CHAPTER 7
INSTITUTIONAL AND LEGISLATIVE IMPROVEMENT

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This chapter deals with the three major subjects related to national water resources management, namely privatization, wastewater reuse and reduction of groundwater abstraction. It reviews the current status of these themes from institutional and legislative standpoint, that is, it summarizes the institutional and legislative measures that have been formulated or are being implemented for them.

Salient points for all the relevant laws, by-laws and other administrative and technical regulations are highlighted in Chapter 7 of the Supporting Report, and the directly related organizations and their functions are presented in 1.7 of Chapter 1 in this report.

Proposals with regard to institutional and legislative improvements are put forward by the JICA study team and are presented in 8.2 of Chapter 8 in this report.

7.1 Privatization of O/M in Water Supply/Transfer System

7.1.1 Evaluation on Privatization of Water Supply System in Amman

(1) PMU

1) PMU, which belongs to WAJ is an abbreviation of Program Management Unit. PMU, which started in 1996, is essentially an organization aiming at UFW reduction. UFW consists of two components. One is the physical component and the other is the administrative component. There are around 25 personnel.

2) PMU consists of four directorates: Capital Investment, Management Contract, Governorate Support and Leak Detection.

3) The Capital Investment is in charge of "restructuring and rehabilitation of Amman networks". It coordinates with the Management Contract during the implementation works. Extending pipes longer than 500 m will be done by the directorate. It coordinates with the Leak Detection directorate in leak detection programs. About 150 million JD will be spent as capital investment up to the year 2003.

4) The management of the Amman Water Supply and Sewerage Services is now left to LEMA, a private company, which is under the Management Contract Directorate. LEMA is responsible for management of the water and sewer systems both on the technical and financial sides, based on certain disciplines.

5) Governorate Support is now engaged in supporting activities for Aqaba and Irbid. Later on, they will cover the entire Middle Sector including Madaba, Zarqa and Balqa. (Middle Sector= Amman, Madaba, Zarqa and Balqa)

6) Leak detection is done by WAJ in coordination with the contractors (private sector).

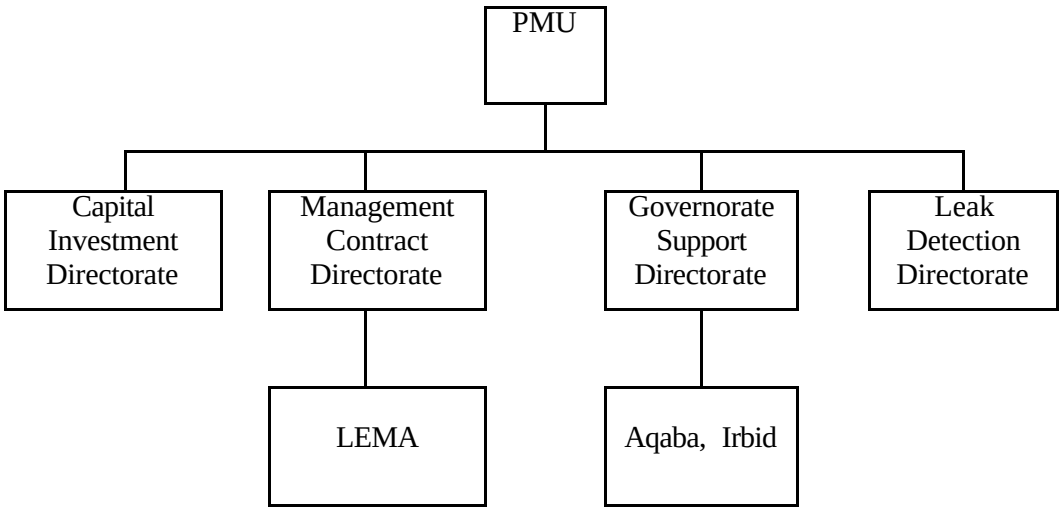


Figure 7.1.1-1 Organization Chart of PMU

(2) LEMA

1) Status Quo
LEMA, which started in July 30, 1999 under the 4 year contract with WAJ, now handles the Zai Water Treatment Plant, 100 water wells, 4,500 km of water networks, 1,500 km of sewers, two wastewater treatment plants and provides water services to 1.8 people in the area.

2) Quantitative Objectives
A major quantitative objective is to reduce UFW by 10 points in 1st year, and 25 points in 4th year. The UFW at the beginning of LEMA was 54.4%. Improvement of bill collection is being aimed for and accounts receivable will be decreased by 30% in 1st year. Overall revenues are planned to be increased by a quarter by the end of the contract period.

3) Major Quantitative Achievements in 1st Year
Refer to Table7.1.1-1 at the end of this section.
   (a) UFW was reduced to 49% as of July 2000, one year from the start of LEMA management, 5 points less than the target. One reason for it is said to be an increasing degree of measurement accuracy.
   (b) Annual revenues increased in one year from 19.2 million JD by 16% to 22.3 million JD. At the same time, accounts receivable were reduced from 40.4% by 28% to 29.2%. All of these can be explained by an effort for improvement in bill collection.
   (c) Technical services improvements were energetically carried out. For instance, 81% of facilities rehabilitation was completed against the target of 50%, and the achievement of preventive maintenance of electro-mechanical equipment such as pumps and motors was 116% in comparison with the target of 50%.
   (d) Water operations were remarkably improved as exemplified by the replacement, sealing and realignment of defective and old meters numbering 50,097, fulfilling the target of 50,000, and the average response time for leakage repairs recording 8 hours as compared to the target of 24 hours.
   (e) In connection with customer services, illegal connections discovered and

disconnected, illegal connections legalized by payment and illegal users sent to court reached 1,144, 1,132 and 492 respectively.

(f) The No. of personnel was reduced from 1,430 by 11% to 1,277, and the No. of personnel trained summed up to 790.

4) Management Concept of LEMA

(a) Demand management is as important as supply management.

(b) Making overhead water tanks as big as possible is a measure of wrong perception and direction.

(c) In Amman water is supplied 1.5 days a week on average. The frequency of water supply differs among areas. LEMA is exerting effort to supply water over different areas in a more even manner through a new rationing program.

(d) Replacing broken meters, repairing leaks from pipelines, repairing/ replacing broken-down pumps, cleaning sewers, disconnecting illegal connections, and stopping supplying water to non-paying customers, these things are being energetically executed to reduce physical and administrative losses. *"Management by Objectives"*

(e) Quick response to customers' call is one of the tasks LEMA is quickly implementing. To this end, automation of daily operations are now underway with the help of GTZ. A customer-oriented service is their 1st priority. *"Customers' Satisfaction"*

(f) LEMA does not think it very important to reduce personnel because labor cost is cheap, although 150 staff have been reduced so far.

(g) Water quality gets bad in some cases. LEMA is trying to upgrade it to meet the Jordanian standard.

(h) Intense training to fulfill one's duty by oneself without leaving it to others is being done. One training program has been completed for meter readers and money collectors to upgrade their performance, meet their job challenges, and better serve the customers. Staff members receive bonuses in accordance with their performances. *"Performance Based Remuneration", "Nurturing of Motivation"*

(i) The importance of water is publicized by LEMA at every opportunity available.

(j) LEMA has been doing business successfully because:

- It maintains good relationships with the client, that is, WAJ.
- It maintains good relationships with on-site workers such as meter readers, bill collectors and repairmen, without which the reduction of losses cannot be achieved.

(k) O & M is not necessarily being reduced because various measures are being taken to reduce water losses.

(l) The task assigned to LEMA is a long-term project and not the one to be completed in a short period.

Table 7.1.1-1 Major Quantitative Achievements in One Year (Aug. 1999 to Jul. 2000)

Item	Aug. 1999	Jul. 2000	1 Yr. Target
UFW (%)	54	49	44
Financial Achievements			
Yearly Revenues Collected (JD)	19,174,319	22,323,177	
Accounts Receivable to Revenues (%)	40.4	29.2	
Technical Services Achievements			
Well Head Protected (%)	0	73	50
Facilities Rehabilitation Completed (%)	0	81	50
Area with Water Mains Digitised (%)	73	100	100
Area with Water Mains Updated (%)	0	113	100
Area with Wastewater Mains Digitised (%)	0	29	25
Preventive Maintenance of Electro-Machanical Equipment (%)	38	116	50
Reduction in Facility Breakdowns since the Starting Date (%)	0	73	20
Water Operations Achievements			
Old Meters Replaced	0	50,097	50,000
Area where Leakage Surveys Completed (%)	0	39	25
Response Time for Leakage Repairs (hrs)	NA	8	24
Wastewater Department Achievements			
No. of Illegal Storm Water Pipe Connections Notices Served		1,391	
No. of Properties that have Disconnected		765	
Wastewater Complaints Response Time (hrs)	NA	3.7	12
Customer Services Achievements		270	
Illegal Connections Discovered and Disconnected (Total for Year)		1,144	
Illegal Connections Legalised by Payment (Total for Year)		1,132	
Illegal Users Sent to Court (Total for Year)		492	
New Connections Registered in the Data Base (Total for Year)		11,153	
Personnel			
No. of Personnel			
Core Personnel	997	913	
Workers	433	364	
Total	1,430	1,277	
No. of Personnel Trained during One Year		790	

Source: LEMA's Report on Progress against Contractual Targets, Year 1, etc.

7.1.2 Institutional and Legislative Improvement for Privatization

The related policies and strategy prepared by MWI in recent years include Water Utility Policy, Jordan's Water Strategy, Wastewater Management Policy and Irrigation Water Policy. The major points stressed in them are described below:

(1) Transfer of management of infrastructure to the private sector

1) The government intends to transfer the management of the infrastructure and services from the public to the private sector to improve performance and to upgrade the level of service.

2) The private sector management will take the form of management contracts, concessions and others.

(2) Concepts of BOO/BOT will be promoted.

1) The concepts of BOO/BOT will be entertained.

2) BOT or similar private sector mechanisms will be considered for new bulk water supply and wastewater treatment facilities. (WAJ)

3) The private sector will be called upon to assume a proper role in development as well as in O & M activities in irrigated agriculture. (JVA)

(3) Private sector role and farmers' participation in irrigated agriculture

1) The private role in irrigated agriculture will be encouraged and expanded.

2) The private sector role in reuse of treated effluent will be encouraged and expanded.

3) Water user groups will be encouraged at the stage level to take on the responsibility for retail delivery of water.

7.2 Treated Wastewater Reuse in Agriculture

7.2.1 Unit Cost of Treated Wastewater for Reuse

The facilities required to bring treated wastewater to the site for reuse include conveyance pipelines, pumping stations, reservoirs and others. The cost consists of investment, as well as O & M costs. More or less 30 such projects are now under way or are being planned. The unit cost was estimated for each project, and eventually the weighted average of all such unit costs was calculated. It was then compared with the unit cost of other water resources. (Refer to Table 7.2.1-1.)

As the table shows, the average unit cost of treated wastewater for reuse comes to 38 fils. It is markedly cheaper than the unit cost of any other fresh water and saline water resources. This fact may augur well for the future of wastewater reuse. Regarding the proposal to pump up the As Samra treated wastewater to the highlands, the feasibility of such project is questioned because the unit cost can be higher than that of fresh water resources.

Table 7.2.1-1 Unit Cost of Wastewater Reuse (at 2000 Prices)

WW Treatment Plant	WW Discharge (m^3/a)		Capital Cost	O & M Cost (JD/a)		PV* of Cost	PV* of WW	Unit Cost
	2010	2020	(JD)	2010	2020	(JD)	Discharge (m^3)	(JD/m^3)
Abu Nuseir	1,060,250	1,458,439	143,000	9,350	9,350	220,591	9,780,231	0.024
Aqaba	7,828,969	14,258,972	7,411,300	113,401	148,007	5,820,054	75,040,116	0.078
As-Samra	45,000,000	76,000,000	15,200,000	450,000	760,000	10,512,871	283,212,867	0.037
Baqa								
Fuhis	744,741	1,094,807	19,240	8,874	8,874	52,018	4,244,138	0.012
Irbid (Central and Wadi Arab)	11,323,637	16,590,810	1,619,800	44,780	44,780	1,322,011	28,226,340	0.047
Jerash (East)								
Karak	951,161	1,417,235	240,240	9,724	9,724	235,103	8,322,489	0.028
Kufranja	2,005,676	3,439,852	455,000	19,350	19,350	318,813	16,268,154	0.020
Maan	755,401	1,399,761	263,900	20,447	21,314	250,179	6,271,124	0.040
Madaba	2,436,025	3,826,764	558,740	33,654	35,525	734,428	21,924,678	0.033
Mafraq	1,058,218	1,549,250	387,010	20,954	21,175	471,311	9,364,057	0.050
Ramtha	1,704,621	2,946,989	511,485	30,463	31,021	509,217	15,066,904	0.034
Salt								
Tafielah	838,258	1,159,795	332,410	21,470	22,191	321,064	6,231,407	0.052
Wadi Arab	11,323,637	16,590,810	1,619,800	44,780	44,780	1,322,011	66,279,771	0.020
Wadi Essir	532,045	805,046	42,900	8,965	8,965	61,599	3,136,401	0.020
Wadi Hassan	547,801	833,660	85,800	9,130	9,130	74,350	3,061,840	0.024
Wadi Mousa	1,115,224	1,607,427	115,180	9,243	9,243	158,625	8,397,390	0.019
Al Jeeza	1,900,025	2,879,440	500,630	34,195	36,391	704,188	17,522,667	0.040
Al Mazar Al Shamali								
Dair Abi Said	0	1,717,489	527,280	0	24,529	349,454	7,057,213	0.50
Dair Alla	1,776,141	2,401,393	785,330	32,813	35,458	890,059	22,713,238	0.039
Jerash West								
Kofur Assad	3,090,798	4,141,692	391,950	19,108	19,108	333,850	20,789,657	0.016
Aqaba South Coast	19,547	19,909	264,550	19,598	19,958	320,121	3,079,175	0.104
Naur	954,206	1,713,175	185,900	9,515	9,515	149,430	7,722,914	0.019
North Queen Alia Airport	6,164,830	9,342,642	822,900	29,565	29,565	706,338	52,350,149	0.013
North Jordan Valley	2,795,832	4,068,588	995,930	63,006	76,135	1,364,434	24,853,060	0.055
Shuna South	1,674,526	2,254,796	760,760	35,197	36,759	821,873	14,324,642	0.057
Torra	0	1,948,666	456,300	0	33,663	346,369	7,599,692	0.046
Um Al Basateen								
Wadi Shallala	4,055,897	5,949,123	967,070	39,908	43,305	953,551	34,866,796	0.027
Wadi Zarqa								
Mazar, Muta, Adnaniya	600,260	960,704	237,640	9,714	9,714	209,297	5,157,722	0.041
Dead Sea East Coast	658,486	1,237,102	523,380	21,719	25,098	445,432	6,039,669	0.074
Total	112916212	183,614,335	36,425,425	1,166,923	1,602,623	29,978,661	788,404,501	0.038

Note: * = In calculating PV, the annual discount rate of 6.5% and the project period of 30 years were assumed.

Comparison:

As Samra (Pumping up to Amman-Zarqa Highlands)

Option HL#2a	12,330,000	12,330,000	19,073,087	2,595,525	2,595,525			0.211
Option HL#3	9,648,000	9,648,000	28,211,803	3,647,284	3,647,284			0.378
Option HL#4	10,000,000	10,000,000	44,269,650	5,735,469	5,735,469			0.574

Source: Pre-Feasibility Study, Water Reuse of Agriculture and/or Forestry in the Amman-Zarqa Highlands by ARD

Rehabilitation of Urban Water Supply Systems					0.147
Water Saving Devices					0.147
Surface Water Development					0.161
Groundwater Development					0.189
Improved On-Farm Irrigation Systems					0.196
Disi Water (Production Cost)					0.385
Brackish Water Desalination					0.449
Sea Water Desalination (Production Cost)					1.035

Source: Middle East Regional Study on Water Supply and Demand Development by GTZ, JICA, etc.

7.2.2 Existing Institutional/Legislative Measures

There are three MWI policies/strategy related to wastewater reuse which were made public in recent years: Wastewater Management Policy, Jordan's Water Strategy and Water Utility Policy. Also, there are three related laws: the Water Authority of Jordan Law #18/1988, the Jordan Standard #202/1991 for Industrial Wastewater Discharge and the Jordanian Standard #893/1995 for Discharge of Treated Domestic Wastewater.
The three government policies/strategy and the three laws were summarized into 10 points from the standpoint of wastewater reuse as described below:

(1) Importance of wastewater as a water resource

High importance will be given to wastewater as a major water resource. In reusing wastewater, the highest priority will be given to irrigation. Also, the importance of recycling and reuse of industrial wastewater will be propagated.

(2) Following international standards for treatment of wastewater for reuse

In treating wastewater for reuse, international standards such as the WHO and FAO guidelines will be given due consideration.

(3) Institutional/legal improvement and development

1) A new organization will be set up in WAJ to deal with the increasing importance of wastewater reuse.
2) The role of the government will gradually evolve to be regulatory and supervisory.
3) The Ministry is moving, through restructuring, towards establishing the institutional capability for monitoring, regulating and enforcing wastewater regulations.
4) Legislation and institutional arrangements will be periodically reviewed and updated.
5) Institutional restructuring will be supported by adequate legislation, efficient law enforcement, and strong human resources development.

(2) Conditions in applying wastewater for irrigation

1) Wastewater intended for irrigated agriculture will be regulated based on the soil characteristics, the types of crops grown, the irrigation schedule and methods, and whether other water is mixed with the treated wastewater.
2) Overuse of nutrients will be avoided.
3) Leaching of soils will be advocated.
4) Farmers' knowledge on the rate of wastewater application needed for different crops will be promoted.
5) Prohibitions: Irrigation must be stopped two weeks before harvesting; sensitivity of some crops to some elements in treated domestic wastewater must be taken into consideration; irrigation of crops eaten raw is prohibited; diluting the treated domestic wastewater on-site is prohibited. (Standard #893/1995)

(3) Monitoring systems to be established

1) Treated effluent quality will be monitored and users will be alerted to any emergency.
2) All irrigated crops with treated wastewater will be periodically monitored.
3) Groundwater quality will be monitored near treatment plants.
4) Capacity of monitoring will be enhanced in terms of analytical methodology, laboratory equipment and human resources.
5) MWI will monitor all water resources for water quality to ensure it meets the standards.
6) Monitoring will be conducted to ensure safe supplies to consumers.
7) Treated wastewater will be isolated from surface and ground waters used for drinking purposes.

(4) Storing and recharging

Studies will be conducted and projects implemented to store the excess treated wastewater in surface and ground water reservoirs through artificial recharge techniques.

(5) Financial consideration to be promoted

1) Wastewater charges, connection fees, sewerage taxes and treatment fees will be set to cover at least O & M costs. It is desirable that a part of capital cost be recovered. The ultimate goal is full cost recovery.
2) PPP will be established.
3) Different charges for different areas, etc. will be applied.

(6) Related standards

Water Authority of Jordan Law #18/1988

1) Standard for industrial wastewater to be discharged to public sewers.
2) It provides the legal foundation for preventing the entry of toxic and damaging substances and liquids to public sewers.

Jordan Standard #202/1991 for Industrial Wastewater

1) Standard for reuse of industrial wastewater.
2) It incorporated the WHO guidelines for reuse of industrial wastewater that included four categories:
   Irrigation; artificial recharge of groundwater; discharge to the sea; discharge to wadis, rivers and catchment areas

Standards #893/1995 – Discharge Standards for Treated Domestic Wastewater

1) Standard for reuse of treated domestic wastewater.
2) It includes 7 categories of wastewater reuse standards depending on the fate of domestic wastewater after it is released from the wastewater treatment facility:
   Recycling of water for irrigation of vegetables that are normally cooked; recycling of water used for tree crops, forestry and industrial processes; discharges to receiving water such as wadis and catchment areas; use in artificial

recharge to aquifers; discharge to water bodies containing fish; discharge to public parks or recreational areas; use in irrigation of animal fodder.

(7) Priority in wastewater sector treatment

Criteria for prioritizing investments in the wastewater sector will take into account the current and future needs of the country, the needs to expand wastewater systems in urban areas and to provide wastewater systems to smaller towns and villages that are not yet served.

(8) Education and Campaigns

1) Public education on the risk and value of wastewater will be conducted.
2) Awareness promotion to farmers on the reuse and hazard of wastewater will be carried out.
3) Concerns for public and workers' health will be stressed in the reuse of treated wastewater.

7.3 Restriction of Groundwater Abstraction in Up/Mid Land

7.3.1 Projected Reduction of Irrigation Area

Because of over-abstraction from aquifers especially in the upper/middle highlands, the volume of groundwater abstraction in the highlands is projected in the World Bank scenario to be reduced from 171 MCM in 1998 to 83 MCM (49% of the 1998 level) in 2020.

In parallel with it, irrigated agricultural area in the highlands will be reduced from 54,100 ha in 1998 to 39,400 ha (73% of the 1998 level) in 2020. (Refer to Table 7.3.1-1.)

Table 7.3.1-1 Planning of Reduction of Agricultural Area in Water Demand Projection Scenario 1

Year	Item	Irrigated Area (000 ha)			Groundwater Abstraction (MCM)		
		Up/Mid-land	JRV	Total	Up/Mid-land	JRV	Total
1998	Total Area	54.1	36.0	90.1	171.0	29.0	200.0
	by Fresh Water	53.0					
	by Wastewater	1.1					
2005	Total Area	52.1	38.5	90.6	149.0	25.0	174.0
	by Fresh Water	48.0					
	by Wastewater	4.1					
2010	Total Area	47.8	42.6	90.4	130.0	20.0	150.0
	by Fresh Water	41.0					
	by Wastewater	6.8					
2015	Total Area	43.6	42.6	86.3	103.0	20.0	123.0
	by Fresh Water	35.0					
	by Wastewater	8.6					
2020	Total Area	39.4	42.6	82.1	83.0	20.0	103.0
	by Fresh Water	30.0					
	by Wastewater	9.4					

7.3.2 Institutional/Legislative Measures

Behind the above-mentioned World Bank projection, the institutional/legislative measures are presupposed to be taken.

7.3.2.1 Existing Policies for Reduction of Groundwater Abstraction

There are three policies concerned that have been prepared by MWI in recent years: Irrigation Water Policy, Water Utility Policy and Groundwater Management Policy.

The points taken up and stressed in the above policies are summarized as follows:

(1) Farmers are encouraged to minimize water use as much as possible by:

1) Applying water in such a way as to match the crop water requirements,
2) Providing over-night water storage facilities,
3) Applying water at night in summer,
4) Automating on-farm irrigation networks and their operation.

(2) Government shall aim for minimizing conveyance losses by:

1) Automating irrigated networks through electronic surveillance and monitoring of

the networks,

2) Preventive maintenance of pumps, motors and valves, and development of human resources in charge of it.

(3) Abstraction of groundwater shall in the course of time be reduced to the sustainable level, which shall be maintained thereafter by:

1) Installing meters to all groundwater wells,

2) Issuing drilling licenses and abstraction permits to all those who want to develop or use groundwater, and penalizing those who violate the regulations,

3) Monitoring the conditions and performance of groundwater reservoirs in response to development and abstraction through a network of observation wells and employing advanced technology such as water meters, remote control devices, telemetry, automation and field central controls,

4) Prohibiting well licensing for agricultural purposes,

5) Using fees and charges as an instrument to control groundwater over-pumping.

7.3.2.2 Measures for Reduction of Groundwater Abstraction

(1) Licensing Measure

The most effective solution for the reduction of groundwater abstraction is to reduce the total well number. It is suggested that wells normally deteriorate in 20 to 30 years after the completion and be renounced (abandoned) because of clogging of screen, corrosion of casing and other failures. If the licensing of the new well drilling and re-drilling of old wells will be suspended or controlled to issue, the well number will be reduced and abstraction amount also get smaller consequently.

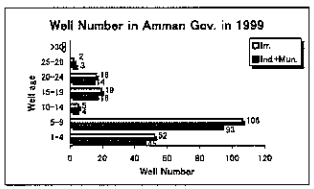
Trial prediction was done for Amman governorate to reduce the groundwater abstraction by controlling the licensing of well drilling. The result is shown in Fig. 7.3.2-1. As shown in this figure, the target reduction amount is 30MCM/a by 2020 in this governorate (refer to Table 2.2.5-1) and 375 wells abstracted renewable groundwater at rate of 64MCM/a in 1999 according to WIS data. Relatively new wells less than 10 years in age occupy about 80% of the total wells. The wells for irrigation purpose may occupy about 55% of total wells. The average abstraction rate per well is estimated at around 0.17MCM/a.

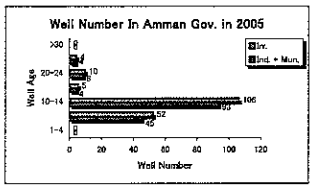
In this trial calculation, following assumptions were set:

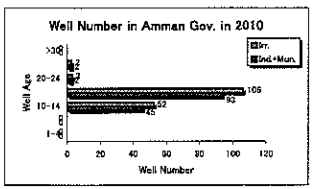
- 50% of the total wells will be renounced during 20 to 24 years aftern the completion
- 87.5% of the total wells will be renounced during 25 to 29 years after the completion

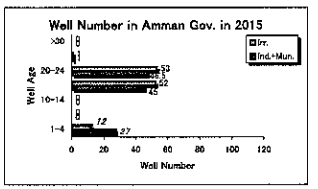
Reduction Plan of Groundwater Abstraction in Amman Governorate
Target Abstraction Amount by 2020 : 34 MCM/a Renounce Rate of Well : 1. 50% of total number will be renounced during 20-24 years in age, 2. 87.5% of tatal number will be renounced during 25-29 years in age, 3. All the wells will be renounced after 30 years in age.

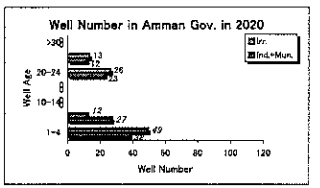
Amman	1999 (actual situation)			2005			2010			2015			2020		
Age	Min.+Ind.	Irr.		Age	Min.+Ind.	Irr.	Age	Min.+Ind.	Irr.	Age	Min.+Ind.	Irr.	Age	Min.+Ind.	Irr.
1-4	45	52		1-4	0	0	1-4	0	0	1-4	*27*	*12*	1-4	*38*	*49*
5-9	93	106		5-9	45	52	5-9	0	0	5-9	0	0	5-9	27	12
10-14	4	5		10-14	93	106	10-14	45	52	10-14	0	0	10-14	0	0
15-19	16	19		15-19	4	5	15-19	93	106	15-19	45	52	15-19	0	0
20-24	14	16		20-24	8	10	20-24	2	3	20-24	46.5	53	20-24	23	26
25-29	3	2		25-29	4	4	25-29	2	2	25-29	1	1	25-29	12	13
>30	0	0		>30	0	0	>30	0	0	>30	0	0	>30	0	0
Total Well Number	175	200	375		154	177	330		142	163	305		119	118	237		99	100	199
AV. Abst. Rate/well	0.17	0.17	0.17		0.17	0.17	0.17		0.17	0.17	0.17		0.17	0.17	0.17		0.17	0.17	0.17
Abst. Amount	30	34	64		26	30	56		24	28	52		20	20	40		17	17	34











	1999	2005	2010	2015	2020
Ind.+Mun.	30	26	24	20	17
Irr.	34	29	28	20	17
Total	64	55	52	40	34

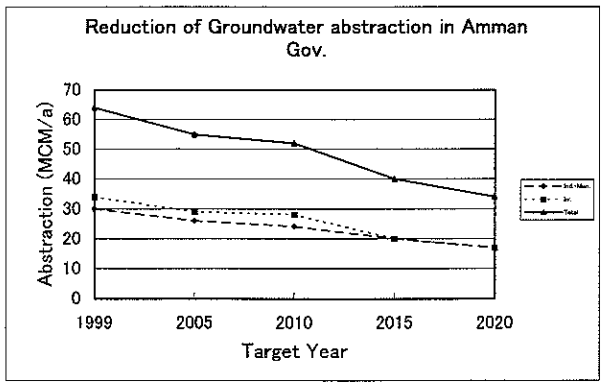


Fig. 7.3.2-1 Trial of Groundwater Abstraction Reduction by Licensing measure in Amman Governorate

- All the wells will be renounced after 30 years after the completion
- Reduction will be also charged to the wells for domestic/industrial purposes as well as irrigation wells

Fig. 7.3.2-1 indicates that the final target of the reduction can be achieved by 2020 if the construction of new wells will not be allowed by 2010 and some wells may be able to be drilled after 2010. Same results with that in Amman governorate may be gotten in other areas.

However, the licensing measure will cause serious social problems, especially for farmers in the Upland because the groundwater for irrigation is indispensable for their lives. In fact, although a Cabinet Decree was issued to impose a ban on further well drilling for irrigation purpose in 1992 and it has been extended until to date, the condition has not been improved but gotten worse. According to WIS data, the number of the new wells drilled after 1995 reached more than 900 wells and wells for irrigation purpose might occupy more than half of them.

The licensing measure is logic and convincing if it will be actually taken effect. However, it is also true that it is a very difficult issue or even almost impossible to implement and/or to be acceptable unless other measures to mitigate the negative social impacts will be implemented simultaneously.

(2) WRPS Action Plans for Reduction of Groundwater Abstraction in Amman/Zarqa Basin

The Water Resource Policy Support (WRPS) activities is a bilateral initiative between the Government of Jordan's Ministry of Water and Irrigation (MWI) and the United States Agency for International Development (USAID).

The WRPS has given JICA Study very important and useful suggestions and because it deals almost same tasks with JICA Study in the Amman/Zarqa Basin (AZB) especially for the reduction of groundwater abstraction. JICA Study has been conducted in close relationship with WRPS project in order to make both activities much effective.

The reduction measures proposed in WRPS are introduced in this section.

1) Outline of the Basic Policies of WRPS

The following five potential options for reducing groundwater abstraction in the AZB highland irrigation were identified in the draft interim report of WRPS. The abstraction amount in AZB highland irrigation is around 60MCM/a based on 1998 MWI abstraction data.

- Irrigation Advisory Services (estimated reduction of 5MCM/a, about 8%)
- Well buy-outs (15-20MCM/a, about 25% to 33%)
- Enforcing abstraction limits (15-20MCM/a, about 25% to 33%)
- Exchange of groundwater with recycled water (10-15MCM/a, about 17% to 25%)
- Municipal and Industrial water reduction (10-30MCM/a)

a. Irrigation Advisory Services (IAS)

The Report suggested the establishment of an IAS for AZB in the absence of proper extension services in the area. Extension services in the highland are mainly the duty of the MOA. The IAS is expected to extend services to the farmers in the area regarding copping pattern, type of agriculture and to raise awareness among farmers of the irrigation techniques in the region in cooperation with the manufacturers of irrigation systems, the MOA and NCARTT. It is also proposed that amendment to the LAW of the Jordan Valley Authority to extend its services to the highland.

In this case a 10 MCM reduction of irrigation water via IAS would be achieved. However, the Report also suggested that if 25% - 30% of the wells will be bought out by the Government, and 30% of the remaining cropped area reduction is achieved, the IAS will save around 5 MCM/a

By the virtue of its Law, it is outside the jurisdiction of the Jordan Valley Authority to undertake any activity in the highlands without violating the Laws and Regulations of the MOA.

b. Wells buy out[1)]

The buy out of wells is valued based on the following alternatives in the Report:

- Present value of gross income expected from the farm for the project period of 5 years.
- Investment in the farm and all fixed equipment such as wells, land, orchards, and farm equipment.
- Market value of the farm and fixed equipment.

Two options have accordingly be suggested in the Report.

1- To save 15MCM at the cost of 7-15.5 million JD

2- To save 20MCM at the cost of 9.5-21.0 million JD

It is also noticed in the Report that either alternative will have negative social impact on the population of the area particularly agricultural employment. In worst cases total labor loss will amount to 2,433 jobs which in fact will have a direct bearing on a population of at least 10,000 individuals. Indirect social impact will affect workers in transportation, wholesale and retail trade, and the market of agricultural imports.

c. Enforcement of Abstraction Limit[2)]

The 38% to 53% reductions would be equivalent to a reduction of around 23 MCM to 32 MCM in AZB highlands irrigation water use. If 25% to 30% of farms are bought out and a 5MCM reduction is achieved via IAS, the total reduction due to limitations of well abstraction will decrease to 13-18MCM. This will further decrease to about 10-15MCM if 20% of farmers surpass abstraction limits and pay extra water charges.

It is stated by the report that the relatively significant reduction of abstraction will lead to a decrease of cropped areas, and therefore a decrease of agriculture production, which in turn may increase the price of produce, especially at the local market.

On the socio-economic impact a total labor loss of on farm jobs of 1824 is expected. The report stated that estimation of indirect labor losses such as transportation, packing, wholesale and retail income incurred by farm input/output is in progress. This option implies highly political issues.

Foot-note

1) Although the financing for the well buy out was not mentioned in the Report, it might not be the concern of WRPS to discuss the ways and means of financing any option. WRPS is only based on recommendations to MWI on how to curtail over-extraction of groundwater in the AZB.

2) Farm ownership including well ownership in the AZB, Wadi Dhulail, Mafraq, and Eastern Plateau dated back to more than 30 years ago when the Government of Jordan intended to provide the Bedouins with a reliable source of income and to enhance their social welfare, and more important to lessen or curtail their migration to the city centers of Amman and Zarqa.

d. Exchange of Groundwater with Recycled Water

Recycled water from Samra is a major source for irrigation water in the Jordan Valley south of Zarqa River. It is suggested that excess of treated waste water can be pumped from al-Samra to Hashimiya-Dulayl- Halabat area to compensate for dry-out wells and increasing salinity in ground wells. The area is said to be the closest to al-Samra WWTP and requires the least lift in elevation compared to the rest of the irrigated farms in the AZB highlands, and appear to provide ideal candidates for recycled water use.

The use of treated wastewater in the suggested area is the most convenient alternative for shortages in irrigation water and increasing salinity.

The cost of supplying pressurized recycled water to farmers in the Dulayl and Hashimiya area is still high estimated to be JD 0.380 per m^3 comparing the official tariff for treated wastewater of 10 fils per m^3.

e. Municipal and Industrial water reduction

Reduction of UFW would save 10 MCM approximately as a result of rehabilitation of water supply networks in areas served from AZB highlands aquifers.

Additional reduction of 20MCM is desirable from the future of Al Wehda Dam and Disi projects in order to reduce current abstraction to safe yield of the renewable aquifers in the AZB highland.

2) Applicability to the Other Governorates and Areas

AZB includes spreads over five governorates which are Amman, Zarqa, Balqa, Irbid and Mafraq. Therefore, reduction plans of WRPS which was introduced in former section will be basically applicable for these five governorates.

Practically "IAS", "Well buy out" and "Enforcement of abstraction limit" can be applied to other governorates outside five governorates mentioned above. However, "Exchange of groundwater with recycled water" (reuse of treated wastewater) is not applicable because of the absence of the large scaled wastewater treatment plant such as As-Samra and Wadi Zaraqa in the other governorates. "M & I reduction" is not applicable too because UFW reduction project and Disi project will mainly contribute for the greater Amman area.

It should be noted that the reduction of groundwater abstraction will be shared not only by reduction of abstraction for irrigation purpose but also by reduction for MIT purpose in the JICA Master Plan. The water amount allocated to MIT will increase and the reduction of the renewable groundwater use for the MIT purpose will be compensated by the additional water resources such as Disi water, peace water and etc. in the JICA Master Plan. On the contrary, although the total water amount allocated to the irrigation purpose is scheduled to maintain the present condition, irrigation water in the Upland including treated wastewater and Disi water will be decreased considerably by 2020 in the Master Plan (from about 314MCM/a to about 229MCM/a).

The plan for the reduction of the renewable groundwater abstraction in the Upland irrigation is formulated in the JICA Master Plan which is shown in the next table.

Table 7.3.2-1 Reduction Plan of the Renewable Groundwater Abstraction in the Upland Irrigation Proposed in the JICA Master Plan

Gover-norate	A) Present Abstraction (MCM/a)	B) Planned Abstraction in 2020 (MCM/a)	C) Target Reduction by 2020 (B-A, MCM/a)	Reduction Rate by 2020 (%, C/A)
Amman	34	17	-17	-50
Zarqa	45	22	-23	-51
Mafraq	53	26	-27	-51
Irbid	2	5	+3	+150
Ajloun	0	0	0	0
Jerash	2	1	-1	-50
Balqa	3	1	-2	-67
Madaba	2	1	-1	-50
Karak	3	2	-1	-33
Ma'an	9	4	-5	-56
Tafielah	1	0	-1	-100
Aqaba	5	3	-2	-40
Total	**158**	**82**	**-76**	**-48**

Source : JICA Master Plan

As shown above table, the necessary reduction rate of the renewable groundwater abstraction in the Upland is around 50% in average.

It is anticipated that the around 50% of the reduction can be achieved in the other governorates by implementing the measures recommended in WRPS which are "IAS (8%)", "Well buy out (25-33%)" and "Enforcement of abstraction limit (25-33%)".

However, certain parameters should be prepared before arriving at conclusions in this matter. These parameters are:

- The area irrigated by ground wells and the cropping pattern
- The aquifer properties, annual abstractions, and renewable capacity
- The owners ability and willingness to sell out their water rights and wells
- The effect of the present level of abstraction on the water table in these areas.
- The social and economic impact of reducing irrigated areas on labor on agricultural products and other economic activities
- The calculation of the opportunity cost on the farmer's income.

CHAPTER 8
EVALUATION OF PROPOSED MANAGEMENT PLANS

CHAPTER 8 EVALUATION OF PROPOSED MANAGEMENT PLANS

8.1 Economic and Financial Evaluation

All the projects proposed in the master plan were classified into three categories, namely water development, wastewater treatment and wastewater reuse projects. Each of these categories of projects was financially and economically analyzed and evaluated as an independent entity in this section.

Regarding individual projects, preconditions and results of economic and financial analysis were summarized and subsequent evaluation was done for representative water development projects, and for all the wastewater reuse projects in this section.

The priority in implementing individual projects is presented in Table 10.1-4 (for wastewater reuse projects), Table 10.1-5 (for wastewater treatment projects) and Table 10.1-6 (for water projects) in Chapter 10. In these tables, projects are listed in the priority order in terms of FIRR, financial unit water price and EIRR.

