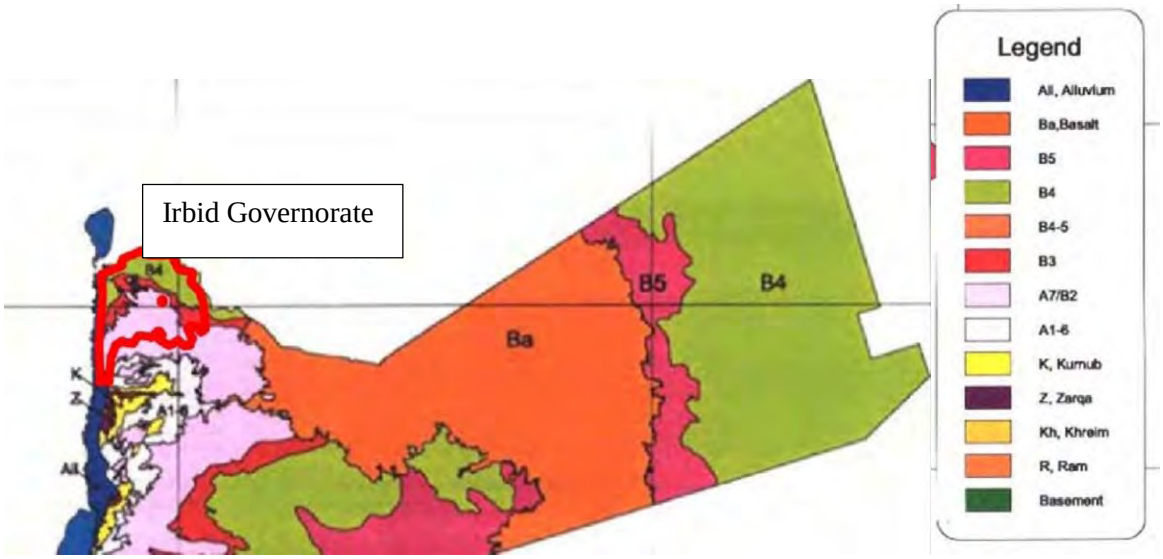
Table 1.1 Geological Formation

ERA	PERIOD		EPOCH	Group	Formation	Symbol	Lithology	Aquifer Characteristics	Aquifer Cond. (m/s)
CENOZOIC	Quarter -nary		Holocene	Alluvium	Fuviatile	Rc	Soil, sand, and gravel	Poor to Good (Aquifer)	Not Available
			Pleistocene	Diluvium	Lacst and Eolian				
	Tertiary	Neogene	Pliocene	J. Valley	Jafer – Azraq	Ja-Az	Marl, clay, and evaporites conglomerate with siliceous sand, gravel, and basalt	Poor Fair	Not Available
			Miocene	Volcanics	Basalts	Ba	Basalt	Good (Aquifer)	4.0 E -04 *
		Paleogene	Oligocene	Volcanics	Basalts	Ba	Basalt		
			Eocene	Balqa	Wadi Shallah	B5	Limestone, chalk, and marl	Good (Aquifer)	5.0 E -05 *
					Rijam	B4	Chert, limestone, chalk, and marl	Good (Aquifer)	5.0 E -05 *
			Paleocene		Muwaqqar	B3	Marly limestone, and shale	Poor (Aquifer)	1.0 E -09 **
					Amman	B2	Chert, limestone, and phosphate	Good (Aquifer)	2.0 E -05 *
MESOZOIC	Cretaceous	Upper	Meastrichtian Campanian Santonian		Wadi Ghudran	B1	Chalk, marl, and marly limestone	Poor (Aquifer)	Not Available
			Taronian ?????	Ajlun	Wadi Sir	A7	Limestone, dolomite, and chert	Very Good (Aquifer)	2.0 E -05 *
					Shueib	A5, A6	Limestone, and marly limestone	Poor (Aquitard)	1.0 E -09 **
			Cenomanian		Hummar	A4	Dolomite, and dolomitic limestone	Fair to Good	2.0 E -05 *
					Fuheis	A3	Marl, and marly limestone	(Aquifer)	1.0 E -09 **
					Naur	A1, A2	Limestone, and dolomitic limestone	Poor (Aquitard) Good (Aquifer)	1.0 E -05 **
		Lower	Albian	Kurnub	Subeihi	K2	Sand and shale	Fair to Good	3.0 E -05 *
			Aptian				Clay and sandy limestone	(Aquifer)	
			Neocomian						
			Berriasian		Aarda	K1	Sandstone, marl and shale		
	Jurassic	Malm	Tithomian						
			Kimmeridgian						
			Oxfordian						

(Source; Northern Governorates Water Transmission System Feasibility Study Final Report CDM International Inc. 2005, Modified from JICA 2001 and BGR 2001)

Table 1.2 Main Aquifers

Symbol	Layer	Type of rock	Layer thickness (m)	Transmissivity (m/s)	Volume to be pumped (m^3/h/m)
BS	Basalt	Basalt	10->500	4.0E-04	0.01
B5/B4	Shallala/Rijam	Limestone, tuffite	0-850	5.0E-05	0.05
B2/A7	Amman/Wadi as Sir	Limestone	80-650	2.0E-05	0.05
A4	Hummar	Limestone	30-100	2.0E-05	0.01
A1.2	Naur	Tuffite, limestone	90-220	1.0E-05	0.01
K	Kurnub	Sandstone	120-350	3.0E-05	0.025

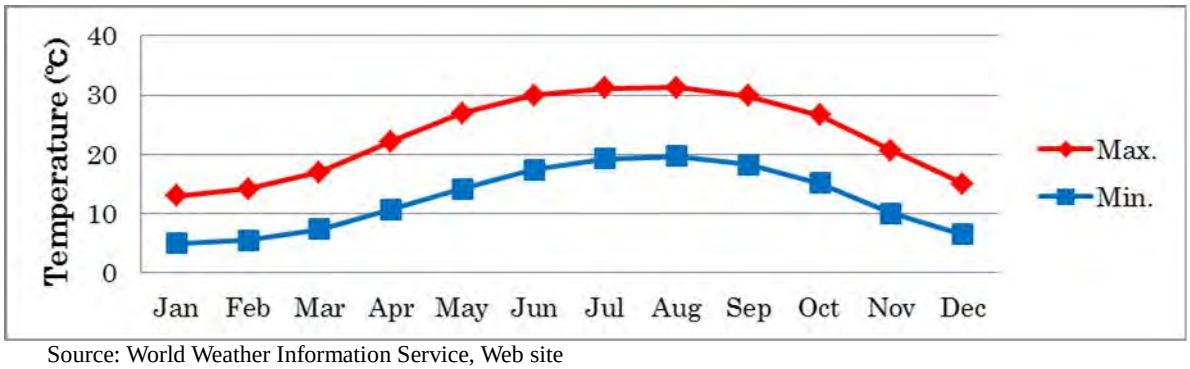


Source: Northern Governorates Water Transmission System Feasibility Study Final Report CDM International Inc. 2005, Modified from JICA, 2001 and BGR 2001

Figure 1.1 Geology of Northern Governorate in Jordan

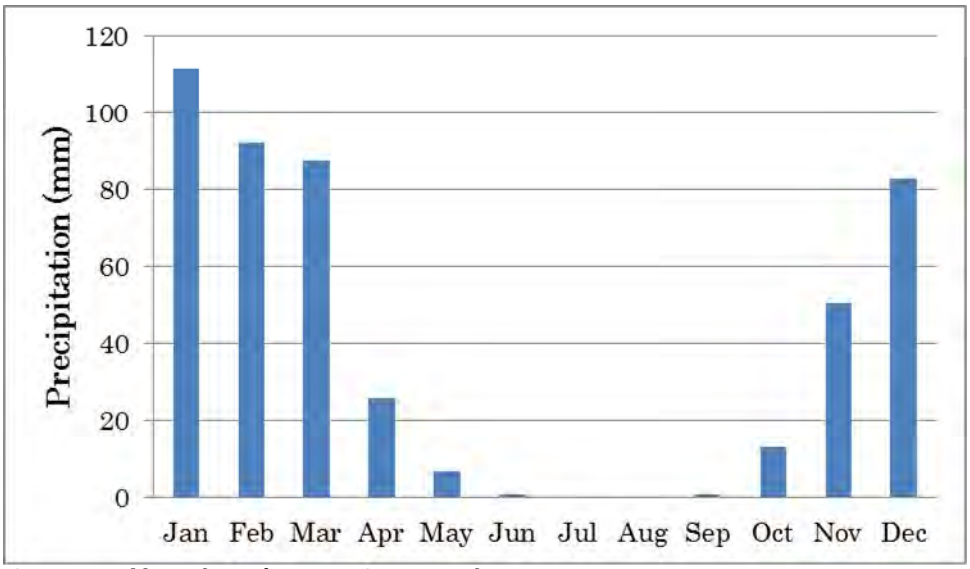
(4) Weather

The weather in Irbid is dry-summer subtropical or Mediterranean climate (Koppen's classification of climate: Csa), with hot summer and cold winter. The annual average maximum temperature is 23.1 ºC, the annual average minimum temperature is 12.4 ºC, and the annual average precipitation is 470 mm. During summer, the temperature may reach close to 40 ºC on some days, hot and dry with harsh climate. On the other hand, when winter approaches, the temperature may fall below freezing point, and snow has also been observed. Since it is dry and hot in summer, water demand increases; "No water" complaints increase, and YWC has to deal with the complaints time and again.



Source: World Weather Information Service, Web site

Figure 1.2 Monthly Average Temperatures in Irbid (Average of Past 30 Years)



Source: World Weather Information Service, Web site

Figure 1.3 Monthly Average Precipitation in Irbid (Average of Past 30 Years)

1.3 Environmental and Social Considerations

Environmental and social considerations were examined in the JICA water supply master plan (January 2015). The project proposed in the master plan are mostly new pipe installation and replacement of existing pipe in Irbid city including the project area of Hawwara and Sarieh. In the 1st stage grant-aid project, new pipe installation and replacement of existing pipe in Hawwara was planned and is now under implementation. Therefore, environmental and social considerations for the Project are reviewed, monitored and examined based on the results of these 2 previous plans. If conditions have been changed from these 2 plans, items changed are updated in this examination.

(1) Current Status of Environment and Society

The current status of key environmental and social items is presented below.

1) Land use

Project area (Hawwara and Sarieh) is shown in the satellite photo from Google Earth (Figure 1.4). Hawwara and Sarieh are mainly residential areas with small scale commercial zones in the central part. The pipelines planned are to be installed mainly along the existing roads in the project areas.

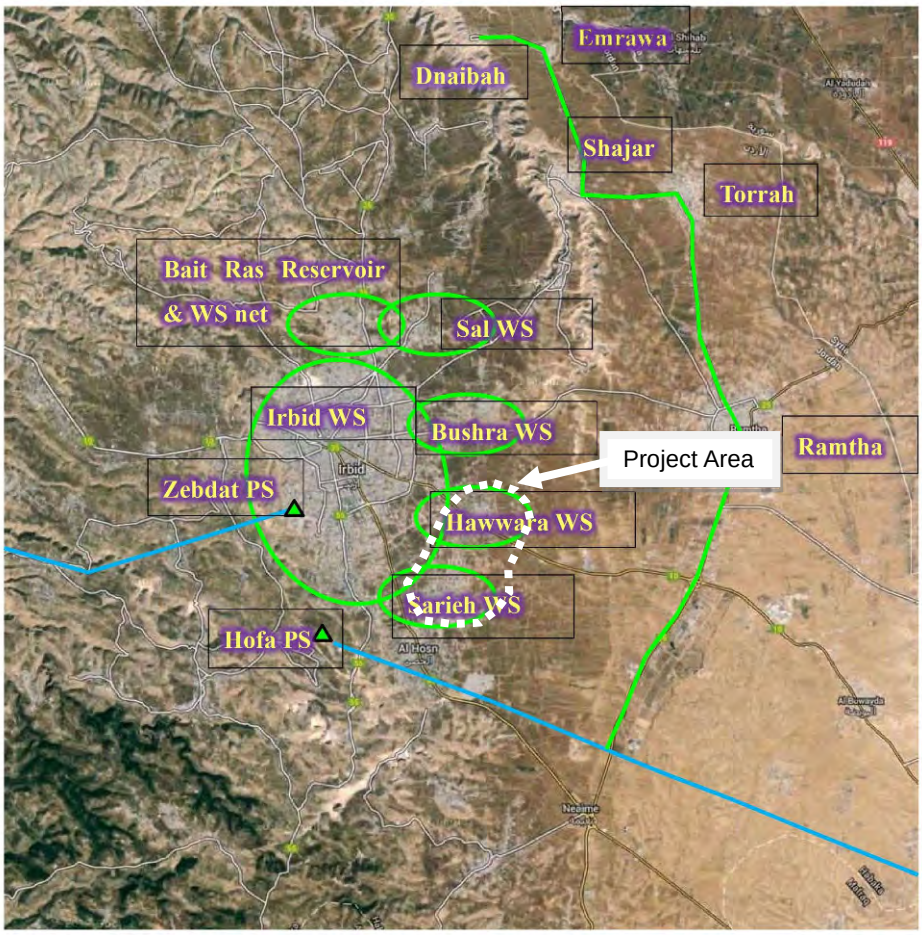


Figure 1.4 Location of the Project (Existing Land Use)

2) Natural environment

Reserve Area

Yarmouk Nature Reserve, Ajloun Forest Reserve and Dibeen Forest Reserve are nature reserve areas in the northern governorates. They are located very far from the project areas - at a distance of more than 10 km.

Conservation of the River Basin

Watersheds exist on the eastern and western sides of the Irbid center. Wadi Al Arab Basin is located on the western side. Wadi Shallalah Basin with Yarmouk River lies on the eastern side. Wadi Al Arab basin with well-field area is not designated specifically as a conservation area.

Historical and cultural heritage areas

There are remains and relics in the project area. According to the Antiquities Law No. 23, 2004 (Antiquities Law No. 12, revised in 1987), the Department of Antiquities in the Ministry of Tourism and Antiquities is responsible for excavating and investigating remains and relics. Remains and relics around Irbid and its suburbs are excavated to study the Old Stone Age. The sites where remains and relics have been found are located along the old highway from Palestine to Damascus and Baghdad. These sites are mainly in Irbid, and the surroundings of Hawwara, Bait Ras, Sal, Azl Yasielah and Al Turra. The site of remains in Hawwara is Ayyubid/Mamluk as shown in Table 1.3. Roman graves and ceramics were found and investigated during the installation of pipelines in Hawwara in the past. (Ismael Melhem et al, Three Burials from Roman era at Hawwara/ Irbid, Annual of the Department of Antiquities of Jordan, Volume 55, 2011)

Table 1.3 Sites around Project Area where Remains were found in Past

Era	Irbid	Hawwara	Bait Ras	Sal	Al Yasielah	Al Turra
Umayyad	○	○	○	○	○	○
Abbasid	-	○	○	○	○	○
Ayyubid/Mamluk	○	○	○	○	○	○

○ Sites where remains and relics have been found in the past (Source: Dar As-Saraya Museum Guide, 2007, Department of Antiquities), Source: JICA study team

(2) Laws/Regulation and Organization related to Environmental and Social Considerations

1) Laws and Regulation related to Environmental and Social Considerations

The Environmental Impact Assessment (EIA) is enforced by the following Laws and Regulation in Jordan.

- Environmental Impact Assessment Regulations No. 37 of 2005, and
- Environmental Protection Law No. 52 of 2006.

Projects subject to EIA either for comprehensive EIA or for Initial Environmental Examination (IEE) are designated in the EIA Regulations No. 37 of 2005. According to the EIA Regulations, the Project is subject to implementation of IEE as described in "Infrastructure projects including housing projects." The Project is examined in terms of environmental and social considerations at the IEE level in accordance with the EIA Regulations above and the JICA's Guidelines for Environmental and Social Considerations.

EIA is enforced according to the following procedure in Jordan:

① Project implementing organization submits project overview document to Directorate of Licensing & Guidance in MOE for examination.

② MOE calls a meeting of the Central License Committee. If necessary, the committee will confirm the current status of the construction site. Based on the review by the committee, a decision will be taken to implement the Comprehensive EIA (Holding of Public Hearings), or IEE (No Holding of Public Hearings), or no EIA. The result will be notified by the MOE to project implementation organization within 45 days after submitting the document.

③ Based on the decision of the committee, project implementation organization may implement EIA if needed, and submit the results to MOE. A committee meeting will be held and the authorization or modified instructions will be given as applicable.

④ The construction of project will be permitted only after approval of the EIA (for the project that requires EIA), is received.

⑤ MOE monitors and checks the parameters included in EIA during the construction period.

The flow of EIA procedure is shown in Figure 1.5.

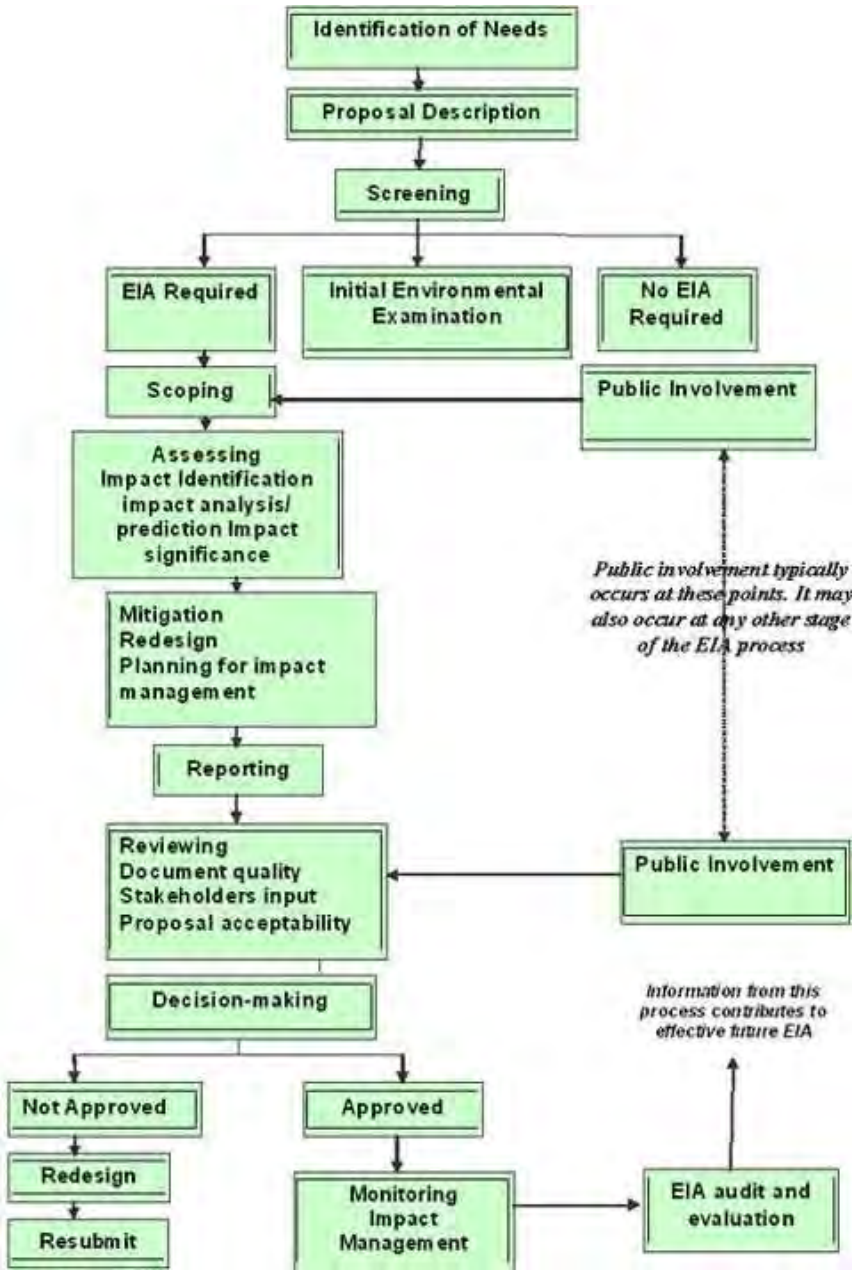


Figure 1.5 Flow of EIA Procedures in Jordan

2) Relevant organization

a. Ministry of Environment (MOE)

The organization chart of MOE is shown in Figure 1.6. The department responsible for supervision and EIA approval is Directorate of Licensing & Guidance.

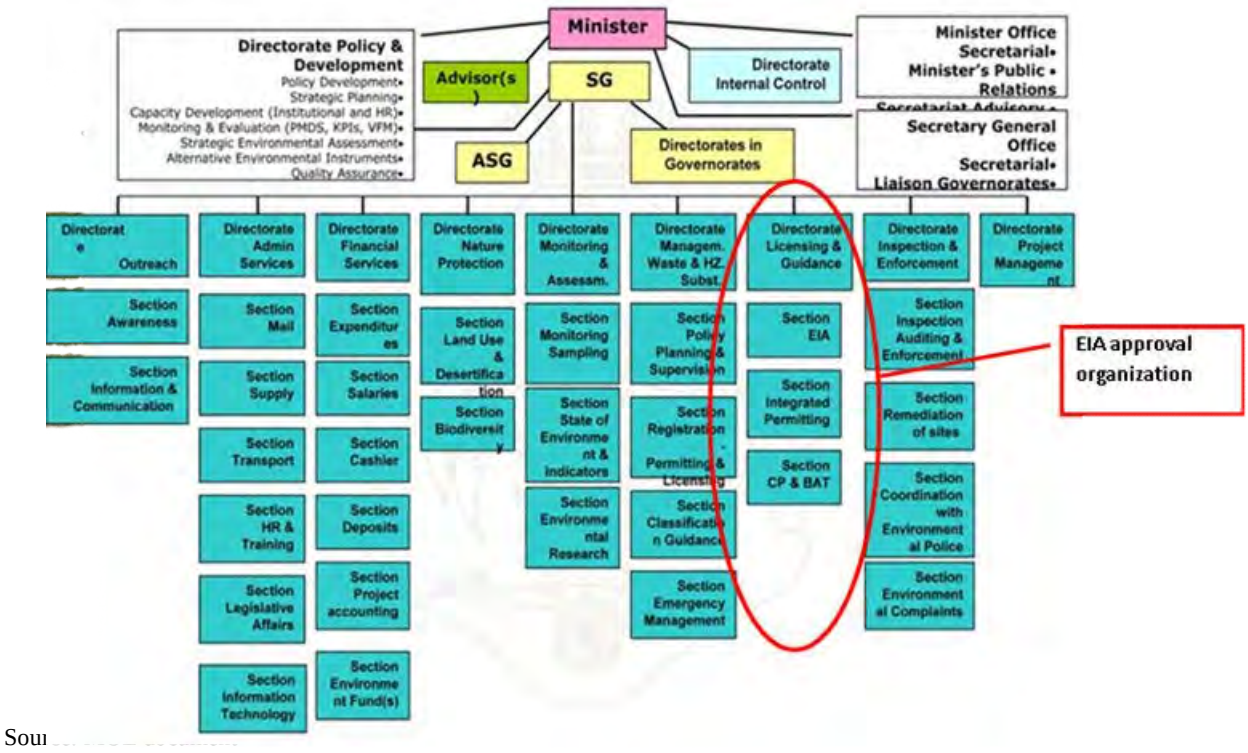


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Figure 1.6 Organization of MOE and EIA Approval Organization

b. PMU of WAJ

The division responsible for EIA management in WAJ is Programme Management Unit (PMU). For this purpose, Department of Technical Monitoring and Inspection is established, and Environmental and Social experts are assigned.

(3) Environmental and Social Considerations for the Project

Environmental and social considerations for the Project are shown below.

1) Results of Environmental and Social Consideration Examination in 1st stage grant-aid project.

In the 1st stage grant-aid project, the Ministry of Environment (MOE) declared that the Environmental Impact Assessment (EIA) is unnecessary for the rehabilitation project of distribution pipes in Hawwara and Sarieh (see Appendix XI 11-1) and no stakeholder meetings were required for the above project. This declaration by MOE is valid for the Project because the Project (the 2nd stage of grand-aid project) is the continuous project of the 1st stage grant-aid project and the project area is same and scope of the project is same. Therefore, JICA Guidelines for Environmental and Social Considerations are used in this study. According to JICA, the Project is categorized as B namely, the project may have adverse impacts on the environment or society, but these impacts are less significant than those of Category A. In category A、the project is likely to have significantly adverse impacts on the environment or society.

2) Outline of the Project

The outline of the Project is shown below and the scope of the Project is shown in Table 2.5 and in Figure 2.9.

3) Examination of Development Alternatives

The Project requires lying of distribution pipe under every road to supply water to every household. For this purpose of the Project, no alternative to lying of distribution pipe is identified.

4) Procedure of Environmental and Social Considerations

The steps of environmental reviews are as follows.

1. Scoping
2. Examination of Environmental and Social Considerations
3. Evaluation of Impacts
4. Monitoring plan

5) Results of Environmental Review

The result of environmental review is shown in Table 1.4 and major results are listed below.

- Some negative environmental impact of the project activities is expected only during the construction stage.
- There is no negative environmental impact during operation of facilities because distribution main and distribution network are located under the ground.
- Resettlement and land acquisition is not expected because pipelines are to be laid under the public roads.

