

**BASIC DESIGN STUDY REPORT (I)
ON
THE PROJECT
FOR DEVELOPMENT OF NEW WATER SOURCES
FOR DAMASCUS CITY
IN
THE SYRIAN ARAB REPUBLIC**

MARCH 2005

**JAPAN INTERNATIONAL COOPERATION AGENCY
GRANT AID MANAGEMENT DEPARTMENT**

PREFACE

In response to a request from the Government of Syrian Arab Republic, the Government of Japan decided to conduct a basic design study on the Project for Development of New Water Sources for Damascus City and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Syria a study team from March 15 to April 16 (the first field survey) and from October 2 to October 22 (the second field survey), 2004.

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

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

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

March 2005

Seiji KOJIMA

Vice-President

Japan International Cooperation Agency

March, 2005

Letter of Transmittal

We are pleased to submit to you the basic design study report on the Project for Development of New Water Sources for Damascus City in the Syrian Arab Republic (Phase I).

This study was conducted by SANYU CONSULTANTS INC., under a contract to JICA, during the period from March, 2004 to March, 2005. In conducting the study, we have examined the feasibility and rationale of the project with due consideration to the present situation of Syria and formulated the most appropriate basic design for the project under Japan's grant aid scheme.

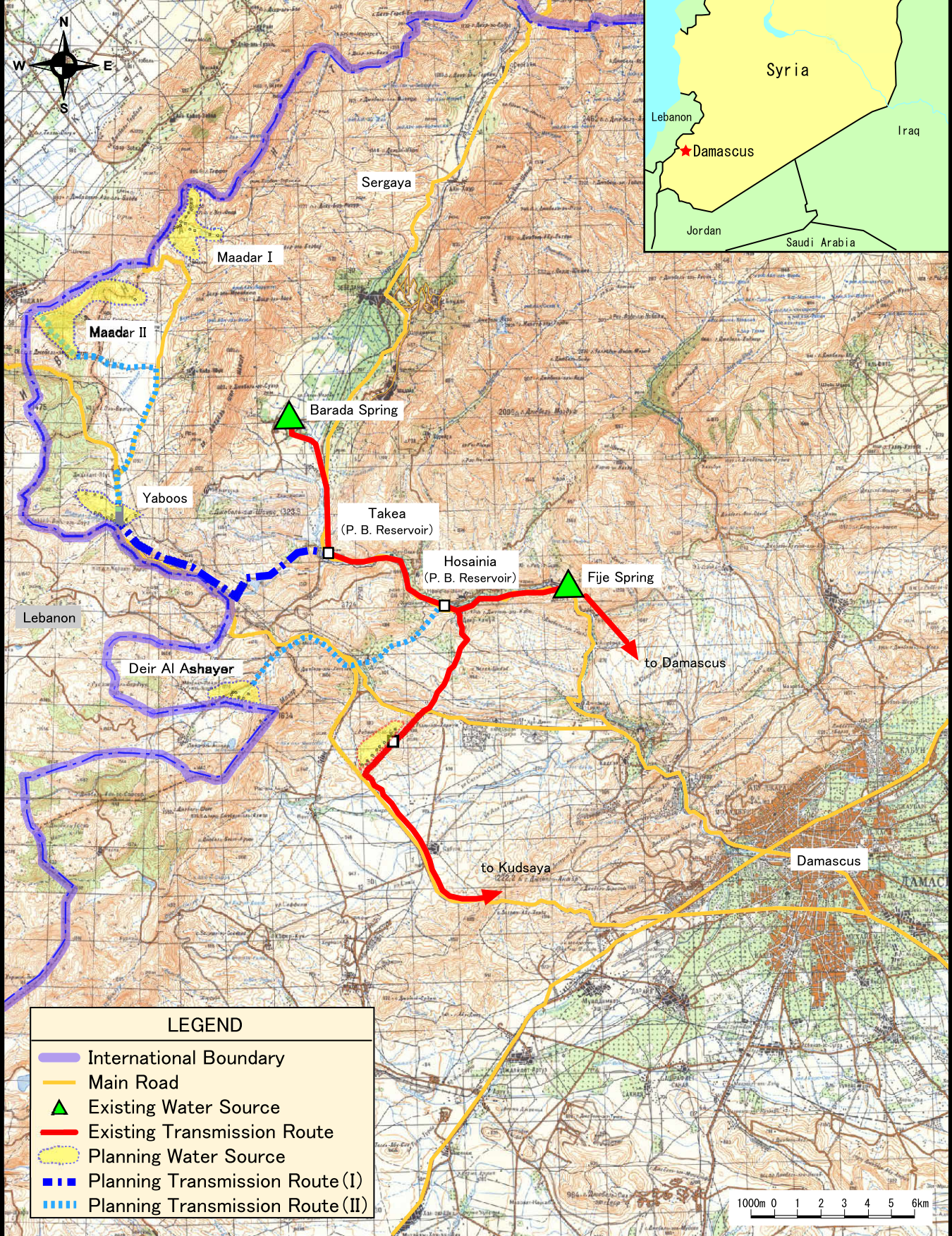
Finally, we hope that this report will contribute to further promotion of the project.

