EVALUATION OF USAID/JORDAN'S STRATEGIC OBJECTIVE 2: IMPROVED WATER RESOURCES MANAGEMENT

FINAL REPORT

Prepared for

United States Agency for International Development (USAID)

Prepared by

Checchi & Company Consulting, Inc.
DevTech Systems, Inc.

DEVTECH

January 2003
Task Order No. AEP-I-00-00-00022-00, Task Order 815

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Evaluation of USAID/Jordan's Strategic Objective 2: Improved Water Resources Management

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FOREWORD

FOREWORD

As a consequence of the Annual Performance Report review, 2002, of USAID/Jordan, the Mission was requested to submit a new five-year strategy during FY 2003. Checchi and Consulting Co. Inc. and DevTech Systems, Inc. were contracted under a USAID IQC to provide a team of four professionals with diverse but complementary backgrounds to conduct an evaluation of USAID/Jordan's Strategic Objective 2: Improved Water Resources.

TEAM

This report is the product of the team's 38-day working visit to Jordan. Team members were:

> John E. Priest, PE, Team Leader — land, water and power resources engineering consultant, with broad experience in the preparation of master plans at the regional, river basin, and national levels.
>
> Eng. Iacovos Iacovides — engineer and hydrologist with 36 years of experience in the operations of the Water Development Department of the Ministry of Agriculture, Natural Resources, & Environment of Cyprus. Many of the conditions affecting development and regulation of the water resources of Cyprus are similar to conditions requiring resolution in Jordan.
>
> Carl Maxwell, PE — an engineer with 38 years of international experience in environmental management, irrigation systems, and facilities construction. Some 20 years of that experience was with USAID in the Middle East, Latin America, and Asia.
>
> Barney P. Popkin — professional geologist and hydrologist who has completed some 500 environmental assessments, reports, and impact statements for programs and projects that have saved clients in the United States and abroad substantial sums of money and that have avoided or ended disputes and delays.

It is the diverse background of the team that has contributed to the successful completion of this report within the allotted time.

ACCURACY AND USE OF DATA

Our team quickly learned that much of the data being used in successive studies are values carried over from report to report without critical analysis. Therefore, we have cited the source of values as they have been used, and have not attempted reconciliation of any minor conflicts among the several sources. It may be noted that our major recommendations, especially with regard to achievement of sustainability in the use of surface water and groundwater, are depicted schematically. The problems are large enough, and proposed initiatives are of such overwhelming importance, that schematic depictions more than adequately illustrate the reasons for suggested initiatives.

ACKNOWLEDGMENTS

Each governmental, USAID, and private-sector person whom we visited provided valuable insights into the issues and problems associated with and affecting the formulation and implementation of initiatives for the water sector. Annex A provides a full list of those contacted and interviewed.

The Minister of Water and Irrigation, Dr. Hazim El-Naser, and his three Secretaries General, Eng. Sa'ad Bakri, Eng. Zafer Alem, and Eng. Munther A. Khleifat, were extremely generous and forthright in expressing their views of the USAID program and its effects on the Jordanian Ministry of Water and Irrigation (MWI), Water Authority of Jordan (WAJ), and Jordan Valley Authority (JVA). In addition, they provided valuable insights into the operations of MWI and ensured our ready access to the professional staff, information, and library resources of the Ministry.

The team is especially appreciative of the support, information, and guidance provided by the staff of USAID/Jordan, including James Franckiewicz, Director WRE, and his six Project Management Specialists and engineers (Setta Tutundjian, Amal Hijazi, Farid A. Salahi, Ramzi A. Sabella, Roy R. Ventura, Jr., and Shank Gupta). Setta Tutundjian deserves a special thanks for her role in coordinating all of our office visits in Amman and for accompanying us on an enlightening field trip to As Samra wastewater treatment plant, the Zarqa reverse osmosis water treatment plant, a private farm and well, and Wala Dam, where groundwater recharge had begun. Amal Hijazi, who also serves as Mission Environmental Officer, gave generously of her time with excellent project briefings and then accompanied our team to Aqaba to visit the waste stabilization ponds, the date farms that are served by reclaimed water, and local WAJ and ASEZA staff and consultants.

Debra Mosel, CTO, and Ziad Abd-Rabu, CO, provided contractual support at critical points when needed.

EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

As a consequence of the Annual Performance review, 2002, of the USAID program in Jordan, the Mission was requested to submit a new five-year strategy for Strategic Objective 2, Water Sector, during FY2003. This evaluation of the Mission's SO2 is in support of the required response to that review. The evaluation was designed to provide a basis and direction for the formulation of a new five-year investment plan for the period FY2004 to FY2009.

EVALUATION

The evaluation team studied the commitments and accomplishments of the portfolio of the Water Resources and Environmental Section (WRE) during the period 1995–2002 and then reviewed the ongoing and planned activities and how they supported the three Intermediate Results (IR)s.

Accomplishments of the SO2 Program

The current construction program focuses on two components of water supply. The first is the conservation of potable water now being lost in defective, badly managed municipal distribution systems, and the second is directed toward improving the quality of reclaimed water, which provides more opportunity for reuse. Thus, IR2.2, Increased Efficiency in the Use of Water Resources, and IR 2.3, Improved Quality of Wastewater, were efficiently and strongly covered through a dynamic construction program that is ongoing. In parallel, nearly 15 percent of the water sector budget was dedicated to the critical need for institutional reform and reorganization within the Ministry of Water and Irrigation (MWI), IR 2.1, Stronger Water Sector Institutions.

Strategic Emphasis of SO2 and Sustainability

The SO2 strategy and three IRs should be carried over into the 2004–2009 plan period. The wording of SO2 should be amended from "Improved Water Resources Management" to "Improved Water Sector Management for Resource Sustainability." The emphasis on *sustainability* broadens strategic focus to *conserving* the basic river and groundwater *resources* as well as the current focus on conserving the *developed* water *supply*.

Also, sustainability extends to the financial arena, whereby the accomplished and ongoing reforms would be focused on changing several units of Ministry of Water and Irrigation (MWI), Water Authority of Jordan (WAJ), and Jordan Valley Authority (JVA) into a financially self-sustaining utility.

Because the utility would be a self-sustaining autonomous organization, it would no longer be constrained by Civil Service Regulations or the duty of striving to meet social goals unrelated to water production and management. Such a utility could be created only if effective, well-staffed organizational units were developed within MWI and then combined with WAJ and JVA. To achieve sustainability throughout the water sector, such a utility could be a bulk water supplier to self-sustaining local end-users, including:

- Private Town Water and Sewerage Boards (TW&SBs) and Village Water Boards established for domestic supply of water and wastewater collection and treatment, and

- Irrigation Divisions (ID) or Associations for distributing water according to national water allocations and for operating, maintaining, and rehabilitating irrigation networks and schemes.

These organizations for water distribution would be responsible for balancing their own finances and for the recovery of costs from the distribution of water and the collection and treatment of wastewater.

Once WAJ, JVA, and the five proposed organizational units devolved from MWI, the Ministry would continue as the governmental institution responsible for policy development and implementation, enforcement of water-related laws, oversight of major water developments with national significance, national and regional water allocation, and regulatory functions, including those for regulation of the utility for bulk water delivery and of Town and Village Boards and Irrigation Divisions. Since the ministry staff would be scaled down, it likely would choose to contract with the strong technical and financial units of the autonomous utility to fulfill a number of its remaining functions.

SITUATION IN THE WATER SECTOR

Deficit Forecasting

Currently and into the future to the year 2020, MWI and World Bank foresee ever-increasing gaps between water supply and demand. The deficit is forecasted to increase from 297 million cubic meters (MCM) to 408 MCM between 2000 and 2020. This dire forecast is predicated on sharply rising demand for municipal and industrial (M&I) water (from 466 MCM in 2005 to 758 MCM in 2020) and a 14 percent increase (from 791 MCM to 900 MCM) in the demand for irrigation water over the period 2000 to 2005. The deficit would occur even though an impressive construction program of conventional water collection and distribution facilities has been forecasted.

A Balanced Scenario Based Largely on Conventional Development

The Japanese International Cooperation Agency (JICA) proposed a balanced water budget in its 2001 Master Planning Report. It forecasted a balanced budget by the year 2005 and carried it through to 2020. This balance was forecasted to be achieved because irrigation demand was maintained level to the year 2010, and it decreased by 7 percent at 2020. JICA also used the low end of population forecasts, but it used a comparatively generous municipal delivery rate of 150 liters per capita per day (lcd). Even though one could wish to use somewhat different numbers for some components of that budget, it is the only hopeful scenario available. For this evaluation, the team reviewed the components of the water budget and the assumptions made regarding inputs. It is a reasonable analysis that promotes the concept that the water used for irrigation should not increase, which is in harmony with enunciated MWI policy.

While the JICA analysis accepts the MWI construction program, the serious threat to the continuing water yield of rivers and aquifers is not emphasized. This evaluation foresees serious impairments to the basic water resources that could negate all of the gains that would accrue from the construction program of the next 20 years if the threats are not addressed on an urgent basis.

Threats to River and Groundwater Resources

Basic resources are in danger of exhaustion. Therefore, the balanced water budget scenario is realizable only if measures are taken to conserve the basic resource and to develop the several projects forecasted. The threats are summarized below.

Groundwater Resources

Jordan is fortunate to have a number of aquifers; some are rechargeable fresh water reservoirs and some store "fossil" water that owes its origin to past geologic periods. These fossil aquifers do not receive recharge. Aquifer systems normally provide water for all purposes with a minimum of treatment, unlike surface reservoirs. Also, evaporation is essentially zero from aquifers. Groundwater is distributed by the aquifer medium and tapping it is very often done at the point where it is needed.

The development of groundwater reserves was very rapid during the 1980s, when licenses for drilling of tubewells were freely provided. Consequently, after a few years, a pattern of systematic overpumping was observed in most of the aquifers. Overpumping was evidenced by trends of water level decline and deterioration of water quality caused by the creation of hydraulic conditions that induced intrusion or upconing of water of inferior quality. This ongoing situation has created serious concern and several measures are presently being undertaken. The objective is to reduce annual extractions to the levels of safe yield, the amount of average annual recharge. These measures include improving the efficiency of groundwater use, licensing of wells, water metering, enforcement, and, more recently, by-laws charging tariffs for the amounts of water extracted. Since these measures have only recently been undertaken, there has as yet been no observed reversal of declining water tables. Also, there is no program in place that permits scientific definition of aquifer characteristics, their recharge, and estimates of safe yield.

Aquifer systems and the water they contain constitute a reserve that can be strategically used and even "mined" at a planned level in years of drought when surface water reserves are not sufficient to meet the most urgent needs for sustaining demand. If drawdowns continue at the present rate, minimum reserves soon will not be available and the several advantages that groundwater offers will be sacrificed. The total renewable annual supply or "safe yield" of all the groundwater basins has been estimated in gross terms to be about 276 MCM (World Bank report, 1997). The overdraft appears to be on the order of 145 to 153 percent of the safe yield. During 1993, agriculture accounted for over 61 percent of groundwater abstraction.

The impact of overextraction is illustrated in the case of the Amman-Zarqa Basin (AZB) aquifers, which receive an annual recharge of 87 MCM and represent 30 percent of the nation's renewable groundwater resources of 276 MCM/year. A significant part of the recharge in this groundwater basin is inflow from the Golan Province of Syria. Increasing overpumping since the 1980s had reached more than 70 percent in 1998 and continued to increase. As a result, significant water level declines and salinity increases occurred in the Dulayl area. Springs near Sukhna stopped flowing and water levels and water quality declined in parts of North Badiya. A groundwater modeling study indicated that continued overpumping would degrade groundwater of the AZB highlands. Over the next 20 years, drawdowns averaging 0.5 meters per year would cause springs to stop flowing, serious water quality deterioration, and the drying up of 70 percent of the wells in the Hashimiya-Dulayl-Hallabat area. Once an aquifer is exhausted, it could require many years without pumping to recover; once an aquifer becomes saline, its production of usable quality water may never be restored. The twin threats posed to groundwater production by water table decline and quality deterioration are depicted on Exhibit A.

It has been estimated that fossil groundwater of good quality may be mined at a steady rate of 143 MCM per year for a period of 40 to 50 years.

Surface Water Resource

Surface water flows nationwide vary both seasonally and annually following the rainfall pattern. The long-term average annual base flow is about 328 MCM and the flood flow is about 334 MCM, giving a total average surface flow of 662 MCM. Several decades past, Jordan utilized the flows of three rivers for irrigation and M&I water supply. The flow of each has now either been cut off or been seriously reduced. The Jordan River lies within the Dead Sea Basin and is generally dry or only has saline water flows due to total appropriation of the water of Lake Tiberias by Israel. Overpumping of groundwater in Jordan and across the Golan Province has adversely impacted the substantial base flows of the Yarmouk and Zarqa Rivers. The Yarmouk River still experiences annual floods, which highlights the importance of constructing Wehda (Unity) Dam.

The main source of surface flow is the Yarmouk River, which contributes about 40 percent of the total surface flow. The water of the Yarmouk River is of good quality, with total dissolved solids ranging from 400 to 800 parts per million. The Yarmouk River forms the international border at the northwest corner of Jordan. It has a total catchment area of 6,780 km^2, of which 1,160 km^2 lie upstream of Adasiya in Jordan, with most of the rest being within Syria.

Depletion of groundwater levels in Golan Province is seriously depleting water available downstream. The flow of springs is drying up and the *base flow* is diminishing seriously. More than 2,850 wells are reported to be operating in the area and may be pumping 80 MCM annually. At the same time, the impoundment of surface water in a large number of small dams is reducing both base flow and flood flows. Water users of Golan are extracting about 160 to170

MCM/year from the Yarmouk River through storage of flow in at least 25 small dams and reservoirs.

Plans are under way for the construction of the Unity Dam, with 110 MCM storage capacity. Its reservoir will yield some 80 MCM, mainly for domestic water supply. The studies and design are ready and tenders are expected by early December 2002; the Arab Fund and Abu Dhabi Fund will finance at least 70 percent of the costs.

It is crucial that a firm, verifiable agreement for equitable sharing of the Yarmouk River flows is reached through negotiations.

INITIATIVES TO ACHIEVE INSTITUTIONAL, FINANCIAL, AND RESOURCE SUSTAINABILITY

The theme of the USAID program for the five-year plan period, 2004 to 2009, could be:

Water is a national resource that has the potential to contribute to the national economy.

And its corollary would be:

Water should neither be free nor sold at such low prices that the national budget must pay the major part of its development and delivery costs.

The corollary is true for economic and social conditions that prevail today. There should be no excuses positing that such a program can be implemented only after certain unattainable pre-conditions prevail. Individual users must pay, Should government judge that fees are overly burdensome to the poor, subsidies should be granted directly so that it is clear what costs are being borne by whom.

With respect to government employees and agencies, possibly the largest combined user of municipal and irrigation water, they should not only be billed but each entity should be required to budget for and pay its bill directly to WAJ and later to the utility and/or Town Boards. There should be no procedure for one government entity to send its bill to another government entity for cancellation without payment. The current procedures are fostering gross overuse and tragic waste of Jordan's precious water resource.

Even as many users are using water poorly and creating increasing demands, ever more costly government projects and programs must meet those demands. At the same time that the Government of Jordan is struggling to increase sources of water, the unregulated use of groundwater is leading to the destruction of aquifers, and the unrestricted exploitation of water in the Golan Province is severely depleting the surface water supply of the Yarmouk River. Both the pricing/financial issue and the physical threat to the surface and groundwater resources require the implementation of projects and programs to achieve *sustainability* in each arena, financial and physical.

Institutional Sustainability

The achievement of financial sustainability can come about only if the many-faceted, ongoing reorganization of MWI leads to entities that can operate outside the civil service and as a business. On the technical side, projects and programs will have to be formulated and implemented to reduce the pumping of upland wells by 25 to 50 percent. This will require investments on the plateau and major water development projects such as the Disi supply to Amman to offset a major reduction of the pumping of private and public wells. The situation along the Yarmouk River can be dealt with only through a strong, verifiable government-to-government agreement.

Financial Sustainability

The prevailing situation is that revenue from the sale of water is so meager, especially that for irrigation water, that the Jordanian Treasury has to make substantial outlays just to support the bureaucracy and to try to close the gap for operation and maintenance monies. There is little or no money available for rehabilitation, equipment replacement, operation and maintenance, and new construction. Most of these monies are coming from foreign aid, loans, and, more recently, private-sector participation (PSP). There is no firm provision for the retirement of loans or for servicing the PSP financial requirements. Section III of this report proposes that USAID, during the plan period 2004 to 2009, implement initiatives to help the Government of Jordan create an institutional structure inside the MWI that will facilitate the evolvement of WAJ and JVA into a self-sustaining, autonomous utility. A scaled-down MWI will develop strong regulatory capacity and will include a group dedicated to periodic allocations of water nationwide. The utility will supply water wholesale to quasi-governmental, self-sustaining water distributors that will be supervised and possibly managed by Town Water and Sewerage Boards, Village Water Boards, and Irrigation Associations and/or Cooperatives.

Sustainability in the financial arena can be achieved only if water can be properly allocated and priced, with all quantities monitored, and tariffs collected by an organizational unit that has enforcement powers. In the institutional category of project budgetary presentation, initiatives are presented to support development of a monitoring unit, the production of an information technology platform, and human resources capacity to match personnel assignments in MWI, WAJ, and JVA to skills required. The cost is estimated to be as much as $17 million over a five-year period for this package of reforms.

Technical Sustainability

Technical sustainability can be accomplished only with considerable institutional support to MWI. Initiatives are proposed for the creation of organizational units for planning, groundwater study, and technical monitoring capacity for both surface water and groundwater. Unlike the financial initiatives, which are totally institutional, the achievement of technical sustainability also will require a series of technical studies to be followed by feasibility studies, preparation of designs and contract documents, implementation of programs, and construction of works. The formation of the groundwater study unit should be budgeted at $10 million over a five-year period. Some $7 million would be required for establishment of a planning unit and expansion of the monitoring program from one for financial sustainability to one that also will support monitoring of aquifers and streamflow and data processing for periodic revisions of water allocations, and for a series of studies and small pilot/demonstration-style initiatives.

Resource Sustainability

Long-term, sustained resource management requires that, in addition to institutional reformation and water allocation, a program of demand reduction measures be implemented.

Reduction of Groundwater Demand

Several initiatives have been identified to reduce fresh water demand and are schematically displayed on Exhibit B. The water-sector evaluation team is not judging the political, economic, or technical efficacy of each of these proposed initiatives, but merely notes their potentials and their possible salutary effects on future demand directly from groundwater and surface water sources. There is an urgent need to carry forward a highlands groundwater demonstration project that addresses as many of the five below-listed initiatives, in one location, as possible.
Five groundwater management options were proposed by ARD, in August of 2001, for reducing groundwater abstraction:

- It has been estimated that 5 MCM/year of groundwater now being used for irrigation could be saved with the inauguration of a strong, well-financed *irrigation advisory service*. The associated cost of setting this up is estimated at $3 million.

- A well-conceived program of *well shut ins or buyouts* might save as much as 15 MCM annually. This option would include considerations of replacing groundwater irrigation with *reclaimed water*.

- *Enforcement of abstraction limits through rigorous bill and penalty collections* will be a necessity once a well-organized monitoring and enforcement unit is in place. It could save as much as 10 to 15 MCM/year.

- Approximately 5 MCM/year of fresh groundwater could be exchanged with *reclaimed water for industrial use.*

- Ten MCM/year could be *regained from unaccounted-for water* and 20 MCM/year could be replaced by *new water supplies* such as Disi, Wehda, Zara-Ma'in, and Amman-Zarqa Basin brackish water sources.

Demand Reduction Through Rehabilitation and Replacement of Municipal Water Distribution Systems

Municipal water systems lose large percentages of supply as unaccounted-for water (UFW) due to physical water losses and unbilled water. Perhaps 55 to 70 percent of water delivered to the municipal water distribution systems in Amman, Aqaba, and Irbid is unaccounted for and thus not billed. It is anticipated that rehabilitation of the physical system will result in recovery of, perhaps, one-half the estimated UFW. The effects of municipal conservation measures are schematically displayed on Exhibit B.

Reduction in Irrigation Water Demand

As discussed above, irrigation is expected to continue to consume more than 50 percent of the total water supply over the next 20 years. Irrigation demand for fresh water can be significantly reduced by the further implementation of physical and management measures to achieve higher irrigation efficiencies. Earlier programs demonstrated that reductions of future demand might range from 10 to 20 percent of the on-farm water demand. There also is scope in the Jordan Valley to conserve important quantities of water through improvements of the main and primary canals. In addition, irrigation demand for fresh water may be decreased by replacement of fresh water with reclaimed water where appropriate. Exhibit C illustrates the possible effects of these important measures, which would in large part replace the indents for fresh surface and groundwater by reclaimed water and in some local areas by desalinated water. It is assumed that water saved by irrigation efficiencies brought about in the Jordan Valley would be used on irrigation lands now without supply. In the highlands, improved efficiencies of water use for irrigation would be credited to reduced demand; area dedicated to irrigation would remain constant.