For detailed preconditions and results of economic and financial analysis for all the individual projects such as hydraulic streams by water use, cost streams by source, revenue streams by water use, FIRR, NPV, unit water price, etc., the readers are advised to refer the relevant sections of Chapters 8, 9 and 10 in the Supporting Report.

8.1.1 Surface Water Development

(1) Wehda Dam

1) Preconditions

(a) Water to be Developed (Unit: MCM/Year)

Water to be Developed	Municipal Water		Industrial Water		Irrigation Water	
108	54%	58.3	5%	5.4	41%	44.3

(b) Investment Costs (Unit: Million JD)

Investment Costs	Local Costs		Foreign Costs	
151	20%	30.2	80%	120.8

(c) Implementation Schedule (Unit: Million JD)

2000	2001	2002	2003	2004	2005
15	25	35	35	33	8

(d) Unit Water Revenues (Unit: JD/m^3)

Municipal Water	Industrial Water	Irrigation Water
0.341	1.000	0.010

(e) Unit Water Benefits (Unit: JD/m^3)

Municipal Water	Industrial Water	Irrigation Water
0.735	2.740	0.283

(f) Project Life: 30 Years

2) Results of Financial Analysis

FIRR	NPV (Million JD)	Unit Water Price (Fils)
12%	86.6	142

Note: Discount Rate=6.5%

3) Results of Economic Analysis

EIRR	NPV (Million JD)	Unit Water Price (Fils)
29%	281.9	187

Note: Discount Rate=10%

4) Evaluation

This project is financially feasible with the FIRR of 12%, NPV of 86.6 million JD and the unit water price of 142 fils per m^3. It is economically highly feasible with the EIRR of 29%, NPV of as much as 281.9 million JD and the unit water price of 187 fils per m^3.

The above evaluation has to be viewed, however, with reservation in the strict sense. This is because the cost concerned is that for production only and does not include that for conveyance.

(2) Small Dam (Ibn, Hamad, Karak, Meddein)

1) Preconditions

(a) Water to be Developed (Unit: MCM/Year)

Water to be Developed	Municipal Water		Industrial Water		Irrigation Water	
13	0%	0	27%	3.5	73%	9.5

(b) Investment Costs (Unit: Million JD)

Investment Costs	Local Costs		Foreign Costs	
13	20%	2.6	80%	10.4

(c) Implementation Schedule (Unit: Million JD)

2003	2004	2005	2006	2007	2008
2.0	2.0	2.5	2.5	2.0	2.0

(d) Unit Water Revenues (Unit: JD/m^3)

Municipal Water	Industrial Water	Irrigation Water
0.294	1.000	0.010

(e) Unit Water Benefits (Unit: JD/m^3)

Municipal Water	Industrial Water	Irrigation Water
0.735	2.740	0.283

(f) Project Life: 30 Years

2) Results of Financial Analysis

FIRR	NPV (Million JD)	Unit Water Price (Fils)
16%	13.7	114

Note: Discount Rate=6.5%

3) Results of Economic Analysis

EIRR	NPV (Million JD)	Unit Water Price (Fils)
37%	39.3	153

Note: Discount Rate=10%

4) Evaluation

This project is financially feasible with the FIRR of 16%, NPV of 13.7 million JD and the unit water price of 114 fils per m^3. Also, it is economically highly feasible with the EIRR of as much as 37%, NPV of 39.3 million JD and the unit water price of 153 fils per m^3.

The above evaluation has to be viewed, however, with reservation in the strict sense. This is because the cost concerned is that for production only and does not include that for conveyance.

It has been shown from the above that the two representative surface water development projects are not only financially feasible but also economically highly feasible. It has to be noted, however, that the projects concern production of water only, and as such the evaluation is not all-inclusive.

8.1.2 Water Conveyance

(1) Preconditions

1) Water to be Transferred, Investment Costs and Implementation Schedule

Transfer Line	Water to be Transferred, 2020 (MCM/Year)	Investment Costs (JD)			Implementation Schedule
		Total	Local Components	Foreign Components	
Abu Alanda - Khaw	18	11,915,800	3,561,090	8,354,710	Jul.2013–Dec. 2014
Zatary – Khaw	30	27,568,060	8,803,678	18,764,382	Jan. 2018–Dec. 2019
KM124 – Zatary	19	14,703,000	5,344,178	9,358,822	Jan. 2018–Dec. 2019
Houfa – Zatary	29	29,621,150	8,886,345	20,734,805	Jan. 2017–Dec. 2019
Houfa – Ajloun/Jerash	4	8,862,100	2,980,406	5,881,694	Jul. 2018–Dec. 2019
Disi – Madaba Branch	15	3,434,699	1,386,788	2,047,812	Jan. 2009–Dec. 2009
Disi – Ma'an Branch	14	5,394,740	1,787,318	3,607,422	Jan. 2009–Dec. 2009

2) Unit Water Price (JD/m^3)

Item	Municipal Water	Industrial Water	Irrigation Water
Financial	0.294	1.000	0.010
Economic	0.735	2.740	0.283

(2) Results of Financial and Economic Analysis

WW Treatment Plant	Financial Analysis			Economic Analysis		
	FIRR (%)	NPV (1,000 JD)	Water Price (Fils/m^3)	EIRR (%)	NPV (1,000 JD)	Water Price (Fils/m^3)
Abu Alanda - Khaw	18	6,012	214	73	18,382	232
Zatary – Khaw	11	3,943	249	44	16,150	277
KM124 – Zatary	10	1,722	263	49	10,053	285
Houfa – Zatary	10	2,410	252	42	10,623	283
Houfa – Ajloun/Jerash	2	-1,041	384	20	1,337	451
Disi – Madaba Branch	23	4,305	211	86	15,154	220
Disi – Ma'an Branch	69	20,764	250	241	41,039	272

Note: Water production cost of 150 fils/m^3 is assumed and incorporated in the O & M cost.

(3) Evaluation

These projects are water conveyance undertakings and as such they do not produce or develop any water. However, they are instrumental in bringing revenues and benefits by delivering water to the beneficiaries. That is to say, by so doing they enhance the values of the water produced. In performing financial and economic analysis, therefore, the estimated production cost of 150 fils per m^3 of water was deducted from the enhanced values by adding such production cost to the O & M costs.

1) Abu Alanda – Khaw Transfer Line

This project is financially feasible with the FIRR of 18%, NPV of 6.0 million JD and the unit water price of 214 fils per m^3. Also, it is economically highly feasible with the EIRR of as much as 73%, NPV of 18.4 million JD and the unit water price

of 232 fils per m^3.

2) Zatary – Khaw Transfer Line
This project is financially feasible with the FIRR of 11%, NPV of 3.9 million JD and the unit water price of 249 fils per m^3. Also, it is economically highly feasible with the EIRR of as much as 44%, NPV of 35.3 million JD and the unit water price of 277 fils per m^3.

3) KM124 – Zatary Transfer Line
This project is financially feasible with the FIRR of 10%, NPV of 1.7 million JD and the unit water price of 263 fils per m^3. Also, it is economically highly feasible with the EIRR of as much as 49%, NPV of 10.1 million JD and the unit water price of 285 fils per m^3.

4) Houfa – Zatary Transfer Line
This project is financially feasible with the FIRR of 10%, NPV of 2.4million JD and the unit water price of 252 fils per m^3. Also, it is economically highly feasible with the EIRR of as much as 42%, NPV of 10.6 million JD and the unit water price of 283 fils per m^3.

5) Houfa – Ajloun/Jerash Transfer Line
This project is financially not feasible with the FIRR of 2%, NPV of –1.0 million JD and the unit water price of 384 fils per m^3. However, it is economically feasible with the EIRR of 20%, NPV of 1.3 million JD and the unit water price of 451 fils per m^3.

6) Disi – Madaba Branch Transfer Line
This project is financially feasible with the FIRR of 23%, NPV of 4.3 million JD and the unit water price of 211 fils per m^3. Also, it is economically highly feasible with the EIRR of as much as 86%, NPV of 15.2 million JD and the unit water price of 220 fils per m^3.

7) Disi – Ma'an Branch Transfer Line
This project is financially highly feasible with the FIRR of as much as 69%, NPV of as much as 20.8 million JD and the unit water price of 250 fils per m^3. Also, it is economically highly feasible with the EIRR of as much as 241%, NPV of as much as 41.0 million JD and the unit water price of 272 fils per m^3.

Among the 7 water conveyance projects, the Disi - Ma'an branch, the Disi - Madaba branch and the Abu Alanda - Khaw transfer lines are higher than others in terms of both financial and economic feasibility. The Houfa – Ajloun/Jerash transfer line is the only project financially not feasible. All the 7 projects are economically viable.

8.1.3 Sea/Brackish Water Desalination

(1) Desalination at Aqaba

1) Preconditions

(a) Water to be Developed (Unit: MCM/Year)

Water to be Developed	Municipal Water		Industrial Water		Irrigation Water	
15	66.7%	10	33.3%	5	0%	0

(b) Investment Costs (Unit: Million JD)

Investment Costs	Local Costs		Foreign Costs	
82.1	0%	0	100%	82.1

(c) Implementation Schedule (Unit: Million JD)

2001	2002	2003	2004	2011	2012	2013	2014
6.8	6.8	6.8	6.8	13.7	13.7	13.7	13.7

(d) Unit Water Revenues (Unit: JD/m^3)

Municipal Water	Industrial Water	Irrigation Water
0.294	1.000	0.010

(e) Unit Water Benefits (Unit: JD/m^3)

Municipal Water	Industrial Water	Irrigation Water
0.735	2.740	0.283

(f) Project Life: 20 Years from the Start of Operation

2) Results of Financial Analysis

FIRR	NPV (Million JD)	Unit Water Price (Fils)
-	-38.3	1,035

Note: Discount Rate=6.5%

3) Results of Economic Analysis

EIRR	NPV (Million JD)	Unit Water Price (Fils)
10%	0.4	1,158

Note: Discount Rate=10%

4) Evaluation

This project is financially not feasible with the NPV of –38.3 million JD and a high unit water price of 1,035 fils per m^3. However, it is economically barely feasible with the EIRR of 10%, NPV of 0.4 million JD and the unit water price of 1,158 fils per m^3.

It is to be noted that the project concerns the production of water only. If the water produced is to be used by the beneficiaries, it has to be conveyed and delivered to them. Such cost has not been considered. In this meaning the above evaluation is limited and not an overall one.

(2) Hisban and Kafrein Desalination Plant

1) Preconditions

(a) Water to be Developed (Unit: MCM/Year)

Water to be Developed	Municipal Water		Industrial Water		Irrigation Water	
30	100%	30	0%	0	0%	0

(b) Investment Costs (Unit: Million JD)

Investment Costs	Local Costs		Foreign Costs	
56.2	10%	5.6	90%	50.6

(c) Implementation Schedule (Unit: Million JD)

2002	2003	2004
18.7	18.7	18.7

(d) Unit Water Revenues (Unit: JD/m^3)

Municipal Water	Industrial Water	Irrigation Water
0.294	1.000	0.010

(e) Unit Water Benefits (Unit: JD/m^3)

Municipal Water	Industrial Water	Irrigation Water
0.735	2.740	0.283

(f) Project Life: 20 Years from the Start of Operation

2) Results of Financial Analysis

FIRR	NPV (Million JD)	Unit Water Price (Fils)
-	-29.1	449

Note: Discount Rate=6.5%

3) Results of Economic Analysis

EIRR	NPV (Million JD)	Unit Water Price (Fils)
19%	32.3	491

Note: Discount Rate=10%

4) Evaluation

This project is financially not feasible with the NPV of –29.1 million JD and the unit water price of 449 fils per m^3. However, it is economically substantially feasible with the EIRR of 19%, NPV of 32.3 million JD and the water price of 491 fils per m^3.

It has turned out that in financial terms the above examples of sea water and brackish water desalination projects are both not feasible. On the other hand, it has been revealed that they are both feasible in economic terms.

It is to be added that it is possible that technological progress will make such desalination projects financially feasible in the future.

8.1.4 Wastewater Reuse

(1) Preconditions

1) Treated Wastewater for Reuse, Investment Costs and Implementation Schedule

WW Treatment Plant	Treated Wastewater for Reuse, 2020 (m^3/Year)	Investment Costs (JD)			Implementation Schedule
		Total	Local Components	Foreign Components	
Abu Nuseir	1,458,439	143,000	105,872	37,128	01/01; 11/11
Aqaba	14,258,972	7,411300	2,887,950	4,523,350	02/03; 06/07; 12/13; 16/17
As-Samra	76,000,000	15,200,000	-	-	03/05; 08/10; 18/20
Baqa					
Fuhis	1,094,807	19,240	15,392	3,848	14/14
Irbid (Central and Wadi Arab)	16,590,810	1,619,800	1,133,860	485,940	04/04; 08/08; 15/15; 18/18
Jerash (East)					
Karak	1,417,235	240,240	182,598	57,642	05/05; 11/11
Kufranja	3,439,852	455,000	331,110	123,890	09/09; 19/19
Ma'an	1,399,761	263,900	152,906	110,994	10/10; 20/20
Madaba	3,826,764	558,740	327,912	230,828	04/04; 12/12; 16/16
Mafraq	1,549,250	387,010	219,031	167,980	03/03; 13/13
Ramtha	2,946,989	511,485	284,157	227,328	06/06; 17/17
Salt					
Tafielah	1,159,795	332,410	161,142	171,269	07/07; 19/19
Wadi Arab	16,590,810	1,619,800	1,133,860	485,940	04/04; 08/08; 15/15; 18/18
Wadi Essir	805,046	42,900	42,900	0	14/14
Wadi Hassan	833,660	85,800	25,740	60,060	15/15
Wadi Mousa	1,607,427	115,180	82,550	32,630	05/05; 11/11
Al Jeeza	2,879,440	500,630	292,910	207,721	02/02; 12/12
Al Mazar Al Shamali					
Dair Abi Said	1,717,489	527,280	246,324	280,956	13/13
Dair Alla	2,401,393	785,330	349,869	435,461	14/14
Jerash West					
Kofur Assad	4,141,692	391,950	283,823	108,128	09/09; 15/15
Aqaba South Coast	19,909	264,550	117,325	147,225	04/04; 20/20
Na'ur	1,713,175	185,900	138,060	47,840	10/10; 16/16
North Queen Alia Airport	9,342,642	822,900	576,030	246,870	05/05; 11/11; 17/17
North Jordan Valley	4,068,588	995,930	451,874	544,057	02/02; 12/12; 18/18
Shuna South	2,254,796	760,760	337,922	422,838	03/03; 13/13
Torra	1,948,666	456,300	236,769	219,531	14./14
Um Al Basateen					
Wadi Shallala	5,949,123	967,070	574,496	392,574	04/04; 15/15; 19/19
Wadi Zarqa					
Mazar, Muta, Adnaniya	960,704	237,640	214,708	22,932	06/06; 20/20
Dead Sea East Coast	1,237,102	523,380	230,584	292,796	07/07; 16/16

2) Unit Water Price (JD/m^3)

Item	Industrial Water	Irrigation Water
Financial	1.000	0.010
Economic	2.740	0.142

3) Project Life: 30 Years

(2) Results of Financial and Economic Analysis

WW Treatment Plant	Financial Analysis			Economic Analysis		
	FIRR (%) WP=10 Fils/m^3	FIRR (%) WP=38 Fils/m^3	Water Price (Fils/m^3)	EIRR (%)	NPV (1,000 JD)	Water Price (Fils/m^3)
Abu Nuseir	-	14	24	62	176	27
Aqaba	-	-	78	16	4,470	94
As-Samra	-	7	37	38	15,820	42
Baqa						
Fuhis	-	103	12	526	258	12
Irbid (Central and Wadi Arab)	-	3	47	39	1,622	52
Jerash (East)						
Karak	-	11	28	93	563	33
Kufranja	-	23	20	105	1,046	22
Ma'an	-	6	40	48	317	43
Madaba	-	9	33	49	1,484	38
Mafraq	-	2	50	32	511	58
Ramtha	-	9	34	55	907	38
Salt						
Tafielah	-	-	52	42	308	56
Wadi Arab	-	17	20	70	4,795	24
Wadi Essir	-	32	20	175	179	21
Wadi Hassan	-	17	24	93	160	27
Wadi Mousa	-	17	19	55	587	23
Al Jeeza	-	5	40	51	1,143	44
Al Mazar Al Shamali						
Dair Abi Said	-	3	50	31	285	58
Dair Alla	-	6	39	38	1,434	46
Jerash West						
Kofur Assad	-	24	16	103	1,393	19
Aqaba South Coast	-	-	104	15	54	113
Na'ur	-	19	19	80	479	23
North Queen Alia Airport	-	32	13	144	4,019	15
North Jordan Valley	-	-	55	35	1,357	60
Shuna South	-	-	57	34	738	63
Torra	-	3	46	40	322	52
Um Al Basateen						
Wadi Shallala	-	12	27	62	2,426	31
Wadi Zarqa						
Mazar, Muta, Adnaniya	-	6	41	36	286	48
Dead Sea East Coast	-	-	74	20	190	86

Note: Discount Rate=6.5%(Financial), 10%(Economic)

(3) Evaluation

It was revealed in the above table that all the 29 wastewater reuse projects are financially not feasible under the current treated wastewater price of 10 fils/m^3, which is by far too low to cover the cost. However, if the average treated wastewater price were set at 38 fils/m^3, which is the weighted average of the treated wastewater prices of the 29 projects, then 15 projects would turn financially feasible with their FIRR's exceeding the discount rate of 6.5%. Economically speaking, all projects are highly feasible with their EIRR's invariably greater than the discount rate of 10%.

Ten projects with higher FIRR's under the average treated wastewater price of 38 fils/m^3 were picked up and tabulated below. Three projects designated as pre-F/S projects are found among them, namely "Fuhis", "Wadi Essir" and "Abu Nuseir", which are placed first, third and tenth respectively. Other pre-F/S designated projects, "Ma'an" and "Tafielah" are placed 17^{th} and 24^{h} respectively.

As a conclusion, it can be said that the wastewater reuse projects will become financially

sufficiently feasible if the price is raised to a reasonable level on one hand, and they are economically quite feasible on the other. Their financial water prices are cheap in a comparative sense, which can be borne by the farmers. All these things may present a promising future for treated wastewater reuse.

Wastewater Treatment Plant	Results of Financial Analysis	
	FIRR (%) (WP=38 Fils/m^3)	Water Price (Fils/m^3)
Fuhis	103	12
North Queen Alia Airport	32	13
Wadi Essir	32	20
Kofur Assad	24	16
Kufranja	23	20
Na'ur	19	19
Wadi Mousa	17	19
Wadi Arab	17	20
Wadi Hassan	17	24
Abu Nuseir	14	24

8.1.5 Overall Financial/Economic Evaluation

Overall Financial/economic evaluation for the three groups of proposed projects, namely water development, wastewater treatment and wastewater reuse projects has been conducted.

The water development projects consists of 16 projects whose objectives are to newly develop or convey surface water/groundwater, out of 24 related projects. The balance are those projects which aim for water saving or keeping the current level of water production through rehabilitation or transference.

The wastewater treatment projects are comprised of 25 projects envisaged by MWI. The wastewater reuse projects are made up of 29 projects proposed by the JICA study team. The readers are advised to refer to the supporting report for further information.

In reading the sections below, refer to Table 8.1.5-1.

(1) Water Development Projects

The overall evaluation of water development projects as a group is that they are in financial terms not feasible with the FIRR of 4%, which is below the assumed discount rate of 6.5% on one hand, and that they are in economical terms highly feasible with the EIRR of 18% (OCC is assumed as 10%) on the other.

At present the unit prices of municipal, industrial and irrigation water can be said to be still considerably low with 341 fils, 1,000 fils and 10 fils per m^3 respectively. According to the team's analysis, the affordable limits of such prices are 735 fils, 2,740 fils and 283 fils.

Supposing the unit prices of the three types of water are raised by 12%, 12% and 1,680% to 382 fils, 1,120 fils and 178 fils respectively, which are all within their respective upper limits, then, FIRR will come to the discount rate of 6.5%.

It means, for instance, that the payment for municipal water as the percentage of household income, which is now 1.86%, will go up to 2.08%, while it is generally recognized that the households can afford to pay for municipal water of up to 4% of their income.

(2) Wastewater Treatment Projects

The overall evaluation of wastewater treatment projects as a group is that they are both in financial and economic terms not feasible with an incalculable FIRR and the EIRR of 4%.

At present the unit price of sewerage services can be said to be still considerably low with 147 fils per m^3. According to the team's analysis, the affordable limit of such price is 363 fils.

Supposing the unit price of sewerage services is raised by 263% to 534 fils, which exceeds its upper limit, then, FIRR will come to the discount rate of 6.5%.
It means that the payment for sewerage services as the percentage of household income, which is now 0.80%, will go up to 2.91%, while it is generally recognized that the households can afford to pay for sewerage services of up to 2% of their income.

When the financially feasible unit prices of municipal water and sewerage are combined together, they come to 916 fils per m^3, while the combined upper limit is 1,103 fils per m^3. That is to say, the former is less than the latter. It means that the households can afford to pay combined water and sewerage charges in the future.

(3) Wastewater Reuse Projects

The overall evaluation of wastewater reuse projects as a group is that they are in financial terms not feasible under the current treated wastewater unit price on one hand, and that they are in economic terms remarkably feasible with the EIRR of 37%, which is 3.7 times the assumed OCC of 10%.

At present, the unit price of treated wastewater is as low as 10 fils per m^3. According to the team's analysis, the affordable limit of such price is 142 fils.

Supposing the unit price of the treated wastewater for reuse in irrigation is raised to 38 fils, which is a fraction compared with its upper limit, then, FIRR will match the discount rate of 6.5%.

It means that the wastewater reuse projects will possibly provide the farmers with attractively cheap treated wastewater for irrigation use.

(4) All Projects

The overall evaluation of all the projects is that they are in financial terms not feasible with the FIRR of 2%, which is below the assumed discount rate of 6.5% on one hand, and that they are in economical terms feasible with the EIRR of 14% (OCC is assumed as 10%) on the other.

The value of EIRR shows that there are still enough room and potential for raising water/wastewater prices so that all the projects may also be made properly feasible in financial terms.

Table 8.1.5-1(1) Overall Financial/Economic Evaluation of Masterplan Water/Wastewater Projects

1. Water Development Projects

Financial Analysis

Financial			Present	Future/Present
FIRR (%)	NPV (M JD)	Unit Water Price (Fils/m^3)	Unit Water Price (Fils/m^3)	Unit Water Price (%)
4	-273	426	327	128

Item	Unit Water Price (Fils/m^3)			
	Present	Increasing Rate	Future	Upper Limit
Municipal	341	12%	382	735
Industrial	1,000	12%	1,120	2,740
Irrigation	10	1680%	178	283

Item	Present	Future	Upper Limit
Payment for Water as % of Income (Municipal Water)	1.86%	2.08%	4.00%

Economic Analysis

Economic			Upper Limit
EIRR (%)	NPV (M JD)	Unit Water Price (Fils/m^3)	Unit Water Price (Fils/m^3)
18	681	520	867

2. Wastewater Treatment Projects

Financial Analysis

Financial			Present	Future/Present
FIRR (%)	NPV (M JD)	Unit Water Price (Fils/m^3)	Unit Water Price (Fils/m^3)	Unit Water Price (%)
	-380	534	147	363

Item	Unit Water Price (Fils/m^3)			
	Present	Increasing Rate	Future	Upper Limit
Municipal	147	263%	534	368

Item	Present	Future	Upper Limit
Payment for WW as % of Income (Municipal Water)	0.80%	2.91%	2.00%

Economic Analysis

Economic			Upper Limit
EIRR (%)	NPV (M JD)	Unit Water Price (Fils/m^3)	Unit Water Price (Fils/m^3)
4	-215	739	368

Table 8.1.5-1(2) Overall Financial/Economic Evaluation of Masterplan Water/Wastewater Projects

3. Wastewater Reuse Projects

Financial Analysis

Financial			Present	Future/Present
FIRR (%)	NPV (M JD)	Unit Water Price (Fils/m^3)	Unit Water Price (Fils/m^3)	Unit Water Price (%)
	-22	38	10	380

Item	Unit Water Price (Fils/m^3)			
	Present	Increasing Rate	Future	Upper Limit
Municipal	10	280%	38	142

Economic Analysis

Economic			Upper Limit
EIRR (%)	NPV (M JD)	Unit Water Price (Fils/m^3)	Unit Water Price (Fils/m^3)
37	46	44	142

4. All Projects

Financial Analysis

Financial			Present	Future/Present
FIRR (%)	NPV (M JD)	Unit Water Price (Fils/m^3)	Unit Water Price (Fils/m^3)	Unit Water Price (%)
2	-680	386	246	157

Item	Unit Water Price (Fils/m^3)			
	Present	Increasing Rate	Future	Upper Limit
Municipal (Water)	341	12%	382	735
Municipal (WW)	147	263%	534	368
Industrial	1,000	12%	1,120	2,740
Irrigation(Water)	10	1680%	178	283
Irrigation (WW)	10	280%	38	142

Item	Present	Future	Upper Limit
Payment for Water as % of Income (Municipal Water)	1.86%	2.08%	4.00%
Payment for Water as % of Income (Municipal WW)	0.80%	2.91%	2.00%

Economic Analysis

Economic			Upper Limit
EIRR (%)	NPV (M JD)	Unit Water Price (Fils/m^3)	Unit Water Price (Fils/m^3)
14	197	523	663

8.2 Evaluation of Proposed Master Plan

8.2.1 Evaluation of Institutional/Legislative Measures for Privatization

(1) General Proposal for Alternative Improvements

1) It shall be clearly stated in the law that all the water supply, sewerage -and irrigation- related facilities are owned by the government.

2) In cases where it is deemed more proper and efficient, the management, O & M and customer services will be taken charge of by the private sector through management contracts, concessions and other forms.

3) Regarding Item 2, subject to government approval, water supply, sewerage, irrigation water and other tariffs will be determined, personnel will be hired, fired and trained, and the construction, rehabilitation and repairing of facilities within a certain limit of amount will be carried out by the private sector management.

4) In Japan, the state-owned, state-run Japan National Railway (JNR) which controlled the railway networks all over Japan was disintegrated a decade or so ago into several private enterprises operating over their respective allocated areas dividing the Japanese Archipelagoes. JNR had been suffering from perennial deficits. But after the private railways were started, which gave rise to competition among each other, their management has improved rapidly and remarkably. They all now enjoy a financial success. The same thing can happen by dividing the water supply and sewerage services of Jordan into several private entities so that they may vie among themselves. "Abolition of State Monopoly of Water Sector and Introduction of Horizontal Competition"

5) By leaving the distribution and retail of irrigation water to the farmers' groups or water user associations, the sense of ownership and involvement will be cultivated among farmers, which may lead to better and more efficient management of irrigation water.

(2) Reduction of Administrative Losses of Water Supply

1) The per capita per day municipal water supply is quite different from one governorate to another. It is markedly higher in the governorates of Aqaba, Mafraq, Madaba and Ma'an, exceeding 200 litres. Since physical losses are not supposed to be much different between governorates, it is suspected that this state of affairs is connected to illegal and stealthy use of municipal water for irrigation purposes.

2) A privatization may give an answer or solution to this problem if it can make the matter transparent by bringing the violators to the public court.

(3) Introduction and Implementation of Modern Management Theory

Privatization attempt can prove to be successful if it is accompanied by the introduction of the modern management theory as presented next:

1) Implementation of Performance-Based Remuneration System

Under the performance-based remuneration system salaries/wages are paid not for the number of work years and ability, but for the results of the work. The crucial point to make it successful is the introduction of management by objectives. It is to

set up one's own work objectives in consultation with one's superior, and manage one's own work in order to achieve the objectives. An independent-minded worker's will and action bring about a higher corporate income, and the remuneration in accordance with the extent of the contribution to corporate income in turn makes him more independent-minded. This way, a favorable circle is created. The individual desired is not a salaried man making a living by being subservient to the company, but a business man willing to create his own job from the cost-benefit perspective. In the management by objectives, emphasis is placed on the development of employees' ability and willingness, which will ultimately result in the overall elevation of corporate performances.

2) Nurturing of Motivation

To lead the management by objectives to a successful end, the nurturing of motivation is very important. To nurture employees' motivation, the investment in education for an elevation of skills and capacity is necessary. A high motivation is generated in an organizational climate where there are mutual trust, respect and warmth between a leader and his subordinates. In a motivated/activated organization, its members share the same objectives/values, and together try to actively realize them.

3) Profitability Focused Management

The salient point of the performance-based remuneration system is that it is connected to the managerial indices such as the current profit to the total assets ratio, capital efficiency and cash flow.

4) Consumers' Satisfaction

It is now an established theory that the growth of a company is achieved by the multiplier effects of consumers' satisfaction and employees' satisfaction, both of which are closely interconnected. Among the most important management concepts are the customer-knows-best services, or thinking on the side of customers, and a positive contribution to the society. In short, the point is to sell what clients want.

5) Strategic Management

Strategic management consists of management vision, management strategy, management plan, execution of management and daily work. There are 5 functions in an organization: Planning, decision-making, coordination, execution and evaluation. A strategy fails sometimes because of insufficient evaluation and feedback.

6) Integration of IT Revolution

Through the prevalence of the IT, the source of corporate values has changed from operational efficiency to innovation. This "informationalization" must be integrated into organizational renovation.

8.2.2 Evaluation of Institutional/Legislative Measures for Treated Wastewater Reuse in Agriculture

In view of the prospects that increasingly more treated wastewater is destined to be used in the future, a parallel strengthening of related institutional/legislative measures is proposed in the course of time, such as described below:

(1) Qualities of WWTP Effluent to be Improved

The general qualities of the effluent from the wastewater treatment plants shall be improved in the future to provide the treated wastewater of better qualities and cheaper prices to the farmers through the following legal measures:

1) More stringent and detailed standards shall be legislated for industrial wastewater influent to the public sewers.
2) The treatment of wastewater in WWTP shall be fuller and more complete. It shall be realized by imposing sewerage charges to industrial, commercial and municipal users in the way that the treatment cost could be recovered to the fullest.

(2) Detailed Standard for Agricultural Reuse of Treated Wastewater to be Prepared

For a wider reuse of treated wastewater being envisaged from the above measure, a detailed standard for the reuse of treated wastewater for irrigation shall be prepared in the following way:

1) The relationships between the treatment cost and the qualities/ingredients of treated wastewater shall be analyzed in detail.
2) The relationships between the qualities/ingredients of treated wastewater and the kinds of crops to be irrigated with treated wastewater shall be analyzed in detail. The characteristics of soils, and the methods and schedule of treated wastewater application will also influence the kinds of crops to be irrigated with treated wastewater.
3) Based on the results of the analysis in Items 1) and 2), the preconditions in applying treated wastewater to different kinds of crops should be clarified in a standard for the reuse of treated wastewater for irrigation.

(3) General Reuse of Treated Wastewater for Irrigation to be Realized

Through a better quality treated wastewater being envisaged by the above-mentioned measures, the reuse of such wastewater will become general and commonplace and there will be legal permission to use treated wastewater irrigation for crops that are eaten raw.

(4) The Concept of Rationing of Irrigation Water

The concept of the rationing of water (including treated wastewater) for irrigation per farmer should be introduced in the future so that farmers will try to make the utmost use of the limited amount of water, thereby eventually contributing to the general development and progress of agriculture.

8.2.3 Evaluation of Institutional/Legislative Measures for Restriction of Groundwater Abstraction in Up/Mid Land

(1) Standard Institutional/Legislative Measures

1) The wells will be abandoned taking the following aspect into consideration:
   (a) Well age
   (b) Social impacts
   (c) Well location: if the well is located in an area where overexploitation is taking place.
   (d) Well spacing: if the well interfere with adjacent wells and/or springs.
   (e) If the aquifers are being exhausted.
   (f) If water quality is deteriorating.
2) Ban on further well drilling for irrigation.
3) Renewal of existing wells to be basically prohibited.
4) Installing meters to all the groundwater wells, thereby securing and solidifying the basis for quantitatively controlling and managing groundwater abstraction and aquifer conditions.
5) Issuing abstraction permits to those deemed proper to use the existing wells.
6) Issuing drilling licenses to those deemed appropriate to develop new wells.
7) Employing financial measures such as taxes, charges and fines so as to facilitate the above measures.
8) Installing a nation-wide electronic monitoring and reconnaissance network systems of groundwater abstraction and aquifer nurturing.
9) Installing a country-wide electronic monitoring and detection network systems for irrigation water conveyance and leakage.
10) Training, education and public relation activities to the farmers for more effective and efficient use of irrigation water.

(2) Proposed Reinforcement/Strengthening of Institutional/Legislative Measures

1) Groundwater abstraction management to be left to farmers' associations
   The groundwater abstraction management shall be left to the Groundwater Management Committees. They will control groundwater distribution throughout the irrigation areas based on individual land ownership taking into consideration total average well yields. They shall perform their functions under the supervision

of an Irrigation Advisory System (WAJ), taking into consideration cropping patterns, plant water consumption, annual climatic changes and estimated groundwater safe yields. This is to assign the right as well as the duty of groundwater management to the farmers' groups, thereby achieving self-sufficiency and group efficiency.

2) Buying up the farmland where there are important wells and over-abstraction of groundwater is practiced.

3) Imposing user charges to well owners, development taxes to well developers and fines and/or punishment by imprisonment to violators of the law, the extent/severity of which will be dependent on the conditions of groundwater over-abstraction and aquifer depletion.

4) Enforcement of law to be emphasized.
In as much as the country is a modern, democratic and legal state, the laws, once promulgated, shall be honored and put into actual force.

8.3 Environmental Evaluation

8.3.1 Guidelines and Methodologies

8.3.1.1 Guidelines of Environmental Impacts Assessment in Jordan

In Jordan, the basic environmental law was enacted in 1995 as Environment Protection Law (No. 12/1995). Under this law, the General Corporation for Environmental Protection (GCEP) was established as a governmental agency for the environment. This law has put water pollution protection as one of the priority environmental issues in the Kingdom.

In 1996, the National Environmental Action Plan (NEAP) was put forward by the Ministry of Planning as the first comprehensive plan for environmental protection in Jordan. Among the main environmental issues listed in the NEAP, water depletion and water pollution were stressed as the top two priority issues. Accordingly, priority actions were proposed within a five-year period regarding water, land, urban environment, cultural and natural heritage, as well as capacity building of GCEP.

Since its establishment in 1995, GCEP has engaged in preparation of national environmental regulations. Currently, a regulation is under preparation on EIA (environmental impacts assessment) based on the Environment Protection Law. This will become the first EIA guideline on a national level. The regulation will specify the procedures of EIA study, report submission and approval, as well as the methodology and environmental elements to be studied, if there are any negative impacts envisaged from a project. Table 8.3.1.1 shows the checklist of environmental elements suggested in the draft regulation (GCEP, 1999).

Table 8.3.1-1 Checklist of Environmental Elements in the Draft EIA Regulation

(1) Social Environment	(2) Natural Environment	(3) Environmental Hazards
Land use	Geography	Noise
Resettlement	Air	Unusual lighting
Neighborhood	Water	Risk of disasters
Transportation	Flora	
Public services	Fauna	
Public facilities	Natural resource	
Human health	Energy	
Beauty spot		
Welfare		
Human resource		

Source: GCEP (1999)

GCEP is the authorized agency for the guidance and approval of EIA study based on the Environment Protection Law.

In the water sector, the Ministry of Water & Irrigation (MOWI) has recently put forward a series of basic policies such as Jordan's Water Strategy (1997), Water Utility Policy (1997), Irrigation Water Policy (1998), Groundwater Management Policy (1998) and Wastewater Management Policy (1998). These documents also provide the baseline for the environmental consideration for water resource development and management projects.

8.3.1.2 JICA Guideline of Environmental Consideration

According to the JICA Guideline of Environmental Consideration (JICA, 1992), the activity of environmental study for the projects implemented under the scheme of international cooperation of Japanese Government will include IEE (initial environmental examination) and EIA. The IEE is usually a preliminary study of the impacts on the environment from the projects, while EIA is a comprehensive study of the environmental impacts. EIA is often the second step of environmental study as significant impacts are predicted by the IEE.

Table 8.3.1-2 is the checklist for IEE and EIA based on the JICA guideline. By comparing this with the checklist of the draft Jordanian Guideline, it is noticed that the two checklists are in common with most of the environmental elements.

Table 8.3.1-2 Checklist of Environmental Elements

(1) Social Environment	(2) Natural Environment	(3) Environmental Hazards
Resettlement	Topography & Geography	Air Pollution
Economic Activity	Soil Erosion	Water Pollution
Traffic & public Facilities	Groundwater	Soil Pollution
Community Separation	Lake & Rivers	Noise & Vibration
Archaeological & Cultural Properties	Coastal Area	Ground Subsidence
	Flora & Fauna	Offensive Odor
Water Right /Right of Common	Meteorology	
Public Health & Sanitation	Landscape	
Solid Wastes		
Risk of Disaster		

Source: JICA Guideline for Environmental Consideration (1992)

8.3.1.3 Methodology of Environmental Evaluation for this Study

For the Water Resources Management Master Plan of this Study, an environmental evaluation will basically follow the JICA guideline considering the related Jordanian regulations and guidelines as mentioned in 8.3.1.1.

Firstly, on the basis of national policies especially the Environment Protection Law and the NEAP, the viability of the Master Plan and the proposed water resource development and management projects will be examined. Secondly, regarding the major projects proposed, IEE will be conducted for screening the impacts on the environment, taking into account all the envisaged project activities and the checklist of environmental elements. An environmental impact examination matrix is devised for the screening process. The answer from the screening will basically be 'Yes' or 'No' for the negative impacts. In the case of a 'Yes' answer, the degree of the negative impact will be evaluated as 'Moderate' or 'Significant'.

As a result of the IEE, an evaluation will be given if there is a need of a comprehensive EIA in the next stage of the feasibility study for the selected priority projects within the scheme of the Master Plan.

8.3.2 Environmental Examination

8.3.2.1 General Examination of the Master Plan

In Jordan, "*water shortages, in particular, led to grave environmental strains and also to water mining from renewable and fossil water sources, all this is already having very serious environmental implications. …… The limited water resources in the country is going to strain the economy and the environment in many ways. …… Management of water resources is Jordan's main environmental challenge.*"

The above passage is from the NEAP, which explains the importance of water resources management in Jordan. The limitation of available water resources, the reality of excessive abstraction of renewable groundwater for meeting the needs of current water supply, the depletion in available quantity and deterioration in water quality – these are the present conditions of water in Jordan that cause increasing anxiety on how to sustain Jordan's development in the future. The answer is already very clear in the above cited passage – a comprehensive water resources management plan should be formulated.