Very truly yours,

Ryoichi KAWSAKI

Chief Consultant,
Basic design study team on
The Project for Development
of New Water Sources
in the Syrian Arab Republic.

Location Map of Study Area



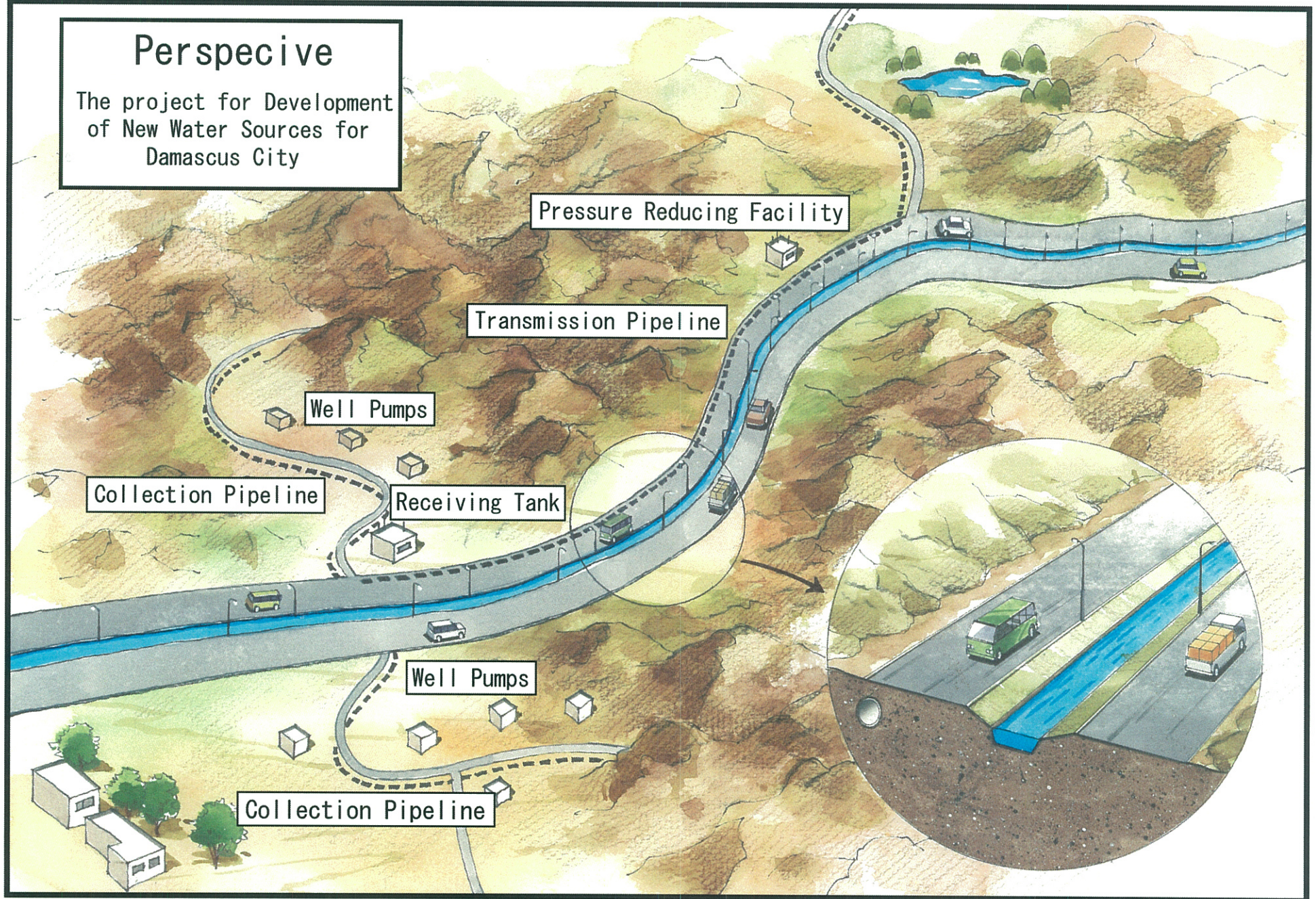
LEGEND

- International Boundary
- Main Road
- Existing Water Source
- Existing Transmission Route
- Planning Water Source
- Planning Transmission Route (I)
- Planning Transmission Route (II)

1000m 0 1 2 3 4 5 6km

Perspective

The project for Development of New Water Sources for Damascus City



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Abbreviations

Organizations

DAWSSA:	Damascus City Water Supply and Sewerage Authority
GCEA:	General Commission for Environmental Affair
JICA:	Japan International Cooperation Agency
MoHC:	Ministry of Housing and Construction
MOI:	Ministry of Irrigation
SPC:	State Planning Commission
WRIC:	Water Resources Information Center, Ministry of Irrigation

Others

BPS:	Booster pumping station
CWLS-Valve:	Constant Water Level Self-control valve
DCIP:	Ductile cast iron pipe
EIA:	Environmental Impact Assessment
EL:	Elevation
E/N:	Exchange of Notes
GDP:	Gross Domestic Product
HHWL:	High-high water level
HWL:	High water level
LLWL:	Low-low water level
LWL:	Low water level
O&M:	Operation and Maintenance
PBR:	Pressure Breaker Reservoir
RT:	Receiving tank
SP:	Steel pipe
WS:	Well site

Unit, Money

AC:	Alternating Currency
Hz:	Hertz