Preservation of Yarmouk River Water

The need is more than urgent that carefully formulated negotiations be undertaken for the drafting and implementation of a *verifiable* agreement for the division of the water of the Yarmouk River. If this is not accomplished within the five-year plan period, 2004–2009, then Jordan may well suffer the total loss of Yarmouk River water during the next one or two decades.

To date, negotiated agreements have not resulted in adequate control of water storage and use in the Golan Province. Thus, releases downstream have not always been the agreed amount. Because of the lack of an agreement with well-defined verification clauses and because the upstream water users still are developing water in a laissez-faire manner, it is proposed that the U.S. Government, through USAID, support the Government of Jordan, technically and diplomatically, to implement a program with the following elements:

Appointment of a Water Master through either the International Bank for Reconstruciton and Development (IBRD) or the United Nations Development Agency (UNDP) to provide a balanced technical perspective and to arbitrate technical issues for both Syria and Jordan. USAID should have on-call a team of technical experts who would provide data, opinion, and analyses as required. USAID could support Syria as well.

- Preparation of the many drafts of an agreement that will be required during what would promise to be a two- to three-year effort.
- A water model(s) that could simulate basin conditions so that the negotiators and the Water Master could evaluate what conditions were at any time over the past half century.
- An agreement that incorporates all of the elements that have affected availability of water today. For this, the agreement must incorporate flows based on conditions before Israel

occupied the Golan Heights and appropriated the water of all of Lake Tiberias and the Jordan River. An accounting of the various abstractions must be carried forward and the two countries must arrive at an equitable sharing of the "natural flow" of the river. Once the proportionality of flow (low flow and flood flow) due each party is agreed, then a measuring structure should be set up near where the Yarmouk River borders or enters into Jordan.

- Defined operating procedures with respect to dams, small dams (tanks), and wells of the Golan Province to fulfill releases required to satisfy the agreed low flows and flood flows.

THREE INVESTMENT SCENARIOS FOR USAID, 2004-2009

Funding levels for USAID's water resources program during the plan period are not known. Therefore, programs and projects are proposed according to priorities established after being filtered through qualitative criteria for three potential levels of financing.

Three scenarios are presented for three levels of annual funding with equal amounts being available each year. The levels are: Low Funding at $10 million/year, Medium Funding at $60 million/year, and High Funding at $100 million/year. The projects and programs listed were drawn from the MWI Action Plan, JICA's Master Plan, and those initiatives that the team recognized as important during the evaluation.

Low Funding Scenario

With $10 million being available annually, there will be total resources of $50 million during the five-year plan period. In this case, USAID will have to make choices. About $26 million will be required for Zara Al Ma'in project completion. Then a choice will have to be made whether to finance some of the institutional work that is so important to sustainability or to finance the Expansion of Community Small Water Treatment Plants for $20 million and/or the Northern Governorates Water Transmission System for $20 million.

The SO2 team recommends that at least $20 million be dedicated to transformation of WAJ, JVA, and five technical units of MWI into a self-sustaining, autonomous utility. The utility would provide bulk water supplies to Town and Village Water Boards and Irrigation Associations. The boards and associations would distribute water to end-users and be responsible for their own finances for operations and maintenance, capital works, replacements, and staffing.

Medium Funding Scenario

With $60 million being available annually, a total funding level of $300 million will be available during the plan period. Following is an illustrative list of projects that could be funded. The team considers the conveyance project for transport of water from the Disi Aquifer near Aqaba to Amman to be the critical project to be completed during the plan period. While it is not certain that USAID is willing to commit resources to this project, the evaluation team suggests that the grant of even a modest percentage of construction cost would have a catalytic effect and propel the project toward realization with private-sector participation. Therefore, two funding allocations are shown below: one with a 12.5 percent contribution for the Disi conveyance project for $93 million, the other without a Disi contribution.

PROJECTS/PROGRAMS	$ Million with Disi	$ Million Without Disi
Carry-over Projects	46	46
Institutional Projects	30	30
Special Studies	3	3
Disi Conveyor at 12.5%	93	0
WWTPs	58	100
Land Consolidation with Reclaimed Water Pipelines to Well Fields for Irrigation	30	30
Constructed Wetlands	7	7
Rehabilitation of Water Supply Systems	9	9
Irrigation Rehabilitation	4	4
Groundwater Conservation Highlands	20	42
Small Dams	0	19
Middle East Water Partnership Grants Program	0	10
TOTAL	300	300

High Funding Scenario

With a funding level of $100 million annually, or $500 million total for five years, it would be possible for USAID to participate in the Disi conveyor project for as much as 25 percent of total cost. This likely would make the project more certain as a PSP since it is understood that the Government of Jordan expects to contribute up to 50 percent. USAID could encounter problems at too high a level of funding should it not be possible to disaggregate pipe from the USAID portion of the project. Even at a 25 percent level, $174 million, there still would be some $123 million more for earmarking.

It may be that under this level of funding USAID should consider the inevitability of the need to explore desalination or major international water transfers.

SUMMARY AND CONCLUSION

The SO2 program has considerable momentum and is poised to achieve dramatic results in the conservation of water being lost in municipal systems and the reclamation of wastewater to high standards of quality for reuse in agriculture. In addition, MWI has been partially convinced and is positioned for dramatic organizational restructuring to put the water sector on a businesslike footing. All of this progress will halt and regress if the funding for SO2 is not maintained for the next five years at least at a level of $50 to 60 million per year. Institutional reform and proper water pricing and allocation will not be truly effective without the sweeping institutional reforms proposed to be finalized and institutionalized during the plan period, 2004–2009.

Specific organizational initiatives that must be financed and implemented within MWI over the five-year plan period will be to provide for:

- Continuous monitoring and data reduction,
- Flow of data to capable planning and scientific units, which, in turn, would ensure
- Supply of information for the making of water allocations nationwide and appropriate pricing of water by an MWI-chaired regulatory body or commission.

Scientifically based water allocation is even more important than the equitable pricing of water. It is only through reorganization of the entire water development, water allocation, and water distribution system that the scarce water resource of the nation can be made to satisfy societal needs and demands.

The large program of investment on the highlands proposed for improving irrigation efficiency, effective use of reclaimed water, and farmer reeducation and persuasion is designed to persuade the farmer to deal with water as a valued commodity that has to be bought at market price. This highlands program requires construction not only of irrigation facilities but also of pipelines for the transport of reclaimed water and the scientific reordering and establishment of well fields. The long-term consequence will be to greatly prolong the life and usability of the rechargeable fresh water aquifers of the highlands.

The Disi conveyance system also is key to the saving of the highlands aquifers. Once water arrives in Amman, there will no longer be a need to pump municipal supply from groundwater. Also, other water now being supplied to Amman will be released for alternative uses.

The Disi-Amman Water Conveyor is listed by MWI as a PSP project. It should have the highest priority for construction because it will provide water of excellent quality to Amman at a time when there is great need to reduce overdraft of water from rechargeable aquifers on the plateau. Also, it should facilitate the filling of the Unity reservoir even if the dam is completed during a drought period. In addition, the Disi pipeline will be an important link in the development of *a national pipeline network*. Should the Red–Dead or an alternative water transfer project be developed in the future, the Disi pipeline will be critical for the transfer of water back to the south. This will be done to conserve the Disi reservoir for emergencies or to supply water to the south if the Disi reservoir will by then have been mined out.

There also is a tremendous need for carefully formulated negotiations leading to the drafting and implementation of a *verifiable* agreement for the division of the water of the Yarmouk River. If this is not accomplished within the five-year plan period, 2004–2009, then Jordan may well suffer the total loss of Yarmouk River water within the next two decades.

Finally, water resources of Jordan continue to be scarce. However, if the basic river and groundwater resources are conserved, and if they are allocated based on sound scientific information and value-oriented pricing, this precious national resource has the potential of meeting demands and contributing to the national economy for several decades more. The use of reclaimed water and water-efficiency schemes must continue to be implemented. Once these fairly traditional initiatives have been exhausted, additional supplies such as desalination of brackish water and the Red–Dead Seas project may become more attractive.

EXHIBIT A

RECHARGEABLE AQUIFERS
PUMPAGE DECLINE DUE TO OVERDRAFT

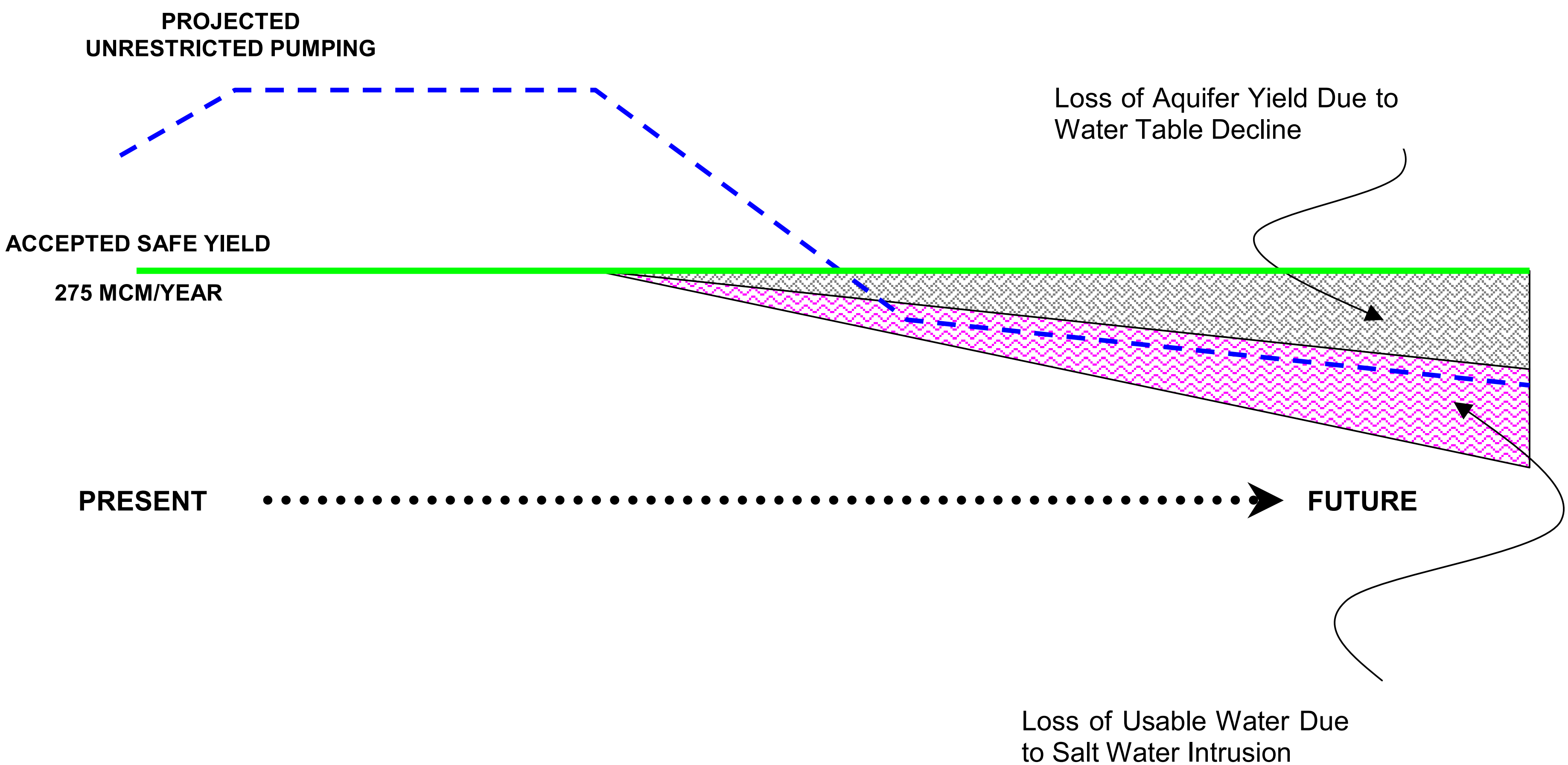


EXHIBIT B

PROJECTED MUNICIPAL DEMAND ON FRESH WATER SOURCES WITH AND WITHOUT CONSERVATION MEASURES

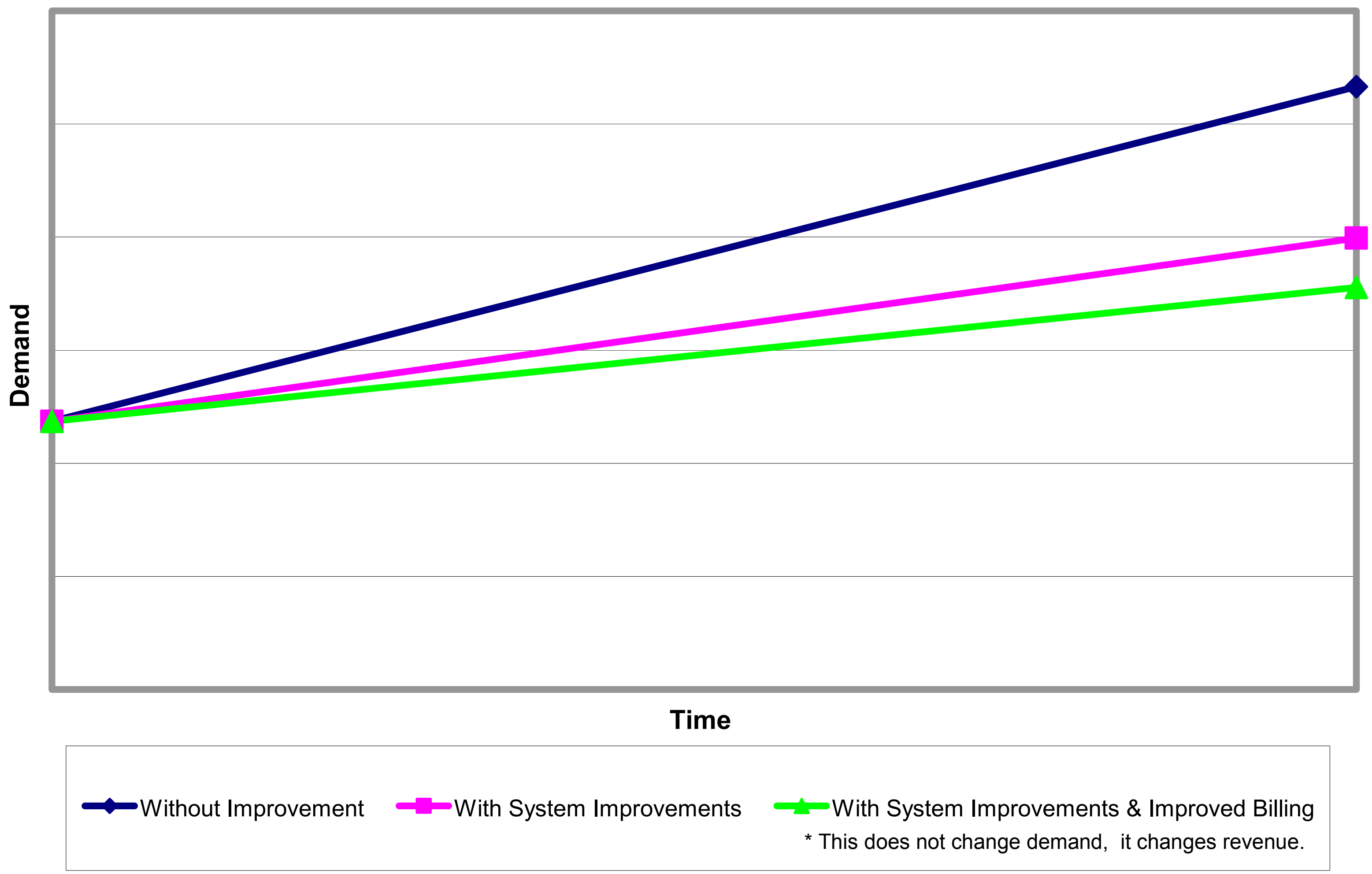
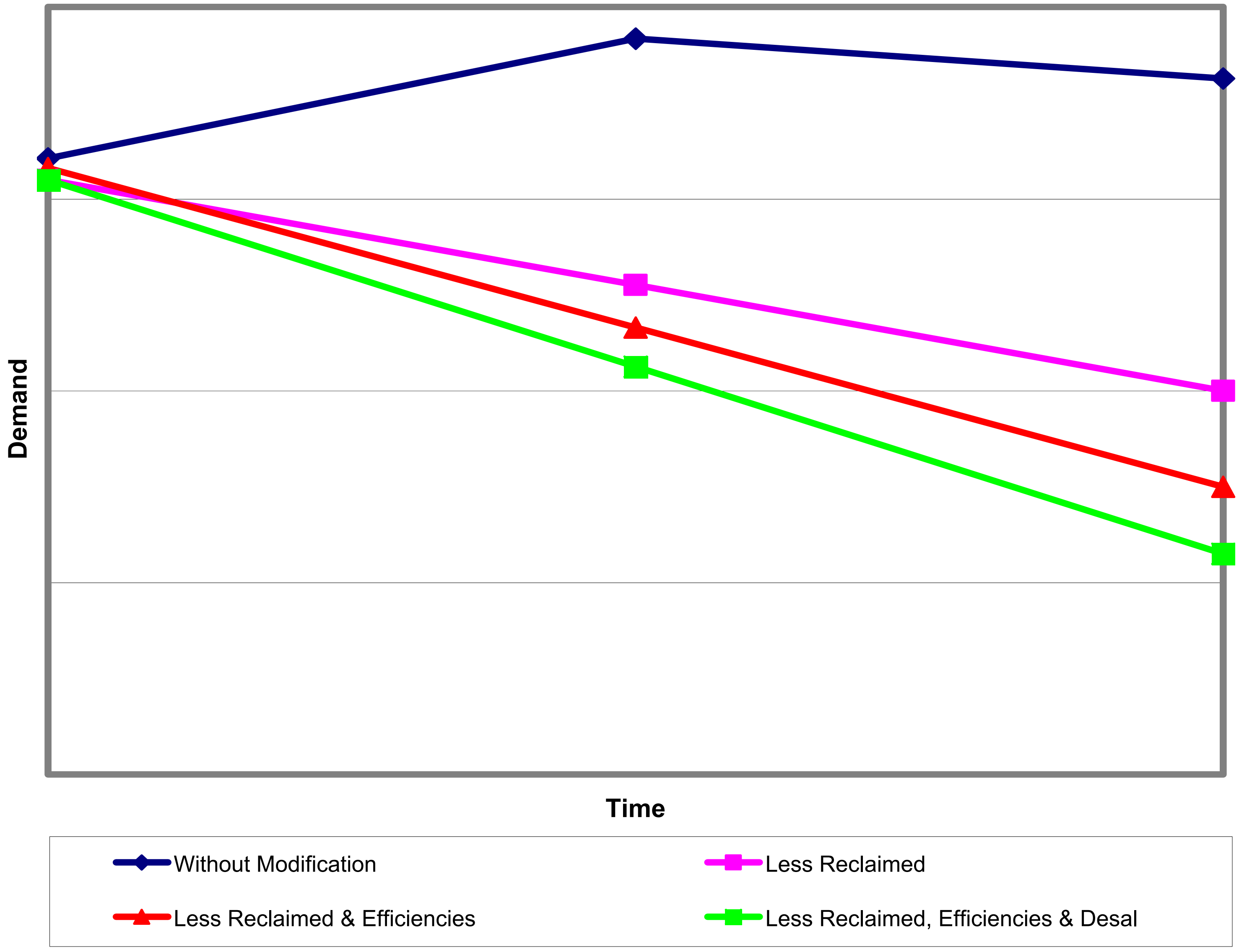


EXHIBIT C

FRESH -WATER DEMAND FOR IRRIGATION



SECTION I:
INTRODUCTION TO JORDAN COUNTRY DEVELOPMENT STRATEGY

SECTION I: INTRODUCTION TO JORDAN COUNTRY DEVELOPMENT STRATEGY

A. SETTING AND THE CHALLENGE

The gravest challenge facing Jordan today is the scarcity of water. The volume of food imports is rising despite continuing increases in the amount of water dedicated to agriculture. Domestic water supply frequently is interrupted during the summer months, while insufficiently treated wastewater poses a serious health hazard and, at least locally, contaminates groundwater reserves. The operation and maintenance of the drinking water supply and wastewater disposal systems are improving but still do not meet the adopted standards. The construction of new sewerage systems has not kept pace with the high growth of population. Existing major sewage treatment facilities have exceeded their design capacity and poorly treated sewage is threatening important groundwater reserves and irrigation water supplies. Unaccounted-for water over the last 10 years is said to have exceeded 50 percent within Greater Amman. With 1.6 million inhabitants, Amman is suffering from an increasing shortage of drinking water. Decreased pressure in water pipes during the summer has increased the likelihood of the introduction of contaminates into the water system network, with heightened risk of water-borne disease. Similar conditions prevail in Irbid and other population centers in the country. Overall, the chronic shortage of water available for use and consumption is the most serious environmental constraint to development in Jordan.