In light of this basic national policy, the Water Resources Management Master Plan as presented in this report has highlighted the following project schemes: (1) reduction of renewable groundwater abstraction and development of unconventional water resources such as brackish water and seawater desalination; (2) reuse of sewage treatment effluent; (3) construction of national control system integrating surface and groundwater supplies. These plans agree with the national environmental policy because they stress the aspect of *Management* but not *Development* following the basic requirement according to the above mentioned NEAP; these plans comply with the fundamental principle of *Sustainable Development* because they call for the reuse of treated wastewater as a supplementary water resource which is renewable forever and will promote rational and efficient utilization of the limited water resources by the integrated national control system; these plans are environmentally viable because implementation of these plans will bring about recovery of groundwater quantity and quality and reduction of waste discharge to the environment.

In general, the implementation of these plans is environmentally beneficial because large-scale negative impacts are not anticipated, or at least the above-mentioned positive side is far over the negative side. However, regarding each of the project component, any possible negative impacts on the environment cannot be neglected and have to be reduced to the minimum. At the Master Plan stage, an IEE has to be conducted for a preliminary evaluation of these impacts.

8.3.2.2 Environmental Examination Matrix

The environmental impacts examination matrix is a commonly used tool for screening environmental impacts. It is a table with a list of environmental elements as horizontal axis and a list of project activities as vertical axis, thus forming a matrix with a series of cells which will be marked by different symbols as the result of examination of the impact from each of the project activities on each of the environmental elements.

(1) Project Activities

The project components to be considered include the following:

a. Groundwater

- Groundwater reduction program
- Brackish water (BW)/seawater (SW) desalination
- Common brine drainage facility

b. Surface water

- Dam construction
- KAC water quality conservation

c. Wastewater

- WWTP upgrading
- TSE reuse schemes

d. National Water Transfer System

- Water transfer facility
- Water supply control system

(2) Environmental Elements

Comparing Table 8.3.1-1 and Table 8.3.1-2, it is noticed that almost all the environmental elements specified in the Draft Jordanian EIA Guideline are included in the JICA Environmental Guideline. Therefore, the IEE will use the environmental elements shown in Table 8.3.1-2 for the screening of environmental impacts.

(3) Environmental Examination Matrix

Using the project activities and environmental elements mentioned above, an environmental examination matrix is obtained as shown in Table 8.3.2-1. Three kinds of marks are used for a brief judgment of the environmental impacts as "Significant negative impact", "Moderate negative impact" and "No negative impact" as a result of screening. The rational is given in the following section.

8.3.2.3 Rational of Environmental Impacts Screening

(1) Groundwater Reduction Program

Reduction of renewable groundwater abstraction in the upland area is the priority task in the Master Plan, but because agriculture is very important to the farmers, implementation of this program will affect the economic activity in the related area unless the appropriate countermeasures are taken. Furthermore, it might be achieved by resettlement of farms from the Highland to Jordan Valley. This scheme will be accompanied with serious social impacts.

(2) Brackish Groundwater/Seawater Desalination

In fact, feasibility studies have already been conducted on several projects such as the Hisban/Kafrein Brackish Groundwater Desalination Plant and the Seawater Desalination at Aqaba. These projects are thought to be environmentally viable as long as certain measures are taken to mitigate the possible negative impacts. In the construction phase, the common problems related to construction such as generation of solid wastes, noise and vibration as well as influence on traffic and living facilities, should be considered. In addition, the effect of brackish groundwater abstraction on other aquifers, and the problem of possible water pollution during concentrated brine discharge cannot be neglected. Anyway, these impacts may not be significant.

(3) Brine Drainage Facility

Brine drainage is in fact part of the facility for BW/SW desalination as a measure of environmental protection. Because it is important, and in the case of construction of desalination plants far from the Dead Sea, long distance brine drainage has to be constructed. It is put in Table 8.3.2-1 as an independent project item. The environmental elements on which possible negative impacts are anticipated include those related to pipeline construction (resettlement, community separation, archaeological and cultural properties, solid waste, topography and geography, noise and vibration) should be considered. Another issue to consider is coastal area because the brine will be ultimately discharged into the Dead Sea. However, these impacts may not be significant.

(4) Dam Construction

Surface water development is considered in the Master Plan for the maximum utilization of surface water resources. Several dam projects are on-going (Tannur, Wala, and Mujib) or under planning (Wehda Dam). A feasibility study or even a detailed design have already been conducted, and these projects are thought to be environmentally viable. From a general viewpoint, the main environmental elements to be considered during dam construction are outlined in Table 8.3.2-1. No negative impacts are anticipated in the operation phase.

Table 8.3.2-1 Environmental Impacts Examination Matrix for the Major Project Components of the Master Plan

Project Activities			Social Environment									Natural Environment								Environmental Pollution						
Project Activities			Resettlement	Economic Activity	Traffic & Living Facilities	Community Separation	Archaeological & Cultural Properties	Water Right / Right of Common	Public Health & Sanitation	Solid Waste	Risk of Disaster	Topography & Geography	Soil Erosion	Groundwater	Lake and Rivers	Coastal Area	Flora & Fauna	Meteorology	Landscape	Air Pollution	Water Pollution	Soil Pollution	Noise & Vibration	Ground Subsidence	Offensive Odor	Hazardous Substances
Construction Phase	Groundwater	Reduction Program		×																						
		BW/SW Desalination			△					△				△							△		△			
		Brine Drainage Facility	△			△	△			△		△				△							△			
	Surface Water	Dam	△	△	△	△				△		△	△		△		△		△				△			
		KAC Conservation			△					△													△			
	Wastewater	WWTP Upgrading							△	△											△				△	
		TSE Reuse							△												△				△	
	Water Transfer System	Facility	△	△	△	△	△			△		△											△			
		Control system																								
Operation Phase	Groundwater	Reduction Program		×																						
		BW/SW Desalination												△							△					
		Brine Drainage Facility																								
	Surface Water	Dam																								
		KAC Conservation																								
	Wastewater	WWTP Upgrading																			△					
		TSE Reuse		×					△												△				△	
	Water Transfer System	Facility																								
		Control system																								

×: Significant Negative Impact   △: Moderate Negative Impact   Shade: No Negative Impact

(5) KAC Water Quality Conservation

An option proposed in the Master Plan for KAC water quality conservation is to cover the canal from the northern border to the Deir Alla intake and change it to a closed waterway. Construction work related to this will possibly have impacts on traffic and living facilities in the area along the canal, will result in the generation of solid wastes and will cause noise and vibration.

(6) WWTP Upgrading

Upgrading of wastewater treatment plants is the important task in the wastewater scheme. Although most of the existing WWTPs are away from populated area and environmental consideration has been given in the selection of their locations, certain environmental elements still have to be taken into account, such as public health and sanitation, solid waste, water pollution and offensive odor.

(7) Treated Sewage Effluent Reuse

One of the common problems related to the reuse of treatedwastewater effluent (TWE) for irrigation is the suitability of water quality for crops and other agricultural products. Public concern may arise on the impacts on the agricultural activities and public health and sanitation. During irrigation using TWE, the problems of pollution of other water sources and offensive odor emitted from TWE (especially when the treatment is not efficient) have also to be considered.

(8) Water Transfer Facilities

Construction of water transfer facilities, especially long distance pipelines, may have impacts to a broad area. Therefore, several environmental elements, such as resettlement, economic activity, traffic and living facilities and community separation, have to be considered. In addition, topography and geography are important factors in selecting the route of pipelines, and the disposal of solid waste and the noise & vibration from the work have also to be taken into account.

(9) Water Supply Control System

Implementation of the water supply control system will not involve large-scale construction work and no negative impacts are anticipated.

8.3.2.4 Summary of Major Environmental Impacts

(1) Significant Negative Impacts

From the above discussion, significant negative impacts are only anticipated on "Economic Activity" from the groundwater reduction program and TSE reuse.

(2) Moderate Negative Impacts

The other impacts may not be significant but attention has to be paid. These can be categorized as the following 3 groups.

- Impacts related to larger scale engineering construction: Resettlement, Traffic & Living Facilities, Community Separation, Archaeological & Cultural Properties, Topography

& Geography.

- Impacts related to common construction work: Solid Waste, Noise & Vibration.
- Impacts related to wastewater: Public Health & Sanitation, Water Pollution, Offensive Odor.

For dam construction, additional items such as Soil Erosion, Flora & Fauna, Landscape will have to be reviewed.

8.3.3 Consideration on EIA in the pre-Feasibility Study

Because significant impacts are anticipated from several project items, the comprehensive environmental impact assessment (EIA) is thought to be necessary in conducting the pre-feasibility study phase for the selected priority projects. The IEE result will provide a basis for the EIA. Therefore, for a certain project item, the environmental elements with no negative impacts anticipated by the IEE will not be specially reviewed in the EIA. As is indicated in 8.3.2.3, the impacts on economic activity from groundwater reduction and reuse of treated sewage effluent for irrigation will be the main topics of the EIA.

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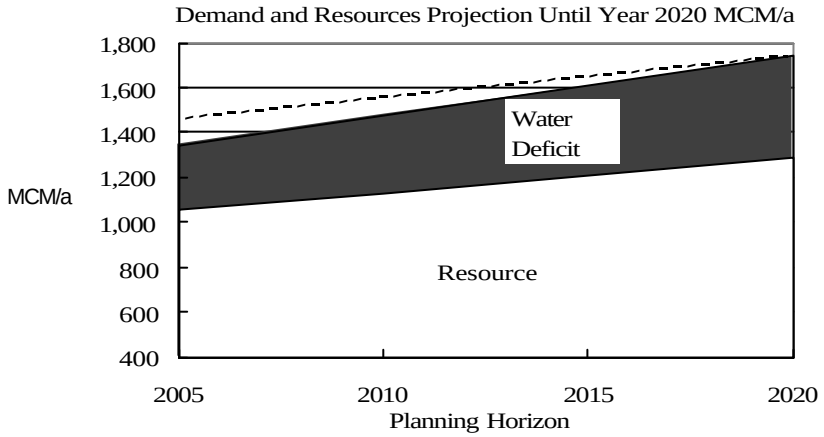
CHAPTER 9
WATER RESOURCES MANAGEMENT PLANS

CHAPTER 9 WATER RESOURCES MANAGEMENT MASTER PLAN

9.1 Basic Policy for Water Resources Management

Throughout the field investigation stage, studies have proceeded based on the understanding that Jordan has been facing a chronic imbalance in its population and that water resources development and management are essential for "sustainable exploitation", "effective water use" and "recycling water". Basic considerations for the Master Plan formulation are summarized in both the demand and the supply sides of the water resources management. Basic consideration for the Master Plan formulation is summarized in the following articles.

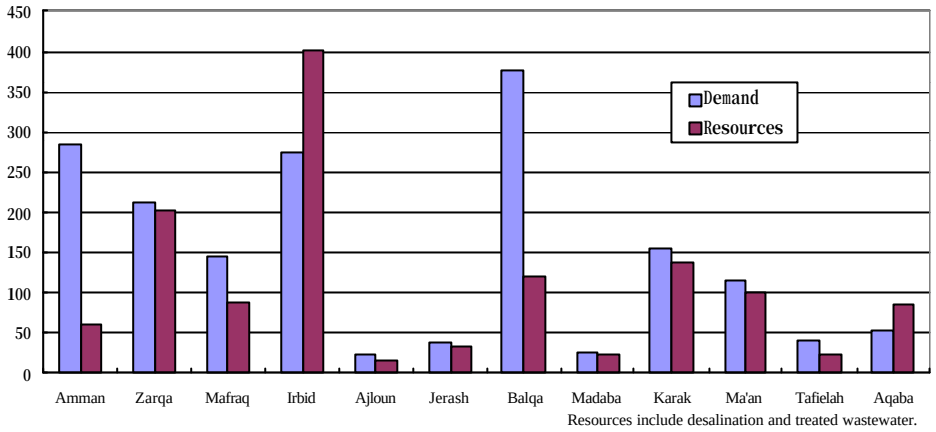
According to the results of the demand projections Jordan's water demand (Senario-2) will increase from about 1,350 MCM in 2005 to about 1,740 MCM in the target year 2020. Regarding the national resources like the safe yield of ground water, surface water and wastewater it becomes obvious that tremendous efforts have to be undertaken to assure the vital needs of Jordan.



The deficit will increase from 290 MCM to 450 MCM even considering the potential sustainable resources being fully utilized, which will never be feasible. This scenario underlines firstly the importance of managing demands carefully and secondly the need for developing all available resources including the total share of international resources.

When the faster realization of target water consumption rate per capita in municipal water supply will be considered, the deficit will increase drastically as shown in broken line in above figure. Namely, the total deficit in 2005 is expected at almost 383 MCM.

The break down of the demands and resources to the governorates shows only for Irbid resources exceeding the demand (Aqaba considers desalination). A severe water shortage occurs in the highly populated governorates of Amman and Zarqa as well as in Balqa governorate. As for Balqa governorate irrigated agriculture in the Jordan Valley represents the lion share of the water demand.



As the projected demand of the country cannot be met by the national resources, the demand has to be suppressed to an extent that can be covered by the available resources. With regard to resources a maximized development of ground- and surface water including treated wastewater reuse, a temporary use of non-renewable water, sea water desalination and Jordan's rightful shares of international resources including Peace Treaty water have to be considered.

In the light of the foreseeable extreme water shortage it occurs to be reasonable to exploit non-renewable water on a temporary scheme to gain the necessary time for the development of sustainable solutions on the long run.

The constrained demand is the basis of the water allocation concept followed throughout the study as the required infrastructure has to be tailored according to the resources availability.

9.1.1 Balancing Demands and Resources Development

As the Water Resources Management Master Plan, balancing between total water demand and water resources development was achieved by managing demand and supply on the national level. The results of the management studies of previous chapters are summarized conceptually in Fig.9.1.1-1. It shows that demands constrained by management are met in each of the target planning years by development, including non-conventional resources, and groundwater development is reduced to the renewable level in 2020.

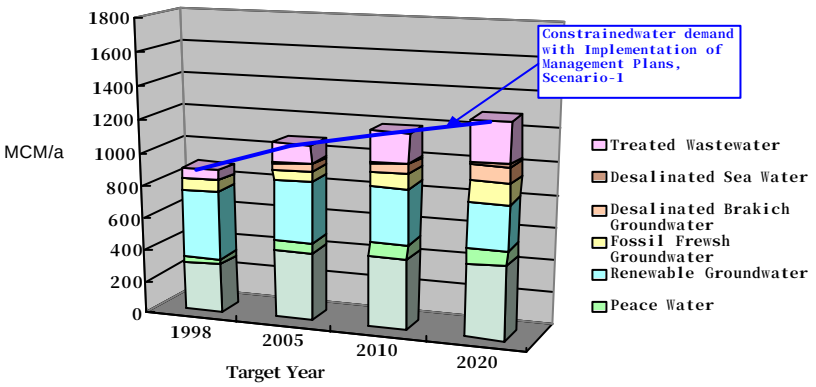
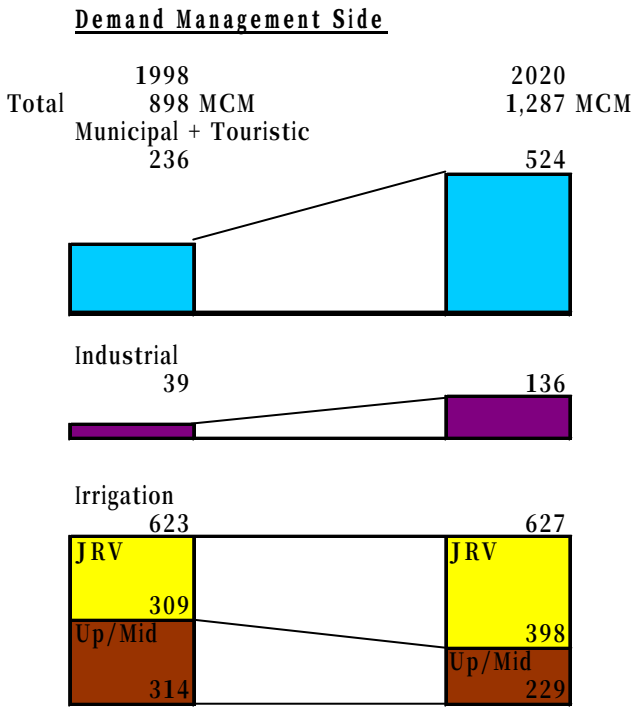


Fig. 9.1.1-1 Total Water Demand and Water Resources Development

9.1.2 Demand Side

As baseline of the management study, a water balance between the three main water uses of the Municipal sector, including Touristic, Industrial and Irrigation and Water resources development, were set up in coordination with MOWI/JICA/World Bank for the planning years of 2005, 2010, 2015 and 2020. In this baseline figures, water uses were severely constrained considering the scarcity of the available water resources as shown in the Figures 9.1.2-2 and 9.1.3-1. The basic considerations of each sector for the baseline are as described below.



Note: Left figure shows the base line prepared by MWI/World Bank/JICA. The formulation of the Water Resources Management was prepared based on this base line. Therefore, the JICA forecast of the future demand is slightly modified from the base line figures.

Fig. 9.1.2-1 Water Balance in 1998 and 2020 (Demand)

(1) Municipal use

The increase in municipal water demand corresponding to the population growth, from 4.7 million in 1998 to 9.2 million in 2020 for Scenario-1, were secured as first priority. However, its per capita unit consumption shall be constrained with a decent increase. At the same time, current imbalance per capita consumptions in the 12 governorates were also equalized in the year of 2020.

Public awareness campaigns shall be waged to protect water resources and to make the public recognize the economic and social value of a unit of water.

(2) Industrial and Touristic use

The importance of the industrial and touristic sectors in the national economy is expected to increase steadily. Their shares in the current GNP are approximately 13% and 10%, respectively, compared to agriculture of approximately 3%, and therefore, industrial and touristic needs shall be satisfied with a certain priority. The "Oil Shale Project", "Special Economic Zones" and "Industrial Zones" in the industrial development plans and

particular touristic development plans of the government were especially be taken into consideration.

(3) Irrigation use

Water use in irrigated agriculture shall be managed in coordination with the other sectors and existing areas of irrigated agriculture shall be maintained basically with the conventional and non-conventional water resources development and the on-farm water management. However, since the deterioration or depletion of groundwater resources were recognized, sustainability of the irrigated agriculture shall be constrained, according to the re-assessment of the renewable volume thereof.

This means replacing the irrigation area in the Up/Mid land to the Jordan Rift Valley as shown in Fig. 9.1.2-2, as well as replacing fresh groundwater irrigation to treated wastewater reuse. In the case of agricultural use of Disi fossil groundwater in the Ma'an and Aqaba governorates, irrigation agriculture shall be ceased gradually but totally to municipal use toward the year of 2020 with socially-acceptable measures.

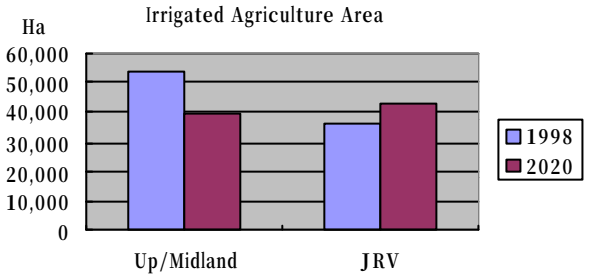


Fig. 9.1.2-2 Irrigation Areas in Up/Mid land and JRV

9.1.3 Resources Side

On the resources side, the development of conventional and non-conventional water resources and their sustainability shall be of importance to the management. The potential of the considerable water resources in Jordan shall be assessed and their socially-, technically-, environmentally- and economically-sound developments shall be considered.

In the baseline of water balance, the utilization of fossil groundwater, wastewater effluent reuse, brackish groundwater, seawater desalination and regional water were set up, as well as conventional surface water and groundwater development. The figures of these resources for current use and development in the year 2020 are summarized in Table 9.1.3-1 and are shown conceptually in Fig. 9.1.3-1 in next page.

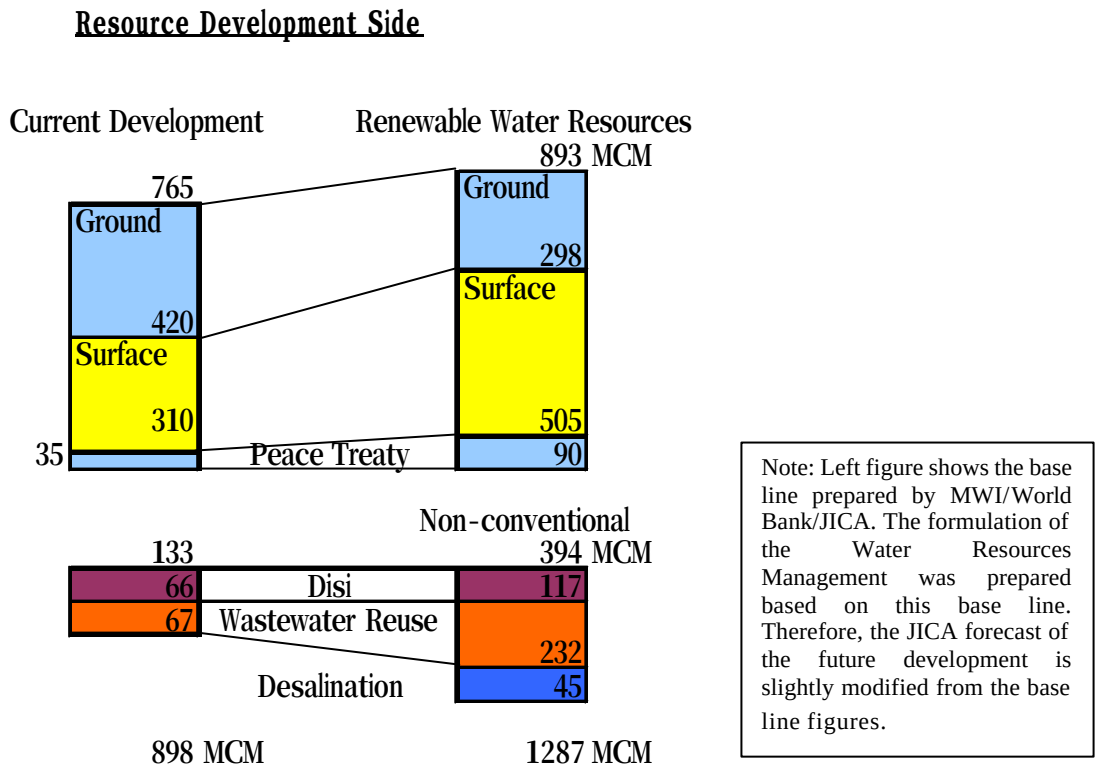


Fig. 9.1.3-1 Water Balance in 1998 and 2020 (Resource)

(1) Resources

Conventional water resources

Surface water and groundwater shall be considered.

For the surface water, there is room for developing the full potential of the resource and its maximum development were considered.

For the groundwater, it is obvious that the current exploitation is exceeding the renewable amount and is causing pollution and depletion. As reported in previous chapters, the renewable amount has been re-assessed already by governorate basis and a step reduction of groundwater exploitation to the estimated safe yield level were considered by 2020 through both municipal and irrigation water use.

Non-conventional resources

Disi fossil groundwater, wastewater effluent reuse, brackish groundwater, seawater desalination and regional water were considered as non-conventional resources. The potential of these resources and the potential areas for their development have been identified and re-assessed so far in the study. Therefore, their viability were examined with the development plan. In particular, the brackish groundwater potential was estimated, with 250 to 300MCM/a in the south Jordan Valley and the Dead Sea Escarpment areas, as a safe yield. However, the main part of brackish groundwater potential in these areas should be reserved for future demand after 2020 or for

unpredictable water shortage in future.

(2) Water Quality Conservation

Based on the water quality analysis for surface water and groundwater in the country, which have been conducted in the study, water quality conservation shall be considered with the water quality simulation analysis.

(3) Water Allocation

For scenario-1, deficits or surpluses between requirements and availability of water resources have been identified in 12 governorates of the country. A water allocation has been conducted based on the management considerations mentioned above. Particular issues to be solved have become obvious in each governorate, such as requirements for new transfer facilities or additional resource development for practical and economical use.

The most effective water allocation was studied and established for the planning years of 2005, 2010, 2015 and 2020, considering the three demand projection scenarios.

(4) Supply/Transfer System

Based on the finalized water allocation plan, the optimistic main water supply/transfer system between governorates/sources were examined and planned with the hydraulic analysis. This system includes a nationwide water supply control facility as well as construction and improvement of pipeline/carrier network.

(5) Institutional and Legislative Arrangements

Institutional and legislative arrangements currently prepared in the ministry shall be summarized, focusing on the privatization of water supply services and wastewater effluent reuse for irrigated agriculture, and recommendations thereupon shall be prepared in the Master Plan.

Table 9.1.3-1 Actual and Projected Water Balance for Jordan 1998-2020 (in MCM)

1998

	1998 Actual Water Use in MCM/year						
	Renewable			Agriculture			Total
Sources	Supply	Municipal	Industrial	Up/Midland	JRV	A.Total	Use
Groundwaer	277	173	32	171	44	215	420
Disi Groundwater	0	10	5	51		51	66
Surface water	505	43	2	81	184	265	310
Peace Treaty	35	10	0	0	25	25	35
Brackish Groundwater	0					0	0
Total Freshwater	817	236	39	303	253	556	831
Wastewater Reuse	67			11	56	67	67
Seawater Desalination	0						0
Total Actual	**884**	**236**	**39**	**314**	**309**	**623**	**898**

2005

	2005 Estimated Water Use in MCM/year						
	Renewable			Agriculture			Total
Sources	Supply	Municipal	Industrial	Up/Midland	JRV	A.Total	Use
Groundwaer	277	160	42.55	149	40	189	392
Disi Groundwater	0	10	7	44		44	61
Surface water	505	73	15	81	247	328	416
Peace Treaty	60	35	0	0	25	25	60
Brackish Groundwater	30	30				0	30
Total Freshwater	872	278	65	274	312	586	929
Wastewater Reuse	108		15	28	65	93	108
Seawater Desalination	5	5					5
Total Actual	**985**	**283**	**80**	**302**	**377**	**679**	**1042**

2010

	2010 Estimated Water Use in MCM/year						
	Renewable			Agriculture			Total
Sources	Supply	Municipal	Industrial	Up/Midland	JRV	A.Total	Use
Groundwaer	277	120	49.3	130	35	165	334
Disi Groundwater	0	80	10	20		20	110
Surface water	505	92	20	81	312	393	505
Peace Treaty	90	60	0	0	30	30	90
Brackish Groundwater	30	30				0	30
Total Freshwater	902	382	79	231	377	608	1069
Wastewater Reuse	177		20	46	110	156	176
Seawater Desalination	5	5					5
Total Actual	**1084**	**387**	**99**	**277**	**487**	**764**	**1250**

2015

	2015 Estimated Water Use in MCM/year						
	Renewable			Agriculture			Total
Sources	Supply	Municipal	Industrial	Up/Midland	JRV	A.Total	Use
Groundwaer	277	135	52	103	20	123	310
Disi Groundwater	0	100	15	10		10	125
Surface water	505	135	22	81	267	348	505
Peace Treaty	90	60	0	0	30	30	90
Brackish Groundwater	30	30				0	30
Total Freshwater	902	460	89	194	317	511	1060
Wastewater Reuse	208		25	59	123	182	207
Seawater Desalination	15	10	5				15
Total Actual	**1125**	**470**	**119**	**253**	**440**	**693**	**1283**

2020

	2020 Estimated Water Use in MCM/year						
	Renewable			Agriculture			Total
Sources	Supply	Municipal	Industrial	Up/Midland	JRV	A.Total	Use
Groundwaer	277	135	60	83	20	103	298
Disi Groundwater	0	100	17	0		0	117
Surface water	505	189	24	81	211	292	505
Peace Treaty	90	60	0	0	30	30	90
Brackish Groundwater	30	30				0	30
Total Freshwater	902	514	101	164	261	425	1040
Wastewater Reuse	245		30	65	137	202	232
Seawater Desalination	15	10	5				15
Total Actual	**1150**	**524**	**136**	**229**	**398**	**627**	**1287**

9.2 Water Resources Management at National Level

The required plans and measures, including regional cooperation for water resources management on the national level, are discussed in the categories of institutional and legislative arrangement, demand management and resources development of previous chapters and are summarized in the conceptual diagram hereunder and in Table 9.2.1-1 (1) and (2).

Water Resources Management

- Demand Management
  - Municipal and Touristic Use
  - Industrial Use
  - Irrigation Use
  - Public Awareness
- Supply Management
  - Water Allocation
  - Decreasing UFW of MIT Water
  - Decreasing UFW of Irrigation Water
- Resources Development
  - Conventional Resources
  - Non-conventional Resources

Environmental Protection

- Water Resources Conservation
  - Establishment of Wastewater Disposal System
  - Water Quality Conservation

Table 9.2.1-1(1) Conceptual Diagram of Water Resources Management

Supply/Demand Management

Policy	Sector	Action Plan	Plans/Projects		
			short term	mid-term	long term
Demand Management	Municipal & Touristic Use	Constrain of Per Capita Consumption	Project Table DM-S1	Project Table DM-M1	Project Table DM-L1
		Optimum Rationing			
		Revising Tariff System			
	Industrial	Treated Wastewater Reuse	Project Table DM-S2	Project Table DM-M2	Project Table DM-L2
		Water Circulation System			
		Desalination or Treatment Plants			
	Irrigation	Increasing Irrigation Efficiency	Projects managed by Ministry of Agriculture		
		Changing Cropping Pattern	Projects managed by Ministry of Agriculture		
		Decreasing Irrigation Area	Projects managed by Ministry of Agriculture		
		Brackish Groundwater Use	Projects managed by Ministry of Agriculture		
	Public Awareness	Water Saving Campaign	Project Table PA-S1	Project Table PA-M1	
		Encouraging Water Saving Devices			
Supply Management	Water Allocation	Inter-Governorate Transfer System	Project Table WT-S1	Project Table WT-M1	Project Table WT-L1
		National Water Control System	Project Table WT-S2	Project Table WT-M2	Project Table WT-L2
	Decreasing UFW of Municipal, Touristic and Industrial Water	Rehabilitation of Network	Project Table PU-S1	Project Table PU-M1	Project Table PU-L1
		Leak Detection System	Project Table PU-S2	Project Table PU-M2	Project Table PU-L2
		Recovery of Administration Loss	Project Table PU-S3	Project Table PU-M3	Project Table PU-L3
	Decreasing UFW of Irrigation Water	Construction of Piped Irrigation System	Project Table IW-S1	Project Table IW-M1	Project Table IW-L1
		Rehabilitation of Distribution System	Project Table IW-S2	Project Table IW-M2	Project Table IW-L2
Resources Development	Conventional Water	Surface Water	Project Table SW-S1	Project Table SW-M1	Project Table SW-L1
		Groundwater	Project Table GW-S1	Project Table GW-M1	Project Table GW-L1
	Non-conventional Water	Treated Wastewater	Project Table TW-S1	Project Table TW-M1	Project Table TW-L1
		Brackish Groundwater	Project Table BD-S1	Project Table BD-M1	Project Table BD-L1
		Seawater Desalination	Project Table SD-S1	Project Table SD-M1	Project Table SD-L1
		Peace Treaty Water	Project Table PT-S1	Project Table PT-M1	Project Table PT-L1
		Regional Water			Project Table RW-L1

Environmental Protection

Policy	Sector	Action Plan	Plans/Projects		
			short term	mid-term	long term
Water Resources Conservation	Establishment of Wastewater Disposal System	Construction of Wastewater Treatment Plant	Project Table WW-S1	Project Table WW-M1	Project Table WW-L1
		Increasing Wastewater Collection Coverage	Project Table WW-S2	Project Table WW-M2	Project Table WW-L2
	Water Quality Conservation	Reduction of Groundwater Abstraction	Project Table RG-S1	Project Table RG-M1	Project Table RG-L1
		Groundwater Quality Monitoring	Project Table QM-S1	Project Table QM-M1	Project Table QM-L1
		Surface Water Quality Monitoring	Project Table QM-S2	Project Table QM-M2	Project Table QM-L2

Table 9.2.1-1(2) Conceptual Diagram of Water Resources Management

Overall Water Resources Management Plans/Projects (1/2)

	Plan/Project in Short Term (2000 to 2005)		Plan/Project in Mid Term (2005 to 2010)		Plan/Project in Long Term (2010 to 2020)
No.	Demand Management DM-S1	No.	Demand Management DM-M1	No.	Demand Management DM-L1
3	The Governorate Support Section (GS)	D1	Demand Mangement Plan for M & T	D1	Demand Mangement Plan for M & T
D1	Demand Mangement Plan for M & T	D2	Demand Mangement Plan for Industrial Use	D2	Demand Mangement Plan for Industrial Use
D2	Demand Mangement Plan for Industrial Use				
1	Water Feasibility, Design Studies				
No.	Demand Management PA-S1	No.	Demand Management PA-M1	No.	Demand Management PA-L1
P1	Public Awarenes Campaign	P1	Public Awarenes Campaign		
No.	Supply Management WT-S1	No.	Supply Management WT-M1	No.	Supply Management WT-L1
32	Dier Alla - Zai Amman II	63	Desalination Conveyor, Peace Project	C2	Inter-Governorates Transfer Line Phase 1
71	Tabaqat Fahil - Irbid	12	Wadi Al Arab - Irbid Municipal Water Supply	C3	Inter-Governorates Transfer Line Phase 2
70	KAC Siphon Upgrading	69	Al Wahda Dam Water Supply Project/Irbid		
68	Dead Sea Water Treatment Plant	C1	Disi Water Conveyer Branch to Ma'an and Madaba		
11	Mujib Weir Conveyor	M1'	National Water Control System Phase 2		
M1	National Water Control System Phase 1				
No.	Supply Management PU-S1	No.	Supply Management PU-M1	No.	Supply Management PU-L1
5	Rehabilitation - Zarqa Governorate	30	Miscellaneus Network Expansion		
10	Amman Municipal Water Network 1	1	Water Feasibility and Design Studies		
(33)	Amman Municipal Water Network II	(8)	Municipal Water Networks Rehabilitation		
4	Planning and Management Unit (PMU)				
9	Amman Water Management Contract				
No.	Supply Management IW-S1	No.	Supply Management IW-M1	No.	Supply Management IW-L1
35	Rehabilitation of Southern Ghors Irrigation I				
36	Rehabilitation of Hisban-Kafrein Irrigation				
34	Jordan Rift Valley Improvement Project				
No.	Resources Development SW-S1	No.	Resources Development SW-M1	No.	Resources Development SW-L1
14	Wala Dam	18	Small Dams (Ibn Hamad, Karak, Meddien)	65	Storage on Jordan river and Side Wadis
13	Mujib Dam			19	Water Harvesting, Badia Region
15	Tannur Dam				
20	Wadi Araba Development Project				
26	Feedan Dam				
62	Wahda Dam				
No.	Resources Development GW-S1	No.	Resources Development GW-M1	No.	Resources Development GW-L1
21	Wadi Mousa Water Supply	6	Disi Amman Water Conveyer	6	Increase of Disi Amman Water Conveyer
24	Lajoon Wells	17	Deep Groundwater Investigation	G1"	Lajjun Groundwater for Oil Shale Project
67	Caradoor Water Supply Project	G1'	Lajjun Groundwater for Oil Shale Project 2	O5	Groundwater in Musaitbeh Well Field
22	Community Infrastructure Project			O6	Disi-Aqaba Hydro-powered RO Desalination
25	Wadi Zarqa Ma'in, Zara spring Project				
G1	Lajjun Groundwater for Oil Shale Project - 1				
G2	Groundwater for Electric P/S in Zarqa				
G3	Groundwater for Info-Technical Park				
No.	Resources Development TW-M1	No.	Resources Development TW-M1	No.	Resources Development TW-L1
W3 (3)	Treated Wastewater Reuse of As-Samura	W3' (3)	Reuse of As-Samura and Zarqa TPs	W3" (3)	Reuse of As-Samura and Zarqa TPs

Table 9.2.1-1(2) Conceptual Diagram of Water Resources Management (continued)

Overall Water Resources Management Plans/Projects (2/2)

	Plan/Project in Short Term (2000 to 2005)		Plan/Project in Mid Term (2005 to 2010)		Plan/Project in Long Term (2010 to 2020)
No.	Resources Development SD-S1	No.	Resources Development SD-M1	No.	Resources Development SD-L1
28	Desalination at Aqaba			28	Desalination at Aqaba (Long Term)
No.	Water Resources Conservation WW-S1	No.	Water Resources Conservation WW-M1	No.	Water Resources Conservation WW-S1
44	Irbid Stage I, Phase 1	45	Irbid Stage II (Wadi Shallala TP) Phase 1	64'	Upgrading Kufranja and Ajlun WWTP 2
37	Rehabilitation Various Cities (WTP)	56	Upgrading and expansion of Karak WWTP	59'	Madaba WWTP Upgrade, Phase 2
50	Wadi Mousa Wastewater Project	41	North Queen Alia Airport TP	60'	Ramtha WWTP Upgrade, Phase 2
39	Ain Gazel Pre-Traetment Plant	46	Mazar, Mu'ta and Aldaniya Wastewater Projects	44'	Irbid Stage I, Phase 2
59	Madaba TP Upgrade and Expansion 1	43	Jordan Valley Sanitation - South Shunah	42'	Jordan Valley Sanitation - North Shunah
57	Upgrading Mafraq TP	61	Abu-Nusier WWTP Upgrade & Expansion	45'	Irbid Stage II (Wadi Shallala TP) Phase 2
60	Ramtha TP Upgrade & Expansion, Phase 1	42	Jordan Valley Sanitation - North Shunah	W15 (22)	Construction of Dair Abi Said TP
51	Na'ur and Adjacent Areas Wastewater	40'	South Amman Wastewater Al Jeza, Phase 2	W1' (23)	Expansion od Dair Alla TP
40	Al Jeza Phase 1	48	Miscellaneus Small Projects (WW Project)	W16 (31)	Construction of Torra TP
55	Dead Sea Wastewater Infrastructure	W8 (4)	Extension of Baqa Treatment Plant		
54	Aqaba Wastewater Project (Central)	W9 (5)	Extension of Fuhis Treatment Plant		
53	Community Wastewater Project	W10 (7)	Expansion of Jerash (East) TP		
52	JRV Community Waste Management Project	W11 (14)	Expansion of Salt TP		
64	Upgrading Kufranja and Ajlun TP, Phase 1	W12 (25)	Construction of Kofur Asad TP		
38	Upgrading of As-Samra TP, Phase 1	W13 (34)	Construction of Wadi Zarqa TP		
58	Upgrading Ma'an TP	W14 (35)	Construction of Mazar, Muta, Adaniya TP		
58	Upgrading Tafila TP				
49	Sakeb Wastewater System (Jerash West)				
W1 (23)	Construction of Dair Alla Treatment Plant				
W2 (26)	Aqaba South Coast TP, Phase 1				
No.	Water Resources Conservation RG-S1	No.	Water Resources Conservation RG-M1	No.	Water Resources Conservation RG-L1
(7)	Groundwater Reduction Program	(7)	Groundwater Reduction Program	(7)	Groundwater Reduction Program
No.	Water Resources Conservation QM-S1	No.	Water Resources Conservation QM-M1	No.	Water Resources Conservation QM-L1
M2	Groundwater Monitoring Plan (WQICP)	M2	Groundwater Monitoring Plan (WQICP)	M2	Groundwater Monitoring Plan (WQICP)
M3	Surface Water Monitoring Plan (WQICP)	M3	Surface Water Monitoring Plan (WQICP)	M3	Surface Water Monitoring Plan (WQICP)
No.	Resources Development RW-S1	No.	Resources Development RW-M1	No.	Resources Development RW-L1
				O7	Red Sea-Dead Sea Canal Project (RSDSC)
				O8	Aqaba Hybrid Sea Water Pumped-Storage
				O9	Development of Deep Sea Water
				O10	Water Conveyonce from Turky by Ship
				O11	Water Conveyonce from Turky by Pipe Line
				O12	Water Conveyonce from Tigris, Euphrates
				O13	Mediterranean-Dead Sea CanalProject

9.2.1 Institutional and Legislative Arrangement

(1) Privatization of Operation and Maintenance Services

- Water Supply Services
- Bulk Water Supply (desalination, Disi conveyer, etc.)
- Sewage Treatment

(2) Control of Groundwater Abstraction

- Limitation of Ground water Abstraction
- Licensing
- Wells buy out
- Replacing Up/Midland Irrigation Agriculture to JRV

(3) Encouragement of Treated Effluent Reuse

- Subsidy/Incentives for reuse Facility Construction/Tariff

(4) Raise Water Tariff

- Cover at least Operation and Maintenance Cost
- Block Tariff System

(5) Water Allocation

- Value added to water considering national economy

(6) Strategic Water Resources Planning and Management System

- Digital National Water Master Plan with Water Information System
- National Water Control Center

9.2.2 Demand Management

(1) Reduction of Irrigation Water

- Improvement of Irrigation Efficiency
- Shifting Cropping Pattern
- Utilization of Brackish Groundwater
- Treated Wastewater Effluent Reuse

(2) Public Awareness

- Water Saving Campaign

9.2.3 Supply Management

(1) Reduction of UFW

- Rehabilitation of water supply network
- Actions for reduction of Administrative Loss

- Formulation of Leakage Detection Teams

9.2.4 Resources Development and Environmental Protection

(1) Resources Development

As mentioned in the previous chapters, there are many resource development projects considered in the master plan and major projects are summarized hereunder.

