No.

JAPAN INTERNATIONAL COOPERATION AGENCY

MINISTRY OF WATER AND IRRIGATION
THE HASHEMITE KINGDOM OF JORDAN

THE STUDY ON WATER RESOURCES MANAGEMENT IN THE HASHEMITE KINGDOM OF JORDAN

FINAL REPORT VOLUME I

MAIN REPORT PART-A

WATER RESOURCES MANAGEMENT MASTER PLAN

DECEMBER 2001

YACHIYO ENGINEERING CO.,LTD.

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Exchange Rate Employed
in the Study

US$1.00=0.700JD=JP¥110
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PREFACE

In response to a request from the Government of the Hashemite Kingdom of Jordan, the Government of Japan decided to conduct the study on Water Resources Management in the Hashemite Kingdom of Jordan and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA selected and dispatched a study team headed by Mr. Noboru Saeki of Yachiyo Engineering Co., Ltd. to the Hashemite Kingdom of Jordan, five times between February 2000 and September 2001.

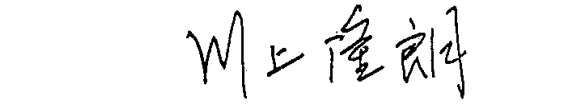
In addition, JICA set up an advisory committee headed by Dr. Masahiro Murakami, Professor of Kochi University of Technology, between February 2000 and December 2001, which examined the study from specialist and technical points of view.

The team held discussions with the officials concerned of the Government of the Hashemite Kingdom of Jordan and conducted field surveys at the study area. Upon returning to Japan, the team conducted further studies and prepared this final report.

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

Finally, I wish to express my sincere appreciation to the officials concerned of the Government of the Hashemite Kingdom of Jordan for their close cooperation extended to the Team.

December 2001



Takao Kawakami
President
Japan International Cooperation Agency

December 2001

Mr. Takao Kawakami
President
Japan International Cooperation Agency

LETTER OF TRANSMITTAL

We are pleased to submit to you the final report of the Study on Water Resources Management in the Hashemite Kingdom of Jordan. The report includes the advise and suggestions of the authorities concerned of the Government of Japan and your Agency. Also included are comments made by the Ministry of Water and Irrigation, the Hashemite Kingdom of Jordan. This report consists of Summary Report, Main Report, Supporting Report and Drawings.

The report deals with the present conditions of water resources management in the Hashemite Kingdom of Jordan and presents the master plan for water resources management with the target year of 2020, as well as the results of the pre-feasibility study for the priority projects proposed in the master plan.

In accordance with the contract with your Agency, we Yachiyo Engineering Co., Ltd. in implemented this study during the period of February 4, 2000 to December 27, 2001. Based on a deep understanding of the existing conditions in the Hashemite Kingdom of Jordan we have prepared a plan that is feasible and can be implemented.

Finally we sincerely hope that this report will be effectively used for the realization of the master plan. We wish to express our deep gratitude to your Agency, the Ministry of Foreign Affairs and other concerned Governmental Agencies for the close cooperation and assistance extended to us during the Study.

Very truly yours,

Noboru Saseki
Team Leader
The Study on Water Resources Management
in the Hashemite Kingdom of Jordan

ACKNOWLEDGEMENT

Upon completion of the Study on "Water Resources Management Plan" in the Hashemite Kingdom of Jordan, JICA Study Team would like to acknowledge with thanks the substantive and mutual cooperation of all competent staff members of the MWI, JVA and WAJ who were contacted in their offices in Amman or in the field as well.

Special gratitude are extended to those who have the most appreciable encouragement and guidance in implementing the Study to such an extent that made this Draft Final Report possible. They are His Excellency Dr. Hazem El-Naser the Minister of Ministry of Water and Irrigation, and His Excellency Mr. Fayez Bataineh, Acting Secretary General of the Ministry.

And Mr. Edward Qunqar, Ms. Suzan Taha, for their beneficial inputs and substantive contribution to the Study.

Many thanks are also extended to all counterparts who helped JICA Study Team in the implementation of the Study, data review and analyses, presentation of results and conclusions; Messers Rakad Ayed Ta'any, Waleed Sukkar, Mohamed Mansour, Mohamed Momani, Mazen Ar Rayyan, Nidal Khalifa, Saleh Malkawi, Salameh Al Khreisheh, Ali Subuh, Yaser Nazal, and Zakariya Zuhdi.

JICA Study Team members; Messers Noboru Saeki, Bader Hirzalla, Yosuke Sasaki, Toshio Murakami, Keiichi Sakaebara, Friz Kaeser, Xiaochang Wang, Masahiro Takeuchi, Yoshio Kawasaki, Naomichi Ishibashi, Abdul Karim Bourini, Naoto Mizuno, Akihiro Shimomura, Mrs. Hala Zawati, and Miss Rawan Habaybeh.

Deserve the worthy consideration and thanks for their excreted efforts to execute the Study according to the agreed upon as spelled out in the Inception Report.

Abbreviations and Glossary

a	anumm/year
abst.	abstraction
AHT	Agrar- und Hydrotechnik (Consulting firm)
AP	Aerated Ponds
Aq.	Aquifer
AS	Activated Sludge Process
a.s.l.	above sea level
Ass. Sec. Gen.	Assistant Secretary Genaral
ARD	Associates in Rural Development (Consulting firm)
ave.	average
avail.	available
AZB	Amman-Zarqa Basin
B	Baseflow
BGR	Geosciences and Natural Resources of Germany
BG, BGW	Brackish Groundwater
BOD_5	Biochemical Oxygen Demand in 5 days
BOT	Build – Operate - Transfer
BOO	Build – Own – Operate
BCM	Billion Cubic Meters
CIDA	Canadian International Development Agency
COD	Chemical Oxygen Demand
cond.	conditionally
concent.	concentration
Cons.	Consumption
d	day
DAR	Deutsche Abwasserreinigungsgesellschaft (Consulting firm)
D/D	Detailed Design
Dept.	Department
Des.	Desalinated
DI	Ductile Iron
Dir.	Directorate
DN	Nominal Diameter (in mm)
Doc.	Document
DOS	Department of Statistics
Donum	0.1 ha
DVS	Digital Visualization System (one of NWMP systems)
EA	Extended Aeration
EC	Electric Conductivity

EIA	Environmental Impact Assessment
EIRR	Economic Internal Rate of Return
Exp.	Expenses
F	Flood flow
FAO	Food and Agriculture Organization
Feddan	0.405 hectar
Fils	0.001 Jordan Dinar
FIRR	Financial Internal Rate of Return
F/S	Feasibility Study
g	gram
GDP	Gross Domestic Product
GNP	Gross National Product
GIS	Geographical Information System
GW	ground water
GCEP	General Cooperation for Environmental Protection
GKW	Gesellschaft fur Klaeranlagen und Wasserversorgung (Consulting firm)
Govt.	Governorate
GTZ	Deutsche Gesellschaft fur Technische Zusammenarbeit (German Technical Cooperation Society)
GW.	Groundwater
Gwh	Giga watt-hour
h	hour
hc	house connection
hh	household
HDPE	High Density Polyethylene
Ha	hector (2.469 Acres)
HKJ	Hashemite Kingdom of Jordan
i	hydraulic gradient
IAEA	International Atomic Energy Agency
IEE	Initial Environmental Examination
Indust.	Industrial
inh	inhabitants
Irr.	Irrigation
JBIC	Japan Bank for International Cooperation
JD	Jordanian Dinar
JES	Jordanian Environmental Society
JICA	Japan International Cooperation Agency
JS	Jordanian standard
JVA	Jordan Valley Authority
JRV	Jordan Rift Valley

JV	Jordan Valley
k	permeability
KAC	King Abdullah Canal
KTR	King Talal Reservoir
KfW	Kreditanstalt fur Wiederaufbau (German Bank for Development and Reconstruction)
kg	kilogram
km	kilometer
kW	kilowatt
Km2	square kilometers
Km3	cubic kilometers =MCM
lcd	litters per capita per day
lit	liter
LEMA	Suez Lyonnaise des Eaux – Montgomery Watson – Arabtech Jardaneh (Managing the Amman Water and Wastewater Services)
LR	Leaching Requirement
MW	mega watt
m	meters
m^3/s	cubic meters per second
mm	millimeters
mm/a	millimeters per annum
mg	milligram
ml	milliliter
mio	million
µ s/cm	micro siemense per centimeter (unit of electric conductivity)
Max.	Maximum
MCM	million cubic meter
MIT	Municipal, Industrial and Touristic
Min.	Minimum
MOA	Ministry of Agriculture
MOH	Ministry of Health
MOP	Ministry of Planning
MOWI, MWI	Ministry of Water and Irrigation
MP	Maturation Pond
MPN	Most Probable Number (for coliform bacteria)
Mun.	Municipal
N	nitrogen
N	Newton
NA	not applicable
NCARTT	National Center for Agricultural Research and Technology Transfer (NGO)

NEAP	National Environmental Action Plan
NIR	Net Irrigation Requirement
NPV	Net Present Value
NWMP	National Water Master Plan (GTZ Project)
NWSCS	National Water Supply Control System
O&M	Operation and Maintenance
OCC	Opportunity Cost of Capital
pH	measure of alkalinity/acidity
ppm	parts per million
P	phosphorus
PE	polyethylene
pop.	population
PT	Peace Treaty
PV	Present Value
PVC	Polyvinyl Chloride
Q	rate of discharge, flow rate
R.	River
Reduc.	Reduction
Rev.	Revenue
R.C.C.	Roll Compacted Concrete
RO	Reverse Osmosis
RBC	Rotating Biological Contactor
RSCN	Royal Society for the Conservation of Nature
RSS	Royal Scientific Society
s	second
S	storage coefficient
SCADA	Supervisory Control and Data Acquisition
SF	Sand Filtration
S.G.	Secretary General
Sn.	Scenario
STP	Scenario Table Pool (one of systems of NWMP)
SS	Suspended Solids
SW	Surface Water
t	ton
T	Transmissivity
Ttl.	Total
TDS	Total Dissolved Solids
TF	Trickling Filter
TN	Total Nitrogen

TOC	Total Organic Carbon
Tour.	Touristic
TSE	Treated Sewage Effluent
TSS	Total Suspended Solids
TFCC	Total Fecal Coliform Count
TKN	Total Kjeldhal Nitrogen
TP	Treatment Plant
TSS	Total Suspended Solids
TWW	Treated Wastewater
uncond.	unconditionally
UFW	Unaccounted for Water
UP	Upland
USAID	United States Agency for International Development
v	velocity
WAJ	Water Authority of Jordan
WB	World Bank
WHO	World Health Organization
WIS	Water Information System
W/O	without
WQICP	Water Quality Improvement and Conservation Project (USAID project)
WRMP	Water Resources Management Plan (JICA project)
WRPS	Water Resources Policy Support (USAID project in AZB)
WSP	Wastewater Stabilization Pond
WWE	Wastewater Effluent
WWTP	Wastewater Treatment Plant
YEC	Yachiyo Engineering Company Ltd. (Consulting firm)
Yr	Year

Abbreviations Used for Governorates

AJ	Ajloun
AM	Amman
AQ	Aqaba
BA	Balqa
IR	Irbid
JA	Jerash
KA	Karak
MA	Madaba
MF	Mafrak
MN	Ma'an
TA	Tafielah
ZA	Zarqa

GLOSSARY

Term	Definition
Administrative Loss	The quantities of water actually supplied to consumers without bringing financial impacts to the suppliers due to such administrative factors as ill-functioning water meters, imperfect billing, non-paying customer, illegal connections, and water theft.
Aquiclude	A geologic formation, which contains water but cannot transmit it rapidly enough to furnish a significant supply to a well or spring.
Aquifer	A geologic formation, which contains water and transmit it from one point to another in quantities sufficient to permit economic development.
Base flow	Part of the surface water flow, which enters a stream channel from groundwater, and identified as rejected groundwater recharge.
Brackish Groundwater	Poor quality groundwater with high range of salinity (>1500-about 30,000 ppm of TDS), generally encountered at depth in the lower aquifer System.
Boundary Conditions	Basic conditions given for groundwater simulation modeling to define the peripheral and internal conditions at the simulation area. It is exemplified by no-flow, flow-constant and head-constant conditions.
Draw down (s)	Change in surface elevation of the groundwater resulting from withdrawal of water from a well.
Equipotential lines	A contour line, which represents or traces the equal head in the aquifer.
Electric conductivity	Reciprocal of electrical resistively of water. It is measured as indicators of water quality and is expressed in micro-mhos.

Term	Definition
Isohyetal Map	the map, which defines or describes rainfall distribution and behavior in a given period.
Isohyets:	lines of equal rainfall amount
Live Storage	Volume or cubic capacity of a lake or reservoir between the normal maximum and minimum operating levels.
Manning Roughness Coefficient	Characteristics of boundary conditions in a stream channel regardless of its slope and size or depth of water flow.
Non-renewable groundwater	Groundwater which occurs in the rock at its formation with no or nil annual recharge and occasionally highly saline. The terms Fossil or connate water are also used.
Parts per million (ppm)	It denotes water quality in weight-per-weights units. One part per million represents 1 milligram.
Permeability (k)	the capacity of a porous medium (aquifer) for transmitting waters.
Piezometric level	the elevation to which the water level rises in a well that taps an artesian (confined) aquifer.
Physical Loss	the quantities of water supplied but lost on the way to the customers due to such physical factors as broken pipes, inconstant water pressure and a high water pressure of the pumps.
Reference Year	1998
Runoff Coefficient	The ratio of surface runoff volume to total volume of storm rainfall over an area and depends on the characteristics of the drainage basin.

Term	**Definition**
Safe yield	the rate at which water can be withdrawn for aquifers without depleting the sustainable source to such an extent that withdrawal at this rate is no longer economically feasible.
Specific capacity (Q/s)	The yield per unit of draw-down in a pumping well
Storage coefficient (S)	The volume of water released from storage, or taken into storage, per unit of surface area of the aquifer per unit change in head.
Surface Runoff	That part of storm precipitation, which flows over the land surface before it reaches definite channel or stream.
Total Dissolved Solids	Total weight of dissolved mineral constituents in water per unit volume of weight of water in the sample.
Transmissivity (T)	The rate at which water will flow through a vertical strip of the aquifer with unit length wide and extending through the full saturated thickness, under a hydraulic gradient of 1.00. (aquifer thickness* permeability)

Glossary of Terms Related with the Computation Of Irrigation Requirements

ACTUAL CROP EVAPOTRANSPIRATION:

Rate of evapotranspiration equal to or smaller than predicted Etc depending on the level of available soil water, wilting phenomena, salinity, field size, or other causes; mm per month

ALLOWABLE DEPLETION. AD:

The readily available soil water over the root zone, which can be safely used by the crop without affecting its evapotranspiation and /or growth, mm.

ALLOWABLE DEPLETION DURING INITIAL PERIOD. AD:

The readily available soil water over the Initial root zone, which can be safely used by the crop without affecting its evapotranspiration and/or growth, mm.

AVAILABLE MOISTURE, AM:

Total available amount of soil water stored in the root zone one or two days after irrigation; difference between soil water content at field capacity and that at wilting point, mm/m soil depth.

CANOPY INTERCEPTION:

The process by which precipitation is caught and held by foliage and branches of trees and other vegetation and lost by evaporation without reaching the ground surface percentage.

CUMULATIVE NET EFFECTIVE PRECIPITATION DURING OFF SEASON, **CNEPO:**

The accumulated precipitation during non growing season excluding interception and occasional runoff during intense events and evaporation from the wet soil surface.

CONSUMPTIVE USE:

The amount of water used by the vegetative growth of a given area in transpiration or building of plant tissue and that evaporated from the soil or intercepted precipitation of the area in any specified time, mm.

TRANSFER EFFICIENCY:

Ratio between wate4r received at inlet to a block of fields and that released at the project head works. This is applicable in the case of king Abdullah Canal.

CROP DEVELOPMENT STAGE:

The time from the end of crop initial stage until the achievement of effective full groundcover (groundcover = 70-80 %), days.

CROP EVAPOTRANSPIRATION, ET:

Rate of evapotranspiration of a disease-free crop under non restricting soil water and fertility conditions and achieving full production potential under the given growing environment, mm/day.

CROP WATER REQUIREMENT:

The depth of water needed to meet the water loss through evapotranspiration of a disease-free crop, growing in large fields under non-restricting soil conditions including soil water and fertility and achieving full production potential under the given growing environment.

CROPPING PATTERN:

Sequence of different crops grown in regular order on any particular field or fields.

DEEP PERCOLATION;

Rate of downward movement of soil water from the root zone prior to and following attainment of field capacity after ample irrigation or heavy rains, mm.

DISTRIBUTION EFFICIENCY:

Ratio between water received at farm gate and the released at inlet to a block of fields. Applicable at King Abdullah canal outlets, and at point of abstraction from ground water or surface water.

DEW POINT TEMPERATURE, Dew P:

Temperature to which the air needs to be cooled down in order to become saturated and at which water vapor starts to condense, degree Celsius.

EFFECTIVE RAINFALL, P_{eff}

The fraction of total precipitation useful for meeting crop water requirements, it excludes deep drainage, run-off, and evaporation from the soil surface, it includes requirements for leaching, fraction.

ELECTRICAL CONDUCTIVITY, IRRIGATION WATER, EC_w,

Measure of salt content of irrigation water, mmhos/cm.

ELECTRICAL CONDUCTIVITY, SATURATION EXTRACTS, ECe:

Measure of salt content of soil water extracted from the soil, mmhos/cm.

EVAPORATION:

The process by which water is converted from liquid state to gaseous one through the transfer of heat energy, mm.

FIELD CAPACITY, Sfc:

The amount of water, expressed as percentage of the oven-dry soil, held in the soil after the excess of gravitational water has drained away and after the rate of downward movement of water has substantially decreased.

FULL GROUND COVER:

Amount of soil covered by crops approaching 100 when looking downward.

GROSS IRRIGATION REQUIREMENT. GIR:

Irrigation requirement at the source of irrigation supplies. It is equal to the net irrigation requirement plus water losses and operational wastes in transit, and water needed for leaching of accumulated salts from the root zone, mm.

GROUND COVER:

Percentage of soul surface shaded by the crop when sun is directly overhead, percentage.

GROWING SEASON:

For a given crop the time between planting or sowing date an harvesting date, days.

INITIAL ROOT DEPTH, $R_{z\ I}$:

The root depth during initial period of crop growth, m.

IRRIGATION FREQUENCY:

The elapsed time in days from the start of one's irrigation to the start of the next on the same field.

LATE SEASON DEPLETION, LSD:

The depletion amount of soil moisture that stored in the root zone near the end of the growing season without replacing it, mm.

LATE SEASON STAGE:

The time from end of mid-season stages until full maturity or harvest, days.

LEACHING:

Removal of soluble salts by passage of water through soil.

LEACHING RATIO. LR:

The fraction of water entering the soil that must pass through the root zone in order to prevent soil salinity from exceeding a specified value, in percentage.

MANAGEMENT ALLOWABLE DEPLETION PERCENTAGE, MADP:

The fraction of total available soil moisture, which can safely be depleted, by the crop without affecting its evapotranspiration and/or growth.

MAXIMUM ROOT DEPTH, $R_{z\,max}$:

The root depth of a full-grown crop, m.

MID-SEASON STAGE:

The time between the attainment of effective full ground cover and the start of maturing of the crop (i.e. leaves start of discolor or fall off). Days.

MINIMUM POSSIBLE IRRIGATION DEPTH, MPID:

The minimum depth of water that con physically be added to the soil due to constraints in the irrigation application system, mm.

NET IRRIGATION CONSUMPTION, NIC:

The quantity of the actual diverted irrigation water, which is evaporated from the an area excluding the amount of, evaporated effective precipitation, mm.

NET IRRIGATION REQUIREMENT, NIR:

The depth of irrigation water, exclusive of effective precipitation and moisture stored in the root zone near the end of the growing season, that is required consumptively for crop production, including the pre-plant irrigation depth whenever it is needed

ON-FARM APPLICATION EFFICIENCY, $Eff_{on\text{-}farm}$:

Ratio between water directly available to the crop and that received at the farm gate

OVERALL IRRIGATION EFFICIENCY, $Eff_{overall}$:

Ratio between water directly available to the crop and that released at headwork's (in the uplands) or Kind Abdullah Canal outlets in the Jordan Valley

PAN EVAPORATION:

The amount of evaporation from the water surface of an experimental tank under measured or observed climatic and cultural conditions.

PRECIPITATION:

The total measurable supply of water of all forms of falling moisture, including dew, rain, mist, snow, hail and sleet; usually expressed as depth of liquid water on a horizontal surface in a day, month, or year, and designated so daily, monthly, and annual precipitation, mm.

PRE-PLANT IRRIGATION DEPTH. PPI:

The amount of irrigation water used to moisten the soil prior to planting whenever it is needed. mm.

RAINFALL FREQUENCY:

The average time interval between rainfall occurrence of a given intensity, and that of an equal or greater intensity.

REFERENCE GRASS EVAPOTRANSPIRATION. ET_o:

The rate of evapo-transpiration from an extensive surface of 8 to 15 cm tall, green grass cover of uniform height, actively growing, completely shading the ground and not short of water. **mm/day.**

SALINITY:

The concentration of salts, usually sodium chloride, dissolved in a given volume of water. It is usually expressed in terms of the number of parts per million of chlorine.

SOIL WATER CONTENT:

At a given time the amount of water held in the soil, weight or volume percentage.

TRANSPIRATION:

Rate of water loss from the plant through the formation of water vapor in living cells which is regulated by physical and physiological processes. **mm/day.**

WILTING POINT, Sw:

The moisture content of the soil, as a percentage of the day weight, at the time when the leaves of a plant growing in the soil first undergo a permanent reduction in their moisture content, as the result of the deficiency in the soil-moisture supply.

WIND SPEED:

Speed of air movement at 2 m above ground surface in unobstructed surroundings; total wind run in Km/day.

EXECUTIVE SUMMARY

1. Activities of the Study

The Study on Water Resources Management in the Hashemite Kingdom of Jordan was executed by JICA Study Team as per the request of the Ministry of Water and Irrigation (MWI) under the situation that have been experienced in Jordan as a result of the chronic imbalance in population and water demands. Water resources management aiming at the sustainable development is essential. The Study's objectives are;

to formulate Water Resources Management Plan in Jordan using the tools that have been developed by the GTZ funded Water Sector Planning Support Project.

to conduct Pre-Feasibility Study of priority project based on the findings and results of Master Plan.

to transfer technologies to counterpart personnel in the course of the Study.

All of the Study has been completed and Final Report will be presented in this Stage as shown on the Study Flow Chart below, which contained two main components of;

- Formulation of Water Resources Management Master Plan (Vol. I)
- Pre-Feasibility Study on Priority Projects (Vol. II)

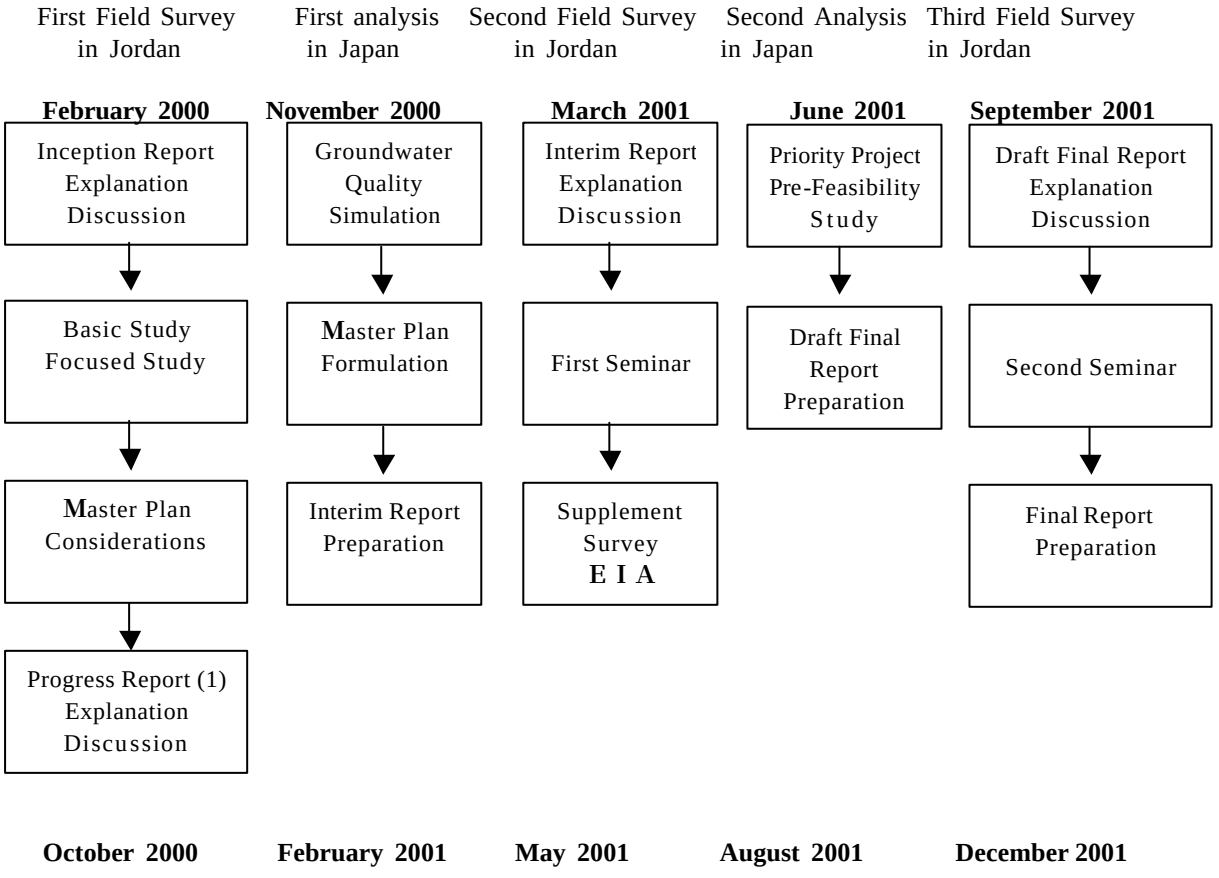


Fig.Sum-1 Study Flow Chart

2. Background of the Study

(1) Unbalance between Water Demand and Supply

The population of Jordan has recently been growing due to massive influx of refugees and displaced persons and high natural growth rate. Rapid population growth rates estimated during the past decade at 3.9% (1990 to 1999) is compound with rising per capita consumption twice as fast.

