APPENDIX-1. Member List of the Team

(1) Field survey (in 1998)

Leader	Hisao USHIKI
	Development Specialist, Institute for International Cooperation
	Japan International Cooperation Agency
Technical Counselor	Nagatoshi MAKITA
	Manager, Hokubu Distribution Management Office,
	Distribution Department, Waterworks Bureau, Yokohama City
Coordinator	Tsutomu TANAKA
	First Project Study Division, Grant Aid Project Study Department,
	Japan International Cooperation Agency
Chief Consultant/ Operation & Maintenance Planning	
	Noriyasu KIMATA
	Sanyu Consultant
Water Supply Facilities Designer	
	Masahiro ISOMURA
	Sanyu Consultant
Water Supply Planner	Yasuo TERAMURA
	Sanyu Consultant
Equipment Planner	Masatoshi ARAI
	Sanyu Consultant
Cost Estimator/ Procurement Planner	
	Yoshiji SAKEMOTO
	Sanyu Consultant
Hydrogeology	Iwao HAMADA
	Sanyu Consultant

(2) Implementation review (Explanation of the draft report in 2000)

Leader	Hisao USHIKI
	Senior Advisor, Institute for International Cooperation
	Japan International Cooperation Agency
Chief Consultant/ Operation & Maintenance Planning	
	Noriyasu KIMATA
	Sanyu Consultant
Water Supply Facilities Designer	
	Takumi MATUO
	Sanyu Consultant
Cost Estimator/ Procurement Planner	
	Yoshiyuki KOJIMA
	Sanyu Consultant

APPENDIX-2. Schedule

(1) Field survey (in1998)

Date	Activities
Aug. 30	Arrive to Damascus,
	Courtesy call on JICA in Damascus office, Embassy of Japan, State Planing Commission, Ministry of Housing & Utility and the Establishment
	Explanation of I/R to the Establishment
31	Discussion with the Establishment
Sep. 1	- ditto-
2	Field inspection in the project area
3	Field inspection in the Phase I project area
4	- ditto-
5	Preparation and discussion of draft Minutes of Discussions
6	Discussion of Minutes of Discussions
7	Signing of the Minutes of Discussions
	Reporting to Embassy of Japan and JICA
8 ～26	Site survey, data collection and discussion with the Establishment
27	Discussion with the Establishment
28	- ditto-
29	Preparation and discussion of Technical Note
30	Discussion of Technical Note
	Reporting to Embassy of Japan and JICA
Oct. 1	Signing of Technical Note
2	Leave Damascus

N.B. The Establishment: General Establishment of Drinking Water and Sewerage in the Rural Province of Damascus

(2) Implementation review (Explanation of the draft report in 2000)

Date	Activities
Feb. 26	Arrive to Damascus,
27	Courtesy call on JICA in Damascus office, Ministry of Housing & Utility and the Establishment Explanation of D/R to the Establishment
28	Discussion with the Establishment, field inspection in the project area
29	- ditto-
Mar. 1	Courtesy call on JICA in Damascus office, Embassy of Japan, State Planing Commission, Ministry of Housing & Utility and the Establishment Explanation of D/R to the Establishment
2	Discussion with the Establishment
3	Field inspection in the project area
4	Preparation and discussion of draft Minutes of Discussions
5	Ditto, courtesy call on Governorate of Rural Damascus
6	Discussion of Minutes of Discussions
7	Signing of the Minutes of Discussions
8	Internal meeting, courtesy call on Ambassador of Japan
9	Reporting to Embassy of Japan and JICA, Courtesy call on State Planing Commission and the Establishment
10	Internal meeting
11	Discussion of Technical Note with the Establishment
12	Signing of Technical Note, reporting to Embassy of Japan and JICA
13	Leave Damascus

N.B. The Establishment: General Establishment of Drinking Water and Sewerage in the Rural Province of Damascus