B. IMPROVED WATER RESOURCES MANAGEMENT — STRATEGIC OBJECTIVE 2

To help address this water crisis, the Government of Jordan and USAID designed in 1993 the Water Quality Improvement and Conservation Project (WQIC), which later became known as the Improved Water Resource Management Strategic Objective. The estimated completion date for the objective is 2004; however, four projects, including the As Samra Build-Operate-Transfer (BOT) Project, will run beyond 2004.

The Strategic Objective (SO2) addresses the critical issue of inadequate water supplies in Jordan and is being accomplished through specific activities to realize the following Intermediate Results: IR2.1 – Stronger Water Sector Institutions; IR2.2 – Increased Efficiency in Use of Water Resources; and IR2.3 – Improved Quality of Wastewater. Specific activities and performance indicators related to the three Intermediate Results are summarized in Table I-1.

The indicators used by USAID to measure progress in achieving SO2 include:

- Index of stronger water institutions,
- Volume of fresh water made available, and
- Total wastewater treatment capacity available.

Table I-1. Intermediate Results for Strategic Objective 2 (1997–2002)

INTERMEDIATE RESULT	ACTIVITIES	PERFORMANCE INDICATORS
1 - Stronger Water Sector Institutions This result will strengthen the capability of the MWI and its two executing entities, WAJ and JVA, to plan, monitor, implement, and sustain activities in the water sector.	▪ A water policy implementation program focused on reducing groundwater depletion and optimizing the reuse of treated wastewater. ▪ A technical assistance (TA) program that aims to strengthen the government's ability to develop, contract, and manage major infrastructure projects and promote Private Sector Participation (PSP) arrangements. ▪ A TA program that will design and implement an automated accrual-based accounting system for JVA. In addition, TA was provided to help JVA in its strategic planning process. ▪ A nationwide water education and public information program that aims to expand public education on the water shortage situation in Jordan and ways in which individuals and public- and private-sector institutions can conserve and more effectively manage scarce water resources. ▪ A two-year program to provide action-oriented, short-term technical and managerial training courses to Ministry staff to improve technical skills. ▪ A TA program for WAJ/MWI to restructure their financial activities and wastewater reuse implementation.	▪ Index of Water Policy Implementation ▪ Index of Management Improvements ▪ Index of Private-Sector Participation and Cost Recovery
2 - Increased Efficiency in Use of Water Resources This result aims at promoting efficient use of existing water resources.	▪ Rehabilitation of 10 springs and wells. ▪ Rehabilitation and restructuring of the water network of 16 zones in Amman, thus considerably reducing unaccounted-for water. ▪ Improvement to the Zai water treatment plant that provides water to 40% of Amman residents. ▪ Funding four Irrigation Advisory Service personnel for the JVA to train farmers in more efficient irrigation methods. ▪ Funding a new improved on-farm irrigation water use efficiency program and watershed management project. ▪ The Ma'in water treatment and pipeline project.	▪ Water systems rehabilitation and/or construction
3 - Improved Quality of Wastewater In a water-scarce country such as Jordan, treated wastewater is reclaimed water, an important supply of irrigation water, and in the future it can serve as a substitute for fresh water used in agriculture and industry.	▪ Design and construction of wastewater treatment facilities at Wadi Mousa. ▪ Expansion of the wastewater treatment facilities in Aqaba. ▪ Design of wastewater facilities in the North Jordan Valley. ▪ Financing the construction of a new wastewater treatment plant to replace As Samra on a BOT basis with a USAID grant component ▪ Expansion of the wastewater treatment facilities in Mafraq.	▪ Wastewater treatment systems design and construction

Source: USAID/Jordan SO2 – Water Resources Objective Activities Description

C. RELATIONSHIP OF SO2 TO OTHER STRATEGIC OBJECTIVES

Strategic Objective 3 (SO3): Improved Access to and Quality of Primary and Reproductive Health Care

USAID-funded activities focus on four main areas: improved knowledge and use of contraceptives, increased availability of reproductive and primary health care services in the public sector, private-sector family planning initiatives, and improved efficiency of the health sector.

One of the components of the health program is "infection control." Identification of outbreak of disease is done through the Centers for Disease Control and Prevention (CDC) project, Epidemiological Surveillance Project. On the average 10 to 15 cases of food- or water-borne disease are reported each month. Most of the water-borne disease is from contaminated well or spring water.

The Ministry of Water and Irrigation (MWI) is responsible for the quality of water before it leaves the water treatment plant. The Ministry of Health (MOH) is responsible for monitoring water after it leaves the plant and for providing training in good sanitation practice to communities. Water-related initiatives with commonalities between the MOH and MWI provide opportunities for mutually beneficial activities such as community training in conservation of water and sanitary practices in the use of water. Under the $40 million Primary Health Care Initiatives (PHCI) 1999–2004, water conservation practices are included in the rehabilitation of facilities.

Strategic Objective 5 (SO5): Increased Economic Opportunities for Jordanians

The three Intermediate Results under this SO are: IR5.1 – Increased Access to Business Services; IR5.2 – More Effective Identification and Implementation of Policy Reform; and IR5.3 – Improved Environment for Sustained Policy Reform.

The Achievement of Market Friendly Initiatives and Results Program (AMIR) is on-going under SO5. The performance period for this program is 2002–2005. The key results under IR 5.1 are as follows: (1) Increased emphasis on the demand side, (2) Enhanced productivity program launched at Ministry of Planning (MOP), and (3) Wholesale lending facility utilized. One of the issues is the need to develop a common donor approach. Under the AMIR program, the Jordan Valley Authority (JVA) Strategic Planning Program (2000–2004) is involved and provides an opportunity to maximize results between SO5 and SO2. Both SO team leaders are coordinating.

D. WATER SECTOR ASSESSMENT

The purpose of this evaluation and the charge to the SO2 evaluation team was to conduct a review of USAID/Jordan's Strategic Objective 2: Improved Water Resource Management for the period 1995–2002. The team was further charged to present options for the direction of SO2 over the five-year period 2003–2009.

The SO2 evaluation team was specifically tasked to address the following three sets of questions—options regarding the direction of SO2, activities undertaken during the past five years, and opinions regarding the environment in which SO2 operates:

1. Jordan's Water Sector and Present Options for the Direction of SO2
   - Is the current SO2 still needed?
   - What is the greatest challenge facing this sector in the next five years?
   - Is there a need to alter the general focus for FY 2004–2009? How?
   - Are there gaps in the water sector in Jordan to be considered in SO2?
   - Is there a need to expand or narrow the focus of SO2? Why?
   - Are the DAI study recommendations appropriate?
   - Is there a more appropriate mix of recommendations?
   - What is a possible USAID follow-on water sector assistance strategy (plan) under different funding scenarios?

2. The 1997–2002 Activities Under SO2
   - Is each activity contributing significantly to the SO2 objective?
   - Is each activity reaching its targeted population?
   - Are all the needed areas covered by the activities?
   - Is there a need for a different mix of activities that will contribute more to the objective?
   - Does the approach used for each project/activity present the best available alternative to address the problem in the sector?

3. The Environment in Which SO2 Operates
   - Are there gaps in overall assistance this sector? What are they? What more or different could USAID be doing in this area (environment: social, political, institutional)?
   - What is the appropriate balance for USAID programming in institutional and technical support versus infrastructure support?
   - Should support be focused by geographical areas or spread throughout Jordan? (i.e., Should SO2 focus on certain cities/villages and complete everything needed for water and wastewater in those places?)

E. Study Methodology

The approach used in the assessment was to collect and analyze information on the water resources of Jordan. This included document research, interviews with key individuals in organizations concerned with water resources (see Annex B for a list of persons contacted), and field trips. In addition to extensive interviews with ministry and agency officials and project managers and stakeholders in Amman, the team met in Aqaba with key persons of the MWI, Aqaba Special Economic Zone Authority (ASEZA), and additional stakeholders. The team also visited a private well and farm near Madaba, Wala Dam, As Samra wastewater treatment ponds, and the Zarqa desalinization plant.

The "Study on Water Resources Management Report" by the Japan International Cooperation Agency (JICA) was completed in December 2001. It brought together much of the information from earlier and concurrent studies, including those of International Bank for Reconstruction and Development (IBRD), Associates in Rural Development (ARD), United States Geological Survey (USGS), Ministry of Water and Irrigation (MWI), and outputs of other donors. The team reviewed of these and other reports and assembled a broad cross-referenced body of information. To address environmental issues, the team reviewed the National Environmental Strategy (NES) for Jordan and recommendations of the Jordan Country Study on Biological Diversity (1998) and has suggested actions as required under Section 119 of the Foreign Assistance Act (FAA) to be considered in SO2 that are linked to and support the water sector. Completed, ongoing, and planned SO2 projects were reviewed with the USAID Office of Water Resources and Environment (WRE) staff. A wealth of current data and information in reviewed reports provided credible technical information to address the physical and infrastructure issues and concerns facing Jordan. Interviews with the stakeholders shaped and confirmed the team's findings and provided valuable information from their experience of having lived with Jordan's water-scarce situation. The team also looked at gaps in the areas of planning, allocation of water resources, the quantifications of supply and demand, and the physical water-sector infrastructure. The following sections of this report address issues, shortcomings, and possible initiatives in the context of SO2 during the next five-year planning period. The above-noted specific questions, which were posed for answer by the team, are addressed in Section VII.

SECTION II: SOCIOECONOMIC-ENVIRONMENTAL VIEW

SECTION II: SOCIOECONOMIC–ENVIRONMENTAL VIEW

This section discusses the severe impacts of population growth on the water sector and the environment. Rapid population growth also has worsened Jordan's already lagging financial capacity, with the consequence that the nature (loans vs. grants) and focus of donor aid has been affected.

A. SETTING

Jordan has experienced high population growth, exacerbated by waves of refugees and returning immigrants from Gaza and the West Bank of the Jordan River to the west, from Iraq to the northeast, and from the Gulf States to the east and southeast. There are approximately 30 Palestinian refugee camps in the country with a total population exceeding 1 million, in addition to the current national population of approximately 4.2 million. The population is expected to be between 8 and 10 million by 2020, depending on the forecasting process used and whether there is resolution of the refugee issue.

Although there has been a ninefold increase in total population over the past 50 years, or over 4.4 percent growth per year, the projected 2020 population would result from a much more modest growth rate of 2.0 to 3.3 percent per year (JICA, December 2001). Since the Jordanian National Population Commission plans to halve the birth rate over the next 20 years by promoting family planning and discouraging further waves of migration, this lower rate seems reasonable. At present, about 80 percent of Jordan's population lives in urban centers, with approximately 1.6 million in the capital, Amman, and more than half that number in Irbid and Zarqa. About 60 percent of the population are Palestinians, many registered as refugees, who fled primarily from the West Bank during the 1948 and 1967 Arab–Israeli wars. Approximately 300,000 Palestinians have returned from the Gulf States to Jordan since the Gulf War in 1990.

Municipal and industrial water demand forecasted for 2020 totals 757 million cubic meters (MCM), compared to a current available water supply of only 675 MCM (256 MCM from surface water and 419 MCM from "safe yield" and fossil groundwater [see Section IV, "Water Resources"]).

1. Population Impacts on Sectors

The populace makes both direct and indirect demands on the water supply of the country. Direct demands are for drinking water, household activities, and other direct municipal use. The population indirectly requires water for government, public health, employment, education, transportation, commercial and industrial pursuits, and irrigated agriculture. In addition, tourism increases water demand, and increasing affluence and improved standards of living increase water demand.

People directly generate wastewater, which must be collected, treated, and disposed of or reused properly, not only to avoid disease and nuisance but also for society to enjoy the multiplier effect of a scarce resource. People also generate solid and hazardous wastes that indirectly can cause reduced water availability through water pollution.

2. Financial Situation

For many years, donor organizations have contributed resources to improve living conditions in Jordan for humanitarian reasons, to respond to refugee and immigration stresses, and to support the Israeli–Jordanian Peace Treaty of 1994. Donors contribute to several sectors of Jordanian life, including water, energy, environment, and others. In addition to the United States, other donors include the World Bank (IBRD), Germany (GTZ, KFW), Japan (JICA), Canada (CIDA), UNDP, the European Union, Italy, France, the Mediterranean Environmental Technical Assistance Program, and several nongovernmental organizations.

USAID is the largest donor in the water sector, contributing approximately $60 million per year since 1995. USAID's contributions over the past five to seven years were directed to the construction of major improvements and additions to the water and wastewater infrastructure. USAID has specifically emphasized institutional strengthening, development and delivery of water resources, and treatment of wastewater. These activities have been funded at an approximate level of 15, 45, and 40 percent, respectively.

Timeline graphs at the end of Section VII illustrate the completed, ongoing, and future projects for USAID, JICA, GTZ/KFW, and the Deloitte Institutional Action Plan activities.

B. ENVIRONMENTAL CONSEQUENCES OF POPULATION GROWTH AND LAGGING FINANCIAL CAPACITY

The population's natural growth and its increase due to refugees, immigrants, and economic migrants have created stresses within Jordan's physical, social, and economic environment, especially with regard to the limited fresh water resources and water sector infrastructure. A range of these adverse impacts and challenges are discussed below in terms of groundwater, surface water, municipal wastewater, land use, mining of fossil or nonrechargeable groundwater, and biodiversity. Potential impacts and mitigation measures are discussed later in this section. Generally, as population increases and municipalities, industry, and tourism demand more water, they use up the scarce and nonsustainable water resources, increasing their unit costs as the elasticity of supply disappears. As water costs increase, inadvertent consequences lead to illegal activities, including well drilling and unauthorized tapping of municipal and agricultural water supplies. If allocated water use is not carefully monitored, priced, and enforced, water is overpumped and overused. This leads to further diminution of the water resource.

1. Groundwater

Groundwater is a precious national resource. It is the main source of fresh water in all parts of the country. Groundwater occurs in aquifers or water-bearing rocks. Aquifers across the country are overpumped beyond estimated safe yields. Most of the aquifers in the highlands and deserts are fractured-rock basalt and limestone, while the narrow Jordan River channel contains a porous-media alluvial aquifer. The shallow aquifers naturally tend to contain fresh water, which is suitable for potable, agricultural, and industrial use with minimal treatment. The deeper aquifers tend to contain brackish or saline groundwater, which is too salty for potable, agricultural, and industrial use without treatment.

The effects of the sudden growth of population on groundwater include:

- Aquifer dewatering,
- Irreversible salinization of aquifers,
- Dissolution of carbonate aquifers and structural collapse, and
- Groundwater contamination.

Aquifer Dewatering

As fresh groundwater is overpumped from shallow aquifers, they become dewatered and yield less. As the water levels or potentiometric water surface drop in these overdrafted fresh water aquifers, flow of natural springs decreases and the springs dry up. The major basalt and limestone aquifers in the highly populated Amman-Zarqa Basin are generally overpumped as their abstraction has exceeded their recharge since the late 1970s and early 1980s (Associates in Rural Development (ARD), May 2000, *Outline Hydrogeology of the Amman-Zarqa Basin*). As groundwater levels decline, pumping lifts increase and pumping costs rise, increasing the cost to maintain well production and to provide a unit of groundwater.

Abstraction, as a percentage of safe yield, has been over 155 percent since the 1980s, and water levels reportedly have declined between 0.67 and 2.0 meters/year in the B2/A7 Limestone Aquifer. Springs in the A4 Dolomitic Limestone Aquifer no longer flow and A4 Aquifer wells in Ain Ghazal north of Amman have declined in excess of 70 meters below their original depths. The Kurnub Sandstone Aquifer in the Baqa and Ain el Basha areas also is excessively depleted; water levels have declined about 70 meters in the last 30 years. This is discussed further in report Section IV, "Water Resources."

Irreversible Salinization of Aquifers

As water levels decline in overdrafted aquifers, underlying or adjacent aquifers, which contain brackish or saline groundwater, leak into them and irreversibly contaminate them with saline water. The major basalt, limestone, and sandstone aquifers in the highly populated Amman-Zarqa Basin have generally become saline as a result of overpumping (ARD, May 2001, *Assessment of Potential Use of Brackish Water for Municipal and Industrial Supply in Amman-Zarqa Basin*).

As aquifers become salinized, they no longer can provide fresh water. Saline water may be desalinized by several processes, including electrodialysis, multistage flash, or reverse osmosis, but all known desalination methods are orders of magnitude more expensive than simply pumping shallow fresh groundwater where available. In addition, desalination produces brines and typically requires the use of hazardous materials. The net result of the salinization of aquifers is reduction in the availability of relatively inexpensive shallow fresh groundwater and replacement of it with saline water, which is generally unusable unless there is expensive treatment.

Dissolution of Carbonate Aquifers and Structural Collapse

Many of the surface soils, surface and subsurface materials, and major aquifers in Jordan are made up of carbonate minerals. Carbonate aquifers are composed primarily of fractured calcium carbonate, which is soluble in dilute simple inorganic acids such as hydrochloric acid and complex organic acids derived from petroleum products. As groundwater is pumped from these carbonate aquifers, natural groundwater velocities increase rapidly and groundwater dissolves the matrix of the fractured carbonate materials. This accelerated dissolution process results in karstic or cavern development and forms sinkholes or collapses in the land surface. This phenomenon is observed, for example, in the heavily pumped limestone aquifers of the Amman-Zarqa Basin. Sinkholes threaten the physical stability and sustainability of farmland, homes, institutions, and constructed infrastructure such as roads, energy and water lines, sanitary sewers, storm drains, and sidewalks.

The net effect of carbonate aquifer dissolution is to make the land surface a risk to human life, property, land use, and infrastructure, and to considerably reduce economic productivity in the areas where it occurs. Reduction of pumping rates is a potential preventive action.

Groundwater Contamination

Surface water contaminants, either direct releases from such point sources as solid waste landfill leachate or leaks in wastewater systems, or indirect releases from nonpoint sources such as agricultural runoff, can travel rapidly into shallow groundwater through the thin soils and fractured basalt, limestone, and sandstone that comprise the major aquifers of most of Jordan. The thin soils and fractured rock aquifers have little or no pollutant-attenuation capacity. Once contaminants enter groundwater in fractured rocks, contaminants have little opportunity to biodegrade or interact with the aquifer materials to reduce their concentrations. Therefore, such contaminated waters must be treated to reduce the risk to human health and the ecology. If salinity is too high, the waters may be unsuitable even for agricultural and industrial use.

2. Surface Water

The Yarmouk, Jordan, and Zarqa Rivers are the only sizeable perennial streams in Jordan. The flow of the Zarqa River has been severely degraded during the past two decades. In earlier times, the base flow of the river was good-quality groundwater, including flow from springs. Today, the groundwater inflow has been substantially decreased due to the proliferation of irrigation wells across its watershed. Also, the discharge of the As Samra wastewater treatment ponds has increased salinity and the level of contaminants in inflows to the King Talal Reservoir and downstream to the Jordan Valley.

Again, over the past several decades, the Jordan River has become, effectively, a drain for highly saline spring water and its entire former fresh water flow has been intercepted in the vicinity of Lake Tiberias. Low flows of the Yarmouk River have been severely reduced due to the development of many small dams across the Golan Province of Syria. In addition, rapid installation of irrigation wells along the Yarmouk River in Syria has reduced already low flows. Several wadis experience flood flow during the winter months, November through March.

In major urban areas, hydrographs of stormwater runoff have been greatly modified, resulting in local peak flow rates that are multiples of runoff volume experienced before areas were paved over and buildings constructed. These flows cause localized flooding but do not affect the flows of the rivers and major wadis.

As the population demands more water, springs, wadis, and rivers become controlled or dammed to capture their flows in reservoirs for direct use or for artificial groundwater recharge, reducing riparian water and riverine habitats. An inadvertent effect of creating reservoirs is to increase the salinity of stored surface water in response to the high evaporation rates in Jordan. Dams, reservoirs, artificial recharge systems, and the infrastructure that create and support them are costly. Currently, Jordan requires donor capital loans or private-sector participation for the construction of large projects.

3. Municipal Wastewater

Wastewater is a valuable resource in Jordan. The treated wastewater itself is an important current and potential source of reclaimed water. Reclaimed water can be used for landscape and park irrigation, date palm farms, mineral quarrying, and other agricultural and industrial uses. In addition, biosolids or wastewater plant sludges can be used for composting, soil amendments, and daily solid-waste landfill cover. Jordanian soils tend to be naturally high in calcium and low in trace minerals since they are derived from basalt, limestone, dolomite. They also are low in organic matter. Compost can help reverse this organic deficit, while soil amendments help reverse the mineral deficit. Both help retain soil moisture in irrigated fields, reducing the crop irrigation requirements.