In addition urban expansion, mainly concentrated in Amman, Zarqa, Irbid, and Balqa, generated pressures on nearby water resources. This makes competition between various demands against very limited water resources availability sharp. Water demand has therefore constantly exceeded the supply in the urban areas. As the frequent cut off of the water supply and restricted water supply, the citizens have suffered inconvenience in their daily life.

Against the background described above, it has been promoting the country to conserve and ration water consumption.

(2) Restricted Water Resources

According to the Water Stress Index* which indicates the degree of the water shortage, Jordan is classified in the category of "Absolute Scarcity" and the water resources is chronically short to the demands. Due to the arid to semi-arid climate of the country, annual rainfall amounts highly fluctuate year by year with 85% of the total rainfall not being available for use due to high evaporation rates. The recent drought conditions and decreasing tendency of rainfall during past three years have exasperated the availability of surface water in the country**. Due to the reasons mentioned above, more than half of the total water resources depend on the groundwater resource of which the nonrenewable groundwater occupies at 14%. The regional groundwater level decline and groundwater quality deterioration have taken place because of the over abstraction of the renewable groundwater. Therefore, it is needed that the groundwater development management and quality conservation plan will be formulated standing on the long-term aspects.

For the surface water, although peace water is being conveyed from Israel to Jordan, this project implies sensitive factors and its amount will be subject to change according to the political and climatic conditions.

* Water Stress Index is the value of annual rainfall divided by the total population (m^3/capita/year) The value of under 1,700 is regarded as "Existing of Stresses", under 1,000 is regarded as "Scarcity" and under 500 is regarded as "Absolute Scarcity"

** Despite the lack of evidence that such a decrease in rainfall indicates global climatic change, some studies predict that the rainfall in the Middle East Area may fall to 10% to 15% after 50years (Hardley Center, UK) (Chapter 5.6).

(3) Request of the Study

Because of the limited water resources mentioned above, it is of the utmost importance for the government of Jordan to utilize the restricted water resources efficiently and to allocate the water resources properly. In September, 1997, the Government of Jordan requested Japanese Government to conduct the comprehensive study for the formulation of the water resources management master plan with the Ministry of Water and Irrigation (MWI) as a counter part agency.

In response to the request of the Government of Jordan, JICA dispatched preparatory study team and the Scope of Work for the Study was agreed upon between both sides, and signed in October, 1999.

2. Outline of the Study

(1) Basic Policy of the Study

In this Study, the Water Resources Management Master Plan was formulated, covering the period until year 2020, and aiming at "Unified, comprehensive and sustainable management of the water resources", and "Strategic development of remaining scarce water resources" while having in mind the future goal of "Shift to water re-cycling society". Special aspects in the country, "global climatic change and characteristic of climatic change of the arid region", and "cooperation for regional peace water development" are considered in formulation of the Master Plan. The relationship among these problems is schematically shown in next figure.

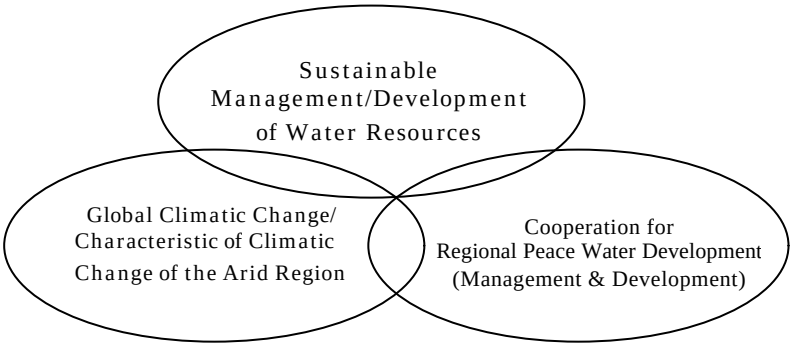


Fig.Sum-2 The problems on the Water Resources Management in Jordan

The comprehensive water resources management master plan for the twelve Governorates has been formulated in the Study under the circumstances mentioned above. Furthermore, the system and database of "Digital Master Plan", which was prepared in MWI with the technical cooperation of GTZ, was utilized for the formulation of the master plan. The Study area, target year of planning and water resources to be developed in the master plan are shown below:

Study Area:	Whole Jordan and twelve Governorates in Jordan
Target Year: of Planning Horizon	Short Term---------- 2000 to 2005 Mid Term----------2006 to 2010 Long Term----------2011 to 2020
Water Resources:	In addition to the conventional water which comprised of surface water, peace water, renewable groundwater and fossil fresh groundwater, the non-conventional water resources which were desalinated brackish groundwater, desalinated sea water and treated wastewater were considered as water resources.

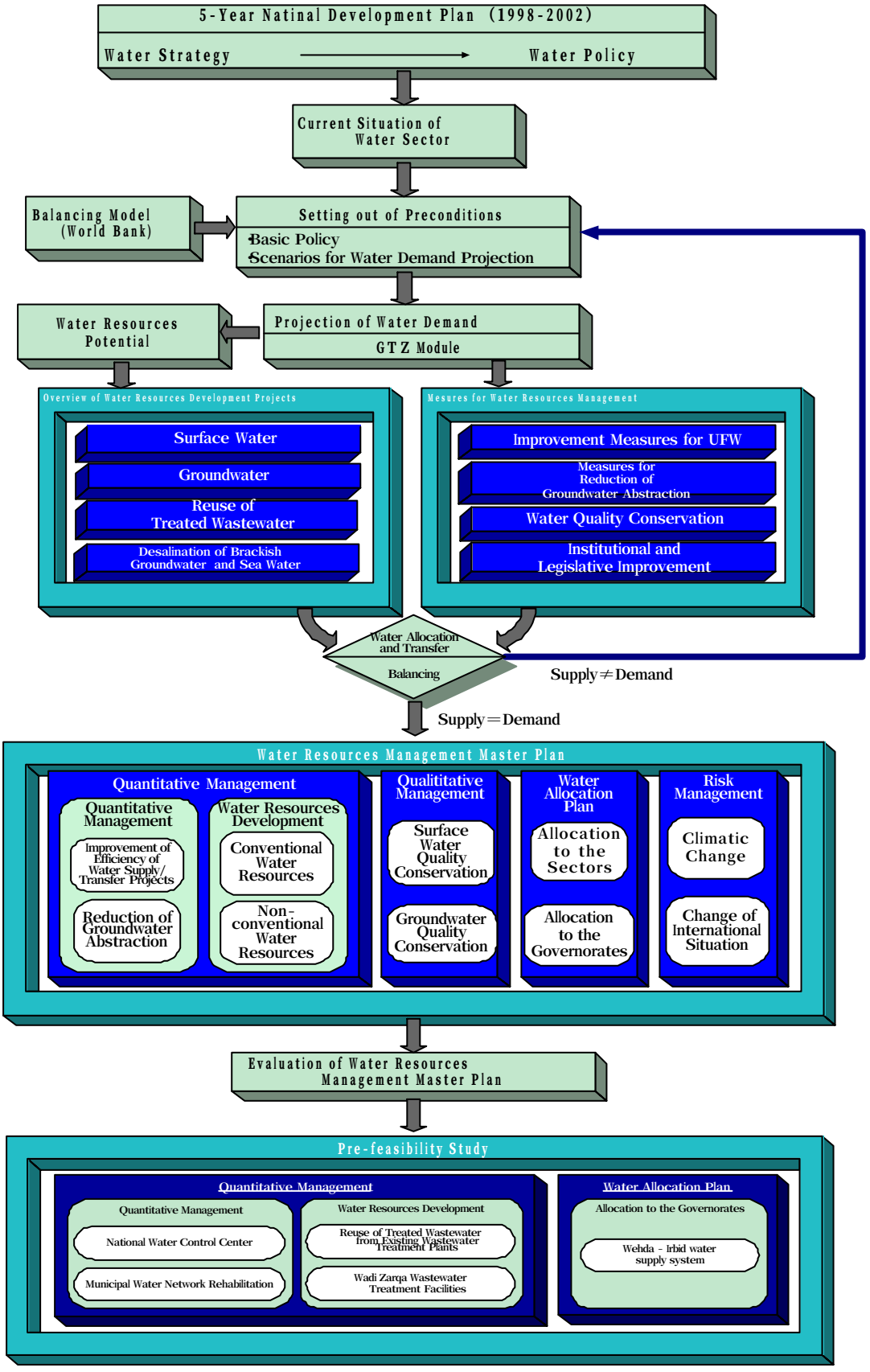


Fig.Sum-3 General Flow of the Study

(2) Contents of the Study

The Study Team started the Study in February, 2000 and conducted Phase-1 Investigation which aimed to formulate the Water Resources Management master Plan and Phase-2 Investigation which aimed to carry out the Pre-Feasibility Study on the priority projects selected in the Master Plan. The general flow of the Study is shown in Fig.Sum-3.

4. Formulation of Water resources Management Master Plan

For the formulation of the Water Resources management Master Plan, examinations were done on both of "Water Resources Management: Conventional/Non-conventional Water resources" and "Water Resources Management: Quantitative Management, Qualitative Management and Institutional/Legislative Management" under the umbrella of "Jordan's Water Strategy" and "Water Policies"

In the course of the formulation of the Water Resources management Master Plan, the Municipal/Industrial/Touristic (MIT) demand and agriculture demand were tried to be balanced with the restricted water supply as much as possible by taking account of the study results of USAID and GTZ projects. After the global balancing of water demand and supply in whole Jordan, the water resources development and water resources management plans including inter-Governorate water allocation plan and water conveyance plan were formulated for twelve governorates in order to supply the water efficiently.

The schematic concepts of the Water Resources Management Master Plan were shown in three drawings in the coming pages.

5. Pre-Feasibility Study on Selected Priority Projects

Selection of the priority projects for the Pre-Feasibility Study was done in Phase-2 Investigation. The selected priority projects for the Pre-Feasibility Study are as follows:

① Treated Wastewater Reuse Scheme of Five Existing Treatment Plants
Ma'an (including expansion of treatment plant), Abu-Nuseir, Fuhis, Tafielah, and Wadi Essir

② Construction of Wadi Zarqa Treatment Plant

③ National Water Supply Control System Integrating Surface and Groundwater

④ Municipal Water Distribution Networks Rehabilitation
Karak, Tafielah, Ma'an, Madaba and South Amman

⑤ Al Wehda Dam Water Supply Project/Irbid]

The Water resources Management Master Plan is described in the Vol. I and the Pre-Feasibility Study is described in Vol. II.

General Concept of Water Resources Management Master Plan in The Hashemite Kingdom of Jordan

Background

- Increasing Water Demand
- Water Stress Index 170m3/capita/year (1999) (Under 500 is regarded as "Absolute Scarcity of Water Resources)
- Limited Water Resources
- Global Climatic Change

↓

National Water Strategy

↓

Sustainable Management and Development of the Water Resources

Problems

- Environment (Necessity of Reduction of Groundwater Abstraction)
- Water Demand (Necessity of Control of Water Demand)
- Amount of Water Resources (Necessity of New Development)

↓

Water Resources Management Master Plan

Quantitative Management

Quantitative Management
- Improvement of Efficiency of Water Supply/Transfer Projects
- Reduction of Renewable Groundwater Abstraction

Water Resources Development
- Conventional Water Resources
- Non-Conventional Water Resources

Qualitative Management
- Surface Water Quality Conservation
- Groundwater Quality Conservation

Water Allocation
- Allocation to the Sectors
- Allocation to the Governorates

Risk Management
- Climatic Change
- Change of International Situation

↓

- Unified and Comprehensive and Sustainable Management of Water Resources
- Strategic Development of Remaining Scarce Water Resources
- Risk Management

↓

Toward Water Re-cycling Society

Balancing of Water Demand and Supply by Target Year

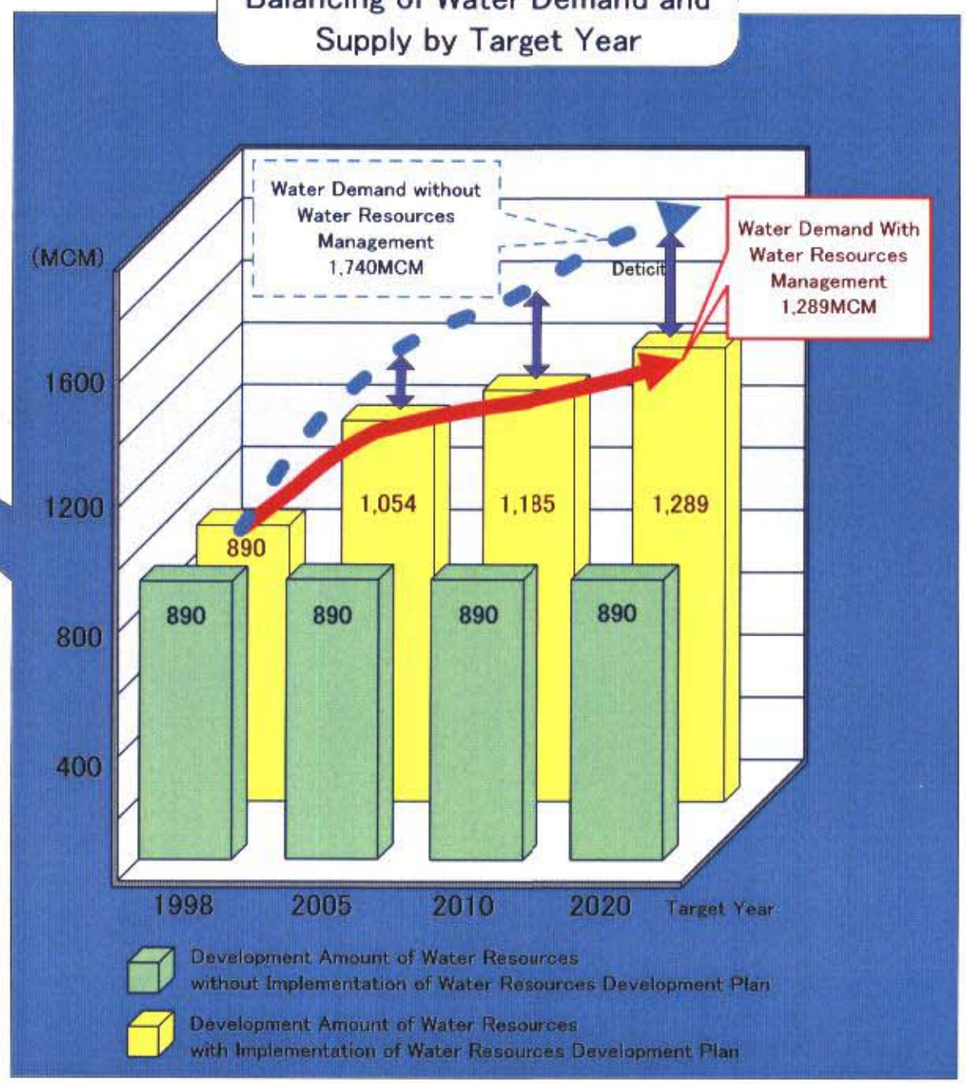


Fig.Sum-4 General Concept of Water Resources Management Master Plan

Comprehensive Water Resources Management

Quantitative Management

- Quantitative Management
  - ・Improvement of Water Supply System
    - Improvement of UFW*(Rehabilitation Plan of Existing Water Supply System, Establishment of National Water Supply Control System)
    - Improvement of Institution (Improvement Plan of Institutional and Legislative System)
  - ・Reduction of Renewable Groundwater Abstraction
- Water Resouces Development (Conventional/Non-conentional)

Qualititative Management — Water Quality Conservation (Surface Water /Groundwater)

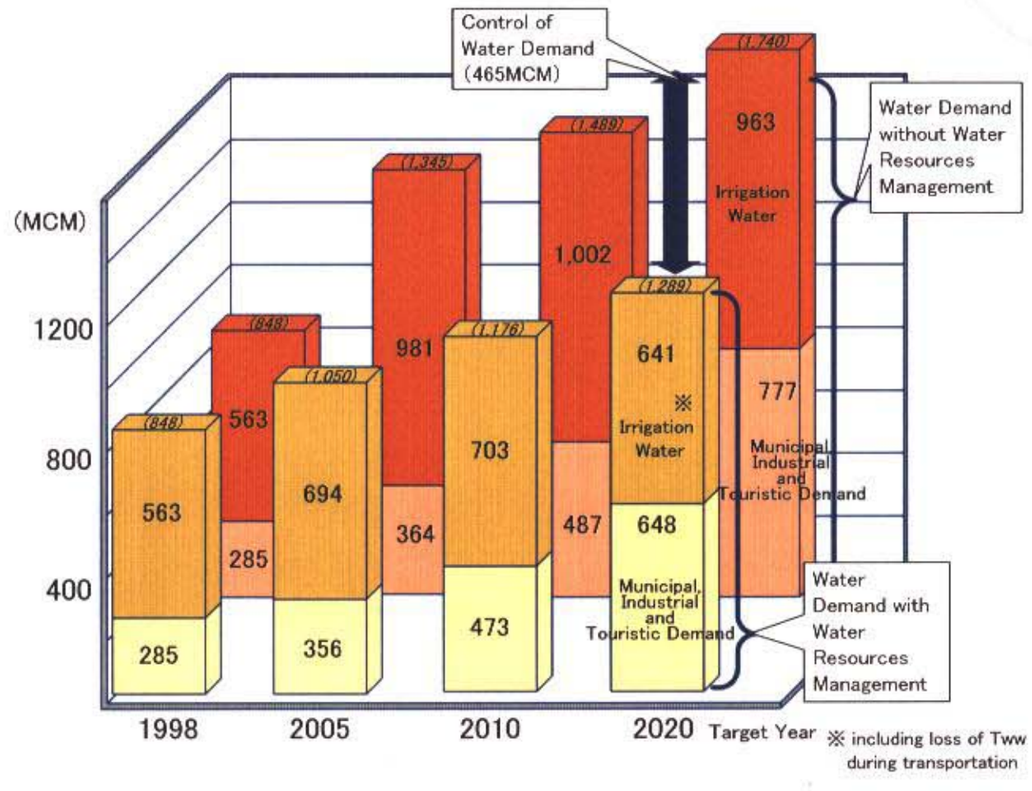
Water Allocation Plan — Water Allocation and Transfer

Risk Management

→

- Securing of Necessary Quantity
- Conservation of Quality
- Apropriate Water Allocation
- Risk Management

Change of Water Demand by Target Year



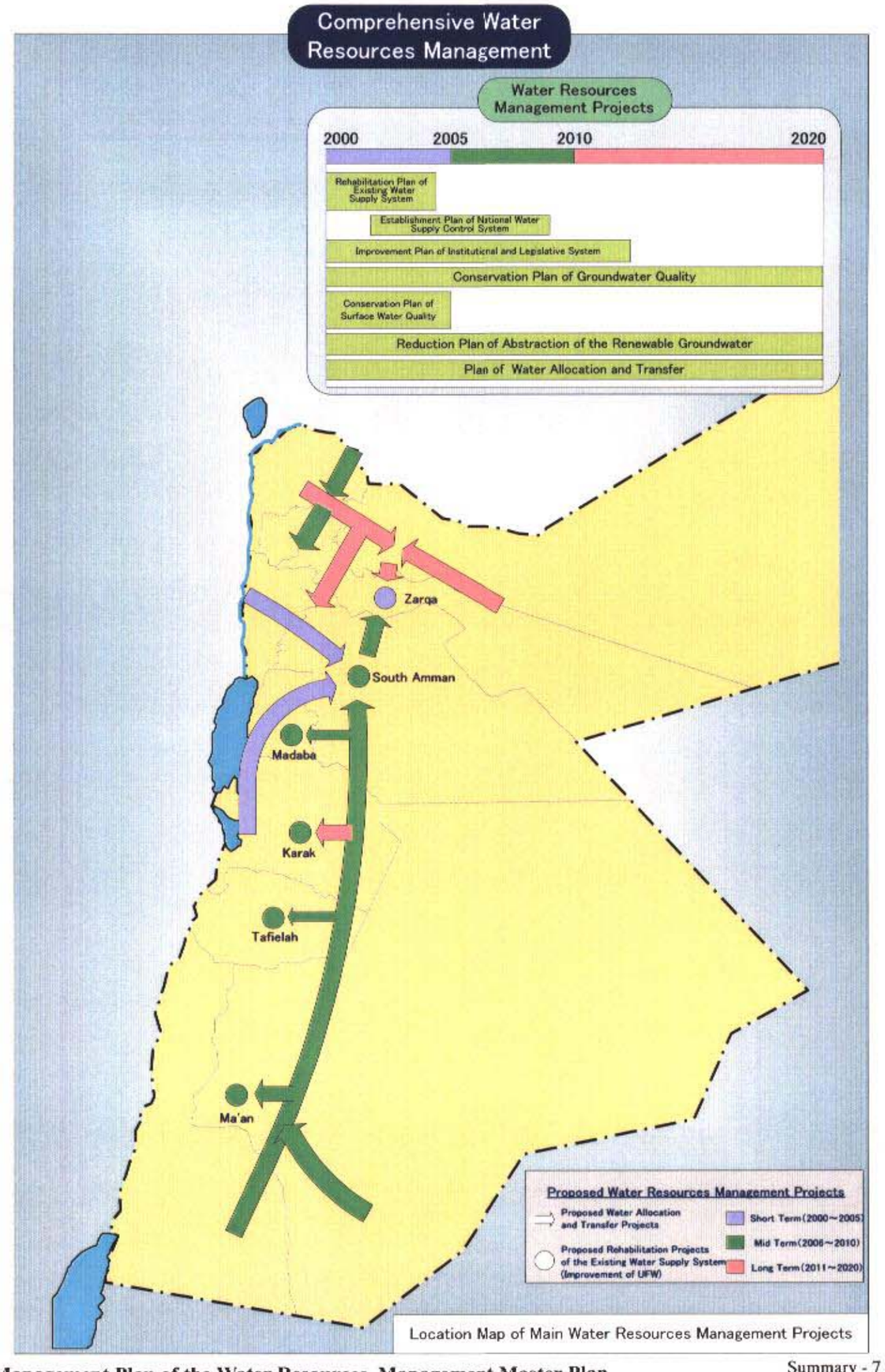


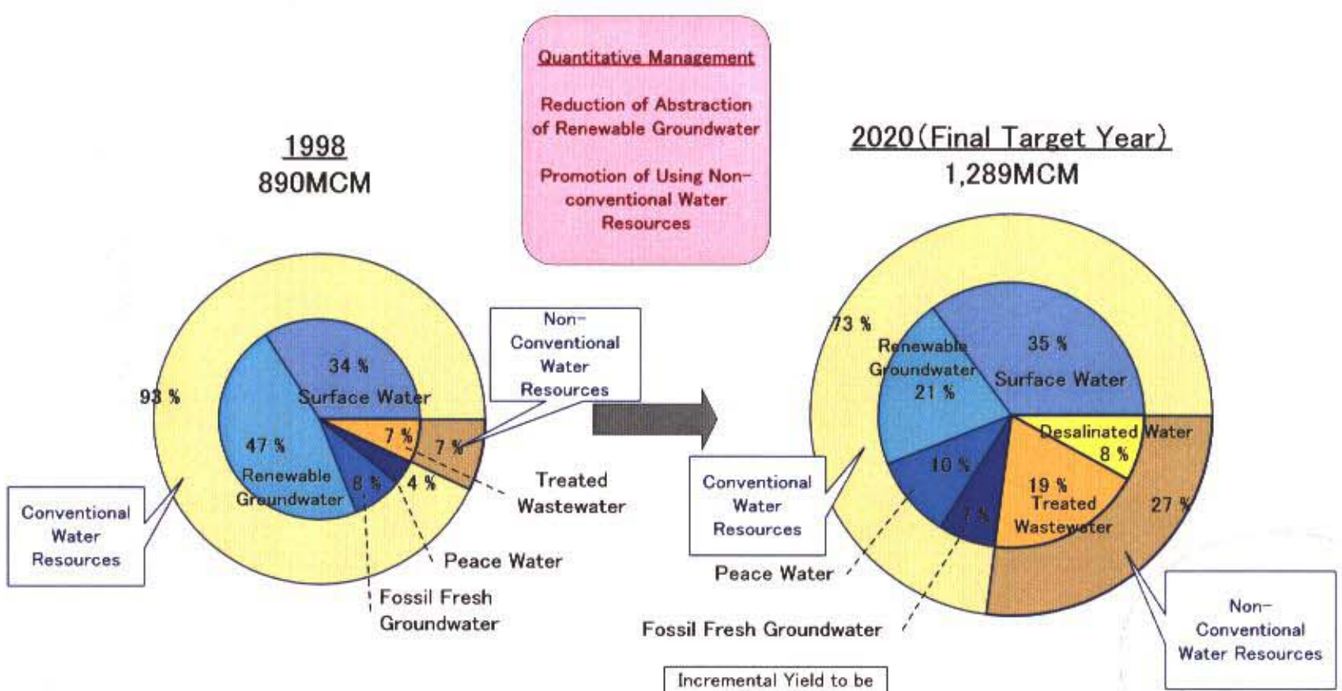
Fig.Sum-5 Water Resources Management Plan of the Water Resources Management Master Plan