Table 1.4 Scoping Plan and Result of Examination

Category	No.	Environmental Item	Evaluation of Impact in Scoping		Evaluation of Impact based on examination result		Reason of evaluation
			Before and under construction	Operation	Before and under construction	Operation	
Pollution Control	1	Air Quality	B-	D	B-	N/A	Air pollution occurs by dust from digging and due to exhaust gas from construction machines and vehicles during construction.
	2	Water Quality	B-	D	D	N/A	Water source in the project area is deep aquifer, and groundwater pollution from sprinkling or car washing during construction is not expected due to deep aquifer.
	3	Wastes	B-	D	D	N/A	Surplus soils generated are reused after taking away stones and concrete objects and so on. Stones and concrete objects and so on are damped as waste.
	4	Soil pollution	B-	D	B-	N/A	Soil pollution is expected due to leakage of small amount of oil from construction machines and vehicles during construction.
	5	Noise and Vibration	B-	D	B-	N/A	Noise and vibration is expected to occur from construction machine and vehicles during construction.
	6	Subsidence	D	D	N/A	N/A	Subsidence is not expected.
	7	Offensive odor	D	D	N/A	N/A	No source of offensive odor is identified.
	8	Substratum	D	D	N/A	N/A	Project activity is not expected to have any impact on Substratum.
Natural Environment	9	Reserve Area	D	D	N/A	N/A	Natural Reserve Area is located far from Project areas (about 10 km or more). Therefore, no negative impact is expected.
	10	Ecosystem	D	D	N/A	N/A	Project area does not include any protected animals and plants.
	11	Hydrology	D	D	N/A	N/A	Alteration of Hydrology is not expected due to project.
	12	Topography, geological feature	D	D	N/A	N/A	Alteration of topography, geological feature is not expected.
Social Environment	13	Resettlement	D	D	N/A	N/A	Resettlement is not expected to occur due to Project.
	14	Poor classes	D	D	N/A	N/A	Project activities are not expected to cause any negative impact on Poor classes.
	15	Ethnic Minorities and Indigenous Peoples	D	D	N/A	N/A	Project area does not include Ethnic Minorities and Indigenous Peoples.
	16	Refugee	D	D	D	N/A	The Project is to lay pipes along road to supply water to household so that project activities will not have any discrimination against Refugee; rather water supply condition is expected to improve for all including refugees.

Category	No.	Environmental Item	Evaluation of Impact in Scoping		Evaluation of Impact based on examination result		Reason of evaluation
			Before and under construction	Operation	Before and under construction	Operation	
	17	Livelihood	B-	D	B-	N/A	During the construction stage, traffic may be regulated and traffic interruption may be caused, and approach/visit of residence to commercial facilities is expected to be limited. To mitigate the impact of traffic control on the daily life of people during the construction stage, the approach side walk should be set appropriately and a traffic regulating person stationed to provide directions on site to ensure safe and smooth traffic flow during construction work.
	18	Cultural Heritage	B-	D	B-	N/A	There is possibility to find remains and relic during excavation work.
	19	Landscape	D	D	D	N/A	No negative impact on Landscape is expected to occur.
	29	Gender	D	D	D	N/A	Negative impact on Gender is not expected due to Project activities.
	21	Work Environment	B-	D	B-	N/A	Construction activities are expected to have some negative impact on working environment of labor in terms of air quality, noise, and vibration due to operation of construction machines.
Others	22	Accident	B-	D	B-	N/A	During construction, there is possibility of occurrence of traffic accident due to regulated and interrupted traffic by installation of pipe.
	23	Influence of the border violation, climate change	D	D	N/A	N/A	No influence on the border violation and climate change is expected.

Note) Evaluation A+/-: Significant positive / negative impact is expected.
Evaluation B+/-: Positive / negative impact is expected to some extent.
Evaluation C+/-: Positive / Negative impact is not clear.（Further examination is necessary, and level of impact becomes clear by the progress of the examination.）
Evaluation D：No impact is expected
N/A: Not applicable, No further evaluation was conducted on this item because this item was evaluated as D in the scoping,

Source: Compiled and reviewed after monitoring of items based on the results of environmental reviews in the JICA water supply master plan

1) Mitigation Measures and Cost

Mitigation measures and cost related to environmental items that are expected to have negative impact due to implementation of the project are shown in Table1.8.

Table 1.5 Mitigation Measures and Cost Estimation

No.	Item	Proposed Environmental management plan	Implementing Agency	Responsible Agency	Cost (JD)
1	Air Quality	To suppress the scattering of dust occurring during excavation in the construction stage, regular sprinkling of water is needed.	Contractor	YWC, WAJ	11,500
4	Soil pollution	Construction machinery and vehicles need to be checked regularly for oil leakage and repairs carried out if required. If leakage occurs, the soil containing leaked oil should be collected and disposed of appropriately.	Contractor	YWC, WAJ	3,400
5	Noise and Vibration	The construction section moves to a different location in a week to 10 days, so the noise emitting period in each section is short and the impact on daytime activity is small. Construction activity should be planned such that noise does not occur at nighttime.	Contractor	YWC, WAJ	7,100
18	Cultural Heritage	Construction plans should be submitted to MOTA in advance requesting that a monitoring person be assigned in case of occurrence of remains or relics. If these are found during excavation, the instructions of monitoring person should be followed for continuing the excavation work.	MOTA	MOTA	-
21	Work Environment	Measures for safety of public and workers and sanitation measures should be taken during the construction stage. Safety management rules should be prepared and implemented on site. Construction area indicators, protection fence, and watchmen at construction sites should be provided to avoid occurrence of accidents. For the workers, dust masks, earmuffs or ear plugs against noise should be provided. Workers at the construction site should wear work clothes, helmet, safety jacket, and safety shoes.	Contractor	YWC, WAJ	4,100
22	Accident	It is necessary to isolate the construction sites and implement traffic restrictions during the construction stage. For this purpose, it is important to put up the construction plan on site, indicate the construction area, install protection fence, station watchmen, and provide lighting arrangements especially at night at the construction site with appropriate traffic indicators to avoid accidents.	Contractor	YWC, WAJ	6,200

Note) Cost is assumed as about 10% of that of the Irbid city using the ratio of area and population between the Project and Irbid city. The cost of Irbid City has been estimated in the JICA water master plan.

2) Monitoring plan

Monitoring plan, which is required only for construction stage, is shown inTable 1.6. The monitored results are firstly compiles and reported to a supervision consultant and then reported to a project implementing organization.

Table 1.6 Monitoring Plan

Environmental Item	Item and the maximum allowable level	Place	Frequency	Responsible institution
Air Quality	Total suspended particulate (TSP): 75 mg/m^3 (24 hours), 260 μg/m^3 (1 year), CO: 26 ppm (1 hour), NO_2: 0.21 ppm (1 hour), 0.08 ppm (24 hours), 0.05 ppm (1 year) and SO_2: 0.135 ppm (1 hour), 0.130 ppm (24 hours), 0.03 ppm (1 year) (The Jordan Standard No. 1140 for ambient air quality, 1996)	Neighborhood of construction site	1 time /month	Contractor YWC, WAJ
Soil pollution	Checking of oil leakage from construction machines and vehicles, and status of cleaning situation of locations where soil is affected by oil leakage	Construction site, construction machinery, vehicle storage place	1 time /month	Contractor YWC, WAJ
Noise and Vibration	According to the standard in Jordan, the maximum level of noise is: City township (daytime: 60 dB, night: 50dB), commercial area (daytime: 65 dB, night: 55 dB), education, hospital, mosque (daytime: 45 dB, night: 35 dB). (MOE, 1997) Load vibration limit is: residential area (daytime: 65 dB, night: 60 dB), commercial, industrial area (daytime: 70 dB, night: 65 dB) (General rules of Japanese local government)	Neighborhood of Construction site	1 time /month	Contractor YWC, WAJ
Livelihood	Condition of blocking, limited approach of commercial facilities	Surrounding Construction site	1 time /week	Contractor YWC, WAJ
Cultural Heritage	Existence of remains and relic	Construction site	MOTA coordination	Contractor MOTA
Work Environment	Situation of wearing working clothes, safe shoes, masks, and other safety related accessories of Workers. Enforcement situation of the safety measures of neighboring inhabitants	Construction site Surrounding Construction site	1 time /week	Contractor YWC, WAJ
Accident	Checking of implementing mitigation measures proposed in Table 1.8 Checking attitude of performance of traffic guide	Surrounding Construction site	1 time /week	Contractor YWC, WAJ

3) Stakeholder's Meeting

Stakeholder's meeting was held for explaining the MP for both water supply and wastewater services under examination to participants and for collecting a wide range of opinions on environmental and social issues from stakeholders. The details are given below.

Date and time : 16 September 2014, 10:00 - 11:00
Venue : WAJ PMU Meeting Room

Participating Organizations:

Ministry of Environment, Ministry of Water and Irrigation, Organizations of EIA Technical Committee (Ministry of Agriculture, Ministry of Industry and Trade, Ministry of Health, Ministry of Municipality, Ministry of Energy and Mineral Resources), Water Authority of Jordan, Yarmouk Water Company, JICA Jordan Office, and JICA study team.

There were two major opinions and comments during the discussion and no major concern of

stakeholders on the Project was shown.

Firstly, a participant from the Ministry of Environment emphasized the importance of considering accident risk during construction. JICA study team stated that safety measures not only during construction but also during operation are proposed in the MP.

Secondly, a participant from the Ministry of Water and Irrigation asked JICA study team about the measures for energy efficiency improvement and wastewater reuse. JICA study team responded that a gravity water supply system as wide as possible would be proposed for conversion from pumping system to gravity system to save energy, and treated wastewater quality would be set to meet the standard for irrigation water in Jordan for wastewater reuse.

(4) Land Acquisition and Resettlement

Land acquisition and resettlement are not expected to occur in implementation of the Project.

(5) Others

1) Monitoring Form (Draft)

Monitoring Form (Draft) is shown in Appendix XI 11-1.

2) Environmental check list

Environmental check list is shown in Appendix XI 11-1.

CHAPTER 2 CONTENTS OF THE PROJECT

CHAPTER 2 CONTENTS OF THE PROJECT

2.1 Basic Concept of the Project

This grant-aid project is to be implemented by UNOPS under the framework of the Japanese grant in association with an international organization. Nonetheless, this report is written based on the system of Japanese grant-aid project.

2.1.1 Overview of the Project

2.1.1.1 Overall Goal and Project Target

(1) Overall Goal

Jordan formulated the "National Agenda 2006-2015," a comprehensive national strategy that specifies issues the country should tackle and guidelines to resolve the challenges. Issues in the water sector include scarce water resources, inefficient distribution of water, inappropriate setting of water tariff, inadequate sewage treatment capacity and so on. One of the guidelines to resolve such issues is "to make operation and maintenance of facilities efficient and to reduce non-revenue water." Furthermore, the Jordanian government has issued comprehensive guidelines in the "Water for Life: Water Strategy of Jordan 2008-2022." This project (the Project) has the base on overall plans of the "National Agenda" and the "Water for Life". The Project will contribute to the realization of the following targets from the guidelines and targets indicated in the overall plans.

- Reduce operating cost and non-revenue water by improving efficiency of the distribution network
- Secure and supply adequately safe drinking water
- Take immediate measures for the entire water sector and for economic development to cope with the increase in population and their water needs.

Furthermore, the Project will meet the demands of water supply and sewerage systems of the host communities under the "National Resilience Plan", thereby contributing to mitigation of the friction between host communities and refugees and lessen the impact of influx of Syrian refugees.

Under such a situation, Japanese assistance of technical cooperation for development planning for "The Project for the Study on Water Sector for the Host Communities of Syrian Refugees" in the northern governorates started in January 2014. The technical cooperation contains three components of A, B and C, through which following projects was selected and put into implementation.

Component A: The Grant-aid Project (Phase 1) (as called the 1st grant aid project hereinafter) (Preparatory Survey on the Programme for Urgent Improvement of Water Sector for the Host Communities of Syrian Refugees in Northern Governorates, December 2014)

Component B: JICA Water Supply Master Plan in Irbid City and some of Suburbs (Study on Water Sector for the Host Communities of Syrian Refugees in Northern Governorates in the Hashemite Kingdom of Jordan, January 2015) During the study, following the master plan, basic design, detailed design and preparation of tender documents for Irbid city and some of suburbs was conducted (refer to. Figure 2.4).

Component C: Pilot activities of technical cooperation with YWC in operation and maintenance of water supply and sewage facilities

The Project is planned to be implemented as the grant-aid project (Phase 2) (as called 2nd stage grant aid project hereinafter) based on the JICA water supply master plan of Component B, followed by the 1st stage grant-aid project, which is scheduled to be completed in 2017.

(2) Project Target

Based on the overall goal, the targets of the Project are as follows:

- to increase the amount of water supplied to the project area (Hawwara and Sarieh) by using the water resource that has increased by rehabilitation of well fields in the eastern part of the northern governorates and development of Disi fossil water; and
- to resolve water unserved areas and reduce leakage through improvement of the distribution system of Hawwara and Sarieh area.

Relationship among the problems in the project area, their countermeasures in the Project, and purpose of the Project is shown in Table 2.1.

Table 2.1 Relationship among the Problems in the Project Area, Countermeasures and Purpose of the Project

Problem	Cause	Condition	Countermeasures	Purpose
Low water supply per capita 62 Lpcd for Hawwara (1) 54 Lpcd for Sarieh (1)	・Limited water resources ・Increase of water demand by rapid influx of Syrian refugees	Increase in water resources by Disi groundwater development and eastern well fields development	・Utilization of new water resources ・Decrease in leakage	Increase in water supply amount
Lots of water unserved areas (0.11-0.5Mpa) (2)	・Limited water resources ・Improper arrangement of distribution network ・A large elevation difference		・Adequate pipe arrangement and pipe size ・Setting of distribution zones ・Installation of pressure reducing valves (PRVs)	Elimination of water unserved areas (equitable water supply/adequate water pressure)
water unserved area	・No pipe		・Installation of new pipe	・Elimination of water unserved areas
High leakage ratio	・Lots of aged pipes ・High water supply pressure in low elevation area		・Replacement of aged pipes ・Adequate water pressure by zoning and installation of PRVs	Decrease in leakage

Note) (1) estimated value from the data of JICA Water Supply Master Plan
(2) Measured by JICA study team

2.1.1.2 Project Overview

2.1.1.2.1 Condition of the Project and Relationship with other Projects

The condition[1] of the Project is that projects related to improvement of the transmission system in the northern governorates should be completed. In addition, the Project is required to be carried out simultaneously with the projects for improving distribution system of Irbid. These related projects are described below.

[1] The Project consists of improvement (pipe size increase and so on) of and rehabilitation of the pipes. Without improvement of the transmission system, water supply amount will not increase. On the other hand, even without improvement of the transmission system, leakage will reduce by rehabilitation of pipes.

(1) Water Transmission System in the Northern Governorates

The improvement plan of clear water transmission system in the northern governorates comprises two steps, namely Case A from 2018 to 2020 and Case B After 2020 to distribute enhanced water productions for meeting the water demand increase in the area (Figure 2.3).

Figure 2.1 shows schematic diagrams of changes of water sources and increase of productions between the current, Case A and Case B. Figure 2.2 indicates the locations of the planned transmission facilities of projects in the northern governorates. Figure 2.3 shows the time frame of water production increase of the plan.

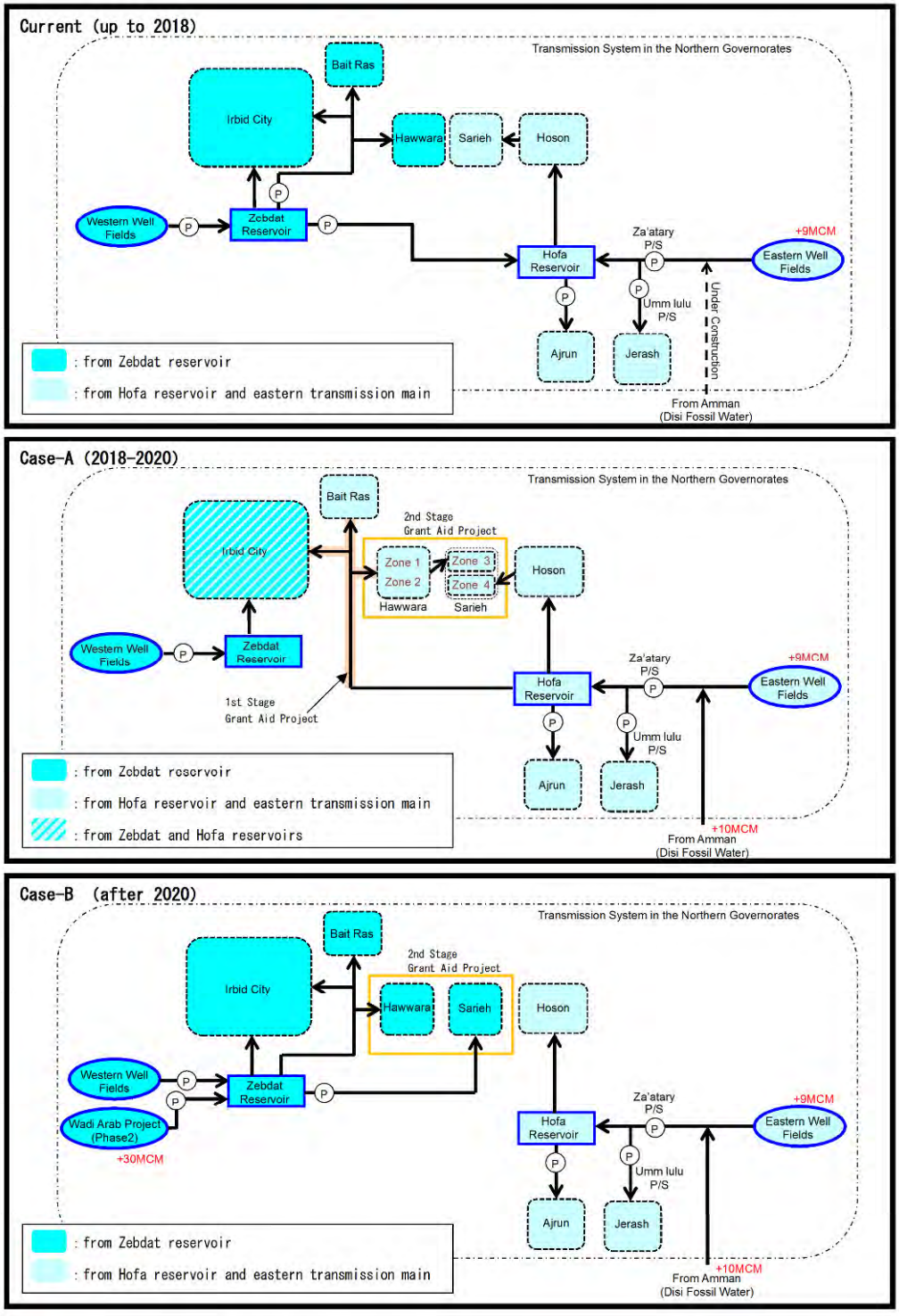
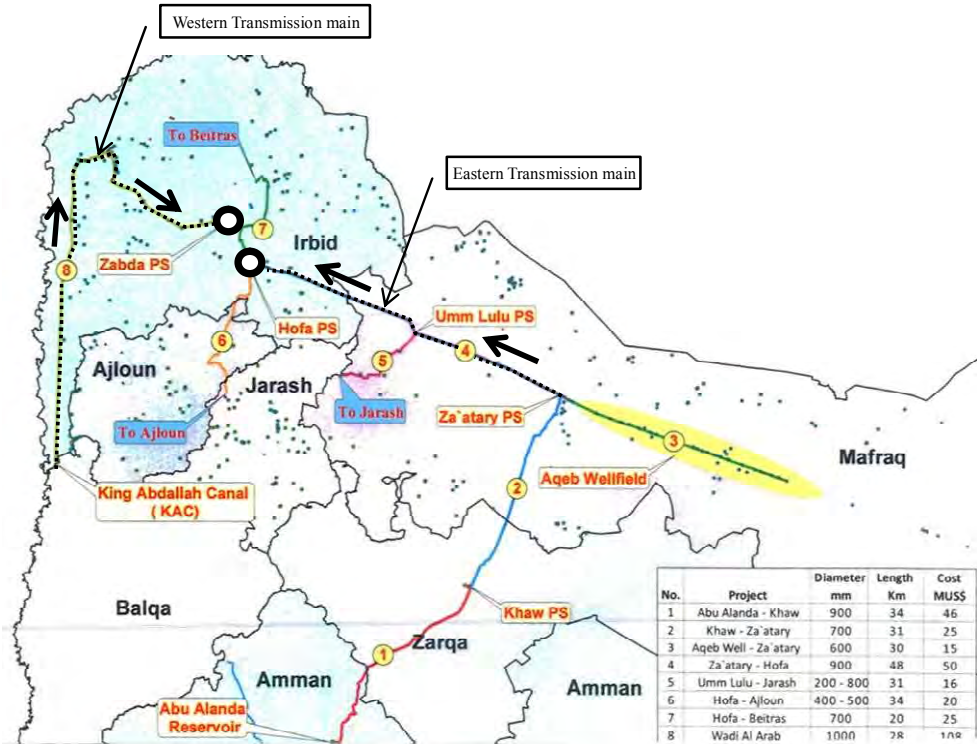


Figure 2.1 Changes in Water Transmission System in the Northern Governorates



No.	Project	Diameter mm	Length Km	Cost MUS$
1	Abu Alanda - Khaw	900	34	46
2	Khaw - Za`atary	700	31	25
3	Aqeb Well - Za`atary	600	30	15
4	Za`atary - Hofa	900	48	50
5	Umm Lulu - Jarash	200 - 800	31	16
6	Hofa - Ajloun	400 - 500	34	20
7	Hofa - Beitras	700	20	25
8	Wadi Al Arab	1000	28	108

Figure 2.2 Location of Projects for Planned Transmission Facilities in the Northern Governorates

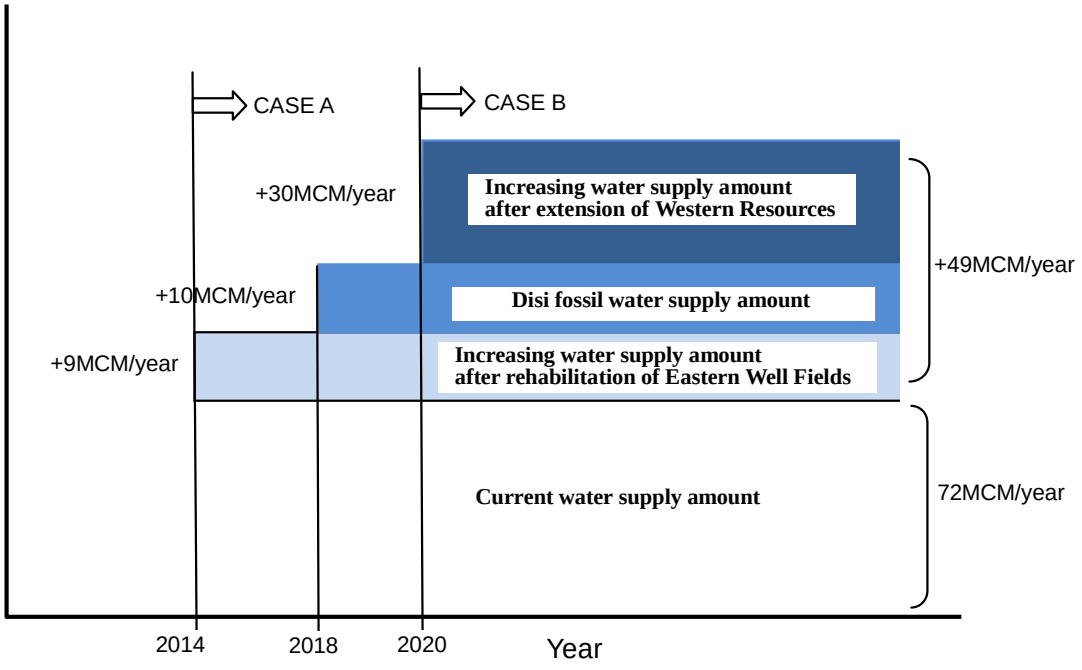


Figure 2.3 Time Frame of Water Production Increase of the Plan in the Northern Governorates

3) Case A (additional 19 MCM/year from the current water supply amount)

Disi fossil water was developed to mitigate water demand-supply imbalance in Jordan. This system started conveying water to Amman in August 2013. As a result, conveying water to Amman from corridor wells belonging to the eastern wellfields was stopped and instead has begun to be used in the northern governorates. The conveyance facilities are being extended to convey additional Disi fossil water amount from Amman to the northern governorates. On completion of these facilities, water distribution amount to the northern governorates will increase by 19 MCM/year.

The following facilities have been constructed or planned for conveying increased water to demand areas as shown in Figure 2.2.

a. Improvement of the transmission main between Abu Alanda reservoir in Amman Governorate and Za'atary pumping station in Mafraq Governorate (① and ② in Figure 2.2) →To be operational in 2018

b. Improvement of Eastern Transmission Main

- Water conveyance from eastern well fields to Za'atary pumping station (③ in Figure 2.2) →Already used.
- Addition of the transmission facilities from Za'atary pumping station to Hofa reservoir (④ in Figure 2.2) →Already used.
- Improvement of the transmission main from Um Lulu pumping station to Jerash Governorate (⑤ in Figure 2.2)
- Improvement of the transmission main from Hofa reservoir to Ajloun Governorate (⑥ in Figure 2.2)

Improvement of the eastern well fields was already completed to increase water resources amount by 9 MCM/year. A part of this amount is available and being conveyed to the Hofa reservoir.

The extension of the national water corridor between Abu Alanda reservoir and Za'atary pumping station will be completed in 2018 and additional 10 MCM/year of water will be available to the northern governorates.

4) Case B (additional 30 MCM/year, accumulated additional water resource amount will be 49 MCM/year)

The expansion of the western water resources (Wadi Arab 2nd stage) is being implemented for the northern governorates. Water will be released from the Tiberius Lake in the north of Israel to the King Abdulla Canal in Jordan (in the half of ⑧ near Irbid city in Figure 2.2). As of September 2016, evaluation to select the consultant for supervision was ongoing, and the project is expected to be completed in 2018 or 2019.

5) Water allocation in the project area

Water allocation to the project area (Hawwara and Sarieh) is shown in Table 2.2. (Calculation detail is shown in Table 2.18.)