km ² :	Square kilometer
kVA:	Kilo-volt-ampere
kW:	Kilo-watt
kWh:	Kilo-watt-hour
m ³ :	Cubic meter
/hr, /min, /s:	per hour, per minute, per second
MCM:	Million cubic meter
mm/a:	Millimeter per year
MPa:	Million Pascal
Euro:	Euro
SP:	Syrian Pond
v:	Voltage
US \$:	US Dollar

SUMMARY

Syrian Arab Republic (hereinafter referred to as “Syria”) is located in the eastern coast of the Mediterranean Sea bounded by Turkey to the north, Iraq to the east, Jordan and Palestine to the south, and Lebanon to the west. The country has 17.55 million population in the year 2003 in 185,000 km² of its territory. Agriculture, mining/manufacturing industries and service business support its economy in good balance, yielding 1,288 US\$ of per capita GNP (2002).

Damascus City, the capital of Syria, plays central roles in political, economical and cultural activities. Damascus City Water Supply and Sewerage Authority (hereinafter referred to as “DAWSSA”) under the Ministry of Housing and Construction is the organization in charge of the water supply for Damascus City and its vicinity covering approximately 2.82 million people. The current water supply situation in the area is in chronic deficit as shown in the table below. Furthermore, not only Damascus City but also the newly developed suburbs of the city are covered within the service area of DAWSSA, the water supply condition will be falling into further serious shortage.