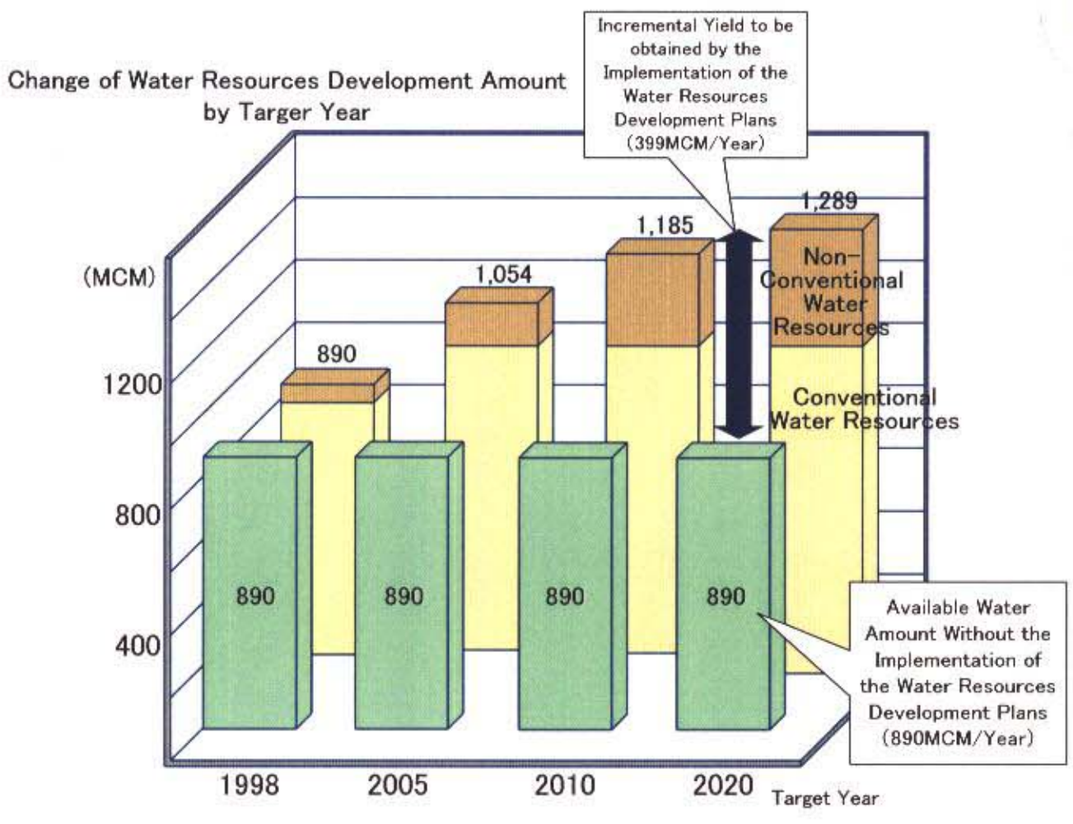
Water Resources Development

Quantitative Management

Reduction of Abstraction of Renewable Groundwater

Promotion of Using Non-conventional Water Resources





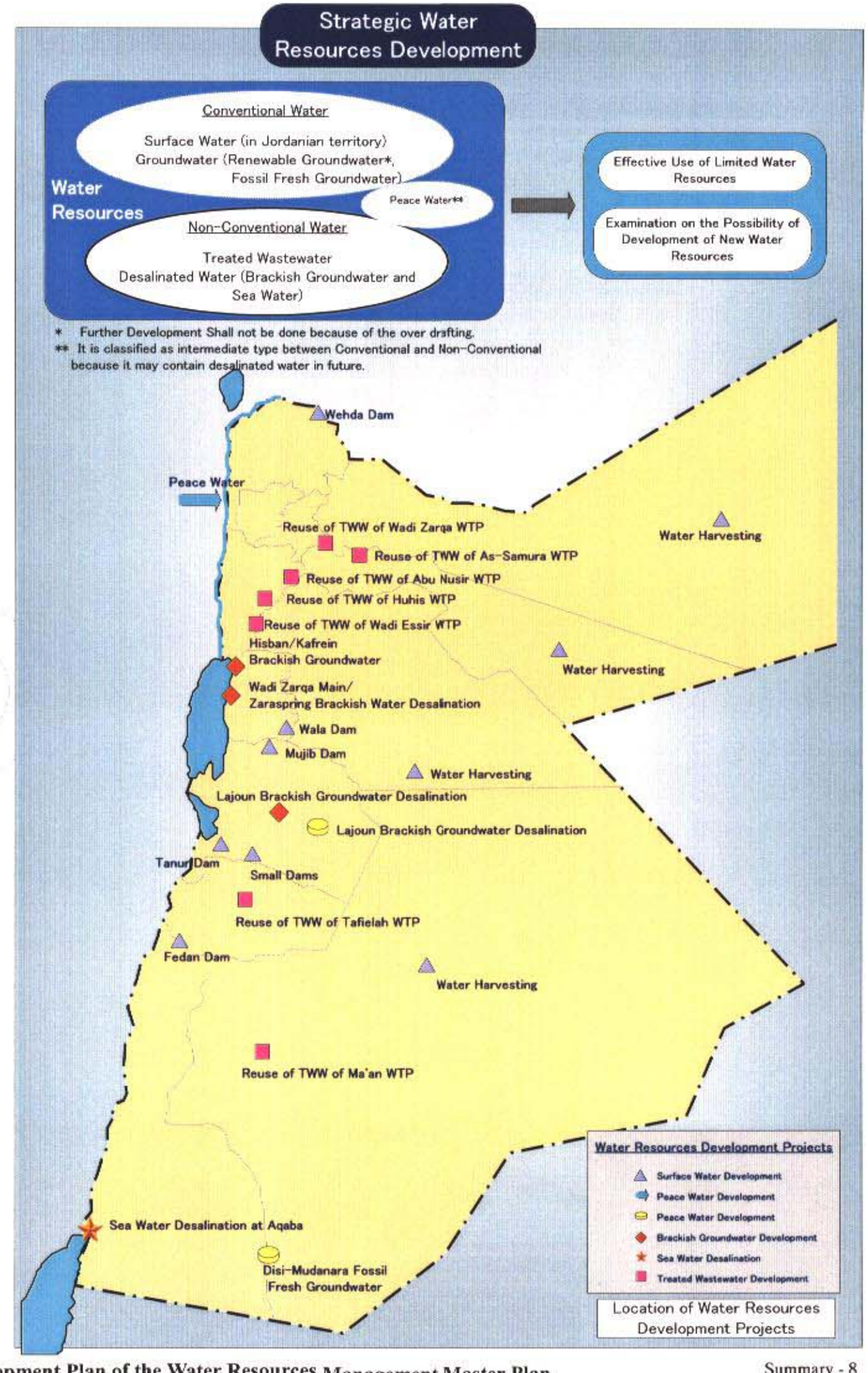


Fig.Sum-6 Water Resources Development Plan of the Water Resources Management Master Plan

The Study on Water Resources Management in the Hashemite Kingdom of Jordan

FINAL REPORT VOLUME I

MAIN REPORT PART-A
WATER RESOURCES MANAGEMENT MASTER PLAN

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CHAPTER 1
PRECONDITIONS OF WATER RESOURCES MANAGEMENT MASTER PLAN

CHAPTER 1 PRECONDITIONS OF WATER RESOURCES MANAGEMENT MASTER PLAN

1.1 Current Water Use in Jordan

1.1.1 Municipal, Industrial and Touristic Water

The total annual municipal water supply across the country maintains more or less the same level of around 240 MCM for the last four years as shown in Table 1.1.1-1. The Governorate of Amman occupied 37.2% of the total water supply in 1999, followed by the Governorates of Zarqa and Irbid with 13.4% and 12.7% respectively.

However, as the population grew at the average annual rate of 3.3% (1996 to 1999), the per capita per day municipal water supply over the whole country decreased from 149 l in 1996 to 133 l in 1999. It is noted that the per capita per day water supply is over 200 l in the three Governorates of Aqaba, Mafraq and Ma'an.

According to PMU, the unaccounted for water (UFW) is estimated to be 55% to 60% of the water supplied, of which leakages or physical losses account for 25% to 30%.

Table 1.1.1-1 Municipal Water Supply by Governorate 1996 to 1999

Governorate	1996			1997			1998			1999		
	Municipal Water Supply (m^3)	Population	lcd	Municipal Water Supply (m^3)	Population	lcd	Municipal Water Supply (m^3)	Population	lcd	Municipal Water Supply (m^3)	Population	lcd
Amman	89,622,000	1,696,300	144.8	88,776,000	1,751,680	138.9	85,213,886	1,809,775	129.0	88,178,551	1,864,500	129.6
Zarqa	31,583,000	687,000	126.0	31,455,000	710,700	121.3	32,372,409	747,860	118.6	31,808,783	770,800	113.1
Mafraq	17,099,000	191,900	244.1	18,416,000	198,720	253.9	19,208,168	219,040	240.3	19,020,755	225,900	230.7
Irbid	31,972,000	802,200	109.2	29,641,000	835,360	97.2	30,531,567	848,340	98.6	30,054,670	874,200	94.2
Ajloun	3,482,000	101,400	94.1	3,705,000	104,880	96.8	3,946,446	105,520	102.5	3,029,091	108,800	76.3
Jerash	3,854,000	132,500	79.7	4,146,000	137,080	82.9	4,545,319	139,815	89.1	3,559,027	144,100	67.7
Balqa	19,172,000	301,300	174.3	18,867,000	306,820	168.5	19,148,504	312,155	168.1	17,920,036	321,400	152.8
Madaba	12,887,000	110,700	318.9	11,737,000	119,140	269.9	11,737,138	121,275	265.2	8,753,836	125,000	191.9
Karak	8,480,000	182,200	127.5	8,728,000	188,600	126.8	9,328,577	191,405	133.5	9,172,530	197,000	127.6
Ma'an	6,762,000	85,300	217.2	6,769,000	88,320	210.0	6,874,630	92,745	203.1	7,155,248	95,600	205.1
Tafielah	2,036,000	67,500	82.6	2,303,000	69,920	90.2	2,354,906	72,465	89.0	2,208,351	74,500	81.2
Aqaba	15,370,000	85,700	491.4	15,077,000	88,780	465.3	16,335,000	95,355	469.3	16,488,600	98,500	458.6
Total	242,319,000	4,444,000	149.4	239,864,000	4,600,000	142.9	241,596,550	4,755,750	139.2	237,349,478	4,900,000	132.7

Notes: 1) The figures include touristic water and the water for small & medium industry.
2) The figures include physical losses.
Source: WAJ/JICA

Regarding water for big industries, whose sources are mostly groundwater, 30 to 40 MCM have been annually supplied these years, and its demand is on the whole increasing fast as shown below:

Table 1.1.1-2 Industrial Water Supply 1993 to 1999

(Unit: MCM/year)

Item	1993	1994	1995	1996	1997	1998	1999
Industrial Water Supply	37	27	37	40	41	42	42
UFW	10%	10%	10%	10%	10%	10%	10%
Actual Supply*	33	24	33	36	37	38	38

Note: *=Actual use from wells for major industries including the industrial water for Aqaba only
Source: MWI

1.1.2 Irrigation Water

The sources of irrigation water are surface water, groundwater and wastewater. The total water supply for irrigation was 521 MCM in 1999, of which surface water, groundwater and wastewater accounted for 37%, 49% and 14% respectively. Of the groundwater supply, up/midland and J.V. accounted for 38%, 1% and 10% respectively. It is noticed that both surface water and groundwater supply is on the whole on the decrease, while wastewater supply is on the whole on the increase. Summing up, the general trend is that the total water supply is decreasing year by year.

Table 1.1.2-1 Irrigation Water Supply by Source 1993 to 1999

(Unit: MCM/year)

Item	1993	1994	1995	1996	1997	1998	1999
Surface Water Supply	341	302	259	253	266	224	195
Groundwater Supply							
Upland	291	254	237	237	222	209	198
Midland	3	3	3	4	4	4	5
Jordan Rift Valley	53	58	52	56	44	46	53
Total	347	315	292	297	270	259	256
Wastewater Supply							
Upland	4	6	6	7	8	11	11
Jordan Valley	45	45	49	52	53	60	59
Total	49	51	55	59	61	71	70
Grand Total	737	668	606	609	597	554	521
UFW (%)	37	36	35	34	-	-	-

Note: The figures include physical losses.
Source: MWI

1.2 Population

The population of Jordan is estimated to have increased for the last 10 years from 3.5 million in 1990 to 4.9 million in 1999 at the average annual rate of 3.9%. The population of the three Governorates of Amman, Irbid and Zarqa forming the most populous areas accounted for 38.1%, 17.8% and 15.7% of the total population respectively, adding up to 71.6% in 1999. (Refer to Table 1.2.1-1.)

Table 1.2.1-1 Population Estimates 1990-1999 by Governorate

Governorate	1990	1991	1992	1993	1994*	1995	1996	1997	1998	1999
Amman	1,450,675	1,497,344	1,556,954	1,627,424	1,576,238	1,631,000	1,696,300	1,751,680	1,809,775	1,864,500
Zarqa	533,206	572,094	595,954	620,940	639,469	661,000	687,000	710,700	747,860	770,500
Mafraq	127,753	148,497	153,300	161,774	178,914	184,500	191,900	198,720	219,040	225,900
Irbid	818,139	904,308	938,005	983,235	751,634	776,600	802,200	835,360	848,340	874,200
Ajloun	0	0	0	0	94,548	98,600	101,400	104,880	105,520	108,800
Jerash	0	0	0	0	123,190	128,700	132,500	137,080	139,815	144,100
Balqa	236,322	227,505	234,741	217,959	276,082	287,400	301,300	306,820	312,155	321,400
Madaba	0	0	0	0	107,321	111,400	110,700	119,140	121,275	125,000
Karak	140,608	155,160	161,923	168,555	169,770	175,900	182,200	188,600	191,405	197,000
Ma'an	113,692	137,074	141,803	149,180	79,670	85,800	85,300	88,320	92,745	95,600
Tafielah	47,606	59,018	61,320	63,934	62,783	64,300	67,500	69,920	72,465	74,500
Aqaba	0	0	0	0	79,839	85,800	85,700	88,780	95,355	98,500
Total of Amman, Irbid and Zarqa										3,509,500
Total Jordan	3,468,000	3,701,000	3,844,000	3,993,000	4,139,458	4,291,000	4,444,000	4,600,000	4,755,750	4,900,000

Note: * = 1994 Population and Housing Census, Source: Dept. of Statistics - Statistical Yearbooks 1990-2000

1.3 Socio-Economic Situation

1.3.1 GDP

The GDP of Jordan grew for the last 10 years from 1990 to 1999 at the average annual rate of 4.6%. However, these 4 years from 1996 to 1999 its growth stays at the 1% level. The GDP deflator grew during the same period at the average annual rate of 3.2%. The per capital GDP in 1999 is calculated at 1,080 JD or 1543 US$. (Refer to Table 1.3.1-1.)
According to the national plan GDP will grow from 1999 to 2003 at the average annual rate of 5.1%. Agriculture and Manufacturing occupied 2.8% and 13.3% of GDP in 1999. Sector-wise, the primary (*mark), secondary (**mark) and tertiary (no mark) sectors accounted for 2.8%, 25.1% and 72.1% of GDP respectively. (Refer to Table 1.3.1-2.)

Table 1.3.1-1 Gross Domestic Product in Jordan

(Unit: JD million)

Year	Current Prices	Constant Prices*	GDP Deflator (%)	GDP Growth Rate (%)
1988	2,264.4	2,183.3		
1989	2,372.1	1,889.6	21.0	-13.5
1990	2,668.3	1,908.0	11.4	1.0
1991	2,868.3	1,951.9	5.1	2.3
1992	3,537.1	2,283.7	5.4	17.0
1993	3,858.7	2,417.0	3.1	5.8
1994	4,246.9	2,601.5	2.3	7.6
1995	4,560.8	2,702.2	3.4	3.9
1996	4,711.0	2,729.6	2.3	1.0
1997	4,945.8	2,764.5	3.7	1.3
1998	5,180.0	2,811.5	3.0	1.7
1999	5,293.0	2,856.5	0.6	1.6

Note: * = at 1985 prices
Source: Department of Statistics-National Accounts Division; National Accounts 1988-1999

Table 1.3.1-2 GDP Projections 1998-2003 at 1997 Constant Prices (Unit: JD million)

Sector	1998	1999	2000	2001	2002	2003
Agriculture*	136	127	129	132	137	142
Mining**	174	181	197	214	234	255
Manufacturing**	601	595	632	672	716	762
Domestic Trade, Restaurants, etc.	537	570	603	650	701	757
Insurance and Financial Services	158	164	171	179	188	198
Total Productive Sectors	**1,607**	**1,637**	**1,731**	**1,847**	**1,976**	**2,115**
Electricity and Water**	121	130	140	152	164	177
Construction**	209	211	213	215	217	219
Transportation, Storage and Communications	666	679	707	760	825	899
Total Infrastructure Sectors	**995**	**1,020**	**1,060**	**1,127**	**1,206**	**1,296**
Government Services	900	918	938	961	985	1,010
Personal and Social Services	162	170	180	194	209	225
Non-Profit Services	53	55	58	61	64	68
Home Services	5	5	5	6	6	6
Housing	632	653	681	710	749	805
Total Service Sectors	**1,752**	**1,801**	**1,862**	**1,932**	**2,013**	**2,114**
Total Sectors	**4,354**	**4,457**	**4,654**	**4,906**	**5,195**	**5,524**
Banking Services	-82	-87	-92	-97	-102	-109
GDP at Cost Prices	**4,272**	**4,370**	**4,562**	**4,809**	**5,093**	**5,416**
Indirect Taxes (Net)	783	785	800	820	847	880
GDP at Market Prices	**5,055**	**5,155**	**5,362**	**5,630**	**5,939**	**6,296**

Source: MOP 5 Years Economic and Social Development Plan; 1999/11/2

1.3.2 National Budget and External Assistance

In 1998 the national revenue budget amounted to 1.7 billion JD. Out of it, the grants accounted for 12%. The ratio of grants to the national revenue budget fluctuated between 10% to 13% for the last 5 years. The national expenditure budget came to 2 billion JD in the same year, of which the payment of interest accounted for 12%. The ratio of the payment of interest to the national expenditure budget is on the whole declining from 15% in 1994. The outstanding external debt more or less equals GDP.

Table 1.3.2-1 Summary of Central Government Budget, 1994-1998

(Unit: JD million)

Item	1994	1995	1996	1997	1998
Total Revenue and Grants	1421.9	1620.6	1650.5	1620.0	1688.0
Domestic Revenues	1246.4	1450.9	1430.6	1395.0	1485.0
Tax Revenues	694.4	757.9	840.9	798.0	858.0
Non-Tax Revenues	552.0	693.0	589.7	597.0	627.0
Foreign Grants	175.5	169.7	219.9	225.0	203.0
Total Expenditures and Net Lending	1504.2	1697.5	1799.0	1773.0	2047.0
Current Expenditures, of Which:	1251.5	1369.1	1449.2	1487.0	1676.0
Interest Payments (Commitment)	234.5	247.6	235.6	238.0	239.0
Capital Expenditures	272.7	333.8	363.6	287.0	326.0
Net Lending	-20.0	-5.4	-13.8	-1.0	45.0

Source: Statistical Yearbook 1998

Table 1.3.2-2 Comparison of Outstanding External Debt with GDP

(Unit: JD million)

Item	1994	1995	1996	1997	1998
Outstanding External Debt	4,339	4,466	4,723	4,581	5,003
GDP	4,247	4,561	4,711	4,946	5,180
O.E.D. / GDP x 100	102	98	100	93	97

Source: Statistical Yearbook 1998

1.3.3 Results of Socio-Economic Interview Survey

(1) General

The socio-economic questionnaire survey was carried out by the JICA Study Team towards the households in the whole country. The number of samples was 1,000. The number was distributed among the 12 Governorates according to the size of their population. The subjects covered were the prevalence of water and wastewater services, dwelling characteristics, frequency of water supply to households, water quality, water consumption, wastewater services, household expenditures on water and wastewater services and customer satisfaction.
We are not going to explain the results of the answers to all the above-mentioned questions, but we focus on the questions concerned to household expenditures on water and sewerage services.

(2) Payment for Water and Sewerage

The average payment for water and sewerage across the country is calculated at 9.8 JD per quarter. On the monthly basis it comes to 3.3 JD. The household in the Governorate of Amman pays 17.0 JD on average per quarter, which is the highest among the 12 governorates, while the household in the Governorate of Tafielah pays the lowest amount of 6.2 JD. The household in the Governorates of Madaba and Karak pays 10.7 JD, which ranks the second highest.

The average payment for water and sewerage as a percentage of household income works out to 1.2% in the whole country. In the Governorate of Amman the households set aside 1.7% of their income on average for the payment for water and sewerage. The percentage is the highest among the 12 Governorates. In the two Governorates of Jerash and Tafielah, the percentage is the lowest with 0.9%. In the Governorate of Karak, it is 1.4%, which is placed the second highest.

The average monthly household income in Jordan is calculated at 281 JD on average. The household of the Governorate of Amman earns the highest monthly income of 327 JD on average, followed by that of the Governorates of Madaba with 297 JD. The lowest earner is the household of the Governorate of Mafraq with 206 JD.

Even if the improvements in water supply is to be made in terms of both quantity and quality, the households are not willing to pay more than they do now.
(Refer to Tables 1.3.3-1 to 1.3.3-4.)