Land taken out of agricultural, urban, or industrial development for wastewater treatment is land removed from direct economic productivity. In addition, if wastewater is treated in open lagoons, it may attract mosquitoes, which are potential disease vectors. Open lagoons in the Jordanian desert also have high evaporation rates, further increasing the salinity of these wastewaters and potentially limiting their agricultural use, especially in clayey highland soils.

All irrigation water brings salts into irrigated soils. This added salt must be leached or drained to sustain the soil's agricultural productivity. The more saline the applied water, the greater the need to apply a leaching fraction. If such measures are not undertaken, agricultural soils may be abandoned without re-establishment of a sustainable vegetative cover, leading to dust formation, wind erosion, and desertification.

Currently, several communities have inadequate wastewater collection and treatment systems. Also, several of the UNRWR, GOJ, and unauthorized refugee camps, including Baqa'a, Souf, Jerash, Talbieh, Souchna (northeast of Amman), and Shilalah, as well as the Old City of Aqaba, reportedly require water and wastewater infrastructure.

ARD (August 2001, *Summary of the Water Resource Policy Support Activity*, 9 August 1999 to 8 August 2001) identified seven priority options to supply reclaimed water in the Highlands, Wadi Zarqa, and the Jordan Valley areas. These options included exchange with groundwater in the Dhuleil-Hallabat area in the AZB Highlands for agricultural use and with the Hashemite-Zarqa area for industrial use; intensification of irrigated agriculture in Wadi Zarqa, the Karameh

Directorate, and the Middle Directorate; exchange with fresh surface water in the Northern Directorate for agriculture; and expansion and intensification of agriculture in the vicinity of minor wastewater treatment plants.

ARD developed scenarios to determine the probable best combinations of these options. Their findings were that it would not be necessary or feasible to implement all of the options in a single plan. Some would be mutually exclusive. ARD concluded that reclaimed water could not be pumped economically to the Highlands for agricultural use. This premise should be revisited as specified under item A2a of Section VIII.

4. Proposed and Ongoing Mining of Fossil Water

Demands for fresh water have led to proposed and ongoing mining of fossil groundwater. Fossil groundwater does not receive recharge from current rainfall and has no safe yield or natural sustainability. The major aquifer of fossil fresh groundwater is locally known as the Ram Group Aquifer (R/D), a sandy facies aquifer containing groundwater approximately 10,000 to 30,000 years old (JICA, December 2001, *Final Report, Summary Report, The Study on Water Resources Management in the Hashemite Kingdom of Jordan*). The Ram Group Aquifer is exploited in the Disi-Mudawara Basin in southeastern Aqaba and southwestern Ma'an Governorates because it is fairly shallow at that location. Ram Group groundwater in the Disi-Mudawara Basin has a salinity of 200 to 300 mg/L TDS.

An annual abstraction of about 125 MCM is expected from the Ram Group in the Disi-Mudawara Basin, which may be sustained for about 50 years according to one study, or 155 to 255 MCM/year for 40 to 100 years according to another study. Saudi Arabia reportedly extracts 700 MCM/year from the Ram Group near the Disi-Mudawara Basin. Currently, approximately 70 MCM/year is extracted from the Ram in this basin in Jordan for use in Ma'an and Aqaba. This implies that an additional 55 MCM/year is available for municipal use in Amman from the Disi-Amman Conveyor once wells, pumps, pipelines, and pumping stations are in operation, assuming that Saudi Arabia does not expand its production. The Disi-Amman Conveyor is envisioned to have a 120-MCM/year capacity. Full use of the capacity would result from new pumping plus freed Disi water through exchanges to provide current users in Aqaba with alternative supplies.

In addition, fossil fresh groundwater development is ongoing in the Lajoun area, southeast of the Dead Sea in Karak Governorate, where 10 MCM/year is developed and conveyed to Amman. The potential for additional development of fossil fresh groundwater in the Lajoun area has not been sufficiently investigated. In addition, there may be unexplored fresh fossil groundwater elsewhere in Jordan.

Fresh fossil groundwater is a national treasure in water-scarce Jordan and, to an even greater extent than potentially replenishable groundwater, it should be managed very carefully because of its purity, limited amount, and nonsustainability. It should be used as an interim resource until agricultural demand can be curtailed by demand reduction, reclaimed water can be optimized, unaccounted-for municipal water losses are ameliorated, accessible surface water is captured for direct use or groundwater recharge, and all other water supply enhancements and water demand curtailments come into place.

C. POTENTIAL ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

The following section lists potential environmental impacts identified during the past and ongoing SO2 project activities. Potential measures of mitigation are noted for possible reference or use in a checklist during formulation of future projects and activities.

1. Aquifer Dewatering

Potential Negative Impacts

As groundwater levels decline, pumping lifts increase and pumping costs rise, increasing the cost to maintain well production and to provide groundwater. Springs, which are typically low points in the water table that are exposed at the land surface, dry up and become unavailable for use to people, indigenous wildlife and migratory birds.

Mitigation

- Pumping within the safe yield of an aquifer in concert with recharge rates is a preventive strategy.

2. Irreversible Salinization of Aquifers

Potential Negative Impacts

As aquifers become salinized irreversibly, they no longer can provide fresh water. Desalination produces brines and typically requires the use of hazardous materials such as chlorine in the water-processing treatment train. Chlorine gas, which is most efficient in disinfecting treated water by oxidation and in providing a residual disinfectant for potable water, is dangerous to work with. As such it provides potential risks to site workers and the public.

Mitigation

- Avoiding overpumping to the salinization level is a preventive strategy.
- Using safer forms of chlorine (e.g., slurry, liquid, powder).
- Using untreated brine for irrigation of salt-tolerant crops (e.g., salicornia-mature plant, a halophyte, provides seeds that produce fine edible oil and a high protein meal. The biomass can be used for animal fodder, particleboard, and firebricks).

3. Carbonate Aquifer Solution

Potential Negative Impacts

As groundwater is pumped from these carbonate aquifers, the accelerated solution process dissolves the carbonate materials and accelerates karstic or cavern development, forming sinkholes in the land surface. Sinkholes threaten the physical stability and sustainability of farmland, homes, institutions, and constructed infrastructure such as roads, energy and water lines, sanitary sewers, storm drains, and sidewalks. The net effect of carbonate aquifer solution is to make the land surface a risk to human life, property, land use, and infrastructure, negatively affecting economic productivity.

Mitigation

- Reducing pumping rates to harmonize with recharge rates is a preventive strategy.

4. Groundwater Contamination

Potential Negative Impacts

Typical contaminants from human activity are derived from human and animal wastes and agricultural, industrial, and commercial byproducts. Some of these contaminants present potential human health and ecological risks.

Mitigation

- Collecting, treating, and disposing of human and animal wastes properly.
- Pretreating industrial waste at the industrial site where it is generated.
- Using best management practices (BMP) for watershed management, controlling land use to protect surface water and groundwater from human and animal wastes, siltation, and solid and hazardous waste disposal.
- Using Integrated Pest Management (IPM).
- Introducing constructed wetlands for control of nonpoint source pollution and as a low-tech solution for municipal wastewater treatment (see Box II-1).

5. Urban Flooding

Potential Negative Impacts

- As population increases, the demands for water and land resources increase, leading to decreases in surface cover or vegetation. The decrease in vegetation in a watershed, as well as warming effects spilling over from urban heat islands, leads to a drying out of the soil surface and irreversible desertification.
- As desertification continues, agricultural development and pre-desert habitats become limited, and biodiversity suffers.
- Human and animal life and property are potentially damaged unless the urban infrastructure accounts for the effects of urbanization on runoff by providing appropriate surface drainage.
- Urban flooding, especially in construction areas and where soils and rocks are exposed or construction materials are disposed, increases soil and rock erosion, leading to turbid- and sediment-rich floodwaters and siltation of downstream basins and back-up flooding. In addition, siltation and deposition of fine materials in natural flood channels, basins, and wadis reduces groundwater recharge.

Box II-1

Constructed Wetlands

Once considered worthless, wetlands are now recognized as one of the most diverse and productive ecosystems in the world. Wetlands clean water, produce food and fiber, provide wildlife habitat, recharge the groundwater, reduce flooding, and offer recreational opportunities.

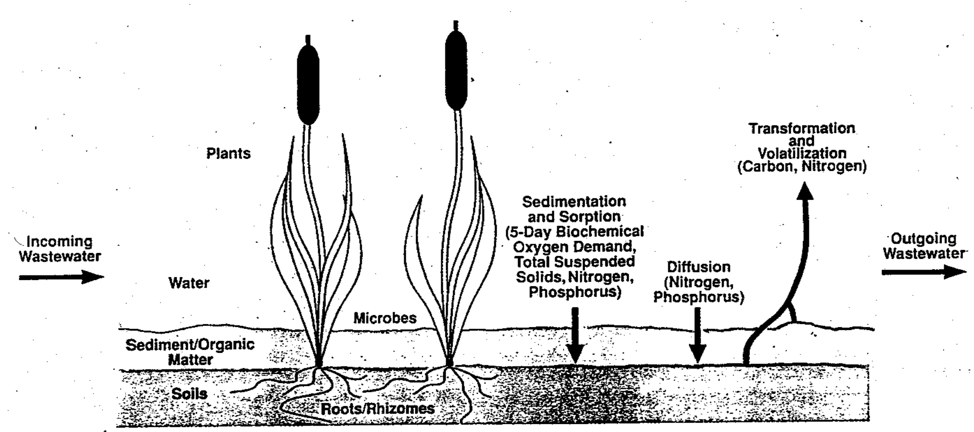
All treatment wetlands, constructed or natural, have the same general components of landform, water, soil, plants, microbes, plant litter (also called organic matter or detritus), and fauna. As a result of physical, biological, and chemical processes in the wetland environment, many pollutants in the water flowing through the system are transformed or inactivated. The low flow rate of the water and the long time the water stays in the wetland (called residence time) result in the settling and trapping of solids and biodegradation of organic matter dissolved in the wastewater.

The plants provide a place for microbes to attach. These microbes take nutrients from the water to grow. The processes by which microbes transform and remove pollutants from the water are complex. With nitrogen, for example, microbes ammonify nitrogen (convert ammonia to nitrite and nitrate, which is used by bacteria and some plants for growth); and denitrify nitrogen (volatilize nitrogen, which is lost to the atmosphere). As a result of these processes, excess nitrogen is removed from the water. Similar microbial processes reduce and stabilize phosphorous nutrients and organic matter dissolved in contaminated inflows.

Wetland plants also absorb nutrients and, like the microbes, they convert the nutrients into a form that the plants use for growth. As the process of uptake, transformation, and release of nutrients in the wetland cycles, some of the nutrients in the system are trapped in the soils or released into the air. The result is water that is cleaner than when it entered the wetland.

Benefits:

- Cost: $500,000 for population 4,000 (less land costs)
- Biodiversity enhancement (2.4 ha)
- Migratory bird stopovers/resting areas
- Local build/mgt by stakeholders
- Ecotourism (Bird watching)
- Carbon sequestering/climate change mitigation
- Low operation and maintenance costs
- Once established, readily sustainable



Mitigation

- Introducing urban drainage planning to catch runoff for reuse.
- Introducing vegetation areas with wetland basins to catch runoff and provide groundwater recharge and diverse habitat.
- Capturing and harvesting floodwaters for landscape and park irrigation, industrial use, and crop irrigation.
- Using BMP for erosion control in the watershed, especially during construction and post-construction activities, on exposed soils and rocks, and prohibit soil winnowing and disposal of construction debris in the watershed.
- Providing collection and treatment services for human and animal wastes, and for solid and hazardous waste so that these do not continue to contaminate surface water.
- Introducing constructed wetlands.

6. Surface-Water Contamination

Potential Negative Impacts

- Ponded fresh water almost immediately attracts insects, including mosquitoes, which may pose human health and animal health risks.

Mitigation

- Managing disease vectors naturally with fish that eat mosquito-larvae or artificially with other chemical or biological pest control measures .
- Wastewater polish ponds may be used as visual buffers, greenbelts, habitat parks, and wetlands to support biodiversity.

7. Use of Wastewater Plant Sludge

Potential Negative Impacts

Sewage sludge has beneficial plant nutrients and soil-conditioning properties; however, it may also contain pathogenic bacteria, viruses, protozoa, or parasites that can cause disease. Land application and surface disposal of untreated sewage sludge create a potential for human exposure to these organisms through direct or indirect contact.

Mitigation

For regulation of the disposal of sewage sludge, following Standard #JS 1145/1996 and modifications thereto resulting from ongoing initiatives. The enforcement of the quoted standard needs to be monitored and regulated with recognition of the following:

- Incorporate specifications in contracts for "biosolids"; specifically refers to sewage sludge that has undergone treatment (e.g., digestion, dewatering or drying, lime stabilization, heat treatment, composting) and meets standards for beneficial use (e.g., compost, soil amendment, landfill cover).

- Provide "biosolids" for agricultural land, strip-mined land, forests, plant nurseries, cemeteries, parks, gardens, lawns, and home gardens.

D. BIODIVERSITY—SACRIFICES AND OPPORTUNITIES

The biodiversity requirements of the previous Country Program Strategy (CSP) were carried out under SO5 through a $3.6 million activity for the construction of a center for the Royal Society for the Conservation of Nature (RSCN). Biodiversity recommendations were included as project elements and made conditional for implementation of the center.

As USAID strategy or equivalent country plans are being rewritten, the requirement of Section 119 of the Foreign Assistance Act (FAA) applies and an appropriate section must be included. To the extent that a previous biodiversity analysis (in this case the Jordan Country Study of Biological Diversity, 1998) is still applicable, then the job of including this section becomes simpler.

However, the process that a Mission goes through to decide what to continue, change, or drop from its previous strategy when writing its revised strategy must include careful consideration of the needs and opportunities for biodiversity in the country. The Mission may decide not to include biodiversity issues in its strategy but it needs to do so based on factual analysis of the current situation in the country. There are several recommendations in the Jordan Country Study on Biological Diversity (1998) that link to and support USAID strategy to improve water resources management in Jordan. This biodiversity study documents Jordan's biological resources and recommends actions to protect those resources.

Recommendations from the Jordan Country Study on Biological Diversity that may be included in the CSP are:

1. Wildlife and Habitats

- Control industrial wastewater discharge in compliance with national and international criteria and standards
- Rehabilitate natural conditions of streams to improve the fish status

2. Land Resources (water resources added)

- Strengthen existing laws and improve enforcement of laws, codes, and regulations.
- Strengthen, update, or develop legislation related to land (water) requirements
- Promote a common definition of sustainable land (water) use and planning
- Promote public participation in land (water) use policies and management

3. Wildlife and Protected Areas

- Promote sustainable development in and around important biodiversity areas such as ecotourism, organic farming, environmental management of resources (water), and others

4. General Issues

- Spread environmental awareness among all sectors of Jordanian society, especially among communities
- Promote sustainable development and initiate socioeconomic projects among local people

5. Wildlife and Genetic Resources

- Modify the national water use policy for the Rift Valley to include enhancement of water quality and quantity to become suitable for aquatic and terrestrial biodiversity

6. Protected Areas

- Improve policies and regulations for land and water use in protected areas

A biological diversity narrative should be incorporated under the appropriate SO. The Jordan Country Study on Biological Diversity would comply with Part 1, Section 119 of the FAA. For compliance with Part 2 of Section 119, the recommendations should be incorporated in the CSP as follows: (a) the Mission need only incorporate the biodiversity study by reference, and (b) under actions recommended in the biodiversity study, the strategy should state what actions it proposes to support, and those actions it will not. The Mission may not plan to do any, but this should be stated to meet the requirements of Section 119.

As a bridge between SO2 and SO5, and in the interest of equity, it is suggested that the Mission consider an environmental partnership program designed after the successful EcoLinks Program for Eastern Europe.

Box II-2

MIDDLE EAST WATER PARTNERSHIP GRANTS PROGRAM

A Water Partnership Grants Program could promote practical, market-based solutions to urban, agricultural, and industrial water and wastewater problems in the Middle East. This would be modeled after the EcoLinks program of the Europe & Eurasia countries managed out of Washington, D.C. (for more information see www.ecolinks.org). Recognizing the crucial role of decision makers at the local level, the program would support partnerships linking Middle East businesses, local governments, and associations with counterparts either in the United States or in other countries in the region. These partnerships help such organizations identify and remedy environmental water and wastewater problems, adopt best practices, and increase trade and investment in environmental goods and services. EcoLinks is comprised of three inter-connected components - Partnership Grants, Investment/Trade and Information Technology.

Introduction: The Partnership Grants Program would build the capacity of businesses and local governments in the Middle East to develop market-based solutions to urban and industrial water and wastewater environmental problems. The grants would help to form partnerships between organizations in the region and the United States or within the region. Through these cross-border partnerships, local project initiators would be able to improve both their environmental and financial performance in the water sector. In addition, funded projects could result in best practices for environmental water and wastewater management that can be replicated by other organizations.

The program would be managed through a cooperative agreement mechanism. The regional office would be located in Amman Jordan. Program Officers who provide outreach and administer the grants program would be based in the participating countries of the region and the United States.

Program Activities: Challenge Grants and Quick Response Awards

Challenge Grants up to $50,000 would support one-year, cost-shared partnership projects that address specific urban, agricultural and industrial water and wastewater environmental problems with a market-based approach. The program would be designed to be transparent, fair, and competitive. A Request for Applications (RFA) would be announced periodically during the year with relevant grant topics. Eligible organizations in the region (businesses, local governments, and associations) would submit a brief concept paper and, if approved, assemble a project team to prepare a full application that meets the Request for Application (RFA) guidelines. If they needed assistance in finding a cross-border partner, the Partnership Program would help find a partner from either the United States or another country in the region. If they needed assistance in preparing the application, the Partnership program would offer proposal-writing workshops in each target country. An independent panel of experts would select the best applications. The funded projects would be carefully monitored to ensure accountability of grant funds and to keep project implementation on track with expected results.

Quick Response Awards (QRAs) up to $5000 would help initiate partnerships within the Water Partnership framework; either to prepare a Challenge Grant application or to facilitate water related environmental trade and investment. The Grants Program, on a rolling basis, would approve QRAs, usually within two weeks of receipt of a completed application. Applicants from the region would be eligible.

Cost of program: $10.0 million over 5 years (In support of administration and grants).

E. ENVIRONMENTAL COMPLIANCE

1. Environmental Workload

The USAID Mission environmental workload in carrying out the compliance requirements in accordance with the Code of Federal Regulations (22 CFR 216), last year, involved the documentation and approval of 13 Initial Environmental Examination (IEE) documents and five Environmental Assessment (EA) reports. The EA scopes of work involved a multidisciplinary team, and for that reason were contracted with resulting mitigation measures and monitoring requirements undertaken through the respective awarded contracts by the contractor. The IEE process differs in that Mission staff, SO team leaders, and the Mission Environmental Officer (MEO) develop and produce the IEE reports for approval by the Bureau Environmental Officer (BEO) in USAID/Washington. Here too, the mitigation and monitoring requirements are included in the respective contracts and/or grants. It was not clear in discussions with the USAID staff members whether funding is made available to pay for implementation of the mitigation measures specified in the EAs. Stronger emphasis should be made on making these funds available as part of the contract funds for the individual activities.

Interviews conducted by the evaluation team indicate that the MEO responsibilities for preparation and monitoring of IEEs, monitoring the EA process, and carrying out Contracting Technical Officer (CTO) duties are becoming increasingly time-consuming and thereby potentially negatively impacting the overall effectiveness of the Mission's environmental compliance program.

Recommendation 1. The roles of USAID staff and their responsibilities for the in-house development of IEEs need to be examined to determine which responsibilities should be shifted from the MEO to the respective SO team leaders in accordance with Automated Directive Systems (ADS) 201 and 204.

Recommendation 2. Section 119 of the FAA authorizes and supports environmental documentation by in-country local entities. USAID should consider contracting, on a selected basis, appropriate activity IEEs for local NGOs in Jordan to complete.

Recommendation 3. The Missions should incorporate, in their annual training plan, a two-day training course on USAID environmental and biodiversity requirements and procedures.

F. MISSION LIAISON AND ASSISTANCE TO THE ENVIRONMENTAL SECTOR

1. Intervention and Assistance to GOJ

USAID should continue to work closely with GOJ to strengthen environmental awareness, regulatory, and compliance programs. This activity should include planning and coordination meetings with the Ministry of Environment, NGOs, and other donor organizations, as well as an environmental impact needs assessment. It should include informational exchanges and technical assistance on environmental regulatory issues and best environmental practices in air quality, water and wastewater management, solid and hazardous materials and waste management (including petroleum), pollution prevention, and resource recovery, as these activities affect the water sector as well as human health and the environment.