Table -1 Balance between Supply and Demand in the past 7 years (unit: 1000 m³/day)

Items	1997	1998	1999	2000	2001	2002	2003
Av. Supply	622	645	536	492	442	466	583
In dry season	564	618	443	410	348	396	550
Av. Demand	648	685	723	680	680	635	585
Av. Deficits	26	40	187	188	238	169	2
Dry season deficits	64	67	280	270	332	239	35

Source: DAWSSA Yearly Report

Population of the Damascus metropolitan area is increasing rapidly in the rate of around 3% per year, therefore, the water supply situation in this area is becoming worse and worse every year. Major water sources for Damascus City and its vicinity are Figh Spring and Barada Spring Pond at around 15 and 30 km northwest from Damascus respectively, as well as the wells fields inside Damascus City. Among them, Figh Spring is overwhelmingly large maintaining 65 - 75% of the total water supply. However, its yield is varying heavily depending on the annual precipitation, and the water supply capacity remains at far below the demand in a dry season (Aug. to Dec.). During the dry season, the water in deficit is supplied from Barada Spring Pond. Additional supply is made from the wells fields inside Damascus City. The both supplemental water sources are, however, not enough usually. Recently, the three-year drought since 1999 enforced water supply suspension for more than 12 hours a day upon Damascus people for six months per year for four years.

JICA conducted the master plan study, “The Study on the Development of Water Supply System for the Damascus City” in 1996-1997, based on the request from the Government Syria. The study recommended DAWSSA to control wasted water (counter-measures for leakage) as the first priority and then to seek new water resources to mitigate further deficits. For the counter-measures on leakage water, required materials were provided under Japanese Grant Aid projects and experts for leakage prevention had been dispatched by JICA. Through such cooperation, DAWSSA’s technologies on the counter-measures on leakage prevention were improved in distribution pipelines and the leakage ratio of 34.7% in 1995 was drastically reduced to 23% in 2003. The efforts to reduce leakage are still being continued. Another JICA development study, “The Study on Water Resources Development in the Northwestern and Central Basins in the Syrian Arab Republic” (hereinafter referred to as “the Development Study”) executed in 1998-2000 revealed that the water balance of “Barada/Awaji Basin” which includes this project area was already in negative, and in particular, the groundwater of the basin was in over-drawn condition. Under the circumstances, the Government of Syria started several studies to avoid further worsening of water deficit and to improve the situation, including the diversion of water resources from other basin as drastic counter-measures, construction of water resources control/monitoring system, further improving on leakage, promoting water-saving

irrigation and reusing of wastewater, etc.

Under such serious circumstance, DAWSSA, as the counterpart agency, planned out the Project for Development of New Water Sources for Damascus City (hereinafter referred to as “the Project”) and requested to the Japanese Government for its equipment and material supply in 2002. The Project was to develop new water resources at Maadar, Yaboos and Deir Al Ashayer in the northwest of Damascus City, and to convey the water to Damascus City through the existing Barada/Figeh Pipeline by constructing two new water pipelines from the three sites to the existing Pressure Breaker Reservoirs at Takea and Hoseinia, respectively.

The Government of Japan decided to accept the request and notified it to JICA. In accordance with the decision, JICA dispatched the Basic Design Study Team (hereinafter referred to as “the Study Team”) to Syria two times, from March 15 to April 16, 2004 (the first field survey team) and from October 2 to 22, 2004 (the second field survey team). After the domestic study on the project, JICA sent the Study Team to Syria again to explain and discuss the draft report on the basic design study with Syrian officials concerned since January 15 to 24, 2005.