Table 1.3.3-1 Payment for Water per Household per Quarter by Income Category (JD)

(Unit: JD/quarter)

Governorate	<100	100-150	151-200	201-250	251-300	301-500	501-800	801-1000	>1000	Average
Amman	6.0	7.1	11.6	11.4	15.5	18.3	38.6	30.1	25.0	17.0
Zarqa	5.4	6.3	8.2	12.0	13.8	15.1	27.6	5.8	18.0	9.5
Mafraq		5.8	8.8	7.8	26.3	22.8	13.8			6.8
Irbid	6.0	8.0	7.5	7.9	10.5	16.6	24.3	29.3	9.5	10.3
Ajloun	5.0	5.0	6.5	19.3	6.5	14.6	6.5			9.8
Jerash	5.0	5.0	11.4	13.0	5.4	6.5			5.0	6.5
Balqa	5.8	7.0	8.6	11.9	6.0	19.3		5.0	6.5	8.8
Madaba		6.3	6.3	6.5	34.5	23.0	9.8	13.0		10.7
Karak	5.8	10.8	9.5	14.3	8.1	9.6	40.5	6.5		10.7
Ma'an		17.2	10.8	9.8	6.0	14.8	13.0			9.1
Tafielah	5.0	5.0	9.8	10.3		13.0	5.0			6.2
Aqaba	5.0	10.9	9.7	12.6	8.5	30.5				8.6
Total	5.7	7.4	9.4	10.8	13.1	17.0	30.5	25.7	19.7	9.8

Table 1.3.3-2 Payment for Water as Percentage of Household Income by Income Category (JD)

(Unit: %)

Governorate	<100	100-150	151-200	201-250	251-300	301-500	501-800	801-1000	>1000	Average
Amman	2.0	1.9	2.2	1.7	1.9	1.5	2.0	1.1	0.8	1.7
Zarqa	1.8	1.7	1.6	1.8	1.7	1.3	1.4	0.2	0.6	1.3
Mafraq	0.0	1.5	1.7	1.1	3.2	1.9	0.7	0.0	0.0	1.1
Irbid	2.0	2.1	1.4	1.2	1.3	1.4	1.2	1.1	0.3	1.3
Ajloun	1.7	1.3	1.2	2.9	0.8	1.2	0.3	0.0	0.0	1.2
Jerash	1.7	1.3	2.2	1.9	0.7	0.5	0.0	0.0	0.2	0.9
Balqa	1.9	1.9	1.6	1.8	0.7	1.6	0.0	0.2	0.2	1.1
Madaba	0.0	1.7	1.2	1.0	4.2	1.9	0.5	0.5	0.0	1.2
Karak	1.9	2.9	1.8	2.1	1.0	0.8	2.1	0.2	0.0	1.4
Ma'an	0.0	4.6	2.1	1.4	0.7	1.2	0.7	0.0	0.0	1.2
Tafielah	1.7	1.3	1.9	1.5	0.0	1.1	0.3	0.0	0.0	0.9
Aqaba	1.7	2.9	1.8	1.9	1.0	2.5	0.0	0.0	0.0	1.3
Total	1.9	1.9	1.8	1.6	1.6	1.4	1.6	1.0	0.7	1.2

Table 1.3.3-3 No. of Samples by Monthly Income Category (JD) and Average Monthly Income (JD)

(Unit: No. of Samples)

Governorate	<100	100-150	151-200	201-250	251-300	301-500	501-800	801-1000	>1000	Average
Amman	18	56	67	49	38	83	29	18	10	327
Zarqa	12	30	40	21	26	22	5	2	1	243
Mafraq	0	17	8	8	3	2	2	0	0	206
Irbid	6	36	48	25	18	26	11	4	1	264
Ajloun	1	2	5	2	3	5	1	0	0	271
Jerash	4	3	11	1	4	5	0	0	1	242
Balqa	2	7	9	5	3	2	0	1	2	268
Madaba	0	6	6	2	3	3	3	1	0	297
Karak	2	9	8	6	11	7	1	1	0	254
Ma'an	0	3	6	2	3	3	1	0	0	253
Tafielah	1	1	6	6	0	1	1	0	0	230
Aqaba	2	4	5	4	5	3	0	0	0	220
Total	48	174	219	131	117	162	54	27	15	281

Table 1.3.3-4 Willingness to Pay More for Improved Quantity and Quality of Water

(Unit: No. of Samples)

Governorate	0	1-5%	6-10%	>10%	total	Average
Amman	246	119	6	4	375	1.00%
Zarqa	95	49	8	9	161	1.70%
Mafraq	26	7	2	5	40	2.10%
Irbid	136	32	10	3	181	1.00%
Ajloun	12	7	0	0	19	0.90%
Jerash	19	6	2	2	29	1.80%
Balqa	26	3	1	2	32	1.10%
Madaba	22	2	0	0	24	0.20%
Karak	38	5	1	0	44	0.50%
Ma'an	16	3	0	0	19	0.40%
Tafielah	16	0	0	0	16	0.00%
Aqaba	18	5	0	0	23	0.50%
Total	670	238	30	25	963	1.10%

1.4 Financial Status of Water Sector

1.4.1 General

There are three organizations directly related to the water sector: Ministry of Water and Irrigation (MWI), Water Authority of Jordan (WAJ) and Jordan Valley Authority (JVA). Out of them, Both MWI and JVA have no commercial accounting system. Instead, the national expenditure budget is annually allocated to them. What they earn is directly transferred to the national coffer. However, the "Forward" project is now underway, whose objective is to introduce an accounting system to JVA, that is, to put its activities on a commercial basis. Only WAJ is now financially managed based on a commercial accounting system. Therefore, we in this section treat the existing financial status of WAJ.

1.4.2 Existing Financial Status of WAJ

As Table 1.4.2-2 shows, WAJ earned about 65.9 million JD in 1998. Out of it, the water and sewerage revenue accounted for 81%, followed by sewerage tax and subscription, maintenance & connection revenue with 16%, adding up to 97%.

In the same year the expenses amounting to 111.2 million JD was incurred. It means the revenue was 59% of the expenses. When the O & M cost is compared with the revenue, it is found that the latter was 119% of the former. That is, WAJ succeeded in recovering the O & M cost at least in 1998. Huge capital expenses (depreciation and the payment of interest) still remain to be untouched.

Supposing WAJ succeeded in reducing UFW from the present 55% to, say, 20%, then 78% more revenue could be earned, which would almost cover capital expenses, leading WAJ to near to financial self-sufficiency.

Ratio of Water and Sewerage Revenue

(Unit: %)

Item	1990	1991	1992	1993	1994	1995	1996	1997	1998
Water & Sewerage Rev. / Ttl. Rev.	76	74	79	76	73	75	76	76	81
Sewerage Tax and Subscription, Maint. & Connect. Rev. / Ttl. Rev.	22	22	20	23	24	21	19	21	16
Total	97	96	99	98	97	96	96	97	97

Cost Recovery

(Unit: %)

Item	1990	1991	1992	1993	1994	1995	1996	1997	1998
Ttl. Rev. / O & M	88	79	85	100	96	87	91	91	119
Ttl. Rev. / Ttl. Exp.	50	41	42	49	47	44	46	47	59

Share of O & M Cost

(Unit: %)

Item	1990	1991	1992	1993	1994	1995	1996	1997	1998
O & M Cost / Ttl. Exp.	56	51	49	49	49	51	50	51	50
Capital Exp. / Ttl. Exp.	44	49	51	51	51	49	50	49	50
Total	100	100	100	100	100	100	100	100	100

Because of the unusual situation where the revenue covers only half the expenses, it is

basically meaningless to analyze the financial status of WAJ using managerial indices.

We cannot evaluate the profitability which incorporates major managerial indices because the profit is negative. One of such index, turn over of total equity and liabilities is by far below the standard level of 1 although it is improving over the years. Regarding the indices representing the safety, the current ratio standing for the solvency is deeply below the desired level of 130% though it is rapidly improving these two years. The two indices from which stability is evaluated, the equity to fixed assets ratio and the equity and fixed liabilities to fixed assets ratio are both not up to the respective standard values of 100% and 120%. However, it is noticed that they are sharply going up these two years. The equity ratio showing financial soundness has climbed up to over the standard level of 50% these two years. The cash flow from operating activities tends to be negative and the active investments make the cash flow deeply negative, which is offset by extensive financing through loans and capital increase, making the final cash flow balance on the whole positive.

Managerial Indices

(Unit: % except item 1)

Item	1990	1991	1992	1993	1994	1995	1996	1997	1998
Turn Over of Ttl. Equity & Liabilities	0.05	0.06	0.06	0.07	0.08	0.08	0.08	0.09	0.11
Current Ratio	94	19	20	15	13	12	14	58	64
Equity / Fixed Assets	40	25	19	15	8	-1	-5	58	56
Equity & Fixed Liabilities/Fixed Assets	98	72	67	61	56	51	50	94	94
Equity Ratio	30	24	18	14	7	-1	-5	54	51

Table 1.4.2-1 Balance Sheet of Water Authority of Jordan

Item	1990	1991	1992	1993	1994	1995	1996	1997	1998
Fixed Assets									
Cost	344,803,604	449,334,987	477,354,772	526,154,425	569,291,298	627,763,127	676,710,549	740,481,753	775,297,528
Accumulated Depreciation	55,371,496	84,489,149	106,821,244	131,209,514	158,020,858	187,474,367	220,460,488	256,453,557	292,672,673
Net Book Value	289,432,108	364,845,838	370,533,528	394,944,911	411,270,440	440,288,760	456,250,061	484,028,196	482,624,855
Work in Progress of Projects	21,694,439	33,045,725	42,503,756	49,737,975	54,205,459	40,750,675	64,549,316	48,442,845	71,350,268
Total Fixed Assets	**311,126,547**	**397,891,563**	**413,037,284**	**444,682,886**	**465,475,899**	**481,039,435**	**520,799,377**	**532,471,041**	**553,975,123**
Current Assets									
Inventories	7,583,379	9,265,893	11,658,097	11,816,219	11,459,419	13,024,395	17,485,122	16,066,365	14,370,920
Debtors Net of Provision	14,103,368	11,798,444	16,535,459	14,962,137	16,757,582	15,116,034	16,777,551	18,193,651	40,255,878
Miscellaneous Debtors	876,932	975,974	2,486,375	2,733,185	2,157,188	2,923,298	7,267,558	5,909,122	8,140,833
Cash	4,424,065	4,081,580	4,099,596	1,628,895	798,357	562,997	282,655	1,807,091	2,170,464
Deferred Currencies Differences	82,700,909	0	0	0	0	0	0	0	0
Total Current Assets	**109,688,653**	**26,121,891**	**34,779,527**	**31,140,436**	**31,172,546**	**31,626,724**	**41,812,886**	**41,976,229**	**64,938,095**
Total Assets	**420,815,200**	**424,013,454**	**447,816,811**	**475,823,322**	**496,648,445**	**512,666,159**	**562,612,263**	**574,447,270**	**618,913,218**
Equity									
Capital	233,541,681	249,534,385	271,022,280	296,414,377	314,444,110	332,721,904	363,164,044	757,737,896	795,210,623
Accumulated Deficit	110,698,114	149,757,656	192,130,568	230,698,468	280,025,492	338,805,763	390,139,977	450,252,761	483,778,202
Net Capital	122,843,567	99,776,719	78,891,612	65,715,909	34,418,618	-6,083,859	-26,975,933	307,485,134	311,432,421
Provision for Contingencies	1,472,820	1,462,746	1,462,686	1,462,686	1,462,548	1,386,417	1,386,203	1,386,203	1,386,188
Total Equity	**124,316,387**	**101,239,465**	**80,354,298**	**67,178,595**	**35,881,166**	**-4,697,442**	**-25,589,730**	**308,871,337**	**312,818,609**
Long-Term Loans									
International Loans	147,049,326	141,044,580	134,233,955	127,344,781	127,342,326	122,268,021	129,083,050	13,905,615	31,580,832
Local Loans	17,796,621	21,682,972	39,531,742	56,598,001	76,879,347	108,427,686	139,502,580	163,829,828	137,764,619
Bonds and Debentures	15,325,000	21,325,000	21,325,000	21,325,000	21,325,000	21,325,000	17,150,000	15,000,000	36,000,000
Total Long-Term Loans	**180,170,947**	**184,052,552**	**195,090,697**	**205,267,782**	**225,546,673**	**252,020,707**	**285,735,630**	**192,735,443**	**205,345,451**
Current Liabilities									
Creditors	5,385,313	257,369	6,367,048	9,065,294	13,887,823	16,349,957	15,334,597	7,668,733	44,422,856
Retention of Contractors	900,444	861,380	1,612,364	2,789,951	2,488,070	2,478,086	2,263,867	1,473,366	1,301,579
Deposits	17,899,892	21,599,711	24,068,073	26,047,917	26,742,896	29,312,926	32,997,878	36,766,846	39,622,397
Overdue Installments and Accrued	84,427,830	109,170,233	133,533,105	158,113,581	182,168,335	209,554,733	231,574,796	7,914,566	2,912,798
Interest on Loans									
Pension Fund	89,721	89,721	89,029	89,029	88,576	88,577	88,576	88,576	88,576
Banks	7,624,666	6,743,023	6,702,197	7,271,173	9,844,906	7,558,615	20,206,649	18,928,400	12,400,952
Total Current Liabilities	**116,327,866**	**138,721,437**	**172,371,816**	**203,376,945**	**235,220,606**	**265,342,894**	**302,466,363**	**72,840,487**	**100,749,158**
Total Equity and Liabilities	**420,815,200**	**424,013,454**	**447,816,811**	**475,823,322**	**496,648,445**	**512,666,159**	**562,612,263**	**574,447,267**	**618,913,218**

Table 1.4.2-2 Revenue and Expenses Statement of Water Authority of Jordan

Item	1990	1991	1992	1993	1994	1995	1996	1997	1998
Revenue									
Water Revenue	15,419,933	16,096,536	18,464,468	21,805,262	24,269,095	25,197,198	29,277,518	31,220,809	44,173,597
Revenue of Water by Tanks	190,731	241,227	185,323	243,581	332,752	347,280	438,390	468,293	402,304
Sewerage and Drainage Revenue	982,410	1,581,221	3,380,938	4,324,811	4,516,323	4,876,173	5,371,184	5,631,573	9,080,811
Sewerage Tax	2,500,003	3,717,430	4,056,347	4,170,716	5,409,723	5,123,458	5,530,067	6,461,258	6,547,561
Subscription, Maintenance and	2,245,538	1,647,984	1,607,992	3,754,851	4,239,095	3,302,778	3,456,528	3,992,113	4,002,222
Connection Revenue									
Meter Maintenance Fees	0	0	0	0	0	645,533	665,622	697,206	730,651
Bank Interest	384,788	530,618	128,218	132,554	48,431	15,329	6,321	19,592	32,560
Other Revenue	0	0	0	0	0	5,871	45,883	42,757	9,542
Miscellaneous	198,694	538,671	16,299	392,533	1,274,909	1,109,653	1,341,445	820,667	934,633
Total Revenue	**21,922,097**	**24,353,687**	**27,839,585**	**34,824,308**	**40,090,328**	**40,623,273**	**46,132,958**	**49,354,268**	**65,913,881**
Expenses									
Salaries and Wages	11,086,670	13,509,452	13,316,713	15,218,277	16,099,444	16,348,330	19,363,086	20,253,170	20,682,574
Operation and Maintenance Expenses	13,166,111	16,605,405	19,057,232	19,017,254	25,187,607	29,764,829	30,639,345	32,868,965	33,733,307
General and Administrative Expenses	671,872	572,821	453,796	497,531	632,735	723,136	805,464	969,817	911,461
Depreciation	15,379,082	21,679,601	22,332,096	24,388,270	27,585,984	29,453,509	32,986,121	35,993,069	38,949,569
Interest on Loans	3,868,825	7,490,219	11,838,784	12,043,867	15,782,498	16,187,979	17,559,898	15,399,391	16,926,975
Total Expenses	**44,172,560**	**59,857,498**	**66,998,621**	**71,165,199**	**85,288,268**	**92,477,783**	**101,353,914**	**105,484,412**	**111,203,886**
Excess of Expenses over Revenue	27,250,463	35,503,811	39,159,036	36,340,891	45,197,940	51,354,511	47,447,472	54,191,138	45,290,305
Differences in Rate of Exchange	8,693,389	4,319,173	3,213,966	2,226,909	4,129,084	6,925,760	3,886,742	969,503	943,958
Previous Years Adjustments	0	-763,432	0	0	0	0	0	0	0
Deficit for the Year	35,943,852	39,059,552	42,373,002	38,567,800	49,327,024	58,280,271	51,334,214	55,160,641	46,234,263
Prior Years Deficit	74,754,262	110,698,114	149,757,666	192,130,668	230,698,468	280,025,492	338,805,763	395,092,120	437,543,939
Accumulated Deficit	**110,698,114**	**149,757,666**	**192,130,668**	**230,698,468**	**280,025,492**	**338,305,763**	**390,139,977**	**450,252,761**	**483,778,202**

Table 1.4.2-3 Cash Flow of Water Authority of Jordan

Item	1993	1994	1995	1996	1997	1998
Operating Cash Flow						
Net Deficit for the Year	-38,567,300	-49,327,024	-58,780,271	-51,334,214	-55,160,641	-46,234,263
Depreciation	24,388,270	26,811,344	29,453,509	32,986,121	35,993,069	36,219,116
Exchange Differences	2,226,909	4,129,084	6,925,760	-3,886,742	-969,503	943,958
Adjustments for Previous Years	0	0	0	0	-4,952,143	0
International Loans						
Changes Relating to Operational						
Assets and Liabilities						
Debtors	1,573,322	-1,795,445	1,641,548	-1,661,517	-1,416,100	-22,062,227
Inventories	-158,122	356,800	-1,564,976	-4,460,727	1,418,757	1,695,445
Miscellaneous Debtors	-246,810	575,997	-766,110	-419,260	749,326	-3,026,101
Creditors	2,698,246	4,822,529	2,462,134	-1,015,360	-7,665,864	36,754,123
Contractors Retentions	1,177,587	-301,881	-9,983	-214,220	-790,501	-171,787
Contracting	24,580,476	0	0	0	0	0
Pension Fund	0	-453	0	0	0	0
Deposits	1,979,344	694,979	2,570,030	3,684,952	3,768,968	2,855,551
Net Cash Flow from Operating	**19,651,922**	**-14,034,070**	**-18,068,359**	**-26,320,967**	**-29,024,632**	**6,973,815**
Activities						
Investment Activities Cash Flow						
Net Additional Fixed Assets and	-56,033,872	-47,604,357	-45,017,044	-72,746,064	-47,664,730	-57,723,201
Works in Progress						
Net Investment Activities Cash Flow	**-56,033,872**	**-47,604,357**	**-45,017,044**	**-72,746,064**	**-47,664,730**	**-57,723,201**

Item	1993	1994	1995	1996	1997	1998
Financing Activities Cash Flow						
Banks (Increase, Decrease)	568,976	2,573,733	-2,286,292	12,648,035	-1,278,249	-6,527,448
Loans (Credit)	7,950,176	17,421,122	23,000,699	32,914,632	-91,421,574	12,460,440
Capital Increase	25,392,097	18,029,733	18,277,794	30,442,140	394,573,851	37,472,728
Provision for Contingencies	0	-138	-76,131	-214	0	-15
Loans Overdue Installments	0	22,783,439	23,933,973	22,782,096	-223,660,230	-5,001,768
Adjustments on Deficit Brought	0	0	0	0	0	12,708,822
Forward						
Net Financing Activities Cash Flow	**33,911,249**	**60,807,889**	**62,850,043**	**98,786,689**	**78,213,798**	**51,112,759**
Total Net Cash Flow	**-2,470,701**	**-830,538**	**-235,360**	**-280,342**	**1,524,436**	**363,373**
Ending Cash Balance	1,628,395	798,357	562,997	282,656	1,807,091	2,170,464
Beginning Cash Balance	-4,099,096	-1,628,895	798,357	562,997	282,655	1,807,091
Total	**-2,470,701**	**-830,538**	**1,361,354**	**845,653**	**2,089,746**	**3,977,555**

1.5 Water Demand Projection

Three scenarios were considered for demand projections. Scenario 1 was based on the results of the balancing model that was jointly developed by the Ministry of Water Irrigation (MWI) and the World Bank (WB) for the projections of future water demand and water supply in Jordan until year 2020. In year 2000, MWI has invited the World Bank to assist in updating the Water Sector Review of 1997, as an input to the formulation of a five year action plan for the water sector.

Accordingly, MWI-WB population and water supply projection figures were considered as the base line of the JICA Study and reflected in the Scenario 1 as a base scenario. As the actual demand projection methodology of the Study, application of the demand projection modules integrated in the "Digital National Water Master Plan" was carried out with the cooperation of MWI/GTZ. Municipal, industrial and touristic water demands were projected by translating these nationwide supply figures into the demand parameters required by the various GTZ demand modules on a governorate basis.

Together with Scenario 1, Scenarios 2 and 3 were prepared, which can be said as the variations of Scenario 1, as detailed in the following sections on municipal, industrial and touristic demands. In view of the increasingly serious water situation of the country, Scenario 1 as the most restrained demand projection is considered the most practical and plausible choice. Scenario 2 is a demand projection in which past statistical tendencies were basically followed, and as such the projected demand in this scenario is treated as the target values with little regard to the restraining factors. In Scenario 3 too, statistical trends were taken into consideration, but with an eye to restraining factors. The consequences are that the projected demand in Scenario 3 is lower than in Scenario 2, but it turned out to be higher than in Scenario 1.

Irrigation water demand projection was conducted at the same time, taking into consideration such factors as decrease of groundwater abstraction, wastewater effluent reuse and water allocation among sectors. Final verification of the irrigation module was completed and the irrigation water demand was finalized.

1.5.1 Municipal Water

(1) Population

The population of Jordan by Governorate was projected for the target years of 2005, 2010, 2015 and 2020 for the three scenarios. Scenarios 1 and 2 represent the joint MWI/World Bank population projections. Scenario 3 reflects the most recent unpublished Department of Statistics (DOS) projections. As shown in Tables 1.5.1-1, Scenarios 1 and 2 are identical so far as the projected population is concerned.

As observed in Table 1.5.1-1, the population of Jordan is projected to nearly double in the 22 years from 1998 to 2020 in the first two scenarios. The projected population of Scenario 3 is less than that of other scenarios.

Table 1.5.1-1 Projection of Population by Governorate and by Target Year
Scenario 1

Governorate	1998	2005	2010	2015	2020
Amman	1,822,393	2,291,402	2,670,748	3,080,749	3,517,571
Zarqa	722,274	908,158	1,058,505	1,221,001	1,394,129
Mafraq	194,792	244,923	285,471	329,295	375,986
Irbid	857,936	1,078,734	1,257,320	1,450,338	1,655,982
Ajloun	117,276	147,458	171,870	198,255	226,365
Jerash	141,492	177,906	207,359	239,192	273,107
Balqa	318,269	400,178	466,429	538,033	614,321
Madaba	114,688	144,204	168,077	193,880	221,370
Karak	193,970	243,890	284,266	327,906	374,400
Ma'an	92,681	116,533	135,826	156,677	178,892
Tafielah	76,653	96,380	112,336	129,582	147,955
Aqaba	103,576	130,232	151,792	175,095	199,922
Total	4,756,000	5,980,000	6,970,000	8,040,000	9,180,000
Growth Rate/Yr		3.3%	3.1%	2.9%	2.7%

Scenario 2

Governorate	1998	2005	2010	2015	2020
Amman	1,822,393	2,291,402	2,670,748	3,080,749	3,517,571
Zarqa	722,274	908,158	1,058,505	1,221,001	1,394,129
Mafraq	194,792	244,923	285,471	329,295	375,986
Irbid	857,936	1,078,734	1,257,320	1,450,338	1,655,982
Ajloun	117,276	147,458	171,870	198,255	226,365
Jerash	141,492	177,906	207,359	239,192	273,107
Balqa	318,269	400,178	466,429	538,033	614,321
Madaba	114,688	144,204	168,077	193,880	221,370
Karak	193,970	243,890	284,266	327,906	374,400
Ma'an	92,681	116,533	135,826	156,677	178,892
Tafielah	76,653	96,380	112,336	129,582	147,955
Aqaba	103,576	130,232	151,792	175,095	199,922
Total	4,756,000	5,980,000	6,970,000	8,040,000	9,180,000
Growth Rate/Yr		3.3%	3.1%	2.9%	2.7%

Scenario 3

Governorate	1998	2005	2010	2015	2020
Amman	1,822,393	2,187,944	2,471,496	2,766,543	3,061,590
Zarqa	722,274	867,154	979,535	1,096,471	1,213,408
Mafraq	194,792	233,865	264,173	295,710	327,247
Irbid	857,936	1,030,028	1,163,517	1,302,418	1,441,318
Ajloun	117,276	140,800	159,048	178,035	197,022
Jerash	141,492	169,874	191,889	214,797	237,704
Balqa	318,269	382,110	431,631	483,159	534,687
Madaba	114,688	137,693	155,538	174,106	192,674
Karak	193,970	232,878	263,059	294,462	325,866
Ma'an	92,681	111,272	125,692	140,697	155,703
Tafielah	76,653	92,029	103,955	116,366	128,776
Aqaba	103,576	124,352	140,468	157,237	174,006
Total	4,756,000	5,710,000	6,450,000	7,220,000	7,990,000
Growth Rate/Yr		2.6%	2.5%	2.3%	2.0%

(2) Unit Water Supply Per Capita Per Day

The per capita per day water supply excluding the leakage and then including it is projected by target year for the three scenarios as shown in Table 1.5.1-2. As the table shows, Scenarios 2 and 3 are identical so far as the projected per capital per day water supply is concerned. The projected unit water supply of Scenario 1 is lower than that of other scenarios.

The per capita per day water supply excluding the leakage in the target years was projected taking into consideration the estimated total water availability, population, and industrial and irrigation water demand in each target year. It should be understood as an attainable maximum in a given target year. Regarding the leakage ratio, the final level was considered 15%, which was assumed to be attained in 2010. In this connection it is to be reminded that the Water Authority of Jordan is making an all-out effort nation-wide in this direction. Actual consumption as shown in Table 1.5.1-2 is to be considered the weighted average of the actual consumption on governorate basis.

Table 1.5.1-2 Projection of Unit Municipal Water Supply by Target Year and by Scenario

Scenario 1 (Unit: lcd)

Year	Unit Municipal Water Supply		Leakage Ratio
	Actual Consumption	Incl. Leakage	(%)
1998	102	136	25
2005	101	126	20
2010	124	146	15
2015	130	153	15
2020	128	151	15

Scenario 2 (Unit: lcd)

Year	Unit Municipal Water Supply		Leakage Ratio
	Actual Consumption	Incl. Leakage	(%)
1998	102	136	25
2005	101	126	20
2010	124	146	15
2015	144	169	15
2020	150	176	15

Scenario 3 (Unit: lcd)

Year	Unit Municipal Water Supply		Leakage Ratio
	Actual Consumption	Incl. Leakage	(%)
1998	102	136	25
2005	101	126	20
2010	124	146	15
2015	144	169	15
2020	150	176	15

(3) Demand Projection

Municipal water demand by Governorate was projected for the target years for the three scenarios based on the projected population and the projected per capita per day water supply including the leakage. The results are shown in Table 1.5.1-3. As the table shows, the demand in Scenario 1 is projected to reach slightly more than 500 MCM in 2020, which is more than double the demand in 1998. The demand in the final target year in Scenario 2 is projected to be a little less than 600 MCM, or nearly 2.5 times the current demand. The projected demand in 2020 in Scenario 3 is around 510 MCM, which is sandwiched between the values of other two scenarios.