1) Surface water development

- Wehda Dam
- Side Wadis Development
- Wadi Mujib, Wadi Wala and Wadi Tanur Dams
- Lower Jordan Valley Development

2) Groundwater development

- Disi Mudawara Fossil Development and Conveyer
- Lajoun Deep Well
- Deep Well Groundwater in Ma'an

3) Brackish groundwater development

- Hisban/Kafrain Brackish Water Desalination
- Zara/Zarqa Main Brackish Spring Water Desalination at Sweima
- Deir Alla/Dead Sea Small-scale Brackish Groundwater Desalination
- Brackish Groundwater Desalination for Karak Oil Shale Project

4) Seawater desalination development

- Aqaba Seawater Desalination

5) National Water Transfer Network

- Disi Conveyer with local connections to southern Governorates
- Mujib/Zara/Sweima Saline Water Conveyer
- Sweima/Hisban/Amman High-lift Conveyer
- Wehda/Irbid Transfer Line

6) Treated wastewater reuse

- Full scale reuse of Treated Wastewater from As-Samra and Wadi Zarqa Wastewater Treatment Plants
- Local Use of Treated Wastewater from other Wastewater Treatment Plants

(2) Environmental Protection

1) Establishment of Wastewater Disposal System (treatment plant construction and improvement of sewerage collection system)

- As-Samra Wastewater Treatment Renovation
- Wadi Zarqa Wastewater Treatment
- Construction and Expansion of Local Wastewater Disposal System

2) Reduction of Groundwater Abstraction

- Improvement of Irrigation Efficiency
- M&I Pumping Reduction

3) Water Quality Conservation

- Groundwater Monitoring by WQICP System
- Surface Water Monitoring by WQICP System

9.2.5 Main Projects for Water Resources Management Master Plan

(1) Basic policy for the formulation of the plan

In this study, Water Resources Management Master Plan has been made, aiming at "unified and comprehensive and sustainable management of water resources" and "strategic development of remaining scarce water resources," while considering a goal of the formation of a re-cycling system of the society. In making the master plan, the considerations were made on "development and management of sustainable water resources", "regional peaceful use of water resources" and "global climate change" which are specific water issues in Jordan

The basic conditions in formulating the Water Resources Management Master Plan are shown in Table9.2.5-1. Among the basic conditions, most critical issue in managing water resources in a unified, comprehensive and sustainable manner is believed to be the problem of renewable groundwater that is almost drying out due to its excessive abstraction. The most important issue in strategically developing remaining scarce water resources is that most of conventional water resources such as surface water and groundwater are scheduled to be developed in near future. Thus, in order to meet the water demand that will further increase in the future, it will be critical to develop and use treated wastewater, desalinated brackish and sea water that has been hardly used.

Table9.2.5-1 Basic Policies for the Formulation of the Master Plan

Management Item		Basic Policies	Existing Policies
Quantitative Management	Improvement of UFW	The present physical loss of 25% shall be reduced to 15% by on-going rehabilitation works by 2010	Policy of UFW Div. of MWI
	Improvement of Institutional System	The necessary improvement plans shall be recommended based on the on-going re-structuring project of the Institutional system in MWI.	Water Strategy, Water Utility Policy, Wastewater Management Policy
	Decline of Groundwater Level Decline	The abstraction of the renewable groundwater shall be reducedto the level of the safe yield. (reduction from 420MCM/a to 275MCM/a by 2020)	Water Strategy, Ground-water management policy, policy of the JICA Study Team
	Development of Conventional Water Resources	The remained potential of the conventional water resources shall be fully developed, the renewable groundwater shuld not be further developed	Water Strategy, Water Utility Policy, Groundwater Management Policy, Policy of the JICA Study Team
	Development of Non-Conventional Water Resources	Reuse of the treated wastewater should be promoted as an important water resource, the desalination of the brackish and sea water should be restricted for necessary but minimum demand considering the environmental impacts and high cost for processing.	Water Strategy, Water Utility Policy, Water Utility Policy, Irrigation Water Policy, Groundwater Management Policy, Policy of the JICA Study Team
Qualitative Management		The monitoring of the surface water and groundwater quality shall be done for the quantitative management	Water Utility Policy, Policy of the JICA Study Team
Water Allocation Management	Municipal Water	Although the increasing water demand due to the population growth shall be met, the consumption rate shall be kept at almost present level (100lcd to150lcd)	Water Strategy, Water Utility Policy
	Industrial Water	Necessary but minimum demand shall be satisfied considering the importance for the national economy	Water Strategy
	Irrigation Water	The amount of allocation for irrigation shall be kept at almost present level in order to meet the necessary but minimum MIT demend (around 620MCM/a in future)	Irrigation Water Policy、Policy of MWI and World Bank
	Allocation to the Governorates	The demand and supply shall be balanced by the inter-Governorate water transfer	Policy of the JICA Study Team
Risk Management (Measures for Drought)		Special water allocation and urgent water development shall be considered for the drought year of 20 year return period	Policy of the JICA Study Team

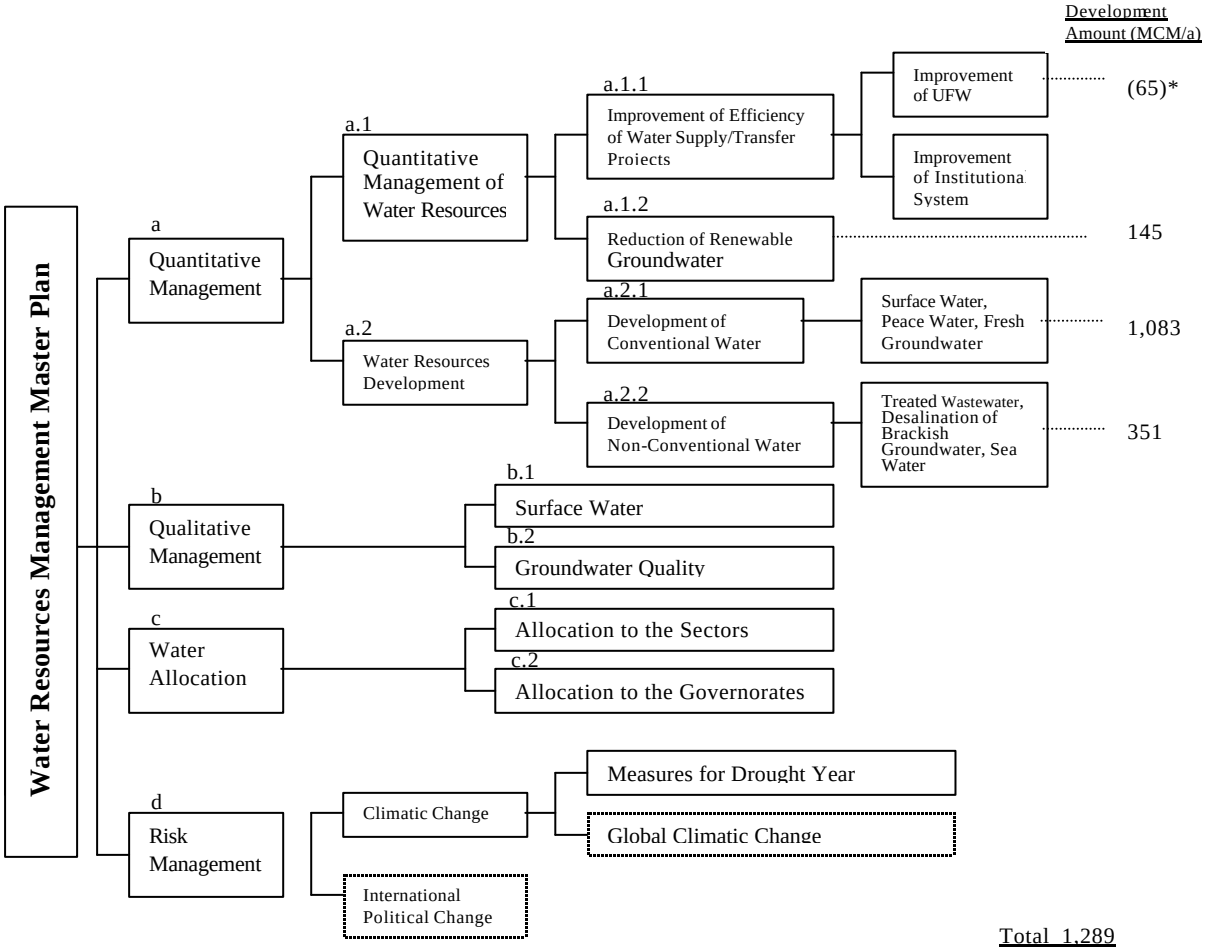
(2) Setting of scenarios of water demand

As described in Chapter 1, Scenario-2 is a targeted demand model assuming the full supply of irrigation water and the higher consumption rate per capita (150l/c/d) which is the ultimate goal of MWI. The water demand largely exceeds possible water supply in each target year, and thus it can be said that Scenario-2 is hard to be realized.

In cases of scenarios-1 and -3, the water demand is estimated to be within the water supply that can be developed, and thus it can be said that the scenarios can be realized. The major difference between the two scenarios is that future population growth rate is greater and water consumption rate is smaller in Scenario-1, and the population growth rate is smaller and water consumption rate is greater in Scenario-3. Therefore, in making the Water Resources Management Master Plan, Scenario-1 that projects the supply-demand relations based on a high population increase and low water demand is used as the basic scenario in giving consideration to the possibility of the delay of the development projects of water resources.

(3) Basic policy of the plan

The contents of the Water Resources Management Master Plan to satisfy the scenario-1 will be described in this section. The tree structure of the Master Plan is shown in Fig. 9.2.5-1.



*: Incremental Amount by the improvement of UFW is counted in the reduction of water supply

Fig. 9.2.5-1 Main Components Forming the Water Resources Management Master Plan

The main policies of the Master Plan shown in Fig. 9.2.5-1 are explained in the following.

a. Quantitative management

a.1. Quantitative management of water resources

a.1.1 Improvement of efficiency of water supply and transfer projects

-Improvement of unaccounted for water (UFW)

The plan to improve unaccounted for water is carried out by the section of unaccounted for water (UFW section) established in the Ministry of Water and Irrigation. Currently, a rehabilitation plan of existing water supply system is carried out across the nation. The plan aims to reduce the current rate of water leakage from the water supply system of about 25% to 15%. The Master Plan adopts this plan to reduce the water leakage rate to formulate a water supply plan. It is also planned to educate citizens to save water and establish legal regulations to tackle illegal water use, in addition to the rehabilitation of the water supply system.

The water resources management master plan also suggests a project to establish water supply control system in an attempt to find out the actual situation of UFW. Because no measures can be taken without understanding the actual situation of UFW, the Master Plan suggests an early establishment of the system.

-Improvement of institutional and management system of water supply projects

The institutional improvement plan is carried out based on a plan formulated with the cooperation of Canada (CIDA). It has generated some positive results, including the reduction in personnel. The PMU established within the MWI promotes the privatization of maintenance and management for improving the efficiency of the management of water and sewage projects, and the works have been actually privatized in Amman. The Master Plan was formulated with the assumption that such plans would be further promoted.

On the other hand, as for the projects except for water projects, including sewage projects and water projects for agricultural use, the tariff is set at a bw level not to allow to cover the maintenance and management costs. The Master Plan suggests the tariff should be raised to a level that will at least allow to cover such costs in order to improve the management of water projects and to provide sufficient services.

a.1.2. Reduction of the renewable groundwater abstraction

The plan of reducing the renewable groundwater abstraction aims to conserve groundwater sources quantitatively. It aims to reduce the abstraction of renewable groundwater, which is excessively abstracted currently, by about 35 percent (from the current abstraction of 420 MCM/a to 275 MCM/a). The USAID conducted a detailed study on the plan of reducing the renewable groundwater abstraction in Amman/Zarqa basin. It made an action plan consisting of projects of provision of agricultural instruction to improve efficiency of water use of agricultural purposes, purchase of wells and use of treated wastewater. The reduction plan is believed to be applicable in other regions. Therefore, under the Master Plan, it is planned that the action plan is first carried out in Amman/Zarqa basin, and then based on the result, it is to be carried out in other regions. The reduction plan is scheduled to be completed by 2020.

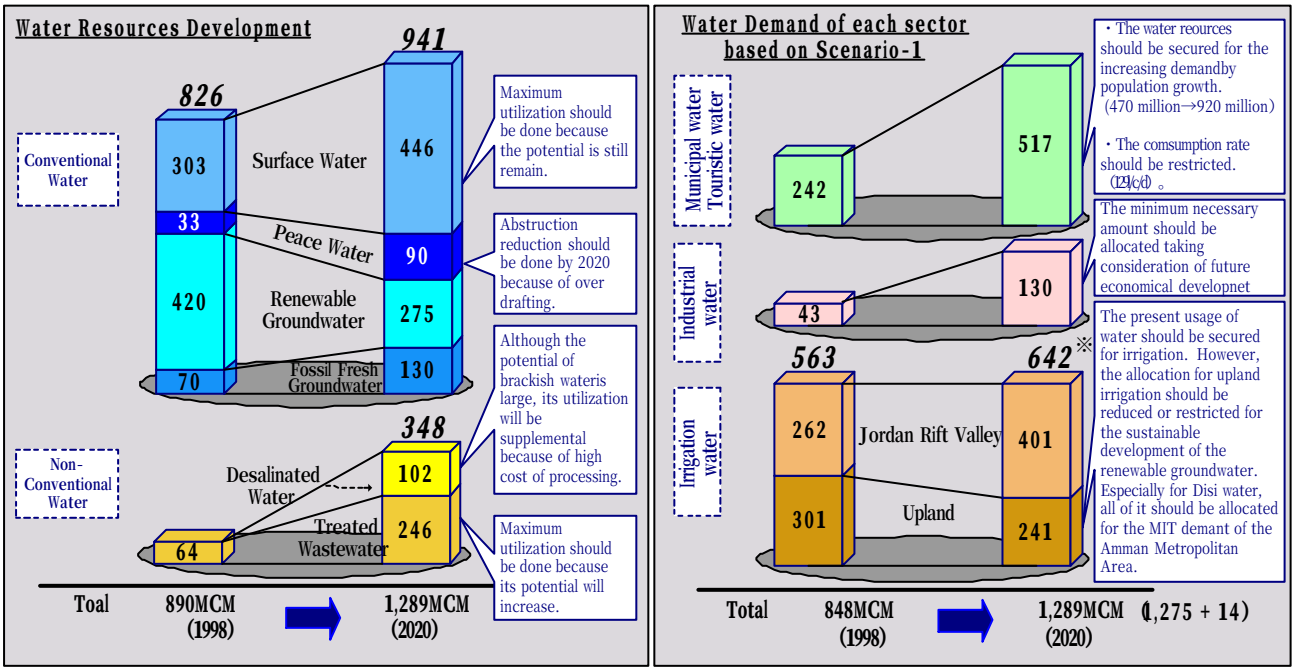
Because the execution of the plant to reduce groundwater abstraction promotes qualitative conservation as well as quantitative conservation of groundwater, it is also

proposed as a plan to conserve quality of groundwater.

a.2. Water resources development

In Jordan, most of the conventional types of water resources that are believed to allow sustainable development is to be developed by 2005, and gradual reduction in the abstraction of the renewable groundwater is necessary. New water resources that will allow sustainable development in Jordan are, as shown in Fig.9.2.5-2, limited to non-conventional water sources of desalinated brackish and sea water and treated wastewater. These non-conventional types of water resources are regarded as important water sources in the Master Plan, and 348 MCM/a of water (85 MCM/a of desalinated brackish groundwater, 17 MCM/a of desalinated sea water and 246 MCM/a of treated wastewater) is expected to be developed by 2020. However, because the use of treated wastewater is limited to certain purposes and cost to desalinate the brackish and sea water is still high, it is difficult to meet the future water demand only with the non-conventional types of water resources.

Therefore, the Master Plan has a policy to aggressively develop the non-conventional types of water sources together with the maximum development of remaining scarce conventional types of water resources including surface water and fossil fresh ground water. However, part of the 1,289 MCM/a of water sources that is scheduled to be developed by 2020 needs to be stored for the next generation, and thus the development should be carried out at a necessary minimum level.



※including loss during transportation of TWW

Fig. 9.2.5-2 Water Balance of the Water Resources Management Master Plan

a.2.1. Development of conventional water

-Surface water

Preparation for the development of surface water is on progress, and most of it is to be completed by 2005. Further large-scale development of surface water will not be possible after 2005. However, development of remaining surface water should be promoted even if it is small in volume, and the Master Plan recommends the implementation of the Water Harvesting Plan. The plan is to store flooded water generated in some regions, although such water is produced rarely, at a dam in the desert area (Badia Region) to use it for the local residents for agriculture and stock breeding. The developable water volume of the plan is projected to be about 15 MCM/a.

-Water from Israel under the peace treaty

Currently, 33 MCM/a of surface water is transported from Israel under the agreement of the peace treaty concluded in 1994. The volume is planned to increase to 90 MCM/a by 2010. The Master Plan includes the "Water Storage in the Jordan River and Side Wadi Plan" as a project to newly develop the increased amount of water under the peace treaty.

-Renewable ground water

As described before, renewable groundwater in Jordan has already been excessively abstracted and the abstraction needs to be reduced. A water allocation plan under which water abstraction is to be reduced both from water for municipal use and agricultural use is formulated in the Master Plan. The WAJ has a plan to prepare alternative water sources to offset the reduced abstraction of municipal water. Improvement of institutional and legislative system is proposed for the reduction of the renewable groundwater for irrigation use is proposed in the Master Plan.

-Fossil fresh groundwater

The development of fossil fresh groundwater in Disi, Ma'an in the southern upland area and Lajoun area in Karak Governorate is proposed in the Master Plan. The water in Disi is being used for municipal purpose in Aqaba and agricultural purpose in the upland area. The amount stood at 66 MCM/a (of which 51 MCM /a was for agriculture) in 1998. The Master Plan includes a project to increase the abstraction to be developed to about 130 MCM/a and transfer it to the greater Amman area (about 300km) by means of pumps in order to convert the fossil fresh groundwater from irrigation water to municipal water.

In the case of the development of fossil fresh groundwater, which is typical mining development, the resources are limited and the period of development is limited to about 50 years, and thus it is not permanently sustainable development. This type of non-renewable water resources should be conserved as water resources for the next generation as much as possible.

a.2.2. Development of non-conventional water

-Treated wastewater

Currently, 64 MCM/a of treated wastewater is generated. The volume is projected to reach 246 MCM/a by 2020, and it is very valuable and important water resources in the future. The Master Plan suggests a plan to promote the use of treated wastewater for

agricultural and industrial purposes.

However, because almost no treated water is used directly without being diluted in Jordan, sufficient care needs to be given to hygiene and thus it is necessary to raise public awareness of the promotion of the use of treated wastewater and possible danger of using such water.

-Desalinated brackish groundwater

Brackish groundwater is one of water resources yet to be developed in Jordan. There is a limited number of detailed studies on brackish groundwater and thus there is not enough data to properly evaluate the potential and water quality. However, the Jordan Valley, east coast of the Dead Sea and Karak regions are expected to have great potential. The Master Plan regards brackish groundwater as critical water resources to meet the future water demand, and counts it as a water resource for water demand that has economically high benefit, which includes municipal, touristic and industrial sectors (40 MCM/a by 2010 for municipal use under the ZarqaMa'in/Zara Spring Project in the east coast of the Dead Sea, 9MCM/a by 2020 for MIT in Amman area under Hisban/Kafrein Brackish Groundwater Desalination Project and 36 MCM/a by 2020 for industrial use under the Lajoun Oil Shall Project).

However, the desalination of brackish groundwater has disadvantages--high costs for processing and negative environmental impacts to be caused by discharging of brain--and thus the development should be conducted carefully watching the future reduction of cost for processing and advancement of the reverse osmosis technology.

-Desalinated sea water

Under the Master Plan, the use of desalinated sea water is planned at Aqaba located in the southern part of Jordan. The study shows that there is high demand of water for industrial and touristic uses in Aqaba which have enough affordability. In order to meet increasing demand, the development is planned to expand gradually, from 5 MCM/a by 2005 and 17 MCM/a by 2020. Desalination of sea water also has disadvantages--high processing costs and negative environmental impacts same with the desalination of brackish groundwater--and thus the development should be conducted carefully watching the future advancement of the technology.

b. Qualitative management

b.1. Conservation of surface water quality

The Master Plan proposes a formulation of the water quality monitoring system as a project for surface water quality conservation. The monitoring project is to accurately detect the change in surface water quality to prevent the deterioration of the water quality. This allows to take measures to prevent the deterioration of surface water quality prior to its actual occurrence as exemplified in the case of the strange smell of tap water occurred in Amman in 1998. The WQICP project conducted by the USAID includes a surface water quality monitoring project and the Master Plan proposes that this project will be carried out by 2005.

b.2. Conservation of groundwater quality

The Master Plan proposes a water quality monitoring project as a plan for ground water quality conservation as well as a plan to reduce the abstraction of groundwater. The execution of the water quality monitoring project enables to take measures to tackle the

rise in the concentration of salinity and nitrate of groundwater at an early stage. The Master Plan includes the water quality monitoring project formulated in WQICP project conducted by the USAID to be carried out by 2005.

Because the irrigation water in the highland area is believed to be the cause of the deterioration of quality of renewable groundwater in the study, the Master Plan suggests the downsizing of agriculture in the upland area and the reduction in the abstraction of groundwater for irrigation as measures to conserve groundwater quality.

c. Water distribution plan

c.1. Allocation among sectors

Water allocation among the sectors is, as shown in Table 9.2.5-2, as follows: water for irrigation will remain to be at the current level and water for MIT (municipal, industrial and touristic) uses will be allocated at the necessary minimum level.

Table 9.2.5-2 Water Allocation among the Sectors

(MCM/a)

		MIT Use		Irrigation Use	
		1998	2020	1998	2020
Conventional Resources	Surface Water	62	182	216	226
	Peace Water	0	40	35	90
	Renewable Groundwater	203	165	211	109
	Fresh Fossil Groundwater	20	130	51	0
Non-Conventional Resources	Desalinated Water (Brackish/Sea Water)	0	102	0	0
	Treated Wastewater*	0	30	50	215
Total		285	649	563	640

* Including Loss which will occur in the conveyance through river and wadis.

Water allocation among the sectors is extremely important for the management for sustainable water use. In order to adjust the allocation, water for agriculture should be partly converted to municipal water, which will be accompanied by the review of agricultural development plan.

-Securing increasing municipal water demand

The Master Plan follows the national water strategy and adopts a policy of putting priority on water allocation to increasing demand of water for municipal, industrial and touristic purposes and maintaining the current level of water distribution for agricultural purposes.

-Change of water sources and an agricultural development plan

The Master Plan suggests the reduction in renewable fresh groundwater that is currently used for agriculture and, as an alternative, use of treated wastewater.

The Master Plan also suggests, accompanying the change of water sources, relocation of agriculture conducted in the Upland area to the Jordan Valley in order to financially enable the use of treated wastewater.

The Ministry of Water and Irrigation will need to work with the JVA, Ministry of Agriculture and related ministries and agencies in relation to the water allocation, change of water sources and relocation of agricultural land to formulate a national agricultural development plan in accordance with the policy.

c.2. Water allocation among Governorates

Imbalance of water supply and demand that occurs in each region is to be solved by transferring water among the Governorates under Master Plan. The Master Plan proposes the construction of main water transfer lines running across the nation after 2005.

d. Risk management (Measures for extraordinarily drought years)

The Master Plan includes a water allocation plan and a plan to urgently develop water resources on assumption of extraordinarily drought years of 20 years return period. As measures to deal with extraordinarily drought years in the field of water resources development, a groundwater development plan in Lajoun in Karak Governorate is assumed. The fossil fresh groundwater that is the water source of the Lajoun wells is almost stagnant, and thus is excellent as a water source for emergencies. Sustainable development of about 11 MCM a year is also believed to be possible in the Lajoun well field. However, because this is not enough to cover the water shortage in extraordinarily drought years (decrease in the development of about 20% of surface water and decrease of 25 MCM/a in total), the Master Plan gives consideration to jointly use a proposal to temporarily stop the execution of a plan to reduce renewable ground water in extraordinarily drought years.

9.3 Water Resources Management in 12 Governorates

The water resources management plans examined in various categories of the previous chapters may be summarized in 12 Governorates in the following text.

9.3.1 Amman Governorate

The Amman Governorate, named after the Capital of the Kingdom, lies in the central region of Jordan. It has an area of about 8231 Km^2. The total population as estimated in 1998 is in the order of 1,809,775 inhabitants giving rise to a population density of about 220 inhabitants/Km^2. The Governorate encompasses the main and central governorate offices and institutions in Jordan, including some of the Royal Family properties, the Cabinet and the various ministries of the government of Jordan. A good number of educational centers, health care institutions and hospitals and clinics of private and public sectors exist in the Governorate. Cultural, social and athletic centers as well as cooperative societies also exist in the Amman governorate. Small industrial firms are also established in the Governorate. Private irrigation activities are practiced in some localities in the Governorate.

(1) Governorate Land Area and Population

Land Area and Population of Amman (1998)

Land Area (Km^2)	Population	Density.
8,231	1,809,775	220

(2) Current Water Use

Current water use in the Amman Governorate is summarized as shown in the table for the year of 1998 below. The feature of water use is that it contains a considerable amount of irrigation water, 37 MCM/a, and almost all of it is groundwater in upland, while 32 MCM out of 85MCM was transferred from outside of the Governorate through the KAC- Deir Ala- Zai line.

Water Use in Amman Governorate (1998 unit:MCM/a)

Municipal	Touristic	Industrial	Irrigation	Total
85.14	0.86	0.77	37.00	**122.98**

a. Municipal and Tourist Water and Unaccounted for Water (UFW)

According to the WIS data, 85MCM was produced and delivered to Amman Governorate in 1998 but the water billed by WAJ (Water Authority of Jordan) was 41 MCM and its UFW rate reached 51.4 % where the nation wide average was 59.4%. Since 1998, operation and maintenance of water supply services in the Amman Governorate have been entrusted to the Private Sector, LEMA, and it was reported that the rate of UFW has remarkably improved through physical rehabilitation of the supply network and countermeasures for administrative loss.

UFW in Municipal and Touristic Water in Amman

Production (m^3)	Per capita Cons. (litter/capita/day)	Water Billed (m^3)	UFW	
			(m^3)	(%)
85,213,886	129.0	41,378,189	43,835,697	51.4

b. Industrial Water

Industrial water is defined as that pertaining to large-scale industries from which light industries and commercial entities are separated and it is included as part of the municipal water. The industrial water in the Amman Governorate is small.

c. Irrigation Water

The Amman Governorate is a capital area but it contains an irrigated agricultural area of approximately 9900 ha, which is approximately 19% of the Upland irrigation area and which consumed 32 MCM in 1998.

The source of irrigation water in Amman depends on groundwater in the Upland but current abstraction, 62 MCM in 1998, including municipal purpose, heavily exceeded the safe yield of the renewable groundwater of the Amman Governorate by 34 MCM/a, and therefore, reduction measures shall be taken for environmental protection.

(3) Demand

Demand in target years of the Master Plan was projected for four sectors as shown in the table below.

Water Demand in Amman Governorate (Scinario-1) (MCM/a)

Year	Municipal	Industrial	Touristic	Irrigation	Total Demand*
1998	85.0	0.86	1.00	37	**124**
2005	99.4	1.14	1.02	42	**144**
2010	136.69	1.33	1.23	42	**181**
2015	167.98	1.48	1.39	41	**211**
2020	191.8	1.56	1.57	39	**234**

* Total Demand does not include inter-governorate water transfer

(4) Resources

Water resources available in the target years of 2005, 2010, 2015 and 2020, including transfer from eternal sources after the water allocation, are summarized in Table 9.3.1-1 next. In 2020, Water resources available inside the Amman Governorate are only 44 MCM/a for fresh water and 15 MCM/a for wastewater effluent. The rest of the sources all come from outside, such as from the KAC-Deir Ala-Zai, Disi, and Zara, Zarqa Ma'in –Kafrain -Hisban Brackish groundwater desalination. The total water import reaches 174 MCM/a. There are some existing wastewater treatment plants in the Governorate and reuse of the treated wastewater is very limited. Reuse plans for Abu-Nuseir and Wadi-Essir treatment plants are to be prepared in the Pre-Feasibility Study. In addition, 3 MCM/a of surface water will be developed through water harvesting project in Badia region in long-term target year (2010-2020).

Table 9.3.1-1 Water Resources in Amman Governorate (MCM/a)

Year	Local Sources						Available Sources					Total	Export to other Govt.
	SW		GW		WWE		Disi	SW		BGW	From other Govt.		
	UP	JRV	UP	JRV	UP	JRV		Zai	Weh				
2005	7		53		8		0	55	0	11 BA	**10 (FW) MF 8 MA 2**	**144**	0
2010	7		47		12		27	58	0	31 BA	0	**181**	0
2015	10		41		14		48	58	0	40 BA	0	**212**	0
2020	10		34		15		75	59	0	40 BA	0	**234**	0

SW: Surface Water, GW: Groundwater, WWE: Wastewater Effluent,
BGW: Brackish Groundwater Desalination, Des. Sea Water: Sea Water Desalination
Zai: Through Zai Water Work, Weh: Through Wehda Dam, PT: Peace Treaty Water
UP: Source in Upland, JRV Source in Jordan Rift Valley, Govt.: Governorate

9.3.2 Zarqa Governorate

Zarqa governorate, with its main city Zarqa lies in the central region of Jordan. It has an area of about 4,080 km2. Total population as estimated in 1998 is about 747,860 inhabitants with 183 inhabitant/km2 as population density. It is the second city in Jordan. There are some educational centers health care institutions, pharmacies, private clinics and public in the governorate. Major industrial firms: the thermal power, refinery, phosphate mines, diaries, animal husbandry nurseries as well as other small industries are occurring in the governorate. A good irrigation and farming activities are practiced in some localities within the governorate. One of the major wastewater treatment plants, As-Samra serving Amman-Zarqa Governorates occur in the area.

(1) Governorate Land Area and Population

Land Area and Population of Zarqa (1998)

Land Area (Km^2)	Population	Density.
4,080	747,860	183

(2) Current Water Use

Current water use in Zarqa Governorate is summarized as shown in the table for the year of 1998 below. The feature of water use is that it contains considerable amount of irrigation water, 60 MCM/a and most of it is groundwater in uplands while 32 MCM out of total 98 MCM was transferred from outside of the Governorate through Mafraq-Zarqa transmission line.

Water Use in Zarqa Governorate (1998 unit: MCM/a)

Municipal	Industrial	Tourist	Irrigation	Total
32.40	6.10	0.01	65	**104**

a. Municipal and Touristic Water and Unaccounted for Water (UFW)

According to the WIS data, 32MCM was produced and delivered to Zarqa Governorate in 1998 but water billed by WAJ (Water Authority of Jordan) was 13 MCM and its UFW rate reached 58.5 % where the nation wide average was 59.4%. Operation and maintenance of water supply services in Zarqa is prepared for the participation of private sector after the services in Amman Governorate have been entrusted to LEMA from 1998 and it was reported that the rate of UFW has been remarkably improved through physical rehabilitation of supply network and countermeasures for administrative loss.

UFW in Municipal and Touristic Water in Zarqa

Production (m^3)	Per capita Cons. (litter/capita/day)	Water Billed (m^3)	UFW	
			(m^3)	%
32,372,409	118.6	13,442,435	18,929,974	58.5

b. Industrial Water

Industrial water is defined as large-scale industries from which light industries and commercial entities are separated and included in municipal water. There are big industrial water demands in Zarqa Governorate.

c. Irrigation Water

Zarqa Governorate is a capital area but it contains large irrigated agricultural area of approximately 18,000 ha, which is approximately 35% of Upland irrigation area and consumed 65 MCM in 1998.

Source of irrigation water in Zarqa is mainly depending on groundwater in the Uplands. The current groundwater abstraction is about 89 MCM (in 1998) including municipal purpose heavily exceeded the safe yield of renewable groundwater of Zarqa Governorate, 47 MCM/a. Therefore reduction measures shall be taken for environmental protection.

(3) Demand

Demand in target years of Master Plan was projected for four sectors as shown in the table below.

Water Demand in Zarqa Governorate (Scinario-1) (MCM/a)

Year	Municipal	Industrial	Touristic	Irrigation	Total
2005	38.5	22.4	0.01	65	**126**
2010	53.2	23.6	0.02	60	**136**
2015	65.9	24.6	0.02	58	**149**
2020	76.02	25.1	0.02	54	**155**

There are large future industrial water demands in Zarqa Governorate. Treated wastewater reuse is considered for new thermal power station with the quantity of about 14 MCM/a.

Irrigation agriculture using the groundwater shall be managed to the level of sustainable exploitation as listed above.

(4) Resources

Water resources available in target years of 2005, 2010, 2015 and 2020 including transfer from eternal sources after the water allocation are summarized in Table 9.3.2-1 next. In 2020, Water resources available within Zarqa Governorate is 65 MCM/a for fresh water and 138 MCM/a for wastewater effluent because all the raw seweage from Amman is collected to As-Samra wastewater Treatment Plant in Zarqa Governorate. Other sources are externals from outside such as Mafraq, Disi, Hisban Brackish groundwater desalination. In addition, 2 MCM/a of surface water will be developed through water harvesting project in Badia region in long-term target year (2010-2020).

Table 9.3.2-1 Water Resources in Zarqa Governorate (MCM/a)

Year	Local Sources						Available Sources					Total	Export to other Govt.
	SW		GW		WWE		Disi	SW		BGW	From other Govt.		
	UP	JRV	UP	JRV	UP	JRV		Zai	Weh				
2005	16		76		67		0			0	10(GW) MF	**170**	**43 (W(W)* BA/IR 3 loss**
2010	16		66		101		12			5 BA	13(GW) MF	**213**	**77 (WW)* BA/IR 6 loss**
2015	18		57		123		14			5 BA	17(GW) MF 8(SW) IR	**242**	**93 (WW)* BA/IR 7 loss**
2020	18		47		138		16			5 BA	20(GW) MF 15 (SW) IR	**258**	**103 (WW)* BA/IR 8 loss**

*Export out of wastewater efluent transferred to Jordan Valley (KTR) /Balqa Governorate.
SW: Surface Water, GW: Groundwater, WWE: Wastewater Effluent,
BGW: Brackish Groundwater Desalination, Des. Sea Water: Sea Water Desalination
Zai: Through Zai Water Work, Weh: Through Wehda Dam, PT: Peace Treaty Water
UP: Source in Upland, JRV Source in Jordan Rift Valley, Govt.: Governorate

9.3.3 Mafraq Governorate

The governorate lies in the northeastern region of Jordan. It has an area of about 26,435 km^2, the second largest area wise in Jordan. Its population is about 219,040 inhabitant (1998 estimates). Population density is of 8 inhabitant /km^2. It relies mainly on agricultural activities and related undertakings small industries, particularly food industries occur in Mafraq.