The major contents of the Grant Aid Project are to provide 25 pumps for production wells constructed in three sites, emergency diesel generators, and pipe materials required for collection pipelines and transmission pipelines. Basic concept on the design policies are (a) the new well fields and their discharge are to be decided carefully based on the consideration of severe water balance over Barada/Awaji Basin, (b) equipment and materials are to be provided by the Japanese side and installation/construction are to be done by the Syrian side as a rule. However, availability of procurement on the equipment or materials by the Syrian side is also considered, and (c) the basic design study shall be conducted for the site where all of the production wells planned out have been constructed.

Based on the request from the Syrian side and the basic concept for basic design mentioned above, two times of the field survey by the Study Team had been conducted. Through the field surveys, the request from the Syrian side and the project components were revised as described below:

- (1) Modification of new well sites: Among the three sites originally requested, Maadar was shifted to adjacent Maadar II because Maadar site is hydro-geologically not suitable to construct a well field due to fear of strong influence to the downstream zone.
- (2) Changes in the number of wells at the sites: All of the wells provided by DAWSSA were found not suitable to be used as production wells in the Project. DAWSSA agreed to construct new production wells with proper specifications. Through the discussions, the number of wells drilled in each site were modified. Total number is 25, the same with the original request.
- (3) Phasing the procurement: Because of the delay of production well construction, DAWSSA agreed to divide the procurement of equipment/materials into two phases.
- (4) Changes in requested items: DAWSSA agreed to omit the diesel generators because they are only use for emergency. The small pipes for collection pipeline were also omitted (below 200mm in diameter) because DAWSSA has enough number of small diameter pipes in their storehouse.

Thus, the items and contents of the original request were finally revised as follows:

Table -2 Project Components Revised

Well Sites	Contents (Original)	Contents (Revised)	
		Phase I	Phase II
Maadar and Yaboos	-Submersible pump (50m ³ /hr) 20 sets -Collection pipes 1 lot -Diesel generator (300KVA) 4 sets -Transmission pipes (500-600mm) 35 km	<u>Yaboos</u> -Submersible pump (50m ³ /hr) 11 sets -Collection pipes 1 lot -Transmission pipes (600mm) 11.5 km -Pressure reducing valve 2 sets	<u>Maadar II</u> -Submersible pump (50m ³ /hr) 8 sets -Collection pipes 1 lot -Booster pump 1 lot -Transmission pipes (350~500mm) 15.2 km -Pressure reducing valve 1 set
Deir Al Ashayer	-Submersible pump (35m ³ /hr) 5 sets -Collection pipes 1 lot -Diesel generator (200KVA) 1 set -Transmission pipes (300-400mm) 12 km		-Submersible pump (50m ³ /hr) 6 sets -Collection pipes 1 lot -Transmission pipes (350-400mm) 8.8 km -Pressure reducing valve 3 sets

Through the two times of field surveys and a domestic study, as well as the explanation and discussions of the draft with Syrian officers concerned, the outlines of the project were formulated as follows.

- (1) Water source plan: Transmission pipeline from Yaboos to Takea designed in the Project shall convey water from Maadar II site planned in the next phase and further up-stream water sources included in DAWSSA's future development plan, such as Maadar I sites. Thus, the water sources plan was examined severely, based on the consideration on the total water balance of Barada/Awaj Basin, results on single well and group well pumping tests, and analysis of group well pumping simulation. The permissible number of production wells in each well field proposed by DAWSSA for a future development plan is summarized in Figure-1, general plan map.
- (2) Collection pipeline plan: The collection pipeline is a pumping system connected between well pumps and the receiving tank. Diameters of the required collection pipes are from 150 mm to 400 mm. The pipe materials with diameters less than 200 mm (total 1,031m) are to be provided by the Syrian side and the remaining 1,123m pipes with more than 250 mm till 400 mm are to be provided by Japan.
- (3) 600 mm Transmission pipeline plan: Maadar/Yaboos Line transfers the water taken from Yaboos site (and Maadar II site including the next phase) to the existing PBR at Takea, with the total length of 26,690m. Although the ground elevation of Maadar II well-field is in between 1,064 and 1,170m, the transmission pipeline goes to Takea (El. 1,092m) passing the highest point (El. 1,361m) and Yaboos well-field (El. 1,270m) through 269m of height gap. Therefore, a siphon system and a pumping system by well pumps are needed in Maadar site, and then water can go through by a gravity system after the highest point. Pipe diameter of the transmission line from Yaboos well field to Takea PBR of 11,500m in length is 600mm.
- (4) Equipment plan:
 - a) Well pump; Well pumps are submersible pump of 0.83 m³/min of discharge capacity with 100mm diameter, having 160m (6 units), 170m (3 units), and 220m (2 units) of head.
 - b) Pipe materials; Diameters of pipes provided by the Japanese side under the Project are from 250mm to 400mm for collection pipes and 600mm for transmission pipes. Ductile Cast Iron Pipes (DCIP) shall be adopted because of enough experiences and easiness of installation, but steel pipes shall also be adopted only for the portions near production wells and an aqueduct.