Table 1.5.1-3 Projection of Municipal Water Demand by Scenario by Governorate and by Target Year

Scenario 1 (Unit: MCM)

Governorate	1998	2005	2010	2015	2020
Amman	85.14	99.94	136.69	167.98	191.80
Zarqa	32.35	38.50	53.19	65.95	76.02
Mafraq	19.25	18.74	21.88	22.49	20.77
Irbid	30.47	39.52	57.63	75.01	90.37
Ajloun	3.94	5.22	7.71	10.15	12.35
Jerash	4.54	6.14	9.16	12.17	14.90
Balqa	19.05	20.75	26.84	31.14	33.52
Madaba	11.72	11.29	13.11	13.34	12.16
Karak	9.35	10.87	14.77	18.02	20.45
Ma'an	6.86	7.08	8.76	9.65	9.82
Tafielah	2.35	3.24	4.89	6.55	8.08
Aqaba	12.05	11.37	12.90	12.67	11.01
Total	237.06	272.67	367.51	445.12	501.26

Scenario 2

(Unit: MCM)

Governorate	1998	2005	2010	2015	2020
Amman	85.14	99.94	136.80	186.19	224.95
Zarqa	32.35	38.50	53.19	73.07	89.09
Mafraq	19.25	18.74	21.88	24.82	24.24
Irbid	30.47	39.52	57.63	83.09	105.90
Ajloun	3.94	5.22	7.71	11.24	14.47
Jerash	4.54	6.14	9.16	13.47	17.47
Balqa	19.05	20.75	26.84	34.48	39.29
Madaba	11.72	11.29	13.11	14.74	14.23
Karak	9.35	10.87	14.77	19.96	23.96
Ma'an	6.86	7.08	8.76	10.68	11.46
Tafielah	2.35	3.24	4.89	7.25	9.46
Aqaba	12.05	11.37	12.90	14.09	12.89
Total	237.06	272.67	367.62	493.07	587.40

Scenario 3

(Unit: MCM)

Governorate	1998	2005	2010	2015	2020
Amman	85.14	95.42	126.77	167.43	195.33
Zarqa	32.35	36.77	49.28	65.70	77.36
Mafraq	19.25	17.89	20.27	22.32	21.05
Irbid	30.47	37.74	53.40	74.72	91.95
Ajloun	3.94	4.99	7.14	10.11	12.56
Jerash	4.54	5.86	8.49	12.11	15.17
Balqa	19.05	19.81	24.87	31.01	34.11
Madaba	11.72	10.78	12.15	13.26	12.36
Karak	9.35	10.38	13.68	17.95	20.80
Ma'an	6.86	6.76	8.11	9.61	9.95
Tafielah	2.35	3.09	4.53	6.52	8.22
Aqaba	12.05	10.86	11.95	12.67	11.19
Total	237.06	260.36	340.65	443.39	510.05

Note: Physical losses are included.

1.5.2 Industrial Water

(1) Inquiry to Main Industrial Users

The sampling questionnaire survey was conducted to the 9 big factories of Jordan. They were chosen as they consume the major part of industrial water, their products being potash, electricity, phosphate, cement and oil. (For more detail refer to the supporting report.) The survey's objective was to obtain the average values regarding the future growth of industrial water demand, seasonal variation of the demand, reuse ratio of industrial wastewater, etc. so that they might be used for planning purposes. The questions asked include main product, water consumption, monthly variation in water consumption, purpose of water use, availability of water treatment facility, future expansion plan and the disposal of wastewater. (For more details regarding the questionnaire and the survey results refer to the supporting report.)

Table 1.5.2-1 summarizes the results of the survey. In the table, 2. Projection of Annual Growth Rates of Water Demand (heretofore to be referred to as 2.), 3. Calculation of Seasonal Variation (referred to as 3.) and 4. Ratio of Wastewater Discharges to Water Demand (referred to as 4.) derived from 1. Data for Individual Factories (referred to as 1.).

"Ratio of Water Demand to 1998 Total (31536018 m^3)" in 1. means "the ratio of the water demand of a particular factory in a particular year to the total water demand of the 9 factories in 1998, which was 31,536,018 m^3". The ratio of a particular factory in 1998, therefore, means the factory's share in the total water consumption in the same year.

Also, "Ratio to 1998 Total" in 2. means "the ratio of the water demand of a particular group of factories in a particular year to the total water demand of the 9 factories in 1998, which was 31,536,018 m^3".

As 2. shows, the average annual growth rate of water demand of 8 factories from 1998 to 2005 is calculated at 1.80%. The 8 factories include 4 factories which replied that they did not have the facility expansion plan, which can mean that such a plan was not immediately available rather than they would not expand their facilities in the future. Factory 9 was excluded from consideration because its expansion plan is extraordinary.

4 factories replied that they have the expansion plan at least up to 2005. Out of them, 2 factories had the plan up to 2020. These 2 factories represent only 25% of the effective samples. On the other hand, 4 factories having the plan up to 2005 occupy 50% of them.

The average annual growth rate from 1998 to 2005 of water demand in the 4 factories is calculated at 2.9% as shown in 2. We think it reasonable and proper to apply this growth rate to the entire big factories. Also, we think it sensible to assume that the growth rate will be the same up to 2020. This growth rate was adopted for Scenario 3.

According to the MOP 5 Years Economic and Social Development Plan published in November, 1999, the government plans the annual growth rate of the manufacturing sector to be more than 6% from 1998 to 2003. Taking into consideration the current stage of economic development in the country, such positive planning is quite reasonable, although the reality is not proceeding as intended.

If industrial water demand is assumed to grow in parallel with industrial growth, 2.9% as the annual growth rate of industrial water demand appears to be on the low side. This may be due to the general tendency that the respondents answer in a conservative way

on such a matter.

The figures under the caption, "Seasonal Variation Weighted" in 3. were calculated, multiplying the figures under the caption, "Seasonal Variation" in 1. by the 1998 figures under the caption, "Ratio of Water Demand to 1998 Total (31,536,018 m^3)" in 1.

In 3., the figures under the caption, "Normalization" was worked out in such a way that the summation of the seasonal variation values in the 6 factories under the caption, "Seasonal Variation Weighted" will become 1.

It was found that there was no distinct seasonal variation in the industrial demand.

As 4. shows, the ratio of wastewater discharges to water consumed is calculated to be 28.5% on average. The destinations of the discharges are wadi, reuse in irrigation, public sewerage and recycling.

Table 1.5.2-1 Analysis of the Results of the Industrial Questionnaire Survey

1. Data for Individual Factories

Item		Factory 1	Factory 2	Factory 3	Factory 4	Factory 5	Factory 6	Factory 7	Factory 8	Factory 9
Consumption in 1998 (m^3)		9533347	915078	3619474	565556	121050	2227023	4532230	3522260	6500000
Annual Growth Rate	1998-1999	0.030	0.058	-0.019	0.000	-0.135	-0.018	0.078	0.086	-0.062
	1999-2005	0.048	-0.069	0.007	0.000	0.000	0.022	0.000	0.000	0.265
	2005-2010	0.000	0.000	0.005	0.000	0.000	0.051	0.000	0.000	
	2010-2015	0.000	0.000	0.020	0.000	0.000	0.000	0.000		
	2015-2020	0.000	0.000	0.014	0.000	0.000	0.071	0.000		
Seasonal Variation	Jan.	0.092			0.069		0.070	0.087	0.081	0.083
	Feb.	0.076			0.060		0.059	0.076	0.075	0.028
	Mar.	0.075			0.086		0.070	0.085	0.076	0.086
	Apr.	0.074			0.081		0.074	0.084	0.077	0.096
	May	0.079			0.105		0.089	0.088	0.082	0.100
	Jun.	0.079			0.092		0.090	0.087	0.087	0.090
	Jul.	0.087			0.093		0.090	0.082	0.093	0.083
	Aug.	0.096			0.087		0.102	0.077	0.084	0.072
	Sep.	0.085			0.076		0.088	0.082	0.101	0.083
	Oct.	0.083			0.074		0.093	0.080	0.080	0.095
	Nov.	0.085			0.091		0.095	0.084	0.080	0.093
	Dec.	0.089			0.086		0.080	0.088	0.083	0.091
Ratio of WW to	1998	0.008		0.175		0.030	0.314	0.800	0.182	0.431
Water Consumed	1999	0.008		0.175	0.354	0.035	0.320	0.800	0.162	0.443
Ratio of Water	1998	0.302	0.029	0.115	0.018	0.004	0.071	0.144	0.112	0.206
Demand to 1998	1999	0.311	0.031	0.113	0.018	0.003	0.069	0.155	0.121	0.193
Total (31536018 m^3)	2005	0.326	0.029	0.117	0.018	0.003	0.079	0.155	0.121	0.245
	2010			0.121			0.104			
	2015			0.134			0.104			
	2020			0.144			0.146			

2. Projection of Annual Growth Rates of Water Demand

Item		Ratio to 1998 Total	Annual Growth Rate
8 Factories	1998	0.794	
(No. 1 to 8)	1999	0.821	3.50%
	up to 2005	0.837	1.80%
4 Factories	1998	0.517	
(No. 1,2,3,6)	1999	0.524	1.40%
	up to 2005	0.539	2.90%
2 Factories	1998	0.186	
(No.3,6)	1999	0.182	-2.33%
	2005	0.197	1.30%
	2010	0.225	2.70%
	2015	0.238	1.10%
	2020	0.290	4.00%

3. Calculation of Seasonal Variation

Item		Factory 1	Factory 2	Factory 3	Factory 4	Factory 5	Factory 6	Factory 7	Factory 8	Factory 9
Seasonal Variation	Jan.	0.02785			0.00124		0.00494	0.01254	0.00905	0.01708
Weighted	Feb.	0.02299			0.00107		0.00414	0.01090	0.00838	0.00568
	Mar.	0.02268			0.00154		0.00493	0.01218	0.00849	0.01775
	Apr.	0.02247			0.00146		0.00525	0.01206	0.00860	0.01988
	May	0.02387			0.00189		0.00629	0.01265	0.00916	0.02059
	Jun.	0.02397			0.00166		0.00636	0.01247	0.00972	0.01864
	Jul.	0.02640			0.00167		0.00636	0.01173	0.01039	0.01704
	Aug.	0.02908			0.00155		0.00718	0.01111	0.00938	0.01491
	Sep.	0.02565			0.00136		0.00620	0.01184	0.01128	0.01704
	Oct.	0.02497			0.00132		0.00655	0.01152	0.00894	0.01953
	Nov.	0.02562			0.00162		0.00672	0.01206	0.00894	0.01917
	Dec.	0.02676			0.00155		0.00568	0.01265	0.00927	0.01882
Normalization	Jan.	0.03267			0.00146		0.00580	0.01471	0.01061	0.02003
	Feb.	0.02697			0.00126		0.00486	0.01279	0.00983	0.00666
	Mar.	0.02661			0.00181		0.00578	0.01429	0.00996	0.02082
	Apr.	0.02636			0.00171		0.00616	0.01415	0.01009	0.02332
	May	0.02800			0.00221		0.00738	0.01485	0.01074	0.02416
	Jun.	0.02812			0.00195		0.00747	0.01463	0.01140	0.02187
	Jul.	0.03098			0.00196		0.00747	0.01376	0.01219	0.01999
	Aug.	0.03412			0.00182		0.00842	0.01303	0.01101	0.01749
	Sep.	0.03009			0.00160		0.00727	0.01389	0.01323	0.01999
	Oct.	0.02930			0.00155		0.00769	0.01352	0.01048	0.02291
	Nov.	0.03006			0.00191		0.00789	0.01414	0.01048	0.02249
	Dec.	0.03139			0.00182		0.00666	0.01485	0.01088	0.02207

Average Seasonal	Jan.	0.085
Variation	Feb.	0.062
	Mar.	0.079
	Apr.	0.082
	May	0.087
	Jun.	0.085
	Jul.	0.086
	Aug.	0.086
	Sep.	0.086
	Oct.	0.085
	Nov.	0.087
	Dec.	0.088

4. Ratio of Wastewater Discharges to Water Consumed

Item	Factory 1	Factory 2	Factory 3	Factory 4	Factory 5	Factory 6	Factory 7	Factory 8	Factory 9	Total
Water Consumed, 1999	9,817,138		3,549,426	565,556	104,730	2,187,984	4,887,893	3,824,820	6,100,000	31,037,547
WW Discharged, 1999	80,000		620,000	200,000	3,650	700,000	3,910,314	620,000	2,700,000	8,833,964
Ratio of WW Discharges	0.8%		17.5%	35.4%	3.5%	32.0%	80.0%	16.2%	44.3%	28.5%

(2) Industrial Development Plan

The regular annual growth rate of industrial water demand is shown in the lower half of Table 1.5.2-2. The growth rate of Scenario 2 was projected using the logarithmic regression equation which was constructed based on the 1992 to 1999 data of the gross industrial output (real terms) of the country. (For details refer to the supporting report.) The growth rate of Scenario 1 was jointly projected by MWI and the World Bank and that of Scenario 3 is based on the sampling questionnaire survey as already mentioned.

Aside from the regular growth of demand, sudden expansion of demand based on industrial development plans, totaling 61.5 MCM as shown in the upper half of Table 1.5.2-2. was incorporated in each of the three scenarios.

Table 1.5.2-2 Projection of Industrial Water Demand Growth

Industrial Expansion Plan

(Unit: MCM)

Year	Oil Shale Operations	Electric Power Stations		Cyber City Industrial Park
	Karak Governorate	Zarqa Governorate		Irbid Governorate
		Wastewater	Fresh Water	
1998-2005	3.25	14.0	1.0	7.5
2005-2010	9.75	0.0	0.0	0.0
2010-2015	13.00	0.0	0.0	0.0
2015-2020	13.00	0.0	0.0	0.0
Total	39.00	14.0	1.0	7.5

Note: The demand is incremental and includes losses.

Regular Annual Growth Rate by Scenario

Scenario	1998-2005	2005-2010	2010-2015	2015-2020
Scenario 1 (World Bank)	4.2%	3.1%	2.1%	1.1%
Scenario 2 (Log. Regression)	5.3%	4.6%	4.6%	4.6%
Scenario 3 (Questionnaire Results)	2.9%	2.9%	2.9%	2.9%

(3) Potential of Wastewater Effluent Reuse

As shown in Item 4 in Table 1.5.2-3, the weighted average of the ratio of wastewater discharges to water consumed in the sampled 8 big factories is calculated at 28.5%. The destinations of the discharges are as shown below:

Table 1.5.2-3 Destinations of Industrial Wastewater Discharges

Item	Factory 1	Factory 2	Factory 3	Factory 4	Factory 5	Factory 6	Factory 7	Factory 8	Factory 9
Destinations of Discharges	Wadi	Irrigation	Recycling	Sewerage Irrigation	(No Ans.)	Irrigation	Wadi	Wadi	(No Ans.)

It can be said from the above table that industrial wastewater is mostly discharged to wadis or destined directly for reuse in irrigation. However, we cannot determine what percentage of the wastewater is discharged to the public sewerage as influent to the wastewater treatment plant.

MWI/World Bank assume that the ratio of industrial wastewater available for reuse to the industrial wastewater consumed is 14% for 1998 and project the future industrial wastewater reuse ratio as shown below:

Table 1.5.2-4 Projection of Industrial Wastewater Reuse Ratio

Item	1998	2005	2010	2015	2020
Reuse Ratio (%)	14	15	16	18	20

These ratios were adopted as common input parameters for the entire scenarios.

(4) Demand Projection

Based on the 1998 actual consumption of industrial water by Governorate, the projected annual growth rates, industrial development plans, projected wastewater reuse ratios, etc., industrial water demand was projected by Governorate, by target years and by scenario as shown in Table 1.5.2-5.

As the table shows, the industrial water demand is projected to be about 130 MCM or 3.3 times the demand in 1998 in the final target year of 2020 in Scenario 1. In Scenario 2 it comes to about 169 MCM, or 30% greater than in Scenario 1. The final demand of Scenario 3 is not so much different from that of Scenario 1 with about 132 MCM.

Table 1.5.2-5 Projection of Industrial Water Demand by Scenario, by Governorate and by Target Year

Scenario 1

(Unit: MCM)

Governorate	1998	2005	2010	2015	2020
Amman	0.86	1.14	1.33	1.48	1.56
Zarqa	6.14	22.42	23.64	24.59	25.13
Mafraq	0.25	0.30	0.35	0.38	0.40
Irbid	1.04	8.89	9.12	9.29	9.39
Ajloun	0.00	0.00	0.00	0.00	0.00
Jerash	0.00	0.00	0.00	0.00	0.00
Balqa	0.45	0.59	0.69	0.77	0.81
Madaba	0.17	0.23	0.26	0.29	0.31
Karak	11.72	18.39	30.64	45.57	59.67
Ma'an	7.22	9.32	10.86	12.05	12.72
Tafielah	5.29	6.75	7.86	8.73	9.22
Aqaba	5.81	8.05	9.38	10.41	10.99
Total	38.95	76.08	94.13	113.55	130.21

Scenario 2

(Unit: MCM)

Governorate	1998	2005	2010	2015	2020
Amman	0.86	1.23	1.54	1.93	2.41
Zarqa	6.14	22.98	24.70	27.52	30.67
Mafraq	0.25	0.32	0.40	0.50	0.63
Irbid	1.04	8.99	9.22	9.84	10.43
Ajloun	0.00	0.00	0.00	0.00	0.00
Jerash	0.00	0.00	0.00	0.00	0.00
Balqa	0.45	0.64	0.80	1.00	1.26
Madaba	0.17	0.24	0.31	0.38	0.48
Karak	11.72	19.55	33.14	51.55	70.99
Ma'an	7.22	10.03	12.56	15.73	19.69
Tafielah	5.29	7.27	9.10	11.39	14.27
Aqaba	5.81	8.82	9.81	14.10	17.83
Total	38.95	80.07	101.57	133.94	168.66

Scenario 3

(Unit: MCM)

Governorate	1998	2005	2010	2015	2020
Amman	0.86	1.05	1.21	1.39	1.61
Zarqa	6.14	21.79	22.84	24.04	25.43
Mafraq	0.25	0.27	0.31	0.36	0.42
Irbid	1.04	8.77	8.97	9.19	9.45
Ajloun	0.00	0.00	0.00	0.00	0.00
Jerash	0.00	0.00	0.00	0.00	0.00
Balqa	0.45	0.54	0.63	0.72	0.84
Madaba	0.17	0.21	0.24	0.28	0.32
Karak	11.72	17.12	29.00	44.46	60.29
Ma'an	7.22	8.54	9.85	11.36	13.11
Tafielah	5.29	6.18	7.13	8.23	9.49
Aqaba	5.81	7.38	8.51	9.82	11.33
Total	38.95	71.85	88.68	109.85	132.28

Note: Physical losses are included.

1.5.3 Touristic Water

(1) Touristic Development Plan

The regular annual growth rate of touristic water demand is shown in the lower half of Table 1.5.3-1. The growth rate of Scenario 1 was projected by MWI/World Bank. The growth rate of Scenarios 2 was projected using the logarithmic regression equation which was constructed based on the 1994 to 1999 data of tourist arrivals in the country, while that of Scenario 3 was projected using the simple regression equation constructed based on the above-mentioned data. (For details refer to the supporting report.)

Aside from the regular growth of demand, sudden expansion of demand based on the touristic development plan on the east coast of the Dead Sea, totaling 14 MCM as shown in the upper half of Table 1.5.3-1. was incorporated in each of the three scenarios.

Table 1.5.3-1 Projection of Touristic Water Demand Growth

Touristic Expansion Plan

(Unit: MCM)

Year	Touristic Infrastructure Project in East Coast of the Dead Sea	
	Balqa Governorate (Suweimeh)	Madaba Governorate (Zara)
1998-2005	2.45	2.22
2005-2010	2.45	2.22
2010-2015	2.45	2.22
2015-2020	0.00	0.00
Total	7.35	6.66

Note: The demand is incremental and includes losses.

Regular Annual Growth Rate by Scenario

Scenario	1998-2005	2005-2010	2010-2015	2015-2020
Scenario 1 (World Bank)	5.0%	5.0%	2.5%	2.5%
Scenario 2 (Log. Regression)	8.4%	8.3%	8.3%	8.3%
Scenario 3 (Simple Regression)	5.5%	4.3%	3.5%	3.0%

(2) Demand Projection

Based on the 1998 actual number of beds and water demand per bed by Governorate, the projected leakage ratios by Governorate, the projected average bed occupancy rate of 33%, seasonal variation of the bed occupancy rates, the projected annual growth rates, the touristic development plan, etc., touristic demand was projected by Governorate, by target years and by scenario as shown in Table 1.5.3-2.

As the table shows, the touristic water demand is projected to be about 16.4 MCM or 11.4 times the demand in 1998 in the final target year of 2020 in Scenario 1. In Scenario 2 it comes to about 21.3 MCM, or by 30% greater than in Scenario 1. The final demand of Scenario 3 is not so much different from that of Scenario 1 with about 17.0 MCM.

Table 1.5.3-2 Projection of Touristic Water Demand by Scenario, by Governorate and by Target Year

Scenario 1 (Unit: MCM)

Governorate	1998	2005	2010	2015	2020
Amman	0.77	1.02	1.23	1.39	1.57
Zarqa	0.01	0.01	0.02	0.02	0.02
Mafraq	0.00	0.00	0.00	0.00	0.00
Irbid	0.02	0.02	0.03	0.03	0.04
Ajloun	0.00	0.00	0.00	0.00	0.00
Jerash	0.00	0.00	0.00	0.00	0.00
Balqa	0.01	2.67	4.70	6.94	6.94
Madaba	0.00	2.35	4.41	6.55	6.56
Karak	0.01	0.01	0.01	0.02	0.02
Ma'an	0.10	0.13	0.16	0.18	0.20
Tafielah	0.00	0.00	0.00	0.00	0.00
Aqaba	0.52	0.69	0.83	0.94	1.06
Total	1.44	6.92	11.40	16.08	16.42

Scenario 2 (Unit: MCM)

Governorate	1998	2005	2010	2015	2020
Amman	0.77	1.28	1.79	2.67	3.98
Zarqa	0.01	0.02	0.02	0.04	0.06
Mafraq	0.00	0.00	0.01	0.01	0.01
Irbid	0.02	0.03	0.04	0.06	0.09
Ajloun	0.00	0.00	0.00	0.01	0.01
Jerash	0.00	0.00	0.00	0.00	0.01
Balqa	0.01	5.13	7.29	7.29	7.29
Madaba	0.00	3.29	6.56	6.57	6.60
Karak	0.01	0.02	0.02	0.03	0.05
Ma'an	0.10	0.16	0.23	0.34	0.51
Tafielah	0.00	0.00	0.00	0.00	0.01
Aqaba	0.52	0.86	1.21	1.80	2.69
Total	1.44	10.79	17.18	18.82	21.28

Scenario 3 (Unit: MCM)

Governorate	1998	2005	2010	2015	2020
Amman	0.77	1.06	1.23	1.46	1.69
Zarqa	0.01	0.01	0.02	0.02	0.02
Mafraq	0.00	0.00	0.00	0.00	0.00
Irbid	0.02	0.02	0.03	0.03	0.04
Ajloun	0.00	0.00	0.00	0.00	0.00
Jerash	0.00	0.00	0.00	0.00	0.00
Balqa	0.01	5.13	7.29	7.29	7.29
Madaba	0.00	3.28	6.55	6.55	6.56
Karak	0.01	0.01	0.01	0.02	0.02
Ma'an	0.10	0.13	0.16	0.18	0.22
Tafielah	0.00	0.00	0.00	0.00	0.00
Aqaba	0.52	0.71	0.83	0.98	1.14
Total	1.44	10.38	16.12	16.55	16.99

Note: Physical losses are included.

1.5.4 Irrigation Water

Irrigated Agriculture in Jordan is the largest user of water, constituting about 70% of the water use in the country. Of the total groundwater supplied to all uses in 1998 (485 MCM), irrigated agriculture consumption accounted for about 53%, at some 259?? MCM. Nearly 80% of the safe yield of the renewable groundwater resources and 40% of the non-renewable groundwater are currently used for irrigated agriculture throughout the country.