(1) Governorate Land Area and Population

Land Area and Population of Mafraq (1998)

Land Area (Km^2)	Population	Density.
26,435	219,040	8

(2) Current Water Use

Current water use in Mafraq Governorate is summarized as shown in the table for the year of 1998 below. The feature of water use is that it contains considerable amount of irrigation water, 56 MCM/a and all of it is groundwater in upland while 16 MCM out of total abstraction 90MCM was transferred to outside of the Governorate through Mafraq-Zarqa line.

Water Use in Mafraq Governorate (1998 unit:MCM/a)

Municipal	Industrial	Touristicl	Irrigation	Total
19.30	0.30	0	56.00	**75.60**

a. Municipal and Touristic Water and Unaccounted for Water (UFW)

According to the WIS data, 19 MCM was produced and delivered to Mafraq Governorate in 1998. Water billed by WAJ (Water Authority of Jordan) was only for less than 4 MCM. Therefore its UFW is rated at 80.5 which indicates the worst one in Jordan where the nation wide average was 59.4%.

UFW in Municipal and Touristic Water in Mafraq

Production (m^3)	Per capita Cons. litter/capita/day	Water Billed (m^3)	UFW	
			(m^3)	%
19,208,168	240.3	3,748,794	15,459,374	80.5

b. Industrial Water

Industrial water is defined as large-scale industries from which light industries and commercial entities are separated and included in municipal water. The industrial water in Mafraq Governorate is generally small.

c. Irrigation Water

Mafraq Governorate is considered as an agricultural area. There are large irrigated agricultural areas of approximately 17,000 ha in total. It forms approximately 30% of the total Upland irrigation area and consumed about 56 MCM of water in 1998.

Source of irrigation water in Mafraq is totally depending on groundwater in the

Uplands. The current groundwater abstraction, 90 MCM in 1998 including municipal purpose exceeded the safe yield of renewable groundwater of Mafraq Governorate, 77 MCM/a. Therefore reduction measures shall be taken for environmental protection of the aquifer.

(3) Demand

Demand in target years of Master Plan was projected for four sectors as shown in the table below.

Water Demand in Mafraq Governorate (Scinario-1) (MCM/a)

Year	Municipal	Industrial	Touristic	Irrigation	Total
2005	18.7	0.3	0	51	**70**
2010	21.9	0.4	0	45	**67**
2015	22.5	0.4	0	41	**64**
2020	20.8	0.4	0	36	**57**

(4) Resources

Water resources available in target years of 2005, 2010, 2015 and 2020 including transfer from internal sources after the water allocation are summarized in Table 9.3.3-1 below. In 2020, Water resources available inside Mafraq Governorate is around 86 MCM/a for fresh water and 1 MCM/a for wastewater effluent and some 30 MCM/a shall be transferred to other Governorate. In addition, 7 MCM/a of surface water will be developed through water harvesting project in Badia region in long-term target year (2010-2020).

Table 9.3.3-1 Water Resources in Mafraq Governorate (MCM/a)

Year	Local Sources						Available Sources					Total	Export to other Govt.
	SW		GW		WWE		Disi	SW		BGW	From other Govt.		
	UP	JRV	UP	JRV	UP	JRV		Zai	Weh				
2005	2		86		1							**88**	**18(GW)** **AM 5** **ZA 11** **JA 1** **AJ viaIR 1**
2010	2		83		1							**86**	**19(GW)** **ZA 13** **AJ viaIR 3** **JA 3**
2015	9		80		1							**90**	**26(GW)** **ZA 16** **AJ viaIR 5** **JA 5**
2020	9		77		1							**87**	**30(GW)** **ZA 20** **AJ viaIR 4** **JA 6**

SW: Surface Water, GW: Groundwater, WWE: Wastewater Effluent,
BGW: Brackish Groundwater Desalination, Des. Sea Water: Sea Water Desalination
Zai: Through Zai Water Work, Weh: Through Wehda Dam, PT: Peace Treaty Water
UP: Source in Upland, JRV Source in Jordan Rift Valley, Govt.: Governorate

9.3.4 Irbid Governorate

The governorate lies in the most northwestern region of the country. It is named after the main city Irbid. It has an area of about 1,621 km^2 and population of about 848,340 inhabitants. Population density is around 523 inhabitants/km^2, the highest in Jordan. It lies mostly within the Yarmouk River basin. Good number of primary health centers, social, cultural and athletic centers occur in this governorate and considered the next after Amman in this respect. Al-hasan Industrial City and the free zone between Syria and Jordan lie in the governorate.

(1) Governorate Land Area and Population

Land Area and Population of Irbid (1998)

Land Area (Km^2)	Population	Density.
1,621	848,340	523

(2) Current Water Use

Current water use in Irbid Governorate is summarized as shown in the table below. for the year 1998. The feature of the current water use is that it contains an important amount of surface water resources and considerable amount of municipal water for urban area (30 MCM). In addition to the irrigation water use in Jordan Rift Valley (144 MCM/a). Some of the surface water, 32 MCM is transferred to Amman area through KAC- Deir Ala- Zai line in 1998.

Water Use in Irbid Governorate (1998 unit:MCM/a)

Municipal	Industrial	Tourist	Irrigation	Total
30.5	1.0	0.02	143.8	**175.32**

a. Municipal and Touristic Water and Unaccounted for Water (UFW)

According to the WIS database, 30MCM was produced and delivered to Irbid Governorate in 1998. Water billed by WAJ (Water Authority of Jordan) was 14 MCM and its UFW rate reached 52.6 % where the nation wide average was 59.4%. Operation and maintenance of water supply services in Irbid is prepared for the participation of private sector after the services in Amman Governorate have been entrusted to LEMA as from 1998. It was reported that the rate of UFW has been remarkably improved through physical rehabilitation of supply network and countermeasures for administrative loss.

UFW in Municipal and Touristic Water in Irbid

Production (m^3)	Per capita Cons. (litter/capita/day)	Water Billed (m^3)	UFW	
			(m^3)	%
30,531,567	98.6	14,470,051	16,061,516	52.6

b. Industrial Water

Industrial water is defined as for large-scale industries. Light industries and commercial entities are separated and included in the municipal water demand. The industrial water demand in Irbid Governorate is generally expanding.

c. Irrigation Water

Irbid Governorate is an urban area in northern part of Jordan but it contains large irrigated agricultural area of more than 50,000 ha, which is approximately 70% of Jordan Valley irrigation area and consumed about 143 MCM in 1998.

Source of irrigation water in Irbid is depending on surface water in Yarmouk River, Jordan Valley side wadis within the governorate, peace treaty water (Dajaniya) and groundwater from Mukheiba well field

(3) Demand

Demands in target years of Master Plan were projected for four sectors as table below and it contains the demand for Cyber City Industrial Development Plan.

Water Demand in Irbid Governorate (Scinario-1) (MCM/a)

Year	Municipal	Industrial	Touristic	Irrigation	Total
2005	39.5	8.9	0.02	151	**200**
2010	57.6	9.1	0.03	167	**235**
2015	75.0	9.3	0.03	167	**252**
2020	90.4	9.4	0.04	167	**268**

(4) Resources

Water resources available in target years of 2005, 2010, 2015 and 2020 including transfer from external sources after the water allocation are summarized in Table 9.3.4-1 below. In 2020, Water resources available inside Irbid Governorate are 272 MCM/a from fresh water and 39 MCM/a from wastewater effluent.

Table 9.3.4-1 Water Resources in Irbid Governorate (MCM/a)

Year	Local Sources						Available Sources					Total	Export to other Govt.*
	SW		GW		WWE		Disi	SW		BGW	From other Gov.		
	UP	JRV	UP	JRV	UP	JRV		Zai	PT				
2005	14	229	12	28	14				60		2	**359**	**159 (FW)** **AM 55** **BA/KAC105**
2010	14	229	15	21	26				90		2	**397**	**163(FW)** **AM 58** **BA 106**
2015	14	229	18	15	35				90		2	**404**	**152(FW)** **AM 58** **ZA 9** **BA 84**
2020	14	229	21	8	39				90		2	**404**	**136(FW)** **AM 59** **ZA 9** **BA 59** **AJ 3**

* Based on the availability of surface water resources.
SW: Surface Water, GW: Groundwater, WWE: Wastewater Effluent,
BGW: Brackish Groundwater Desalination, Des. Sea Water: Sea Water Desalination
Zai: Through Zai Water Work, Weh: Through Wehda Dam, PT: Peace Treaty Water
UP: Source in Upland, JRV Source in Jordan Rift Valley, Govt.: Governorate

9.3.5 Ajloun Governorate

The governorate lies to the south of Yarmouk River basin in the northwestern region of Jordan. It has an area of about 412 km^2 and population is about 105520 inhabitants as per 1998 estimates. Population density is around 256 inhabitant/km^2. The governorate area receives good annual rainfall volume compared with the other ones in Jordan.

(1) Governorate Land Area and Population

Land Area and Population of Ajloun (1998)

Land Area (Km^2)	Population	Density.
412	105,520	256

(2) Current Water Use

Current water use in Ajloun Governorate is summarized as shown in the table for the year of 1998 below. The feature of the current water use is that it contains good amount of irrigation water (12 MCM/a) most of it is from groundwater in the Uplands. Some municipal water demand is supplied from Mafraq governorate through Irbid.

Water Use in Ajloun Governorate (1998 unit:MCM/a)

Municipal	Industrial	Touristic	Irrigation	Total
3.9	0.0	0.0	6	**10**

a. Municipal and Tourist Water and Unaccounted for Water (UFW)

According to the WIS database, 4 MCM was produced and delivered to Ajloun Governorate in 1998. Water billed by WAJ was 2 MCM and its UFW rate reached 58.1% where the nation wide average was 59.4%.

UFW in Municipal and Touristic Water in Ajloun

Production (m^3)	Per capita Cons. (litter/capita/day)	Water Billed (m^3)	UFW	
			(m^3)	%
3,946,446	102.5	1,654,285	2,292,161	58.1

b. Industrial Water

Industrial water is defined as large-scale industries from which light industries and commercial entities are separated and included in municipal water demand. The industrial water demand in Ajloun Governorate is generally small.

c. Irrigation Water

Ajloun Governorate is an irrigated agricultural area of approximately 5,000 ha, forms approximately 10% of Upland irrigation area. It consumed about 12 MCM in 1998.

Source of irrigation water in Ajloun is depending on surface water in the Uplands and Jordan Rift Valley. Therefore it can be sustained with improvement of irrigation efficiency.

(3) Demand

Demand in target years of Master Plan was projected for four sectors as shown in the table below.

Water Demand in Ajloun Governorate (Scinario-1) (MCM/a)

Year	Municipal	Industrial	Touristic	Irrigation	Total
2005	5.2	0	0	7	**12**
2010	7.7	0	0	8	**16**
2015	10.2	0	0	8	**18**
2020	12.4	0	0	9	**21**

(4) Resources

Water resources available in target years of 2005, 2010, 2015 and 2020 including transfer from external sources after the water allocation are summarized in Table 9.3.5-1 below. In 2020, water resources available inside Ajloun Governorate is 13 MCM/a from fresh water and 3 MCM/a from wastewater effluent and other source, 7 MCM is from outside such as Wehda-Irbid line or from Mafraq via Irbid.

Table 9.3.5-1 Water Resources in Ajloun Governorate (MCM/a)

Year	Local Sources						Available Sources					Total	Export to other Govt.
	SW		GW		WWE		Disi	SW		BGW	From other Govt.		
	UP	JRV	UP	JRV	UP	JRV		Zai	PT				
2005	9	2	1		1						**1(GW) MF(via IR)**	**14**	**2(SW) (IR/JRV)**
2010	9	2	1		2						**3 (GW) MF(via IR)**	**17**	**2(SW) (IR/JRV)**
2015	9	2	2		3						**5 (GW) MF(via IR)**	**21**	**2(SW) (IR/JRV)**
2020	9	2	2		3						**7(GW) MF(viaIR)**	**23**	**2(SW) (IR/JRV)**

SW: Surface Water, GW: Groundwater, WWE: Wastewater Effluent,
BGW: Brackish Groundwater Desalination, Des. Sea Water: Sea Water Desalination
Zai: Through Zai Water Work, Weh: Through Wehda Dam, PT: Peace Treaty Water
UP: Source in Upland, JRV Source in Jordan Rift Valley, Govt.: Governorate

9.3.6 Jerash Governorate

The governorate lies also in the northwestern developmental region of the country. It is almost similar to Ajlun governorate in view of the socio-economic parameters. It has an area of about 402 km^2 and about 13,9815 populations with about 348 density (inhabitant/km^2).

The governorate also receives moderate total average annual rainfall.

(1) Governorate Land Area and Population

Land Area and Population of Jerash (1998)

Land Area (Km^2)	Population	Density.
402	139,815	348

(2) Current Water Use

Current water use in Jerash Governorate is summarized as shown in the table below for the year of 1998. The feature of water use is that same as Ajloun Governorate it contains good amount of irrigation water, 20 MCM/a and most of it is from surface water in the Upland and Jordan Rift Valley.

Water Use in Jerash Governorate (1998 unit:MCM/a)

Municipal	Industrial	Touristic	Irrigation	Total
4.55	0.0	0.0	12	**16.55**

a. Municipal and Touristic Water and Unaccounted for Water (UFW)

According to the WIS data, 5 MCM was produced and delivered to Jerash Governorate in 1998 but water billed by WAJ (Water Authority of Jordan) was 2 MCM and its UFW rate reached 55.2 % where the nation wide average was 59.4%.

UFW in Municipal and Touristic Water in Jerash

Production (m^3)	Per capita Cons. (litter/capita/day)	Water Billed (m^3)	UFW	
			(m^3)	%
4,545,319	89.1	2,037,345	2,507,974	55.2

b. Industrial Water

Industrial water is defined as large-scale industries from which light industries and commercial entities are separated and included in the municipal water demand. The industrial water demand in Jerash Governorate is generally small.

c. Irrigation Water

Jerash Governorate is an irrigated agricultural area of approximately 5,000 ha, which is approximately 10% of the Upland irrigation area and consumed about 12 MCM in 1998.

Source of irrigation water in Jerash is depending on surface water in Upland and Jordan Rift Valley, the same as in Ajloun Governorate. Therefore it can be sustained with improvement of irrigation efficiency.

(3) Demand

Demand in target years of Master Plan was projected for four sectors as shown in the table below.

Water Demand in Jerash Governorate (Scenario-1) (MCM/a)

Year	Municipal	Industrial	Touristic	Irrigation	Total
2005	6.1	0	0	12	**18**
2010	9.2	0	0	12	**21**
2015	12.2	0	0	12	**24**
2020	14.9	0	0	11	**26**

(4) Resources

Water resources available in target years of 2005, 2010, 2015 and 2020 including transfer from external sources after the water allocation are summarized in Table 9.3.6-1 below. In 2020, Water resources available inside Jerash Governorate is 28 MCM/a for fresh water and 5 MCM/a for wastewater effluent and when treated wastewater reuse will be realized, other source is about 7 MCM/a needed from outside through Mafraq Governorate.

Table 9.3.6-1 Water Resources in Jerash Governorate (MCM/a)

Year	Local Sources						Available Sources					Total	Export to other Govt.
	SW		GW		WWE		Disi	SW		BGW	From other Govt.		
	UP	JRV	UP	JRV	UP	JRV		Zai	PT				
2005	12	8	5		1						1(gw) MF	**27**	**9** BA8**(sw)via** KTR 1 (ww)
2010	12	8	6		3						3(gw) MF	**32**	**11** BA 8 (sw)via KTR 3(ww)
2015	12	8	7		4						5(gw) MF	**36**	**12** BA 8 (sw)via KTR 4 (ww)
2020	12	8	8		5						7(gw) MF	**39**	**13** BA 8 (sw)via KTR 5 (ww)

SW: Surface Water, GW: Groundwater, WWE: Wastewater Effluent,
BGW: Brackish Groundwater Desalination, Des. Sea Water: Sea Water Desalination
Zai: Through Zai Water Work, Weh: Through Wehda Dam, PT: Peace Treaty Water
UP: Source in Upland, JRV Source in Jordan Rift Valley, Govt.: Governorate

9.3.7 Balqa Governorate

It lies in the center developmental region of Jordan. It has an area of about 1,076 km^2. Its population is around 312,155 inhabitants with density of 290 inhabitant/km^2. It is almost halfly divided into Uplands and South Jordan Valley areas. Rainfall average in the Uplands reach as high as 500-600 mm/a. Good primary health, educational cultural and athletic centers exist in the governorate. It is mainly of substantive agricultural activities especially in the Valley area of the governorate.

(1) Governorate Land Area and Population

Land Area and Population of Balqa (1998)

Land Area (Km^2)	Population	Density.
1,076	312,155	290

(2) Current Water Use

Current water use in Balqa Governorate is summarized as shown in the table below for the year of 1998. The feature of water use is that it contains considerable amount of irrigation water, 144 MCM/a in Jordan Valley, most of it is from surface water in Jordan Valley and treated wastewater effluent from Greater Amman area through King Talal Dam/ Balqa Governorate. It received approximately 30 MCM from Irbid Governorate through KAC other than the municipal water through KAC- Deir Ala- Zai line.

Water Use in Balqa Governorate (1998 unit:MCM/a)

Municipal	Industrial	Touristic	Irrigation	Total
19.1	0.5	0.01	124	**144**

a. Municipal and Touristic Water and Unaccounted for Water (UFW)

According to the WIS database, 19 MCM was produced and delivered to Balqa Governorate in 1998. Water billed by WAJ was 7 MCM and its UFW rate reached 61.1% where the nation wide average was 59.4%. Since 1998, a part of operation and maintenance of water supply services in Balqa Governorate have been entrusted to Private Sector, LEMA and it was reported that the rate of UFW has been remarkably improved through physical rehabilitation of supply network and countermeasures for administrative loss.

UFW in Municipal and Touristic Water in Balqa

Production (m^3)	Per capita Cons. (litter/capita/day)	Water Billed (m^3)	UFW	
			(m^3)	%
19,148,504	168.1	7,442,511	11,705,993	61.1

b. Industrial Water

Like-wise in the other governorates the large-scale industries water demand are separated from that of the light industries and commercial entities. They are included in the municipal water demands. Also the industrial water demand in Balqa Governorate is small.

c. Irrigation Water

Balqa Governorate is an urban and agricultural area. It contains large irrigated agricultural area of approximately 40,000 ha in the southern Ghor of Jordan Valley, which forms approximately 50% of the irrigation area of Jordan Rift Valley. It consumed about 144 MCM in 1998.

Source of irrigation water in Balqa is depending on surface water and treated wastewater effluent and groundwater in Jordan Rift Valley. The current groundwater abstraction, 47 MCM in 1998 to satisfy the municipal purpose, heavily exceeded the safe yield of the renewable groundwater potential of Balqa Governorate, 19 MCM/a. Therefore strict reduction measures shall be taken for environmental protection and sustainable irrigation agriculture.

(3) Demand

Demand in target years of Master Plan was projected for four sectors as shown in the table below.

Water Demand in Balqa Governorate (Scenario-1) (MCM/a)

Year	Municipal	Industrial	Touristic	Irrigation	Total
2005	20.8	0.6	2.7	213	**238**
2010	26.8	0.7	4.7	234	**267**
2015	31.1	0.8	6.9	220	**259**
2020	33.5	0.8	6.9	197	**239**

(4) Resources

Water resources available in target years of 2005, 2010, 2015 and 2020 including transfer from external sources after the water allocation are summarized in Table 9.3.7-1 next. In 2020, conventional water resources available inside Balqa Governorate are only 47 MCM/a from fresh water. Non-conventional waters are 123 MCM/a from wastewater effluent and 49 MCM/a from brackish groundwater desalination (24local and 25 Mujib). Other sources are from outside the governorate such as KAC-Deir Alla-Zai, and its total of importation reaches 38 MCM/a.

There are some existing wastewater treatment plants in the Governorate and reuse of the treated effluent is very limited. Reuse plan of Fuhis wastewater treatment plant is to be prepared in the Pre-Feasibility Study.

Table 9.3.7-1 Water Resources in Balqa Governorate (MCM/a)

Year	Local Sources						Available Sources					Total	Export to other Govt.
	SW		GW		WWE		Disi	SW		BGW	From other Govt.		
	UP	JRV	UP	JRV	UP	JRV		Zai	PT				
2005	7	21	7	31		51		7		**20** KA/Mujib	106 (fw) IR 99 JA 7 (KAC& KTR)	**250**	**12** AM 11(bgw) MA 1
2010	7	21	7	25		90		20		**15** local **25** KA/Mujib	93 (fw) IR 85 JA 8 (KAC& KTR)	**304**	**37** AM 31(bgw) ZA 5 MA 1
2015	7	21	6	19		111		25		**24** local **25** KA/Mujib	67 (fw) IR 59 JA 8 (KAC/ KTR)	**305**	**46** AM 40(bgw) ZA 5 MA 1
2020	7	21	6	13		123		28		**24** local **25** KA/Mujib	38 (fw) IR 30 JA 8 (KAC/ KTR)	**285**	**46** AM 40(bgw) ZA 5 MA 1

SW: Surface Water, GW: Groundwater, WWE: Wastewater Effluent,
fw: Fresh waterAC: King Abdulla Canal, KTR: King Talal Resorvoir
BGW,(bgw) : Brackish Groundwater Desalination, Des. Sea Water: Sea Water Desalination
Zai: Through Zai Water Work, Weh: Through Wehda Dam, PT: Peace Treaty Water
UP: Source in Upland, JRV Source in Jordan Rift Valley, Govt.: Governorate

9.3.8 Madaba Governorate

The governorate belongs to the central development region in Jordan. It is a tourist attractive governorate. Good irrigation activities are practiced in the area. It has a total area of about 2,008 km^2. Its population is about 121,275. The population density is around 60 inhabitant/km^2. Annual average rainfall ranges from 200-300mm/a.

(1) Governorate Land Area and Population

Land Area and Population of Madaba (1998)

Land Area (Km^2)	Population	Density.
2,008	121,275	60

(2) Current Water Use

Current water use in Madaba Governorate is summarized as shown in the table below for the year of 1998. The feature of the current water use is that it contains good amount of irrigation water, 7 MCM/a and most of it is from the groundwater resources in the Upland areas.

Water Use in Madaba Governorate (1998 unit:MCM/a)

Municipal	Industrial	Touristic	Irrigation	Total
11.7	0.2	0.0	8	**20**

a. Municipal and Touristic Water and Unaccounted for Water (UFW)

According to the WIS database, 12 MCM was produced and delivered to Madaba Governorate in 1998. Water billed by WAJ) was only 2 MCM and its UFW rate reached 86.2 % where the nation wide average was 59.4%. It is quite obvious that the improvement of UFW reduction and lowering of the per capita consumption unit to a reasonable level are essential measures to be considered in this Governorate.

Rehabilitation and improvement plan of the distribution network in Madaba city would be considered in the Pre-Feasibility Study

UFW in Municipal and Touristic Water in Madaba

Production (m^3)	Per capita Cons. (litter/capita/day)	Water Billed (m^3)	UFW	
			(m^3)	%
11,737,138	265.2	1,625,492	10,111,646	86.2

b. Industrial Water

Large-scale industries water demand are separated from that of the light industries and commercial entities water requirements and included in the municipal water. The industrial water demand in Madaba Governorate is generally small.

c. Irrigation Water

Madaba Governorate is an urban and agricultural area and it contains some irrigated agricultural area of approximately 2000 ha, which forms approximately 4 % of the Upland irrigation area. About 7 MCM of water was consumed in 1998.

Source of irrigation water in Madaba is depending on groundwater in Upland and surface water in Jordan Rift Valley. Therefore with the execution of the ongoing surface water development activities, irrigation in this Governorate can be managed at the current level.

(3) Demand

Demand in target years of Master Plan was projected for four sectors as shown in the table below.

Water Demand in Madaba Governorate (Scenario-1) (MCM/a)

Year	Municipal	Industrial	Touristic	Irrigation	Total
2005	11.3	0.2	2.4	8	**22**
2010	13.1	0.3	4.4	9	**27**
2015	13.3	0.3	6.6	9	**29**
2020	12.2	0.3	6.6	10	**29**

(4) Resources

Water resources available in target years of 2005, 2010, 2015 and 2020 including transfer from external sources after the water allocation are summarized in Table 9.3.8-1 below. In 2020, Water resources available inside Madaba Governorate is only 19 MCM/a for fresh water and 4 MCM/a for wastewater effluent and other sources is from outside such as Disi fossil groundwater and its total of importation reaches 6 MCM/a

Table 9.3.8-1 Water Resources in Madaba Governorate (MCM/a)

Year	Local Sources						Available Sources					Total	Export to other Govt.
	SW		GW		WWE		Disi	SW		BGW	From other Govt.		
	UP	JRV	UP	JRV	UP	JRV		Zai	PT				
2005	5	5	11	1	2		0			1 BA		**24**	**2** AM 2
2010	5	5	10	1	3		0			1 BA		**27**	
2015	5	5	9	1	3		5			1 BA		**29**	**0**
2020	5	5	8	1	4		5			1 BA		**29**	**0**

SW: Surface Water, GW: Groundwater, WWE: Wastewater Effluent,
BGW: Brackish Groundwater Desalination, Des. Sea Water: Sea Water Desalination
Zai: Through Zai Water Work, Weh: Through Wehda Dam, PT: Peace Treaty Water
UP: Source in Upland, JRV Source in Jordan Rift Valley, Govt.: Governorate

9.3.9 Karak Governorate

It is one of the main developing governorates in the south developmental region in Jordan. The total area of the governorate is around 3,217 Km^2. Its population as estimated in 1998 is 191, 40 inhabitant, with population density of 59 inhebtant/km^2. Primary health care educational and some athletic centers occur in the area. Southern Ghor Safi agricultural area belongs to this governorate. Potash Industrial and Salt complex industrial establishments occur in the governorate. Karak area receives rainfall ranges from 300-350 mm/a. and occasional snowfall.

(1) Governorate Land Area and Population

Land Area and Population of Karak (1998)

Land Area (Km^2)	Population	Density.
3,217	191405	59

(2) Current Water Use

Current water use in Karak Governorate is summarized as shown in the table below for the year of 1998. The feature of water use is that it contains considerable amount of irrigation water, 54 MCM/a and most of it is surface water in the Upland and Jordan Rift Valley areas.

Water Use in Karak Governorate (1998 unit:MCM/a)

Municipal	Industrial	Touristic	Irrigation	Total
9.4	11.7	0.0	54.8	**75.9**

a. Municipal and Touristic Water and Unaccounted for Water (UFW)

According to the WIS database, 9 MCM was produced and delivered to Karak Governorate in 1998 but water billed by WAJ) was 4 MCM and its UFW rate was 59.9 % same as the nation wide average was 59.4%.

Rehabilitation and improvement plan of the distribution network inside urban area of Karak is to be prepared in the Pre-Feasibility Study.

UFW in Municipal and Touristic Water in Karak

Production (m^3)	Per capita Cons. (litter/capita/day)	Water Billed (m^3)	UFW	
			(m^3)	%
9,328,577	133.5	3,741,898	5,586,679	59.9

b. Industrial Water

Industrial water is defined as large-scale industries from which light industries and commercial entities are separated and included in municipal water demand. There are no light industries but the industrial water demand in Karak Governorate is quite large for Potash Company.

c. Irrigation Water

Karak Governorate is a n industrial and agricultural area and it contains large irrigated

agricultural area of approximately 20,000 ha, which is approximately 10% of irrigation area of Jordan Rift Valley and consumed about 55 MCM in 1998.

Source of irrigation water in Karak is depending on surface water in Upland and Jordan Rift Valley.

(3) Demand

Demand in target years of Master Plan was projected for four sectors as shown in the table below.

Water Demand in Karak Governorate (Scenario-1) (MCM/A)

Year	Municipal	Industrial	Touristic	Irrigation	Total
2005	10.9	18.4	0.01	81	**110**
2010	14.8	30.6	0.01	81	**126**
2015	18.0	45.6	0.02	80	**143**
2020	20.5	59.7	0.02	81	**161**

There is a big industrial water demand forecasted in the Governorate, i.e. for "Oil Shale Development Project" with the total demand in 2020 approximately 60 MCM/a.

(4) Resources

Water resources available in target years of 2005, 2010, 2015 and 2020 including transfer from external sources after the water allocation are summarized in Table 9.3.9-1 below. In 2020, Water resources available inside Karak Governorate are 98 MCM/a for fresh water and 2 MCM/a for wastewater effluent and other sources from Disi is 17 MCM/a.

Table 9.3.9-1 Water Resources in Karak Governorate (MCM/a)

Year	Local Sources						Available Sources					Total
	SW		GW		WWE		Disi	SW		BGW	From other Govt.	
	UP	JRV	UP	JRV	UP	JRV		Zai	PT			
2005	18	56	16	7	1		0			0	0	**97**
2010	18	64	16	5	1		2			13 local	0	**118**
2015	18	64	15	3	1		11			23 local	0	**136**
2020	18	64	15	1	2		17			36* local	0	**153**

SW: Surface Water, GW: Groundwater, WWE: Wastewater Effluent,
BGW: Brackish Groundwater Desalination, Des. Sea Water: Sea Water Desalination
Zai: Through Zai Water Work, Weh: Through Wehda Dam, PT: Peace Treaty Water
UP: Source in Upland, JRV Source in Jordan Rift Valley, Govt.: Governorate

* Local brackish groundwater potential may be higher than 36MCM/a (after BGR)

9.3.10 Ma'an Governorate

The governorate is the largest one that lies in the southeastern region of the country. Its land area is 33,163 km^2. About 92,745 inhabitant at a density of about 3 inhabitant/km2 populates it. It is mostly of dessert climate and encompasses Jafer and part of Sirhan basins. Average annual rainfall is generally less than 100mm/a.

Appreciable agricultural activities are practiced in the governorate mainly in Mudawara area. Shadhiya phosphate industry, glass factory and white cement factory are the major industrial establishments that occur in the governorate.

(1) Governorate Land Area and Population

Land Area and Population of Ma'an (1998)

Land Area (Km^2)	Population	Density.
33,163	92,745	3

(2) Current Water Use

Current water use in Ma'an Governorate is summarized as shown in the table below for the year of 1998. The feature of water use is that it contains considerable amount of irrigation water, 55 MCM/a and most of it is from Disi fossil groundwater, 41 MCM and in the Uplands' groundwater, 12 MCM.

Water Use in Ma'an Governorate (1998 unit:MCM/a)

Municipal	Industrial	Tourist	Irrigation	Total
6.9	7.2	0.1	53	**67**

a. Municipal and Tourist Water and Unaccounted for Water (UFW)

According to the WIS database, 7 MCM was produced and delivered to Ma'an Governorate in 1998. Water billed by WAJ) was 5 MCM and its UFW rate reached 68.0 % where the nation wide average was 59.4%. Therefore countermeasures for UFW shall be established in this Governorate.

Rehabilitation and improvement plan of the distribution network in the Ma'an city is to be considered in the Pre-Feasibility Study.

UFW in Municipal and Touristic Water in Ma'an

Production (m^3)	Per capita Cons. (litter/capita/day)	Water Billed (m^3)	UFW	
			(m^3)	%
6,845,830	203.1	2,191,668	4,654,162	68.0

b. Industrial Water

Industrial water is defined as large-scale industries from which light industries and commercial entities are separated and included in municipal water demand. The industrial water requirement in Ma'an Governorate is large.

c. Irrigation Water

Ma'an Governorate is a rural and arid area but it contains large irrigated agricultural

area of approximately 5000 ha using Disi non-renewable groundwater, which is approximately 20% of the Upland irrigation area and consumed 53 MCM in 1998.

(3) Demand

Demand in target years of Master Plan was projected for four sectors as shown in the table below.

Water Demand in Ma'an Governorate (Scenario-1) (MCM/a)

Year	Municipal	Industrial	Touristic	Irrigation	Total
2005	7.1	9.3	0.1	46	**63**
2010	8.8	10.9	0.2	27	**47**
2015	9.7	12.1	0.2	24	**46**
2020	9.8	12.7	0.2	13	**36**

As a basic water resources management policy, Disi fossil groundwater shall be used for the municipal water for North Jordan in general. Irrigation in Ma'an, especially in Disi area is planned to be reduced gradually as shown in above demand table.

(4) Resources

Water resources available in target years of 2005, 2010, 2015 and 2020 including transfer from external sources after the water allocation are summarized in Table 9.3.10-1 below. In 2020, Water resources available inside Ma'an Governorate is about 97 MCM/a for fresh water and 3 MCM/a for wastewater effluent. Large part of the available resources would be transferred outside the governorate through Disi-Amman conveyer.

There is an existing wastewater treatment plant in the Governorate and its reuse of the treated effluent is quite limited. Reuse plan of the treated wastewater including an expansion plan of the Ma'an treatment plant is to be prepared in the Pre-Feasibility Study. In addition, 3 MCM/a of surface water will be developed through water harvesting project in Badia region in long-term target year (2010-2020).

Table 9.3.10-1 Water Resources in Ma'an Governorate (MCM/a)

Year	Local Sources						Available Sources					Total	Export to other Govt.
	SW		GW		WWE		Disi	SW		BGW	From other Govt.		
	UP	JRV	UP	JRV	UP	JRV		Zai	PT				
2005	4		19	1	1		41					**66**	3
2010	4		17	1	2		58					**81**	35 AM
2015	7		15	1	2		65					**90**	45 AM
2020	7		13	1	3		76					**99**	63 AM

SW: Surface Water, GW: Groundwater, WWE: Wastewater Effluent,
BGW: Brackish Groundwater Desalination, Des. Sea Water: Sea Water Desalination
Zai: Through Zai Water Work, Weh: Through Wehda Dam, PT: Peace Treaty Water
UP: Source in Upland, JRV Source in Jordan Rift Valley, Govt.: Governorate

9.3.11 Tafieleh Governorate

The governorate encompasses the southern part of Hasa basin and extends westwards into north Wadi Araba basin. It belongs to the south development region of Jordan. The land area is about 2,114 km^2 with total 1998 estimates of population 72,465. Population density is around 34 inhabitant/km^2 . Moderate socio-economic parameters are prevailing in the governorate. Annual average rainfall over the area ranges from 100 to 200mm/a. One of the main Phosphate mining industry occur in this governorate.

(1) Governorate Land Area and Population

Land Area and Population of Tafieleh (1998)

Land Area (Km^2)	Population	Density.
2,114	72,465	34

(2) Current Water Use

Current water use in Tafieleh Governorate is summarized as shown in the table below for the year of 1998. The feature of water use is that it contains small amount of irrigation water, 8 MCM/a and most of it is surface water in the Uplands.

Water Use in Tafieleh Governorate (1998 unit:MCM/a)

Municipal	Industrial	Tourist	Irrigation	Total
2.4	5.3	0.0	8	**16**

a. Municipal and Tourist Water and Unaccounted for Water (UFW)

According to the WIS data, 2 MCM was produced and delivered to Tafieleh Governorate in 1998 but water billed by WAJ (Water Authority of Jordan) was 1 MCM and its UFW rate was good, 44.7 % where the nation wide average was 59.4%.

Rehabilitation and improvement plan of the distribution network inside the urban area of Tafieleh is to be prepared in the Pre-Feasibility Study.

UFW in Municipal and Touristic Water in Tafieleh

Production (m^3)	Per capita Cons. (litter/capita/day)	Water Billed (m^3)	UFW	
			(m^3)	%
2,354,915	89.0	1,303,282	1,051,633	44.7

b. Industrial Water

Industrial water is defined as large-scale industries from which light industries and commercial entities are separated and included in municipal water The industrial water in Tafieleh Governorate is small.

c. Irrigation Water

Tafieleh Governorate is a rural and arid area and it has only limited irrigated agricultural area of approximately 1000 ha, which is approximately 2% of the Upland irrigation area and consumed about 8 MCM in 1998. Source of irrigation water in Tafieleh is mainly dependent on surface water utilizing the geography in Upland.

(3) Demand

Demand in target years of Master Plan was projected for four sectors as shown in the table below.

Water Demand in Tafieleh Governorate (Scenario-1) (MCM/a)

Year	Municipal	Industrial	Tourist	Irrigation	Total
2005	3.2	6.8	0.0	11	**21**
2010	4.9	7.9	0.0	11	**24**
2015	6.6	8.7	0.0	11	**27**
2020	8.0	9.2	0.0	11	**29**

(4) Resources

Water resources available in target years of 2005, 2010, 2015 and 2020 including transfer from eternal sources after the water allocation are summarized in Table 9.3.11-1 below. In 2020, Water resources available inside Tafieleh Governorate are 22 MCM/a for fresh water and 1 MCM/a for wastewater effluent. It fulfills the demand in future when current irrigation area will be maintained with improvement of irrigation efficiency. Other resource from Disi (Ma'an Governorate) will be 6 MCM/a in 2020.

There is an existing wastewater treatment plant in the Governorate and its reuse of the treated effluent is quite limited. Reuse plan of the treated wastewater including an expansion plan of the Tafieleh treatment plant is to be prepared in the Pre-Feasibility Study.

Table 9.3.11-1 Water Resources in Tafieleh Governorate (MCM/a)

Year	Local Sources						Available Sources					Total	Export to other Govt.
	SW		GW		WWE		Disi	SW		BGW	From other Govt.		
	UP	JRV	UP	JRV	UP	JRV		Zai	PT				
2005	4	6	8		1		3 Fr. MN.					**21**	0
2010	4	6	8	1	1		4 Fr. MN.					**24**	0
2015	4	6	10	1	1		5 Fr. MN.					**27**	0
2020	4	6	11	1	1		6 Fr. MN.					**29**	0

SW: Surface Water, GW: Groundwater, WWE: Wastewater Effluent,
BGW: Brackish Groundwater Desalination, Des. Sea Water: Sea Water Desalination
Zai: Through Zai Water Work, Weh: Through Wehda Dam, PT: Peace Treaty Water
UP: Source in Upland, JRV Source in Jordan Rift Valley, Govt.: Governorate, MN: Ma'an Govt.

9.3.12 Aqaba Governorate

The governorate is named after Aqaba the sole Jordan port at the Red Sea in the southeastern end of Jordan. It encompasses the Jordanian territory of the Red Sea basin. The land area of Aqaba governorate is about 6,583km^2. Its population as per the 1998 estimates is around 95,355 and population density of 14 inhabitant/km^2. Aqaba airport, Aqaba port, thermal power station, fertilizer factory and the recent declared free Zone are the main infrastructures and facilities established in the governorate. It is considered one of the main tourist attractive cities in Jordan.