Table 2.2 Water Allocation in Hawwara and Sarieh

Case	Year	Water allocation in the Northern Governorates (MCM/y)	Water allocation to the Project area (MCM/y)		
			Hawwara	Sarieh	Total
Current	Up to 2018	72	0.60 (1,635 m^3/day)	0.86 (2,365 m^3/day)	1.46
Case A	2018 - 2020	91	0.72 (1,985 m^3/day)	1.09 (2,989 m^3/day)	1.81
Case B	After 2020	121	0.96 (2,639 m^3/day)	1.45 (3,975 m^3/day)	2.41

(2) Improvement of Distribution System in Irbid Governorate

In conjunction with the improvement of the transmission system in the northern governorates, restructuring plan of the distribution system in Irbid was studied. This study has been conducted under the framework of Technical Cooperation for Development Planning "The Project for the Study on Water Sector for the Host Communities of Syrian Refugees" in the Northern Governorates (refer to Figure 2.4). This technical cooperation consists of three components of A, B and C. Component A is the implementation of grant-aid projects, Component B is formulation of water supply and sewerage master plan, and Component C is execution of technical cooperation. In Component B, the JICA water supply master plan for the whole area of Irbid city and some of suburbs has been formulated. Following the master plan, basic design, detailed design and preparation of tender documents for Irbid city and some of suburbs was conducted.

In Component A, the grant-aid project (the Programme for Urgent Improvement of Water Sector for the Host Communities of Syrian Refugees in Northern Governorates, December 2014) by JICA (thereinafter called "the 1st stage grant-aid project) has been selected from the JICA water supply master plan and is put into implementation, which includes construction of Hofa-Bait Ras pipeline from Hofa reservoir to Bait Ras in the northern Irbid (⑦ in Figure 2.2) and rehabilitation of main distribution pipes in Hawwara. This 1st stage grant-aid project started in 2015 and will be completed in 2017.

The 2nd stage grant-aid project corresponding to the Project aims to improve the distribution system in Hawwara and Sarieh after the 1st stage grant-aid project.

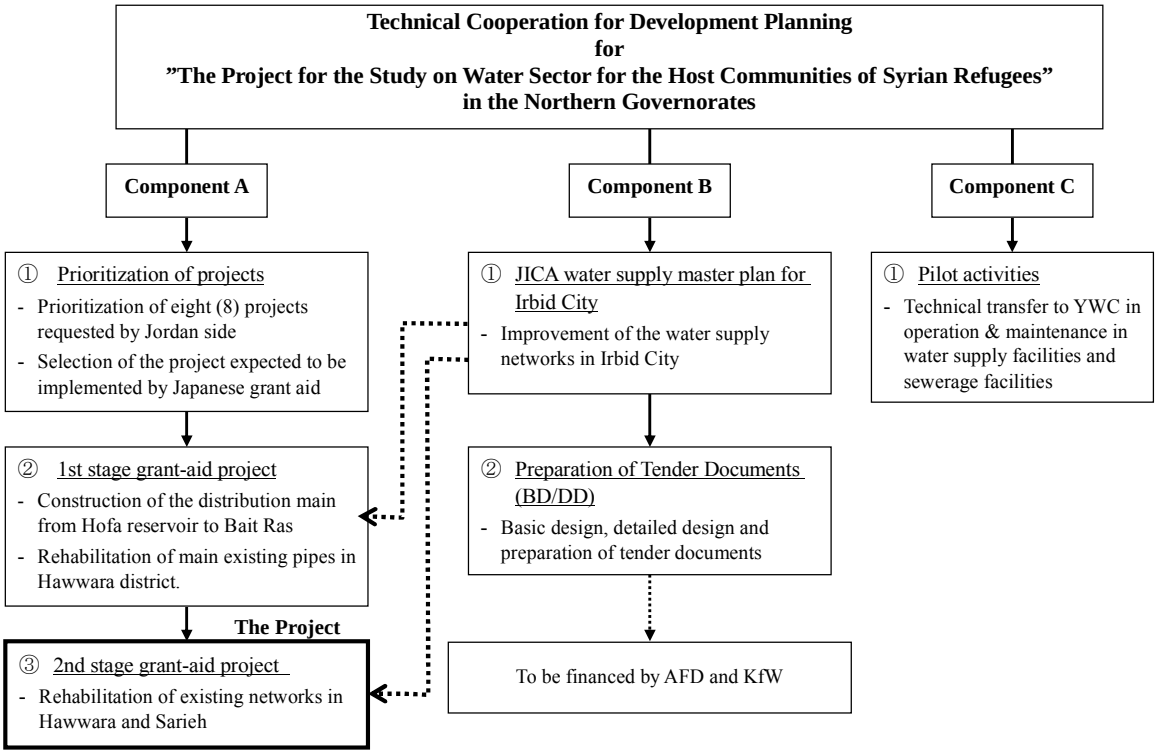


Figure 2.4 Technical Cooperation for Development Planning

1) JICA Water Supply Master Plan of Irbid City

The restructuring of the distribution system in Irbid is planned based on the scenario of Case B after year 2020. According to the JICA water supply master plan, the distribution blocks (DMAs), are planned for the distribution system. Water will be distributed from the Zebdat reservoir to all the areas of the Project, with Zones 1 & 2 of Hawwara (Figure 2.5) being incorporated in Zebdat Gravity Zone

and Zones 3 & 4 of Sarieh being incorporated in Zebdat Pumping Zone. Based on the master plan, the detailed design will be completed, and the tender documents will be prepared at the beginning of year 2017. The master plan is expected to be put into implementation using KfW and AFD finance.

The Project is to be planned so as to be adoptable for both cases; Case A before year 2020 and Case B after year 2020.

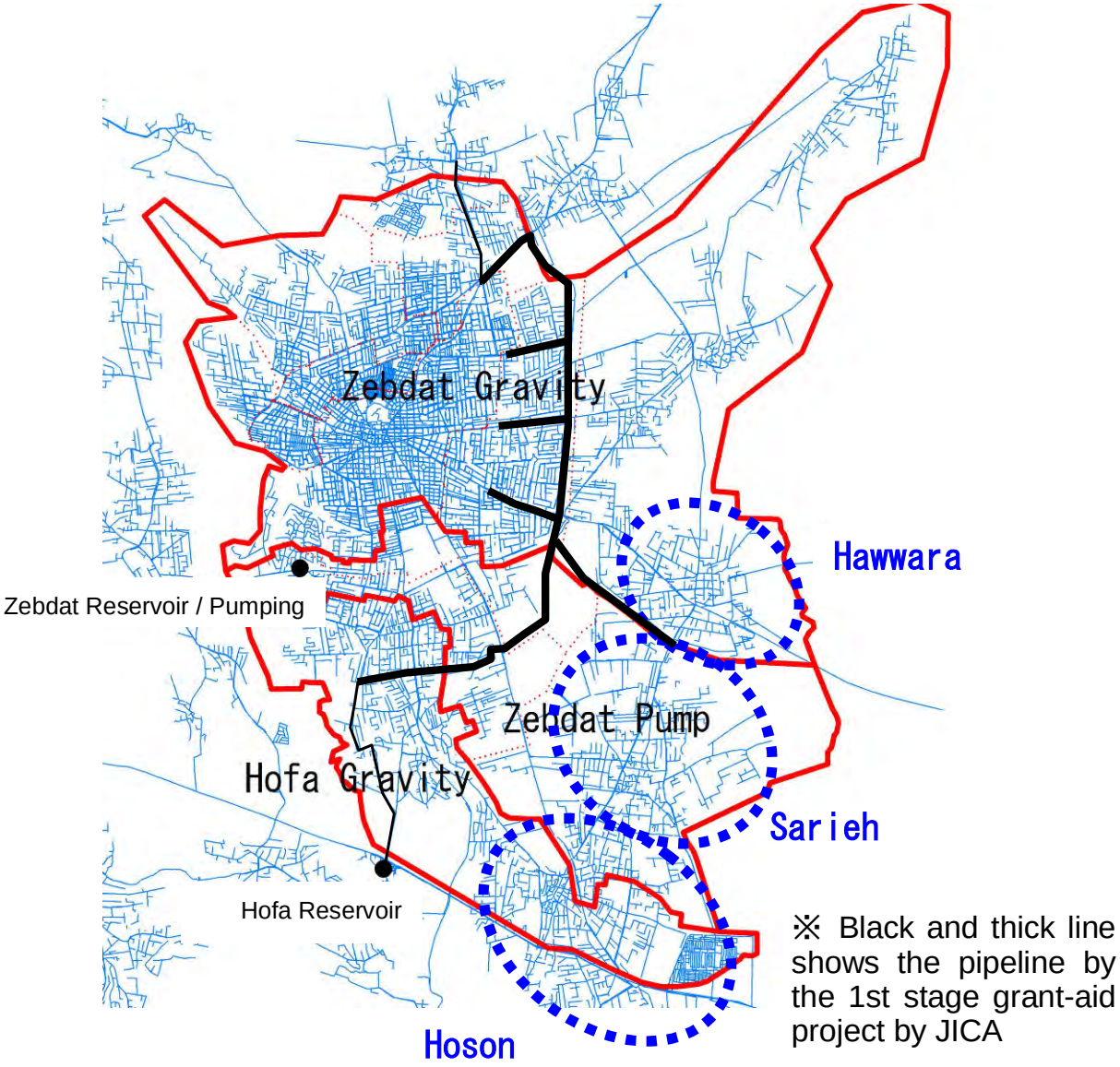
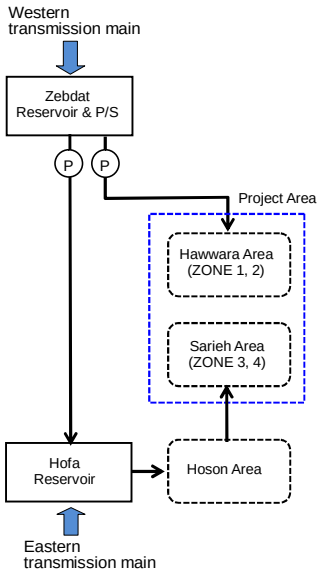
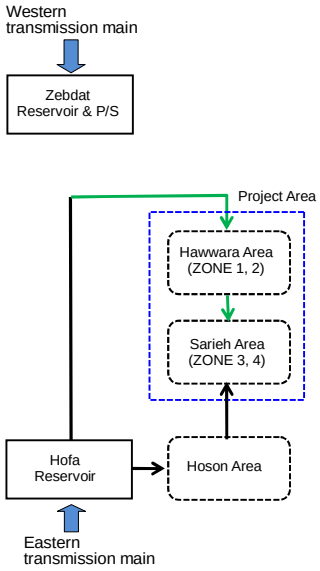
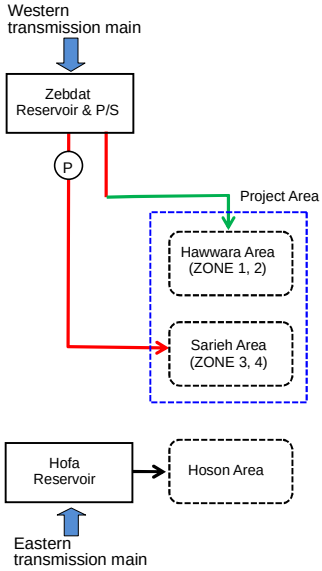


Figure 2.5 Water Distribution Zoning for Case B in JICA Water Supply Master Plan

2) Transition of Distribution System in Hawwara and Sarieh

The source of water (reservoir) and the distribution system (gravity or pumping) will change with the project progress (Case A to Case B), because Irbid city, Hawwara and Sarieh areas are located at the boundary between eastern and western resources from the viewpoint of water management. The transition of water distribution system in the project area is shown in Table 1.3.

Table 2.3 Transition of Water Distribution System in the Project Area

	At Present (2016)	Case A (2018 -) Completion of Disi Groundwater Transmission System in 2018	Case B (2020 -) Completion of Wadi Arab 2nd Stage in Year 2020
Schematic Flow Diagram			
Improvement of Distribution System in Irbid		Completion of Hofa - Bait Ras pipeline (1st stage grant-aid project) in year 2017	Improvement of distribution system ・ Water can reach Hawwara (Zone 1 and 2) by KfW and AFD financing in around 2018. ・ Water can reach Sarieh (Zone 3 and 4) by improvement of Zebdat pumps and installation of pipelines from the pump station to Zone 4 (have not started).
Hawwara	From Zebdat Reservoir by pumping	From Hofa reservoir via Hofa – Bait Ras pipeline by gravity	From Zebdat reservoir by gravity
Sarieh	From Hofa reservoir via Hoson area by gravity	・ From Hofa reservoir to Zone 3 through Bait Ras pipeline by gravity ・ From Hofa reservoir to Zone 4 via Hoson area by gravity	From Zebdat reservoir by pumping

The extension of national water corridor to Za'atary pumping station corresponding to Case A is scheduled to be completed in 2018, and then, the water amount to Hofa reservoir through the eastern transmission system will increase. The current method of water distribution for Hawwara and Sarieh; Zebdat reservoir to Hawwara by pumping and Hofa reservoir to Sarieh by gravity; will then change to conveying all water from Hofa reservoir by gravity.

The 1st stage grant-aid project aims to construct the distribution facilities for Irbid city center, Irbid city north area, and Hawwara and Sarieh in east Irbid. The facilities include the distribution main between Hofa reservoir and Bait Ras and branch pipes.

In this study, the distribution network in Hawwara and Sarieh is divided into four zones* (Figure 2.6)

* Note: Four (4) pressure zones in Hawwara and Sarieh indicate 4 district metering areas (DMSs); however they are called as zone in this report. Four zones are corresponding to 4 DMAs in the Zebdat gravity or pump zones proposed in JICA water supply master plan.

and a facility plan of the Project has been prepared with prioritization for implementation so that it will be applicable to Case B after year 2020 as well as Case A.

In and after 2020 (Case B), water supply to Hawwara and Sarieh will be entirely done from Zebdat reservoir according to the JICA water supply master plan. Hawwara will belong to Zebdat gravity zone and Sarieh will belong to Zebdat pump zone.

At present, water is distributed to Sarieh from Hofa reservoir, to which water is conveyed both from Zebdat reservoir by pumping and through the eastern transmission main pipe. In Case B, water will be distributed directly to Sarieh from Zebdat by pumping without using Hofa reservoir.

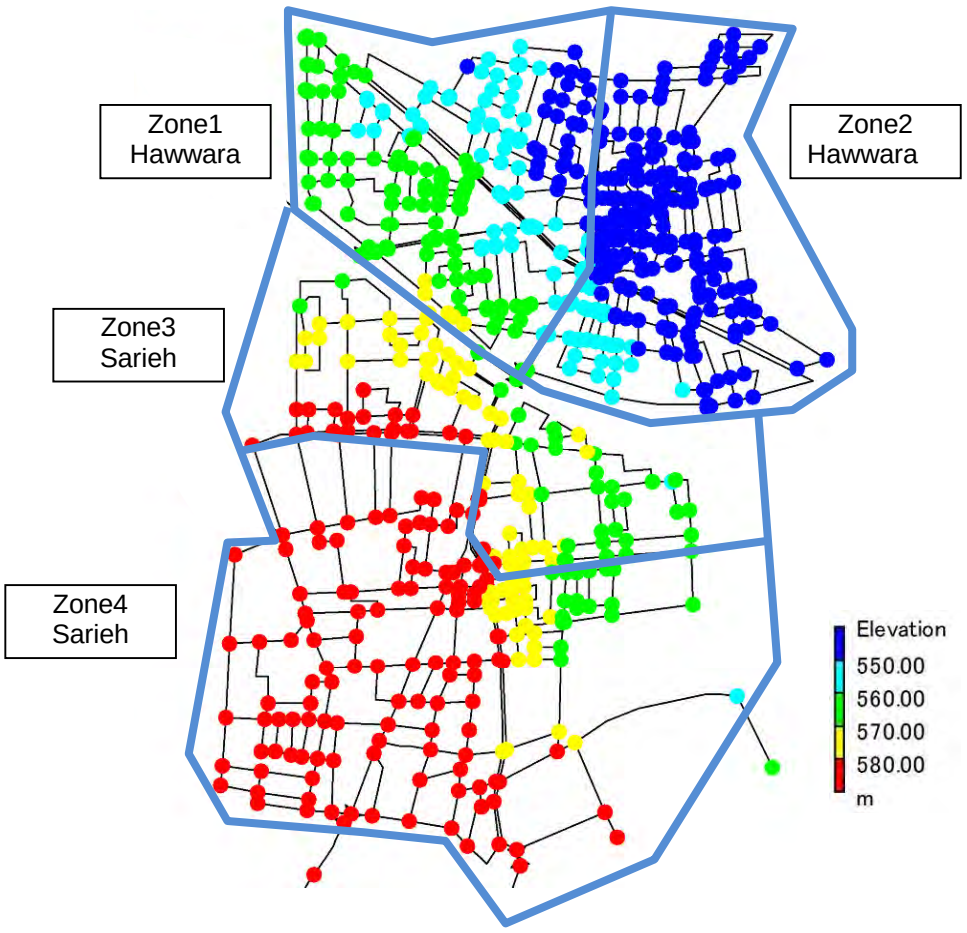


Figure 2.6 Zone Division in Hawwara and Sarieh based on Land Level

3) 1st Stage Grant-aid Project

The 1st stage grant-aid project is to construct the distribution main to Bait Ras and 4 branch pipelines (3 pipelines to Irbid city center area and 1 pipeline to Hawwara and Sarieh) and to rehabilitate main pipelines of a part of Zone 1 (Zone 1A) under Case A. The project is now under implementation and scheduled to be completed in 2017.

In Case A, water to both Hawwara and Sarieh will be supplied from Hofa reservoir. Water to Hawwara will be supplied through the distribution main above, while water to Sarieh will be supplied through the existing distribution main via Hoson after the completion of the 1st stage grant-aid project (Figure 2.7).

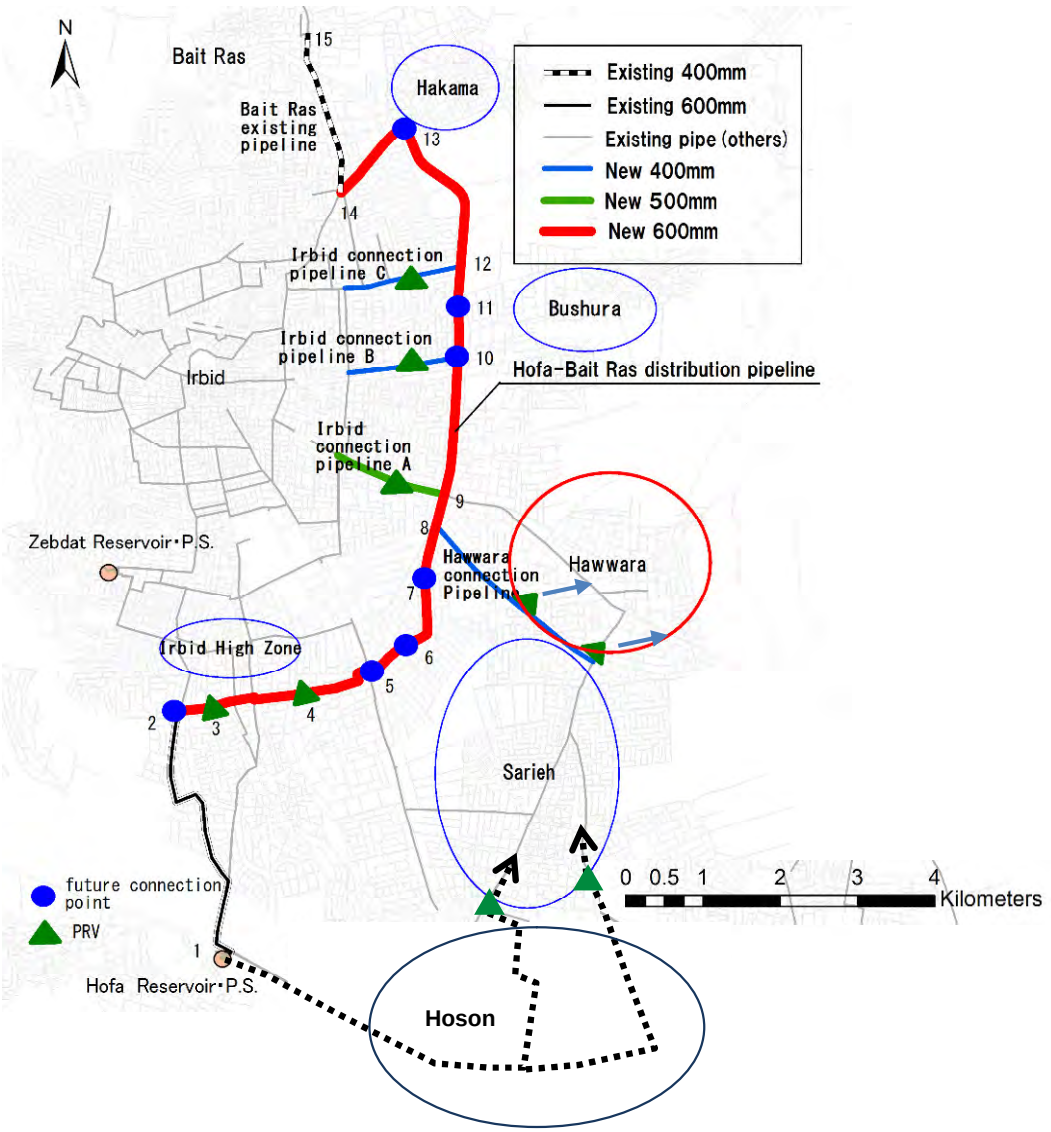


Figure 2.7 1st Stage Grant-aid Project
(Hofa – Bait Ras Pipeline and Rehabilitation in part of Hawwara)

4) Relationship of the Project with the 1st Stage Grant-aid Project

The purpose of the Project (the 2nd stage grant-aid project) is to improve the existing distribution network in Hawwara and Sarieh continuously after the 1st stage grant-aid project. In the 1st stage grant-aid project, the only part of Zone 1 (Zone 1A) in Hawwara is improved. Therefore, the Project gives the highest priority to rehabilitation of the remaining part of the existing pipe in Zone 1 that is not improved in the 1st stage grant-aid project, and plans to improve the distribution network in priority order of Zone 2, Zone 3 and Zone 4 due to budgetary constraints.

2.1.1.2.2 Outline of the Project

(1) Outline of the Project

The Project is to improve the existing distribution network in Hawwara and Sarieh under the condition of improvement of transmission system in the northern governorates and the 1st stage grant-aid project in order to achieve the project purposes. The purposes of Project are to resolve water unserved areas by measures of adequate water supply pressure and equitable water distribution, eliminate water

unserved area, and reduce leakage. The Project consists of the following water supply facilities:

1) Creation of 4 zones in Hawwara and Sarieh and installation of PRVs at the inlets of Sarieh (Zone 4)
2) Replacement of aged pipe in Hawwara and Sarieh
3) Supply and installation of new pipes in Hawwara and Sarieh.

The Project area (Hawwara and Sarieh) is shown in

Figure 2.8 where pipes laid in the 1st stage grant-aid project are also shown.

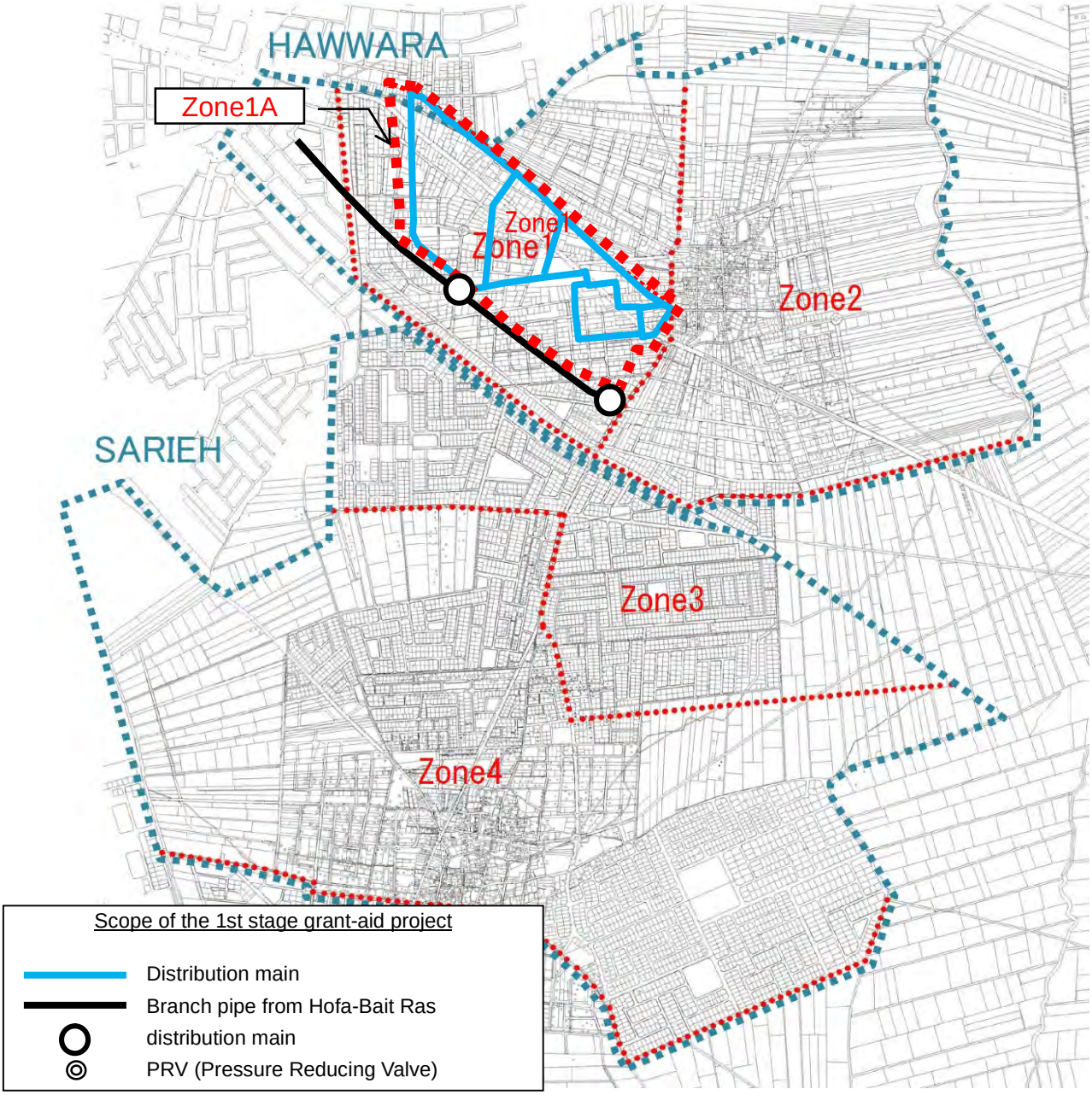


Figure 2.8 Project Area in Hawwara and Sarieh

(2) Contents Requested by Jordanian Side

The contents requested by Jordanian side consist of replacement of existing distribution pipes, installation of service pipes and installation of PRVs. In these contents, existing distribution pipes to be replaced are shown in Table 2.4.