(1) Assumptions for Irrigation Water Demand Projection

Irrigation Demand projections were based on assumptions related to the following:

- Irrigated Areas in Relation to the Reference Year
- Cropping Pattern
- Distribution of irrigation methods
- Types of Distribution Systems
- Salinity of Irrigation Water
- Climatic conditions

1) Irrigated areas

Irrigated areas in the uplands were fixed at 59,576 ha, currently equipped with irrigation infrastructure (Table 1.5.4- 1). However, future irrigation requirements in the Jordan Rift Valley assume full development of the Jordan Rift Valley Irrigation System by the year 2010. Some 38,469 hectares are envisaged by the year 2005 as a result of JVA plans to develop additional 1,000 ha in the South Valley, 1,100 ha in Southern Ghors and 400 ha in Wadi Araba. Full development of the JRV is assumed to reach its peak at 42,729 hectares in the year 2010 (of which about 35,969 hectares are presently developed for irrigation). Assuming a cropping intensity of 110%, this translates to a total cropped area of around 42.2 thousands hectares and 46.8 thousands hectares, respectively. development of the Jordan Rift Valley Irrigation System at 38,469 hectares in 2005 and will reach its peak at 42,729 hectares by the year 2010 (of which about 35,969 hectares are presently developed for irrigation). Assuming a cropping intensity of 110%, this translates to a total cropped area of around 42.2 thousands hectares and 46.8 thousands hectares, respectively (Table 1.5.4-2).

Table 1.5.4- 1 Projected Irrigated Areas in the Uplands and Jordan Rift Valley (ha)

Gov.	1998	2005	2010	2015	2020
Up/Midland[1]	59,576	59,576	59,576	59,576	59,576
JRV[2, 3]	25,391	42,291	46,968	46,968	46,968
Total	84,967	101,867	106,544	106,544	106,544

[1]Source MOA
[2]Source JVA
[3]Contour Line <300 m

Table 1.5.4-2 Planned Development and Cropped Areas in the Jordan Rift Valley at 110% Crop Intensity.

JRV Region	Developed Area 1998	Irrigated Area 1998	Developed Area 2005	Developed Area 2010-2020	Cropped Area 2005	Cropped Area 2010-2020
North JV	11,812		11,812	14,765	12,993	16,242
Central JV	7,451		7,451	8,751	8,196	9,626
South JV	5,925		6,925	6,612	7,618	7,273
14.5km extension	5,985		5,985	6,225	6,584	6,848
Sub-Total	**31,173**	**19,946**	**32,173**	**36,353**	**35,390**	**39,988**
Southern Ghor I	4,596		4,596	4,590	5,056	5,049
Southern Ghor II	0		1,100	1,186	1,100	1,186
Wadi Araba	200		600	600	600	600
Sub-Total	**4,796**	**5,299**	**6,296**	**6,376**	**6,756**	**6,835**
Total	**35,969**	**25,245**	**38,469**	**42,729**	**42,146**	**46,823**
Aqaba[1]		**145**			**145**	**145**
Grand Total JRV		**25,391**			**42,291**	**46,968**

Source JVA
[1]Source MOA 2000

2) Cropping patterns:

Cropping Patterns in both the Jordan Rift Valley and the Uplands were assumed during the planning horizon to remain similar to that prevailing in 1998. Cropping patterns for that year were aggregated per governorate in the upland areas and per region in the Jordan Valley.

3) Distribution of irrigation methods:

Water saving is assumed to be incurred as a result of improvements in on-farm application efficiency and distribution (system) and conveyance efficiency. Hence gradual replacement of surface irrigation methods with drip irrigation is considered wherever such replacement is possible throughout the JRV and the uplands. Results are shown in Table 1.5.4-3 and -4.

4) Types of Distribution Systems:

Improvement in system efficiency in the uplands is envisaged through cement lining of earth canals. Currently water originating from springs and wadis in the uplands is either delivered to farms by earth canals or lined canals. The substitution of open earth ditches with concrete lined ditches is a task undertaken by WAJ, since the 1980's. Table 1.5.4- 5 shows the projected improvement in System efficiency as a result of progressive lining of earth canals in uplands areas wherever they are in use.

Table 1.5.4- 5 Projected Improvement in System Efficiency Due to lining of Canals in the Uplands

Governorate	1998	2005	2010	2015	2020
Amman	96.89%	97.05%	97.21%	97.38%	97.54%
Zarqa	97.06%	97.21%	97.37%	97.52%	97.67%
Mafraq	97.83%	97.86%	97.89%	97.92%	97.94%
Irbid	93.18%	93.93%	94.67%	95.41%	96.16%
Ajloun	82.28%	84.71%	87.14%	89.56%	91.99%
Jarash	87.51%	89.13%	90.75%	92.37%	93.99%
Balqa	94.46%	95.00%	95.55%	96.10%	96.64%
Madaba	95.33%	95.72%	96.11%	96.50%	96.89%
Karak	87.57%	89.18%	90.78%	92.39%	93.99%
Maan	97.71%	97.75%	97.80%	97.85%	97.89%
Tafila	88.07%	89.68%	91.30%	92.92%	94.54%
Aqaba	97.82%	97.85%	97.88%	97.91%	97.93%
Ma'an: Disi	98.00%	98.00%	98.00%	98.00%	98.00%
Aqaba: Disi	98.00%	98.00%	98.00%	98.00%	98.00%

Based on the above, the foreseeable improvement in overall Irrigation efficiency (System and Application efficiency) is shown in Table 1.5.4-6 and -7 for both the uplands and each region of the JRV, respectively.

Table 1.5.4- 6 Projected Improvements in Overall Efficiency in the Uplands

Governorate	Projected Overall Efficiency			
	2005	2010	2015	2020
Amman	79.71	79.99	80.38	81.18
Zarqa	76.02	77.21	78.52	80.27
Mafraq	80.39	80.63	80.91	81.41
Irbid - Uplands	71.95	73.74	75.78	78.86
Ajloun - Uplands	58.12	61.86	66.17	72.51
Jarash	65.39	67.68	70.50	75.37
Balqa - Uplands	76.13	76.99	78.04	79.84
Madaba - Uplands	78.32	78.84	79.48	80.57
Al Karak - Uplands	67.96	70.06	72.53	76.44
Ma'an Excl. Mudawwara & Disi Ma'an	78.89	79.52	80.26	81.39
Ma'an - Mudawwara & Disi_Ma'an	72.89	72.93	72.96	0.00
Al Tafila Uplands	69.06	70.71	72.77	76.48
Aqaba Excl. Disi Aqaba & W. Araba North	79.30	79.91	80.59	81.56
Aqaba - Disi Aqaba	75.32	75.34	75.36	75.39

Table 1.5.4- 7: Estimated Improvement in Overall Efficiency in the Jordan Rift Valley

Year	Area ('000Du.)	Drip %	Sprink. %	Surf. %	Wtd. App. Eff. %	System Eff %	Overall Eff.%
N. Valley (Z1)							
1998	148.46	32.16	0.60	67.20	67.79	98.00	66.43
2005	211.89	53.69	10.97	35.34	74.53	98.00	73.04
2010	258.68	63.64	17.06	19.30	77.83	98.00	76.28
2015	258.68	66.56	17.96	15.48	78.67	98.00	77.10
2020	258.68	69.49	30.51	0.00	81.25	98.00	79.63
S. Valley (Z2)							
1998	51.01	67.77	1.15	31.21	76.51	98.00	74.98
2005	142.01	92.30	4.24	3.46	82.79	98.00	81.13
2010	141.21	93.74	4.16	2.11	83.12	98.00	81.46
2015	141.21	94.66	4.28	1.05	83.36	98.00	81.69
2020	141.21	95.59	3.71	0.00	83.08	98.00	81.42
S. Ghors, W. Araba, & S. JRV							
1998	54.44	91.12	2.68	5.85	82.06	98.00	80.42
2005	69.01	91.03	5.30	3.67	82.64	98.00	80.99
2010	69.80	91.28	6.26	2.46	82.85	98.00	81.19
2015	69.80	91.46	6.31	2.24	82.90	98.00	81.24
2020	69.80	91.63	8.37	0.00	83.25	98.00	81.58
Jordan Rift Valley							
1998	253.91	51.95	1.16	46.82	72.60	98.00	71.15
2005	422.91	72.75	7.78	19.47	78.63	98.00	77.05
2010	469.68	76.79	11.58	11.63	80.17	98.00	78.56
2015	469.68	78.71	12.12	9.17	80.71	98.00	79.09
2020	469.68	80.62	19.17	0.00	82.10	98.00	80.46

5) Salinity of Irrigation Water:

Four salinity classes have been identified. These are shown in Table 1.5.4- 8, below. Leaching requirements is assumed for Salinity Class II for all the JRV regions except for the North Jordan Valley and the Southern Ghors, where water salinity is expected to remain within Class 1 salinity range. Hence, adequate amounts of water are assumed to be available for leaching depending on the water salinity class and the crop type.

Table 1.5.4- 8: Salinity Classes

S-Description		TDS_MIN	TDS_MAX	TDS(mg/l)
Salinity Class 1	mg/l	0	1000	500
	mmhos/cm	0	1.4	0.7
Salinity Class 2	mg/l	1000	2000	1500
	mmhos/cm	1.4	2.9	2
Salinity Class 3	mg/l	2000	2800	2450
	mmhos/cm	2.9	4	3.5
Salinity Class 4	mg/l	2800	50000	28000
	mmhos/cm	4	72	40

Where by 1dS/m = 700mg/l
1dS/m = 1mmhos/cm=1000microS/cm

6) Climatic Conditions:

Irrigation water requirements as well as other domestic water sectors in this study were computed under long term average precipitation. Irrigation water demand shall be considered in various climatic conditions (median, dry and wet). Water availability during dry years on satisfying water demands in general including irrigation were discussed in Chapter 5.

Table 1.5.4- 3 1/2 JRV Projected Areas and Distribution of Irrigation Methods

Irbid_N.Valley (Zone 1)	**1998**				**2005**				**2010**				**2015**				**2020**			
Main Crop Group (M_CG)	Area	Drip	Sprink.	Surf.	Area	Drip	Sprink.	Surf.	Area	Drip	Sprink.	Surf.	Area	Drip	Sprink.	Wtd Eff.	Area	Drip	Sprink.	Surf.
Vegetables Summer	20.67	50.83	1.99	47.18	28.02	72.80	1.10	26.10	35.03	85.50	0.59	13.92	35.03	92.75	0.29	82.30	35.03	100.00	0.00	0.00
Vegetables Winter	12.19	51.00	2.00	47.00	16.52	72.90	1.11	26.00	20.65	85.55	0.59	13.86	20.65	92.77	0.29	82.31	20.65	100.00	0.00	0.00
Fruit Trees	49.38	3.22	0.37	96.41	66.96	28.63	18.05	53.33	83.69	42.90	28.66	28.44	83.69	42.90	28.55	74.58	83.69	42.90	57.10	0.00
Olives	1.32	45.44	0.07	54.49	1.78	59.76	10.10	30.14	2.23	67.81	16.12	16.07	2.23	67.81	16.09	78.69	2.23	67.81	32.19	0.00
Vegetables Summer Plastic	2.67	100.00	0.00	0.00	3.62	100.00	0.00	0.00	4.53	100.00	0.00	0.00	4.53	100.00	0.00	84.00	4.53	100.00	0.00	0.00
Vegetables Winter Plastic	0.05	100.00	0.00	0.00	0.07	100.00	0.00	0.00	0.08	100.00	0.00	0.00	0.08	100.00	0.00	84.00	0.08	100.00	0.00	0.00
Field Crops Summer	6.45	4.00	0.00	96.00	8.74	2.95	43.95	53.10	10.93	2.36	69.32	28.32	10.93	2.36	83.48	73.09	10.93	2.36	97.64	0.00
Field Crops Winter	0.10	0.00	0.00	0.00	0.14	0.00	26.25	73.75	0.17	0.00	60.67	39.33	0.17	0.00	80.33	72.05	0.17	0.00	100.00	0.00
Bananas	2.92	25.91	0.00	74.09	3.96	45.36	13.66	40.98	4.95	56.29	21.86	21.86	4.95	56.29	21.86	76.79	4.95	56.29	43.71	0.00
Other Categories	0.08	51.00	2.00	47.00	0.11	72.90	1.11	26.00	0.14	85.55	0.59	13.86	0.14	92.77	0.29	82.31	0.14	100.00	0.00	0.00
Total	95.82	23.67	**0.88**	75.34	129.93	45.03	**13.22**	41.75	162.42	57.15	**20.59**	22.27	162.42	59.64	**21.40**	77.52	162.42	62.13	**37.87**	0.00
Balqa_N.Valley (Zone 1)	**1998**				**2005**				**2010**				**2015**				**2020**			
Main Crop Group (M_CG)	Area	Drip	Sprink.	Surf.	Area	Drip	Sprink.	Surf.	Area	Drip	Sprink.	Surf.	Area	Drip	0.91	Wtd Eff.	Area	Drip	Sprink.	Surf.
Vegetables Summer	23.18	58.00	0.00	42.00	36.09	79.77	0.00	20.23	42.39	88.52	0.00	11.48	42.39	94.26	0.00	82.62	42.39	100.00	0.00	0.00
Vegetables Winter	10.25	58.00	0.00	42.00	15.95	79.77	0.00	20.23	18.74	88.52	0.00	11.48	18.74	94.26	0.00	82.62	18.74	100.00	0.00	0.00
Fruit Trees	11.30	20.42	0.07	79.51	17.59	48.89	12.81	38.30	20.66	56.48	21.78	21.74	20.66	56.48	21.76	76.82	20.66	56.48	43.52	0.00
Olives	0.28	0.64	0.04	99.33	0.44	36.18	15.97	47.85	0.52	45.66	27.18	27.16	0.52	45.66	27.17	75.03	0.52	45.66	54.34	0.00
Vegetables Summer Plastic	2.61	100.00	0.00	0.00	4.07	100.00	0.00	0.00	4.77	100.00	0.00	0.00	4.77	100.00	0.00	84.00	4.77	100.00	0.00	0.00
Vegetables Winter Plastic	0.03	100.00	0.00	0.00	0.04	100.00	0.00	0.00	0.05	100.00	0.00	0.00	0.05	100.00	0.00	84.00	0.05	100.00	0.00	0.00
Field Crops Summer	4.73	14.00	1.00	86.00	7.36	8.99	50.22	40.78	8.65	7.66	69.19	23.15	8.65	7.66	80.77	73.95	8.65	7.66	92.34	0.00
Field Crops Winter	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bananas	0.16	0.00	0.00	100.00	0.25	35.77	16.06	48.17	0.30	45.31	27.34	27.34	0.30	45.31	27.34	74.98	0.30	45.31	54.69	0.00
Other Categories	0.10	58.00	0.00	42.00	0.16	79.77	0.00	20.23	0.19	88.52	0.00	11.48	0.19	94.26	0.00	82.62	0.19	100.00	0.00	0.00
Total	52.64	47.60	0.10	52.39	81.96	67.42	7.40	25.18	96.26	74.59	11.12	14.29	96.26	78.24	12.16	80.60	96.26	81.90	18.10	0.00
Balqa_S.Valley (Zone 2): Excl. 14 Km Ext	**1998**				**2005**				**2010**				**2015**				**2020**			
Main Crop Group (M_CG)	Area	Drip	Sprink.	Surf.	Area	Drip	Sprink.	Surf.	Area	Drip	Sprink.	Surf.	Area	Drip	Sprink.	Wtd Eff.	Area	Drip	Sprink.	Surf.
Vegetables Summer	6.11	58.73	0.05	41.23	18.37	89.71	0.01	10.28	17.54	93.14	0.01	6.85	17.54	96.57	0.00	83.18	17.54	100.00	0.00	0.00
Vegetables Winter	6.94	58.64	0.04	41.32	20.87	89.69	0.01	10.30	19.93	93.13	0.01	6.87	19.93	96.56	0.00	83.18	19.93	100.00	0.00	0.00
Fruit Trees	5.32	90.73	7.63	1.64	16.01	96.92	2.67	0.41	15.29	100.00	0.00	0.00	15.29	100.00	0.00	84.00	15.29	100.00	0.00	0.00
Olives	0.62	85.00	0.00	15.00	1.87	95.01	1.25	3.74	1.79	99.51	0.16	0.33	1.79	99.51	0.24	83.92	1.79	99.51	0.49	0.00
Vegetables Summer Plastic	0.54	100.00	0.00	0.00	1.62	100.00	0.00	0.00	1.54	100.00	0.00	0.00	1.54	100.00	0.00	84.00	1.54	100.00	0.00	0.00
Vegetables Winter Plastic	0.02	100.00	0.00	0.00	0.07	100.00	0.00	0.00	0.07	100.00	0.00	0.00	0.07	100.00	0.00	84.00	0.07	100.00	0.00	0.00
Field Crops Summer	0.82	14.00	1.00	86.00	2.45	4.65	74.24	21.11	2.34	4.87	83.54	11.58	2.34	4.87	89.33	74.57	2.34	4.87	95.13	0.00
Field Crops Winter	0.25	14.00	1.00	86.00	0.75	4.65	74.24	21.11	0.72	4.87	83.54	11.58	0.72	4.87	89.33	74.57	0.72	4.87	95.13	0.00
Bananas	4.50	100.00	0.00	0.00	13.53	100.00	0.00	0.00	12.91	100.00	0.00	0.00	12.91	100.00	0.00	84.00	12.91	100.00	0.00	0.00
Other Categories	0.21	58.00	0.00	42.00	0.63	89.53	0.00	10.47	0.60	93.02	0.00	6.98	0.60	96.51	0.00	83.16	0.60	100.00	0.00	0.00
Total	25.32	72.43	**1.67**	25.94	76.18	89.82	**3.72**	6.45	72.73	92.39	**3.52**	4.09	72.73	94.19	**3.77**	83.17	72.73	95.98	**4.02**	0.00
Balqa_S.Valley (Zone 2):14Km Ext.	**1998**				**2005**				**2010**				**2015**				**2020**			
Main Crop Group (M_CG)	Area	Drip	Sprink.	Surf.	Area	Drip	Sprink.	Surf.	Area	Drip	Sprink.	Surf.	Area	Drip	Sprink.	Wtd Eff.	Area	Drip	Sprink.	Surf.
Vegetables Summer	0.00	0.00	0.00	0.00	11.48	100.00	0.00	0.00	11.94	100.00	0.00	0.00	11.94	100.00	0.00	84.00	11.94	100.00	0.00	0.00
Vegetables Winter	0.00	0.00	0.00	0.00	28.04	100.00	0.00	0.00	29.17	100.00	0.00	0.00	29.17	100.00	0.00	84.00	29.17	100.00	0.00	0.00
Fruit Trees	0.00	0.00	0.00	0.00	3.16	100.00	0.00	0.00	3.29	100.00	0.00	0.00	3.29	100.00	0.00	84.00	3.29	100.00	0.00	0.00
Olives	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Vegetables Summer Plastic	0.00	0.00	0.00	0.00	0.17	100.00	0.00	0.00	0.18	100.00	0.00	0.00	0.18	100.00	0.00	84.00	0.18	100.00	0.00	0.00
Vegetables Winter Plastic	0.00	0.00	0.00	0.00	9.57	100.00	0.00	0.00	9.96	100.00	0.00	0.00	9.96	100.00	0.00	84.00	9.96	100.00	0.00	0.00
Field Crops Summer	0.00	0.00	0.00	0.00	0.72	0.00	100.00	0.00	0.75	0.00	100.00	0.00	0.75	0.00	100.00	75.00	0.75	0.00	100.00	0.00
Field Crops Winter	0.00	0.00	0.00	0.00	2.46	0.00	100.00	0.00	2.55	0.00	100.00	0.00	2.55	0.00	100.00	75.00	2.55	0.00	100.00	0.00
Bananas	0.00	0.00	0.00	0.00	10.23	100.00	0.00	0.00	10.64	100.00	0.00	0.00	10.64	100.00	0.00	84.00	10.64	100.00	0.00	0.00
Other Categories	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.00	0.00	0.00	0.00	65.84	95.17	4.83	0.00	68.48	95.17	4.83	0.00	68.48	95.17	4.83	83.57	68.48	95.17	4.83	0.00
Balqa_S.Valley (Zone 2): Wells	**1998**				**2005**				**2010**				**2015**				**2020**			
Main Crop Group (M_CG)	Area	Drip	Sprink.	Surf.	Area	Drip	Sprink.	Surf.	Area	Drip	Sprink.	Surf.	Area	Drip	Sprink.	Wtd Eff.	Area	Drip	Sprink.	Surf.
Vegetables Summer	3.92	74.00	1.00	25.00																
Vegetables Winter	6.90	74.00	1.00	25.00																
Fruit Trees	1.44	77.00	0.00	23.00																
Olives	0.44	77.00	0.00	23.00																
Vegetables Summer Plastic	0.21	100.00	0.00	0.00																
Vegetables Winter Plastic	0.79	100.00	0.00	0.00	**Analysis Included in Balqa_S.Valley (Zone 2):14Km Ext.**															
Field Crops Summer	0.00	0.00	0.00	0.00																
Field Crops Winter	5.49	14.00	1.00	86.00																
Bananas	6.50	77.00	0.00	23.00																
Other Categories	0.00	0.00	0.00	0.00																
Total	25.68	63.17	**0.64**	36.40																
Karak_S.Ghors (Zone 3)	**1998**				**2005**				**2010**				**2015**				**2020**			
Main Crop Group (M_CG)	Area	Drip	Sprink.	Surf.	Area	Drip	Sprink.	Surf.	Area	Drip	Sprink.	Surf.	Area	Drip	Sprink.	Wtd Eff.	Area	Drip	Sprink.	Surf.
Vegetables Summer	11.58	100.00	0.00	0.00	14.15	100.00	0.00	0.00	14.34	100.00	0.00	0.00	14.34	100.00	0.00	84.00	14.34	100.00	0.00	0.00
Vegetables Winter	32.09	100.00	0.00	0.00	39.22	100.00	0.00	0.00	39.73	100.00	0.00	0.00	39.73	100.00	0.00	84.00	39.73	100.00	0.00	0.00
Fruit Trees	0.68	52.00	0.00	48.00	0.83	60.73	9.82	29.45	0.84	61.23	19.39	19.39	0.84	61.23	19.39	77.60	0.84	61.23	38.77	0.00
Olives	0.05	52.00	0.00	48.00	0.06	60.73	9.82	29.45	0.06	61.23	19.39	19.39	0.06	61.23	19.39	77.60	0.06	61.23	38.77	0.00
Vegetables Summer Plastic	0.01	100.00	0.00	0.00	0.01	100.00	0.00	0.00	0.01	100.00	0.00	0.00	0.01	100.00	0.00	84.00	0.01	100.00	0.00	0.00
Vegetables Winter Plastic	0.19	100.00	0.00	0.00	0.24	100.00	0.00	0.00	0.24	100.00	0.00	0.00	0.24	100.00	0.00	84.00	0.24	100.00	0.00	0.00
Field Crops Summer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Field Crops Winter	0.87	66.00	0.00	34.00	1.06	54.00	25.14	20.86	1.08	53.31	32.96	13.73	1.08	53.31	39.82	78.77	1.08	53.31	46.69	0.00
Bananas	4.89	52.00	0.00	48.00	5.97	60.73	9.82	29.45	6.05	61.23	19.39	19.39	6.05	61.23	19.39	77.60	6.05	61.23	38.77	0.00
Other Categories	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 1.5.4- 3 2/2 JRV Projected Areas and Distribution of Irrigation Methods

Aqaba_N.W.Araba (Zone 3)	**1998**				**2005**	**0.98**			**2010**				**2015**				**2020**			
Main Crop Group (M_CG)	Area	Drip	Sprink.	Surf.	Area	Drip	Sprink.	Surf.	Area	Drip	Sprink.	Surf.	Area	Drip	Sprink.	Wtd Eff.	Area	Drip	Sprink.	Surf.
Vegetables Summer	1.20	60.00	35.00	5.00	2.74	86.85	11.51	1.64	2.74	91.23	7.67	1.10	2.74	95.62	3.84	83.52	2.74	100.00	0.00	0.00
Vegetables Winter	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fruit Trees	0.03	89.00	0.00	11.00	0.07	95.18	1.21	3.62	0.07	95.18	1.61	3.21	0.07	95.18	2.41	83.20	0.07	95.18	4.82	0.00
Olives	0.40	89.00	0.00	11.00	0.91	95.18	1.21	3.62	0.91	95.18	1.61	3.21	0.91	95.18	2.41	83.20	0.91	95.18	4.82	0.00
Vegetables Summer Plastic	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Vegetables Winter Plastic	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Field Crops Summer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Field Crops Winter	1.00	0.00	100.00	0.00	2.28	0.00	100.00	0.00	2.28	0.00	100.00	0.00	2.28	0.00	100.00	75.00	2.28	0.00	100.00	0.00
Bananas	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Other Categories	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	2.63	41.93	53.99	4.08	6.00	55.19	43.47	1.34	6.00	57.19	41.79	1.03	6.00	59.19	40.17	80.23	6.00	61.19	38.81	0.00
Aqaba_JRV (Zone 12)	**1998**	**0.98**	**1.00**	**0.00**	**2005**	**0.98**	**1.00**	**0.00**	**2010**	**0.98**	**1.00**	**0.00**	**2015**	**0.98**	**1.00**	**0.00**	**2020**	**0.98**	**1.00**	**0.00**
Main Crop Group (M_CG)	Area	Drip	Sprink.	Surf.	Area 2005	Drip	Sprink.	Surf.	Area 2010	Drip	Sprink.	Surf.	Area 2015	Drip	Sprink.	Wtd Eff.	Area 2020	Drip	Sprink.	Surf.
Vegetables Summer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Vegetables Winter	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fruit Trees	1.14	89.00	0.00	11.00	1.14	89.00	2.75	8.25	1.14	89.00	3.67	7.33	1.14	89.00	5.50	82.19	1.14	89.00	11.00	0.00
Olives	0.01	89.00	0.00	11.00	0.01	89.00	2.75	8.25	0.01	89.00	3.67	7.33	0.01	89.00	5.50	82.19	0.01	89.00	11.00	0.00
Vegetables Summer Plastic	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Vegetables Winter Plastic	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Field Crops Summer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Field Crops Winter	0.30	37.00	13.00	50.00	0.30	37.00	25.50	37.50	0.30	37.00	38.00	25.00	0.30	37.00	50.50	76.46	0.30	37.00	63.00	0.00
Bananas	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Other Categories	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	1.45	78.25	2.69	19.06	1.45	78.25	7.45	14.30	1.45	78.25	10.77	10.99	1.45	78.25	14.80	81.00	1.45	78.25	21.75	0.00
Total Areas in Dunums	**253.91**				**422.91**				**469.68**				**469.68**				**469.68**			