APPENDIX-3. List of Parties Concerned in the Syrian Arab Republic

(1) State Planing Commission

Mr. Bassam Al Sibai	Director of Technical & Scientific Cooperation
Ms. Elham Mourad	In charge of Japan Desk

(2) Ministry of Housing & Utilities

Mr. Husam Al Safadi	Minister
Eng. Mazen Al Laham	Director of Planing and Statistic
Eng. Mazen Saffour	Mechanical Engineer

(3) Governorate of Rural Damascus

Eng. Subhi Muhammed Hamidah	Governor

(4) General Establishment of Drinking Water and Sewerage in the Rural Province of Damascus

Eng. Adnan Deeb	General Director
Eng. Mamdouh Youniss	Director of Studies & Execution
Mr. Wafa Al Safadi	Director of Finance
Eng. Kamilia Abdul Aziz	Director of Planning
Eng. Faouzy Al Saqa	Director of Operation & Maintenance
Eng. Najdat Maksoud	Geologist of Water Resources Development
Mr. Mustafa Al Souki	Surveyor
Mr. Monir Damaa	Head of Qatana Water Unit
Mr. Amjad Gandour	Head of Daraya Water Unit
Mr. Yousyf Qazah	Subside of Daraya Water Unit
Ms. Joumana Zein Aldeen	Head of Sehneya Water Unit
Eng. Ali Borro	Chief of Workshop
Eng. Mostafa Kahlous	Chief Electrical Engineer of Workshop
Eng. Heithen Shillia	Mechanical Engineer in Workshop
Eng. Norman Asaad	Mechanical Engineer in Workshop
Eng. Abdel Azeez Alwakay	Mechanical Engineer in Workshop
Eng. Khaled Al Khateeb	Head of Yabroud Water Unit
Eng. A. Rahman Aynieh	Head of Nabek Water Unit
Eng. Khaled Ghanum	Head of Deir Atiya Water Unit
Eng. Atres Al Msuty	Head of Ruheibe Water Unit
Eng. Ibrahim Hishan	Head of Domair Water Unit

(5) Damascus City Water Supply and Sewerage Authority

Eng. Khaled Shalak	Director of Design and Construction Works

(6) Ministry of Irrigation

Eng. Mohamed Salim Al Aiyubi	Hydrology of Barada Al Awaj Basin
Eng. Marwahn Sateh	Hydrology of Barada Al Awaj Basin

(7) Embassy of Japan

Mr. Takeshi KAGAMI	Ambassador (in 1998)
Mr. Kishichiro AMAE	Ambassador (in 2000)
Mr. Katsuhito SAKA	First Secretary
Mr. Seizoou MATSURA	First Secretary

(8) JICA Syria Office

Mr. Katsuhiko EBINA	Resident Representative
Mr. Shinji GOTO	Assistant Resident Representative (in 1998)
Mr. Teruhiko KAWABATA	Assistant Resident Representative (in 2000)
Mr. Chiaki SUZUI	Expert

APPENDIX-4. Minutes of Discussions

(1) Field Survey (in 1998)

(2) Explanation of the Draft Report (in 2000)

APPENDIX-5. Technical Note

(1) Field Survey (in 1998)

(2) Explanation of the Draft Report (in 2000)

APPENDIX-6. Discharge of Natural Fountains in Rima District

(1) Present Condition of Natural Fountains

There are seven natural fountains in the Rima district, three at the upper stream of the water source and four at the downstream. These are used of water source of drinking in the Rima and irrigation in the field. Location of these natural fountains is shown Fig. V-1 and the present conditions are shown as follows.