Table 2.4 Distribution Pipe Length requested by Jordanian side

District	Pipe size (150-300 mm)	Pipe size (100 mm or smaller)	Total
Hawwara	20 km	50 km	70 km
Sarieh	26 km	60 km	86 km
Total	46 km	110 km	156 km

In the minutes of discussion signed on December 2015 (Appendix IV), JICA and Water Authority of Jordan (WAJ) discussed and confirmed the scope of request as follow.

- Improvement works should include not only distribution pipes but also road side service pipes.
- Construction of service pipes inside private premises and installation of water meters should be carried out by Jordanian side.
- Area-wise improvement should be adopted; distribution pipes and service connections should be implemented concurrently.

However, the scope of request is reduced and limited to only distribution pipe due to the following reasons in the meeting held on 1st September 2016 (see Appendix VIII);

- The quantity of distribution pipes and road side service pipe is very large.
- Higher priority is given to improvement of distribution pipes due to budgetary constraints.
- Yarmouk Water Company (YWC) has a lot of stock of service pipes and water meters supplied by the donors which can be used for service pipe works.
- YWC can carry out the service pipe connection work using the materials mentioned above.

(3) Scope and Area of the Project

Improvement of the distribution network for Hawwara and Sarieh is planned and designed in the Project. The target area is divided into four zones as mentioned above and the project area is selected from these zones since it is difficult to cover all the zones due to budgetary constraints.

Water pressure measurement conducted by JICA study team showed that water pressures of Hawwara at 10 locations are lower than the target minimum pressure of Jordan (0.25MPa), while water pressures of Sarieh at 10 locations satisfy the target pressure of Jordan. Therefore, the Project puts higher priority on the improvement of distribution network in Hawwara than that in Sarieh, The priority is set in the order of Zone 1, zone 2, Zone 3 and Zone 4 and the project area are limited to Zone 1, Zone 2 and Zone 3 excluding Zone 4 considering the scale of the project budget.

The scope of the Project by pipe installation type is shown in Table 1.5 and Figure 2.9. In addition, the quantity of pipe for the Zone 4, which is not included in the scope of the Project, is shown in Table 1.5 for reference. The comparison of proposed new pipe route, existing pipe route for replacement and existing pipe to be used in the Project is shown in Figure 2.10.

Table 2.5 Scope of the Project by Pipe Installation Type

Area	Zone	Items		Unit	Quantity of Distribution Pipe			Remark
					Replace. of exist. pipe	Installation of new pipe	Total	
Hawwara	Zone 1	Distribution Pipe	DN300 (DCI)	m	0	0	0	
			DN200 (DCI)	m	0	0	0	
			DN150 (DCI)	m	775	0	775	
			DN100 (DCI)	m	8,792	4,804	13,596	
			OD63(HDPE)	m	10,033	10,803	20,836	
			Total	m	19,600	15,607	35,207	
		Trenchless (Jacking) Works		Place	2			Bagdad Road
	Zone 2	Distribution Pipe	DN300 (DCI)	m	262	0	262	
			DN200 (DCI)	m	512	0	512	
			DN150 (DCI)	m	1,420	593	2,013	
			DN100 (DCI)	m	7,622	6,035	13,657	
			OD63(HDPE)	m	11,284	14,922	26,206	
			Total	m	21,100	21,550	42,650	
		Trenchless (Jacking) Works		Place	2			Bagdad and Sarieh Road
Sarieh	Zone 3	Distribution Pipe	DN300 (DCI)	m	0	657	657	
			DN200 (DCI)	m	0	1,093	1,093	
			DN150 (DCI)	m	268	577	845	
			DN100 (DCI)	m	2,561	3,079	5,640	
			OD63(HDPE)	m	7,171	12,536	19,707	
			Total	m	10,000	17,942	27,942	
		Trenchless (Jacking) Works		Place	1			Petra Road
	Zone 4	PRV		Set	2			Sarieh Road and main Road
Total		Distribution Pipe	DN300 (DCI)	m	262	657	919	
			DN200 (DCI)	m	512	1,093	1,605	
			DN150 (DCI)	m	2,463	1,170	3,633	
			DN100 (DCI)	m	18,975	13,918	32,893	
			OD63(HDPE)	m	28,488	38,261	66,749	
			Total	m	50,700	55,099	105,799	
		Trenchless (Jacking) Works		Place	5			
		PRV		Set	2			

Reference: Distribution Pipes in Zone 4 (designed, but out of scope of the Project)

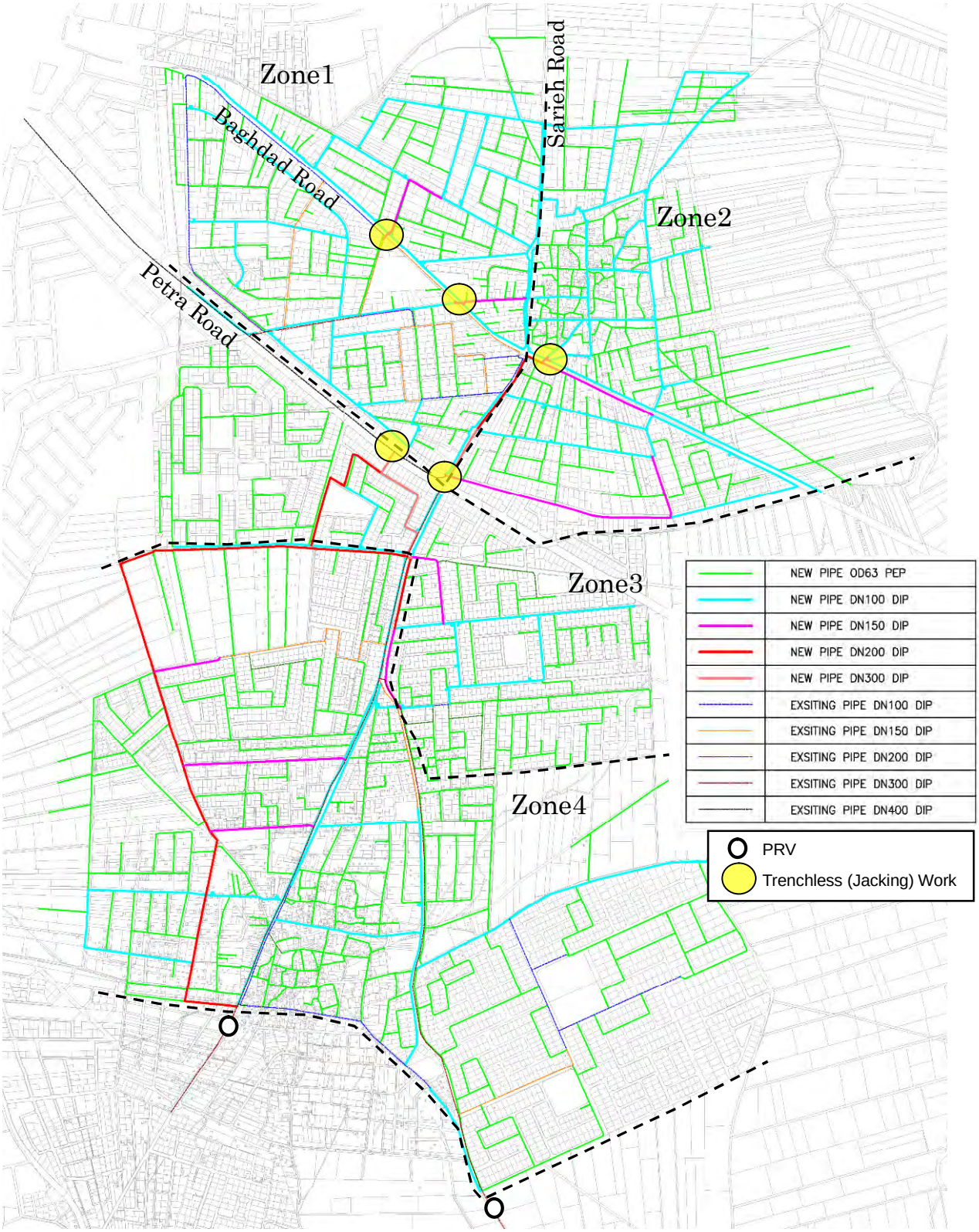
Area	Zone	Items		Unit	Distribution Pipe Quantity			Remark
					Replace. of exist. pipe	Installation of new pipe	Total	
Sarieh	Zone 4	Distribution Pipe	DN300 (DCI)	m	0	12	12	
			DN200 (DCI)	m	1,879	737	2,616	
			DN150 (DCI)	m	878	10	888	
			DN100 (DCI)	m	8,738	1,216	9,954	
			OD63(HDPE)	m	29,605	19,775	49,380	
			Total	m	41,100	21,750	62,850	

Note)- From the view point of cost reduction, it is recommended that the jacking method be changed to the open-cut method if the Ministry of Public Works and Housing (MPWH) permits it.

- Quantity of pipes of each zone is estimated by two categories: replacement of existing pipe overlapped with existing pipes, and installation of new pipe in new route shown in Figure 2.10

DN: Nominal diameter (indication of ductile cast iron pipe for inside diameter)

OD: Outside diameter (indication of high density polyethylene (HDPE) pipe for outside diameter)



Note) 'New Pipe' means replacement of the existing pipe and installation of new pipe. 'Existing Pipe' means continuous use of the existing pipe not to be replaced. Zone 1A is shown in

Figure 2.8

Figure 2.9 Proposed Distribution Pipe and Facilities

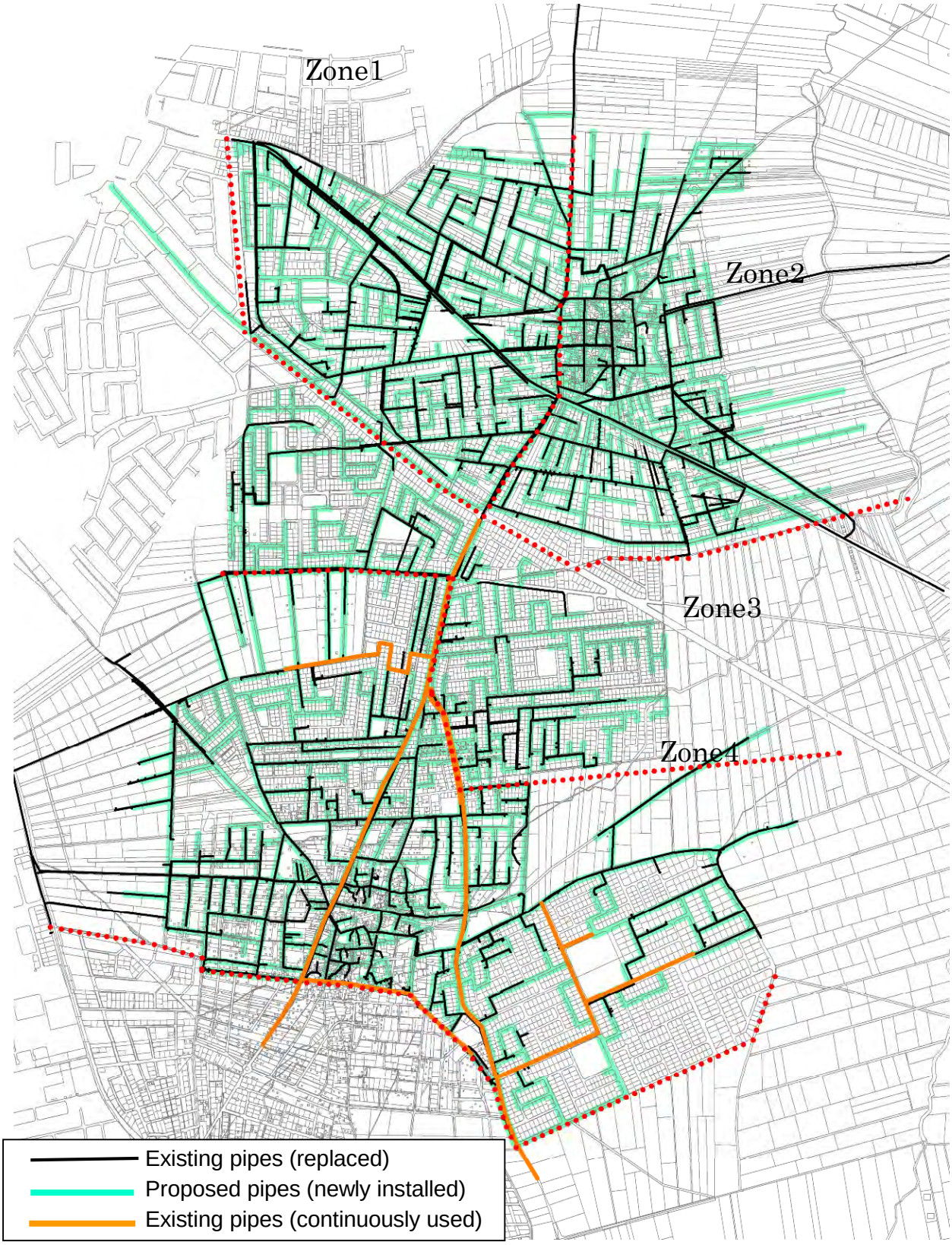


Figure 2.10 Comparison of Proposed New and Replaced Pipe and Existing Pipe to be Utilized

2.2 OUTLINE DESIGN OF THE REQUESTED JAPANESE ASSISTANCE

2.2.1 Design Policy

(1) Conditions

The purpose of the Project is to improve water supply situation in the Project area (Hawwara and Sarieh) by use of additionally available water amount to the northern governorates including the project area so that the transmission facilities explained below needs to be completed. On the other hand, another purpose of the Project, reduction of NRW will be achieved even without additionally available water amount.

1) Case A project

- Eastern transmission main between Za'atary reservoir/ pumping station and Hofa reservoir (already in operation)
- Eastern wellfields development (already in operation and 9 MCM/year of water is available)
- Extension of the National Water Corridor between Abu Alanda reservoir in Amman and Za'atary reservoir in Mafraq (to be completed latest by 2019 making available 10 MCM/year of Disi groundwater; implemented dividing into 2 sections, 1st section by AFD and 2nd section by KfW and both sections scheduled to be completed in 2018)

2) Case B project

- Expansion of the western water resources (Wadi Arab 2nd stage) (expected to be completed in 2018 or 2019)

3) 1st stage grant-aid project

- Main pipeline between Hofa reservoir and Bait Ras and branch (400mm) to Hawwara (plan to be completed in 2017)

The completion of these facilities increases water resource amount to the northern governorates by 19 MCM in Case A, 30 MCM in Case B and 49 MCM in total. It is also the condition of the Project that YWC distributes the increased water to municipalities in the northern governorates including Hofa reservoir according to planned amount in JICA water supply master plan. The part of the increased water is utilized for water supply to the project area (Hawwara and Sarieh).

(2) Basic Policy

1) Scope of cooperation

The scope of cooperation is improvement of distribution network (excluding service pipe) in Hawwara and Sarieh. The improvement includes replacement of existing pipe and new pipe installation.

2) Targets of the Project

The targets of the Project are:

- To increase the amount of water supplied to the project area where water demand has increased because of the influx of Syrian refugees into the host communities using the water amount that is increased through improvement of the eastern wellfields of the northern governorates, development of Disi fossil water, and potential implementation of Wadi Arab 2nd project; and;
- To alleviate the water supply situation in poor water supply areas through equalization of water pressure and water supply amount, eliminate water unserved area, and reduce leakage by

improving the distribution network of Hawwara and Sarieh.

3) Project area

The Project area is Hawwara (Zones 1 and 2) and Sarieh (Zone 3). In addition, Sarieh (Zone 4) is included as the study area.

4) Target year

The target year of the Project is 2020, immediately after the Project is completed in 2019, because of the urgency of the Project.

5) Planned population

The estimated served population in Hawwara and Sarieh for the target year of 2020 is the sum of the estimated Jordanian population in 2020 and number of Syrian refugees in 2013 as shown in Table 2.6. As the number of Syrian refugees of the target year of 2020 is difficult to be estimated, that of 2013 is fixed and used for the Project, which was already agreed with WAJ in JICA water supply master plan and the 1st stage grant-aid project.

Table 2.6 Served Population in 2020 (Target Year)

Area	Jordanian Population	Syrian Refugees	Total	Planned Service Population	
				Study Area	Project Area
				Zone 1 - 4	Zone 1 - 3
Hawwara	18,333	3,298	21,631	21,631 (*1)	21,631
Sarieh	27,615	4,968	32,583	32,583	6,333 (*2)
Total	45,946	8,266	54,214	54,214	27,964

Note) (*1) 10,008 for Zone 1 and 11,623 for Zone 2 obtained from the ratio of household numbers
(*2) Obtained from the household ratio of Zone 4 to the total households in Hawwara and Sarieh

6) Issues to be resolved

The issues in water supply in the study area are summarized in Figure 2.11 and following text. The main issues to be solved are “No water”; about 20,000 annual complaints of unsatisfactory water supply in Irbid City followed by leakage at 5,000 complaints. Other issues are comparatively fewer. Although leakage does not directly affect the lifestyle of the residents, it is linked to the complaint of “No water” because of the reduction in available water supply.

The purpose of the Project is to distribute increased water resource amount evenly. As the main cause of “No water” is unequal distribution of limited water, the Project contributes to reducing the “No water” problem by distributing the increased water amount evenly through improvement of distribution network.

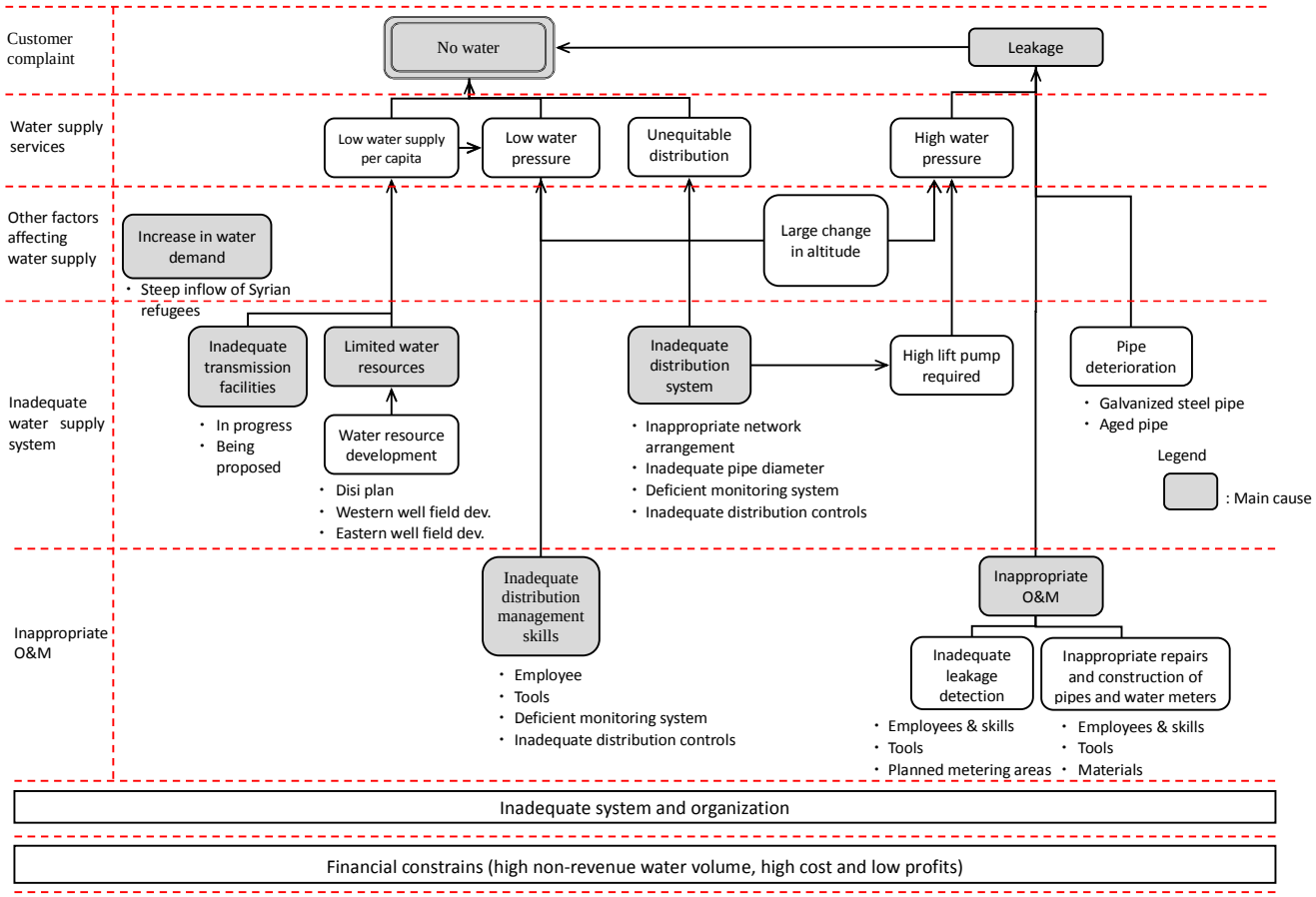


Figure 2.11 Summary of Issues in Water Supply of the Study Area

a. Shortage of water resource (shortage in supply amount)

Water supply services in the northern governorates including Irbid governorate has been in a very poor condition. The main cause is the shortage of absolute amount of water resource. According to JICA water supply master plan, the daily average water supply amount is 1,635 m^3/day for Hawwara and 2,365 m^3/day for Sarieh. In conversion to daily average water consumption per person (leakage 23%), those are calculated at 62 Lpcd for Hawwara and 54 Lpcd for Sarieh, which are much less than the target value of Jordan of 88 Lpcd (Water Reallocation Strategy 2010). Thus, the supply volume is always less than the demand in Irbid City including Hawwara and Sarieh.

b. Increase in water demand due to rapid increase in the influx of Syrian refugees

The increase in Syrian refugees in the host communities of the northern governorates started in 2011. The water amount per capita has decreased because of this increase in population, which has also become the main cause of the increase in complaints of water supply services.

c. Inadequate water supply pressure

JICA study team measured water supply pressures at 20 locations in Hawwara and Sarieh in January, 2016 (see Table 2.7, Table 2.8, Figure 2.12). For selection of water pressure measurement locations, it was considered that locations disperse fairy in each area. The pressure gauges were set at the service pipes of the houses after getting their permission. The pressure gauges were set at before the booster pumps to measure accurately, in considering that many houses install the booster pumps because of poor water supply pressure.

Measured pressures in Hawwara are under 0.25MPa of lowest value of Jordanian Standard at all the locations, resulting in poor water supply pressure condition. In contrast, those of Sarieh exceed 0.25MPa at all the locations, but Sarieh involves problems of lots of leakage due to many aged pipes.

Table 2.7 Measured Water Pressure by Zone

Area	Zone	Measured Water Pressure (MPa)		Comparison with Jordan Standard (0.25 – 0.75 MPa)
		Average	Range	
Hawwara	Zone 1	0.16	0.11 - 0.23	Low
	Zone 2	0.18	0.11 - 0.24	Low
Sarieh	Zone 3	0.39	0.25 - 0.50	Satisfied
	Zone 4	0.42	0.35 - 0.50	Satisfied

Source: JICA study team

Table 2.8 Measurement Points

District	No.	Longitude	Latitude	District	No.	Longitude	Latitude
Hawwara (Zone 1)	H1.1	32-32-28.680	35-53-19.715	Sarieh (Zone 3)	S3.1	32-31-22.116	35-53-47.066
	H1.2	32-32-21.493	35-54-23.144		S3.2	32-31-16.793	35-54-16.190
	H1.3	32-31-45.600	35-54-20.374		S3.3	32-31-03.305	35-53-57.359
	H1.4	32-32-10.981	35-53-20.070		S3.4	32-30-53.717	35-54-25.182
	H1.5	32-31-52.306	35-53-38.958		S3.5	32-30-43.328	35-54-05.628
Hawwara (Zone 2)	H2.1	32-32-06.891	35-54-41.138	Sarieh (Zone 4)	S4.1	32-30-51.397	35-53-54.280
	H2.2	32-31-56.911	35-54-32.184		S4.2	32-30-33.689	35-53-25.884
	H2.3	32-31-41.891	35-54-46.940		S4.3	32-30-19.048	35-53-37.103
	H2.4	32-31-28.958	35-54-09.616		S4.4	32-30-17.555	35-53-54.533
	H2.5	32-31-25.453	35-54-50.520		S4.5	32-30-07.670	35-53-30.800

Source: JICA study team

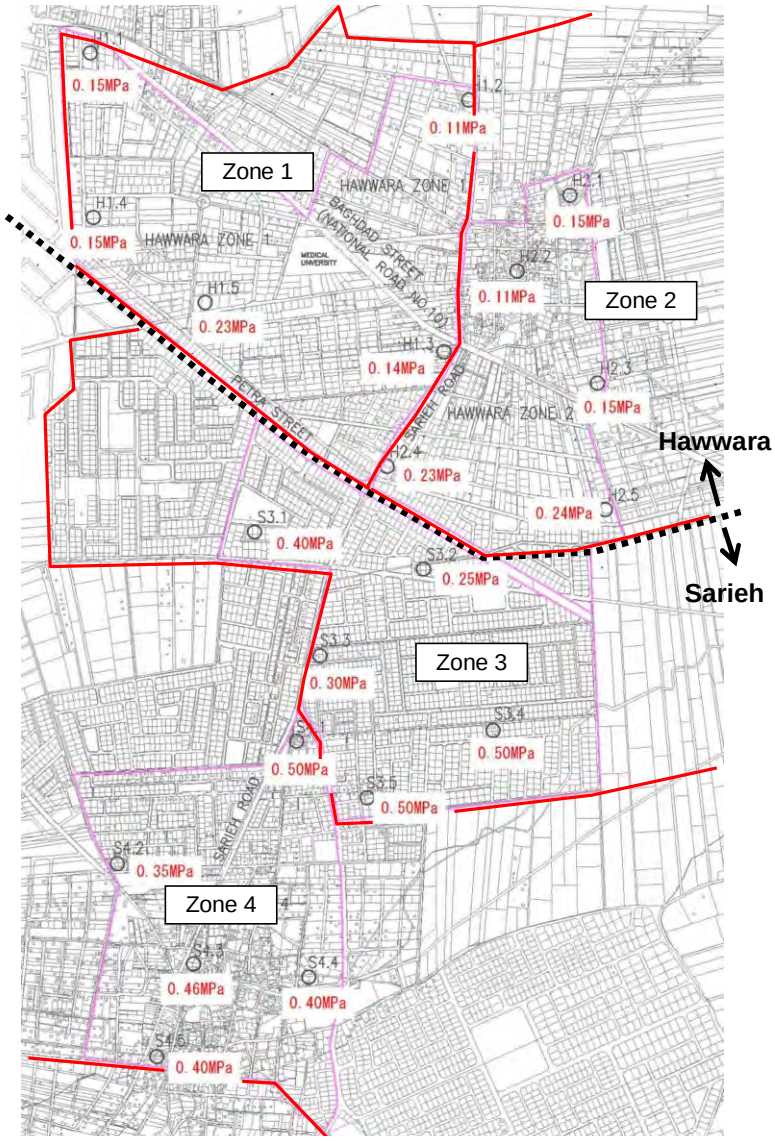


Figure 2.12 Supply Water Pressure Measurement

d. Improper arrangement and inadequate capacity of distribution network

The improper arrangement and inadequate capacity of the distribution network are additional causes as described below. This is because even if water is pumped at a high pressure of 2 MPa from the Zebdat pumping station (low water level 625 m); the water supply pressure is low (below 0.2 MPa) in a part of the Hawwara area (altitude 520-580 m) and the eastern part of Irbid City. Had the distribution network been arranged with pipeline of appropriate diameter, water could have been distributed by gravity flow from this reservoir.