Table 1.5.4- 4 1/2 Upland Projected Areas and Distribution of Irrigation Methods

Gov:Amman	**1998**				**2005**				**2010**				**2015**				**2020**	**0.9754**		
Main Crop Group (M_CG)	Area[1]	Drip	Sprinkler	Surface	Area	Drip	Sprinkler	Surface	Area	Drip	Sprinkler	Surface	Area	Drip	Sprinkler	Surface	Area	Drip	Sprinkler	Surface
Vegetables Summer	12.80	96.00	3.00	1.00	12.80	97.00	2.25	0.75	12.80	98.00	1.50	0.50	12.80	99.00	0.75	0.25	12.80	100.00	0.00	0.00
Vegetables Winter	12.32	96.00	3.00	1.00	12.32	97.00	2.25	0.75	12.32	98.00	1.50	0.50	12.32	99.00	0.75	0.25	12.32	100.00	0.00	0.00
Fruit Trees	29.77	86.00	0.00	14.00	29.77	86.00	3.50	10.50	29.77	86.00	4.67	9.33	29.77	86.00	7.00	7.00	29.77	86.00	14.00	0.00
Olives	10.93	86.00	0.00	14.00	10.93	86.00	3.50	10.50	10.93	86.00	4.67	9.33	10.93	86.00	7.00	7.00	10.93	86.00	14.00	0.00
Vegetables Summer Plastic	0.97	100.00	0.00	0.00	0.97	100.00	0.00	0.00	0.97	100.00	0.00	0.00	0.97	100.00	0.00	0.00	0.97	100.00	0.00	0.00
Vegetables Winter Plastic	0.82	100.00	0.00	0.00	0.82	100.00	0.00	0.00	0.82	100.00	0.00	0.00	0.82	100.00	0.00	0.00	0.82	100.00	0.00	0.00
Field Crops Summer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Field Crops Winter	0.18	37.00	13.00	50.00	0.18	37.00	25.50	37.50	0.18	37.00	38.00	25.00	0.18	37.00	50.50	12.50	0.18	37.00	63.00	0.00
Bananas	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Other Categories	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	67.79	89.95	1.15	8.90	67.79	90.32	3.00	6.68	67.79	90.69	3.46	5.85	67.79	91.06	4.61	4.33	67.79	91.43	8.57	0.00
Gov:Zarqa	**1998**				**2005**				**2010**				**2015**				**2020**			
Main Crop Group (M_CG)	Area	Drip	Sprinkler	Surface	Area	Drip	Sprinkler	Surface	Area	Drip	Sprinkler	Surface	Area	Drip	Sprinkler	Surface	Area	Drip	Sprinkler	Surface
Vegetables Summer	16.51	51.60	0.00	48.40	16.51	63.70	0.00	36.30	16.51	75.80	0.00	24.20	16.51	87.90	0.00	12.10	16.51	100.00	0.00	0.00
Vegetables Winter	2.93	26.07	0.00	73.93	2.93	44.55	0.00	55.45	2.93	63.03	0.00	36.97	2.93	81.52	0.00	18.48	2.93	100.00	0.00	0.00
Fruit Trees	9.19	87.00	0.00	13.00	9.19	87.00	3.25	9.75	9.19	87.00	4.33	8.67	9.19	87.00	6.50	6.50	9.19	87.00	13.00	0.00
Olives	65.45	87.00	0.00	13.00	65.45	87.00	3.25	9.75	65.45	87.00	4.33	8.67	65.45	87.00	6.50	6.50	65.45	87.00	13.00	0.00
Vegetables Summer Plastic	0.04	100.00	0.00	0.00	0.04	100.00	0.00	0.00	0.04	100.00	0.00	0.00	0.04	100.00	0.00	0.00	0.04	100.00	0.00	0.00
Vegetables Winter Plastic	0.07	100.00	0.00	0.00	0.07	100.00	0.00	0.00	0.07	100.00	0.00	0.00	0.07	100.00	0.00	0.00	0.07	100.00	0.00	0.00
Field Crops Summer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Field Crops Winter	12.10	3.00	0.00	97.00	12.10	3.00	24.25	72.75	12.10	3.00	48.50	48.50	12.10	3.00	72.75	24.25	12.10	3.00	97.00	0.00
Bananas	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Other Categories	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	106.28	70.27	0.00	29.73	106.28	72.66	5.04	22.30	106.28	75.05	8.56	16.39	106.28	77.44	12.85	9.71	106.28	79.83	20.17	0.00
Gov:Mafraq	**1998**				**2005**				**2010**				**2015**				**2020**			
Main Crop Group (M_CG)	Area	Drip	Sprinkler	Surface	Area	Drip	Sprinkler	Surface	Area	Drip	Sprinkler	Surface	Area	Drip	Sprinkler	Surface	Area	Drip	Sprinkler	Surface
Vegetables Summer	78.90	100.00	0.00	0.00	78.90	100.00	0.00	0.00	78.90	100.00	0.00	0.00	78.90	100.00	0.00	0.00	78.90	100.00	0.00	0.00
Vegetables Winter	8.35	100.00	0.00	0.00	8.35	100.00	0.00	0.00	8.35	100.00	0.00	0.00	8.35	100.00	0.00	0.00	8.35	100.00	0.00	0.00
Fruit Trees	30.24	89.00	0.00	11.00	30.24	89.00	2.75	8.25	30.24	89.00	3.67	7.33	30.24	89.00	5.50	5.50	30.24	89.00	11.00	0.00
Olives	36.76	89.00	0.00	11.00	36.76	89.00	2.75	8.25	36.76	89.00	3.67	7.33	36.76	89.00	5.50	5.50	36.76	89.00	11.00	0.00
Vegetables Summer Plastic	0.18	100.00	0.00	0.00	0.18	100.00	0.00	0.00	0.18	100.00	0.00	0.00	0.18	100.00	0.00	0.00	0.18	100.00	0.00	0.00
Vegetables Winter Plastic	0.20	100.00	0.00	0.00	0.20	100.00	0.00	0.00	0.20	100.00	0.00	0.00	0.20	100.00	0.00	0.00	0.20	100.00	0.00	0.00
Field Crops Summer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Field Crops Winter	14.48	37.00	13.00	50.00	14.48	37.00	25.50	37.50	14.48	37.00	38.00	25.00	14.48	37.00	50.50	12.50	14.48	37.00	63.00	0.00
Bananas	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Other Categories	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	169.10	90.25	1.11	8.64	169.10	90.25	3.27	6.48	169.10	90.25	4.71	5.05	169.10	90.25	6.50	3.25	169.10	90.25	9.75	0.00
Gov:Irbid - Uplands	**1998**				**2005**				**2010**				**2015**				**2020**			
Main Crop Group (M_CG)	Area	Drip	Sprinkler	Surface	Area	Drip	Sprinkler	Surface	Area	Drip	Sprinkler	Surface	Area	Drip	Sprinkler	Surface	Area	Drip	Sprinkler	Surface
Vegetables Summer	2.57	21.00	0.00	79.00	2.57	40.75	0.00	59.25	2.57	60.50	0.00	39.50	2.57	80.25	0.00	19.75	2.57	100.00	0.00	0.00
Vegetables Winter	0.81	21.00	0.00	79.00	0.81	40.75	0.00	59.25	0.81	60.50	0.00	39.50	0.81	80.25	0.00	19.75	0.81	100.00	0.00	0.00
Fruit Trees	5.39	73.00	0.00	27.00	5.39	73.00	6.75	20.25	5.39	73.00	9.00	18.00	5.39	73.00	13.50	13.50	5.39	73.00	27.00	0.00
Olives	6.68	73.00	0.00	27.00	6.68	73.00	6.75	20.25	6.68	73.00	9.00	18.00	6.68	73.00	13.50	13.50	6.68	73.00	27.00	0.00
Vegetables Summer Plastic	0.05	100.00	0.00	0.00	0.05	100.00	0.00	0.00	0.05	100.00	0.00	0.00	0.05	100.00	0.00	0.00	0.05	100.00	0.00	0.00
Vegetables Winter Plastic	0.04	100.00	0.00	0.00	0.04	100.00	0.00	0.00	0.04	100.00	0.00	0.00	0.04	100.00	0.00	0.00	0.04	100.00	0.00	0.00
Field Crops Summer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Field Crops Winter	0.20	0.00	38.00	62.00	0.20	0.00	53.50	46.50	0.20	0.00	69.00	31.00	0.20	0.00	84.50	15.50	0.20	0.00	100.00	0.00
Bananas	0.46	73.00	0.00	27.00	0.46	73.00	6.75	20.25	0.46	73.00	9.00	18.00	0.46	73.00	13.50	13.50	0.46	73.00	27.00	0.00
Other Categories	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	16.19	61.40	**0.47**	38.13	16.19	65.52	**5.88**	28.60	16.19	69.64	**7.81**	22.55	16.19	73.76	**11.49**	14.75	16.19	77.88	22.12	0.00
Gov:Ajloun - Uplands	**1998**				**2005**				**2010**				**2015**				**2020**			
Main Crop Group (M_CG)	Area	Drip	Sprinkler	Surface	Area	Drip	Sprinkler	Surface	Area	Drip	Sprinkler	Surface	Area	Drip	Sprinkler	Surface	Area	Drip	Sprinkler	Surface
Vegetables Summer	0.78	2.00	0.00	98.00	0.78	26.50	0.00	73.50	0.78	51.00	0.00	49.00	0.78	75.50	0.00	24.50	0.78	100.00	0.00	0.00
Vegetables Winter	1.73	2.00	0.00	98.00	1.73	26.50	0.00	73.50	1.73	51.00	0.00	49.00	1.73	75.50	0.00	24.50	1.73	100.00	0.00	0.00
Fruit Trees	1.85	34.00	0.00	66.00	1.85	34.00	16.50	49.50	1.85	34.00	22.00	44.00	1.85	34.00	33.00	33.00	1.85	34.00	66.00	0.00
Olives	5.43	34.00	0.00	66.00	5.43	34.00	16.50	49.50	5.43	34.00	22.00	44.00	5.43	34.00	33.00	33.00	5.43	34.00	66.00	0.00
Vegetables Summer Plastic	0.00	100.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	100.00	0.00	0.00
Vegetables Winter Plastic	0.00	100.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	100.00	0.00	0.00
Field Crops Summer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Field Crops Winter	2.00	2.00	0.00	98.00	2.00	2.00	24.50	73.50	2.00	2.00	49.00	49.00	2.00	2.00	73.50	24.50	2.00	2.00	98.00	0.00
Bananas	0.04	0.00	0.00	0.00	0.04	0.00	25.00	75.00	0.04	0.00	33.33	66.67	0.04	0.00	50.00	50.00	0.04	0.00	100.00	0.00
Other Categories	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	11.83	21.71	**0.00**	77.93	11.83	26.91	**14.38**	58.72	11.83	32.10	**21.93**	45.97	11.83	37.30	**32.89**	29.81	11.83	42.50	57.50	0.00
Gov:Jarash	**1998**				**2005**				**2010**				**2015**				**2020**			
Main Crop Group (M_CG)	Area	Drip	Sprinkler	Surface	Area	Drip	Sprinkler	Surface	Area	Drip	Sprinkler	Surface	Area	Drip	Sprinkler	Surface	Area	Drip	Sprinkler	Surface
Vegetables Summer	1.43	0.00	0.00	100.00	1.43	25.00	0.00	75.00	1.43	50.00	0.00	50.00	1.43	75.00	0.00	25.00	1.43	100.00	0.00	0.00
Vegetables Winter	1.48	0.00	0.00	100.00	1.48	25.00	0.00	75.00	1.48	50.00	0.00	50.00	1.48	75.00	0.00	25.00	1.48	100.00	0.00	0.00
Fruit Trees	6.64	52.00	0.00	48.00	6.64	52.00	12.00	36.00	6.64	52.00	16.00	32.00	6.64	52.00	24.00	24.00	6.64	52.00	48.00	0.00
Olives	15.99	52.00	0.00	48.00	15.99	52.00	12.00	36.00	15.99	52.00	16.00	32.00	15.99	52.00	24.00	24.00	15.99	52.00	48.00	0.00
Vegetables Summer Plastic	0.02	100.00	0.00	0.00	0.02	100.00	0.00	0.00	0.02	100.00	0.00	0.00	0.02	100.00	0.00	0.00	0.02	100.00	0.00	0.00
Vegetables Winter Plastic	0.06	100.00	0.00	0.00	0.06	100.00	0.00	0.00	0.06	100.00	0.00	0.00	0.06	100.00	0.00	0.00	0.06	100.00	0.00	0.00
Field Crops Summer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Field Crops Winter	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bananas	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Other Categories	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	25.63	46.24	**0.00**	53.76	25.63	49.08	**10.60**	40.32	25.63	51.93	**14.13**	33.95	25.63	54.77	**21.19**	24.04	25.63	57.61	42.39	0.00

Table 1.5.4- 4 2/2 Upland Projected Areas and Distribution of Irrigation Methods

Gov:Madaba - Uplands	1998				2005				2010				2015				2020			
Main Crop Group (M_CG)	Area	Drip	Sprinkler	Surface	Area	Drip	Sprinkler	Surface	Area	Drip	Sprinkle	Surface	Area	Drip	Sprinkler	Surface	Area	Drip	Sprinkler	Surface
Vegetables Summer	1.33	97.00	0.00	3.00	1.33	97.75	0.00	2.25	1.33	98.50	0.00	1.50	1.33	99.25	0.00	0.75	1.33	100.00	0.00	0.00
Vegetables Winter	2.66	97.00	0.00	3.00	2.66	97.75	0.00	2.25	2.66	98.50	0.00	1.50	2.66	99.25	0.00	0.75	2.66	100.00	0.00	0.00
Fruit Trees	2.03	80.00	0.00	20.00	2.03	80.00	5.00	15.00	2.03	80.00	6.67	13.33	2.03	80.00	10.00	10.00	2.03	80.00	20.00	0.00
Olives	1.54	80.00	0.00	20.00	1.54	80.00	5.00	15.00	1.54	80.00	6.67	13.33	1.54	80.00	10.00	10.00	1.54	80.00	20.00	0.00
Vegetables Summer Plastic	0.03	100.00	0.00	0.00	0.03	100.00	0.00	0.00	0.03	100.00	0.00	0.00	0.03	100.00	0.00	0.00	0.03	100.00	0.00	0.00
Vegetables Winter Plastic	0.01	100.00	0.00	0.00	0.01	100.00	0.00	0.00	0.01	100.00	0.00	0.00	0.01	100.00	0.00	0.00	0.01	100.00	0.00	0.00
Field Crops Summer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Field Crops Winter	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bananas	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Other Categories	0.05	97.00	0.00	0.00	0.05	97.00	0.00	3.00	0.05	98.00	0.00	2.00	0.05	99.00	0.00	1.00	0.05	100.00	0.00	0.00
Total	7.65	89.07	**0.00**	10.91	7.65	89.46	**2.34**	8.20	7.65	89.86	**3.11**	7.02	7.65	90.26	**4.67**	5.07	7.65	90.66	9.34	0.00
Gov:Al Karak - Uplands	**1998**				**2005**				**2010**				**2015**				**2020**			
Main Crop Group (M_CG)	Area	Drip	Sprinkler	Surface	Area	Drip	Sprinkler	Surface	Area	Drip	Sprinkle	Surface	Area	Drip	Sprinkler	Surface	Area	Drip	Sprinkler	Surface
Vegetables Summer	11.39	74.00	0.00	26.00	11.39	80.50	0.00	19.50	11.39	87.00	0.00	13.00	11.39	93.50	0.00	6.50	11.39	100.00	0.00	0.00
Vegetables Winter	0.62	74.00	0.00	26.00	0.62	80.50	0.00	19.50	0.62	87.00	0.00	13.00	0.62	93.50	0.00	6.50	0.62	100.00	0.00	0.00
Fruit Trees	11.10	52.00	0.00	48.00	11.10	52.00	12.00	36.00	11.10	52.00	16.00	32.00	11.10	52.00	24.00	24.00	11.10	52.00	48.00	0.00
Olives	8.42	52.00	0.00	48.00	8.42	52.00	12.00	36.00	8.42	52.00	16.00	32.00	8.42	52.00	24.00	24.00	8.42	52.00	48.00	0.00
Vegetables Summer Plastic	0.02	100.00	0.00	0.00	0.02	100.00	0.00	0.00	0.02	100.00	0.00	0.00	0.02	100.00	0.00	0.00	0.02	100.00	0.00	0.00
Vegetables Winter Plastic	0.04	100.00	0.00	0.00	0.04	100.00	0.00	0.00	0.04	100.00	0.00	0.00	0.04	100.00	0.00	0.00	0.04	100.00	0.00	0.00
Field Crops Summer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Field Crops Winter	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bananas	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Other Categories	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	31.59	60.44	**0.00**	39.56	31.59	62.92	**7.42**	29.67	31.59	65.39	**9.89**	24.72	31.59	67.86	**14.83**	17.31	31.59	70.33	29.67	0.00
Gov:Ma'an Excl. Mudawwara & Disi Ma'an	**1998**				**2005**				**2010**				**2015**				**2020**			
Main Crop Group (M_CG)	Area	Drip	Sprinkler	Surface	Area	Drip	Sprinkler	Surface	Area	Drip	Sprinkle	Surface	Area	Drip	Sprinkler	Surface	Area	Drip	Sprinkler	Surface
Vegetables Summer	12.50	12.00	88.00	0.00	12.50	34.00	66.00	0.00	12.50	56.00	44.00	0.00	12.50	78.00	22.00	0.00	12.50	100.00	0.00	0.00
Vegetables Winter	2.37	12.00	88.00	0.00	2.37	34.00	66.00	0.00	2.37	56.00	44.00	0.00	2.37	78.00	22.00	0.00	2.37	100.00	0.00	0.00
Fruit Trees	35.09	89.00	0.00	11.00	35.09	89.00	2.75	8.25	35.09	89.00	3.67	7.33	35.09	89.00	5.50	5.50	35.09	89.00	11.00	0.00
Olives	11.54	89.00	0.00	11.00	11.54	89.00	2.75	8.25	11.54	89.00	3.67	7.33	11.54	89.00	5.50	5.50	11.54	89.00	11.00	0.00
Vegetables Summer Plastic	0.00	0.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	100.00	0.00	0.00
Vegetables Winter Plastic	0.02	100.00	0.00	0.00	0.02	100.00	0.00	0.00	0.02	100.00	0.00	0.00	0.02	100.00	0.00	0.00	0.02	100.00	0.00	0.00
Field Crops Summer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Field Crops Winter	1.36	37.00	13.00	50.00	1.36	37.00	25.50	37.50	1.36	37.00	38.00	25.00	1.36	37.00	50.50	12.50	1.36	37.00	63.00	0.00
Bananas	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Other Categories	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	62.87	69.67	**21.08**	9.24	62.87	74.87	**18.19**	6.93	62.87	80.07	**13.94**	5.98	62.87	85.27	**10.38**	4.35	62.87	90.47	9.53	0.00
Gov:Ma'an - Mudawwara & Disi Ma'an	**1998**				**2005**				**2010**				**2015**				**2020**			
Main Crop Group (M_CG)	Area	Drip	Sprinkler	Surface	Area	Drip	Sprinkler	Surface	Area	Drip	Sprinkle	Surface	Area	Drip	Sprinkler	Surface	Area	Drip	Sprinkler	Surface
Vegetables Summer	14.49	12.00	88.00	0.00	14.49	12.00	88.00	0.00	14.49	12.00	88.00	0.00	14.49	12.00	88.00	0.00	14.49	0.01	88.00	0.00
Vegetables Winter	11.87	12.00	88.00	0.00	11.87	12.00	88.00	0.00	11.87	12.00	88.00	0.00	11.87	12.00	88.00	0.00	11.87	12.00	88.00	0.00
Fruit Trees	1.86	89.00	0.00	11.00	1.86	89.00	0.00	11.00	1.86	89.00	0.00	11.00	1.86	89.00	0.00	11.00	1.86	89.00	0.00	11.00
Olives	0.40	89.00	0.00	11.00	0.40	89.00	0.00	11.00	0.40	89.00	0.00	11.00	0.40	89.00	0.00	11.00	0.40	89.00	0.00	11.00
Vegetables Summer Plastic	0.00	100.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	100.00	0.00	0.00
Vegetables Winter Plastic	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Field Crops Summer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Field Crops Winter	14.79	37.00	13.00	50.00	14.79	37.00	13.00	50.00	14.79	37.00	13.00	50.00	14.79	37.00	13.00	50.00	14.79	37.00	13.00	50.00
Bananas	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Other Categories	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	43.41	24.53	**57.86**	17.61	43.41	24.53	**57.86**	17.61	43.41	24.53	**57.86**	17.61	43.41	24.53	**57.86**	17.61	43.41	0.00	0.00	0.00
Gov:Al Tafila Uplands	**1998**				**2005**				**2010**				**2015**				**2020**			
Main Crop Group (M_CG)	Area	Drip	Sprinkler	Surface	Area	Drip	Sprinkler	Surface	Area	Drip	Sprinkle	Surface	Area	Drip	Sprinkler	Surface	Area	Drip	Sprinkler	Surface
Vegetables Summer	2.16	98.52	1.35	0.13	2.16	98.89	1.02	0.10	2.16	99.26	0.68	0.06	2.16	99.63	0.34	0.03	2.16	100.00	0.00	0.00
Vegetables Winter	1.07	100.00	0.00	0.00	1.07	100.00	0.00	0.00	1.07	100.00	0.00	0.00	1.07	100.00	0.00	0.00	1.07	100.00	0.00	0.00
Fruit Trees	4.34	58.00	0.00	42.00	4.34	58.00	10.50	31.50	4.34	58.00	14.00	28.00	4.34	58.00	21.00	21.00	4.34	58.00	42.00	0.00
Olives	10.41	58.00	0.00	42.00	10.41	58.00	10.50	31.50	10.41	58.00	14.00	28.00	10.41	58.00	21.00	21.00	10.41	58.00	42.00	0.00
Vegetables Summer Plastic	0.00	100.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	100.00	0.00	0.00
Vegetables Winter Plastic	0.00	100.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	100.00	0.00	0.00
Field Crops Summer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Field Crops Winter	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bananas	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Other Categories	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	17.99	65.36	**0.16**	34.48	17.99	65.41	**8.74**	25.86	17.99	65.45	**11.57**	22.98	17.99	65.49	**17.27**	17.23	17.99	65.54	34.46	0.00
Gov:Aqaba Excl. Disi Aqaba & W. Aqaba North excl Aqaba city	**1998**				**2005**				**2010**				**2015**				**2020**			
Main Crop Group (M_CG)	Area	Drip	Sprinkler	Surface	Area	Drip	Sprinkler	Surface	Area	Drip	Sprinkle	Surface	Area	Drip	Sprinkler	Surface	Area	Drip	Sprinkler	Surface
Vegetables Summer	3.09	60.00	35.00	5.00	3.09	70.00	26.25	3.75	3.09	80.00	17.50	2.50	3.09	90.00	8.75	1.25	3.09	100.00	0.00	0.00
Vegetables Winter	0.89	60.00	35.00	5.00	0.89	70.00	26.25	3.75	0.89	80.00	17.50	2.50	0.89	90.00	8.75	1.25	0.89	100.00	0.00	0.00
Fruit Trees	3.03	89.00	0.00	11.00	3.03	89.00	2.75	8.25	3.03	89.00	3.67	7.33	3.03	89.00	5.50	5.50	3.03	89.00	11.00	0.00
Olives	0.87	89.00	0.00	11.00	0.87	89.00	2.75	8.25	0.87	89.00	3.67	7.33	0.87	89.00	5.50	5.50	0.87	89.00	11.00	0.00
Vegetables Summer Plastic	0.00	0.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	100.00	0.00	0.00
Vegetables Winter Plastic	0.00	0.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	100.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Field Crops Winter	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bananas	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Other Categories	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

(2) Irrigation Demand Projections

A Global stress factor of about 0.75 was assumed for almost all the uplands areas in order to account for suppressed crop water consumption due to absence of ideal, pristine agricultural conditions caused by poor water supply, poor agronomic practices, salinity, or crop varieties. Irrigation Water Requirements results for 1998 indicate significant difference between requirements as computed by the modules (following FAO 56 recommendations) and the actual deliveries recorded in the WIS. A factor of 0.44 needs to be applied globally in Jordan in order to bring the computed irrigation requirements into line with the reported water use. This however masks extreme local variability in some governorates. Some of the factors contributing to such discrepancies include incomplete and inaccurate measurements of water usage, overestimates of irrigated areas, absence of adequate leaching practices and illegal water uses. Hence to use a global figure of 0.44 would overlook the errors resulting from such inaccuracies. Based on expertise knowledge, a factor of 0.75 was thought to be reasonable. This, however, needs to be reviewed on a governorate basis to reflect local variations. It is therefore highly recommended that further analysis be made using yield reports to indicate the severity of stress and whether it agrees somewhat with this factor.