- (5) Pressure reducing facility: Because of its safety and actual application records, the combined method by use of Constant Water Level Self-control valve (CWLS-Valve) and PBR shall be employed.

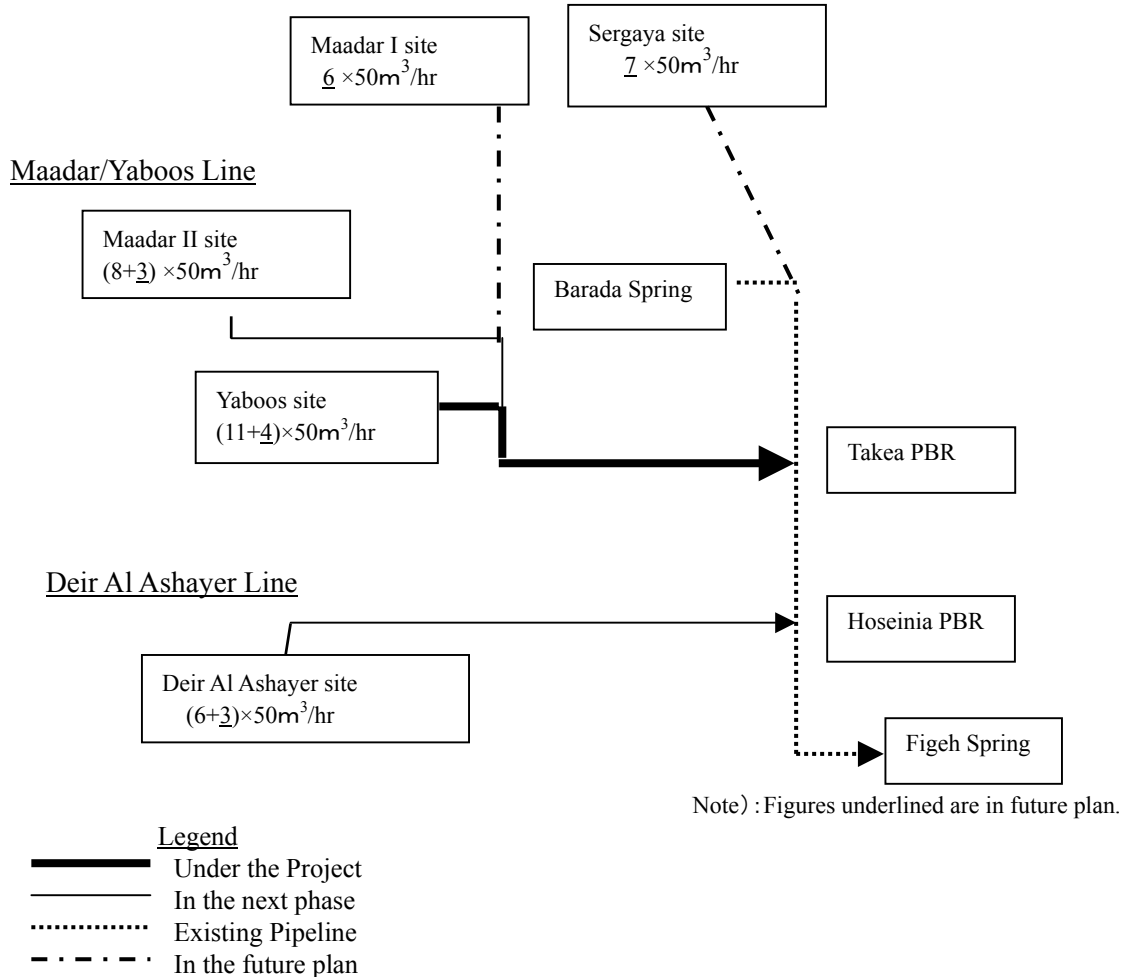


Figure -1 General Plan

Thus, the equipment and materials provided under the Project are summarized as Table -3.

Table -3 Summary of Equipment and Materials to be Provided

Item	Quantity	Purpose
DICP	Collection pipeline (250mm ~ 400mm, 1.1km)	Collection of water source from 11 wells
	Transmission pipeline (600mm, 11.5km)	Transfer water from Yaboos water field to Takea PBR
Submersible pump	Q=0.83m ³ /min, 11sets	Well pumps in Yaboos well field
CWLS-Valve	600mm, 2sets Accessoires : Strainer, Butterfly valve, etc.	To protect pipelines from high water pressure

The project cost is roughly estimated as follows through detailed and comprehensive design and examination.

Project Cost: 946 million yen (Japanese side; 737 M.Yen, Syrian side; 209 M.Yen)

Table -4 Project Cost born by Japan

Items	Cost (million yen)
(1) Construction cost	-
(2) Procurement cost	709
(3) Consultant fee	28
Total	737

Direct beneficiaries by the implementation of the Project are 2.822 million people living in Damascus metropolitan area and it corresponds to around 16% of the total population of Syria. Under the Project, a new water source shall be provided and 13,200 m³/day of water can be supplied additionally during dry season from October to November, and it will contribute to reduce the water supply suspension times for around 30 minutes against around 13 hour a day in an average of current five years. It shall reduce severe inconveniences for economic, hygienic, and/or social aspects caused by quite often and for long time water supply suspension to the people living in the area, in particular to the poverty zone, and relieve social unrest. Furthermore, for DAWSSA, flexibility on selecting water sources in dry season or for emergency is to be expanded enabling to avoid intensive groundwater withdrawing from one site. Through the EIA process under the Project, the rural people raised up their concern to the environmental and social influences and/or healthy drinking water, as well as a saving water for irrigation.