Table Present Condition of Natural Fountains

Natural Fountains	Location	Discharge (m3/h)	Used for
Kosiata	Upper stream	10	Drinking
Ein-Kebir	Upper stream	5-10	Irrigation
Obscurity	Upper stream	2	Irrigation
Obscurity	Down stream	Dry up	Irrigation
Ein-Shabahni	Down stream	120	Irrigation
Ein-Bardeh	Down stream	24	Irrigation
Ein-Aljan	Down stream	Unclear	Irrigation

(2) Outline of Irrigation

(a) Water source: Springs mentioned in the Table V-1 and well No.825R'
(b) Irrigation area: 45 ha of orchard, 50% of them are irrigated by pump.
(c) Irrigation period: June-October
(d) Irrigation Unit: 5 mm/day or 50 m3/day/ha
(e) Efficiency: 60 %
(f) Irrigation hour: 20 hr/day
(g) Total volume: 1.2 1/s/ha × 45ha=54 1/s

(3) Outline of Well No. 825 R'

(a) Operation and maintenance unit: Multi-objective Farmers Society in Rime Village
Chairman of society; Mr. Fares Ma'en
(b) Number: 146 farmers
(c) Irrigation area: 23 ha
(d) Specification of pump
Type; Borehole pump
Bore; 100mm
Delivery; 40 1/s
Well depth; 40m
Driver; V-belt motor, 30kw, 380v

APPENDIX-7. Results of Pumping Test by the Survey Mission

The Survey Mission conducted 3 series of pumping test by use of the existing 6 wells and a observation well in Rima district. The wells selected for pumping are No. 825C, 867 and 825A, while others were for observation of ground water table.

(1) Preliminary pumping test

Preliminary tests were made at about 40 l/s (3,456 m3/day). Water table drop in the pumping wells are as small as 0.76 to 2.81m, and the table became stable within 1 to 2 minutes and were kept unchanged thereafter. After stop of pumping, the table recovered in a minute or so. Accordingly, incremental pumping rate for step drowdown pumping test was set at a quarter of 40 l/s as 10 l/s.

(2) Step drowdown pumping test

Results of step drowdown pumping test by incremental 4 stages and 1 recovery are as follows.

Well No.	Stage	Specific production l/s/m	Coefficient of head loss in aquifer B	Coefficient of had loss of well C	Well efficiency
825A	1 2 3 4	17.8 12.0 13.6 14.2	0.0676	0.0675	90.6%
867	1 2 3 4	18.2 20.3 21.2 20.9	0.0551	-0.00022	119%
825A	1 2 3 4	55.0 50.2 52.1 52.7	0.0187	0.000056	97%

From the above results, loss heads by pumping rate were calculated as follows.

Well No.	at 40 l/s	at 45 l/s	at 50 l/s
825C	2.98	3.39	3.82
867	1.86	2.04	2.21
825A	0.78	0.88	0.98

(3) Constant discharge pumping test

Drops of water tables by continuous 12-hour pumping in the pumped and observation well were observed as follows.

(a) Drop of water table observed after 12-hour pumping from No. 825C, was 7 cm, 3.5 cm and 1.5

cm in well Nos. 867, 825B and 825A, respectively. No drop of water table was observed by other wells.

(b) Any drop of water table observed after 12-hour pumping from No. 867, was not observed.

(c) Drop of water table observed after 12-hour pumping from No. 825A, was 1.0 cm in both wells Nos. 825B and 825R. No drop was observed in other wells.

(d) Recovery of water table was so rapid in all well within 1 to 3 minutes to the original.

Drop of water table after continuous 12-hour pumping is summarized as follows.

Well No.	Static water table		Distance from pumping well	Drop of table after 12-hour pumping	Purpose
	Depth from riser head	Water table			
825C	10.7	1427.01	-	3.240	Pump. Well
825B	7.46	1430.11	51.46	0.035	Observ. Well
867	22.22	1419.82	132.69	0.070	Observ. Well
825A	6.20	1427.02	94.08	0.015	Observ. Well
825R	6.66	1427.09	112.08	0.000	Observ. Well
864	12.00	1415.37	213.16	0.000	Observ. Well
K1	8.40	1428.87	123.26	0.000	Observ. well
867	22.30	1419.74	-	1.54	Pump. Well
K1	8.40	1428.87	247.03	0.00	Observ. Well
825C	10.77	1426.94	132.69	0.00	Observ. well
825A	6.31	1426.91	-	0.71	Pump. Well
825R	6.78	1426.97	18.14	0.01	Observ. Well
825B	7.60	1426.97	42.70	0.00	Observ. Well
825C	10.70	1427.01	94.08	0.00	Observ. well