(1) Governorate Land Area and Population

Land Area and Population of Aqaba (1998)

Land Area (Km^2)	Population	Density.
6,583	95,355	14

(2) Current Water Use

Current water use in Aqaba Governorate is summarized as shown in the table below for the year of 1998. The feature of water use is that it depends totally municipal, industrial and irrigation water on the non-renewable groundwater from Disi-Mudawara well fields.

Water Use in Aqaba Governorate (1998 unit:MCM/a)

Municipal	Industrial	Tourist	Irrigation	Total
12.1	5.8	0.5	16.4	**34.8**

a. Municipal and Tourist Water and Unaccounted for Water (UFW)

According to the WIS data, 85 MCM was produced and delivered to Aqaba Governorate in 1998. The amount of water billed by WAJ was about 41 MCM and its UFW rate reached 69.3 % where the nation wide average was 59.4%. Operation and maintenance of water supply services in Aqaba Governorate are under consideration to be entrusted to Private Sector for better management and the improvement of rate of UFW.

UFW in Municipal and Touristic Water in Aqaba

Production (m^3)	Per capita Cons. (litter/capita/day)	Water Billed (m^3)	UFW	
			(m^3)	%
16,333,461	469.3	5,019,993	11,313,468	69.3

b. Industrial Water

Industrial water is defined as large-scale industries from which light industries and commercial entities are separated and included in municipal water. The industrial water in Aqaba Governorate is quite large including potash company and power station.

c. Irrigation Water

Aqaba Governorate is an urban area but it contains large irrigated agricultural area of approximately 500 ha in Disi-Mudawara localities, which is approximately 10% of

the Upland irrigation area and consumed about 16 MCM in 1998.

Source of irrigation water in Aqaba is depending on the non-renewable groundwater resources potential in Disi/Ram aquifer in south Jordan..

(3) Demand

Demand in target years of Master Plan was projected for four sectors as shown in the table below.

Water Demand in Aqaba Governorate (Scenario-1) (MCM/a)

Year	Municipal	Industrial	Tourist	Irrigation	Total
2005	11.4	8.1	0.7	20	40
2010	12.9	9.4	0.8	16	39
2015	12.7	10.4	0.9	7	32
2020	11.0	11.0	1.1	9	32

(4) Resources

Water resources available in target years of 2005, 2010, 2015 and 2020 including transfer from external sources after the water allocation are summarized in Table 9.3.12-1 below. In 2020, water resources available inside Aqaba Governorate is only 9 MCM/a for fresh water as conventional resource and 7 MCM/a for wastewater effluent and other sources are Disi fossil groundwater which will be sent to Amman capital area and new seawater desalination replaced to Disi groundwater to fulfill the future demand.

Table 9.3.12-1 Water Resources in Aqaba Governorate (MCM/a)

Year	Local Sources						Available Sources					Total	Export* to other Govt.
	SW		GW		WWE		Disi	SW		Des. Sea Water	From other Govt.		
	UP	JRV	UP	JRV	UP	JRV		Zai	PT				
2005	1		5	2		4	24			5		**40**	0
2010	1		5	2		5	34			5		**51**	12
2015	1		6	2		6	38			17		**70**	38
2020	1		6	2		7	54			17		**86**	54

* : Indicates non-renewable fresh groundwater (fresh fossil g roundwater) production from Aqaba to meet local use and exports to north Jordan.

SW: Surface Water, GW: Groundwater, WWE: Wastewater Effluent,
BGW: Brackish Groundwater Desalination, Des. Sea Water: Sea Water Desalination
Zai: Through Zai Water Work, Weh: Through Wehda Dam, PT: Peace Treaty Water
UP: Source in Upland, JRV Source in Jordan Rift Valley, Govt.: Governorate

9.4 Financial Plan

The projected financial statements for the three groups of proposed projects, namely, water development projects, wastewater treatment projects and wastewater reuse projects, have been prepared.

The water development projects consist of 16 projects whose objectives are to newly develop or convey either surface or underground water, out of 24 water related projects. The balance are those projects which aim for new ways of saving water or for keeping the existing level of water production through the rehabilitation of facilities, or transferring such water.

The wastewater treatment projects are comprised of 25 projects envisaged by MWI. The wastewater reuse projects are made up of 29 projects as proposed by the JICA study team. The readers are advised to refer to the supporting report for further information.

9.4.1 Preconditions

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

(1) Unit Prices

Item	Unit Price (Fils/m^3)
Municipal water	382
Industrial water	1,120
Irrigation water	178
Sewage	537
Treated wastewater for irrigation use	38

The above unit water/wastewater prices derive from the results of financial analysis.

(2) Financing, etc.

Item	Case I	Case II
Financing resources	70% : External; 30%: Local	80% : External; 20%: Local
Financing terms	Repayment period: 25 years	Repayment period: 30 years
	Grace period: 3 years	Grace period: 5 years
	Annual interest rate: 6.5%	Annual interest rate: 4%
Executing Entity	Private + Public	Public
Corporate Tax	15%	0%
Depreciation period	30 years	

9.4.2 Projected Financial Statements in Case I

The attached Tables 9.4.2-1(1), 9.4.2-1(2) and 9.4.2-1(3) show the financial statements, namely the income statement, the funds statement and the balance sheet, for the above-mentioned three groups of projects

As for the supporting data used for the preparation of the financial statements, readers are advised to refer to the related section in the supporting report.

The financial statements are summarized by the representative managerial indices as follows:

(Unit: %)

Project Groups	Profit before Tax/Revenues		Working Capital/Revenues		Profit Before Tax/Liabilities and Capital	
	To 2020	To 2030	To 2020	To 2030	To 2020	To 2030
Water Development	11.5	21.1	3.9	18.8	1.7	3.3
Wastewater Treatment	2.5	30.3	-6.7	26.5	0.3	4.5
Wastewater Reuse	29.9	41.3	3.5	29.6	6.2	7.3

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

Regarding the profit to revenues ratio, both water development and wastewater reuse projects have been found to be perfectly OK compared with the standard level. However, wastewater treatment projects would be below the standard at least in the initial years.

As regards the working capital to revenues ratio, all the three groups of projects would face bottlenecks at least in the initial years.

With respect to the profit before tax to liabilities and capital ratio, all groups of projects except wastewater reuse projects would not be up to the standard level. However, this point should not be overemphasized because these undertakings of social nature are essentially not profit-oriented and, therefore, the estimated values should be on the whole, regarded as acceptable.

In conclusion, it can be stated that generally speaking, all the projects would be financially ultimately sustainable under the afore-mentioned preconditions, although it should be noted that all the projects might more or less face liquidity problem at least in the initial years, which must be overcome by either the fund on hand or by borrowings.

Table 9.4.2-1(1) Financial Statements - Case I

1. Water Development Projects

(Unit: M JD)

Item	Before 2000	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
(1) Income Statement																						
Revenues	0.0	0.0	1.6	7.1	21.3	32.3	47.0	80.8	115.4	118.5	145.0	148.6	148.6	148.6	148.6	148.6	152.0	167.8	167.8	167.8	167.8	167.8
O & M Cost	0.0	0.0	0.3	1.4	10.1	10.8	18.3	18.8	40.9	40.9	51.0	53.5	53.7	53.8	54.0	54.1	57.2	58.4	58.5	58.6	58.7	59.9
Depreciation	0.0	0.0	0.3	1.4	5.7	7.1	12.2	16.7	30.2	30.2	33.6	34.7	34.7	34.7	34.7	34.7	36.4	39.1	39.1	39.1	39.1	39.1
Interest Payment	1.5	5.1	12.0	20.0	27.8	34.3	37.3	40.3	40.6	41.0	40.1	37.9	40.0	39.1	38.9	39.2	37.9	35.4	32.7	30.0	27.4	24.7
Expenditures	1.5	5.1	12.6	22.8	43.6	52.2	67.8	75.8	111.7	112.1	124.7	126.1	128.4	127.6	127.6	128.0	131.5	132.9	130.3	127.7	125.2	123.7
Profit Before Tax	-1.5	-5.1	-11.0	-15.7	-22.3	-19.9	-20.8	5.0	3.7	6.4	20.3	22.5	20.2	21.0	21.0	20.6	20.5	34.9	37.5	40.1	42.6	44.1
Tax								0.8	0.6	1.0	3.0	3.4	3.0	3.2	3.2	3.1	3.1	5.2	5.6	6.0	6.4	6.6
Profit After Tax	-1.5	-5.1	-11.0	-15.7	-22.3	-19.9	-20.8	4.3	3.1	5.4	17.3	19.1	17.2	17.9	17.9	17.5	17.4	29.7	31.9	34.1	36.2	37.5
	(to 2020)	(to 2030)																				
Average Profit Before Tax to Revenues Ratio	11.5%	21.2%																				
Average Profit After Tax to Revenues Ratio	9.1%	17.7%																				
(2) Funds Statement																						
Profit After Tax	-1.5	-5.1	-11.0	-15.7	-22.3	-19.9	-20.8	4.3	3.1	5.4	17.3	19.1	17.2	17.9	17.9	17.5	17.4	29.7	31.9	34.1	36.2	37.5
Loans+Budget	33.0	79.0	152.8	199.6	195.0	168.2	104.4	108.9	48.8	53.8	22.7	1.8	15.5	15.5	33.0	43.5	26.3	0.0	0.0	0.0	0.0	0.0
Depreciation	0.0	0.0	0.3	1.4	5.7	7.1	12.2	16.7	30.2	30.2	33.6	34.7	34.7	34.7	34.7	34.7	36.4	39.1	39.1	39.1	39.1	39.1
Sources	31.5	73.9	142.1	185.3	178.4	155.4	95.8	129.9	82.1	89.4	73.6	55.6	67.4	68.1	85.6	95.7	80.1	68.8	71.0	73.2	75.3	76.6
Capital Works	33.0	79.0	152.8	199.6	195.0	168.2	104.4	108.9	48.8	53.8	22.7	1.8	15.5	15.5	33.0	43.5	26.3	0.0	0.0	0.0	0.0	0.0
Payment of Principal	0.0	0.0	0.0	3.3	11.2	31.4	33.8	34.2	34.2	34.9	38.1	38.9	38.9	39.2	39.2	39.2	39.2	41.4	41.4	41.4	41.4	41.4
Working Capital	-1.5	-5.1	-10.7	-17.6	-27.8	-44.2	-42.4	-13.3	-0.9	0.7	12.8	14.9	13.0	13.4	13.4	13.0	14.6	27.4	29.6	31.8	33.9	35.2
Applications	31.5	73.9	142.1	185.3	178.4	155.4	95.8	129.9	82.1	89.4	73.6	55.6	67.4	68.1	85.6	95.7	80.1	68.8	71.0	73.2	75.3	76.6
	(to 2020)	(to 2030)																				
Average Working Capital to Revenues Ratio	3.9%	18.8%																				
(3) Balance Sheet																						
Liabilities	23.1	78.4	185.4	321.8	447.1	533.4	572.7	614.7	614.7	617.5	595.2	557.6	529.6	501.2	485.1	476.4	455.6	414.2	372.8	331.4	290.0	248.6
Capital	8.4	27.0	61.8	106.0	142.2	172.8	183.3	220.2	238.0	259.6	283.7	303.3	325.1	347.6	375.4	405.9	431.3	460.9	492.8	526.9	563.1	600.6
Liabilities and Capital	31.5	105.4	247.2	427.8	589.3	706.2	756.0	835.0	852.7	877.0	878.9	860.9	854.7	848.8	860.5	882.3	886.8	875.1	865.6	858.2	853.1	849.1
Current Assets	-1.5	-6.6	-17.3	-34.9	-62.7	-106.9	-149.3	-162.6	-163.4	-162.7	-149.9	-135.0	-122.0	-108.7	-95.3	-82.3	-67.7	-40.3	-10.7	21.0	55.0	90.1
Fixed Assets	33.0	112.0	264.5	462.7	652.0	813.1	905.3	997.5	1,016.1	1,039.7	1,028.8	995.9	976.7	957.5	955.8	964.6	954.5	915.4	876.3	837.2	798.1	759.0
Assets	31.5	105.4	247.2	427.8	589.3	706.2	756.0	835.0	852.7	877.0	878.9	860.9	854.7	848.8	860.5	882.3	886.8	875.1	865.6	858.2	853.1	849.1
	(to 2020)	(to 2030)																				
Average Profit Before Tax to Liabilities and Capital Ratio	1.7%	3.3%																				

Table 9.4.2-1(2) Financial Statements - Case I

2. Wastewater Treatment Projects (Unit: M JD)

Item	Before 2000	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
(1) Income Statement																						
Revenues	0.0	0.0	0.0	6.5	7.0	7.3	11.7	17.5	27.7	31.8	36.1	48.7	50.5	51.7	53.0	54.3	55.7	57.1	58.4	59.8	61.2	62.7
O & M Cost	0.0	0.0	0.9	0.9	0.9	1.5	1.9	7.3	7.8	8.0	9.3	9.3	9.8	9.8	9.8	9.8	9.8	9.8	9.8	9.8	9.8	9.8
Depreciation	0.0	0.0	2.8	4.1	4.1	5.7	6.6	10.6	12.0	12.7	16.7	16.7	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0
Interest Payment	4.3	6.4	8.0	11.2	14.8	17.4	18.9	20.5	21.7	22.4	21.4	20.3	19.0	17.9	16.6	15.3	14.1	12.9	11.6	10.4	9.2	7.9
Expenditures	4.3	6.4	11.7	16.2	19.8	24.6	27.4	38.4	41.5	43.1	47.4	46.3	46.8	45.7	44.4	43.1	41.9	40.7	39.4	38.2	37.0	35.7
Profit Before Tax	-4.3	-6.4	-11.7	-9.7	-12.8	-17.3	-15.7	-20.9	-13.8	-11.3	-11.3	2.4	3.7	6.0	8.6	11.2	13.8	16.4	19.0	21.6	24.2	27.0
Tax												0.4	0.6	0.9	1.3	1.7	2.1	2.5	2.9	3.2	3.6	4.1
Profit After Tax	-4.3	-6.4	-11.7	-9.7	-12.8	-17.3	-15.7	-20.9	-13.8	-11.3	-11.3	2.0	3.1	5.1	7.3	9.5	11.7	13.9	16.2	18.4	20.6	23.0
	(to 2020)	(to 2030)																				
Average Profit Before Tax to Revenues Ratio	2.5%	30.3%																				
Average Profit After Tax to Revenues Ratio	-0.6%	24.4%																				
(2) Funds Statement																						
Profit After Tax	-4.3	-6.4	-11.7	-9.7	-12.8	-17.3	-15.7	-20.9	-13.8	-11.3	-11.3	2.0	3.1	5.1	7.3	9.5	11.7	13.9	16.2	18.4	20.6	23.0
Loans+Budget	94.0	47.0	33.9	71.9	83.9	65.9	53.0	56.6	46.6	39.6	4.0	4.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Depreciation	0.0	0.0	2.8	4.1	4.1	5.7	6.6	10.6	12.0	12.7	16.7	16.7	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0
Sources	89.7	40.6	25.0	66.3	75.2	54.3	43.9	46.3	44.8	41.0	9.4	22.7	21.1	23.1	25.3	27.5	29.7	31.9	34.2	36.4	38.6	41.0
Capital Works	94.0	47.0	33.9	71.9	83.9	65.9	53.0	56.6	46.6	39.6	4.0	4.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Payment of Principal	0.0	0.0	0.4	4.7	6.3	13.4	14.7	14.9	17.1	18.1	19.1	19.1	19.1	19.1	19.1	19.1	19.1	19.1	19.1	19.1	19.1	19.1
Working Capital	-4.3	-6.4	-9.3	-10.3	-15.0	-25.0	-23.8	-25.2	-18.9	-16.7	-13.7	-0.4	2.0	4.0	6.2	8.4	10.6	12.8	15.1	17.3	19.5	21.9
Applications	89.7	40.6	25.0	66.3	75.2	54.3	43.9	46.3	44.8	41.0	9.4	22.7	21.1	23.1	25.3	27.5	29.7	31.9	34.2	36.4	38.6	41.0
	(to 2020)	(to 2030)																				
Average Working Capital to Revenues Ratio	-6.7%	26.5%																				
(3) Balance Sheet																						
Liabilities	65.8	98.7	122.4	168.4	221.1	253.8	276.2	300.9	316.5	326.1	309.8	293.5	274.4	255.3	236.2	217.1	198.0	178.9	159.8	140.7	121.6	102.5
Capital	23.9	31.6	30.1	41.9	54.3	56.8	57.0	53.1	53.2	53.8	43.7	47.0	50.1	55.2	62.5	72.0	83.8	97.7	113.9	132.2	152.8	175.7
Liabilities and Capital	89.7	130.3	152.5	210.3	275.4	310.6	333.2	354.0	369.7	379.9	353.5	340.4	324.5	310.5	298.7	289.1	281.7	276.6	273.6	272.9	274.4	278.2
Current Assets	-4.3	-10.7	-19.6	-29.6	-44.3	-69.3	-93.1	-118.3	-137.2	-153.9	-167.6	-168.0	-165.9	-161.9	-155.7	-147.3	-136.7	-123.8	-108.8	-91.5	-72.0	-50.2
Fixed Assets	94.0	141.0	172.1	239.9	319.7	379.9	426.3	472.3	506.9	533.8	521.1	508.4	490.4	472.4	454.4	436.4	418.4	400.4	382.4	364.4	346.4	328.4
Assets	89.7	130.3	152.5	210.3	275.4	310.6	333.2	354.0	369.7	379.9	353.5	340.4	324.5	310.5	298.7	289.1	281.7	276.6	273.6	272.9	274.4	278.2
	(to 2020)	(to 2030)																				
Average Profit Before Tax to Liabilities and Capital Ratio	0.3%	4.5%																				

Table 9.4.2-1(3) Financial Statements - Case I

3. Wastewater Reuse Projects

(Unit: M JD)

Item	Before 2000	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
(1) Income Statement																						
Revenues	0.000	0.000	0.000	0.014	0.134	0.383	0.737	1.344	1.496	1.638	1.754	2.029	3.499	3.588	3.676	3.807	3.996	4.119	4.222	4.324	4.427	4.529
O & M Cost	0.000	0.000	0.000	0.009	0.140	0.343	0.492	0.640	0.680	0.724	0.724	0.762	1.214	1.142	1.159	1.220	1.274	1.286	1.289	1.549	1.290	1.291
Depreciation	0.000	0.000	0.000	0.003	0.038	0.175	0.246	0.327	0.340	0.395	0.403	0.421	0.641	0.651	0.674	0.752	0.772	0.785	0.792	0.840	0.857	0.879
Interest Payment	0.000	0.000	0.005	0.132	0.296	0.434	0.422	0.399	0.378	0.424	0.483	0.531	0.472	0.469	0.478	0.435	0.380	0.344	0.317	0.368	0.410	0.442
Expenditures	0.000	0.000	0.005	0.144	0.474	0.952	1.160	1.366	1.398	1.543	1.610	1.714	2.327	2.262	2.311	2.407	2.426	2.415	2.398	2.757	2.557	2.612
Profit Before Tax	0.000	0.000	-0.005	-0.130	-0.340	-0.569	-0.423	-0.022	0.098	0.095	0.144	0.315	1.172	1.326	1.365	1.400	1.570	1.704	1.824	1.567	1.870	1.917
Tax									0.015	0.014	0.022	0.047	0.176	0.199	0.205	0.210	0.236	0.256	0.274	0.235	0.281	0.288
Profit After Tax	0.000	0.000	-0.005	-0.130	-0.340	-0.569	-0.423	-0.022	0.083	0.081	0.122	0.268	0.996	1.127	1.160	1.190	1.335	1.448	1.550	1.332	1.590	1.629
	(to 2020)	(to 2030)																				
Average Profit Before Tax to Revenues Ratio	29.9%	41.3%																				
Average Profit After Tax to Revenues Ratio	25.0%	34.9%																				
(2) Funds Statement																						
Profit After Tax	0.000	0.000	-0.005	-0.130	-0.340	-1.977	-0.423	-0.019	0.083	0.081	0.122	0.268	0.996	1.127	1.160	1.190	1.335	1.448	1.550	1.332	1.590	1.629
Loans+Budget	0.000	0.000	0.114	2.780	3.622	3.022	1.352	1.110	1.157	2.626	2.915	2.682	0.316	1.565	1.806	0.671	0.416	0.828	1.032	2.740	2.526	2.327
Depreciation	0.000	0.000	0.000	0.003	0.038	0.175	0.246	0.327	0.340	0.395	0.403	0.421	0.641	0.651	0.674	0.752	0.772	0.785	0.792	0.840	0.857	0.879
Sources	0.000	0.000	0.109	2.653	3.320	1.220	1.175	1.418	1.580	3.102	3.440	3.371	1.953	3.343	3.640	2.613	2.523	3.061	3.374	4.912	4.973	4.835
Capital Works	0.000	0.000	0.114	2.780	3.622	3.022	1.352	1.110	1.157	2.626	2.915	2.682	0.316	1.565	1.806	0.671	0.416	0.828	1.032	2.740	2.526	2.327
Payment of Principal	0.000	0.000	0.000	0.000	0.000	1.133	1.133	1.133	1.133	1.133	1.133	1.133	1.133	1.133	1.133	1.133	1.133	1.133	1.133	1.133	1.133	1.133
Working Capital	0.000	0.000	-0.005	-0.127	-0.302	-2.935	-1.310	-0.825	-0.710	-0.657	-0.608	-0.444	0.504	0.645	0.701	0.809	0.974	1.100	1.209	1.039	1.314	1.375
Applications	0.000	0.000	0.109	2.653	3.320	1.220	1.175	1.418	1.580	3.102	3.440	3.371	1.953	3.343	3.640	2.613	2.523	3.061	3.374	4.912	4.973	4.835
	(to 2020)	(to 2030)																				
Average Working Capital to Revenues Ratio	3.5%	29.6%																				
(3) Balance Sheet																						
Liabilities	0.000	0.000	0.080	2.026	4.561	5.544	5.357	5.001	4.678	5.383	6.291	7.035	6.123	6.086	6.217	5.554	4.712	4.158	3.748	4.533	5.168	5.664
Capital	0.000	0.000	0.029	0.733	1.480	0.409	0.392	0.706	1.137	2.005	3.002	4.075	5.166	6.762	8.464	9.855	11.315	13.012	14.872	17.026	19.373	21.700
Liabilities and Capital	0.000	0.000	0.109	2.759	6.041	5.953	5.749	5.707	5.815	7.388	9.293	11.110	11.289	12.848	14.681	15.409	16.027	17.170	18.619	21.558	24.541	27.364
Current Assets	0.000	0.000	-0.005	-0.132	-0.434	-3.369	-4.679	-5.504	-6.213	-6.871	-7.478	-7.923	-7.418	-6.773	-6.072	-5.263	-4.289	-3.189	-1.980	-0.941	0.373	1.748
Fixed Assets	0.000	0.000	0.114	2.891	6.475	9.322	10.428	11.211	12.028	14.259	16.771	19.032	18.707	19.621	20.753	20.672	20.316	20.359	20.599	22.499	24.168	25.616
Assets	0.000	0.000	0.109	2.759	6.041	5.953	5.749	5.707	5.815	7.388	9.293	11.110	11.289	12.848	14.681	15.409	16.027	17.170	18.619	21.558	24.541	27.364
	(to 2020)	(to 2030)																				
Average Profit Before Tax to Liabilities and Capital Ratio	6.2%	7.3%																				

9.4.3 Projected Financial Statements in Case II

The attached Tables 9.4.3-1(1), 9.4.3-1(2) and 9.4.3-1(3) show the financial statements, namely the income statement, the funds statement and the balance sheet, for the above-mentioned three groups of projects.

As for the supporting data used for the preparation of the financial statements, readers are advised to refer to the related section in the supporting report.

The financial statements are summarized by the representative managerial indices as follows:

(Unit: %)

Project Groups	Profit/Revenues	Working Capital/Revenues	Profit Before Tax/Liabilities and Capital
	Up to the Year 2020	Up to the Year 2020	Up to the Year 2020
Water Development	17.8	16.0	2.2
Wastewater Treatment	10.2	9.0	1.0
Wastewater Reuse	29.9	15.7	6.0

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

Regarding the profit to revenues ratio, all the three groups of projects have been found to be perfectly OK compared with the standard level.

As regards the working capital to revenues ratio, both the water development and wastewater reuse projects would be perfectly OK in comparison with the standard values. Even the wastewater treatment projects are only slightly below the standard, and in this meaning they can be said to be acceptable.

With respect to the profit before tax to liabilities and capital ratio, all groups of projects except wastewater reuse projects would not be up to the standard level. However, this point should not be overemphasized because these undertakings of social nature are essentially not profit-oriented and, therefore, the estimated values should be on the whole, regarded as acceptable.

In conclusion, it can be stated that generally speaking, all the projects would be financially sustainable under the afore-mentioned preconditions, although it should be noted that all the projects might more or less face liquidity problem at least in the initial years, which must be overcome by either the fund on hand or by borrowings.

Table 9.4.3-1(1) Financial Statements - Case II

1. Water Development Projects

(Unit: M JD)

Item	Before 2000	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
(1) Income Statement																						
Revenues	0.0	0.0	1.6	7.1	21.3	32.3	47.0	80.8	115.4	118.5	145.0	148.6	148.6	148.6	148.6	148.6	152.0	167.8	167.8	167.8	167.8	167.8
O & M Cost	0.0	0.0	0.3	1.4	10.1	10.8	18.3	18.8	40.9	40.9	51.0	53.5	53.7	53.8	54.0	54.1	57.2	58.4	58.5	58.6	58.7	59.9
Depreciation	0.0	0.0	0.3	1.4	5.7	7.1	12.2	16.7	30.2	30.2	33.6	34.7	34.7	34.7	34.7	34.7	36.4	39.1	39.1	39.1	39.1	39.1
Interest Payment	1.1	3.6	8.5	14.9	21.1	26.5	29.7	32.7	33.1	33.5	32.9	31.7	30.9	29.9	29.4	29.3	28.7	27.2	25.6	24.0	22.4	20.7
Expenditures	1.1	3.6	9.1	17.7	36.9	44.4	60.2	68.2	104.2	104.6	117.5	119.9	119.3	118.4	118.1	118.1	122.3	124.7	123.2	121.7	120.2	119.7
Profit Before Tax	-1.1	-3.6	-7.5	-10.6	-15.6	-12.1	-13.2	12.6	11.2	13.9	27.5	28.7	29.3	30.2	30.5	30.5	29.7	43.1	44.6	46.1	47.6	48.1
Tax																						
Profit After Tax	-1.1	-3.6	-7.5	-10.6	-15.6	-12.1	-13.2	12.6	11.2	13.9	27.5	28.7	29.3	30.2	30.5	30.5	29.7	43.1	44.6	46.1	47.6	48.1
	(to 2020)	(to 2030)																				
Average Profit Before Tax to Revenues Ratio	17.8%	24.7%																				
Average Profit After Tax to Revenues Ratio	17.8%	24.7%																				
(2) Funds Statement																						
Profit After Tax	-1.1	-3.6	-7.5	-10.6	-15.6	-12.1	-13.2	12.6	11.2	13.9	27.5	28.7	29.3	30.2	30.5	30.5	29.7	43.1	44.6	46.1	47.6	48.1
Loans+Budget	33.0	79.0	152.8	199.6	195.0	168.2	104.4	108.9	48.8	53.8	22.7	1.8	15.5	15.5	33.0	43.5	26.3	0.0	0.0	0.0	0.0	0.0
Depreciation	0.0	0.0	0.3	1.4	5.7	7.1	12.2	16.7	30.2	30.2	33.6	34.7	34.7	34.7	34.7	34.7	36.4	39.1	39.1	39.1	39.1	39.1
Sources	31.9	75.4	145.6	190.4	185.1	163.2	103.4	138.2	90.2	97.9	83.8	65.2	79.5	80.4	98.2	108.7	92.4	82.2	83.7	85.2	86.7	87.2
Capital Works	33.0	79.0	152.8	199.6	195.0	168.2	104.4	108.9	48.8	53.8	22.7	1.8	15.5	15.5	33.0	43.5	26.3	0.0	0.0	0.0	0.0	0.0
Payment of Principal	0.0	0.0	0.0	0.0	0.0	3.3	11.3	31.6	34.0	34.4	34.4	35.1	38.3	39.1	39.1	39.4	39.4	39.4	39.4	41.7	41.7	41.7
Working Capital	-1.1	-3.6	-7.2	-9.2	-9.9	-8.3	-12.3	-2.3	7.4	9.7	26.7	28.3	25.7	25.8	26.1	25.8	26.7	42.8	44.3	43.5	45.0	45.5
Applications	31.9	75.4	145.6	190.4	185.1	163.2	103.4	138.2	90.2	97.9	83.8	65.2	79.5	80.4	98.2	108.7	92.4	82.2	83.7	85.2	86.7	87.2
	(to 2020)	(to 2030)																				
Average Working Capital to Revenues Ratio	16.0%	23.4%																				
(3) Balance Sheet																						
Liabilities	23.1	78.4	185.4	325.1	461.6	576.0	637.8	682.4	682.6	685.9	667.3	633.5	606.1	577.8	561.8	552.9	531.9	492.5	453.1	411.4	369.7	328.0
Capital	8.8	28.9	67.2	116.5	159.4	197.8	215.9	261.2	287.0	317.1	351.4	380.6	414.6	449.4	489.8	533.4	570.9	614.0	658.6	704.7	752.3	800.4
Liabilities and Capital	31.9	107.3	252.6	441.6	621.0	773.8	853.7	943.6	969.6	1,002.9	1,018.7	1,014.1	1,020.6	1,027.2	1,051.6	1,086.2	1,102.8	1,106.5	1,111.7	1,116.1	1,122.0	1,128.4
Current Assets	-1.1	-4.7	-11.9	-21.1	-31.0	-39.3	-51.6	-53.9	-46.5	-36.8	-10.1	18.2	43.9	69.7	95.8	121.6	148.3	191.1	235.4	278.9	323.9	369.4
Fixed Assets	33.0	112.0	264.5	462.7	652.0	813.1	905.3	997.5	1,016.1	1,039.7	1,028.8	995.9	976.7	957.5	955.8	964.6	954.5	915.4	876.3	837.2	798.1	759.0
Assets	31.9	107.3	252.6	441.6	621.0	773.8	853.7	943.6	969.6	1,002.9	1,018.7	1,014.1	1,020.6	1,027.2	1,051.6	1,086.2	1,102.8	1,106.5	1,111.7	1,116.1	1,122.0	1,128.4
	(to 2020)	(to 2030)																				
Average Profit Before Tax to Liabilities and Capital Ratio	2.2%	3.2%																				

Table 9.4.3-1(2) Financial Statements - Case II

2. Wastewater Treatment Projects (Unit: M JD)

Item	Before 2000	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
(1) Income Statement																						
Revenues	0.0	0.0	0.0	6.5	7.0	7.3	11.7	17.5	27.7	31.8	36.1	48.7	50.5	51.7	53.0	54.3	55.7	57.1	58.4	59.8	61.2	62.7
O & M Cost	0.0	0.0	0.9	0.9	0.9	1.5	1.9	7.3	7.8	8.0	9.3	9.3	9.8	9.8	9.8	9.8	9.8	9.8	9.8	9.8	9.8	9.8
Depreciation	0.0	0.0	2.8	4.1	4.1	5.7	6.6	10.6	12.0	12.7	16.7	16.7	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0
Interest Payment	3.0	4.5	5.6	7.9	10.6	12.7	14.2	15.8	16.7	17.4	16.9	16.4	15.6	14.9	14.1	13.3	12.6	11.8	11.0	10.3	9.5	8.7
Expenditures	3.0	4.5	9.3	12.9	15.6	19.9	22.7	33.7	36.5	38.1	42.9	42.4	43.4	42.7	41.9	41.1	40.4	39.6	38.8	38.1	37.3	36.5
Profit Before Tax	-3.0	-4.5	-9.3	-6.4	-8.6	-12.6	-11.0	-16.2	-8.8	-6.3	-6.8	6.3	7.1	9.0	11.1	13.2	15.3	17.5	19.6	21.7	23.9	26.2
Tax																						
Profit After Tax	-3.0	-4.5	-9.3	-6.4	-8.6	-12.6	-11.0	-16.2	-8.8	-6.3	-6.8	6.3	7.1	9.0	11.1	13.2	15.3	17.5	19.6	21.7	23.9	26.2
	(to 2020)	(to 2030)																				
Average Profit Before Tax to Revenues Ratio	10.2%	32.8%																				
Average Profit After Tax to Revenues Ratio	10.2%	32.8%																				
(2) Funds Statement																						
Profit After Tax	-3.0	-4.5	-9.3	-6.4	-8.6	-12.6	-11.0	-16.2	-8.8	-6.3	-6.8	6.3	7.1	9.0	11.1	13.2	15.3	17.5	19.6	21.7	23.9	26.2
Loans+Budget	94.0	47.0	33.9	71.9	83.9	65.9	53.0	56.6	46.6	39.6	4.0	4.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Depreciation	0.0	0.0	2.8	4.1	4.1	5.7	6.6	10.6	12.0	12.7	16.7	16.7	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0
Sources	91.0	42.5	27.4	69.6	79.4	59.0	48.6	51.0	49.8	46.0	13.9	27.0	25.1	27.0	29.1	31.2	33.3	35.5	37.6	39.7	41.9	44.2
Capital Works	94.0	47.0	33.9	71.9	83.9	65.9	53.0	56.6	46.6	39.6	4.0	4.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Payment of Principal	0.0	0.0	0.0	0.0	0.0	4.4	6.0	13.5	14.8	15.0	17.2	18.2	19.2	19.2	19.2	19.2	19.2	19.2	19.2	19.2	19.2	19.2
Working Capital	-3.0	-4.5	-6.5	-2.3	-4.5	-11.3	-10.4	-19.1	-11.6	-8.6	-7.3	4.8	5.9	7.8	9.9	12.0	14.1	16.3	18.4	20.5	22.7	25.0
Applications	91.0	42.5	27.4	69.6	79.4	59.0	48.6	51.0	49.8	46.0	13.9	27.0	25.1	27.0	29.1	31.2	33.3	35.5	37.6	39.7	41.9	44.2
	(to 2020)	(to 2030)																				
Average Working Capital to Revenues Ratio	9.0%	32.1%																				
(3) Balance Sheet																						
Liabilities	75.2	112.8	139.9	197.4	264.6	312.9	349.3	381.1	403.5	420.2	406.2	391.2	372.0	352.8	333.6	314.4	295.2	276.0	256.8	237.6	218.4	199.2
Capital	15.8	20.7	18.2	26.2	34.3	34.9	34.5	29.6	30.2	31.8	25.8	32.9	40.0	49.0	60.1	73.3	88.6	106.1	125.7	147.4	171.3	197.5
Liabilities and Capital	91.0	133.5	158.1	223.6	298.9	347.8	383.8	410.7	433.7	452.0	432.0	424.1	412.0	401.8	393.7	387.7	383.8	382.1	382.5	385.0	389.7	396.7
Current Assets	-3.0	-7.5	-14.0	-16.3	-20.8	-32.1	-42.5	-61.6	-73.2	-81.8	-89.1	-84.3	-78.4	-70.6	-60.7	-48.7	-34.6	-18.3	0.1	20.6	43.3	68.3
Fixed Assets	94.0	141.0	172.1	239.9	319.7	379.9	426.3	472.3	506.9	533.8	521.1	508.4	490.4	472.4	454.4	436.4	418.4	400.4	382.4	364.4	346.4	328.4
Assets	91.0	133.5	158.1	223.6	298.9	347.8	383.8	410.7	433.7	452.0	432.0	424.1	412.0	401.8	393.7	387.7	383.8	382.1	382.5	385.0	389.7	396.7
	(to 2020)	(to 2030)																				
Average Profit Before Tax to Liabilities and Capital Ratio	1.0%	3.8%																				

Table 9.4.3-1(3) Financial Statements - Case II

3. Wastewater Reuse Projects

(Unit: M JD)

Item	Before 2000	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
(1) Income Statement																						
Revenues	0.000	0.000	0.000	0.014	0.134	0.383	0.737	1.344	1.496	1.638	1.754	2.029	3.499	3.588	3.676	3.807	3.996	4.119	4.222	4.324	4.427	4.529
O & M Cost	0.000	0.000	0.000	0.009	0.140	0.343	0.492	0.640	0.680	0.724	0.724	0.762	1.214	1.142	1.159	1.220	1.274	1.286	1.289	1.549	1.290	1.291
Depreciation	0.000	0.000	0.000	0.003	0.038	0.175	0.246	0.327	0.340	0.395	0.403	0.421	0.641	0.651	0.674	0.752	0.772	0.785	0.792	0.840	0.857	0.879
Interest Payment	0.000	0.000	0.004	0.093	0.209	0.305	0.348	0.384	0.375	0.414	0.462	0.502	0.466	0.471	0.483	0.459	0.427	0.408	0.395	0.437	0.472	0.501
Expenditures	0.000	0.000	0.004	0.105	0.387	0.823	1.086	1.351	1.395	1.533	1.589	1.685	2.321	2.264	2.316	2.431	2.473	2.479	2.476	2.826	2.619	2.671
Profit Before Tax	0.000	0.000	-0.004	-0.091	-0.253	-0.440	-0.349	-0.007	0.101	0.105	0.165	0.344	1.178	1.324	1.360	1.376	1.523	1.640	1.746	1.498	1.808	1.858
Tax																						
Profit After Tax	0.000	0.000	-0.004	-0.091	-0.253	-0.440	-0.349	-0.007	0.101	0.105	0.165	0.344	1.178	1.324	1.360	1.376	1.523	1.640	1.746	1.498	1.808	1.858
	(to 2020)	(to 2030)																				
Average Profit Before Tax to Revenues Ratio	29.9%	40.0%																				
Average Profit After Tax to Revenues Ratio	29.9%	40.0%																				
(2) Funds Statement																						
Profit After Tax	0.000	0.000	-0.004	-0.091	-0.253	-0.440	-0.349	-0.007	0.101	0.105	0.165	0.344	1.178	1.324	1.360	1.376	1.523	1.640	1.746	1.498	1.808	1.858
Loans+Budget	0.000	0.000	0.114	2.780	3.622	3.022	1.352	1.110	1.157	2.626	2.915	2.682	0.316	1.565	1.806	0.671	0.416	0.828	1.032	2.740	2.526	2.327
Depreciation	0.000	0.000	0.000	0.003	0.038	0.175	0.246	0.327	0.340	0.395	0.403	0.421	0.641	0.651	0.674	0.752	0.772	0.785	0.792	0.840	0.857	0.879
Sources	0.000	0.000	0.110	2.692	3.407	2.757	1.249	1.430	1.598	3.126	3.483	3.447	2.135	3.540	3.840	2.799	2.711	3.253	3.570	5.078	5.191	5.064
Capital Works	0.000	0.000	0.114	2.780	3.622	3.022	1.352	1.110	1.157	2.626	2.915	2.682	0.316	1.565	1.806	0.671	0.416	0.828	1.032	2.740	2.526	2.327
Payment of Principal	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.139	1.139	1.139	1.139	1.139	1.139	1.139	1.139	1.139	1.139	1.139	1.139	1.139	1.139	1.139
Working Capital	0.000	0.000	-0.004	-0.088	-0.215	-0.265	-0.103	-0.819	-0.698	-0.639	-0.571	-0.374	0.680	0.836	0.895	0.989	1.156	1.286	1.399	1.199	1.526	1.598
Applications	0.000	0.000	0.110	2.692	3.407	2.757	1.249	1.430	1.598	3.126	3.483	3.447	2.135	3.540	3.840	2.799	2.711	3.253	3.570	5.078	5.191	5.064
	(to 2020)	(to 2030)																				
Average Working Capital to Revenues Ratio	15.7%	32.7%																				
(3) Balance Sheet																						
Liabilities	0.000	0.000	0.080	2.026	4.561	6.677	7.623	7.261	6.932	7.631	8.533	9.271	8.353	8.310	8.435	7.766	6.918	6.358	5.942	6.721	7.350	7.840
Capital	0.000	0.000	0.030	0.773	1.607	2.073	2.130	2.456	2.904	3.797	4.836	5.985	7.258	9.051	10.953	12.530	14.178	16.067	18.122	20.442	23.008	25.564
Liabilities and Capital	0.000	0.000	0.110	2.799	6.168	8.750	9.753	9.717	9.836	11.428	13.369	15.256	15.611	17.361	19.388	20.296	21.096	22.425	24.064	27.163	30.358	33.404
Current Assets	0.000	0.000	-0.004	-0.092	-0.307	-0.572	-0.675	-1.494	-2.192	-2.831	-3.402	-3.776	-3.096	-2.260	-1.365	-0.376	0.780	2.066	3.465	4.664	6.190	7.788
Fixed Assets	0.000	0.000	0.114	2.891	6.475	9.322	10.428	11.211	12.028	14.259	16.771	19.032	18.707	19.621	20.753	20.672	20.316	20.359	20.599	22.499	24.168	25.616
Assets	0.000	0.000	0.110	2.799	6.168	8.750	9.753	9.717	9.836	11.428	13.369	15.256	15.611	17.361	19.388	20.296	21.096	22.425	24.064	27.163	30.358	33.404
	(to 2020)	(to 2030)																				
Average Profit Before Tax to Liabilities and Capital Ratio	4.7%	5.8%																				

9.5 Projects in the Master Plan and Implementation Schedule

9.5.1. Projects in the Master Plan

Table 9.5.1-1 shows the whole water resources management projects that constitute the Water Resources Management Master Plan (Master Plan). Table 9.5.1-2 shows the water resources development projects of the Master Plan. The locations of the water resources management projects are also shown in Fig. 9.5.1-1 and the locations of the water resources development projects are shown in Fig. 9.5.1-2.