- Low capacity of distribution facilities (diameter smaller than required),
- Distribution network is unsuitable for increased population and expansion of urban area. Accordingly, high lift pumps are used with uneconomically high energy loss for areas where demand is high,
- Transmission pipeline, distribution main, branch pipe, and service pipeline are not systematically and properly arranged, and
- Distribution zones have not been divided considering the difference in elevation.

e. Leakage because of deteriorated (aged) pipeline network, particularly consisting of galvanized

iron pipe (GI), and inadequate O&M

Leakage has been occurring all over the project area. The causes of leakage are as listed below.

- Corrosion of GI pipe used in service pipe and small diameter distribution pipe
- Damaged steel pipe
- Inappropriate and low-quality pipe connection
- Inadequate repair of leakage
- Damage due to construction work.

In particular, the distribution network of the Hawwara and Sarieh consists of galvanized pipe laid in the seventies. Deterioration of these pipes is severe and leakage is likely to occur easily.

7) Measures for issues in the Project

In order to improve water supply services and solve the issues mentioned in the previous section 6), the Project is planned with the following policy:

a. Shortage of water resource (shortage in supply amount) and increase in demand due to rapid increase in the influx of Syrian refugees

Measure: Improvement of distribution network with appropriate pipe size

Increase in volume of water resources of the study area is the conditions of the Project, and will be tackled by implementing other projects mentioned in Table 2.3. The facilities with adequate pipe size are planned to meet the water demand in 2020.

b. Elimination of poor water supply areas (optimization of water supply pressure and equalization of water supply quantity)

Measure: Formulation of distribution zone and installation of PRVs

Improper arrangement and inadequate capacity of the distribution network cause lots of poor water supply areas. In order for water supply pressure to be kept at appropriate range, formulation of distribution zone, installation of PRVs and increasing pipe size in replacement are to be carried out in the Project. This also contributes to reducing leakage because of appropriate pressure range.

c. Elimination of no water supply areas

Measure: New pipe installation

Installation of new pipe is proposed in the "urban extension areas" where the town layout has been already planned along with the infrastructure such as roads, electricity supply and so on, designated by the "Greater Irbid Master Plan". Some settlements are already constructed without water supply. For this reason, new pipe will be installed in such area to eliminate no water supply areas.

d. Leakage reduction

Measure: Replacement of aged pipes in Hawwara and Sarieh and optimization of water supply pressure

Aged GI pipe in Hawwara and Sarieh will be replaced with high density polyethylene (HDPE) pipe to reduce the leakage ratio. When replacing the aged pipes, the diameter of the new pipe will be selected so that the pipe can distribute water properly to meet water demand in 2020 as well. Improvement of YWC skills to repair pipe for reduction of leakage was implemented in "Component C" of "the Programme for Urgent Improvement of Water Sector for the Host Communities of Syrian Refugees in Northern Governorates".

8) Distribution facilities in Hawwara and Sarieh corresponding to change of transmission of water

resource

The Project assumes additional water resource amount from the east; firstly by the improvement of the eastern wellfields and secondly by construction of the National Corridor conveying Disi groundwater. Subsequently, additional water will be brought from the west by the Wadi Arab 2nd stage project. Depending on these projects, Hawwara and Sarieh will receive additional water from different reservoirs with distribution methods of pumping or gravity. Accordingly, the proposed distribution pipe in these areas is planned so that distribution network will be utilized regardless of whether it is transmitted from the eastern or the western water resources.

(3) Policy on Natural Conditions

- Care is necessary especially when placing concrete in summer when daytime temperatures are close to 40ºC; quality controls must be properly implemented.
- The geology of the study area shows limestone mixed with gravel (soil) and limestone (soft rock). The ground shows adequate bearing capacity based on geological conditions. According to test boring study results (Appendix XI 11-4), soft rock exists in all sections of the pipe laying route. However, sections at shallow locations (less than 3 m below ground surface) account for about 20% of the water pipe sections, while locations more than 3 m below the ground surface account for the remaining 80% of the sections. Accordingly, 20% along the pipeline length is regarded as soft rock, while the rest is treated as ordinary soil.

(4) Policy on Socioeconomic Conditions

- Water supply rationing is routinely practiced in the study area because of shortage of water resource to supply. The supply time is generally one or two days per week on average although the supply time varies by area. Water demand has grown because of the influx of refugees but the water resource amount has not been increased. As a result, the per capita water supply amount has decreased, and the following have appeared: unsatisfactory water supply has increased to larger areas, and supply time has decreased for the user. The Project aims to increase the water supply amount, eliminate the areas where water supply is poor, and increase the water supply time.
- Such construction methods will be employed in commercial areas and dense residential areas that hindrance to normal living and commercial activities is minimized. Similarly, appropriate construction method will be implemented at roads where traffic is heavy so as not to cause adverse effects on traffic and safety.
- Benefits for the residents in the study area such as employment in construction work and so on, will be considered.

(5) Policy related to Procurement

- Materials and equipment that can be procured in Jordan will be procured in Jordan. Materials and equipment that cannot be procured in Jordan or for which adequate quality cannot be ensured, will be procured from third countries or from Japan. Laborers, materials and equipment will be procured locally as far as possible so as to contribute to the local economy of the project area (see section 2.4.6).

(6) Policies related to Construction Methods and Construction Periods

- Deteriorating conditions of the host communities in water supply because of the influx of refugees must be improved as early as possible; therefore, construction period shall be shortened as much as possible. Since most of the work is pipeline work, simultaneous work in parallel is possible at different work sections. The number of working teams will be increased, the construction period will be set at 2 years, and the year of 2019 will be taken as the year for start

of usage of the facilities. Transmission facilities for Disi groundwater are to be completed by that year.

- Even if the work on the Disi groundwater transmission facilities becomes prolonged, the water amount increased by rehabilitation of the eastern water resource can be conveyed to the Hofa reservoir using the transmission facilities already in use in the northern governorates. Thus, it can be used immediately after the Project is completed, although the increase in amount of water will be partial.
- The work plan of excavation for installation of pipe will be formulated considering minimization of traffic hindrance. Work safety measures will be devised.
- Excavation work for pipeline crossings in trunk roads under the jurisdiction of the Ministry of Public Works and Housing (MPWH) is not permitted. Accordingly, trenchless method will be used. From the view pint of cost reduction, it is recommended that the trenchless method be changed to the open-cut method if the MPWH permits it.
- It is expected to take long periods for obtaining road crossing permissions from the MPWH, causing delay in the entire project. In order to complete the Project within the planed period of 2 years, initiative assistance of WAJ is required.

2.2.2 Basic Plan

(1) Effect Index of the Project

The following effect indices of the Project are defined and the values are fixed.

- Effect index: Value that measures the effect of the Project
- Target value: Value related to the Project taken as target for improvement by YWC
- Reference value: Reference value to measure the effect of the Project since current value cannot be measured but is estimated.

Water pressure is taken as the effect index of the Project and target water pressure is set as shown in Table 2.9. The same locations measured in the study shall be used for evaluation of the effect of the Project; the location map and its information are shown in Figure 2.12 and Table 2.8 respectively.

Table 2.9 Effect Index of the Project in the Study Area

Item	Unit	Current value (2016)	Target value (2020)	Remark
Water supply pressure	MPa	0.11 - 0.50	0.25 – 0.75	Effect index

Table 2.10 Target and Reference Values of the Project in the Study Area

Item	Unit	Current value (*1) (2012)	Target value (2020) (*2)	Remark
Supply amount per capita per day	Lpcd	68	110	Reference value
Water use per capita per day	Lpcd	62 for Hawwara 54 for Sarieh	88	Reference value
Leakage ratio (assumed)	%	23%	20 %	Target value

Note) *1: the data of JICA Water Supply Master Plan
*2: Refer to Table 2.9, 2.10, 2.13

(2) Planning Conditions

1) Planned supply area

Hawwara and Sarieh consisting of 4 zones are studied.

2) Planned service population

The Jordanian population in Hawwara and Sarieh are estimated as shown in Table 2.11 and Table 2.7 respectively. The estimated methods are the same as used in JICA water supply master plan, employing population growth rates of DOS (Department of Statistics) (2% per year) in Irbid governorate. The population growth rates have been decreasing year by year as shown below. Based on this trend, DOS decided to employ 2.0% for the average annual population growth rate of Irbid Governorate to estimate future population.

The average annual population growth rate of Irbid governorate
- 4.8% (1961-1979)
- 4.4% (1979-1994)
- 2.6% (1994-2004)
- 2.2% (2004-2012)

The average annual population growth rate of Jordan
- 2.0% (1994-2004)

The number of Syrian refugees as of 2013 is added to the population in Hawwara and Sarieh on agreement with WAJ, because the number of Syrian refugees is difficult to estimate.

Table 2.11 Planned Population in Hawwara

Year	Population*1,*2	Number of Refugees*3	Total	Note
2012	15,622	-	15,622	Base Year used of the 1st stage grant-aid project
2016	16,920	3,298	20,218	Base Year of the Project
2020	18,333	3,298	21,631	Target Year

Note: *1 Population in 2012 is estimated by Department of Statistics (DOS) based on 2004 census population with annual growth rate of 2% in Irbid governorate.
*2 Population in 2016 and 2020 is estimated at an annual growth rate of 2%
*3 Allocated total number of refugees in Irbid governorate into each area in proportion to area population

Table 2.12 Planned Population in Sarieh

Year	Population	Number of Refugees*3	Total	Note
2012	23,532*1	-	23,532	Base Year used of the 1st stage grant-aid project
2016	25,486*2	4,968	30,454	Base Year of the Project
2020	27,615*2	4,968	32,583	Target Year

Note: Same note as in Table 2.11 is applied.

Planned service population by Zone in the target year 2020 is estimated based on the current household numbers of each zone using population of Hawwara and Sarieh above.

Table 2.13 Planned Service Population by Zone in the target Year 2020

Area	Zone	Numbers of households (2016)	Population	Remark
Hawwara	Zone 1	967	10,008	= 21,631 x 967/2,090
	Zone 2	1,123	11,623	= 21,631 x 1,123/2,090
	Total	2,090	21,631	
Sarieh	Zone 3	292	6,333	= 32,583 x 292/1,502
	Zone 4	1,210	26,250	= 32,583 x 1,210/1,502
	Total	1,502	32,583	

3) Planned daily per capita water consumption

Planned daily per capita water consumption is given below, based on the planned values in the “Water Reallocation Strategy 2010” of MWI. WAJ has been using 1.5 to 2.0 as the hourly peak factor, although

this figure varies depending on projects. For the Project, 1.5 will be used as the minimum required limit.

Table 2.14 Planned Daily Per Capita Water Consumption

S.N.	Item	Rural area (Bait Ras, Hawwara)
1	For Domestic water (Lpcd)	80
2	For commercial use	3% of water for domestic use
3	For industrial use	2% of water for domestic use
4	For tourism use	-
5	For emergency use	5% of water for domestic use
6	**Daily average water consumption (Lpcd)**	88
7	Seasonal variation coefficient	1.17 (on daily average water consumption)
8	**Daily maximum water consumption (Lpcd)**	103
9	**Hourly peak factor**	1.50 (on daily maximum water consumption)
10	**Hourly maximum water consumption (Lpcd)**	155 (=155/24=6.438 L/capita/h)

Source: Water Reallocation Strategy 2010, Ministry of Water and Irrigation

4) Planned non-revenue water ratio and planned leakage ratio

The planned non-revenue water (NRW) ratio and planned leakage ratio are shown in Table 2.15. The planned NRW ratio in 2020 (40%) employs the target value of "Water Strategy of Jordan in 2022". This value can be considered to be achieved comparing with the value of 43% of Irbid 2013. The planned leakage ratio is determined as 20% using half the planned NRW ratio, which is frequently used in Jordan. This value is also the same as the target value in "Water Reallocation Strategy 2010". Although it is true that the NRW ratio and the leakage ratio cannot be improved easily, the national target values are used in the Project.

Table 2.15 Planned NRW Ratio and Planned Leakage Ratio in Hawwara and Sarieh

Index	2020	Remarks
Non-revenue water (NRW) ratio (%)	40	Target value of "Water Strategy of Jordan in 2022" is applied.
Planned leakage ratio (%)	20	Target value of "Water Reallocation Strategy 2010 of MWI" is applied.

5) Planned average daily water supply

Planned average daily water supply is estimated as follows using daily average water consumption in Table 2.14, planned leakage ratio in Table 2.15 and planned service population in Table 2.11 and Table 2.12.

Table 2.16 Planned Average Daily Water Supply

Item	Formula	Hawwara	Sarieh	Remarks
Daily average water consumption (Lpcd)	A	88		Table 2.14
Planned leakage ratio (%)	B	0.2（20%）		Table 2.15
Daily average water supply (Lpcd)	C=A/(1-B)	110		
Planned service population (person)	D	21,631	32,583	Table 2.11, Table 2.12
Planned daily average water supply (m^3/day)	C x D / 1000	2,379	3,584	

6) Planned maximum hourly water supply

The planned maximum hourly water supply is given in the table below using the planned leakage ratio and planned daily per capita water consumption.

Table 2.17 Planned Maximum Hourly Water Supply

Item	Formula	Hawwara	Sarieh	Remarks
Per capita maximum hourly water consumption (L/capita/h)	A	6.438		Table 2.14
Planned leakage ratio (%)	B	0.2（20%）		Table 2.15
Per capita maximum hourly water supply (L/capita/h)	C=A/(1-B)	8.0475		
Planned service population (person)	D	21,631	32,583	Table 2.11, Table 2.12
Planned maximum hourly water supply (m^3/h)	C x D / 1000	174	262	

7) Water balance between planned average daily water supply and possible water supply

Water balance between planned daily water supply and possible water supply in the target year 2020 can be checked on an annual average basis.

a. Possible water supply

Possible water supply in Hawwara and Sarieh is estimated using the data of JICA water supply master plan. The JICA water master plan estimates the water demand in 2035 of the northern governorates, Hawwara and Sarieh. The water demand of 118 MCM/y of the northern governorates is almost equal to the possible water supply 121 MCM/y of Case B after year 2020. Using this ratio, possible water supply in Hawwara and Sarieh is assumed as shown in Table 2.18.

Table 2.18 Possible Water Supply

Item	Northern Governorates (MCM/y)	Hawwara (Zones 1 &2) (m^3/day)	Sarieh (Zones 3 & 4) (m^3/day)	Remarks
Water demand in 2035	118	2,574	3,876	(A) JICA water supply master plan
Current (up to 2018)	72	1,635	2,365	= (A) x 72/118
Case A (2018-2020)	91	1,985	2,989	= (A) x 91/118
Case B (after 2020)	121	2,639	3,975	= (A) x 121/118

b. Water balance

Possible water supply is 1.11 times as much as the required amount of planned daily average water supply in the target year 2020.

Table 2.19 Water Balance between Planned Average Water Supply and Possible Water Supply

Item		Hawwara	Sarieh	Remarks
Planned daily average water supply (m^3/day)	(A)	2,379	3,584	Table 2.16
Possible water supply (m^3/day)	(B)	2,639	3,975	Table 2.18
Result	(B) / (A)	1.11 → satisfied	1.11 → satisfied	

8) Planned water supply pressure

According to the WAJ guideline, effective water pressure is targeted between 0.25 and 0.75 MPa. Due to large difference in elevation in the study area, it is considerably difficult to meet these criteria for the whole area. The minimum pressure of 0.25 MPa must be kept. However, some depression area is allowed to exceed the maximum pressure of 0.75 MPa, otherwise the facilities is inclined to be excessive and noneconomic design. However, even in this case, the maximum pressure should not be higher than 1.0 MPa (100 m water head).

(3) Plan of distribution facilities

The distribution facilities are planned to meet the water flow to the project area in Case A and Case B.

1) Distribution zone in Case A

Land elevation difference in Hawwara and Sarieh is of about 100 m (El+510 – 610) at maximum. In order to equalize water pressure as much as possible, the target area is divided into 4 zones based on the land elevation and considering roads and existing distribution network. The boundary between Hawwara (Zone 1 and 2) and Sarieh is set as the Petra road that connects Irbid center and Ramtha, and has a lot of traffic. The boundary between Zone 1 and Zone 2 in Hawwara is set as the Sarieh road.

There is 50 m land elevation difference in Sarieh; its elevation ranging from EL+610 in the southwestern corner to EL+560 in the north area. The southwestern area is located near the existing distribution main via Hoson from Hofa reservoir, while the northwest area is located near the branch pipe of 400mm in diameter from the Hofa-Bait Ras distribution main that is being constructed under the 1st stage grant-aid project. Considering such topographic features and hydrological conditions, Sarieh is divided into two zones; Zone 3 and Zone 4. The boundary between Zone 3 and Zone 4 in Sarieh is defined, considering primarily land elevation and secondly relatively arrangement of large road for easy confirmation of the boundary from the viewpoint of maintenance. The defined boundaries of zones, inlet of water supply to Hawwara and Sarieh in Case A and distribution pipes are shown in Figure 2.3.

Figure 2.13 Water Supply Zones and Inlet of Water Supply to Hawwara and Sarieh (Case A)

2) Distribution zone in Case B

According to JICA water supply master plan, the water supply area of Irbid will be reorganized into 3 water supply zones as follows, and DMA are planned within each water supply zone for equal water supply.

- Zebdat Reservoir, Zebdat Gravity Zone
- Zebdat Reservoir, Zebdat Pump Zone
- Hofa Reservoir, Hofa Gravity Zone

Zones 1 to 4 are set in the planning of the Case A, which are able to be functionally regarded as a DMA. In the master plan, Hawwara corresponding to Zones 1 and 2 will belong to DMA GR04 (Zebdat Reservoir, Zebdat Gravity Zone), and Sarieh corresponding to Zones 3 and 4 will belong to

DMA P02 (Zebdat Reservoir, Zebdat Pump Zone) (see Table 2.20, Figure 2.14). For the Case B, DMA according to the master plan will be applied.

Water is distributed to Zones 1 and 2 from the branch pipe same as Case A from Zebdat reservoir by gravity, while water is conveyed to the western Sarieh using the pump at Zebdat reservoir and distributed to Zones 3 and 4. The defined boundaries of zones and inlet of water supply to Hawwara and Sarieh in Case B are shown in Figure 2.4.

Table 2.20 DMA Allocation Plan in Irbid Urban Area

Water Source	Main DMA	Sub DMA	Hawwara and Sarieh
Zebdat Reservoir	Zebdat Gravity Zone	Zebdat_Gr_01	
		Zebdat_Gr_02	
		Zebdat_Gr_03	
		Zebdat_Gr_04	Hawwara (Zone 1 and 2)
		Zebdat_Gr_05	
	Zebdat Pump Zone	Zebdat_P_01	
		Zebdat_P_02	Sarieh (Zone 3 and 4)
Hofa Reservoir	Hofa Gravity Zone	Hofa_Gr_01	
		Hofa_Gr_02	

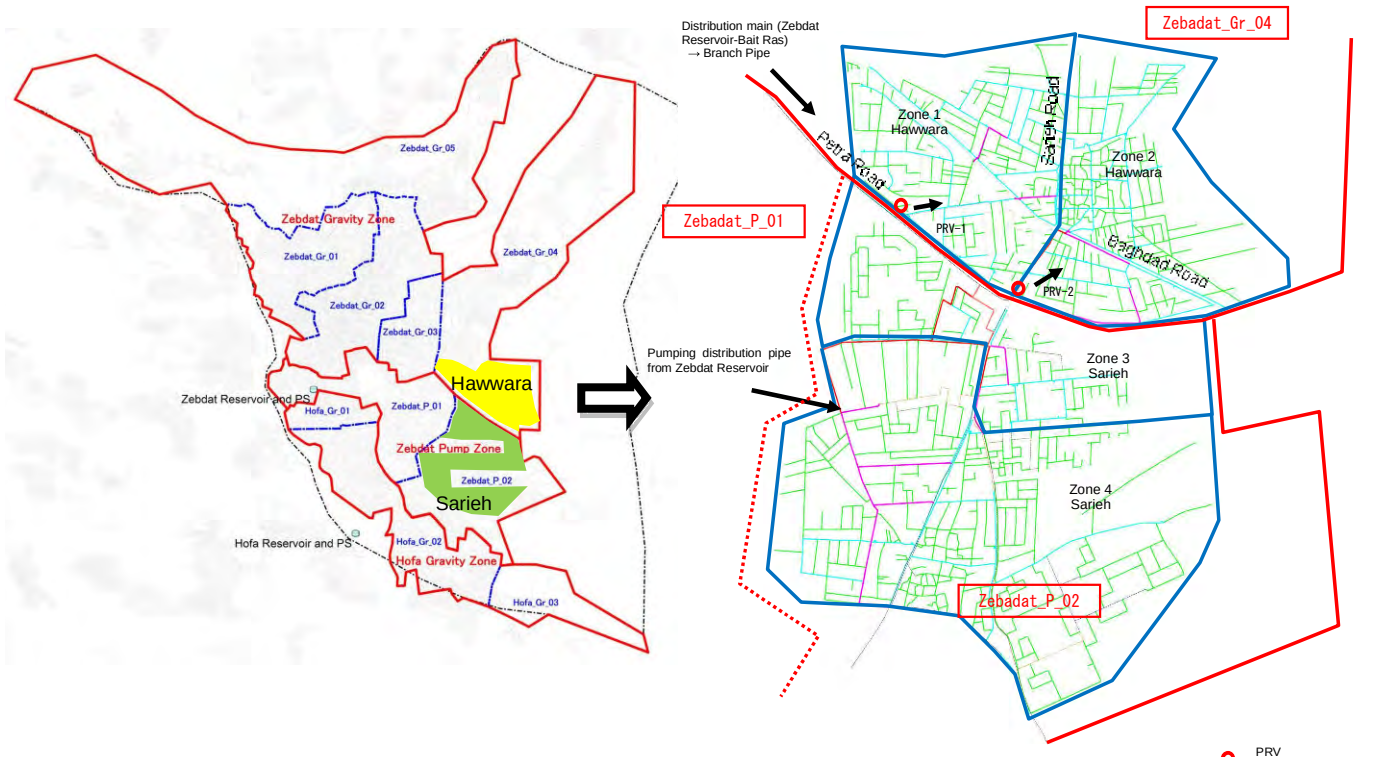


Figure 2.14 Water Supply Zones and Inlet of Water Supply to Hawwara and Sarieh (Case B)

3) PRV (Pressure Reducing Valve) Plan

PRVs are used for reducing excessive upstream pressure (primary pressure) and maintaining the downstream pressure (secondary pressure) in the designated pressure range. Pressure reducing valves have been already installed in Hawwara in the 1st stage grant-aid project. In the 1st stage grant-aid project, installation of pressure reducing tanks was considered from viewpoint of the advantage of few troubles even though the cost of land acquisition and construction is high. However, the type of PRVs widely used in Jordan was finally adopted due to difficulties in land acquisition and longer period

required for land acquisition for pressure reducing tanks.

For reducing the troubles, the PRVs are equipped with accessories like a by-pass pipe, safety valve, and a strainer, same as WAJ's existing practices. Therefore, PRVs are also planned to be installed in Sarieh in the Project.

Hawwara (Zone 1 and 2)

In Hawwara, PRVs are required in Case A, in which the water is distributed from Hofa reservoir. The difference between the high water level of Hofa reservoir (EL+790 m) and land elevation of Hawwara (EL+510~570m) is 220~280 m. From this reason, the PRVs were installed at two locations of the distribution main to Bait Ras in the 1st stage grant-aid project. In addition, the PRVs were installed at the inlet of Zones 1 and 2; PRV-1 for Zone 1 and PRV-2 for Zone 2 (see Figure 2.15).

The secondary pressures of the PRVs are set at 52 m for Zone 1 and 45 m for Zone 2, at the same elevation of EL+565 m for both PRVs, based on network analysis results.

In Case B, water supply source will be changed to Zebdat reservoir by gravity. In this case, pressure reducing is unnecessary because the high water level of Zebdat reservoir is only EL+631m.