(4) Water quality

Quality of pumped water from No. 825C showed nominal turbidity in the beginning while sand particles of 0.2 to 0.5 mm were found in the water. The turbidity seemed to be 100 to 500 ppm. PH showed slightly alkaline 7.8 and water temperature was 16.7℃.

Water quality of No. 867 showed turbidity for 30 minutes after start of pumping and became clear. Sand particles were continued to appear while pumping and the concentration seemed to be similar to No. 825C.

Water quality of No. 825A was also similar to No. 825C. No turbidity was observed but sand continuously appeared though the concentration seemed to be a half of No. 825C's.

(5) Drop of water table by new well

Drop of water table by installation of new wells require some additional pumping loss head (aquifer loss plus well loss) which has to be calculated from the result of step drawdown pumping tests. However, the design capacity of pumps shall be determined after the pumping tests of the new wells, which have not been dug yet. For convenience in practice, some relation between drop of water table by aquifer loss and well loss and that by specific production has been found and applied instead.

Drops of water table by aquifer loss and well loss given by the step drawdown pumping tests in wells No. 825C, 867 and 825A have been compared with those calculated from the specific well production.

Drop of water table by pumping stage by step drawdown pumping tests (m)

Well No.	B	C	at 40 l/s	at 45 l/s	at 50 l/s
825C	0.0676	0.0675	2.98	3.39	3.82
867	0.0551	-0.00022	1.86	2.04	2.21
825A	0.0187	0.0000556	0.78	0.88	0.98

Drop of water table by pumping stage by specific production (m)

Well No.	Specific production	at 40 l/s	at 45 l/s	At 50 l/s
825C	14.2	2.82	3.17	3.52
867	20.9	1.91	2.15	2.39
825A	52.7	0.76	0.85	0.95

Ratio of water table drop by step drawdown pumping test to that by constant discharge pumping test and recovery testis given in the following table.

Ratio of drop by step drawdown pumping test to that by constant discharge pumping test

Well No.	at 40 l/s	at 45 l/s	At 50 l/s
825C	1.06	1.07	1.08
867	0.97	0.95	0.92
825A	1.03	1.03	1.03

As the above table indicates, the ratio varies between 0.93 and 1.08. Accordingly, additional 10 % of the drop by specific production have been employed to substitute the table drop by aquifer loss and well loss.

(6) Design pumping head

For determination of required pumping loss heads for the new wells, the water table drop for independent wells by pumping rate has been taken at the lowest specific production rate of 4.80

l/s/m among those by pumping test up to present.

Water table drop for independent well

Specific production	at 40 l/s	At 45 l/s	at 50 l/s
4.80	9.71 m	10.32 m	11.46 m

In addition to the above, sum of seasonal fluctuation of static water table and well group interference gives the total pumping head. As shown in the well inventory, the maximum fluctuation of stable water table so far recorded is 7.60 m, which is exceeding the seasonal fluctuation of 5～6 m in hilly area by 1 m or more.

The water table drop by well group interference may be not more than 10 % of the water table drop by the independent well, judging from the following reasons;

① water table drop of maximum 7 cm by current constant discharge pumping tests,
② influence circle as 50 m,
③ distance between wells more than 30 m or 40 % of the circle,
④ same pumping rate for each well, and
⑤ same well bore designed 300mm in diameters,

Accordingly the drop by the interference has been assumed as 1.2m or less. Consequently the total water table drop has been estimated as in the table below.