2. Liaison with Environmental Agencies

USAID should take the leadership role in coordinating meetings and activities with GOJ, NGOs, and other donor agencies for environmental issues because of the U.S. leadership in these areas and the strong expertise of the USAID Mission MEO. At a minimum, the evaluation team recommends monthly half-day meetings, which might include formal meetings, field trips to facilities, theme-specific workshops, and formal and informal technical and administrative presentations. Liaison meetings should be documented by memoranda, and appropriate literature and web page references should be distributed for long-lasting influence.

3. Capacity Building Assistance

Environmental issues that currently are affecting human health and the environment are: 1) air quality in the urban and industrial areas, including limestone quarrying and cement production, and port activities in Aqaba, 2) pesticides and fertilizers in agricultural runoff, 3) environmental impacts of the water crisis, 4) water and wastewater quality, 5) land-use activities that adversely affect air and water quality (solid and hazardous waste disposal, pesticide use, petroleum handling, quarrying and mining), 6) wastewater lagoons and poorly treated wastewater, and 7) petroleum leaks from storage tanks, tank farms, and pipelines. USAID should perform an environmental impact needs assessment to help identify and prioritize the environmental issues that they can then address.

The assessment should include a team review of existing reports, including the FTA and other studies, meetings and interviews with knowledgeable parties, and field tours to identify specific issues more fully such as solid waste, industrial materials, hospital wastes, irrigation return flow, petroleum facilities, and completion, review, and distribution of a formal report to present a formal set of observations, conclusions, and priority recommendations. Surface and groundwater is especially vulnerable to liquid releases because there is little soil cover in much of the country and the predominant basaltic and limestone aquifers have little if any attenuation capacity to reduce contaminant concentrations once contaminants enter the aquifers.

Environmental training should be provided to other Mission staff in WRE, population and health, and economic opportunity, so that they may better appreciate and implement positive environmental policies and actions, such as phasing out hazardous and acutely hazardous materials in construction (for example, asbestos in USAID-funded clinics, chlorine gas in USAID-funded water and wastewater treatment plants).

Immediate technical assistance in capacity building for the new Ministry of Environment should include:

- Conducting a needs assessment for the new MOE. The assessment would focus on the current mission of the ministry and identify the impediments to achieving that mission.

The assessment should review ministry organization and staffing, training needs, and identify areas where policy, law and regulations are lacking.

- Based on the findings of this needs assessment USAID could provide assistance to the MOE to provide support in capacity building, environmental permitting, environmental monitoring and reporting, setting and promotion of environmental standards, and public outreach.

SECTION III: INSTITUTIONAL AND POLICY FRAMEWORK

SECTION III: INSTITUTIONAL AND POLICY FRAMEWORK

Currently within the MWI and its two subsidiaries (WAJ and JVA), institutional changes are being formulated and implemented incrementally. These initiatives are being undertaken in recognition of the need to mobilize increasing amounts of capital, as with Build-Own-Transfer (BOT) and other Private Sector Participation (PSP), for project implementation and management and in recognition of organizational deficiencies for centralized planning, water allocation and demand management, wastewater management and reuse, and financial sustainability. Organizational changes are being made on the basis of policies enunciated by MWI in its Water Strategy and Action Plan and Policy documents for 2002, assisted in part by six ongoing initiatives of USAID. To date there are, however, major legal, social, budgetary, and institutional barriers to the realization of the MWI organization and staffing to meet these new demands. Substantial further assistance by USAID is contemplated for SO2 in the 2004–2009 planning period. This section discusses some of the areas where USAID may want to consider focusing its efforts.

A. THE NEED FOR SUSTAINABILITY IN THE WATER SECTOR

USAID, MWI, and higher councils of the Government of Jordan recognize the need to achieve financial and institutional sustainability of water supply, especially with respect to municipal systems. USAID has contributed to the articulation of possible initiatives in the financial arena with the preparation of its yet to be released report, "MWI — Institutional Improvement Action Plan" (IIAP), Deloitte, Touche Tohmatsu, draft of November 7, 2002. This report section draws upon the preliminary results of that study for four of the herein-suggested USAID initiatives for the period 2004–2009. The initiatives would address the need for strengthening or developing within MWI:

- Its strategic management capacity.
- An information technology platform.
- Reallocation of staff to suit new institutional needs.
- A groundwater-monitoring program.

Each of these initiatives would be oriented toward the goal of achieving financial sustainability.

Our evaluation team recognizes the additional need for achieving sustainability in perpetuity for the production of basic water resources and the supply of irrigation water. Proposed below is the partial merger of the two sets of institutional initiatives, financial and technical. Also, potential interfaces of new initiatives with ongoing initiatives of USAID and MWI are identified.

B. REQUIRED ORGANIZATIONAL REFOCUS WITHIN MWI

Organizational capacity of MWI must be refocused to achieve sustainable management, operation, maintenance, and capital financing of the water supply systems of Jordan. The water sector is already undergoing significant institutional change because the managements of MWI, WAJ, and JVA recognize the ever-growing complexity of efficiently managing and operating the water sector. The MWI Action Plan (2002–2006) introduces activities for:

- Personnel optimization;
- A public awareness program;
- Establishment of a regulatory body;
- Modification of by-laws; and
- Commercializing sector institutions.

There also is discussion of building a sector-wide information technology (IT) infrastructure. While the Action Plan is comprehensive in scope, there is no accompanying implementation plan.

The water network is being expanded and rehabilitated, and there recently have been, as a part of a demand management effort, graduated tariff increases to improve cost recovery and to regulate and reduce well pumpage.

Strategic issues of the financial arena that should drive refocus of MWI, JVA, and WAJ organization and management are:

- Current groundwater production exceeds the availability of the renewable groundwater resource.

- The cost of producing and treating potable water and wastewater for reuse is rising faster than tariff charges. In the absence of a strong demand management effort, this trend of revenue shortfall will be even more severe when new, more expensive technologies, such as reverse osmosis, are adopted on a wide scale. Besides, debt service and operation and maintenance costs of private-sector developments will further burden tariffs.

- The personnel of MWI and its subsidiaries have not been recruited and retained for the types of operations now envisioned. For example, new wastewater treatment plants require trained specialized operators. The threatened water resource requires personnel to make sophisticated technical analyses, to carry out resource monitoring, and to make periodic allocations based on the output of a capable planning unit. There also is a need for more staff with business, management, information technology, accounting, financial, and private-sector contracting skills for this new, more technically based organization.

- In the financial arena, new approaches and knowledgeable staff are required for the conduct of corporate planning, budgeting, management of water demand, and the rationalization of subsidies.

1. Financial Management of the Water Resource

The financial arena of MWI needs to adopt an approach akin to the management of a private utility. Such an approach would be accomplished, as outlined in the IIAP, by:

- Strengthening the strategic management capacity of JVA, WAJ, and MWI;
- Building a commercial information technology platform;
- Implementing a staff reallocation plan; and
- Establishing a groundwater monitoring and enforcement unit.

Each of these areas is discussed below.

a. Strengthening Strategic Management Capacity for Finance

Three important areas for capacity building within MWI, JVA, and WAJ would be for:

- Establishment of corporate-style financial planning;
- Preparation of annual business plans and implementation budgets; and
- Set-up of a results-oriented Performance Monitoring and Reporting System using data provided by a Water Information System and a Financial Accounting System.

b. Building a Commercial Information Technology Platform for the Water Sector

The IIAP urges that USAID support preparation and implementation of an Information Technology Master Plan for the water sector. Preparation of the IT Master Plan would commence with a review of implementation strategies for all ongoing IT activities.

c. Implementing a Staff Reallocation Plan

The process of implementation of staff reallocation and training to rationalize and achieve job skills match to positions is envisioned as a five-part effort. It would be critical to the achievement of sustainability. These efforts would include.

- Preparing a *staff reallocation program* that reassigns redundant staff to functions that would facilitate performance of the water sector with respect to unaccounted-for water, efficiency of collection of revenue, and efficiency of the use of water for irrigation.
- Preparing a *staff incentive program* that would identify means and procedures to link employee performance to strategic performance.
- Developing a proposal to *streamline procedures for hiring* skilled staff within civil service regulations and in recognition of budgetary constraints.
- Implementing a wide-ranging, continuing *program of training* for reallocation of redundant personnel to positions critical to achieving strategic objectives of the water sector.
- Developing a *supervisory system and staff* with the capacity to prepare position descriptions suitable to the required new job skills and to support and manage the reallocation of staff.

d. Establishing a Groundwater Monitoring and Enforcement Unit

It is recommended in the November 2002 draft of the IIAP that USAID support the formation of a Groundwater Monitoring and Enforcement Unit in either WAJ or MWI. It appears that this unit was envisioned to be typical of an arm of a utility for ensuring that revenue would be collected for water delivered. In any event, the need for such a unit is further explored in this report as a scientific/engineering-oriented unit necessary not only for revenue collection but also for ensuring continuing availability of the groundwater resource.

In addition to the above four outlined efforts defined in the IIAP, it was recommended that the achievement of financial sustainability likely would occur more rapidly if USAID were to support indefinite quantity contracts to strengthen MWI staff over the near term.

e. Potential Interface of New Institutional Initiatives with Ongoing Programs of USAID

The IIAP identifies seven ongoing USAID activities that are directed toward institutional strengthening within MWI, JVA, and WAJ. Six of these activities would be scheduled to continue into the year 2004. Three of the seven projects could be modified to incorporate activities proposed to accomplish the strengthening of strategic management capacity and the development of a monitoring and enforcement unit. The activities are:

- The JVA Strategic Planning Program Phase II could interface directly with the performance monitoring and reporting component of the strategic management capacity initiative;
- The Cost Recovery Model, already developed, could interface with the pricing component of the development of the strategic management capacity initiative; and
- The Water Efficiency and Public Information, Phase II could support the monitoring, allocation, and enforcement initiative.

2. Technical Management of the Water Resource

To achieve sustainability in the exploitation of the surface water and groundwater resources, the majority of the organizational units of MWI need to be established as new organizations or strengthened. Particularly needed are units dedicated to the tracking and management of demand, the monitoring of water resources including reclaimed wastewater, water delivery, and delivery systems, the scientific documentation of aquifers and their potential yields of groundwater, and an integrated information management system. The combined information developed by these units needs to be designed to support the work of a central planning unit that will guide allocations of the water resource nationally. The capacity to allocate efficiently will depend, in part, on whether a national pipeline network is built to support allocations.

a. Groundwater Unit

As shown in Section IV, groundwater is being over-drawn beyond aquifer safe yield (average annual recharge) by 50 to 100 percent. Without allocation and better management of the aquifers, their capacities will be substantially diminished during future years due to drawdown, with consequent drying of stratas of the aquifers and quality degradation resulting from salt-water intrusion laterally or vertically. It even is likely that it will become difficult or impossible to pump fresh water from several zones of the 14 rechargeable aquifers at even half the rate of the current extractions.

The formation and empowering of an institutional unit for the scientific investigation, study, and documentation of each aquifer is essential for future efficient, sustainable management of the groundwater resource. This Groundwater Unit would provide information to planning units and regulatory groups for demand management and the setting of allocations and for other units to monitor the aquifers and to achieve good financial management. Further examination of a Groundwater Unit and a probable program for its establishment is presented in the box below. The program would extend over the entire plan period of five years (2004–2009). The unit should be funded to support an aggressive program of procurement, investigation, testing, analysis, report production, and contributions to planning (master and annual).

b. Monitoring and Enforcement Unit

This organizational unit would take advantage of observation wells, piezometer installations, and other equipment installed for aquifer investigations along with water-measuring equipment of the operating entities, JVA and WAJ, to observe both stresses on water sources and actual consumption. Stresses would be observed and measured for each aquifer in Jordan, along with the effects of reservoir storage and pumping of groundwater in Syria on flow of the Yarmouk River. Additionally, for the sake of water pricing, billing, collection, and budgeting, the consumption of water by municipalities and government and for industry, tourism, and irrigation would be recorded on a scheduled basis.

Information regarding system deficiencies and water theft or misallocation would be promptly forwarded to appropriate authorities for redress.

c. Information Technology Platform

The Master Plan for the development of an Information Technology Platform, as proposed in paragraph III B 1.b above, would focus on support of the attainment of financial sustainability. In addition, this platform should be designed to facilitate the easy collection and dissemination of information to the newly formed Planning Unit, described below.

d. Reclaimed Wastewater Management and Reuse Unit

This unit should be staffed with professionals capable of carrying out pilot projects and demonstrations for the reuse of treated wastewater, including artificial groundwater recharge, and the application of sludge to lands for differing uses. The objective should be to determine what applications would be safe and acceptable for reclaimed waters and sludge of differing qualities.

It is vital that the market- and health-oriented activities of USAID be carefully coordinated with the activities of other studies and groups that are dealing with measures to protect and preserve fresh water aquifers.

Box III-1

ESTABLISHMENT OF A GROUNDWATER UNIT WITHIN MWI AND SUBSIDIARIES

Current Situation: The lack of scientific/engineering knowledge of the hydrogeology of the aquifers of Jordan is not only unfortunate but carries with it the potential for greatly diminished future availability of an already scarce water resource. There currently are no reliable estimates of recharge and, thus,estimates of safe yield are only approximations. Of equal importance is the lack of basic hydrogeological information regarding the structure, saturated thickness, transmissivity, permeability, storage coefficient, and capacity of individual aquifers and the interconnections between aquifers with water of varying qualities.

Need for a Dedicated Unit Staffed by a Cadre of Experts: The gathering of data through a well-designed program of field investigation, which can be used to analyze and quantify aquifer characteristics for the issuance of USGS-style reports for each aquifer, can be achieved only if a cadre of groundwater experts is brought into a unit and dedicates a number of years to establishing it and gathering the necessary data.

Two to three scientists, hydrogeologists, and/or engineers should be recruited to work with MWI staff who have appropriate academic backgrounds and possibly experience in government or industry for the study and development of groundwater. MWI staff would be trained through the process of the investigation and study of aquifers one-by-one from the most prolific to those with the least production potential.

The study and investigations likely would commence with a survey and development of a catalogue register of every existing and abandoned well. Cataloguing would be completed from the files of WAJ and other governmental units, followed by visits to drillers and to each well and its owner and operator. This information would be plotted both planimetrically and as strategraphic profiles. Based upon this information an initial program of exploration and testing could be developed.

The Disi Aquifer, a special case, should be scheduled early during the program to confirm its potential and to carefully determine if parts of the aquifer would benefit from recharge or will suffer from the intrusion of saltier adjacent waters. Also, there needs to be careful evaluation of whether neighboring countries can undertake pumping that would significantly diminish the potential in Jordan.

Suggested Scope of Institution Building: Experts should be recruited from abroad, possibly through the USGS, to provide approximately 10 man-years of effort over a period of five years. University training likely should be provided during the first one or two years for several promising local recruits to earn master's degrees in hydrogeology or related disciplines. These recruits should be obligated to dedicate several years of service to the Unit in appreciation of the privilege of receiving paid training. Also, the proposal of incentive pay suggested in the IIAP should be evaluated to retain these local experts. Field investigations should be contracted to capable Jordanian drillers (there are to our knowledge capable well drillers located in Jordan). If needed, equipment for specialized tests may have to be imported. It is suggested that USAID budget approximately $10 million for the five-year SO2 horizon (2004–2009) for establishment of this Groundwater Unit.

Scope of Field Investigations: Field investigations likely would include the drilling and establishment of a carefully designed network of boreholes and aquifer tests to establish stratigraphy and information regarding transmissivities and storativity of an aquifer. The boreholes could be converted to observation wells for future monitoring or could be converted to production wells if desirable. In some cases, arrays of piezometers could be left in place if information collected would be useful for future evaluations.

e. Central Planning Unit for Demand Management and Allocation

The severe deficiencies of knowledge regarding the actual volume of water annually available in Jordan and the lack of precision surrounding statistics and data regarding the consumption of water are powerful reasons for the formation of a Planning Unit within MWI and its subsidiaries, JVA and WAJ.

A permanent cadre of planners would receive data gathered by the monitoring unit and analyses of the groundwater and water reuse units as organized by the IT platform. Planners would use this information to determine and manage the evolving demands for water and the ever-changing estimates of available water supply. These two data sets, supply and demand, would be reconciled annually or seasonally and rationalized by the Central Planning Unit for use by regulators and to facilitate water management, demand reduction initiatives, and allocation of water by area of the country and by class of user.

Along with the determinations of demands by area of the country, the Central Planning Unit would formulate and propose policies and initiatives for the reduction of water demand. Initiatives would include incentives and disincentives through pricing and technological improvements especially to reduce irrigation demand. Initiatives also would address substitution of reclaimed water to reduce the demand for source water from streams and from fresh water aquifers.

Should the Central Planning Unit be transferred into an autonomous utility, it would be necessary for MWI to contract for these services from the Unit.

C. SUMMARY OF POTENTIAL USAID INITIATIVES — POLICY AND INSTITUTIONAL ARENA

USAID should consider assistance with the formation of strong, well-staffed units within MWI, WAJ, and JVA for seven functional categories:

- Planning Unit(s),
- Analytical Unit for Groundwater Resource Assessment,
- Monitoring and Enforcement Unit for All Water, Surface and Ground,
- Reclaimed Wastewater Management and Reuse Unit,
- Information Technology Platform, Technical and Financial/Business,
- Corporate Type Water Management Unit, and
- Human Resources Capacity to Rationalize and Reallocate Staff.

Besides these unit-level organizational developments MWI staff should be augmented to create or strengthen capacity for certifying periodic water allocations across the country and for leading a water-sector regulatory body (commission) that likely would have members from several ministries and possibly from the private sector.

Box III-2

ESTABLISHMENT OF A TECHNICAL SUPPORT TEAM FOR NEGOTIATIONS OF YARMOUK RIVER WATER DIVISION

Current Situation: As detailed above and in Section IV, the need is more than urgent for Jordan and Syria to formulate and implement a verifiable agreement over the division of the water of the Yarmouk River. If this is not accomplished within the five-year plan period, 2004–2009, then Jordan may well suffer the total loss of Yarmouk River water during the next one or two decades.

Proposed Process: To date, negotiations have not resulted in control of water storage and use in the Golan Province. Thus, releases downstream have not always been the agreed amount. Because of the lack of an agreement that has well-defined verification clauses and because upstream water users are still developing water in a laissez-faire manner, it is proposed that the U.S. Government, through USAID, support the Government of Jordan, technically and diplomatically, to implement a program with the following elements:

- Seek the appointment of a Water Master through either the IBRD or the UNDP to provide a balanced technical perspective and to arbitrate technical issues for both Syria and Jordan. USAID should have on-call a team of technical experts who would provide data, opinion, and analyses as required. USAID could support Syria as well.
- Assist in preparation of the many drafts of an agreement that will be required during what would likely be a two- to three-year effort.
- Develop a water model(s) that could simulate basin conditions so that the negotiators and the Water Master could evaluate what conditions were at any paricular time over the past half century.
- Finalize an agreement that incorporates all of the elements that have affected availability of water today. For this, the agreement must incorporate flows based on conditions before Israel occupied the Golan Heights and appropriated all of Lake Tiberias and the Jordan River. Then carry forward an accounting of the various abstractions and arrive at an equitable sharing of the "natural flow" of the river between the two countries. Once the proportionality of flow (low flow and flood flow) due each party is agreed on, then a measuring structure should be set up near where the Yarmouk River borders or enters into Jordan.
- Define operating procedures with respect to dams, small dams (tanks), and wells in the Golan Province to fulfill releases required to satisfy the agreed low flows and flood flows.

Measuring Structure: Any agreement must be verifiable on a continuing basis. In the interest of precision, it may be necessary to build a sharp-crested or V-shaped measuring weir off channel and to build, say, a concrete broad-crested weir and or flume across the entire section of the river valley. If control of low flow requires, a rubber dam of one-meter diameter could be installed on the broad-crested weir.

Costs: This initiative could eventually cost several million dollars. The U.S. Government could finance its input through USAID or through an international agency. Relatively modest costs could accrue due to an initial educational effort, directed to both Syria and Jordan, based on hydrologic and hydraulic data and analyses. Once negotiations commence, it may become necessary to identify and seek commitments from a group of friendly nations. Such a need could involve the construction of a pipeline from northern Syria to transfer water to the Golan Province. The transferred water would replace Yarmouk River water now being used there that would be released for use in Jordan.

Early negotiations between Jordan and Syria should be encouraged. A primary USAID objective would be to educate members of the U.S. Foreign Service and of the Jordanian Foreign Ministry about the threat of the loss of a major portion of the already inadequate river and groundwater resources. This process of information transfer should lead to the undertaking of the negotiation of a firm, enforceable agreement between the two countries. An agreement would be drawn to guarantee that neither dam construction nor groundwater abstractions would be permitted to reduce base flow and flood flow of the Yarmouk River below agreed quantities where the river enters Jordan. Second, there should be agreement regarding the unrestricted regional flow of groundwater to the aquifers of Jordan from the vicinity of Mount Arab. It is not clear if there is need to negotiate international protocols for use of the Disi Aquifer.