Operation and maintenance of the facilities constructed under the Project are to be done by the Production Division of DAWSSA. Total 239 staffs including temporary workers are on the register of the division (as of March, 2004). Under the division, the Barada and Figh Branch-office is operating and maintaining the Barada-Figh transmission pipeline (1,200 mm in diameter) with 55 staffs including a general manager, and the scale or functions of the pipeline is similar to the one planned under the Project. For repairing of the pumps, the division has 40 staffs in charge of mechanical and electrical works, with enough capacity for checking pumps, replacing parts, and so on required for operation and maintenance. Thus, DAWSSA is deemed to have enough capacity to operate and maintain the facilities to be constructed under the Project from technical and work force points of view, as well as the financial support for operation and maintenance.

Direct and indirect effects mentioned above are expected through the implementation of the project, and the project shall contribute to level up the living standard and relieve social anxiety of the people in Damascus metropolitan area, in particular of the poverty zone. These effects justify the project to be undertaken under Japan's Grant Aid scheme. However, the total water balance of Barada/Awaji Basin including the project sites was already in deficit, and groundwater system was in over-withdrawal. Under the situation, a systematic groundwater monitoring and serious operation of the new water sources based on the monitoring records are quite essential to avoid further deterioration of the water balance of the basin. And, on the contrary, to promote countermeasures to improve water supply condition of Damascus without further aggravating of water balance in the basin is also required when the quite poor water supply condition of the capital is considered. Finally, the Project can be implemented more smoothly and effectively when the following technical issues are fulfilled or provided:

- (a) Production Division of DAWSSA shall be trained to install, operate and maintain the pressure reducing facility newly introduced under the Project,
- (b) Production wells constructed under the Project were deep and the pumps must be installed as deep as more than 100m which DAWSSA had less experience. Training or technical assistance on this issue shall be needed, and
- (c) DAWSSA has enough number of engineers on construction, operation, and maintenance but the number of hydrogeologist in charge of planning, investigation, and analysis of water resources is insufficient, and the technologies on hydrogeological analyses such as the installation of well site, interpretation of pumping test, group well pumping simulation, etc., are not so sufficient. Technologies transfer on hydrogeological investigation and analysis are required.

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Chapter 1. Background of the Project

Damascus City Water Supply and Sewerage Authority (hereinafter referred to as “DAWSSA”) under the Ministry of Housing and Construction (hereinafter referred to as “MoHC”) is the organization in charge of the water supply for Damascus City and its vicinal villages. Major water source to supplying areas by DAWSSA is the Fiegh Spring. However, water supply condition for Damascus City was fallen into severe water shortage recently due to rapidly increasing population of Damascus Metropolitan Area, causing a deficit in water supply around 35,000 m³/day even in a wet year. It becomes very severe in particular during the period from August to December, when the yield of Fiegh Spring used to be decreased, enforcing heavy inconvenience upon the people such as water supply suspension for many hours.

Under the situation, DAWSSA tried to formulate a master plan on the improvement of Damascus City water supply and the development study by Japan International Cooperation Agency (hereinafter referred to as “JICA”), “The Study on the Development of Water Supply System for the Damascus City” (hereinafter referred to as “the Master Plan Study”) was conducted from 1996 to 1997. The Master Plan Study recommended the water supply improvement schemes consisted of the rehabilitation of existing facilities, the reduction measures on leakage from the networks, the improvement of water quality and intake facilities, as well as the water supply expansion schemes including the provision of water supply on the illegal residential zone and the development of new water sources. In response to the recommendations, the Government of Japan carried out two phases of grant aid projects of “The Project for Rehabilitation of Water Distribution Pipelines in Damascus City” since 1997, and dispatched experts on the water leakage to Syria. Through these activities, the leakage ratio of Damascus City has been drastically improved from 34.7% in 1995 to 23% in 2003. Such efforts are still presently continued, but additional water sources through development of new water sources inside Damascus City well fields were not so much to improve the water supply condition of the city. While, “The Project of Supplying Part of the Water Demand of Damascus City and its Countryside from the Syrian Coastal Area Water Supply”, one of the future water sources development plans of DAWSSA expected to be a drastic improvement plan for Damascus City, is still in a planning/designing stage and it will be realized after 2017. Thus, the serious water supply condition of Damascus City is predicted to be worse and worse for the time being.

Under such circumstances, the Government of Syrian Arab Republic formulated “The Project for Development of New Water Sources for Damascus City” (hereinafter referred to as “the Project”) and requested the Government of Japan to provide equipment and materials needed to implement the Project, after DAWSSA obtained the water rights for water resources development in the three sites; at Deir Al Ashayer site around 25 km west of Damascus City, and at Yaboos and Maadar sites around 45km northwest of Damascus City.

Equipment and materials requested by the Government of Syria are as follows:

- (a) Yaboos and Maadar Sites;
 - Submersible pump (50 m³/hr, H=300m) 20 sets
 - Collection pipes 1 set
 - Emergency diesel generator (300 KVA) 4 sets
 - Transmission pipes (500 ~ 600mm) 35 km
- (b) Deir Al Ashayer Site;
 - Submersible pump (35 m³/hr, H=100m) 5 sets
 - Collection pipes 1 set
 - Emergency diesel generator (200 kVA) 1 set
 - Transmission pipes (300 ~ 400mm) 12 km