Table 9.5.1-1 Outline of the Main Projects Constituting the Master Plan

Projects				Outline of the Projects	Main Projects	Anticipated Effects
Quantitative Management	Quantitative Management of Water Resources	Improvement of Efficiency of Water Supply and Transfer Projects	Rehabilitation of Existing Supply System (Reduc. UFW)	Replacement of existing old pipeline system	Rehabilitation Projects at main cities such as Amman, Zarqa and Karak, Reduction of 65MCM/a physical loss	Rate of physical loss will be reduced from 25% to 15% by 2010
			Water Supply Control System (Reduc. UFW)	Establishment of Water Supply Control System	Project recommended by the JICA Study	Quantitative detection of UFW will be made possible
			Improvement of Institutional System	Improvement of efficiency through private sector participation and public awareness	Improvement plan of institutional System such as GS, PMU, Concession of Operation & Maintenance, Public Awareness through Mass Media	Improvement of the financial condition, Reduction of UFW, Improvement of Service Level
		Reduction of the Renewable Groundwater Abstraction (Reduction from 420MCM/a to 275MCM/a by 2020)		Reduction of abstraction within safe yield	[a]Improvement of Irrigation Efficiency (Farmer Education), Well buy-out, Reuse of Treated Wastewater	Saving Renewable Groundwater from Exhaustion,
	Water Resources Development	Conventional Water Resources Development		Surface Water, Peace Water, Fresh Groundwater Development	Wehda Dam, Mujib Dam and other dams, Development of Fossil Fresh Groundwater in Disi-Mudawara Area	1998：826MCM/a 2005：917MCM/a 2010：950MCM/a 2020：941MCM/a
		Non-Conventional Water Resources Development		Construction of TP, Reuse of TWW, Brackish & Sea Water Desalination	Sea water Desalination at Aqaba, Expansion of As Samra TP., Reuse of Treated Wastewater at existing Plants	1998：64MCM/a 2005：137MCM/a 2010：235MCM/a 2020：348MCM/a
Quantitative Management	Surface Water Quality Conservation			Strengthening of the Monitoring System	Formulation of the Comprehensive Monitoring System Proposed by WQICP	Prior detection of the deterioration and Quick Response to it
	Groundwater Quality Conservation			Strengthening of the Monitoring System	Formulation of the Comprehensive Monitoring System Proposed by WQICP	Prior detection of the deterioration and Quick Response to it
				Reduction of Groundwater Abstraction	Same projects mentioned in a above	Water Quality Conservation can be done by 30% reduction
Water Allocation Management	Allocation among the Sectors			Coordination among the Sectors	Securing MIT Water, Changing Water Source for Irrigation	Appropriate Allocation to the Sectors
	Allocation among the Governorates			Construction of Water Transfer lines	Disi-Amman, Wehda-Irbid water Transfer line	Balancing the Demand & Supply in whole Jordan
Risk Management	Measures for Extraordinary Drought Years (20 years return period)			Formulation of Special Water Allocation Plan, Development of Urgent Water Resources	Development of Lajoun Well Field, Suspension of Reduction Program of Groundwater Abstraction, Reduction of Water Supply	Preparation for such emergency cases can be made.

Table 9.5.1-2 Future Water Development Projects and Development Amount

(MCM/a)

Resource Type		Main Project Name	[1]Existing Develop. Amount	Short Term 2001 ～ 2005	Mid Term 2006 ～ 2010	Long Term 2011 ～ 2020	[2]Incremental Develop. Amount during 1998 ～2020	Total Develop. Amount by 2020 (1+2)
Conventional Water resources	Surface Water	Existing Development Amount	303	-	-	-	-	303
		Wehda Dam	-	93	-	-	93	93
		Mujib Dam (including base flow develop.)	-	12	-	-	12	12
		Tanur Dam	-	8	-	-	8	8
		Wala Dam	-	5	-	-	5	5
		Small Dams (Ibn Hamad, Karak, Meddien)	-	-	7	-	7	7
		Feedan Dam	-	3	-	-	3	3
		Water Harvesting	-		-	15	15	15
		Total	303	121	7	15	143	446
	Peace Water	Desalination Conveyor to Urban Jordan	33	27	-	-	27	60
		Storage on Jordan River and Side Wadis	-	-	30	-	30	30
		Total	33	27	30	-	57	90
	Renewable GW	Reduction of the Abstraction	420	-52	-31	-62	-145	275
	Fossil Fresh Groundwater	Disi	70	-5[a]	27	38	60	130
		Lajoun Wells	-	(11)*	-	-	(11)*	(11)*
		Total	70	-5	27	38	60	130
Non-Conventional Water Resource	Brackish Groundwater Desalination (including brackish spring)	W. Zarqa Ma'in/Zara Spring Project	-	20**	20**	-	40**	40**
		El-Lajoun Desalination Project	-	-	13	23	36	36
		Hisban/Kafrein Desalination Plant	-		-	9	9	9
		Total	-	20	33	32	85	85
	Sea Water Desalination	Aqaba Sea Water Desalination	-	5	-	12	17	17
	Reuse of Treated Wastewater	As-Samra TP	46	21	-6[b]	22	37	83
		Wadi Zarqa TP	-	-	40	14	54	54
		Existing 5 TPs	2	2	2	2	6	8
		Other TPs	16	25	29	31	85	101
		Total	64	48	65	69	182	246
Ground Total			**890**	**164**	**131**	**104**	**399**	**1,289**
Total Amount by Target Year			**890**	**1,054**	**1,185**	**1,289**	-	**1,289**

Source : Investment Program 2000 to 2010 and JICA Master Plan

a: The water abstraction of the Fossil Fresh Groundwater will be temporarily reduced because the irrigation use of Disi water for irrigation will be restricted.

b. The treated waste effluent will be temporarily reduced from the As- Samra TP because of the completion of the Wadi Zarqa TP

*: It is not included in the Master Plan because it will be used for urgent purposes such as drought.

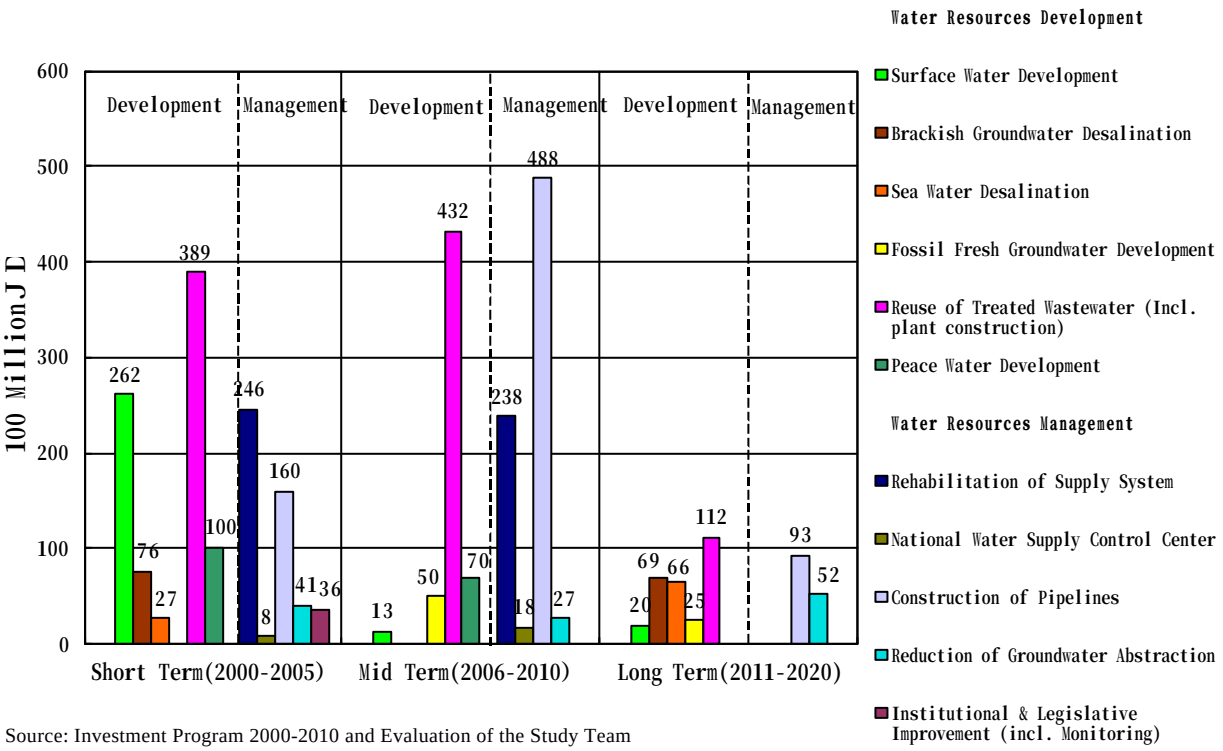
**: It includes desalinated surface water from Wadi Mujib, its amount will be 30MCM/a.

9.5.2. Implementation Schedule of the Water Resources Management Master Plan and Cost Estimation

Fig. 9.5.2-2 shows main projects of water resources management and Fig. 9.5.2-3 shows the main projects of water resources development. Table 9.5.2-1 and Table 9.5.2-2 also show implementation schedule of the Water Resources Management Master Plan.

As shown in the tables and figures, main new water resources development projects are scheduled to be mostly completed in the short-term target years (2001-2005). In the mid-term target years (2006-2010), monitoring systems of water supply/transfer systems, rehabilitation of existing water supply systems and main transfer lines are scheduled to be mostly completed, and rehabilitation and construction of wastewater treatment plants, reuse of the treated wastewater and measures to reduce the abstraction of the renewable groundwater are expected to be mostly completed in the long-term target years (2011-2020.)

Fig. 9.5.2-1 shows projected costs for the development and management in short-, mid- and long-term plans. The projection is based on the Investment Program 2,000-2,010, and most of the costs is not actually secured. The short-term projects are roughly estimated to cost 1,350 million JD and mid-term projects are projected to require 1,340 million JD. Please refer to the attachments of the "List of Water-Related Projects" and "Location of Water-Related Projects" in Supporting Report Vol. VII to find out the details of each project.



Source: Investment Program 2000-2010 and Evaluation of the Study Team

Fig. 9.5.2-1 Estimated Cost for Implementation of the Master Plan

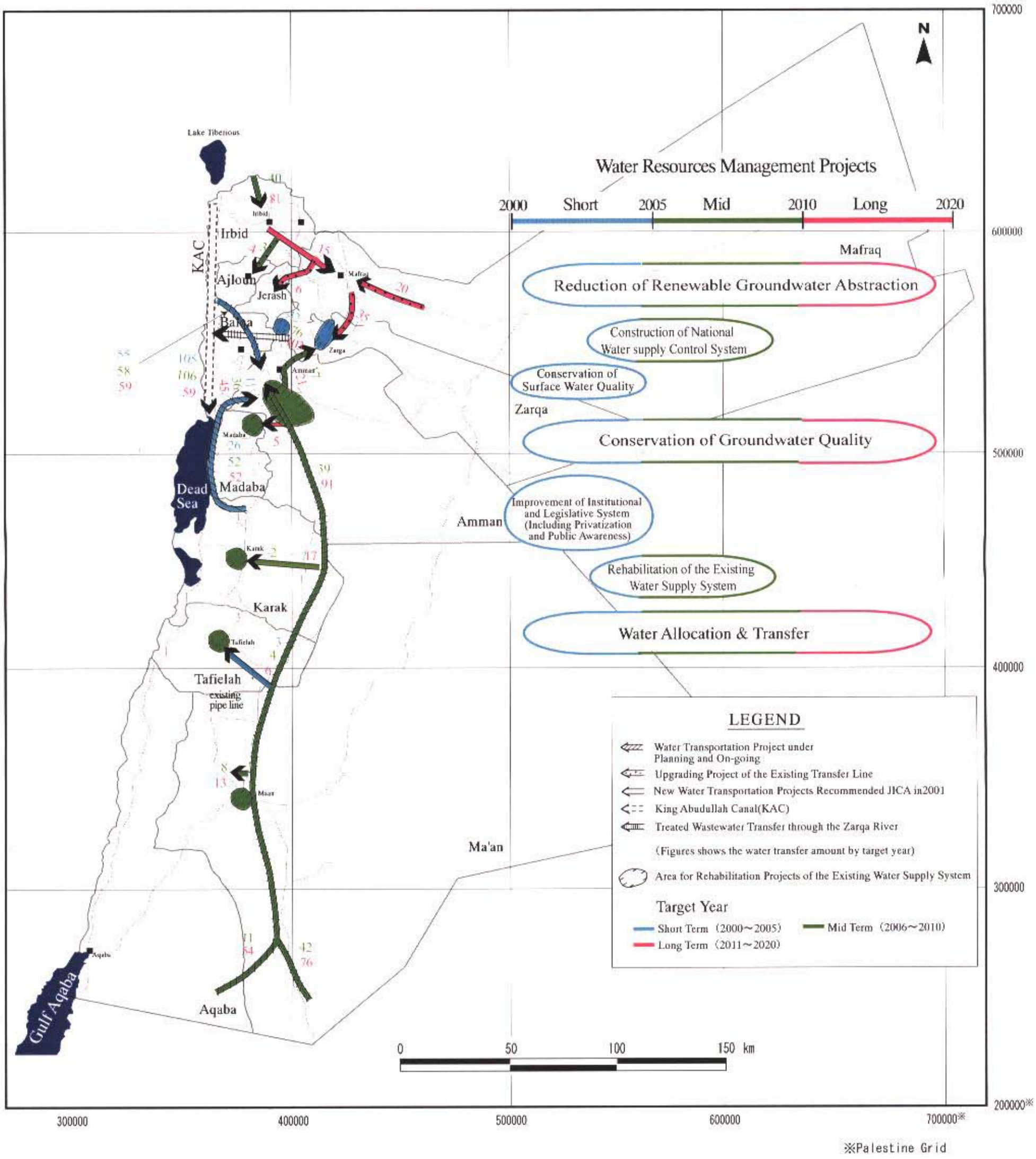


Fig. 9.5.2-2 Location of Main Water Resources Management Projects

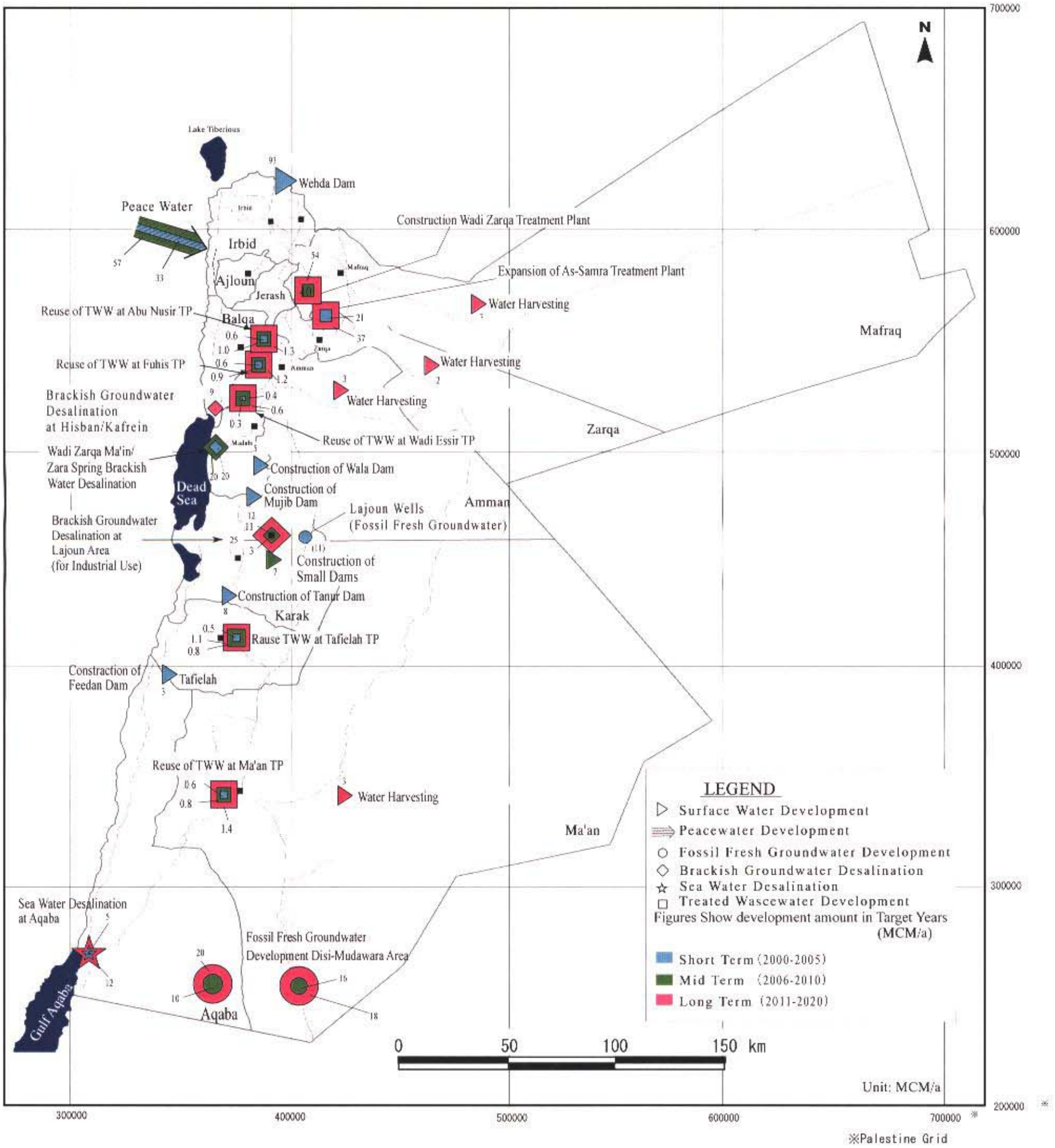


Fig. 9.5.2-3 Location of Main Water Resources Development Projects

Table 9.5.2-1 Implementation Schedule of the Water Resources Management Master Plan

Management Item	Exist. Develop (MCM/a)	Incremental Yield (MCM/a) Short 2000-2005	Mid 2006-2010	Long 2011-2020	Total	Project No.	Project Cost (Mill.JD/ Mill US$)	Finance	Implementation Schedule Short 2000 — 2005	Mid 2006 — 2010	Long 2011 — 2020
Qualitative Management											
①Rehabilitation of Existing Supply System	-	-	-	-	-	8	484/691	WB,,USAID,EIB, Kfw, HKJ、not secured			
②Construction of Main Transfer Line	-	-	-	-	-	2	26/37	not confirmed			
③Improvement of Institutional System (including education and Public Awareness)	-	-	-	-	-	3	36/51	USAID,EU,GTZ, Kfw			
④Reduction of Groundwater Abstraction	420	-52	-31	-62	275	4	120/171	not secured			
⑤Water Resources Development											
Conventional Surface Water	303	121	7	15	446	7	295/421	Arab F. HKJ			
Peace Water	33	27	30	0	90	2	170/243	not secured			
Fossil Fresh Groundwater	70	-5	27	38	130	2	75/107	HKJ、not secured			
Non-Conventional Desal. of Brackish Water	0	20	33	32	85	3	145/207	USAID, HKJ、 Private、not secured			
Desal. of Sea Water	0	5	0	12	17	1	93/133	not confirmed			
Reuse of Treated astewater (incl. construction of TP)	64	48	65	69	246	62	933/1,334	Kfw,USAID,France, Italy,CIDA,Korea, EU,HKJ,Private,not secured			
Total Water Resources Amount at Target Year	890	1,054	1,185	1,289	1,289						
Quantitative Management											
①Surface Water Quality Conservation (Strengthening of Monitoring System)	-	-	-	-	-	1	-	not secured			
②Groundwater Quality Conservation (Monitoring System, Reduction of the GW. Abstraction)	-	-	-	-	-	5	-	not secured			
Allocation Management											
①Allocation and Transfer (incl. water supply)	-	-	-	-	-	10	741/1,058	JICA,GKW,Arab F., HKJ、Private、not secured			
Risk management											
①Measures for Extraordinary Drought Years	-	-	-	-	-	-	-	not secured			
Total	-	-	-	-	-	110	3,118/4,452	-	-	-	-

Source: Investment Program 2000—2010 and other information from MWI、Projects under the conceptual stage are excluded.

Table 9.5-2(1) Implementation Plan of Water Projects

Proj. No.	Project	Project Description	Finance	SHORT TERM								MID TERM					LONG TERM									
				1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
	Groundwater & Desali. Projects																									
21	Wadi Mousa Water Supply	Groundwater dev., surface water dev. and water conveyonce from Jintheh well field to Wadi Mousa for the tourism at Petra	KFW, France, USAid, HKJ, Tendering																							
24	Lajoun Wells	Supplying of fresh fossil Ram GW from Al-Lajoun to Amman via Karak. Drilling 5 deep wells of 1000m, Transmission pipe line of 43Km	HKJ, Tender Doc. under preparation																							
67	Corridor Water Supply Project	Groundwater Dev. of Basalt Aq. from 15 Corridor wells drilled in Zarqa Gov. in order to mitigate severe water shortage in Greater Amman.	HKJ. F/S done																							
22	Community Infrastructure Project	to supply domestic water to 28 urban settlements (Amman 18, Zarqa 4, Ruseifa 5, Aqaba 1) and 13 peri-urban settlements using groundwater	HKJ, WB, tendering																							
25	Wadi Zarqa Ma'in, Zara spring Project	to utilize the water of springs and side wadis in Zara/Ma'in area for irrigation and tourism in JV. and Conveyonce to Greater Ammen area	USAID, HKJ																							
16	Hisban and Kafrein Desalination Plant	Brackish groundwater desalination project for domestic purpose in G. Amman and tourism in Dead Sea, planned as BOT project	not secured (BOT planned)																							
28	Desalination at Aqaba	Sea water desalination for domestic, industrial and touristis porpose in Aqaba	not secured, F/s on-going																							
G1	Groundwater Development for El Lajjun Oil Shale Project	Renewable groundwater development from A7/B2 aquifer for El Lajjun Oilshale Project for 30 years	Private Sector																							
G2	Groundwater Development for Electric Power Stations in Zarqa Gov.	Renewable groundwater development from A7/B2 aquifer for electric power stations	Private Sector																							
G3	Groundwater Development for Industrial & Info-Technical Park near Ramtha	Renewable groundwater development for industries	Private Sector																							
7	Groundwater Reduction Program	Reduction of renewable groundwater abstraction in the Upland. The potential projects cover various components related to regulation, of irrigation efficiency, education of farmers, reuse of TSE and so on	not secured																							
6	Disi Amman Water Conveyer and Yield Increase in Future	Supplying an average of 100MCM/a of fresh fossil GW from Disi to Amman, a distance of more than 300Km, BOT doc. Prepared	BOT or Libya and Iran, D/D done																							
17	Deep Groundwater Investigation	Development of nonrenewable Ram aquifer system in the Northern area of Jordan	not secured																							
Proj. No.	Surface water Projects	Project Description	Finance																							
14	Wala Dam	Construction of dam of 45m in height at Mujib Basin for recharge of A7/B2 aquifer by impounding the floodwater	Arab F., HKJ, D/D done																							
13	Mujib Dam	Construction of dam of 62m in height at Mujib Basin for supplies for future industrial and agricultural needs in the S. Ghors	Arab F., HKJ																							
15	Tannur Dam	Construction of dam of 60m in height at Wadi Hasa for supplies for agricultural needs in the S. Ghors by impounding the floodwater	Arab F., HKJ, D/D done																							
20	Wadi Araba Development Project	Exploitation of surface water and shallow groundwater, Rehabilitation of 18Km extension project and Wadi Araba pumping station for develop. of 6000 dunums irrigated area	HKJ. TOR done																							
26	Feedan Dam	to store floodwater, additional studies required	not secured																							
62	Wehda Dam	to construt the rock fill dam of 100m inheight at the Yarmouk River, Power generation is 8 Mega Watts	Arab F., HKJ, D/D done																							
18	Small Dams (Ibn Hamad, Karak, Meddien)	to maximize the use of the floodwater in the catchments through the constraction of storage /recharge small dam in the Eastern Highlands	not secured, F/S not yet																							
63	Desalination Conveyor to Urban Jordan (50 + 10 MCM/a), Peace Project	to build the needed conveyance system to transfer desalinated 60MCM/a water from Israel to the urban areas	not secured, Israeli side on-going																							
65	Storage on Jordan river and Side Wadis	Construction of storage system on the Jordan River, side wadis, conveyor system, increasing the effiency of KAC, to be done during 2011 to 2020	not secured, under study																							
19	Water Harvesting, Badia Region	to identify practical techniques for Artificial Recharge impounding the floodwater at by dykes in Badia region	USAID, F/S done, partly D/D done																							

Table 9.5-2(2) Implementation Plan of Water Projects

Proj. No.	Rehabilitation & Conveyance Projects	Project Description	Finance	SHORT TERM								MID TERM					LONG TERM									
				1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
5	On-going Rehabilitation - Zarqa Governorate	Rehabilitation and expansion of water supply system in Mun. of Zarqa, Russeifa, Hashemiya, Sukhna, and Shnellar Refugee Camp	not secured (Japan)																							
71	Tabaqat Fahil - Irbid	Water conveyance	HKJ																							
32	Dier Alla - Zai Amman II (Conveying of Peace Water)	to increase the scheme supply capacity from 45MCM/a to 90MCM/a, Water source is from Peace Water	JICA, GKW, D/D done																							
70	KAC Siphon Upgrading	Upgrading of siphon system of the King Abdulla Canal																								
35	Rehabilitation of Southern Ghors Irrigation Stage I	Rehabilitation of Water supply system for Irrigation of 46800 dunumus	not secured, F/S done																							
36	Rehabilitation of Hisban-Kafrein Irrigation Project	Rehabilitation of existing pipe network and study on surfave water development from W. Hisban building storage facility	WO, HKJ																							
68	Dead Sea Water Treatment Plant	Construction of water treatment plant of 15MCM/a for touristic purpose in the East Coast of Dead Sea, raw water will be supplied from Mujib and Wala Reservoirs	Private Sector, M/P done																							
10	Amman Municipal Water Network Restructuring Phase 1	Overall rehabilitation of water supply system in Amman for water loss reduction	WB, USAID, EIB, KFW and HKJ, D/D done																							
11	Mujib Weir Conveyor and Southern Ghors Infrastructure	Utilization of base and flood flow of Wadi Mujib Wadi Wala & Hasa for the purpose of touristic industrial and agricultural	Arab F., ISSD & other Arab C. Tender Doc.																							
34	Jordan Rift Valley Improvement Project	to specify means and actions for maximization of returns from sustainable development of JRV	not secured, F/S not yet																							
12	Wadi Al Arab - Irbid Municipal Water Supply	Reallocation of water of 20MCM/a from Mukheiba Well Field to Irbid	not secured																							
69	Al Wahda Dam Water Supply Project/Irbid	Conveyance of water from Wahda Dam to Irbid with 3000m3/h treatment plant, transmission pumps of 580m in head and 2850m3/h capacity, 27Km transmission line, reservoirs of 110,000m3	not secured																							
30	Miscellaneus Small Projects, Network Expansion	Construction of new water networks throughout of jordan in order to meet the increasing water demand	not secured, to be HKJ and others																							
C1	Disi Amman Water Conveyer Branch to Ma'an and Madaba	Construction of transmission main, pump station and reservoir	not secured																							
C2	Upgrading of Inter-Governorates Transfer Line Phase 1	Construction of transmission main, pump station and reservoir	not secured																							
C3	Upgrading of Inter-Governorates Transfer Line Phase 2	same as above	not secured																							
Proj. No.	Technical & Private Sector Management Projects	Project Description	Finance	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
3	The Governorate Support Section (GS)	Improvement of drinking water Supply through transfering experience gained in Amman Water and Wastewater Management Contract and OMS Project to other Governorates	GTZ, KFW																							
4	Planning and Management Unit (PMU)	Establishing of qualified Planning & Management Unit for appropriate utilization of funds necessary coordination with donars and implementation of rehabilitation program	EU																							
9	Amman Water and Wastewater Management Contract	A performance-based management contract with private sector for the provision of water and wastewater services in Amman	USAID																							
1	Water Feasibility, Design and Assessment Studies	Hydraulic analysis, Consulting services and so on	HKJ, Others																							
Proj. No.	Monitoring Project	Project Description	Finance	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
M1	National Control System Integrating Surface and Groundwater Phase 1	Construction of nation wide monitoring and control system of the Water Trunk Line	not secured, not studied																							

Table 9.5-2(3) Implementation Plan of Water Projects

Proj. No.	Wastewater Projects	Project Description	Finance	SHORT TERM								MID TERM					LONG TERM									
				1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
44	Irbid Stage I, Phase 1 (Wadi Arab TP and Wadi Hassan TP)	Construction of TP at Wadi Araba, Wadi Hassan	KFW, HKJ	T.P.																						
				Reuse																						
37	On-going Rehabilitation Various Cities (Wastewater Treatment Project)	Rehabilitation and construction of sewer infrastructure network of various cities, Amman, Zarqa, Mafraq, Irbid, Ajloun, Jerash, Balqa, Karak	EIB, HKJ, D/D done	T.P.																						
				Reuse																						
50	Wadi Mousa Wastewater Project	Approx. 88Km of wastewater collection networks, approx. 22.5Km conveyance system, TP of 3400m3/day, for 4 towns and small comunities in Petra	USAID, D/D done	T.P.																						
				Reuse																						
39	Ain Gazel Pre-Traetment Plant and Conveyer	Wastewater conveyor of 32.5Km, Tunnel of 4.75Km, Upgrading of pre-treatment works	KFW, HKJ, D/D done	T.P.																						
				Reuse																						
59	Madaba TP Upgrade and Expansion	Construction of TP of 7800m3/day	Korea, D/D done	T.P.																						
				Reuse																						
57	Upgrading Mafraq TP	Construction of TP, re-use program	USAID, HKJ, F/S done	T.P.																						
				Reuse																						
60	Ramtha TP Upgrade & Expansion	Construction of collection networks	France, HKJ, D/D done	T.P.																						
				Reuse																						
51	Na'ur and Adjacent Areas Wastewater Project	Wastewater collection network of 65Km, TP of 3200m3/day	Italia, D/D done	T.P.																						
				Reuse																						
40	South Amman Wastewater Project Phase I : Jiza - Talbiya (Al Jeza)	Construction of collection networks and TP, Re-use program	Italia, HKJ, Low Income Areasa Programs	T.P.																						
				Reuse																						
55	Dead Sea Wastewater Infrastructure (Dead Sea Eest Coast)	Construction of TP of 4360m3/day, re-use network for landscape irrigation (gardening)	USAID, D/D done	T.P.																						
				Reuse																						
54	Aqaba Wastewater Project (Central)	Expansion of TP, main trunk lines and collection network, Re-use program	USAID, D/D done	T.P.																						
				Reuse																						
53	Community Infrastructure Wastewater Project	Construction of networks and TP for the refugee camps in Jordan including public education at Talbieh, Marka, Gaza, Azmi Al-Mufti and El-Soukhneh.	WO, D/D done	T.P.																						
				Reuse																						
52	Jordan Valley Community Waste Management Project	Construction of small-scaled community TP, Re-use program, involvement of private sector	CIDA, HKJ, D/D done	T.P.																						
				Reuse																						
64	Upgrading Kufranja and Ajlun TP	Construction of new collection networks, TP, installation of TSE disposal and/or re-use system, The Project Area covers all areas within catchments of the Yarmouk R. and the Jordan R.	not secured, under study	T.P.																						
				Reuse																						
38	Upgrading and Expansion of As-Samra TP	to provide more adequate treatment facilities for Amman - Zarqa area up to year 2020. As-Samra TP to be operated by BOT system. 5MCM/a will be reused in the vicinity of TP	Private Sector, USAID, D/D done	T.P.																						
				Reuse																						
58	Upgrading Ma'an TP	Construction of TP, collection system, pumping station. Reuse program is not included.	not secured	T.P.																						
				Reuse																						
58	Upgrading Tafila TP	Construction of TP, collection system, pumping station. Reuse program is not included.	not secured	T.P.																						
				Reuse																						
49	Sakeb Wastewater System (Jerash West)	Construction of wastewater collection system, conveyance, TP, listed in the Invest. Prg. In 1997	almost secured (Italy), D/D done	T.P.																						
				Reuse																						
W1	Dair Alla TP	Construction of new collection networks, TP, re-use system for irrigation, implemented in 2 phases, the cost written in left column shows phase 1 work	not secured, F/S done	T.P.																						
				Reuse																						
W2	Aqaba South Coast TP	Construction of TP, force main and PS, the figures show phase 1	USAID	T.P.																						
				Reuse																						
45	Irbid Stage II (Wadi Shallala TP)	Building the interceptors and networks for 3 villages. Construction of Wadi Shallala TP. Treated sewage will be reused in JV.	KFW, HKJ, F/S done	T.P.																						
				Reuse																						
56	Upgrading and expansion of Karak WWTP	Construction of TP, collection system, pumping station and re-use program	KFW, HKJ, F/S & D/D will start soon	T.P.																						
				Reuse																						
41	South Amman Wastewater Project Phase I : Stage 2 (North Queen Alia Airport Treatment Plant)	to construct sewerage system, wastewater network of 500Km and TP including re-use system for irrigation	not secured, D/D done	T.P.																						
				Reuse																						

Table 9.5-2(4) Implementation Plan of Water Projects

Proj. No.	Wastewater Projects	Project Description	Finance		1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
					SHORT TERM								MID TERM					LONG TERM									
46	Mazar, Mu'ta and Aldaniya Wastewater Projects (Al Mazar Al Shamali)	Construction of wastewater collecn networks, conveyance and TP	not secured. F/S will be done soon	T.P.																							
				Reuse																							
43	Jordan Valley Sanitation - South Shunah and Ghor Nimerine (Shuna South)	Construction of sewers, TP at South Shunah, Ghor Nimerine and re-use system	not secured. D/D done	T.P.																							
				Reuse																							
61	Abu-Nusier WWTP Upgrade & Expansion	Upgrading and expansion of TP. Re-Use program is not included	not secured. D/D done	T.P.																							
				Reuse																							
42	Jordan Valley Sanitation - North Shunah (North Jordan Valley)	Construction of sewers of 300Km, TP at North Shunah and re-use system	not secured. D/D done	T.P.																							
				Reuse																							
48	Miscellaneus Small Projects (WW Project)	Construction of new wastewater networks, conveyor lines, house connections within the whole Jordan	not secured. D/D done	T.P.																							
				Reuse																							
W8	Extension of Baqa TP	Construction of TP, Networks, Pipeline, Dam/Storage	not secured	T.P.																							
				Reuse																							
W9	Extension of Fuhis TP	Construction of TP, Networks	not secured	T.P.																							
				Reuse																							
W7	Reuse Scheme of Treated Wastewater from Wadi Essir Treatment Plant	Reuse for irrigation in the vicinity of the treatment plant	not secured	T.P.																							
				Reuse																							
W10	Extension of Jerash (East) TP	Construction of TP and Networks, to be reused in JV	not secured	T.P.																							
				Reuse																							
W11	Extension of Salt TP	Construction of TP, Networks	not secured	T.P.																							
				Reuse																							
W12	Construction of Kofur Asad TP	Construction of new collection networks, TP, re-use system for irrigation, to be continued untill 2020	not secured. F/S done	T.P.																							
				Reuse																							
W13	Constrcction of Wadi Zarqa Treatment Plant	Construction of new TP, conveyance system, Discharging TSE to KTR and re-use in JV. 5MCM/a will be reused in the vicinity of TP. Implemented in two phases, Phase 2 will be implemented after 2025.	not secured. Pre-F/S done	T.P.																							
				Reuse																							
W14	Construction of Mazar, Multa, Adaniya TP	Construction of new TP, collection System	not secured	T.P.																							
				Reuse																							
W15	Construction of Dair Abi Said TP	Expansion of existing TP meeting the sewage amount up to year 2020	not secured	T.P.																							
				Reuse																							
W16	Construction of Torra TP	Construction of TP, collection networks, Dam/storage and re-use program	not secured	T.P.																							
				Reuse																							

9.6 Evaluation of Water Resources Management Master Plan

9.6.1 Plan Evaluation

In the Water Resources Management Plan in this Study, the basic policies for demand control and water resources development were set up from the viewpoints of "water environment conservation" and "water recycle" and the demand balance among 12 Governorates was planned with the individual measures as described below. Therefore, the integrity of the entire project was realized.