Table 1.5.4-9 and 10 show water requirements for irrigation during the planning horizon, under unrestrained conditions with respect to development plans and irrigated areas and for a median year under average climatic conditions.

Regarding future irrigation water demand of this study, there were two demands considered. One is, for scenario-1 and scenario-3 based on the policy of the government that securing the current water supply of approximately 600 MCM/a, surplus water after the allocation for MIT (municipal, industrial and touristic) demands from the available water supply in the sustainable development scheme. Table 1.5.4- 9 shows the results of water allocation to the irrigated agriculture decided in the water resources management plan in Chapter 6.

Table 1.5.4- 9 Irrigation Water based on the Water Allocation Unit: MCM/a

Governorate	2005	2010	2015	2020
Amman	42.1	41.9	40.8	39.1
Zarqa	65.2	60.0	58.1	54.5
Mafraq	50.5	44.7	41.3	36.4
Irbid	150.8	158.4	164.2	167.4
Ajulun	6.8	7.7	8.3	8.9
Jerash	11.9	12.1	12.1	11.1
Balqa	230.9	242.6	221.3	197.9
Madaba	8.1	9.9	9.2	9.5
Karak	73.4	72.2	71.5	72.0
Ma'an	46.4	26.9	23.8	13.4
Tafiela	11.6	10.9	10.2	9.4
Aqaba	19.6	16.2	7.5	8.3
Total	717.3	703.7	668.4	628.0

In this study, irrigation water demands for Scenario-1 and Scenario-3 are basically considered to be remaining water resource after municipal, industrial and touristic sector demands are allocated from the total available water resources but it should be more than current irrigation water use (approximately 600 MCM/a).

On the other hand, JVA and MOA have their own agricultural development plans in Jordan Rift Valley and Up/Mid Land though water resources are not substantiated as water allocation. MWI computed future irrigation water demand using Digital National Master Plan Tool developed by GTZ/MWI and its results is summarized hereunder Table 1.5.4- 10 with a huge demand of 963 MCM/a for the planning horizon of year 2020.

This demand can be considered as "Target Demand of Irrigation Water" and was taken into consideration to that of Scenario-2 (Target Demand Scenario).

Table 1.5.4-10 Target Irrigation Water Demand and Irrigated Areas in 12Governorates

Year / Gov.	1998		2005		2010		2015		2020	
	Irrigated Area	Water Supply	Irrigated Area	Water Demand	Irrigated Area	Water Demand	Irrigated Area	Water Demand	Irrigated Area	Water Demand
	1000Ha	MCM/a	1000Ha	MCM/a	1000Ha	MCM/a	1000Ha	MCM/a	1000Ha	MCM/a
Amman	6.8	37	6.8	55	6.8	55	6.8	55	6.8	54
Zarqa	10.6	60	10.6	98	10.6	97	10.6	94	10.6	93
Mafraq	16.9	55	16.9	122	16.9	122	16.9	121	16.9	120
Irbid	11.2	92	14.6	148	17.9	170	17.9	170	17.9	158
Ajulun	1.2	6	1.2	10	1.2	9	1.2	8	1.2	8
Jerash	2.6	12	2.6	24	2.6	23	2.6	22	2.6	20
Balqa	12.4		24.4	331	25.8	336	25.8	334	25.8	329
Madaba	0.8	7	0.8	4	0.8	4	0.8	4	0.8	4
Karak	8.2	60	9.3	64	9.4	63	9.4	62	9.4	60
Ma'an	10.6	53	10.6	86	10.6	85	10.6	84	10.6	83
Tafielah	1.8	5	1.8	18	1.8	18	1.8	17	1.8	16
Aqaba	1.9	18	2.3	20	2.3	20	2.3	20	2.3	20
Up/MidLand	59.6	292	59.6	486	59.6	479	59.6	471	59.6	459
JRV	25.4	258	42.3	495	47.0	523	47.0	520	47.0	505
Total	85.0	551	101.9	981	106.5	1,002	106.5	992	106.5	963

Source: Based on the agricultural development plans of JVA and MOA, MWI computed the irrigation water demand using GTZ/MWI demand modules.

1.6 Water Strategy and Sector Policy

In considering water allocation among sectors, two things would be the most important: availability and supply cost (unit investments/O & M cost of supply).

1.6.1 Irrigation Water

(1) Treated Wastewater

There is abundant wastewater, and there will be in the future much more wastewater, which, if properly treated and widely utilized, can play a major role in easing the tense demand supply situation in the municipal water sector. A great advantage is that its cost will be cheaper than that of any of other sources. Cost estimate: 38 fils/m^3.

(2) Brackish Water

There is a promising potential amount of brackish water, which, if used extensively, can occupy a major position as a new source, channeling the fresh water heretofore used for irrigation for municipal purposes. The current hindrance is that the desalination cost is not as low as is expected.

(3) Saving by the Newest Irrigation Methods (Demand Management)

There can be a substantial saving of water by adopting new irrigation techniques such as the on-farm dripping method in place of the sprinkler. The water saved this way can be transferred to the municipal water sector. The unit investments/O & M cost of such a technique seems to be a reasonable one. Cost estimate: 147 fils/m^3.

(4) Reduction of Conveyance Losses (Demand Management)

There is a considerable difference of 30% or more between the irrigation water supplied and the irrigation water sold in JRV. One major cause can be the losses due to open channel conveyance. Investments in closed pipelines and proper operation & maintenance will reduce such losses. The water saved this way can be transferred to the municipal water sector. The unit cost of such undertaking is estimated to be reasonably low.

(5) Possible Effects of Higher Tariffs (Demand Management)

Higher irrigation water tariffs in an attempt to meet the cost may possibly result in less use of water, which will bring down demand, making it possible to direct the saved water for municipal use. There is no direct cost involved.

(6) Conventionally Available Surface/Ground Water

It is estimated that as much as 70% of the fresh surface and underground water now available is used for irrigation. This can be an inappropriate use of the precious lifeline. The comparative economic value per m^3 is estimated to be 3:10:1 for municipal, industrial and irrigation water respectively. In this light it is obviously a great economic loss to use a majority of water for agriculture.

Therefore, in the future, major stress must be placed on the above sources 1 to 5. Only after they are considered, the conventional resources should be mobilized. Cost estimate: 161-189 fils/m^3.

(7) Peace Treaty Water

This water should be basically used for municipal purposes. Some of it, however, can be used for irrigation in case of its proximity to farms (cost factor).

(8) Disi Fossil Water

Disi fossil water which is now profusely used for agriculture must be phased out. Cost estimate (production): 385 fils/m^3.

1.6.2 Industrial Water

(1) Brackish Water

This is a possible water source for industrial use, which can partially replace the fresh water now used in industries, so that it may be reserved for municipal purposes. One major hindrance at the present moment is a high cost of desalination. Cost estimate (production): 449 fils/ m^3.

In addition, some industries do not require high quality water and can consider using brackish water for its process and should be given incentives to replace fresh water with brackish water for its processes.

(2) Sea Water

This is also a possible water source for industrial use. Its importance cannot be overemphasized considering its infinite availability. The fresh water replaced by desalinated water can be reserved for municipal use. One major current bottleneck is a high desalination cost. Cost estimate (production): 1,035 fils/ m^3.

(3) Treated Wastewater

Treated wastewater has a big possibility to be used for industrial water. It has two advantages: its unit cost is cheaper than that of any other resources, and increasingly more availability of such water.

(4) Recycling of Industrial Wastewater (Demand Management)

Recycling of industrial wastewater in a closed system will pave the way for the saving of industrial water to be used for municipal purposes. New investments and O & M cost will be required. However, the unit cost concerned may be reasonably cheap.

(5) Reduction of Leakage (Demand Management)

At present the water for industrial use is mostly taken from the wells. In as much as such a practice continues, there will be little problem concerning conveyance

losses. However, it is possible that more industries will connect to the water supply network in the future. If such were the case, the reduction of such losses would become an important issue.

(6) Possible Effects of Higher Tariffs (Demand Management)

Higher industrial water tariffs in an attempt to meet the cost may possibly result in less use of water, which will bring down demand, making it possible to direct the saved water for municipal use. There is no direct cost involved.

(7) Conventionally Available Surface/Ground Water

At present the water used for big industries is mostly extracted from underground or derived in a few cases from the water supply networks (potash industry uses surface water). In any case, fresh, essentially potable water is used for industries. This practice cannot be justified in a water scarce country like Jordan.

As mentioned already, the unit cost of the conventionally available surface and ground water is cheap. Such precious resources of low cost and good quality should be reserved for municipal use as much as possible.

Therefore, in the future, major stress must be placed on the above sources 1 to 6. Only after they are considered, the conventional resources should be mobilized.

(8) Peace Treaty Water

This water should be basically used for municipal purposes. Some of it, however, can be used for industry in case of its proximity to big factories (cost factor).

(9) Disi Fossil Water

Now the precious Disi fossil water is used in major industries located in Aqaba. Industries in Aqaba should consider replacing Disi water with desalinated sea water in the event such change becomes financially feasible in the future. The Thermal Power Plant in Aqaba has already decreased use of Disi water by operating desalination plant to make the fresh water from the seawater.

1.6.3 Municipal Water

(1) Conventionally Available Surface/Ground Water

The conventionally available surface and ground water should be essentially reserved for municipal use. These precious low cost good quality resources should be preserved with care and are destined to be more and more used for the lifeline purposes of the people.

(2) Water to be Transferred from Other Sectors

At present these precious low cost, good quality resources are abundantly used for irrigation and industry. The practice must be gradually, but drastically changed so that the two sectors will increasingly use treated/recycled wastewater and

desalinated sea/brackish water, at the same time increasingly saving the water from conventional sources through demand management means.

It is proposed that a great amount of conventional fresh water heretofore consumed in the two sectors will thus be available for municipal consumption in future.

(3) Reduction of Leakage (Demand Management)

The government of Jordan is now seriously committed to reducing the unaccounted for water in light of the fact that 55% on average of the water produced disappears elsewhere without generating any financial benefits. Out of it, 25 to 30% is estimated to be due to leakages. Supposing it is reduced to 10%, then 15 to 20% (40 to 50 MCM, which will double in the future) more water will be made available without any investments for the new development of water sources. Preliminary estimate (rehabilitation): 147 fils/m^3.

(4) Possible Effects of Higher Tariffs (Demand Management)

Higher municipal water tariffs in an attempt to meet the cost may possibly result in less use of water, which will bring down demand, contributing to easing the tense demand supply situation. There is no direct cost involved.

(5) Disi Fossil Water

This precious non-renewable fresh water is now used profusely in agriculture and industry. This practice must be stopped in future so that it may be reserved for municipal use. One possible problem is an additional cost of transmission in case the water is conveyed to Amman, which will raise the unit cost of supply.

(6) Peace Treaty Water

This is also an important option for future municipal use.

(7) Brackish Water

Because of its salinity, the priority in the use of desalinated water should be given to industry. A shift of water sources from fresh water to brackish water in the sector will leave a certain volume of coveted fresh water for municipal use.

In case the demand supply situation of municipal water is very tense, brackish water will be used for municipal purposes too.

(8) Sea Water

Because of its salinity, the priority in the use of desalinated water should be given to industry. A shift of water sources from fresh water to sea water in the sector will leave a certain volume of needed fresh water for municipal use.

In case the demand supply situation of municipal water is very problematic, sea water will be used for municipal purposes too.

1.7 Related Organizations

There are three organizations directly related to the water sector, namely Ministry of Water and Irrigation, Water Authority of Jordan and Jordan Valley Authority.

1.7.1 Ministry of Water and Irrigation

To consolidate control over water resources and to achieve policy alignment, the Ministry of Water and Irrigation (MWI) was created in 1992 under By-Law #54/1992. Its objective was to centralize and improve the management of the nation's critically short water resources under one minister. MWI legislation centralized the control of water resources that were formally regulated by several agencies with different mandates including the Jordan Valley Authority, the Water Authority of Jordan, the Ministry of Agriculture and the Ministry of Health. The comprehensive MWI gained substantial power to allocate and regulate the water resources of Jordan, and to resolve differences among agricultural users and water supply authority.

There are three secretary generals directly under the minister of MWI, namely Secretary General of MWI, Secretary General of the Jordan Valley Authority and Secretary General of the Water Authority of Jordan. There are four organizational units under Secretary General of MWI, that is, Legal Affairs, Assistant Secretary General of Water Resources Development, Assistant Secretary General of Finance and Administration, and Project and Finance. (Refer to Figure 1.7.1-1.) MWI currently has 35 staff.

1.7.2 Water Authority of Jordan

Under Law #18/1988 the Water Authority of Jordan (WAJ) is tasked with provision of water and sewer systems and the management of the nation's water resources. According to the legislation, WAJ is to formulate water and wastewater policy and to plan the development of water resources. It also has responsibility for monitoring of water and wastewater projects.

Five assistant secretary generals (ASG's) report to Secretary General of WAJ. They are ASG of Technical Support Sector, ASG of Planning and Investment Sector, ASG of Maintenance and Workshops Sector, ASG of Financial Affairs Sector, and ASG of Administrative Affairs Sector. (Refer to Figure 1.7.2-1.)

WAJ had 7,460 personnel in 1998, of which classified, unclassified, contract and daily workers accounted for 16%, 53%, 3% and 28% respectively, as shown in the table below. It is noted that regular (classified and unclassified) workers are on the decrease, while irregular (contract and daily) workers are on the increase.

WAJ Workers

Classification	1996	1997	1998
Classified	1,257	1,197	1,179
Unclassified	4,035	3,967	3,938
Contract	184	217	263
Daily	1,955	2,033	2,080
Total	7,431	7,414	7,460

1.7.3 Jordan Valley Authority

In 1977 the Jordan Valley Authority was created by Law #18/1977. Under this law, the agency gained substantial power to plan and execute water supply projects in the Jordan Valley. Later, under Law #19/1988, JVA consolidated its control over the development of infrastructure (water, electricity, lands and towns/villages) in the Jordan Valley. Over the years, it has directed the development of water supply systems in the valley and built an advanced water management system.

Six assistant secretary generals (ASG's) are assigned under Secretary General of JVA. They are ASG for Planning and Environment, ASG for Southern Ghors and Wadi Araba, ASG for Lands and Urban Development, ASG for Administration, Finance and Tenders, ASG for Northern and Middle Ghors, and ASG for Studies and Projects. (Refer to Figure 1.7.3-1.)

Out of 2,094 personnel, 1,020 or 49% were those related to irrigation water supply in 2000, which were broken down to classified, unclassified, contract and daily employees, accounting for 11%, 57%, 0% and 32% respectively, as shown in the following table. It is noticed that regular (classified and unclassified) employees are on the decrease on one hand, and irregular (daily) employees are on the increase on the other.

JVA Personnel

Classification	1998	1999	2000
Grand Total	2,022	2,116	2,094
Related to Irrigation Water Supply			
Classified	123	120	114
Unclassified	615	611	583
Contract	3	3	3
Daily	254	295	320
Total	995	1,029	1,020

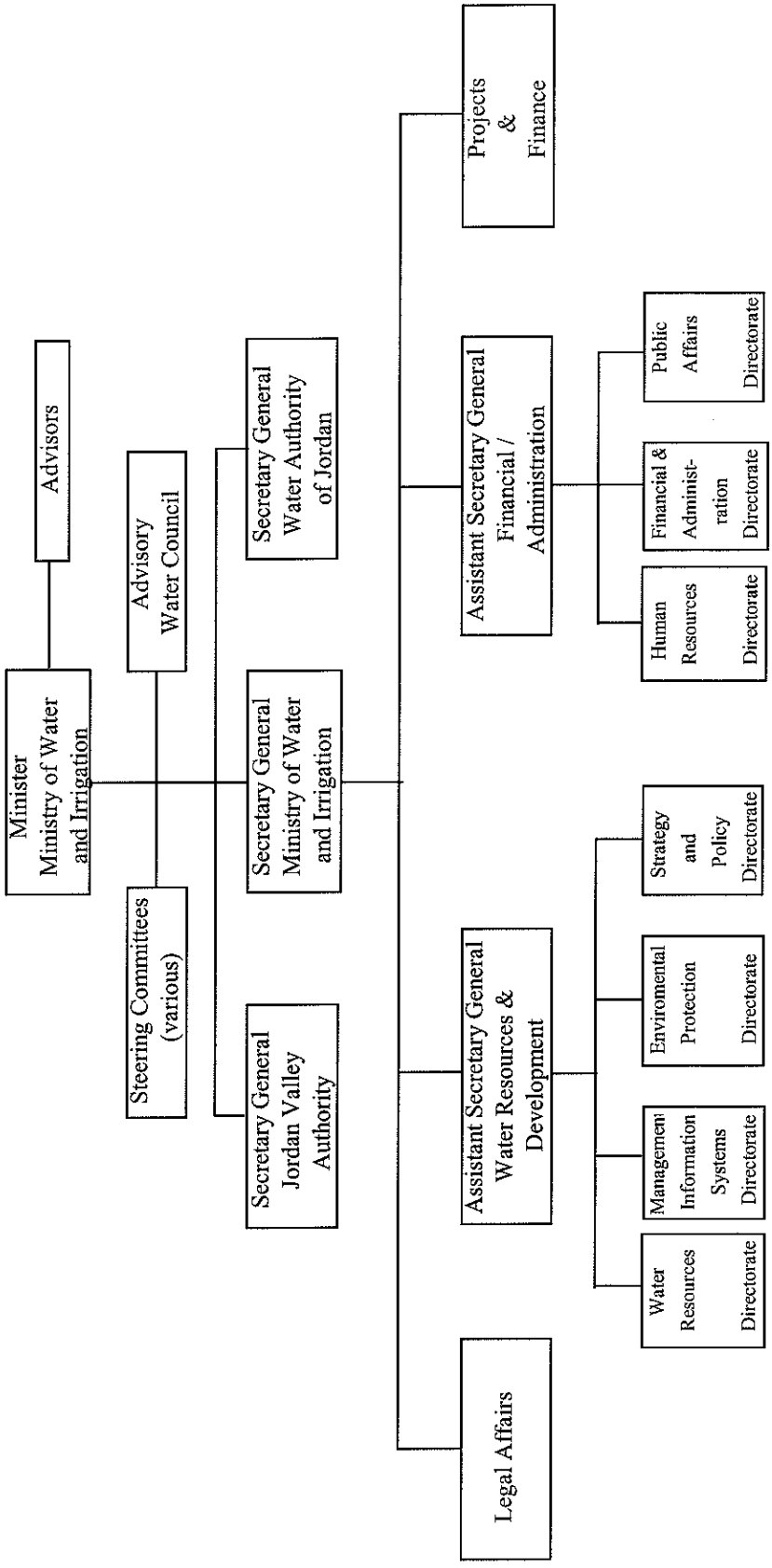

Figure 1.7.1-1 Organization Chart of Ministry of Water and Irrigation

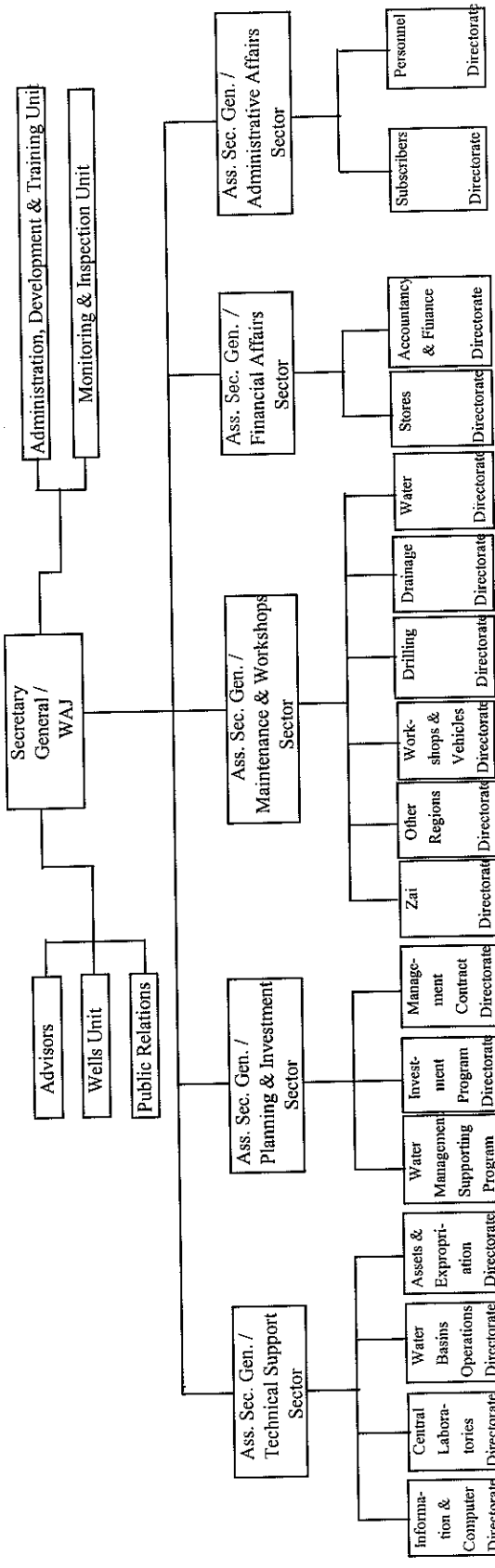

Figure 1.7.2-1 Organization Chart of Water Authority of Jordan

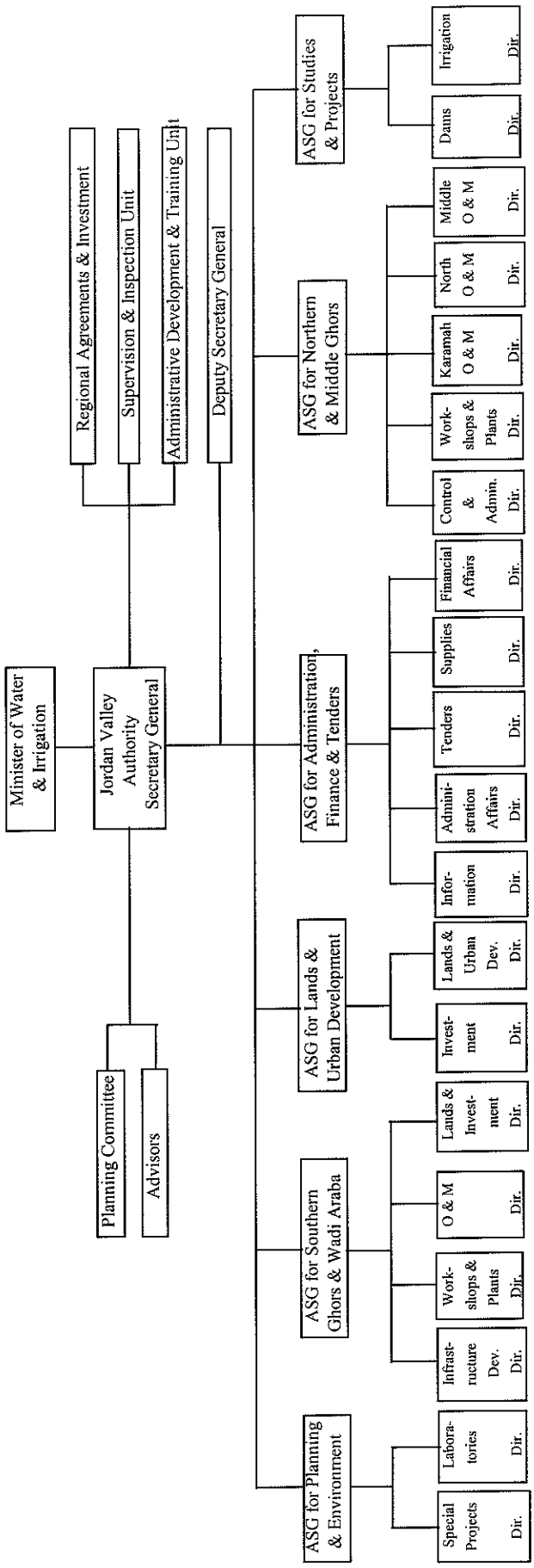

Figure 1.7.3-1 Organization Chart of Jordan Valley Authority