Sarieh (Zone 3 and 4)

In Case A, water is distributed to Zone 3 in the same way as Zones 1 and 2 through the Hofa– Bait Ras distribution main by reducing pressure using two PRVs. In contrast, water is distributed to Zone 4 from the existing distribution main of 300 mm diameter via Hoson. The difference between the high water level of Hofa reservoir (EL+790 m) and land elevation of Zone 4 (EL+574~610 m) is 216 m at maximum. The Project plans the installation of two PRVs at the inlet of Sarieh. From network analysis, the secondary pressures of the PRVs are set at 60 m for PRV-3 (EL+596 m) and 40 m for PRV-4 (EL+607 m).

4) Network analysis

Network analysis are conducted for both Cases A and B. The network model covers all 4 zones and includes every distribution pipe of 63 mm and above in diameter. The conditions of network analysis are as below and network model is shown in Figure 2.15.

- Program: EPANET (open code program published by EPA; United States Environmental Protection Agency)
- Algorithm: Node energy potential method, Multi reservoirs application
- Formula: Hazen-Williams Formula
- C value: 110
- Flow Case: Hourly maximum flow
- Selection of pipe diameter: Pressure range from 0.25 to 0.75 MPa. However, it is allowed that the maximum water pressure exceeds 0.75MPa in a part of the study area. Even in such case, the maximum pressure should not be higher than 1.0 MPa (100m).

a. Network Model

The network model and PRV locations are shown in Figure 2.15.

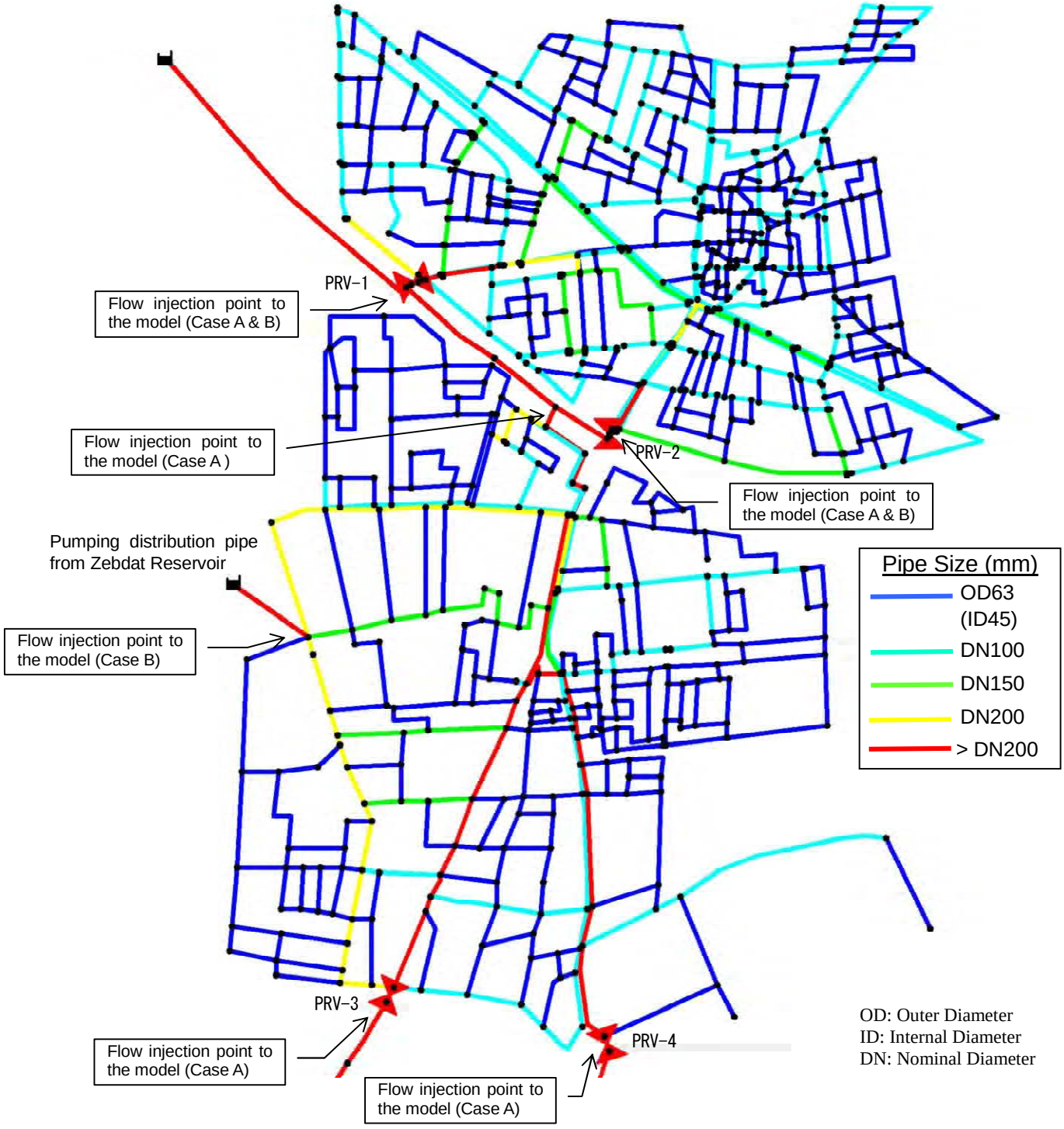


Figure 2.15 Network Model and PRV Location

b. Analysis Result

The dynamic water pressures under the hourly maximum water demand are presented in Figure 2.16 for Case A and in Figure 2.17 for Case B. The dynamic water pressures for both cases are within the designated values with some peripheral points exceeding the designated maximum value of 0.75 MPa. The layout and diameters of distribution pipes are the same for both cases.

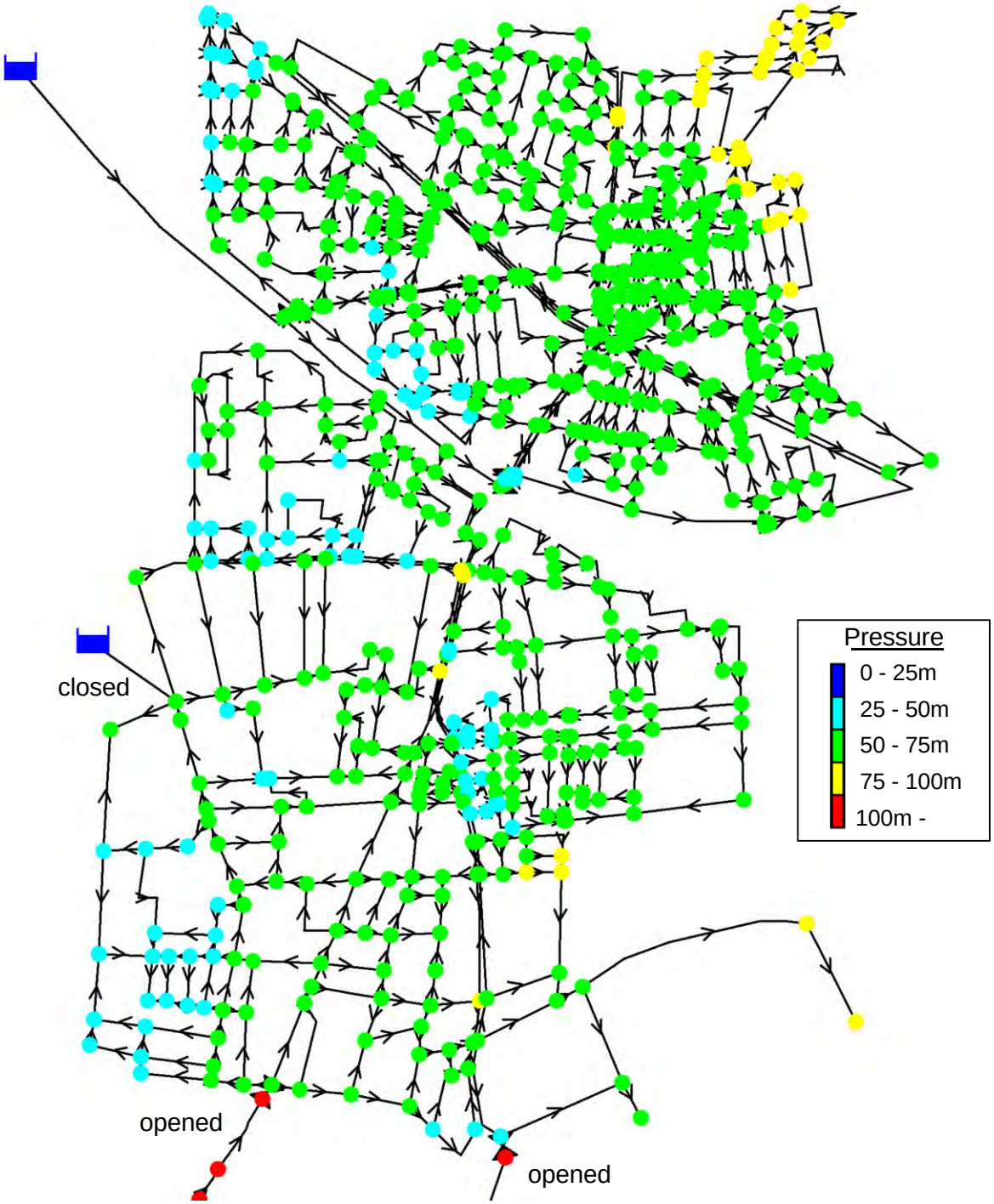


Figure 2.16 Estimated Dynamic Water Pressure Distribution (Case A)

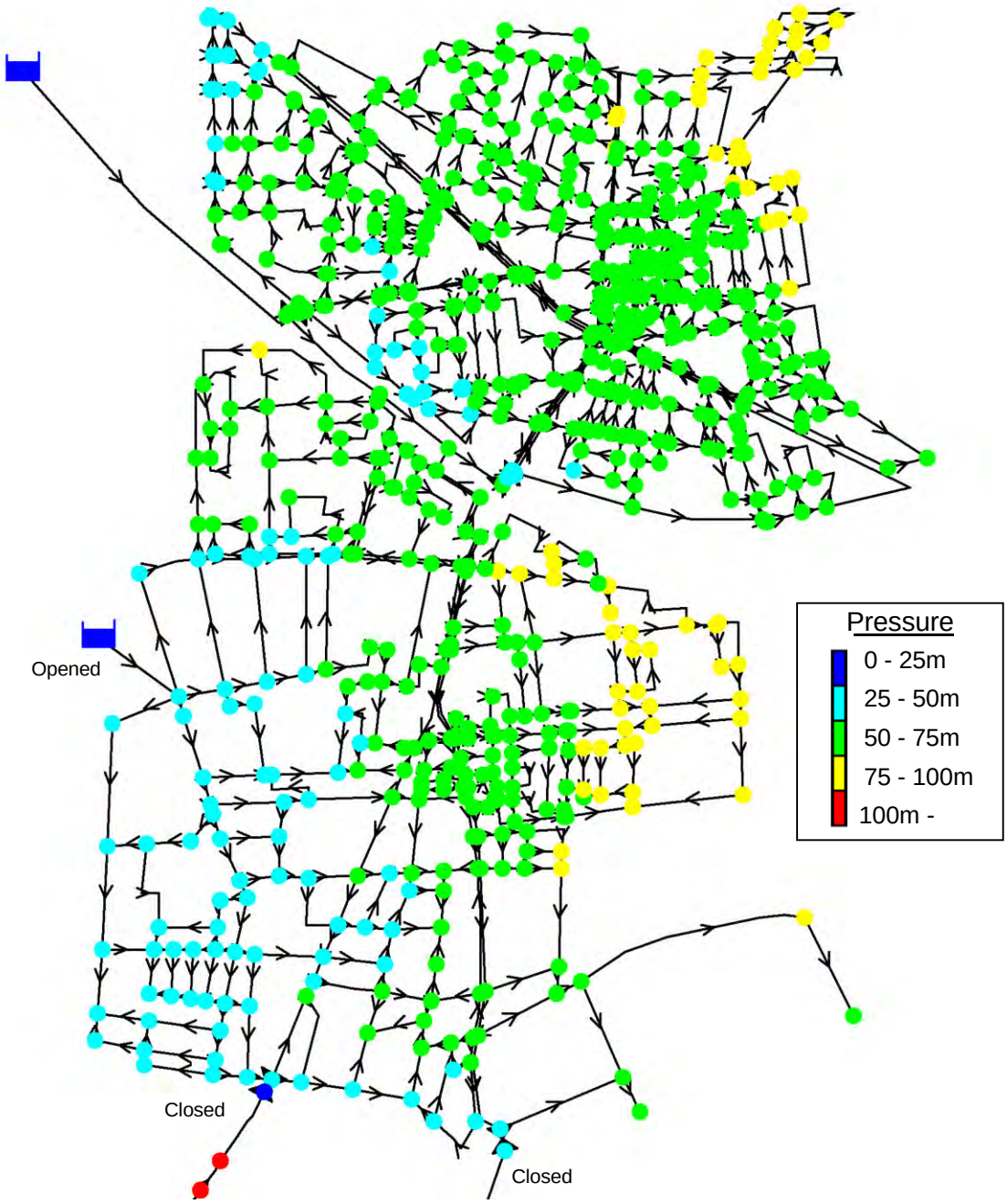


Figure 2.17 Estimated Dynamic Water Pressure Distribution (Case B)

5) Design water pressure

Setting of design water pressures is different in Case A and Case B because the way of water distribution is different in these cases. Therefore, higher design water pressure is to be set as the design water pressure for the study area by comparing both pressures. Design water pressure is defined in Table 2.21 for each water distribution way.

Table 2.21 Design Water Pressure for Water Distribution Way

Water Distribution Way	Design water pressure
By gravity	Hydrostatic pressure + Water hammer pressure (in the case of quick closing of all valves in the target network)
By pumping	Pump shut-off pressure or Water hammer pressure occurred in the case of power loss due to electricity failure

a. Case A

Case A is gravity flow system to Zones 1, 2 & 3 from Hofa reservoir through the distribution main toward Bait Ras, of which HWL is +790m. This practice will be continued up to 2019. The hydrostatic pressure will reach 280m in some areas of the Zones exceeding the allowable pressure of HDPE pipe of Grade PN25. One of the alternative pipe materials is DCIP, which is costly but used for pipes of DN 100mm or larger in WAJ.

For providing appropriate service pressure, pressure reducing valves (PRVs) were already installed under the preceding Japanese grant project. As far as such PRVs are properly functioning, hydrostatic pressure in Zones 1, 2 & 3 will be suppressed to allowable level to HDPE pipe. (See Figure 2.18 and Figure 2.19)

Considering risks of malfunctioning PRVs, subsequently subjecting the HDPE pipe to exceedingly high hydrostatic pressure, and potential leakage/burst incidents, in comparison to cost consequence, WAJ accepted use of HDPE pipe of PN25 instead of DCIP of K9 grade. (Refer to Table 2.22 for design water pressures.) Although such high pressure will be generated during the short transition period (2018 – 2019), YWC has to service PRVs properly for minimizing risks mentioned above.

As for Zone 4, maximum hydrostatic pressures are to remain within the range of 180 – 216m. Thus the design pressure will be 241m for HDPE, of which Grade PN25 is found applicable. Zone 4 will have two PRVS in parallel for controlling service pressure.

For comparative study of design pressure and pipe material, refer to Appendix XI 11-6 and 11-7.

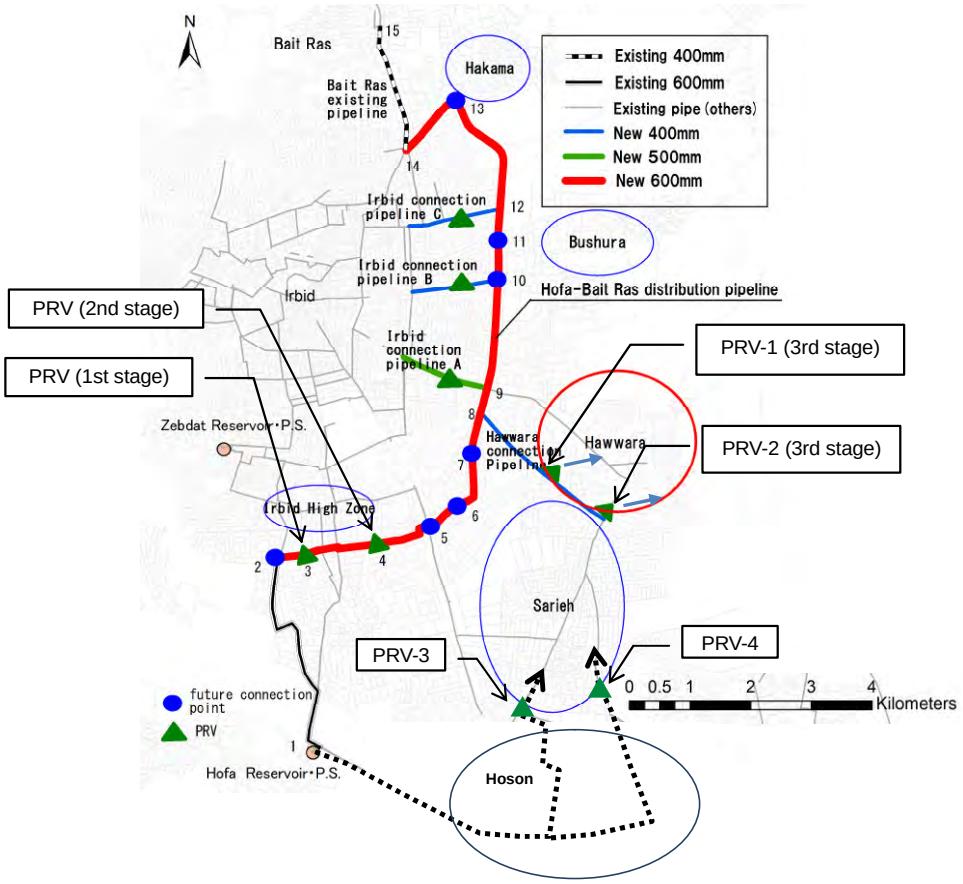


Figure 2.18 PRVs Arrangement

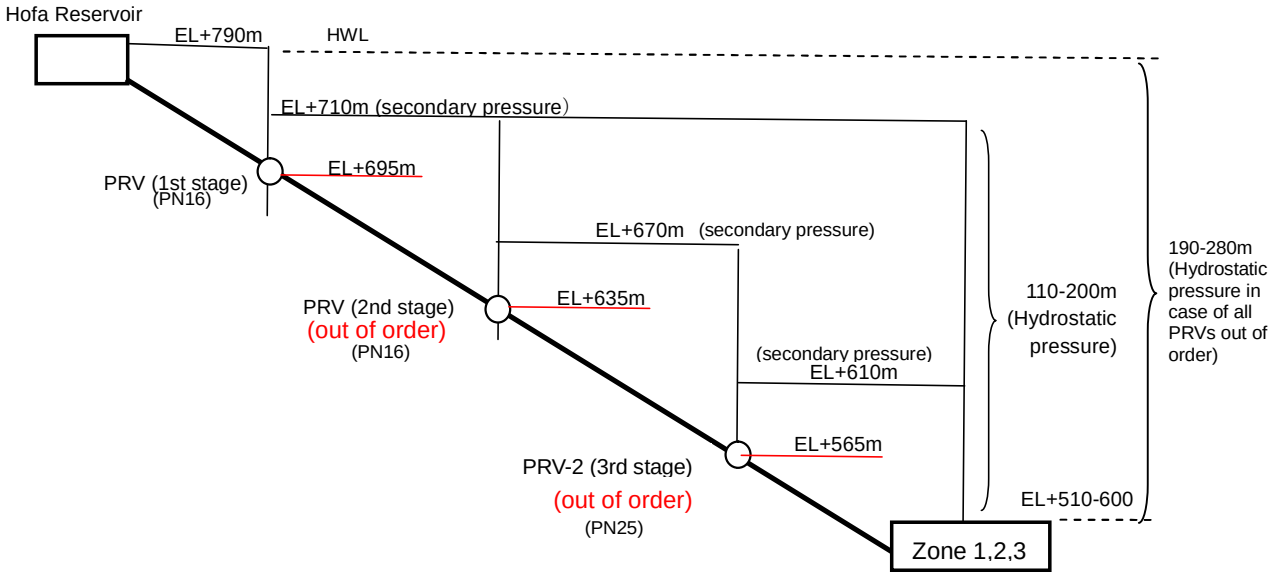


Figure 2.19 Hydrostatic Pressure when Two PRVs are Out of Order

Water hammer pressures are set as 55 m for ductile cast iron pipe and 25 m for HDPE pipe based on the Japanese design guidelines of Design Criteria for Waterworks Facilities 2012. Accordingly, the design water pressures for Case A are shown in Table 2.22.

Table 2.22 Design Water Pressure Range (Case A)

Zone	Base water Level	Land Elevation	Hydrostatic Pressure Range	Design Water Pressure Range (Hydrostatic Pressure + Water Hammer Pressure [3)])	
				DCI Pipe	HDPE Pipe
Zone 1 & 2	EL+710m [1)]	EL+510-570m	140 - 200m	195-255m	165-225m
Zone 3		EL+560-600m	110 - 150m	165-205m	135-175m
Zone 4	EL+790m [2)]	EL+574-610m	180 - 216m	235-271m	205-241m

Note) 1) Secondary pressure of the PRV at 1st stage
2) HWL of Hofa reservoir
3) 55 m for Ductile Cast Iron (DCI) pipe, 25 m for HDPE pipe

b. Case B

Zones 1 and 2 are to be incorporated in the gravity DMA from Zebdat reservoir, and the design water pressures of these zones are set at the hydrostatic pressures and water hummer from Zebdat reservoir. The range of design water pressures is shown in Table 2.23.

Table 2.23 Design Water Pressure Range of Zone 1 and 2 (Case B)

Zone	Base water Level	Land Elevation	Hydrostatic Pressure Range	Design Water Pressure Range (Hydrostatic Pressure + Water Hammer Pressure [2)])	
				DCI Pipe	HDPE pipe
Zone 1 & 2	EL+631m [1)]	EL+510-570m	61 - 121m	116-176m	86-146m

Note) 1) HWL of Zebdat reservoir
2) 55 m for DCI pipe, 25 m for HDPE pipe

Water is distributed to Zone 3 and Zone 4 from Zebdat reservoir by pumping. The distribution main will connect with the network in Zone 4, and the design water pressure can be set at the shut-off pressure of the pump or water hammer pressure when electricity fails. The water hammer pressure becomes highest just behind the pump outlet of the distribution main, and gradually drops with a distance away from the pump. Water hammer calculation provides water pressure elevation of EL+708 just behind the pump. This shows a significant impact on the distribution main but a little impact on the water supply zones. Therefore, the shut-off pressure is set as the design water pressure in this design. The shut-off pressure is estimated at 1.33 times (generally used value) as high as the rated pressure, and the base water level is set at EL+698m as shown in Figure 2.20.

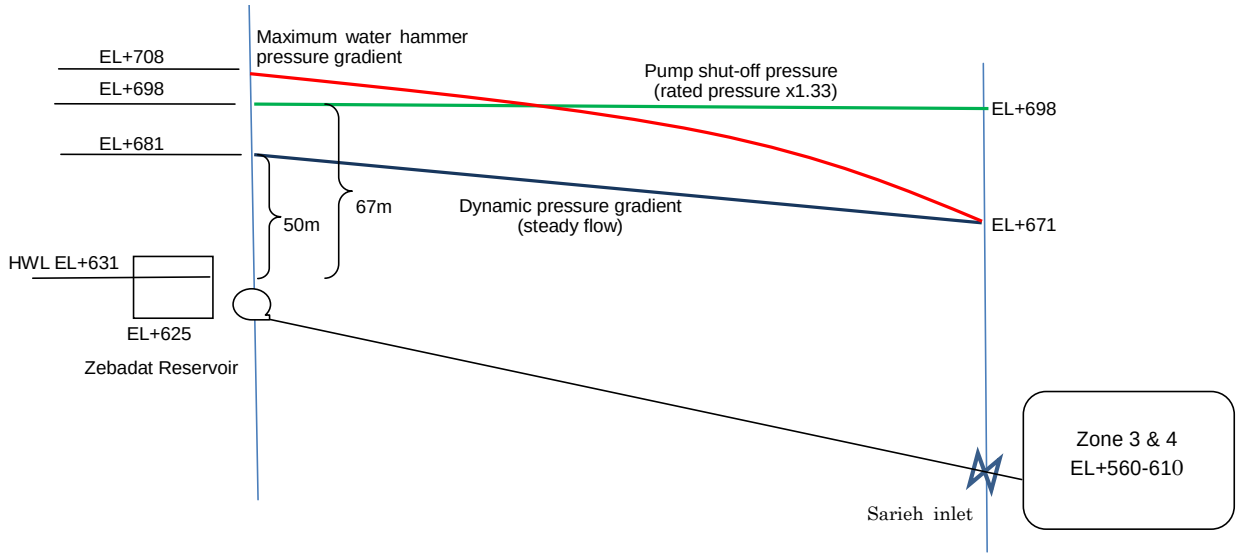


Figure 2.20 Water Pressure of Pump Operation

Consequently, the design water pressures for Zone 3 and 4 are shown in Table 2.24.

Table 2.24 Design Water Pressure Range of Zone 3 and 4 (Case B)

Zone	Base Water Level	Land Elevation	Design Water Pressure Range
Zone 3 & 4	EL+698m [1)]	EL+560-610m	88 - 138m

Note) 1) during pump shut-off operation

c. Setting of design water pressure

As discussed in the previous sections, the design water pressures for Case A and Case B are summarized in Table 2.25.