9.6.1.1 Demand Control

(1) MIT water

The supply quantities of municipal water were planned as shown in Table 9.6.1-1 to ensure securing the required quantities which controlling the demands in the Governorates to the minimum levels.

Table 9.6.1-1 Projected MIT Water Supply per Governorate

(unit: MCM/a)

Govrenorate	2005			2010			2015			2020		
	Municipal	Industrial	Touristic	Municipal	Industrial	Touristic	Municipal	Industrial	Touristic	Municipal	Industrial	Touristic
Amman	99.94	1.14	1.02	136.69	1.33	1.23	167.98	1.48	1.39	191.80	1.56	1.57
Zarqa	38.50	22.42	0.01	53.19	23.64	0.02	65.95	24.59	0.02	76.02	25.13	0.02
Mafraq	18.74	0.30	0.00	21.88	0.35	0.00	22.49	0.38	0.00	20.77	0.40	0.00
Irbid	39.52	8.89	0.02	57.63	9.12	0.03	75.01	9.29	0.03	90.37	9.39	0.04
Ajloun	5.22	0.00	0.00	7.71	0.00	0.00	10.15	0.00	0.00	12.35	0.00	0.00
Jerash	6.14	0.00	0.00	9.16	0.00	0.00	12.17	0.00	0.00	14.90	0.00	0.00
Balqa	20.75	0.59	2.67	26.84	0.69	4.70	31.14	0.77	6.94	33.52	0.81	6.94
Madaba	11.29	0.23	2.35	13.11	0.26	4.41	13.34	0.29	6.55	12.16	0.31	6.56
Karak	10.87	18.39	0.01	14.77	30.64	0.01	18.02	45.57	0.02	20.45	59.67	0.02
Ma'an	7.08	9.32	0.13	8.76	10.86	0.16	9.65	12.05	0.18	9.82	12.72	0.20
Tafielah	3.24	6.75	0.00	4.89	7.86	0.00	6.55	8.73	0.00	8.08	9.22	0.00
Aqaba	11.37	8.05	0.69	12.90	9.38	0.83	12.67	10.41	0.94	11.01	10.99	1.06
Total	272.67	76.08	6.92	367.51	94.13	11.40	445.12	113.55	16.08	501.26	130.21	16.42
		MIT Tota	355.67		MIT Tota	473.04		MIT Tota	574.75		MIT Tota	647.89

(2) Irrigation water

For irrigation water, it was planned to positively reuse treated wastewater for achieving the environmental requirements for reduction of groundwater abstraction. It is, therefore, possible to keep to the policy of maintaining the present gross quantity of irrigation water through the target years. The irrigation plan (in terms of farm products and cultivated area) based on the water allocation was formulated under implementation in 12 Governorates under this Water Resources Management Plan, and the irrigation area and net irrigation requirement by Governorate was also planned as shown in Table 9.6.1-2.

Table 9.6.1-2 Agricultural Water Demand in the 12 Governorates

Governorate	2005		2010		2015		2020	
	Irrigation area	NIR	Irrigation area	NIR	Irrigation area	NIR	Irrigation area	NIR
	Ha	MCM/a	Ha	MCM/a	Ha	MCM/a	Ha	MCM/a
Amman	3.16	32.7	2.80	28.9	2.17	22.3	1.91	19.4
Zarqa	4.80	55.9	4.41	50.6	3.68	41.3	3.28	36.1
Mafraq	5.27	47.3	4.83	43.0	3.76	33.3	3.10	27.4
Irbid	16.37	155.7	27.22	234.5	25.19	212.2	20.79	168.8
Ajloun	0.67	6.7	0.61	5.7	0.78	6.5	0.83	6.5
Jerash	1.01	10.3	1.11	11.0	1.10	10.6	1.11	10.4
Balqa	11.46	124.1	15.05	159.6	16.54	173.8	17.32	180.6
Madaba	0.99	6.7	0.93	6.1	0.88	5.7	0.84	5.1
Karak	14.29	92.8	11.16	67.6	7.93	49.9	7.80	42.3
Ma'an	5.02	36.3	2.58	20.4	1.93	16.0	0.57	6.7
Tafielah	0.89	10.3	0.90	10.3	0.83	8.3	0.80	7.8
Aqaba	1.27	13.2	0.99	10.3	0.37	4.2	0.56	5.6
Total	65.20	592.0	72.60	648.1	65.16	584.1	58.91	516.6

Notes: "Digital National Master Plan": Summing up of the irrigation water distribution plan for the 12 Governorates by the Ministry of Water and Irrigation using the irrigation water module.

9.6.1.2 Water Resources Development

On the water resources development side, each project is reevaluated to finalize the available water resources from both the conventional types, such as surface water, peace water, renewable groundwater, fossil fresh groundwater and from the non-conventional types such as desalinated brackish groundwater, reuse of treated wastewater and use of desalinated seawater as shown in Table 9.6.1-3. In particular, the existing treatment facilities development plan for treated wastewater was compiled on the national level to be worked out as the treated wastewater reuse plan. For irrigation, excessively exploited groundwater is used at present, and that is the reason why the reduction plan of groundwater abstraction to recover the renewable water quantity was drawn up. This plan is expected to ensure the sustainable development of groundwater.

In the UFW reduction measures, the physical loss rate due to water leakages was set to 15% in each target year in order to reduce the loss to approximately 10% below the present level. By this measure, water resources of about 60 MCM (included in the demand statistics) will be created in 2020.

Table 9.6.1-3 Water Resources by Sustainable Development (MCM/a)

Water resource	2005	2010	2015	2020
Surface water	424	431	446	446
Peace Water	60	90	90	90
Renewable Groundwater	368	337	307	275
Fossil Fresh Groundwater*	65	92	104	130
Desalinated Brackish Groundwater	20	53	72	85
Desalinated Seawater	5	5	17	17
Treated wastewater	112	177	220	246
Total	1,054	1,185	1,256	1,289

*: Development will be done for 50 years

9.6.2 Environmental Evaluation

In the formulated Water Resources Management Master Plan, some improvement to the natural environment on the one hand, and on the other hand some negative impacts on the agro-social environment are foreseen.

9.6.2.1 Natural Environment

One of the most important issues in the implementation of water resources management is the effect it will generate on the water resources environment. This environmental effect may be categorized as follows:

- Exhaustion of groundwater sources and water quality deterioration
- Surface water quality deterioration

(1) Groundwater

a. Water source exhaustion

In Jordan, excessive groundwater abstraction of renewable groundwater has continued to be practiced in recent years (National total in 1998: 420 MCM/year), resulting in substantial fall in water level. If the abstraction in the current level is continued, some wells dry up sooner rather than later. Thus, the reduction plan of groundwater abstraction is an indispensable project. In this Study, the water resource quantity under sustainable development (national total: 275.0 MCM/year) from the renewable recharge water was calculated to formulate the reduction plan to reduce the groundwater exploitation to the renewable water level in turn by 2020. Groundwater will be used as both irrigation and municipal water, and the reduction quantity should be shared by both uses. As a result, the available groundwater quantities and the groundwater for irrigation water allocations to 12 Governorates are shown in Table 9.6.2-1.

The reduction of the groundwater abstraction for municipal water to be made by MWI will be implemented under the new water source development plan, but the procedures for reduction of groundwater for irrigation water were formulated as below in reference to the USAID groundwater reduction plan in the Amman-Zarqa basin. These plans will ensure that the reduction is realistically made and may be applicable to other areas in Jordan.

Table 9.6.2-1 Available Groundwater and Allocation to Agriculture

(Unit: MCM/Year)

Governorate	Current	Reduction Plan of Groundwater Abastraction				Allocation to Irrigation			
	1998	2005	2010	2015	2020	2005	2010	2015	2020
Amman	62.5	53.4	47.0	40.5	34.0	30.4	26.5	19.8	16.6
Zarqa	89.1	75.7	66.1	56.6	47.0	40.4	35.2	26.3	22.0
Mafraq	89.9	85.8	82.9	79.9	77.0	47.9	41.8	31.2	26.1
Irbid	45.1	40.0	36.3	32.7	29.0	17.0	17.0	14.0	13.0
Ajloun	0.7	1.1	1.4	1.7	2.0	0.0	0.0	0.0	0.0
Jerash	3.5	4.9	6.0	7.0	8.0	1.8	1.6	1.2	1.0
Balqa	47.4	38.4	31.9	25.5	19.0	33.1	27.1	19.0	14.0
Madaba	12.9	11.7	10.8	9.9	9.0	1.8	1.6	1.2	1.0
Karak	28.3				16.0	3.1	2.7	2.0	1.7
Ma'an	22.6	19.9	17.9	16.0	14.0	7.6	6.7	5.0	4.2
Tafielah	8.0	9.3	10.2	11.1	12.0	0.8	0.7	0.5	0.4
Aqaba	5.7	6.4	7.0	7.5	8.0	5.1	4.5	3.3	2.8
Total	419.8				275.0	189.1	165.4	123.4	102.7

b. Water quality deterioration

This Study made clear that the groundwater quality deterioration was caused by insufficient wastewater treatment facilities in the city areas and accumulated salts due to irrigation agriculture in the uplands. To eliminate the former problem, the rehabilitation plans for existing wastewater treatment facilities were integrated as a project. The simulation of water quality deterioration due to irrigation was carried out in the Amman south area, and it showed that the water quality problem could be solved by implementation of the groundwater abstraction reduction plan as described in the preceding clause a. The nationwide application of this groundwater abstraction reduction plan will give the effect of keeping the same water quality throughout the country because the hydrogeological conditions are almost identical.

The USAID "WQICP" project has proposed a comprehensive water quality monitoring system for groundwater and surface water, so that this system will be able to offer the complete solution to this problem when it is implemented.

(2) Surface water

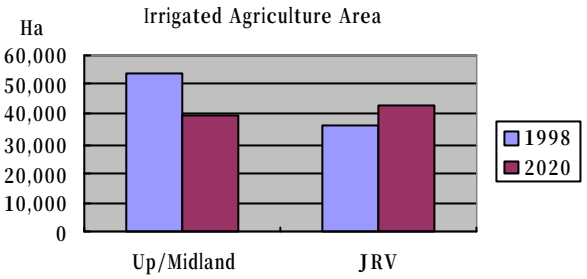
The causes of surface water deterioration can be focused on the insufficient wastewater treatment facilities in the city areas and the algae generated due to eutrophication in water areas. The former problem will be effectively improved because the rehabilitation of treatment plants, especially the projects of As Samra and Wadi Zarqa wastewater facilities have already entered the implementation stage. On the other hand, the eutrophication problem will be solved when the treatment plants are improved and when the nationwide water quality monitoring system as proposed is implemented.

9.6.2.2 Social Environment

The formulated Water Resources Management Plan generates the impacts on the social environment in the following two points regarding irrigation-based agriculture:

(1) Shift from upland agriculture to the Jordan Valley

The water resources in Uplands/Midlands are limited, but the groundwater reduction to the safe yield quantity and the use of fossil groundwater exclusively for municipal water cannot be avoided in the Master Plan. On the other hand, under the policy of maintaining agriculture at the maximum level, the use of wastewater in the Jordan Valley was planned as an alternative plan, in which the farm products adaptable to the available water sources and water quality as well as some agricultural development projects were proposed. In accordance with this alternative, part of the upland agriculture has to be shifted to the Jordan Valley. This plan requires that about 1/3 of irrigation water and area for the upland agriculture be shifted gradually by 2020 as shown in Fig. 9.6.2-1. As described above, it was verified technically that the necessary water sources could be secured and that the agricultural land development plan is feasible, but the detailed agricultural shift plan has not been formulated yet. In particular, the shift will have large impacts on the agricultural society, so that full care should be taken on this point.



Source: Plan of JICA Study

Fig. 9.6.2-1 Changes in the Irrigated Agriculture Areas by Shifting of Agriculture Activities from the Upland to the Jordan Valley

(2) Reuse of treated wastewater

In Jordan, the treated wastewater that flows from the As Samra treatment plant down to the Jordan Valley has been used for irrigation-based agriculture. In this case, no serious problem has been caused because the wastewater flow is diluted with the surface water on its flow downstream and the freshwater from the King Abdullah Canal.

However, the proposal in this Study is to directly use the wastewater from the secondary treatment. The environmental assessment including questionnaire survey was implemented in the Pre-FS wastewater reuse project as described in Part B, verifying that 90% of the farmers in the vicinity of Abu Nusir, Fuhis, Wadi Esir, Tafielah and Ma'an treatment plants had willingness to reuse the treated wastewater according to the questionnaire survey of about 100 families. However, it is necessary to take effective social measures deliberate care for through education of residents and implementation of reuse campaigns.

9.6.3 Economic and Financial Evaluation

Overall financial/economic evaluation for the three groups of proposed projects, namely water development, wastewater treatment and treated wastewater reuse projects was conducted in the Master Plan study.

The water development projects consists of 16 projects (e.g. Wehda Dam Construction Project) whose objectives are to newly develop or convey surface water/groundwater, out of 24 related projects. The balance are those projects which aim for water saving or keeping the current level of water production through rehabilitation or transference.

The wastewater treatment projects are comprised of 25 projects (e.g. As Samra Wastewater Treatment Plant Expansion), and the treated wastewater reuse projects are made up of 29 projects (e.g. Aqaba Wastewater Reuse Project). The total amount of investment for these projects will reach 1,938 MJD (million JD) by the final target year. It corresponds to about 20% of Jordan's GDP. The breakdown of the amount is shown in Table 9,6.3-1. The figures in the table are not the same with those in Chapter 7 "Projects in the Water Resources Management" because the projects are different in the scope and definition.

Table 9.6.3-1 Cumulative Investment Amounts by Sector and Target Year (MJD)

Investment Sector	2005	2010	2015	2020
Water source development and supply	932.1	1,168.3	1,302.2	1,302.2
Wastewater treatment	449.6	600.2	600.2	600.2
Treated wastewater reuse	10.9	21.4	26.2	35.6
Total	1,392.6	1,789.9	1,928.6	1,938.0

It was found that these projects would be financially feasible if the water tariff would be increased in future within the affordable cost of the users according to the financial analysis in case of 6.5% of discount rate.

The water tariff was set aiming the full recovery to the cost based on the concept of Long-Run Marginal Cost (LRMC).

The wastewater project can be divided into wastewater treatment project and treated wastewater reuse project. The former does not have any problems on its financial feasibility. For the latter, the financial feasibility can be obtained if the financial evaluation will be done together with the water resources development project.

(1) Water resources development projects

The overall evaluation of water development projects as a group is that they are in financial terms not feasible with the FIRR of 4%, which is below the assumed discount rate of 6.5% on one hand, and that they are in economical terms highly feasible with the EIRR of 18% (OCC is assumed as 10%) on the other.

Thus, it is necessary to raise the average water prices in future to make this project group financially feasible.

At present the unit prices of municipal, industrial and irrigation water are 341 fils, 1,000 fils and 10 fils per m^3 respectively. According to the analysis, the affordable limits of such prices are 735 fils, 2,740 fils and 283 fils.

Supposing the unit prices of the three types of water are raised by 12%, 12% and 1,680% to 382 fils, 1,120 fils and 178 fils respectively, which are all within their respective upper limits, then, the water development projects will be financially feasible (See Table 9.6.3-2).

Table 9.6.3-2 Unit Prices of Water for Sectors

Item	Unit Water Prices (Fils/m^3)			
	Present	Increase Rate	Future	Upper Limit
Municipal Water	341	12%	382	735
Industrial Water	1,000	12%	1,120	2,740
Irrigation Water	10	1680%	178	283

When the unit price of municipal water is raised to 382 fils, the payment for municipal water as the percentage of household income, which is now 1.86%, will go up to 2.08%, while it is generally recognized that the households can afford to pay for municipal water of up to 4% of their income as shown in Table9.6.3-3.

Table 9.6.3-3 Payment for Municipal Water as Percentage of Household Income

Item	Present	Future	Upper Limit
Payment for municipal water as percentage of household income	1.86%	2.08%	4.00%

In short, the project group has a high economic feasibility, and by raising water prices to proper levels in future, it will also be financially feasible.

(2) Wastewater treatment projects

The overall evaluation of wastewater treatment projects as a group is that they are both in financial and economic terms not feasible with an incalculable FIRR and the EIRR of 4%.

It is necessary to raise the average sewerage charges in future to make these projects financially feasible.

At present the unit price of sewerage services can be said to be still considerably low with 147 fils per m^3. According to the analysis, the affordable limit of such price is 368 fils as shown in Table 9.6.3-4.

Supposing the unit price of sewerage services is raised by 263% to 534 fils, which exceeds its upper limit, then, the wastewater treatment project group will be financially feasible.

Table 9.6.3-4 Tariff for Wastewater (Municipal Water)

Item	Sewage Unit Price (Fils/m^3)			
	Present	Increase Rate	Future	Upper Limit
Wastewater	147	263%	534	368

If the unit price of sewerage services is raised to 534 fils, the payment for sewerage services as the percentage of household income, which is now 0.80%, will go up to 2.91%, while it is generally recognized that the households can afford to pay for sewerage services of up to 2% of their income as shown in Table 9.6.3-5.

Table 9.6.3-5 Payment for Sewage Services as Percentage of Household Income

Item	Present	Future	Upper Limit
Payment for sewage services as percentage of household income	0.80%	2.91%	2.00%

Therefore, it is concluded that these projects will independently be unfeasible in both economic and financial terms.

However, when the financially feasible unit prices of municipal water and sewerage are combined together, they come to 916 fils per m^3, while the combined upper limit is 1,103 fils per m^3. That is to say, the former is less than the latter. It means that the households can afford to pay combined water and sewerage charges in the future.

(3) Treated wastewater reuse projects

The overall evaluation of wastewater reuse projects as a group is that they are in financial terms not feasible under the current treated wastewater unit price on one hand, and that they are in economic terms remarkably feasible with the EIRR of 37%, which is 3.7 times the assumed OCC of 10%.

It is necessary to raise the unit price of treated wastewater in future to make these projects financially feasible.

At present, the unit price of treated wastewater is as low as 10 fils per m^3. According to the analysis, the affordable limit of such price is 142 fils.

Supposing the unit price of the treated wastewater for reuse in irrigation is raised to 38 fils, which is a fraction compared with its upper limit, then, the treated wastewater reuse projects will be financially feasible (See Table 9.6.3-6).

Table 9.6.3-6 Treated Wastewater for Irrigation

Item	Wastewater Unit Price (Fils/m^3)			
	Present	Increase Rate	Future	Upper Limit
Treated Wastewater for Irrigation	10	280%	38	142

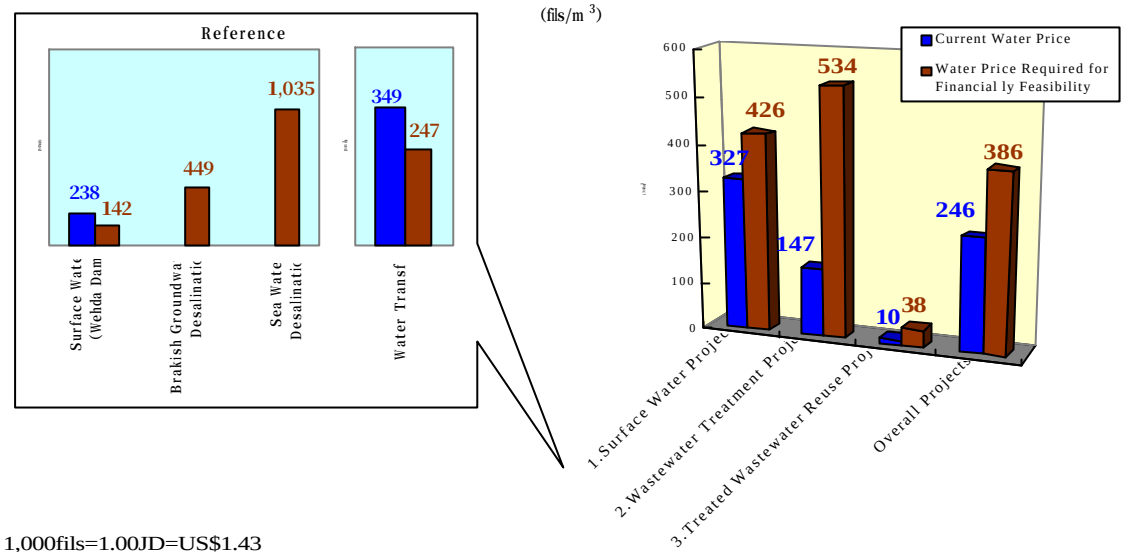
In short, the project group has a remarkably high economic feasibility, and by raising the unit price of treated wastewater to proper levels in future, it will also be financially feasible.

(4) Entire project

The overall evaluation of all the projects is that they are in financial terms not feasible with the FIRR of 2%, which is below the assumed discount rate of 6.5% on one hand, and that they are in economical terms feasible with the EIRR of 14% (OCC is assumed as 10%) on the other.

The value of EIRR shows that there are still enough room and potential for raising water/wastewater prices so that all the projects may also be made properly feasible in financial terms.

Fig. 9.6.3-1 shows the present cost and financially feasible cost of water by water project.



1,000fils=1.00JD=US$1.43

Fig. 9.6.3-1 Cost by Water Project

9.6.4 Overall Evaluation

In the overall evaluation of all the projects, the Water Resources Management Master Plan is deemed to be feasible through the demand management and the development of the conventional and non-conventional types of water source.

On the other hand, the M/P involves the future problems such as positive use of treated wastewater, partial shift of the agriculture in uplands to the Jordan Valley and revision of water and sewage service charges. These problems may be solved if there is cooperation between the Government and people of Jordan with each other. Thus, it is desired that the Project be prepared for implementation.

9. 7 Recommendations

Jordan's total rainfall is absolutely little (more than 70 percent of national land has annual rainfall of less than 100 millimeters,) and thus developable water resources are extremely limited. In particular, renewable groundwater faces the danger of drying out and deterioration of water quality due to excessive abstraction.

On the other hand, the population of the country has been increasing in recent years (average yearly increase rate of 3.9 percent in the 1990s,) and, according to the 2000 report compiled by the Higher Council for Science and Technology, water resources per capita, which stood at 327 m^3 a year in 1990 dropped to 170 m^3 in 1999 (when the figure is less than 1000 m^3 a year per capita, it is categorized as absolute shortage in the water resources stress index.) If the population increases at the same level as in the 1990s, the water per capita is projected to drop to 121 m^3 by 2025. Without proper water resources management, the nation will fall into a critical condition.

In order to conduct sustainable water resources management, it will become necessary to curve the water supply and demand by promoting effective use of water resources, water-saving and use of renewable water, and create a society where renewable water is used at a significant level.

In this Study, we formulated a water resources management master plan, aiming to work, by 2020, on "unified and comprehensive and sustainable management of water resources" and "strategic development of remaining scarce water resources," while having in mind the goal of "development of re-cycling oriented society".

In making the Master Plan, we also gave consideration to "management and development of sustainable water resources," which is unique to Jordan, "peace water development" and "global climate change."

The Master Plan includes plans to reduce the total water demand, review water distribution by use and reduce the volume of groundwater abstraction to a proper level as major policies for effective use of water resources and conservation of water quality. It also proposes the promotion of reuse of treated wastewater that is non-conventional water resources as complimentary water source of water for agricultural irrigation.

The following is what the Government of Jordan should urgently work on as an action plan based on the policies mentioned above in order to realize the Master Plan.

9.7.1 Unified and Comprehensive and Sustainable Management of Water Resources

(1) Management for sustainable water use

1) Reduction of the abstraction of renewable fresh groundwater

The volume of abstracted renewable groundwater in Jordan (420 MCM in 1998) largely exceeds the volume that allows sustainable development (275 MCM/a.) Because prevention of drying out of precious water resources of renewable groundwater is an issue of primal importance to be worked on in water resources management, the government should carry out 35-percent reduction in the abstraction of groundwater for both municipal and agricultural use based on the plan to reduce the abstraction of groundwater toward 2020 proposed in this study.

Although reduction in groundwater abstraction for municipal use is believed to be

possible, including the preparation of alternative water sources, not only ministries and agencies that supervise the use of water for agriculture but farmers need to be involved to realize the reduction of abstraction of groundwater for agriculture. Purchase of irrigation wells is believed to a means most likely to be accepted for the reduction.

The government should soon make a concrete plan for allocating budgets and plan and establish organizations and institutions for realizing the reduction, including the means of well buy-out.

Meanwhile, development of renewable groundwater is on progress in the Upland area. The development of renewable groundwater should be regarded as an emergency means to offset the water shortage in extraordinary dry years, and it is necessary to make a comprehensive abstraction plan based on the reduction plan in the study.

2) Change of use of Disi fossil groundwater from agricultural use to municipal use

The national water distribution policy of Jordan has a basic policy to prioritize water for municipal use (people's daily life, industry and tourism), and maintain the current level of water distribution for agricultural use (about 620 MCM/a). In accordance with the policy, the government should convert Disi fossil groundwater most of which is used for agriculture in the southern Upland area to water for municipal use in an attempt to meet the demand of water for municipal use in the metropolitan area. It also should carry out a project to transport water to the metropolitan district.

However, careful observation of changes in groundwater is essential because development of fossil ground water is that of non-renewable water resources, and the government should consider that resources are to be shared by both the current and next generations.

Use of Disi fossil groundwater for agriculture reached 51 MCM in 1998. Thus the conversion should be carried out gradually and social influence from the conversion should be minimum.

3) Use of treated wastewater for agriculture and industry

Treated wastewater generated in the metropolitan area increases in accordance with an increase in population (about 100 MCM/a). It is easy, both financially and technically, to execute a reuse plan at existing five wastewater treatment plants that carried out pre-F/S in the Study, while working for the realization of extensive use of treated wastewater. The government should urgently begin preparation for carrying out the treated wastewater use project, including the plan mentioned above.

Use of properly treated harmless wastewater was considered to cause no problem at a conference of the Council of Leading Islamic Scholars held in Saudi Arabia in 1978, and thus there is no religious restriction on its reuse any longer.

However, there is a possibility that the use of treated wastewater for agriculture may cause health problems to humans due to bio-hazard caused by colon bacilli in excrement in the treated water and that it may include a trace element that affects the growth of farm products. Therefore, it is necessary to have more than one organizations manage and monitor the quality of treated wastewater, appropriately apply legal regulations related to the use of treated wastewater and disclose information and raise public awareness of the promotion of its use.

4) Downsizing of the agricultural development plan accompanying the water resources management plan

a. Review of the agricultural development plan

The agricultural sector (Ministry of Agriculture (MOA) and Jordan Valley Authority (JVA)) has the agricultural development plan outside the framework of water demand adjustment among sectors. Under the plan, the target demand of water for agriculture exceeds 900 MCM/a in comparison to the current 600 MCM/a. As there is structural water shortage, it is impossible to satisfy the demand. Therefore, it is necessary to adjust demand related to the agricultural development plan together with MOA/JVA based on the water distribution plan of the Master Plan in this Study. At the same time, the government needs to explain to farmers who will be directly affected by the demand adjustment.

b. Relocation of farm land

In the Study, we suggested a plan to reduce abstraction of renewable groundwater in the Upland area for the conservation of water sources and conversion of Disi fossil ground water into waster for municipal use. The plans force the downsizing of irrigation agriculture in the Upland area.

On the other hand, it is possible in the Jordan Valley to use treated wastewater generated in the metropolitan area by releasing it down to the valley. By using the treated wastewater as non-conventional water resources, agriculture can be expanded there. Use of alternative water sources is necessary to maintain the current demand for agricultural water while reducing the abstraction of renewableground water and changing Disi fossil ground water into one for municipal use. Thus, agricultural land should be relocated from the Upland area to the Jordan Valley. The Ministry of Water and Irrigation has made a plan of agricultural water use by Governorate by using the "Digital Master Plan" tool in accordance with the water distribution plan in the Study.

This shows that appropriate selection of agricultural districts, water sources and farm products enables the relocation of agricultural land. However, because relocation of agricultural land includes serious social issues such as security of farmers' life in the Upland area and approval of the relocation by farmers in the Jordan Valley, measures to reduce influence on social environment should be considered in reviewing the agricultural development plan.

5) Monitoring of water quality for the conservation of surface water quality

In 1998, there occurred contamination of tap water (strange smell) in the Amman metropolitan area. In an attempt to find out possible deterioration of surface water quality to take proper preventive measures, as exemplified in the 1998 case, the government should establish a regular and continuous monitoring system of quality of water in the Yarmouk River and KAC as soon as possible.

However, for effective operation of the system, it is necessary to add items to be monitored, including water ecology (including plankton) in addition to the chemistry of water quality and construct a comprehensive system to manage the environment of water quality under the Ministry of Water and Irrigation, which includes the unification of database.

(2) Formation of a society in which water-saving is promoted

1) Improving efficiency of water supply and distribution projects

a. Improvement of unaccounted for water

Effective use of water resources is a basic policy of water resources management, and it is critical to improve the unaccounted for water (UFW) that accounted for more than50 percent of water supply in 1998. The unaccounted for water is divided into two categories-leakage due to physical causes (physical loss) and water for which tariff is not paid (administrative loss.) Although each type of the loss is believed to account for 25 percent of supplied water, the actual figures are not known. Rehabilitation and improvement projects of the water supply system have been promoted quite substantially with the final goal of 23 percent, mainly in the metropolitan district. However, UFW and PMU sections were just recently established within the Ministry of Water and Irrigation as entities in charge of understanding the actual situations of basic development, supply and the volume of supplied water, and thus the efforts for the improvement of unaccounted for water just began to be made. The government should use the organizations to conduct a study to find out how unaccounted for water is generated (for example, stolen water and illegal use of water for the municipal purpose for agricultural water) in addition to detection of water leakage to establish comprehensive measures against illegal water use, which includes the establishment of a basic legal system.

The government also needs to set up a national water control center for unified and comprehensive control of water transport, which we proposed in this study.

b. Improvement of management of the supply project of municipal water

Because tariff for agricultural water and sewage, including that for water for municipal purpose, remains to be very low, it does not pay for all the maintenance and management costs. Because the budget for the maintenance and management is limited, water supply and distribution services have deteriorated. An increase in the maintenance and management costs per unit of water volume is unavoidable in the development and expansion of new water resources. Against the backdrop, each types of water tariff should be raised drastically. According to the result of the Study, citizens are believed to be able to afford to pay more tariff in comparison with the upper limit of such tariff they can pay from their household income.

The water supply project in Amman is entrusted with the private sector and the efficiency of improving water for unaccounted has increased. Income from water tariff increased from 1,920 million JD (27.4 million dollars) to 2,230 million JD (31.9 million dollars) in two-year period. Learning from this successful example, the government should transfer the maintenance and management of water and sewage facilities that are under the jurisdiction of WAJ to the private sector. In doing so, it is important to privatize local organizations of WAJ currently located in each administrative district without changing the system by changing the system in order to facilitate the transfer. It is necessary for the government to structurally end the deterioration of financial conditions WAJ is experiencing and its inefficient work by introducing the vitality of the private sector.

2) Increase in efficiency of the use of agricultural water

The government also needs to introduce techniques to promote better efficiency of the use of agricultural water, just like municipal water, for the effective use of water resources.

For example, the government can introduce irrigation facilities with high efficiency of water use and promote farmers to change farm products they grow to ones that require little water. The agricultural development plan of the Ministry of Water and Irrigation shows that the change of farm products and improvement of irrigation lead to better efficiency of water use.

3) Raising public awareness of water-saving

a. MIT water

According to Jordan's national water strategy, water resources are distributed first for MIT use (municipal, industry and tourism use). Following the strategy, the water for MIT use is increased from 34 percent of the total volume of water to be used in 1998 to 51 percent of the total in 2020 in this study. To restrict the planned volume of supply for MIT use, planned water supply will be restricted. Although MIT use is given priority of water distribution, because the available water resources are limited, the government should continuously carry out campaigns to raise people's and companies' awareness of scarcity and importance of water resources, significance of treated wastewater as water resources and the necessity of water-saving and reuse of water.

b. Agricultural water

Technical training for the introduction of irrigation facilities is extensively provided in order to promote farmers to change farm products they grow to other types of farm products that require little water and improve efficiency of water use for agriculture mainly in the Jordan Valley area. These efforts have yielded some success. The government should provide the same kind of technical training and raise public awareness, including the promotion of the use of treated wastewater, not only in the Jordan Valley but also in the Upland area.

9.7.2 Strategic Development of Remaining Water Resources

(1) New water resources development

Water resources development plans that are highly reasonable technically and financially are to be carried out toward 2020 under the water resources management master plan. However, because it is also essential to give consideration to water resources for the next generation, detailed study is needed in relation to the following two plans as development from mid-to long-term perspectives.

1) Promotion of development of surface water in the desert area (Water Harvesting Plan)

Although it is rare, the desert area (Badia Region) has torrential rain that results in flood. There is a plan to store the flooded water at a dam to use it for local residents, which is named the Water Harvesting Plan. Developable water volume is estimated to be about 15 MCM/a. The Water Harvesting Plan should be promoted in an attempt to use remaining scarce water resources effectively.

2) Survey and development of brackish groundwater

One type of water resources yet to be developed in Jordan is brackish groundwater and it is believed to have great potential. The Water Resources Management Master Plan formulated in the Study considers the brackish groundwater as important water resources to partially satisfy future water demand. In the Master Plan, desalinated brackish

groundwater is regarded as a water source for water demand especially for highly economical industrial development (e.g. Lajoun Oil Shale Project.)

However, use of desalinated brackish water has a problem in terms of its sustainability and economy. It is necessary to carefully watch the future advancement of cost cut and reverse osmosis technology which is the applied technology for the development, from the view point of long-term development. There is a limited number of detailed studies on brackish groundwater in Jordan and thus there is not enough data to properly evaluate its potential, water quality and sustainability. Substantial study on brackish groundwater should be conducted in the east coast of the Dead Sea, where the water is believed to have great potential as major water resources for the next generation.

9.7.3 Risk Management Involved in Water Resources Management

(1) Climate change

Annual rainfalls in Jordan have far below a long-term average in recent years (since 1998.) Long-term water shortage that has occasionally happened and global climate change that has been pointed out recently are believed to be the main possible causes of the small rainfalls. Although it is impossible to decide which is the real cause in this study, risk management against the change in the usable volume of water resources in water resources management is especially important in Jordan. We refer to the two issues.

1) Measures against extraordinary water shortage

The Master Plan has formulated based on the volume of water resources of years with ordinary amount of rainfalls. However, as seen in the dry weather in recent years, the usable volume of water resources can decrease. In addition to the dry weather, there are some other factors that can have short-term effect on the volume of water resources. It is necessary to establish measures against possible risks such as the delay of carrying out the water resources development plan and the change in water provided under the peace treaty.

The Master Plan assumed a case of serious water shortage due to dry weather in 2005 and studied possible measures to restrict demand and demand management that can be taken under a water distribution plan. Because there are many uncertain factors of water shortage, including the time, place and the volume of shortage, the WAJ needs to prepare for measures against as many assumed patterns of water shortage as possible in advance.

2) Measures to tackle global climate change

A British research institute predicts that rainfalls will decrease by 10 to 15 percent and average temperature will rise by 1.5 ° C to 2.5 ° C by 2050 in Middle East due to global climate change. Although it is not possible to decide whether the recent decline in rainfalls in Jordan is due to the climate change or not in this study, decline in rainfalls is a serious issue and measures are necessary from the viewpoint of national risk management in relation to water resources management.

a. Monitoring of climate change of wide areas

Global climate change involves a rise in temperature and a wider regional gap of rainfalls. In particular, in order to understand the trend of decrease in rainfalls due to climate

change, it is necessary to establish a system to exchange data of meteorological observation and conduct joint study and research with other countries including its neighboring nations, in addition to the continuation and analysis of regular meteorological and hydrological observation to understand extensive climate change at home.

b. Revision of management plan and water distribution plan

It is necessary to review the volume of long-term average water resources in the Study and revise the Master Plan in accordance with the amount of decrease in rainfalls from the viewpoint of demand restriction and proper water distribution, if it is most likely that rainfalls are apparently on a decline trend based on the monitoring result.

(2) Response to changes in the international situation surrounding Jordan

Jordan is currently carrying out two development plans in the Yarmouk River and Side Wadi as part of peaceful use of water resources. For the implementation of these projects, the attentions as shown below should be paid. The plans require coordination with neighboring nations and thus there is a need for risk management to respond to unpredictable changes during the negotiation process. In case that these projects will not be implemented, the Water Resources Management master Plan including water allocation and etc. should be modified using the tools of GTZ's "National Water Master Plan".

1) Development of surface water in the Yarmouk River

The biggest development project of surface water in the future is the Wehda dam to be built in the Yarmouk River. However, because water resources development is on progress in Syria, where upper stream of the river runs, the basic water flow of the river is decreasing and there are some media reports are concerned about the development of scheduled volume of water. Surface water to be developed as a result of the construction of Wehda dam will be very important water source for Jordan, and thus its government needs to establish a cooperative system with Syria in relation to water use of the Yarmouk River.

2) Peace Water from Israel

To-be-developed water volume in the "Storage Plan in the Jordan River and Side Wadi," which is one of peace treaty water projects, is large at 30 MCM a year. It is one of important projects in the Master Plan. However, almost no study on the plan is conducted. There is an urgent need to study the plan substantially and assure the water volume and feasibility of the development.