USAID could allocate as much as $5 to $7 million annually over the five-year period (2004–2009) to institution building if total resources committed to the water sector should annually range from, say, $60 million to $100 million, our medium to high allocation scenarios posed in Section VIII. Should less than $10 million be available annually for the water sector, our low resource scenario, it is suggested that as much as possible be dedicated to the achievement of these institutional changes while maintaining funding of those projects in the pipeline. This is recommended because the achievement of sustainability is so vital to the continued availability of even the basic fresh water resources of the nation.

D. POLICY FRAMEWORK AND BUDGETARY REQUIREMENTS TO ACHIEVE SUSTAINABILITY

Water is a natural resource that has the potential to contribute to the national economy. The prevailing situation is that revenue from the sale of water, especially irrigation water, is so meager that the treasury of the Government of Jordan has to make substantial outlays just to support the bureaucracy and for operations. There is little or no money available for rehabilitation, equipment replacement, operation and maintenance, and new construction. Most of these monies are coming from foreign aid, loans, and, more recently, from private-sector participation (PSP). In this section it is proposed that USAID, during the plan period 2004 to 2009, implement initiatives to help the Government of Jordan change the institutional structure inside the MWI that would facilitate transition of JVA and WAJ into an autonomous utility. The utility would be a self-sustaining organization that would no longer be constrained by Civil Service Regulations or the duty of striving to meet social goals unrelated to water production and management. Such a utility could be created only if effective, well-staffed organizational units would be developed within MWI and then combined with WAJ and JVA. To achieve sustainability within the water sector, such a utility could be a bulk water supplier to end-users, including:

- Private Town Water and Sewerage Boards and Village Water Boards established for domestic supply and wastewater collection and treatment, and
- Irrigation Divisions (ID) or Associations for distributing water according to national water allocations and for operating and maintaining irrigation networks and schemes.

These implementing organizations would be responsible for balancing their own finances and the recovery of costs from the distribution of water and the collection and treatment of wastewater.

Once WAJ, JVA, and the five proposed organizational units devolve from MWI, the ministry would continue as the governmental institution responsible for policy development and implementation, enforcement of water-related laws, oversight of major water developments with national significance, national and regional water allocation, regulatory functions, including those for regulation of the utility for bulk water delivery and of Town and Village Boards and Irrigation Divisions. Since the ministry staff would be scaled down, it likely would choose to contract with the strong technical and financial units of the autonomous utility to fulfill a number of its remaining functions.

1. Enforcement

Sustainability in the financial arena could be achieved only if water could be properly priced, quantities monitored, and tariffs collected by an organizational unit that would have enforcement authority. Enforcement authority would extend to delivery of water as allocated according to a national plan of demand management and allocations and to collection of posted fees. Effective enforcement could be achieved only if the utility had police powers, or speedy recourse to those with police powers, to penalize violators and to terminate deliveries to those who refuse to pay or who are overdrafting beyond allotments.

2. Program Costs

In the budgetary presentation of the IIAP report and in Section VIII of this report, three clusters of initiatives are presented to:

- Support development of a monitoring unit,
- Facilitate formation of an information technology platform, and
- Develop institutional capacity to administer a match between personnel assignments in MWI and skills required.

The cost could be as much as $17 million over a five-year period. This program was outlined in the IIAP report. Since that report is still a draft, it is not clear if the program will be modified and the cost changed. It is fairly certain, however, that if financial sustainability is to be accomplished before it is too late, during what appears to be a window of opportunity (2004–2009), then outlays of considerable size will be required.

In parallel, technical sustainability could only be accomplished with some considerable support by USAID. Initiatives are proposed above in Subsection B.2. for the creation of planning capacity, a groundwater unit, a unit for management and reuse of reclaimed wastewater, and a monitoring unit that would provide information for the periodic allocation of surface water and groundwater on a nationwide basis. The cost of these efforts would require the dedication of some $10 million to $15 million during the five-year plan period. It is fairly certain that economies could be realized if the organizational restructuring for financial sustainability were coordinated and merged with that designed to achieve technical sustainability of the water resources of the nation.

Box III-3

INSTITUTIONAL STRUCTURE FOR THE WATER SECTOR

Autonomous Utility: Perhaps the approach that would enjoy widest acceptance within MWI and other councils of government would be to let WAJ, JVA, and the five newly formed units (see above) evolve as a combined unit into an autonomous utility for bulk water delivery, independent of civil service regulations, duties of striving for social equity through subsidies, or being a conduit for the employment of poorly qualified staff for political or social reasons. The new organization would be merit-based and would operate on a par with private industry with regard to compensation.

The utility would be responsible for implementing MWI's water policy for rational development and management of water. WAJ and JVA already collect, process, classify, and archive data in their respective domains of interest. They plan, design, construct, operate, and maintain water works. They monitor and protect water resources from pollution and develop bulk water supplies for domestic and irrigation water. The successor utility would continue all of these functions and would be responsible for the construction, operation, and maintenance of major waterworks and would sell water in bulk to private end-user organizations. They would also either buy treated effluent from the private organizations, such as the Town Water and Sewage Boards (TW&SBs) described below, or undertake an advanced level of treatment by themselves, which in turn would sell as bulk water for irrigation.

The End-User Organizations: A number of local, not-for-profit, nongovernmental institutions could be chartered and established and be responsible for water administration at the local level. These Town Water and Sewage Boards and Village Water Boards would deal with domestic supply and wastewater collection and treatment. Irrigation Divisions or Associations would be responsible for managing irrigation schemes and distributing irrigation water: They would buy their water in bulk from the utility.

Town Water and Sewage Boards: These Boards would distribute water to domestic and industrial consumers within a city or town. The TW&SB would be established by special legislation. Each Board would manage its own finances, produce a balance sheet annually, and fix its charges and future budgets accordingly. All domestic water supplies would be metered. The same would be done for the collection and treatment of sewage. The TW&SB would derive its bulk supplies partly from wells but mainly from bulk supplies of treated water delivered to storage reservoirs by the utility trunk main system. Governing Boards could have members nominated by government and private citizens from each of the municipalities. Rates and tariffs would need to be approved by government and the MWI-chaired regulatory board or commission.

Village Water Boards: Village Water Boards could be set up similarly to the TW&SBs for a village or group of villages. A Village Water Board could be established to manage its water undertaking on the basis of spring(s), well(s), and direct supply with bulk supplies from the utility.

Irrigation Divisions or Associations: Irrigation Divisions (ID) could be chartered and established to collect revenue for buying water from the utility and for operating and maintaining local irrigation systems. Water would be delivered from the major water storage and conveyance systems of the utility. The utility should be involved when technical assistance would be required to work for lower operation and maintenance costs and a higher level of user satisfaction. Effectively, the utility would be free from having to locally allocate scarce supplies and charging individual farmers and from dealing with any resultant disputes. The Irrigation Divisions could be set up as totally private entities or could be quasi-public. Supplies would be metered or divided by time and/or volume or on the basis of the area actually irrigated.

Planning Staff of the Utility: It is envisioned that the planning and monitoring units of the utility would be staffed with a cadre of highly skilled professionals. With this almost unique planning capacity residing in one organization, it may be appropriate for the unit to offer services, in a paid consulting capacity, to MWI and other units of government and abroad. Consideration should be given to maintaining close coordination of the necessary training programs of the utility with programs and activities of a regional water management-training center. This use of the planning and training capacities of the utility would help to ensure that the highly skilled staff would be professionally stimulated and, thus, would remain with the utility.

Regulatory Body: A regulatory body (commission) would have to be created, chaired by MWI and, ideally, staffed with business/technocrat-oriented commissioners. This body would ensure that rates/fees set by the utility and the boards would be fair to water users and at the same time would permit the utility and the boards to:

- Pay the full costs of their organizations as a business,
- Fully fund operation and maintenance of all water-producing facilities under the control of each, and
- Provide enough revenue to pay off bond issues and to maintain several sinking funds dedicated to rehabilitation of works and equipment.

In addition, the commission would have authority to review the salaries of utility executives and high-level technocrats to ensure that guidelines based on industry standards would not be violated. Either the commission or a separate regulatory body would have to mandate water allocations on a regional basis, by user category, on a regular schedule, whether quarterly, semi-annually, or annually. This body would base its allocations upon the planning and monitoring information and estimates of the utility and boards and in consideration of the water users needs.

SECTION IV:
THE WATER RESOURCES OF JORDAN

SECTION IV: THE WATER RESOURCES OF JORDAN

A. GEOGRAPHY AND CLIMATE

Jordan has a land-area of 90,000 km^2, extending from the border with Syria in the north to the tip of the Red Sea in the south and from the Jordan River boundary with Israel and the West Bank in the west to the deserts of the east bordering Iraq and Saudi Arabia. The highlands of the northwest are better watered and have attracted most of the population, while nomadic herders inhabit the eastern desert areas. The Jordan Valley, a major area of irrigated agriculture, lies at an elevation reaching 400 meters below sea level at the Dead Sea.

Jordan's climate is mainly semi-arid to arid. Only the highlands that are to the east of the Jordan Rift Valley have a Mediterranean climate. There the weather is cool and wet in winter and hot and dry in summer. In the rest of Jordan, the temperatures are usually very high during the summer season and cool in winter.

The primary factor that determines the availability of water is precipitation, although there are important quantities of surface water and groundwater that flow into the country from Syria. Most precipitation falls in the winter months of December, January, and February, with more than two-thirds of the annual total falling in the months of October to April. Average annual rainfall ranges between less than 25 mm in the eastern desert to approximately 600 mm over Ajloun heights in the northwestern part of Jordan. The long-term (1937–1998) average annual precipitation volume was 8,500 MCM, of which an average of 92.5 percent was lost to evaporation. The remainder flows into wadis and partially infiltrates into aquifers. Table IV-1 shows that almost 94 percent of the country receives less than 200 mm of rainfall per year and is classified as arid to desert land.

Table IV-1. Classification by Rainfall Distribution

Climatic Zone	Annual Rainfall (mm/yr)	Catchment Area (km^2)	Area Ratio (%)	Rainfall Volume (1937-1998) (MCM)
Semi –humid	500 – 600	620	0.7	425
Semi-arid	300 – 500	2,950	3.3	1,170
Marginal	200 – 300	2,030	2.2	530
Arid	100 – 200	20,050	22.3	2,950
Desert	<100	64,350	71.5	3,425
TOTAL		**90,000**	**100**	**8,500**

Source: WIS database of MWI (after JICA)

The second factor relating to the available water resource is the immense regional variation in rainfall. Annual precipitation averages 94.4 mm, but varies from 500 to 600 mm over only 0.7 percent of the country in the northwest, comprised of the highlands adjacent to the Jordan Valley. Precipitation is less than 100 mm in the eastern and southern desert areas comprising 71 percent of the Kingdom (Table IV-1). In effect, only 4 percent of the country's total area receives more than 300 mm/year of rain.

The third factor determining runoff is the annual variation in rainfall. Records are available for precipitation starting from 1937. Precipitation in this type of climate varies significantly from year to year, with several consecutive two- or even three-year dry periods occurring. It is reported that in the last five decades there was a noted decrease in precipitation, the decrease being about 30 percent. A similar reduction has been noted in other countries in the general region in the form of an abrupt reduction after 1970. The observed reduction of rainfall in the last few years cannot as yet be explained as being due to climate change since the available record is rather short. However, this tendency needs to be carefully observed and studied since its effect on runoff is far more serious, resulting in a reduction of more than 40 to 50 percent.

These regional imbalances limit major water impoundment works to the areas receiving high rainfall with frequent runoff and necessitate development of costly inter-basin transfers and transfers of water over long distances.

The fourth factor basic to the availability and management of water resources is the high level of evaporation and evapotranspiration. The average maximum annual temperature of 38.8°C during April to October and the low humidity in Jordan result in an extremely high evaporation rate. The long-term average evaporation rate is 92.5 percent; this ranges from 63 percent in the highlands to around 99 percent in the eastern desert. The losses by evaporation from surface water reservoirs is an important factor in the operation of the reservoirs and needs to be taken into account in all water management studies in Jordan.

Under these climatic conditions, full irrigation is necessary during the late spring and summer months to sustain production of crops. Irrigated agriculture has been constrained by the increasingly limited water resource.

B. SURFACE WATER SUPPLY IN CRISIS

1. Summary of Resource Availability

Surface water flows nationwide vary both seasonally and annually following the rainfall pattern. The long-term average annual base flow is about 328 MCM and the flood flow is about 334 MCM, giving a total average surface flow of 662 MCM. Several decades past, Jordan utilized the flows of three rivers for irrigation and municipal and industrial water supply. The flow of each has now either been cut off or been seriously reduced. The Jordan River lies within the Dead Sea Basin and is generally dry or only has saline water flows due to total appropriation of its water at Lake Tiberias by Israel. Overpumping of groundwater in Jordan and Syria has adversely impacted the substantial base flows of the Yarmouk and Zarqa Rivers. The Yarmouk River still experiences annual floods, which highlights the importance of constructing Wehda (Unity) Dam.

The main source of surface flow is the Yarmouk River, which contributes about 40 percent of the total surface flow. The water of the Yarmouk River is of good quality, with total dissolved solids ranging from 400 to 800 parts per million. The Yarmouk River forms the international border at the northeast corner of Jordan. It has a total catchment area of 6,780 km^2, of which 1,160 km^2 lie above the Adasiya stream gage in Jordan, with most of the rest being within Syria.

2. Downstream Riparians

Jordan is the downstream riparian along both the Jordan and the Yarmouk Rivers. In the Americas, Europe, Asia, and Africa, it is the downstream riparian that has to struggle to receive even a minimal volume of water and that may be of poor quality.

Flows of these two rivers have been drastically diminished over the past 55 years. The situation on the Jordan River is catastrophic for Jordan; Israel has appropriated the entire flow through interception at Lake Tiberias. Thus, during a normal water-year, Jordan receives only the flow of saline springs diverted from the environs of Lake Tiberias.

There still is some base flow and some flood flow down the Yarmouk River where it enters Jordan. The flow has over the past several decades been so diminished by impoundment in surface reservoirs and groundwater development across the Golan Province that the Government of Jordan has twice downsized the dam and reservoir at the Unity site.

3. Agreements and a Treaty

Jordan and Israel concluded a Treaty of Peace in 1994 that codified the loss of the Jordan River at least until a final peace treaty may be concluded among Israel, Syria, and the Palestinians.

The situation is different between Jordan and Syria. There are agreements but they have no effective verification and arbitration provisions, so water development across the Golan Province and even along the Yarmouk River, where it forms the international boundary, are proceeding laissez faire. As with the Jordan River, Jordan is facing eventual extinction of its water rights to water of the Yarmouk River. One government official who is knowledgeable of developments and events along the Yarmouk River characterized the river within Jordan as just a small wadi today by comparison with its condition three decades ago. Jordan now faces the prospect of losing one-third of the total base flow of its rivers and one-half the flood flow of its rivers and wadis combined.

This evaluation team concludes that the Government of Jordan cannot wait. It must initiate meaningful negotiations with the Syrians that will lead to an operating agreement that compels the scheduled release of water from the more than 25 reservoirs along the upper Yarmouk River and tributaries (see Box III-2, Section III).

C. Surface Water Resources

Surface water flows vary both seasonally and annually following the rainfall pattern. As noted earlier, the total average surface flow is 662 MCM. Table IV-2 presents the amount of surface runoff by major basin and for the main rivers flowing within them based on a 1993 report.

Overpumping of groundwater in Jordan and Syria has adversely impacted the substantial base flows of the Yarmouk, Zarqa, and Jordan Rivers. Due to the deteriorating groundwater situation, it is ever more important that flood flow of the Yarmouk River be captured by the yet-to-be-constructed Wehda (Unity) Dam.

More recent estimates (JICA, 2001), based on the measured flows at the gauging stations on the various rivers (1937–1998) when summed by each governorate, bring the total surface water potential to some 707 MCM; of this total, 451 MCM was determined to have been base flow and 256 MCM was flood flow. Of these renewable surface water resources, an estimated 424 to 495 MCM/yr would be usable or could be economically developed.

Table IV-2 Surface Water Resources (MCM/yr)

Basin	Base flow	Flood flow	Total
1. Dead Sea	**318.6**	**269.1**	**596.9**
1.1 Dead Sea North	199.3	204.7	404.1
- Yarmouk	105.0	155.0	260.0
- Rift Side Wadis	60.8	24.1	84.9
- Zarqa River	33.5	25.7	99.2
1.2 Dead Sea East	119.5	61.8	181.2
- Mujib	38.1	45.5	83.6
- Hasa	27.4	9.0	36.4
- Others	54.0	7.2	61.2
1.3 Dead Sea South	9.0	2.6	11.6
2. Azraq	**0.0**	**26.8**	**26.8**
3. Jafer	**0.0**	**10.0**	**10.0**
4. Other Basins	**0.0**	**28.3**	**28.3**
TOTAL	**327.8**	**334.2**	**662.0**

* Source: Jordan River Basin Management Study, Regional Office for Integrated Development, December 1993

The surface water potential during a drought event with a recurrence interval of 20 years was estimated to be about 560 MCM/yr, which is about 80 percent of normal season potential according to the analysis of the long-term runoff observation data.

The main source of surface flow is the Yarmouk River, which historically has contributed about 40 percent of the total surface flow. The Yarmouk River forms the boundary between Jordan and the Golan Province of Syria, including the Golan Heights. It has a total catchment area of 6,780 km^2, of which 1,160 km^2 lie in Jordan upstream of Adasiya gaging station. A small area of the basin lies in Jordan along the Jordan strip downstream from Adasiya. The area is mostly agrarian, with some small industries located in the main towns.

Water users of the Golan Province extract 160 to 170 MCM/yr from the Yarmouk River through 25 small dams with a total capacity of 156 MCM and through some 2,850 wells that pump approximately 80 MCM annually. The October 1994 Peace Agreement with Israel indicates that Jordan will receive none of the Jordan River inflow to Lake Tiberias and will divert 105 MCM/yr from the Yarmouk River into King Abdullah Canal and store 20 MCM/yr in Lake Tiberias during the winter season, while Israel will get 25 MCM/yr from the Yarmouk River.

Plans are under way by Jordan for the construction of the Unity Dam, which will have 110 MCM storage capacity, yielding some 80 MCM, mainly for domestic water supply. The studies and design are ready and tenders are expected by early December 2002; the Arab Fund and Abu Dhabi Fund will finance 70 percent of the costs.

The Jordan River provides only small quantities of water to Jordan except during floods and when Lake Tiberias is full. Israel has used all of the water of the Upper Jordan since 1962, controlling releases from Lake Tiberias into the Lower Jordan River. Saline springs surrounding Lake Tiberias are channelled downstream of Tiberias into the Jordan River. The major streams feeding the Lower Jordan are the Yarmouk River and Zarqa River, both joining the river from the eastern side.

Water development projects in Israel, Syria, and Jordan have reduced the discharge of the Jordan River into the Dead Sea to about 250 to 300 MCM/yr. This discharge is comprised of irrigation return flow, saline spring discharges, and a small amount of runoff. The water salinity is so high that it would be usable only after desalination or under strict restrictions. No treatment is presently provided.

The Zarqa River provides the second largest surface water supply for Jordan after the Yarmouk River. Its catchment area of 4,025 km^2, all within Jordan, is the most densely populated area in Jordan, comprising around 65 percent of the country's population, 80 percent of its industries, and some minor agricultural activities. It receives an average annual precipitation of 237mm/year.

Large quantities of sewerage and industrial effluent enter the Zarqa River from the As Samra Wastewater Treatment Plant and other smaller plants such as the Ba'qa and Jerash as well as from a number of industries. These discharges create concern for the quality of the river's flow. The ratio of treated wastewater to fresh water in the King Talal Reservoir, which controls this river along its downstream reaches, ranges from 45 to 50 percent wastewater in the winter to 55 to 60 percent in the summer. The Zarqa River water is used principally for irrigation and stock watering.

Smaller catchments within the Jordan Valley area have smaller annual flows: the Al Arab has approximately 6 MCM; Ziglab, 8 MCM; Shueib, 10 MCM; and Kafrain, 15 MCM. Dams control each of these basins. The main wadis that flow directly to the Dead Sea are Wadi Mujib and Wadi Hidan (Wala), with combined annual discharge of 84 MCM (half of which is base flow), the Zarqa Ma'in, with average annual discharge of 20 MCM, and Hasa, with 3 MCM augmented by more than 30 MCM/yr of thermal spring flow suitable only for salt-tolerant crops. Finally, notable annual wadi flows within the Wadi Araba area are the Northern Wadi Araba (11 MCM), the Southern Wadi Araba (10 MCM), and the Azraq Basin (27 MCM flood flow only).

D. PEACE WATER

The Peace Treaty between Jordan and Israel, signed on October 26, 1994, includes an article on "Water" with a view to achieving a comprehensive and lasting settlement of all of the water problems between the two countries. The stipulations of this agreement on surface waters are shown in Table IV-3.