Estimation of water table drop

Cause of drop	At 37 l/s	At 40 l/s	At 45 l/s	At 50 l/s
On specific production at 4.80 l/s/m	8.60 m	9.17 m	10.32 m	11.46 m
Seasonal fluctuation	8.00 m	8.00 m	8.00 m	8.00 m
Interference	0.80 m	0.92 m	1.04 m	1.15 m
Safety margin (20%)	1.72 m	1.84 m	2.07 m	2.30 m
Total	19.12 m	19.93 m	21.43 m	22.91 m

Consequent to the above evaluations, the depth of pumps will be at El 1,390 m. In case that the HWL of the receiving tank will be provided at El 1,442 m, the boosting head becomes 51 m at maximum.

APPENDIX-8. Design Data

- Hydraulic Calculation of Transmission Pipeline
- Calculation table for pump capacity
- Water Hammer Pressure Curve (without measure)
- Water Hammer Pressure Curve (without measure by air vessel)

Calculation table for pump capacity

Item	Unit	Well pump	Transmission Pump	Booster pump
Per unit delivery	M3/h	138	402	75
	M3/m	2.3	6.7	2.50
Loss head calculation:	Mm	150	-	-
Bore of well pump pipe	M/s	2.2	-	-
Hydraulic gradient of the above	M/m	0.042	-	-
Length of well pump pipe	M	36 – 48	-	-
Loss head by the above	M	1.5 – 2.0	-	-
Total delivery	M3/m	20.1	20.1	2.5
Bore of collection/transmission pipe	Mm	150 – 300	500	200
Flow velocity of the above	M/s	1.78 –1.06	1.71	1.33
Hydraulic gradient of the above	M/m	-	0.0069	0.013
Length of collect./transmit. Pipeline	M	-	2,604	328
Loss head by the above	M	4.1 – 1.3	18.0	4.2
Loss head around pump	M	1.0	3.0	2.0
① Total loss head	M	5.1 – 2.3	21.0	6.2
Actual head calculation:				
WL at delivery end	El m		1565.0	799.5
WL at suction end	El m	1442.0	1439.5	762.5
Dynamic water table in well	El m	1396.3- 1408.0		
② Actual head	M	45.7 –34.0	125.5	37.0
①+②	M	52.6 –38.7	146.5	43.2
Total pump head	M	54 - 45	150	45
Driver output	Kw	30	280	18.5
No. of unit	Unit	9	3	1

APPENDIX-9. Reference Drawings

Drawing List

Dwg. No.	Drawing Title
1	General Plan
2	Plan of Collection Pipeline
3	Plan of Well and Well House
4	Layout of Transmission Pump Station
5	Section of Transmission Pump Facility
6	Layout of Booster Pump Station
7	Plan of Ground Reservoir
8	Section of Ground Reservoir
9	Layout of Pressure Reducing Facility
10	Plan & Profile of Transmission Line
11	Typical Type of Thrust Blocks

APPENDIX-10. Cost Estimation borne by the Syrian Government

APPENDIX-11. List of Collected Data

- Statistical Abstract 1997、1996、1995
- Rapport Economique Syrien 1995-1996、1994-1995
- 1998 Syrian's Budget
- Report on the 1998 Syrian's Budget
- 8^{th} Five years plan (draft)
- Space Image Atlas
- Syria Today
- Budget report (1997、1996、1995)
- Topographical map(1/2,000,000、1/1,000,000、1/200,000、1/50,000、1/25,000)
- Geological map（1/200,000)
- Well datain Rima and Erena
- Hydro geological report：Derectrate of Generak Irrigation for Barada and Awaji Basin, Hermon Project (Ministry of Irrigation)
- Location map of wells (1:1,000)
- Survey drawing and field data
- City plan, Daraya (1:2,000), Moadamiya (1:2,000), Sehnaya (1:2,000), Ashrafia (1:2,000), Quatana (1:2,000)
- Typical Drawings (valve, railway crossing, elevated tank, etc.)