Table 2.25 Design Water Pressure

Zone	Case A		Case B	
	DCI Pipe	HDPE Pipe	DCI Pipe	HDPE Pipe
Zone 1 & 2	255m (2.55MPa)	225m (2.25MPa)	176m (1.76MPa)	146m (1.46MPa)
Zone 3	205m (2.05MPa)	175m (1.75MPa)	138m (1.38MPa)	
Zone 4	271m (2.71MPa)	241m (2.41MPa)		

6) Pipe Type

Among pipes available, pipe types to handle the design water pressure mentioned above are steel pipe, ductile cast iron (DCI) pipe and high density polyethylene (HDPE) pipe. DCI pipe with anti-corrosion measure is adopted for 100 mm diameter or bigger pipes and HDPE pipe is adopted for smaller than 100 mm diameter. In addition, concrete blocks, restraint joints or their combined uses are adopted.

(4) Conceptual design of distribution pipeline

Distribution pipeline is designed according to the following policies:

- The planned pipe routes will be shown in Figure 2.9.
- DCI pipe is selected. It has good strength, durability, and shock resistance. It has also good flexibility so that it can withstand movement in the ground. In addition, it is generally used in Jordan for pipe diameters of 100mm and above. Specifications of DCI pipe will conform to ISO 2531 (K-9 pipe). The allowable water pressure of K-9 pipes is as follows.

Pipe Diameter	Allowable pressure (MPa)
DN150 and below	6.4
DN200	6.2
DN300	4.9

- HDPE pipe with following specifications is adopted below 100 mm inside diameter.

Standard:	ISO4427
Pressure rating:	PN25
Material:	PE100
Outer diameter:	63 mm

- Buried pipe criteria will conform to Jordan's standards (WAJ, Ministry of Public Works and Housing (MPWH) standards for national road and Irbid municipality for municipality road). Basically, buried pipe criteria will conform to the organization's standard, which has jurisdiction of the road, and the WAJ's standard is taken as reference.

  National road (MPWH standard)
  - Along the paved road

- Crossing the paved road

Municipality road (Irbid city standard)
- Along the paved road
- Crossing the paved road
- Along the unpaved road (natural road, gravel road of old city, tiled side walk)
- Double pipes for the paved road
- Double pipes for the unpaved road

- Air valves, blowoffs and drain valves will be installed at required locations according to the pipe route profile, and isolating valves will be installed at the required locations for O&M. In principle, isolating valves will be installed at 1 to 2-km interval in straight line sections.
- To satisfy the water supply pressure indicated in the design conditions, pressure-reducing valves will be installed at the required locations.
- Because excavation of national roads under the jurisdiction of MPWH is not permitted, trenchless construction method will be basically used for road crossing of pipes. The Project uses the lead-pipe jacking method because of its low-cost and appropriateness for soil features. However, it is better from view point of cost reduction to change from the trenchless method to the open-cut method if it is approved by the MPWH.

Table 2.26 Feature of Trenchless Method

Method	Feature	Sleeve Pipe Diameter
Hand excavated jacking method	Manual excavation and pipe jacking	800mm or larger
Micro-tunneling method	Machine excavation and pipe jacking	smaller than 800mm

(5) Utilization of the recently laid pipes

YWC has laid some new pipes and replaced old pipes in the study area to some extent. Of these, DCI pipe installed after 2007 can be used; however, steel and GI pipes are to be replaced. In addition, Polyethylene (PE) pipe is also to be replaced because of allowable pressure difference. The existing PE pipes are of PN16 while the proposed HDPE pipe is of PN25.

(6) Selected area for the Project

The length and diameter of pipes is calculated for Zones 1 to 4 based on the network analysis results. Because it is difficult to include all the zones due to the limited budget, the zones 1 to 3 are considered as the project scope, and the project cost is estimated. The following is the selection criteria of the project scope.

① Hawwara is given high priority of improvement of network because of its low water pressure and lots of aged pipes followed by Sarieh.

② The 1st stage grant-aid project selected the project area on the basis of area near the newly constructed Hofa-Bait Ras distribution pipes. The Project adopts the same criteria.

③ The priority is set in the order of Zone 1, Zone 2, Zone 3 and Zone 4.

(7) Conceptual Design of PRV (Pressure Reducing Valve)

The equipment and accessories as shown in Table 2.27 are installed to minimize the frequency of PRV troubles as much as possible. A strainer is installed for preventing foreign objects from getting into the valve body, and a safety valve is installed in the case when downstream pressure rises over the planned set value. A bypass pipe is also installed for the maintenance of PRV. During its maintenance, water can flow through bypass pipe. The following equipment and accessories shall be installed for every PRV.

Table 2.27 Equipment and Accessories of Pressure-Reducing Valve

Accessory equipment and accessories of pressure-reducing valve	No.	Installation location	Remarks
Strainer	1	Upstream of PRV	Same diameter as that of PRV
Sluice valve (for O&M of PRV)	2	Upstream/downstream of PRV	Same diameter as that of PRV
Sluice valve (for bypass pipe)	1	Bypass pipe	Same diameter as that of bypass pipe (80 mm)
Safety valve	1	Downstream of PRV	
Air valve	2	Upstream/downstream of PRV	
Pressure gauge	2	Upstream/downstream of PRV	
Bypass pipe	1	Parallel to PRV	Diameter 80 mm

2.2.3 Outline Design Drawing

Outline design drawings are listed below (refer to Appendix XI 11-8).

Outline design drawing list

Drawing No.	Drawing Title	Quantity
1	Zone Division Plan	1
2	Zone 1 General Site Plan	1
3	Zone 2 General Site Plan	1
4 - 5	Zone 3 General Site Plan (1) (2)	2
6	Typical Trench Cross Section for Pipeline in the Road under MPWH	1
7 - 8	Plan of Secondary Distribution Pipeline (Zone 1) -1 & 2	2
9 -11	Plan of Secondary Distribution Pipeline (Zone 2) -1 to 6	3
12 - 14	Plan of Secondary Distribution Pipeline (Zone 3) -1 to 6	3
15 - 17	Structural Drawing of Chamber 1, 2, 3	3
18	Plan of Jacking Method	1
19 - 23	Pipe Arrangement (BJM-1,2,3, PJM-1, SJM-4)	5
24 - 28	Jacking Method (BJM-1,2,3, PJM-1, SJM-4)	5
29- 32	Zone 4 General Site Plan (1) (2) (3) (4)	4
Total		32

2.2.4 Implementation Plan

This section is prepared on the premise that the Project will be implemented by the Japanese grant-aid although it is not determined yet.

2.2.4.1 Implementation Policy

(1) Project Implementing Agency

The organization responsible for the Project is the Ministry of Water and Irrigation (MWI). The WAJ will take up the role of the organization implementing the Project under this Ministry and the operation and management after completion of the facilities will be done by Yarmouk Water Company (YWC).

(2) Consultant

The Japanese consultant company will conclude an agreement with the project-implementing agency of the Government of Jordan, and will perform the detailed design and work supervision. The Consultant will also prepare the tender documents, and assist in the examination of the tenderer's qualifications and the tendering work for selecting the Contractor by open tender. After the start of construction of the facilities, the Consultant will supervise the construction from an objective standpoint and also ensure that the grant-aid is being appropriately utilized.

(3) Contractor

In accordance with the framework of Japan's grant-aid scheme, the Japanese contractor selected through open tendering will carry out the construction of facilities according to the construction plan. As the construction work is to be performed at a remote site quite different from the social environment and social background in Japan, the Contractor is required to possess adequate capability to complete the work overseas. Furthermore, since this plan requires the use of locally-procured materials and equipment, and work in congested urban areas, the Contractor shall be adequately aware of the local market, local labor laws, the geography of the place, and the local customs and acceptable practices. The Contractor will maintain a proper communication system even after handing over the facilities after completion of the Project since after-sales services such as response to breakdowns and procurement of replacement parts will be necessary during operation and maintenance.

(4) Local Constructor

The JICA study team met two local constructors in Irbid, who have experience of the water supply works. The two constructors are small companies with approximately 20 employees each. They usually use construction machines and equipment by accommodating the need of each other according to works volume. The two constructors confirmed that they conduct pressure tests under YWC supervision after water pipe laying works in consideration of quality control. However, as the construction work volume of the 2nd stage grant-aid project amounts to several tens km, nearly ten such small constructors are needed to complete the Project within construction period of two years. This causes the difficulty of quality control, schedule control and safety control. Therefore, it is desirable that few relatively large-scale constructors in Amman be selected as subcontractors.

2.2.4.2 Implementation Conditions

(1) Construction of Distribution Pipeline

The routes for laying the pipeline include main roads and service roads where the traffic frequency is high; thus, safety measures, measures against effects of traffic on the third-parties, and measures against existing buried objects, especially underground high voltage cables, will become important. Considerations are necessary for preventing any adverse effects on the activities of the local businesses as far as possible.

The works will be carried out by replacing the existing pipe with the same pipe diameter and laying new pipe with adequate pipe diameter different from the existing pipe, and the work of service pipe will be done by Jordanian side. The connection work with the existing pipe needs to be done during other days except for water supply days not to adversely affect people; in addition, construction schedule of service pipe needs to be discussed. It is needed that the whole work will not adversely affect the water supply service.

Road crossing pipe laying works of national roads under the Ministry of Public Works and Housing (MPWH) need to use trenchless methods. However, it is desirable that trenchless methods be changed to open-cut methods if MPWH permits it from the viewpoint of cost saving. Pipe laying works at municipality roads using open-cut methods, needs to be carried out during night time considering the activities of the local businesses for busy roads, and during daytime for not busy roads.

(2) Procurement of materials

Basic materials, such as cement, aggregate and reinforcement bars, etc. are available and can be procured in the local markets. However, ductile cast iron pipe is not possible to be procured in the local markets; thus, it should be imported from Japan and/or the other OECD member countries or Japan.

Basic labor force and construction machines can be procured in the local markets. However, the contractors which have ability to meet the specifications and quantity of the Project are based in Amman. Therefore, the procurement of engineers and construction materials is assumed to take place in Amman.

(3) Prompt process of tax exemption procedure

In order to exempt the tax in Jordan, the cabinet letter to implementing agency of the Project is necessary. The acquisition procedure of the cabinet letter on the tax exemption, necessary when the Project starts, is as follows.

WAJ → Ministry of Planning → the Cabinet → Ministries concerned (Ministry of Public Works and Housing, Ministry of Interior Affairs, Ministry of Finance) →the Cabinet → Ministry of Planning → WAJ

The Cabinet letter refers to a duty tax and other taxes such as VAT (Value Added Tax). The Contractor will submit the applications for tax exemption attached with the cabinet letter to the related authorities. According to the Contractor of the 1st stage grant-aid project, it took too much time to get the cabinet letter. The request letter for issuance of the cabinet letter referred to the contents of the contract between WAJ and the Contractor. The delay of issuance of the cabinet letter may cause the delay of the Project due to the delay of arrival of construction materials and equipment at site.

For the Project, the procedure is required to be promptly proceeded between the both governments or JICA and WAJ to keep implementation schedule. The sample of these documents in 1st stage grant-aid project is given in Appendix XI 11-2. In addition, the letter of commencement of construction works should be promptly issued from the Contractor because the Contractor has to get the cabinet letter after the construction starts.

(4) Prompt acquisition of road use permission

As the pipes will be laid under the roads, road use permissions are needed from the related authorities when the work starts. There are two kinds of roads; the national road and the municipality road under the jurisdiction of MPWH and Irbid city, respectively.

For the pipe laying works along the national roads, MPWH requires the Contractor to pay the bank bond against road pavement recovering works. In the tendering of the grant-aid project in July 2016, "the Project for Rehabilitation and Expansion of the Water Networks in Balqa Governorate", WAJ issued the letter that WAJ guarantees the bank bond. For the 1st grant grant-aid project, WAJ also issued the letter that WAJ guarantees the bank bond. The Project will proceed in a similar manner to prevent the delay of permission. The sample of the related documents in the 1st stage grant-aid project is given in Appendix XI 11-2.

(5) Temporary yard

In the 1st stage grant-aid project, Jordanian side prepared two lands as temporary yards adjacent to the YWC's reservoirs; Hofa and Zebdat. However, the Contractor had to lease vacant land near the site, because both lands are far from construction site and inconvenient. The temporary land is needed to be located inside the construction site in order to minimize the transportation time and thereby construction period. The temporary land for stock yard will be provided by the Government of Jordan, and it is needed to request the Government of Jordan to secure and provide it as early as possible. Required space for the stock yard for materials can be estimated as about 5,000m^2.

(6) Safety control

The JICA study team enquired about the existence of the construction safety standards or rules in Jordan with two constructors in Irbid and two constructors in Amman. The two constructors in Irbid did not know about its existence, while the two constructors in Amman knew about its existence, but did not know about its contents. Jordanian National Building Code No.22 "Public Safety at Construction Site Code" consists of the following chapters and seems to cover all the necessary safety control items.

Chapter 1	General (Design responsibility, Safety measures at the beginning of works, Instruction and training, Display and measures for safety)
Chapter 2	Environmental protection (Tidy, Water, Medical care, Fire protection, Lighting, Ventilation, Noise, Temporary electricity, Personnel transport)
Chapter 3	Material Handling and storage (Loading, Transportation, Storage)
Chapter 4	Safety measures for each construction work (Welding, Steel structure, Concrete, Soil collection, Soil dumping, Excavation, Piling, Blasting, Painting)
Chapter 5	Safety for Machines, and tools (Tools, Lifting machines, Erath work machines)
Chapter 6	Worker protection (Head, Face, Eyes, Ears, Hands, Feet, Respiratory protection, Protective equipment)
Chapter 7	Temporary fixture (Ladders, Stairs, Scaffolding)

"Safety Measure Plan" and "Safety Construction Plan" should be prepared in consideration of construction environment, construction items and contents of the contract after reviewing the above Jordanian safety standards as well as the Guidance for the Management of Safety for Construction Works in Japanese ODA Projects, 2016, JICA. In particular, attention should be paid to the prevention of following accidents:

- Falling of workers into a trench and a pit

- Falling of heavy materials such as cast iron pipes when lifting
- Collapse of natural ground during construction of a trench or a pit
- Accidents when operating heavy machines for excavation works, sand conveying, materials loading and unloading, and road paving works
- Accidents of vehicles and passers around the construction sites on the public road
- Traffic accident of workers in and near the exclusive area for construction sites on the public road
- Damage to the existing buried objects, and overhead power and communication wires
- Short circuit accidents of drainage pumps or electrical equipment such as lighting fixtures.

(7) Quality control

Pipe laying works shall be in accordance with the standard of MPWH for national roads and the municipality standard of Irbid City for municipality roads as mentioned in Section 2.2 (4). As for CBR test standard for the recovering work of roads, Japanese standard of JIS A1211 will be applied (refer to Table 2.31), because the standard of MPWH (the Specification for Highway and Bridge Construction issued by Directorate of Planning & Development in 2008, Volume I-IV) is basically same as JIS A1211, both of which are originally derived from AASHTO (American Association of State Highway and Transportation Officials).

(8) Permission of the work and the environmental and social aspects.

EIA is exempted as mentioned in Section 1.2. Road use permission is required from the road-management authorities before starting of pipe laying works.

(9) Other considerations

The Japanese contractor of the 1st stage grant-aid project has pointed out followings to be considered for implementation of the project in the project area.

- Residents in the project area make a unified community to be very exclusive to outside persons. (It seems that they come from Bedouin).
- Public safety is extremely poor in the project area. For Sarieh in particular, serious crimes such as murder and arson have happened. However, Syrian refugees have no relation to them.
- The Japanese contractor employs the construction companies in Amman and so on, who have been working with the Japanese contractor for a long time, because the performance of local construction companies in the project area is very poor. The local construction companies have frequently interrupted the Japanese contractor from the beginning of the project.
- There is a big difference in works quality between Japanese construction companies and local construction companies. Authorities in control of the roads show a differential attitude to them. It seems that double standards exit. Other donors usually relegate all the works to the local construction companies, but never carry out the works by themselves.
- Tax office usually does not accept 100% tax exemption. In this project, 100% tax exemption is applied in particular, because its clause is written in the Cabinet Letter by chance.
- MPWH requires the penalty of the Japanese contractor by making claim for below the standards. The claim is suspected for requiring penalty because the contract specification is made based on the MPWH standards.

2.2.4.3 Scope of Works

Demarcation of construction works of facilities between the two countries are shown in Table 2.2.1.

Table 2.28 Demarcation of Construction Works of Facilities between the Two Countries

Construction	Japan	Jordan
1. Installation of distribution pipeline		
(1) To install distribution pipeline	●	
(2) To cooperate for construction work on the road including acquisition of its approvals and permissions, and traffic control procedure		●
(3) To cooperate during pipe connection work such as attendance at water suspension work, its notice to people and etc.		●
2. Service pipes connection works (including water meters)		●
3. Common items for construction works		
(1) To secure temporary stock yards for construction materials and machineries and lands for temporary works		●
(2) To take all necessary measures to secure disposal sites for excess excavated soils	●	
(3) To provide necessary water and chemicals (chlorine) without charge for testing, cleaning and disinfection of the pipeline constructed		●

2.2.4.4 Consultant Supervision

(1) Construction supervision of the Consultant

The Consultant will supervise and guide a Contractor to "complete construction of facilities safely and within the predetermined work period," "according to the contractual drawings." Furthermore, the Consultant also has the role of supervising and confirming that the construction of the facilities is being implemented appropriately under the framework of Japanese grant-aid scheme.

1) Main supervisory duties of the Consultant

The main items of the construction supervision of the Consultant are required as below.

a. Progress control

The Consultant will confirm the construction schedule plan submitted by the Contractor at the initial stage and monitor the actual progress of construction with the construction plan, schedule on daily, weekly, and monthly bases. If actual progress is expected to be behind the construction schedule plan, the Consultant will inform the Contractor of it. If a delay is unavoidable, the Consultant will analyze its causes and instruct the Contractor to take necessary measures. The construction supervision will include management of the following items:

- Progress of construction volume
- Input (carrying in and installation) of main materials and equipment
- Input of manpower such as engineers and workers.

b. Quality control

The Consultant will check whether the construction conform to the specifications or not. If there is a concern about quality, the Consultant will inform the Contractor and request to adopt required modifications and measures. Quality control will be implemented using the measures listed below.

- Checking catalogs, specifications, and manufacturing drawings of materials and equipment
- Checking test results of materials and equipment

- Checking shop drawings including construction methods and material samples proposed and submitted by the Contractor
- Attendance at the factory inspection, if necessary
- Site inspections of rolling, reinforcing bar arrangement and concrete strength during work
- Site checks of work implementation status, work methods, etc., and guidance
- Witnessing of trial operation and inspection of performance
- Checking and binding supervision records and reporting to the Client and JICA periodically
- Checking construction records including as-built drawings submitted by the Contractor and its reporting and submission to the Client

c. Safety control

The Consultant will perform the validity check of the safety control plan of the Contractor and check its implementation status. The Consultant will supervise the work on site beforehand to prevent accidents at work and accidents to a third party. Safety control will be implemented using the measures listed below.

- Checking of the safety control plan proposed by the Contractor and the presence of a safety control manager appointed by the Contractor
- Checking of the validation of the safety control plan and a safety manager
- Checking of the progress status of the safety control plan
- Checking of the scheduled operating routes of vehicles and the validity of precautions during operation, and adherence to the plan
- Confirmation of contents of health and safety system for workers and enforcement of holidays and resting in a work for them
- Checking of carry-in route and time for construction materials and equipment
- Checking of the number of guardsmen in daytime and night

2) Construction supervision

The Consultant will organize the construction supervision system for conducting construction supervision consisting of schedule control, quality control and safety control mentioned above. In this case, construction supervision considering the gist of the basic design is necessary; therefore, a system consistent with the series of tasks of outline design, detailed design and work supervision will be established. The Consultant will organize the construction supervision system mentioned below since work supervision needs to be implemented in both Japan as well as at the site.

a. On-site Construction supervision

Since it is important to confirm that the construction work is performed appropriately based on the framework of Japanese grant-aid, the supervision on site needs to be performed by Japanese engineers who thoroughly understand the grant-aid scheme. The Japanese supervision system on site considered necessary for this plan is shown in the table below. During the work period, the quality of work will be confirmed by engineers in charge of design and the chief consultant, who manage the entire project including work within Japan, and who will give instructions such as warnings to the work supervisors at the appropriate timing. The Consultant will also employ local engineers, and implement work supervision using the local engineers together with the Japanese engineers.

Table 2.29 Japanese Supervision Organization at the Site

Job title	Field (MM)	No. of travels	Responsible for
Supervision engineer (Chief consultant)	1.5	3	Overall work supervision
Resident representative supervision engineer	24.0	2	Resident supervision during construction, quality control, schedule control and safety control
Completion inspection	0.3	1	Inspection for completion
Safety manager	20.0	2	Safety managing for all the works
Defect inspection	0.3	1	Inspection of defect after one year
Total	46.1	9	

b. Construction supervision in Japan

Systems necessary for overall supervision of the Project mentioned below will be maintained in Japan, and the overall work supervision including work at site and work in Japan will be supervised.

- Checking the contents of the agreement and the process, progress, and quality
- Studies to resolve issues that have occurred on site and instructions to contractors
- Technical and financial assistance to Consultant's local offices.

(2) Contractor's control system

The Project needs to be carried out by many teams as it should be completed in the short period, although a part of the works will be able to be performed by local subcontractors. This requires appropriate management of works. Distribution pipeline laying works are performed in trunk roads near important facilities and buildings, therefore, strict safety controls are necessary. For this reason, the Contractor with extensive overseas experience in similar work and overall capability of quality, process and safety controls must be selected. The responsibility of resident and short term engineers of contractors required according to the scale and type of the facilities of the Project assumed below.

Table 2.30 Contractor's Work Control System

Job title	Responsible for
Project Manager	As a responsible person in the large scale project in Irbid Governorate, on-site representative is in charge of discussions with national organizations of Jordan and with relevant construction companies, checks and adjustments of various work ranges and processes, formalities such as work permits, overall work control including construction work, labor, and safety.
Office Manager	On-site labor control, financial control, procurement of materials and equipment, transportation control, and general administrative aspects related to fulfilling the contract.
Chief Engineer	Responsible for the whole piping work. In charge of quality control, progress control and safety control of the piping work. The engineer who has a thorough experience of urban civil engineering and laying work of pipelines should be dispatched since laying work of distribution pipelines is implemented in urban area, and should manage construction work in multiple sites.
Civil Engineer (Zone 1) Hawwara	Responsible for laying work of pipelines in Zone 1, Hawwara. The engineer who has a thorough experience of urban civil engineering and laying work of pipelines should be dispatched since laying work of distribution pipelines is implemented in urban area, and should manage construction work in multiple sites.
Civil Engineer (Zone 2) Hawwara	Responsible for laying work of pipelines in Zone 2, Hawwara. The engineer who has a thorough experience of urban civil engineering and laying work of pipelines should be dispatched since laying work of distribution pipelines is implemented in urban area, and should manage construction work in multiple sites.
Civil Engineer (Zone 3) Sarieh	Responsible for laying work of pipelines in Zone 2, Hawwara. The engineer who has a thorough experience of urban civil engineering and laying work of pipelines should be dispatched since laying work of distribution pipelines is implemented in urban area, and should manage construction work in multiple sites.
Safety Manager	Responsible for safety control for all the works and personnel affairs management in assistance to Project Manager and Office Manager.

The Contractor will also employ local engineers, and implement work control using the local engineers together with the Japanese engineers mentioned above.

2.2.4.5 Quality Control Plan

The Project is pipe laying works consisting of open cut and trenchless pipe laying works. The quality control is required for respective work. The control items to be implemented for quality control of important works are shown in Table 2.31.

Table 2.31 Quality Control Plan

Type of work	Control item	Method	Standard (Example)
Pipe materials	Strength and size	Factory inspection	JIS G5527, G5528
	Lining and painting	Visual inspection	JWWA B122, B144, B145
Pipe laying work	Pipe connection for DCI Pipe	Check for intercalary length of pipes	• DCI Pipe Association Guideline
	Pipe connection for PE Pipe	Visual check	
	Leakage	Leak test	Design Criteria for Waterworks Facilities 2012
Paving work	Base course	CBR test	JIS A1211
Foundation work	Soil bearing capacity	Plate bearing test	JIS A1215
Concreting work	Concrete quality	Mixing test	JIS A5308, A1119
		Compressive strength test	JIS A1108
		Air test	JIS A1116, A1118, A1128
		Aggregate test	JIS A1102, A1103, A1104, A1105, A1109, A1110, etc.
Reinforcement	Strength	Tensile test, bending test	JIS Z2241, Z3121
	Reinforcing bar arrangement	Measuring spacing and size of reinforcing bars	Specification for Highway Bridges by Japan Road Association

Note) JIS: Japanese Industrial Standard, JWWA: Japan Water Works Association
JIS A1211 is similar to Jordan's standard as mentioned in Section 2.4.2 (7).

2.2.4.6 Procurement Plan

(1) Locations for procurement of materials and equipment

1) Labors

Ordinary laborers and general skilled laborers (carpenters, plumbers, etc.) will be hired locally by the Contractor.

2) Materials and equipment

General construction materials and equipment such as cement and reinforcing bars can be procured locally. Ready-mixed concrete can be supplied from the ready-mixed concrete plant in Amman city. Since ductile cast iron pipes and valves are not being manufactured in Jordan, these items will be procured from OECD countries including Japan.

3) Construction machinery

There are no companies that lease construction machinery in Jordan; however local construction companies can provide general construction machinery such as large breakers, backhoes, bulldozers, dump trucks and truck cranes. A contractor will select a local construction company for hiring construction machinery considering the lease rate, transportation cost, and number of days for which the machinery is offered.

Considering the local conditions mentioned above, the main materials and equipment to be procured

and used in the Project are shown in Table 2.32.