Table IV-3 The Israeli - Jordanian Peace Treaty Stipulations on Surface Waters

Source of water	Season and quantity	Remarks
Yarmouk River	Summer: Israel pumps12 MCM; Jordan- remainder Winter: Israel pumps 13 MCM; Jordan – remainder[1]	To minimize waste of water, both countries may use excess floodwater downstream of point 121/Adassiya Diversion
Jordan River	Summer: Jordan – 20 MCM[2]; Winter: Jordan–minimum 20 MCM[3]; Jordan entitled 20 MCM desalinated spring water now diverted to Jordan River. Until desalination is operational, Jordan receives only10 MCM outside summer.	Israel maintains current uses of Jordan River between confluences with Yarmouk and with Tirat Zvi/Wadi Yabis. Jordan entitled equivalent if does not harm above.
Additional Water	Israel and Jordan cooperate or supply Jordan 50 MCM of drinking water	Joint Water Committee develops plans

Source: Checchi December, 2002 after S. T. Abu-Jamra, 2001.
1: Jordan concedes to Israel additional 20 MCM in return for Israel transferring to Jordan additional quantities during the summer period from the Jordan River.
2: In return of (1) above, Israel concedes to transfer to Jordan the indicated quantity directly upstream from Deganya gates on the river.
3: Entitled to store from the floods in Jordan River south of its confluence with Yarmouk.

According to Table IV-3, Israel seems to be getting first take and Jordan would depend on the remaining water passed downstream from the Golan Province. The estimates of future water availability from the Yarmouk River are based on there being no further upstream development of water projects.

Thus, according to the estimates of the MWI, an additional 215 MCM/yr of various qualities is expected to be made available during an average water year as a result of this treaty summarized as follows:

Diversion from Yarmouk River	105 MCM/yr
Supply from Israel	50 MCM/yr
Jordan River Dams	30 MCM/yr
Yarmouk River water stored in Lake Tiberias	20 MCM/yr
Desalinated springs	10 MCM/yr
Total	**215 MCM/yr**

E. RECLAIMED WASTEWATER

1. Current Situation

In a water-scarce country such as Jordan, wastewater is an important component of the water resources. According to current regulations and guidelines, fully treated wastewater generally is suitable for use in agriculture and for recharge of aquifers with some restrictions. By the year 2020, the population is projected to be about 9.9 million, with 65 percent being provided with sewerage services. Some 237 MCM/yr of wastewater will be treated and available for reuse.

Currently, there are 19 wastewater treatment plants, as shown in Table IV-4 and Figure IV-1, serving around 26 cities; many of these plants are overloaded. Moreover, industrial wastewater is discharged into public sewers, used for gardening, or collected by vacuum trucks for treatment. Regulations concerning discharge of industrial effluent into public sewers are insufficient and need revision. It is reported that Standard No. 202/1991 currently is being revised by the Jordanian Institution for Standards and Metrology (JISM). A study initiative is proposed to address this important issue and minimize further demand by industry through process modifications and greater recycling (see Box V-1, Section V).

About 80 MCM/yr of wastewater is treated and discharged into various watercourses or used directly for irrigation, mostly in the Jordan Valley. Currently, around 70 percent of the urban population is provided with sewerage services.

The average salinity of the municipal water supply is 580 ppm Total Dissolved Solids (TDS). With the low domestic water consumption of 70 liters per day (lpd) (World Bank report, 1997), the resulting salinity in wastewater is high. This salinity is increased further when stabilization ponds exposed to evaporation are used for the treatment of effluent resulting in an effluent salinity level averaging 1,180 ppm. This salinity level limits the types of crops that can be irrigated directly with reclaimed water.

Table IV- 4. Wastewater Treatment Plants in Jordan

Treatment Plant	Type	Design Capacity (m^3/day)	Average inflow 1999 (m^3/day)	Effluent Disposal
As-Samra	WSP	68,000	166,844	350 ha forest, olives, KTD
Aqaba	WSP	9,000	8,774	15 ha forest, dates by drip Irrigation,
Ramtha	WSP	1,900	2,174	40 ha forest, fodder irrigation
Mafraq	WSP	1,800	1,933	20 ha forest, olives, fodder
Madaba	WSP	2,000	3,609	20 ha fodder flood irrigation
Ma'an	WSP	1,600	1,738	7 ha olives drip irrigation
Irbid (Central)	TF+AS	11,000	4,612	Jordan Valley for irrigation
Irbid (Wadi Al-Arab)	EA	21,000	5,993	Jordan Valley for irrigation
Baq'a	TF	15,000	10,284	KTD
Abu Nuseir	AS +RBC	4,000	1,411	Wadi Berein
Jeresh	EA+MP	3,500	1,603	Tributary KTD
Salt	EA+MP	7,700	3,166	Wadi Shueib
Karak	TF	800	1,146	Wadi Al Karak
Tafilah	TF	1,600	815	Ghor Fifa
Kufranjah	TF	1,800	1,734	5 ha fodder, forest, Wadi Kufranjah
Fuheis	AS	2,400	1,019	Wadi Shueib
Wadi Sir	WSP+EA	4,000	914	Local irrigation
Wadi Hasan/Nueimeh	OD	1,600	-	JUST for Irrigation
Wadi Mousa	EA	3,400	-	Local Irrigation, forest
Total		**162,100**	**217,769**	

Source: WAJ
(WSP) Waste Stabilization Ponds, (AS) Activated Sludge, (RBC) Rotational Biological Contactor, (TF) Trickling Filter, (EA) Extended Aeration, (MP) Maturation Ponds, (OD) Oxidation Ditch

Table IV-4 indicates that many wastewater treatment plants run in excess of their rated capacity, with the As Samra facility running at twice design capacity. USAID is providing financing for a proposed 25-year BOT contract for the design, construction, operation, and maintenance of a new wastewater treatment plant to replace the existing As Samra treatment plant. The new wastewater treatment plant will provide treatment of up to 270,000 m^3 per day of wastewater from the Greater Amman area. USAID will provide a grant for 50 percent of the construction costs, up to a maximum of $75 million, as an MWI contribution towards the construction costs of the winning bidder. The bidders will have to provide 20 percent equity financing for the project, with the balance of the construction costs to come from whatever commercial sources they can arrange on their own. In the case of Mafraq, which has been overloaded for the past four years, USAID has committed funding for a now completed Treated Wastewater Reuse Feasibility and Concept Design and for a Wastewater Treatment Plant Technology and Conceptual Design

Study and an Environmental Assessment that are now being completed. USAID has, to date, committed $ 8.0 million for the expansion of the treatment plant.

2. Wastewater Reuse and Water Management

The majority of the treated wastewater is already reused indirectly in agriculture. Thus, reclaimed water has become a major component of the national water budget, particularly in the densely populated Amman-Zarqa Basin and Jordan Valley. With the supply of fresh water very limited and the demand expected to continue to increase, it is vital that the anticipated increases in reclaimed water be managed to meet, at least in part, national and regional demands. The present and planned use of reclaimed water for agriculture and trees is projected for areas within the immediate vicinity of a plant. It is being considered for use for agriculture in the wadis downstream from a plant, and for agriculture after mixing with natural surface water from the King Abdullah Canal.

Wastewater is a valuable resource and should be treated to such a level that it could be suitable for unrestricted use in agriculture and for artificial groundwater. Reclaimed water should be used for existing irrigation commitments, replacing valuable good-quality groundwater that can be used for domestic purposes.

A good example of beneficial reuse of reclaimed water is the ongoing USAID wastewater reuse project at Aqaba, where treated effluent is being used to irrigate date palm trees. This availability of "new" water provides job opportunities and income to local families. At the same time, the coastal ecosystem is being protected from the discharge of effluent.

It is recommended that pilot/demonstration schemes be set up, as part of either ongoing or planned projects, for controlled groundwater recharge through shallow recharge ponds. These trials should be set up where the experiment could be fully controlled with no adverse effects on water supply systems. Aquifers with differing lithologies should be investigated and instrumentation should be put in place to observe the hydraulics and efficiency of the recharge operations and the quality effects both on the recharge water and within the aquifer. Recharge operations elsewhere have proved to be efficient for furthering the treatment of effluent. Locales where there is fracturing, karst development, and solutioning offer special challenges for achieving success with recharge operations while avoiding contamination of the aquifers.

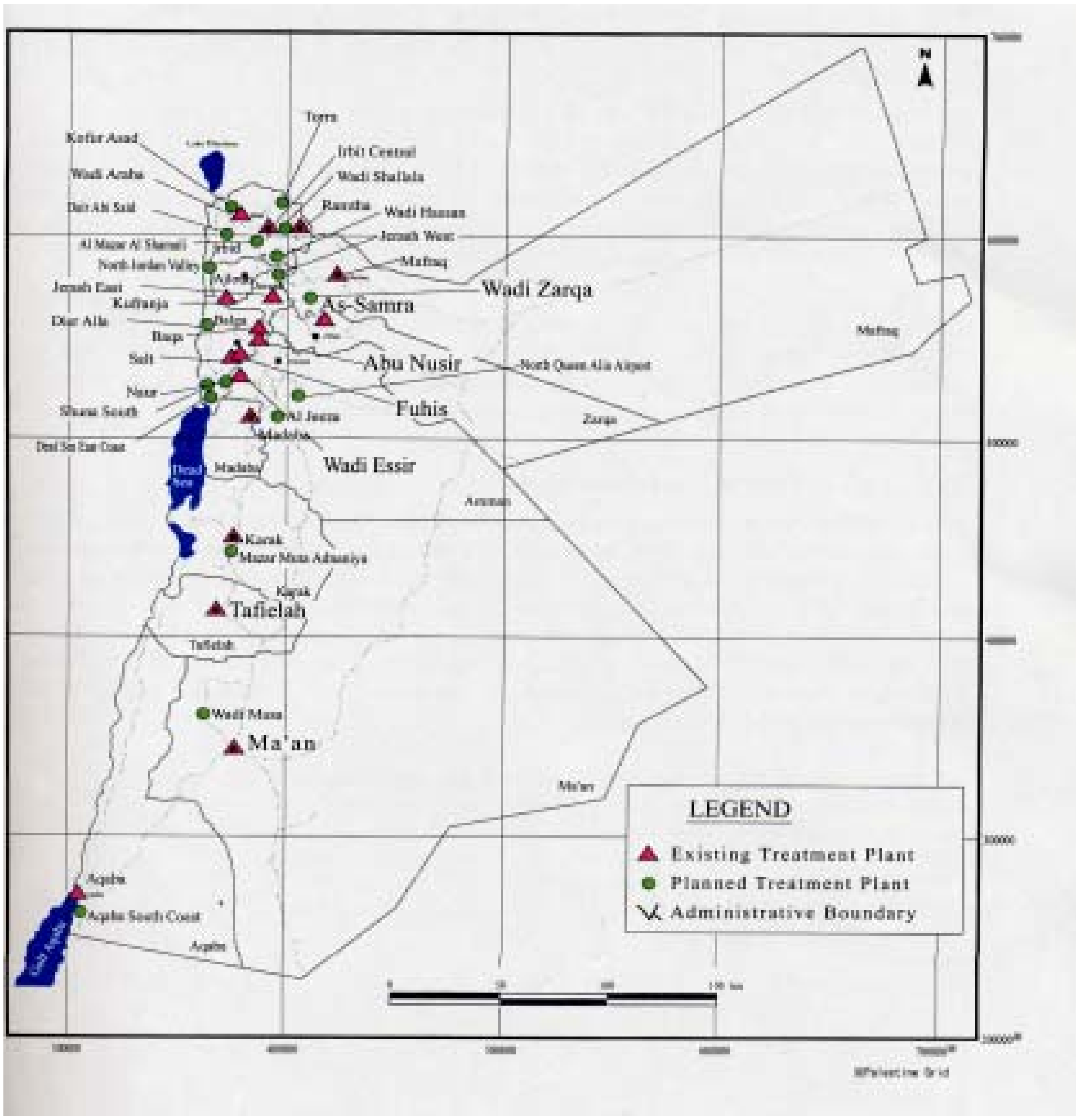
Thus, to promote the substitution of reclaimed water for current use of fresh surface water and groundwater, USAID should continue its support to the Government of Jordan for the study of the reuse of reclaimed water, especially through controlled trials. Work is to be continued at Wadi Moussa, Aqaba, Mafraq, and Wadi Hassan under the Phase I Implementation of the Water Reuse Project and the Phase I Water Management Project. The statement of work for the Phase II programs (2003 and 2004) should take into account the proposal of the evaluation team, in Section V, to reduce industrial demand for fresh water as well as to account for controlled aquifer trials as noted above.

The planned Phase II activities for watershed management and wastewater reuse should be pursued during 2003 and the five-year plan period at the already committed levels of $2.0 million each. Should a well-designed program of recharge be added to either of these initiatives, the budget likely would double.

F. SURFACE BRACKISH WATER RESOURCES

The brackish water resources available come from springs issuing near and flowing to the Dead Sea. Some of these waters are suitable for salt-tolerant crops and others need desalination to become suitable for any purpose. It is envisaged that the brackish surface water of Wadi Mujib (30 MCM/yr) would be mixed with brackish water from Wadi Zarqa Ma'in and Zara Spring. It would be desalinized at Swim. Other brackish surface water that may be desalinated comes from the Jordan River at low flow. The Jordan River receives saline water from springs around Lake Tiberias and from return flow from irrigation throughout the valley. These waters are not part of the current accounting due to the high cost of desalination; however, they constitute a strategic reserve for the future.

Figure IV–1. Locations of Existing and Planned Wastewater Treatment Plants
(after JICA 2001)



G. PRESENT AND FUTURE DEVELOPMENT OF SURFACE WATER

Table IV-5 lists the existing and planned water impoundment works in Jordan, including the King Abdullah Canal. The total storage capacity of the 19 existing dams is 194.7 MCM, while three new dams are under way that will raise the total dam capacity to 251 MCM. JICA (2001) estimated that the total reservoir storage, including the Unity Dam, would reach 446 MCM by 2020, which is deemed as the optimum development quantity.

Figure IV-2. Locations of the Main Existing Dams and Planned Dams
(after JICA, 2001)

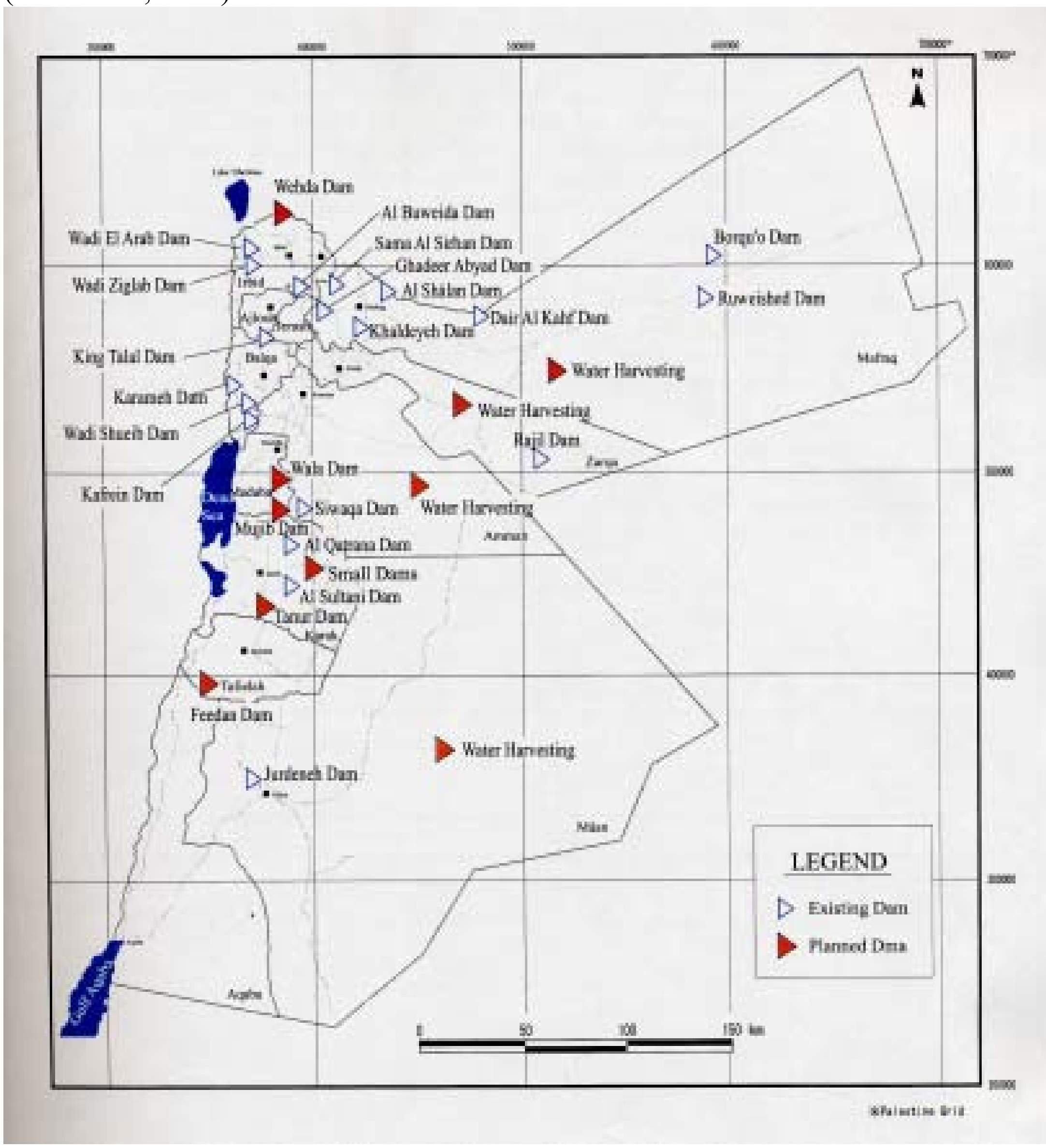


Table IV-5. Dams in Jordon

Name of Dam	Type	Date	Capacity	Purpose	Remarks
Existing dams					
King Talal	Earth fill	1977	89	Irrigation	Present capacity 75 MCM. M&I effluent is 50% of inflow
Wadi Arab	Earth fill	1986	20	Irrig – M&I	Springs dried up as a result of over-pumping at Irbid.
Ziqlab	Rock fill gravity	1966	4.3	Irrig – M&I	
Shueib	Earth fill	1968	2.3	Recharge	Receives irrig. return flows and effluent from the Salt wastewater plant
Kafrain	Earth fill	1968	8.5 (1996)	Irrig - recharge	Stores water from: Wadi Kafrein, wells and diversion from Wadi Hisban.
Karameh	Earth fill	1998	55	Irrig. of Salt tolerant crops	King Abdullah Canal (KAC) excess water / floods from wadis - Zarqa River downstream King Talal Reservoir.
Highland and Desert Dams					**Livestock, irrigation and recharge. Total 30.15 MCM**
Sama Serhan	Rockfill		1.7		Mafraq
Ghadeer Abdyadh	Concrete		0.7		Mafraq
Borgue	Earthfill		1.5		Mafraq
Khaldiah	Earthfill		1.1		Mafraq
Deir Kahif	Rockfill		1.5		Mafraq
Sha'lan	Earthfill		1		Mafraq
Bowidah	Concrete		0.7		Irbid
Qatranah	Rockfill		2		Karak
Sultani	Rockfill				Karak (Filled with sediments)
Lohfi	Earthfill		0.7		Zarqa
Abu Swanah	Earthfill		0.2		Zarqa
Rajel	Earthfill		3.5		Zarqa
Swaqa	Rockfill		2.5		Amman
Dams Under Construction					
TANNUR	RCC		12	Flood	Roller Compacted Concrete (RCC). Control the floods of Wadi Hisa
Wala	RCC		9.3	Recharge	Artificial filtration through eight wells
Mujib	RCC		35		
Al Wehdeh					Feasibilities / financing completed
King Abdullah Canal (KAC)			**(prompted development of Jordan Valley)**		
KAC is a concrete lined, trapezoidal, gravity-fed waterway 101.5 km canal started in 1957 and completed in 1988, with a design capacity that ranges from 20 m^3/s at the intake to 2.3 m^3/s at the downstream end near the Dead Sea. The water quality in the canal north of Deir Alla intake is a blend of good quality water from the Yarmouk River, the Tiberias North Conveyor (peace water), Mukheibeh wells, Wadi Al-Arab dam and other side wadi supplies. South of Deir Allah, KAC receives KTR water that consists of flood water from the Zarqa River mixed with poor quality treated wastewater from Amman.					