Table 2.32 Procurement Plan for Main Materials and Equipment

Item	Local	Japan	OECD Member Country	Remark
Materials and equipment				
Cement	○			
Aggregate	○			
Reinforcing bars	○			
Concrete form materials and timbering work materials	○			
High Density Polyethylene pipe (HDPE Pipe)	○			
Ductile cast iron pipe and fittings		○	○	
Asphalt	○			
Sluice valves (80mm-300mm)	○			
Base course material	○			
Air valves and PRVs		○	○	
Liner plates for jacking work pits		○		
Sleeve Pipes for Jacking Method		○		
Construction machinery				
Backhoes	○			
Breaker	○			
Truck cranes	○			
Trucks with crane	○			
Dump truck	○			
Sprinkler truck	○			
Grader	○			
Tire roller	○			
Concrete pump vehicles	○			
Vibrating roller	○			
Tamper	○			
Concrete cutter	○			
Generator	○			
Air Compressor	○			
Machine for lead-pipe jacking method		○		

(2) Transportation plan

Ductile cast iron pipes and large-sized materials and equipment will be packaged in bundles or as bare packages, and machinery will be packed in considering long-term transportation by sea, loading and unloading at ports, and transport on land to the project area of the materials and equipment procured from Japan and third countries. The unloading port in Jordan is only Aqaba port. Accordingly, the imported materials and equipment will be unloaded at Aqaba port and transported over land to the project area.

2.2.4.7 Operational Guidance Plan

The Consultant will prepare the O&M manuals for the whole distribution system including the manuals submitted by the Contractor. In addition, the Consultant will conduct its training for distribution pipelines and accident response.

The Contractor will prepare the operation and maintenance (O&M) manual of PRV (Pressure Reducing

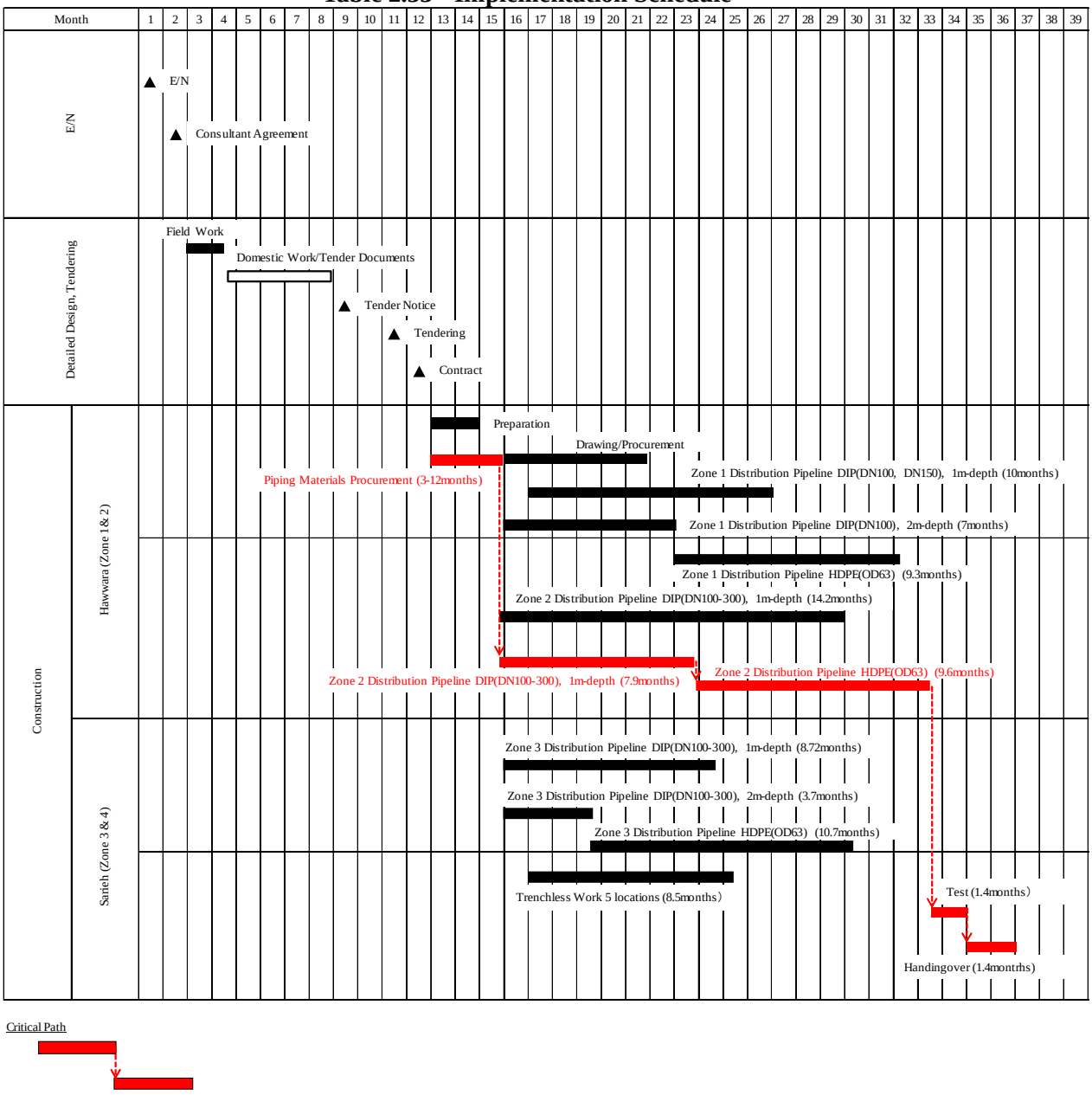
Valve) and other required manuals, and carry out its training.

The PRVs are installed to keep the service pressure within a range of 0.25Mpa to 0.75Mpa. In case of malfunction of PRVs, the service pressure will increase up to 2.5Mpa in the lower elevation area of the project area. Since the HDPE pipe does not have enough withstanding capacity to such increasing pressure, it is essential that the PRVs be repaired immediately and pressure be always kept in the appropriate range.

2.2.4.8 Implementation Schedule

Expected implementation schedule is shown below.

Table 2.33 Implementation Schedule



2.3 Obligation of Recipient Country

The Project is composed of the works to be undertaken by Japanese cooperation and Jordanian side with self-effort. The necessary measures and obligations of Jordanian side activities for the Project are listed as follows:

Table 2.34 Obligation of Recipient Country

Items
1. Installation of distribution pipeline
(1) To provide water and chemicals for testing, cleaning and disinfection without charge
(2) To cooperate for construction work on the road including acquisition of its approvals and permissions, and traffic control procedure
(3) To cooperate during pipe connection work such as attendance at water suspension work, its notice to people and so on.
2. Installation of service pipes
(1) To Install service pipes including water meters
(2) To provide water and chemicals for testing
3. Common Items for construction works
(1) To provide temporary stock yards without charge for construction materials and machineries and lands for temporary works
4. Other Items
(1) To coordinate for required approvals and permissions from relevant authorities to implement detailed design and construction works
(2) To cooperate in consultation with residents living near the construction sites and to coordinate procedures for traffic control in works with relevant authorities
(3) To carry out necessary procedures for issue of A/P required for payments to Japanese Consultants and Contractor and to bear the commissions for advising and payment to a bank in Japan for banking services based upon the Banking Arrangement
(4) To ensure prompt unloading and customs clearance of the goods for the Project at the port of disembarkation in Jordan
(5) To accord Japanese nationals whose services may be required in connection with the supply of products and services under the verified contract such facilities as may be necessary for their entry into Jordan and stay there for the performance of their works.
(6) To exempt Japanese nationals from customs duties, internal taxes and other fiscal levies which may be imposed in Jordan with respect to the supply of the products and services under the verified contract and to take necessary measures for such tax exemption.
(7) To use, operate and maintain properly the facilities and equipment constructed or procured under the Japan's Grant-aid program.
(8) To bear all the expenses, other than to be borne by the grant-aid, necessary for construction of the facilities.
5. After the Project
(1) To maintain and use properly and effectively the facilities constructed and equipment provided under the Grant-aid ➢ Allocation of maintenance cost ➢ Operation and maintenance of facilities ➢ Routine check/Periodic inspection

2.4 Project Operation Plan

2.4.1 Basic Principle of Operation and Maintenance

The Project is to replace the existing pipe and install new pipe in new supply area. Therefore, current operation and maintenance organizations of YWC will be able to operate and maintain the completed facilities sufficiently.

2.4.2 Organization of Operation and Maintenance

(1) Monitoring of PRV

Water will be distributed from Hofa reservoir by the time when water is distributed from Zebdat reservoir utilizing transferred water from Wadi Arab 2nd system. Pressure reducing valves (PRVs) are installed along the pipeline starting from Hofa reservoir as shown in Table 2.35 to keep water pressures below allowable water pressures of pipe materials. Failure of PRVs will lead to pipe bursts at the worst case so that periodical maintenance of the PRVs is very important.

Table 2.35 PRV (Pressure Reducing Valve) List

Location	Quantity	Remark
Distribution main (M1 line) DN600	2	1st stage grant-aid project
Branch point from M5 line to Zone 1	1	1st stage grant-aid project
Branch point from M5 line to Zone 2	1	1st stage grant-aid project
Entrance at distribution pipe of Hofa reservoir to Zone 4	2	Installed in the Project (2nd stage grant-aid project)

(2) Organization of operation and maintenance

The Project will improve distribution system by addition of new pipe and replacement of the existing pipe. As improvement of distribution system decreases the frequency of the valve operation in rationing system, additional staff members for operation and maintenance of YWC will not be required but the workload for valve operation can be reduced. In addition, decrease in leakage accidents will provide staff members with sufficient time to conduct preventive leakage control.

(3) Inspection Items

The periodical inspection items and their intervals for the distribution pipeline of the Project are shown in Table 2.36. YWC staff will be able to successfully operate and maintain them as they are currently maintaining the distribution network.

Table 2.36 Periodical Inspection for Pipelines

Location	Inspection interval	
	Monthly	Annually
① Status of water leakage		○
② Conditions of sluice valves, air valves, plugs and lids	○	
③ Status of ground subsidence	○	
④ Status of pipeline damage	○	
⑤ Equipment and tools for emergency use		
⑥ Function of drainage valves	○	○

Periodical inspection of the PRVs is of significance and the periodical inspection items and their intervals are shown in Table 2.37.

Table 2.37 Periodical Inspection for Pressure Reducing Valves

Inspection items	Interval
PRV data management (Setting pressure, Manufacturer, Installation Year, Inspection Date)	-
Cavitation damage check	Every 6 months
Cleaning strainer	Every 3 months

In addition, the following are the main causes of PRV going out of order.

- Small objects like small stones, woodchips and debris enter into the PRV
- Copper tubes for drawing water from upstream and downstream main pipes to the PRV actuator are clogged with small objects.

To avoid PRV going out of order, following maintenance is required and WAJ has to ensure this maintenance.

- Strainer and filters at the copper tubes both equipped with the PRV should be cleaned periodically (every 3 months or less).
- Regular measurement of the downstream pressure at the PRV. In case the downstream pressure of PRV is out of the value set initially, it should be adjusted to the initial value.
- Spare parts of PRV should be kept always.
- After-service system for PRV should be established in case of the damage of PRV.

2.5 Project Cost Estimation

2.5.1 Initial Cost Estimation

The part of estimated costs for the Project covered by Jordanian side is summarized in Table 2.38.

Table 2.38 Summary of Estimated Costs to be Implemented by Jordanian Side

Items	Project cost (thousand JD)	Remark
1. Laying work of distribution pipelines		
(1) Provision of necessary water and chemicals (chlorine) for trial operation of the facilities constructed	15	Estimated based on the previous grant aid projects
2. Laying work of service pipes	834	JD350 per 1 connection x 2,382 connections
3. Others		
(1) Provision of temporary stock yards for construction materials and machineries and lands for temporary works		
(2) Preparation of disposal site for waste soil		
4. Commissions for issue of A/P (Authorization to pay) and B/A (Banking Arrangement)	5	Estimated based on the previous grant aid projects
Total	854	

Conditions of Cost Estimation

1) Date of estimation : February 2016
2) Exchange rate : 1US$ = JPY121.95, 1JD = JPY172.24
3) Work period : The work period for detailed design and construction is shown in the implementation schedule (Section 2.4.8).
4) Other : The estimation of the project cost is made in accordance with the grant-aid scheme of the Government of Japan

2.5.2 Operation and Maintenance Cost

The major operation and maintenance items of the constructed facilities are checking and repair of pipeline and PRVs. The staff has already been engaged for the patrol and repair of pipeline. New facilities can be maintained by current staff with existing materials so that no increase of operation and maintenance cost required. .

2.5.3 Other Relevant Issues

(1) Installation (new installation and replacement) of distribution pipe

Roads for installation of distribution pipe of the Project are classified as national road or municipality road. The installation of pipes in the Project should comply with the standard of MPWH in case of the national road and the standard of Irbid city for municipality road. It is required to communicate with respective organizations and employ appropriate procedures for construction work. In addition, it is also required to closely communicate with concerned organizations such as police and not to affect social lives of neighborhoods because planned pipes run through heavy traffic area in some locations.

(2) Tax exemption procedure (refer to Section 2.4.2 Implementation Conditions)

Delay of acquisition of tax exemption documents for imported materials and equipment may cause delay of the construction schedule. To prevent the delay, WAJ is required to contact and discuss with the organizations concerned with initiative.

(3) Early acquisition of road use permission (refer to Section 2.4.2 Implementation Conditions)

Delay of acquisition of road use permission may cause delay of the construction schedule. To prevent the delay, WAJ is required to contact and discuss promptly with the MPWH, Irbid city and the police who control the roads.

CHAPTER 3 PROJECT EVALUATION

CHAPTER 3 PROJECT EVALUATION

3.1 Preconditions for Project Implementation

(1) Budget preparation for the works to be undertaken by the Jordanian side

Budget for the works to be undertaken by the Jordanian side needs to be prepared firmly and to be released timely without delay.

(2) Arrangement of tax exemption

The Jordanian side should guarantee exemptions on taxes related to the project such as value added tax (VAT), customs duty, and any other taxes and surcharges. WAJ should take the procedure necessary for tax exemption. If the exemption is not obtained, WAJ should bear any taxes.

3.2 Obligations undertaken by Recipient Country for the Project Accomplishment

(1) Certain execution of obligations to be undertaken by Jordanian side

Jordanian side will be able to sufficiently accomplish the obligations to be undertaken by Jordanian side, such as installation of service pipes and meters, water supply for testing, and preparation of stock yards at the beginning of and during construction works, even if financial weakness is considered. WAJ and YWC have a number of meters and service pipes supplied by donors, and commit the utilization of those for the Project. For other obligations, considered to be same as in the past projects, these will be covered by governmental subsidy as same as before.
The Jordanian side should certainly execute the obligations to be undertaken by the Jordanian side so that the Project will be completed as scheduled.

(2) Service pipes connection

Connection works between distribution pipes constructed by Japanese side and service pipes installed by Jordanian side are essential for impact by the Project to be realized. Jordanian side has a number of service pipe materials and is required to efficiently install service pipes by sharing information with Japanese side.

3.3 External Conditions

For the achievement of the Project, issues to be challenged by Jordanian side, preconditions and external conditions are explained below.

(1) No changes in political and security situation in Jordan

Security situation in Jordan might be worsened due to unexpected rise in refugees caused by disturbances in the neighboring countries especially in Syria. It is required for completion of the Project that security situation in Jordan will not worsen..

(2) Continuous transfer of water amount proposed in the Project

Transmission facilities of Disi fossil water from Amman to Za'atary reservoir in Mafraq governorate will be completed as schedule, which is mow underconstruction by WAJ, and water amount proposed in the Project will be transferred up to Hofa reservoir without interruption.

3.4 Project Evaluation

3.4.1 Relevance

(1) Beneficiaries and its number

Beneficiaries will be inhabitants in Hawwara and Sarieh including Syrian refugees and its number will be 21,631 persons for Zone 1 and Zone 2 of Hawwara, and 6,333 persons in Zone 3 of Sarieh, totaling 27,964 persons in 2020.

(2) Project target and BHN

Water pressures in the Project area will be improved from the current value of 0.11 - 0.50 Mpa to the target value of 0.25 - 0.75 Mpa. This will be able to eliminate poor water supply areas and such, contribute to satisfying BHN.

(3) Improvement of life environment and stabilization of the people's livelihood

A number of Syrian refugees have been flowing into Hawwara and Sarieh. The implementation of the Project will improve the water supply service such as optimization of the service pressure and increase in water supply amount because of reduction of leakage. This will contribute to improving the water supply service and thereby improving the life environment of both Jordanian and Syrian refugees. Accordingly, tensions between them will be eased.

(4) Contributing to realization of targets of medium and long-term development plans

The "National Water Strategy" which is Jordan's medium to long-term plan has the policy of effectively using limited water sources to the maximum extent. This project will contribute to the realizing the targets of the medium to long-term plan through reduction in water leakage and non-revenue water.

(5) Conformity with Japan's assistance policy

Japan announced in the Supporting Syria and the Region Conference London, February 2016 that Japan would extend new assistance of approximately 350 million US dollars to Syria, Iraq and neighboring countries. One of the principles Japan expressed is to alleviate the burden on the host countries. Thus, the implementation of the Project is in conformity with the above Japan's assistance policy.

3.4.2 Effectiveness

(1) Quantitative effect

Water will be distributed in the Project area with adequate water pressure ranging from 0.25 to 0.75 Mpa.

(2) Qualitative effect

- Leakage will be reduced by pipe rehabilitation.
- Water served area will be expanded due to additional pipes in un-served areas.
- Poor water supply area will be narrowed due to additional available water amount.
- Water supply duration will be increased due to additional available water amount.

3.4.3 Conclusion

The Project will have the abovementioned relevance and effects; therefore, implementation of the Project is adequate to be implemented under Japan's grant aid assistance.

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Appendix I: **Member List of the Study Team**

(1) Preparatory Survy (Decembe 16, 2015 to February 12, 2016)

No.	Name	Job title	Occupation
1	Mr. Shigeyuki MATSUMOTO	Team Leader	JICA Senior Advisor,
2	Mr. Kazufumi MOMOSE	Chief Consultant	TEC International Co., Ltd.
3	Mr. Hirotaka SATO	O & M planning	TEC International Co., Ltd.
4	Mr. Yoshikata KUBOSAKI	Water Supply Planning (Water Group Coordinator)	TEC International Co., Ltd.
5	Mr. Katsutoshi IWASAKI	Water Supply Facility Design 3	TEC International Co., Ltd.
6	Mr. Mitsuru HIGUCHI	Water Supply Facility Design 4	TEC International Co., Ltd.
7	Mr. Hiroshi KOBAYASHI	Equipment Planning / Procurement Planning / Cost Estimation 3	TEC International Co., Ltd.
8	Mr. Koichi IWAMOTO	Project Coordinator 2 / Cost Estimation Assistance	TEC International Co., Ltd.

(2) Explanation on Draft Preparatory Suervr Report (December 1 to 10, 2016)

No.	Name	Job title	Occupation
1	Mr. Yuki ARATSU	Team Leader	Senior Assistant Director, Water Resources Group, Dissaster Risk Reduction Group, Global Environment Department, JICA
2	Mr. Yoshiki OMURA	Project Advisor	Senior Advisor (Water Supply Development), JICA
3	Ms. Makiko KIMURA	Project Coordinator	Assistant Director, Water Resources Team 1 Water Resources Group Global Environment Department, JICA
4	Mr. Kazufumi MOMOSE	Chief Consultant	TEC International Co., Ltd.
5	Mr. Makoto HOMMA	Water Supply Planning (Water Group Coordinator)	TEC International Co., Ltd.

Appendix II: **Study Schedule**

(1) Preparatory Survy (Decembe 16, 2015 to February 12, 2016)

		Team Leader	Chief Consultant	Water Supply Planning (Water Group Coordinator)	O&M Planning	Water Supply Facility Design 3	Water Supply Facility Design 4	Equipment Planning / Procurement Planning / Cost Estimation 3	Project Coordinator 2/ Cost estimation Assistance
		Shigeyuki MATSUMOTO	Kazufumi MOMOSE	Yoshikata KUBOSAKI	Hirotaka SATO	Katsutoshi IWASAKI	Mitsuru HIGUCHI	Hiroshi KOBAYASHI	Koichi IWAMOTO
16-Dec	Wed		Leaving Narita	Leaving Narita					
17-Dec	Thu		Arrival Amman	Arrival Amman					
18-Dec	Fri	Leaving Haneda, Arrival Amman				Leaving Narita	Leaving Narita		Leaving Narita
19-Dec	Sat	Field survey (Irbid)				Arrival Amman	Arrival Amman		Arrival Amman
20-Dec	Sun	Meeting with WAJ, KfW				Field Survey	Field Survey		Coordination work
21-Dec	Mon	Signing of MD with WAJ, Meeting with Afd, Meeting with Japanese Embassy							
22-Dec	Tue	Meeting with JICA Jordan office							
23-Dec	Wen	Arrival Narita		Meeting C/P					
24-Dec	Thu		Leaving Amman						
25-Dec	Fri		Arrival Narita						
26-Dec	Sat			Team meeting		Team meeting	Team meeting		
27-Dec	Sun			Data collection & meetings		Field Survey	Field Survey		
28-Dec	Mon								
29-Dec	Tue								
30-Dec	Wen								
31-Dec	Thu								
1-Jan	Fri								
2-Jan	Sat			Team meeting		Team meeting	Team meeting		
3-Jan	Sun			Data collection & meetings		Outline design	Outline design	Leaving Narita	
4-Jan	Mon							Arrival Amman	
5-Jan	Tue				Leaving Narita			Field Survey	
6-Jan	Wen				Arriving at Amman				
7-Jan	Thu				O&M survey				
8-Jan	Fri								
9-Jan	Sat			Team meeting	Team meeting	Team meeting	Team meeting	Team meeting	
10-Jan	Sun			Meeting C/P	O&M survey	Meeting C/P	Meeting C/P	Survy of local contractor, Esitimation request	
11-Jan	Mon					Outline design	Outline design		
12-Jan	Tue			Meeting with WAJ	Leaving Amman				
13-Jan	Wen			Leaving Amman	Arrival Narita				
14-Jan	Thu			Arrival Narita					
15-Jan	Fri					Leaving Amman	Leaving Amman		Leaving Narita
16-Jan	Sat					Arrival Narita	Arrival Narita	Procurement survey	Arrival Narita
17-Jan	Sun								Coordination work
18-Jan	Mon								
19-Jan	Tue								
20-Jan	Wen								
21-Jan	Thu								
22-Jan	Fri								
23-Jan	Sat							Team meeting	Team meeting
24-Jan	Sun							Construction environment survey	Coordination work
25-Jan	Mon								
26-Jan	Tue								
27-Jan	Wen								
28-Jan	Thu								
29-Jan	Fri								
30-Jan	Sat			Leaving Narita		Leaving Narita		Quatation collection	Coordination work
31-Jan	Sun			Arrival Amman		Arrival Amman			
1-Feb	Mon			Preparation of T/N		Meeting with C/P		Leaving Amman	Leaving Amman
2-Feb	Tue							Arrival Narita	Arrival Narita
3-Feb	Wen								
4-Feb	Thu			T/N meeting					
5-Feb	Fri			Leaving Amman					
6-Feb	Sat			Arrival Narita		Meeting with C/P			
7-Feb	Sun								
8-Feb	Mon								
9-Feb	Tue								
10-Feb	Wen								
11-Feb	Thu					Leaving Amman			
12-Feb	Fri					Arrival Narita			

(2) Explanation on Draft Preparatory Suervr Report (December 1 to 10, 2016)

		Team Leader	Prject Advisor	Project Coordinator	Chief Consultant	Water Supply Planning (Water Group Coordinator)
		Yuki ARATSU	Yoshiki OMURA	Makiko KIMURA	Kazufumi MOMOSE	Makoto HOMMA
DEC-1	Thu				Leaving Narita	Leaving Narita
DEC-2	Fri	Leaving Haneda	Leaving Haneda	Leaving Haneda	Arrival Amman	Arrival Amman
DEC-3	Sat	Arrival Amman	Arrival Amman	Arrival Amman		
		Team Meeting				
DEC-4	Sun	Meeting with JICA Jordan Office				
		Meeting with WAJ to discuss DFR and M/D				
		Coutesy Visit to MoPIC				
		Meeting with UNOPS				
DEC-5	Mon	Meeting with WAJ to discuss DFR and M/D				
		Team Meeting				
DEC-6	Tue	Meeting with YWC				
		Meeting with the Japanese Contractor of 1st Stage Grant Aid Project				
		Site Survey				
DEC-7	Wed	Signing of M/D with WAJ				
		Meeting with UNOPS (+WAJ)				
		Meeting with AFD				
		Meeting with kfW				
DEC-8	Thu	Meeting with JICA Jordan Office				
		Coutesy Visit to Japanese Embassy				
DEC-9	Fri	Leaving Amman	Leaving Amman	Leaving Amman	Leaving Amman	Leaving Amman
DEC-10	Sat	Arrival Narita	Arrival Narita	Arrival Narita	Arrival Narita	Arrival Narita

Appendix III: **List of Parties Concerned in the Recipient Country**

＜Jordanian side＞

1. Water Authority of Jordan (WAJ)

Eng. Tawfiq Z. Habashneh	Secretary General
Eng. Iyad Dahiyat	PMU director
Eng. Salameh Mahasneh	PMU project manager
Eng. Bashar Bataineh	PMU project manager

2. Yarmouk Water Company

Eng. Mohammad Al-Rababah	General Manager
Eng. Ashraf Batineh	Director of Technical department
Eng. Dalal Eliwah	Project manager of Technical department
Eng. Belel Alrabeea	Manager of GIS unit

＜Japanese side＞

1. Embassy of Japan

Mr. Norimasa YOSHIDA	First Secretary

2. JICA Jordan Office

Mr. Syokiti SAKATA	Chief Representative
Mr. Tsutomu KOBAYASHI	Chief Representative
Mr. Jyunji WAKUI	Senior Representative
Mr. Masaki Itagaki	Representative
Mr. Furuya.Ryosuke	Representative
Mr. Hani Kurdi	Advisor

＜Others＞

1. KfW Amman Office

Mr. Floriaan Rabe	Director

2. AFD Amman Office

Mr. Serge SNRECH	Chief Representative
Mr. Akita Ben Maid	Project officer

3. UNOPS Operational Hub in Amman

Ms. Bana Kaloti	Regional Director
Ms. Muna Al-Banna	Regional Infrastrucure Lead
Mr. Muhammad Usman Akram	Head of Programme
Mr. Naomitsu Nakagawa	Project Support Analyst

4. The Contractor of 1st Stage Grant Aid Project (Dai Nippon Construction)

Mr. Makoto IKAWA	Project Manager