Checchi December 2002 (after S. T. Abu-Jamra, 20

H. GROUNDWATER RESOURCES

There are 14 groundwater basins in Jordan, each underlain by more than one aquifer. Some aquifers are rechargeable fresh water reservoirs and some store "fossil" water that owes its origin to past geologic periods. These fossil aquifers do not receive recharge. Groundwater was the first water resource in Jordan to be developed, starting with spring water, shallow wells, and then deeper wells. As the technology for drilling improved and with the advent of electric pumps, extraction from greater depths was possible. This progression of exploitation of groundwater resources was quite normal since surface water resources, with the exception of inundation agriculture, are far more expensive to develop. Surface water developments often require reservoirs to store water during the season of plenty and transmission pipes to deliver water. In addition, surface water storage is diminished by evaporation whereas groundwater is not. Aquifer systems normally provide water for all purposes with the minimum of treatment, as opposed to surface reservoirs; evaporation loss is absent, something that is very important under semi-arid to arid climates. Finally, water is distributed by the aquifer medium and tapping it is very often done at the point where it is needed.

The development of the groundwater reserves was very rapid during the 1980s when licenses for drilling of tubewells were freely provided. As a result, in a few years a pattern of systematic overpumping was observed in most of the aquifers. The overpumping was evidenced by trends of water level decline, deterioration of the water quality caused by the creation of hydraulic conditions that induce intrusion, or upconing of masses of water bodies of inferior quality. This ongoing situation has created serious concern and several measures are presently being undertaken. The objective is to reduce extractions to the levels of safe yield. These measures include improving the efficiency of groundwater use, licensing of wells, water metering, and, more recently, by-laws charging tariffs for the amounts of water extracted. Since these measures have only recently been undertaken, there has, as yet, been no observed reversal of declining water tables. Also, there is no program in place that will permit scientific definition of aquifer characteristics, their recharge, and estimates of safe yield.

Aquifer systems and the water they contain constitute a reserve that can be strategically used and even "mined" at a planned level in years of drought when surface water reserves are not sufficient to meet the most urgent needs for the sustaining of demand. If drawdowns continue at the present rate, soon (5 to 15 years) minimum reserves will not be available and this advantage that groundwater offers will have been sacrificed.

The hydrogeology of Jordan has been broadly described in a series of reports and investigations carried out by Jordanian and international agencies, including a detailed National Water Master Plan prepared in cooperation with GTZ in 1977. The major aquifer systems, shown on Figures IV-3 and IV-4, are:

The Upper Aquifer System, Quaternary – Tertiary Aquifers (All, Ba, B5, B4): These are made up of shallow aquifers such as the valley fill of the Jordan Valley and Wadi Araba and the limestone, chalk, marl, and sand and gravel aquifers in Jafer, Azraq, and Sirhan areas; and the Basalt aquifer extending from the Syrian border south toward the Azraq and Wadi Dhuleil areas, occupying 11,000 km^2 in northeastern Jordan and extending into Syria. Similar aquifers lie along reaches of the Yarmouk River in Syria, and are already heavily pumped.

The Middle Aquifer System, Carbonate Rock Aquifers (A7/B2): The Amman-Wadi Sir aquifer system, which is composed of limestone, cherty limestone, and sandy limestone, forms the most important and most extensive aquifer in Jordan. It is recharged in the highland areas within Jordan and Syria, with minor local recharge or recharge from adjacent aquifers. Depth to water in the carbonate aquifer is often less than 180 meters, and the quality is generally good, with TDS less than 1,000 mg/l.

The Lower Aquifer System, Sandy Facies Aquifers (K, Z, R): This aquifer system contains mainly untapped brackish groundwater resources.

The total renewable annual "safe yield" of all the groundwater basins has been estimated in gross terms to be about 276 MCM (World Bank report, 1997). The water balance of the main groundwater basins, on the basis of estimated safe yields for each basin, and the reported extractions in 1998 are shown in Table IV-6. Pumpage appears to be on the order of 175 percent of the safe yield. The table also shows the extraction by each sector for 1993. Agriculture accounted for over 61 percent of the abstraction.

It has been estimated that fossil groundwater of good quality may be mined at a steady rate of 143 MCM per year for a period of 40 to 50 years. After that, it is assumed that this supply will no longer be available. However, Saudi Arabia pumps extensively from the fossil groundwater reservoir.

Figure IV-3. Simplified Hydrogeological Map of Jordan (From WISP)

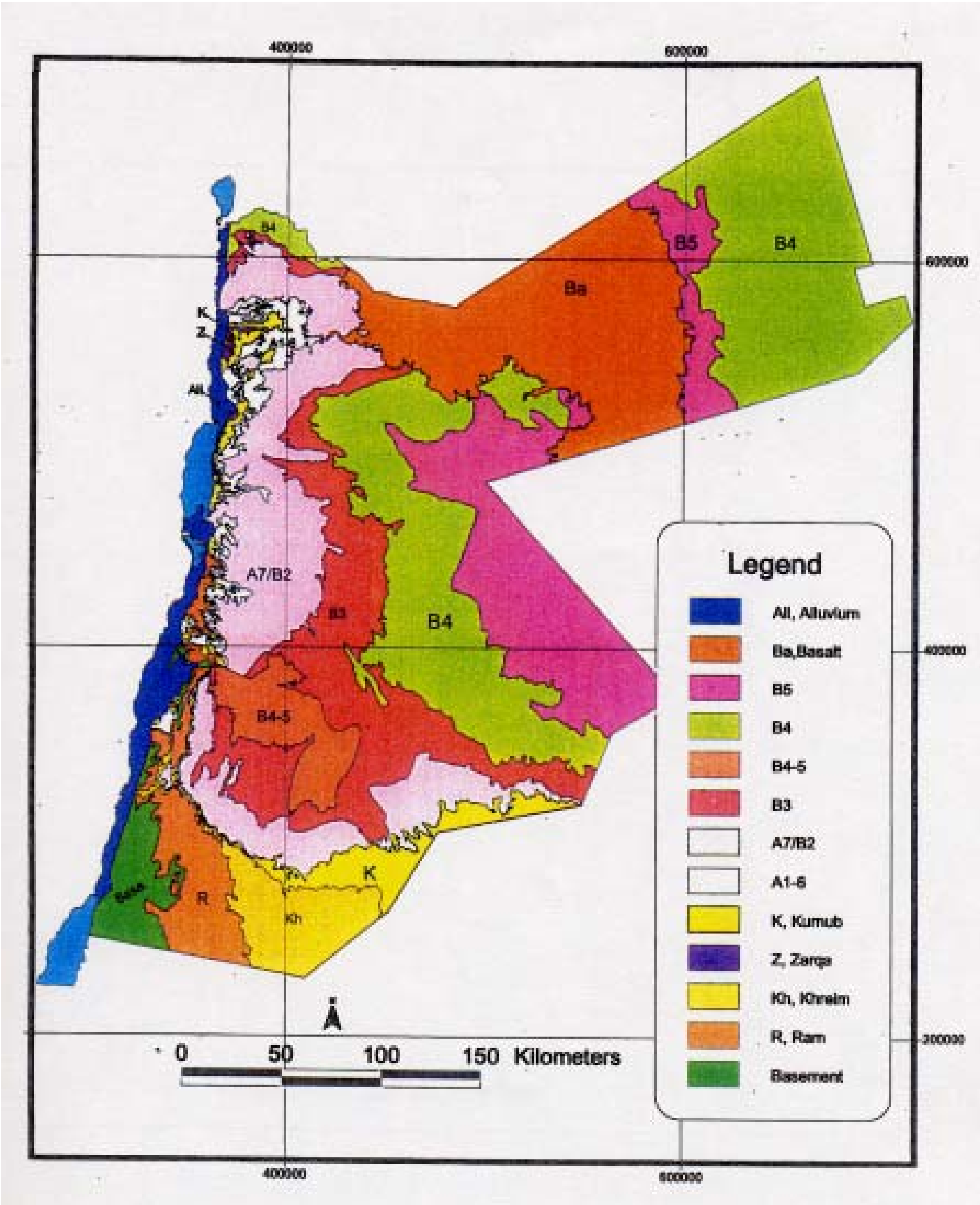


Figure IV-4.

General Flow System and Renewable Groundwater Basins (after JICA, 2001)

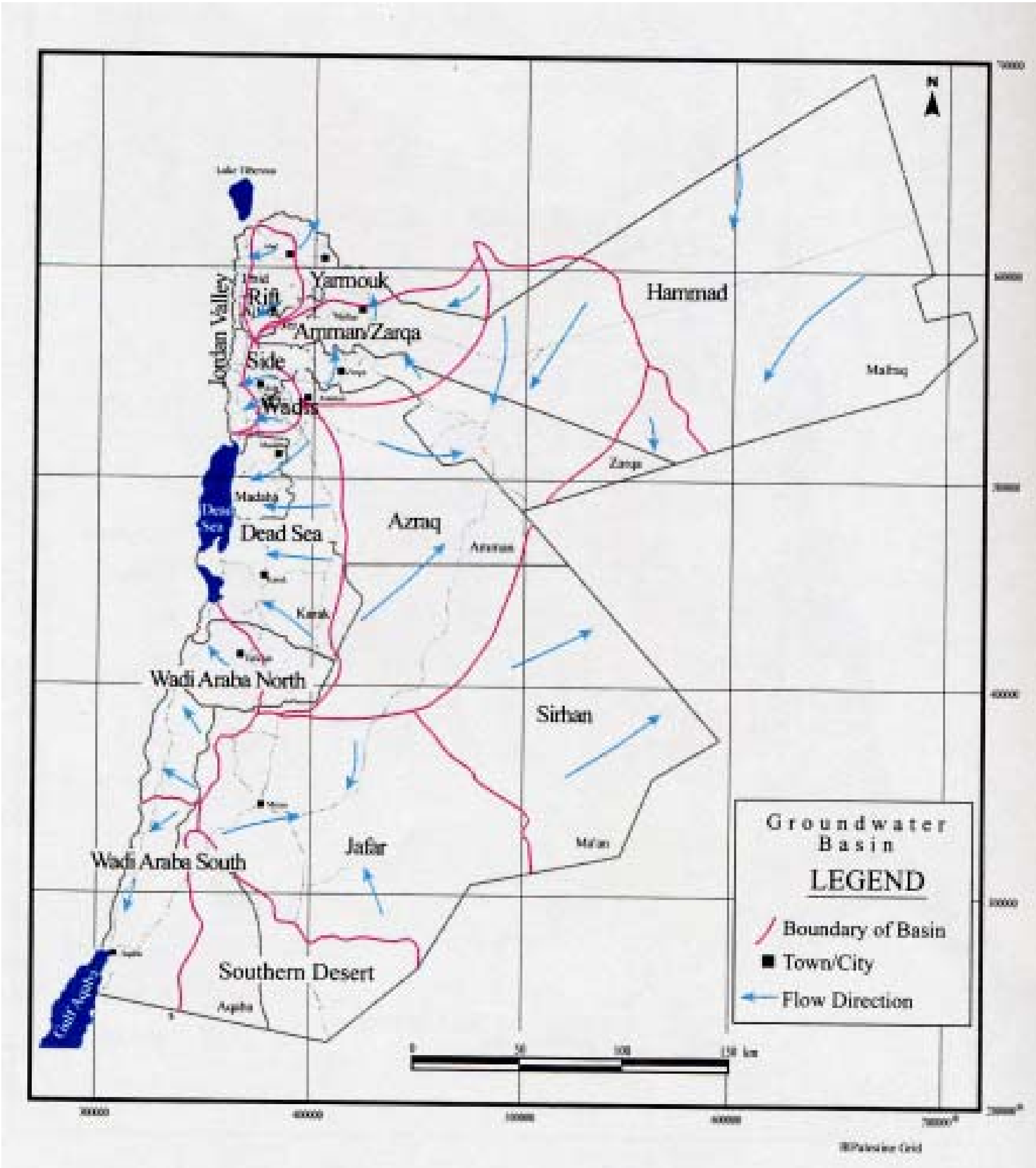


Table IV-6.
Groundwater Resources of Jordan

Ground Water Basins	**Estimated Safe Yield MCM/yr**	**Ground water Utilization for 1993***					**Estimated Total Extraction MCM/1998**	**Balance MCM/ yr**	**1998 Extraction as % of Safe Yield**
		Domestic	**Industry**	**Agriculture**	**Remote Areas**	**Total Use**			
Yarmouk Basin	40	26.4	0.13	40.5		67.0	55	-15	137%
Side Wadis Basin (North Jordan Valley Basin)	15	1.8		1.2		3.0	12	3	80%
Jordan Valley Basin	21	5.3	0.04	36.8		42.1	38	-17	181%
Amman-Zarqa Basin	87	57.6	7.79	118.1		183.5	138	-51	159%
Dead Sea Basin	57	29.0	17.19	46.0	0.04	92.2	85	-28	149%
Northern Wadi Araba Basin	4			0.9	0.11	1.0	4	0	100%
Southern Wadi Araba Basin	6	1.6		2.8	0.07	4.4	5	1	83%
Al Jafer Basin *(Renewable)* *(Non-Renewable)*	9 Fossil	3.3	0.86	12.3	3.66	20.1	23 -	-14	256% -
Azraq Basin	24	24.4	0.06	25.0	0.36	49.8	56	-32	233%
Al Sarhan Basin	5				0.15	0.1	1.5	3.5	30%
Al Hammad Basin	8	0.4		0.7	0.72	1.8	1.3	6.7	16%
Disi	Fossil		?	?	?	?	65	-	-
Total	**276**	**149.8**	**26.06**	**284.3**	**5.11**	**465.2**	**483.8**		**175%**

Total safe yield from renewable aquifers is 276 MCM/yr
Fossil aquifer yields not included in above Table are:

- Al Jafer: 18 MCM over 40 years
- Al Disi: 125 MCM over 50 years

Total Fossil: 143 MCM

Total Safe yield (renewable and fossil) is 419 MCM

Source of figures except for 1993, is the database of MWI and provided by S. T. Abu-Jamra (USAID, WRE)
* Based on Table prepared by WAJ and appearing in World Bank Report of 1997

Overpumping is notable in six of the basins where the quoted safe yields have been seriously exceeded for a number of years, as shown in Table IV-7. This situation has resulted in a serious downward trend of the water levels, which causes great concern for the future availability of supplies from these systems.

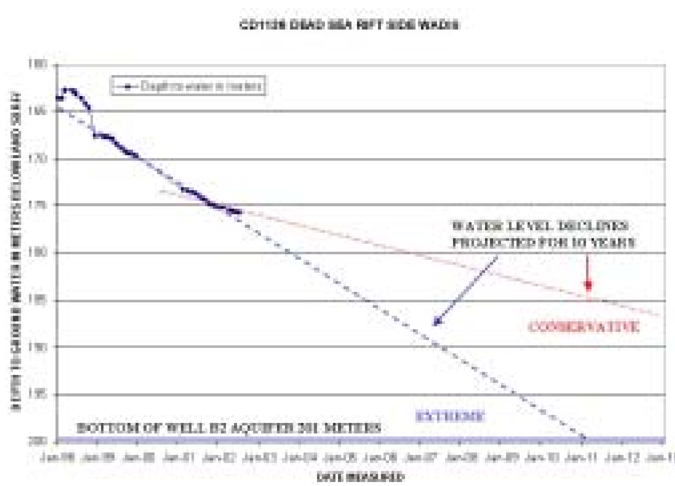
Table IV-7. Estimated Groundwater Extraction and Overdraft from Renewable Resources in 1989, 1993 and 1998 (MCM)

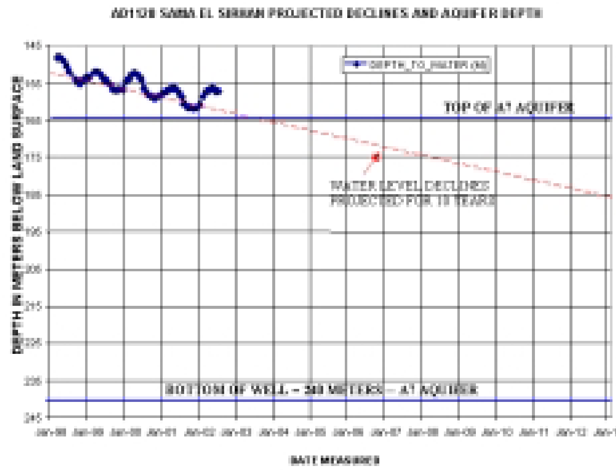
Basins	Safe Yield	Extraction			Overdraft		
		1989	1993	1998	1989	1993	1998
Yarmouk	40	72	67	55	32	27	15
Jordan Valley	21	40	42	38	19	21	17
Amman-Zarqa	87	156	184	138	69	96	51
Dead Sea	57	82	92	85	25	35	28
Al Jafer	9	23	20	23	14	11	14
Al Azraq	24	37	50	56	13	26	32
Other	38	12	10	24	0	0	0
Total	**276**	**422**	**465**	**419**	**172**	**216**	**157**

Source: Checchi December 2002 after World Bank 1997 and S. T. Abu-Jamra, 2001

A U.S. Geologic Survey (USGS) team working with MWI staff in August 2002 (report submitted to USAID) projected future basin-wide water deficits and, with hydrogeologic and surface water resources information, projected future deficits of sustainable water resources to describe the long-term viability of "mining" of groundwater. Of particular concern were the groundwater withdrawals and potential for problems that may arise from unanticipated dewatering or increased salinity in aquifers before projected new, planned, or proposed projects can be brought on-line.

The USGS prepared graphs using data from MWI to illustrate projected water-level declines and to correlate those declines with the amount of groundwater potentially remaining in the aquifer. Water-level declines were projected for 10 years based on trend lines of water levels from 1998 to 2002 (see sample charts below). Actual declines could of course be larger or smaller than these projections due to factors such as increases or decreases in pumping, sudden encroachment of saline water, a characteristic of upconing, and differences in the physical capacity of the aquifers to yield water as water levels decline.





In general, the projected 10-year water level declines in the Yarmouk, North Rift Side Wadis, and Hamad Basins, while severe in some areas, do not indicate large-scale dewatering of aquifers during that time period (2000 to 2010). However, as indicated on Figure IV-5 below, for the Dead Sea Rift Side Wadis, the projected 10-year water-level declines would exceed 30 meters in a large portion of the northeast part of the basin, and in some wells projected declines could exceed 60 meters. Unlike most projected water-level declines in the other basins, the projected decline in the northeast part of the Dead localized areas. It is urgent that further calculations of the amount of recoverable water Sea Basin would be severe and would diminish the sustainability of the aquifer in remaining in aquifer storage be made for this area along with additional scientific monitoring and investigations.

In 2000, there were approximately 2,449 operational groundwater wells; of these, 510 were illegal. In an attempt to regulate groundwater abstraction, the government in 1994 passed the regulation requiring all licensed wells to have meters. Presently, most of the licensed wells are metered. Recently, the Council of Ministers decided to impose fees on the use of groundwater wells that pump a minimum of 150,000 cubic meters per year. The decision reflects the serious intent of the Ministry to work on groundwater issues, the concept of sustainable yield, and the value of Jordan's renewable and nonrenewable resources. MWI estimates projected savings of about 40 to 50 MCM over the next three to five years as farmers reduce pumpage due to the new fees. Decreases of this magnitude could reduce the 2001 pumpage for irrigation by 25 percent, or 13 percent of the gross extraction rate. More will have to be accomplished to bring the groundwater basins into balance.

The estimated potential of nonrenewable fresh groundwater in the Ram Aquifer ranges from 125 to 225 MCM/yr for a period of 40 years to 100 years, according to two studies for the Wadi Araba Basin and for the Southern Desert Basin (Disi-Mudawara Basin). Abstraction from the Ram Aquifer in both basins was approximated to be 29 MCM in 1998. In addition, an estimated abstraction of about 40 MCM was made by unidentified wells from the same aquifer in the Southern Desert Basin during 1998. Thus, the total abstraction from the Ram Aquifer was assumed to be on the order of 70 MCM. Therefore, on the basis of the estimated potential for nonrenewable water from this aquifer being on the order of 125 MCM/yr, some 55 MCM/yr could be considered as available for future development if the aquifer is to be developed to serve basic demand on a steady basis. This, however, may not be the most beneficial use of this exhaustible resource. A master plan needs to be drawn up to determine if the fossil water should be pumped only during periods of shortage. Thus, Disi fossil water may be used for a century or longer. It is emphasized that future installations of wells in the Disi-Mudawara basin should be concentrated along the Jordan–Saudi Arabia frontier to ensure that the groundwater gradient of the Disi aquifer is to the northwest.

The brackish groundwater is the sole water resource remaining almost undeveloped. However, studies of brackish groundwater resources are limited. Therefore, the potential of the brackish groundwater is only preliminarily evaluated. Most investigations have indicated that the brackish groundwater potential occurs mainly in the Lower Aquifer systems (sandy facies aquifer) and may be considered as fossil groundwater. The brackish groundwater in the Middle and Upper Aquifer Systems is presented in Table IV-8 and a summary of the brackish groundwater potential is shown in Table IV-9.

Figure IV-5. Ten-Year Projected Water-Level Decline in the Dead Sea Rift Side Basins (after USGS, 2002)

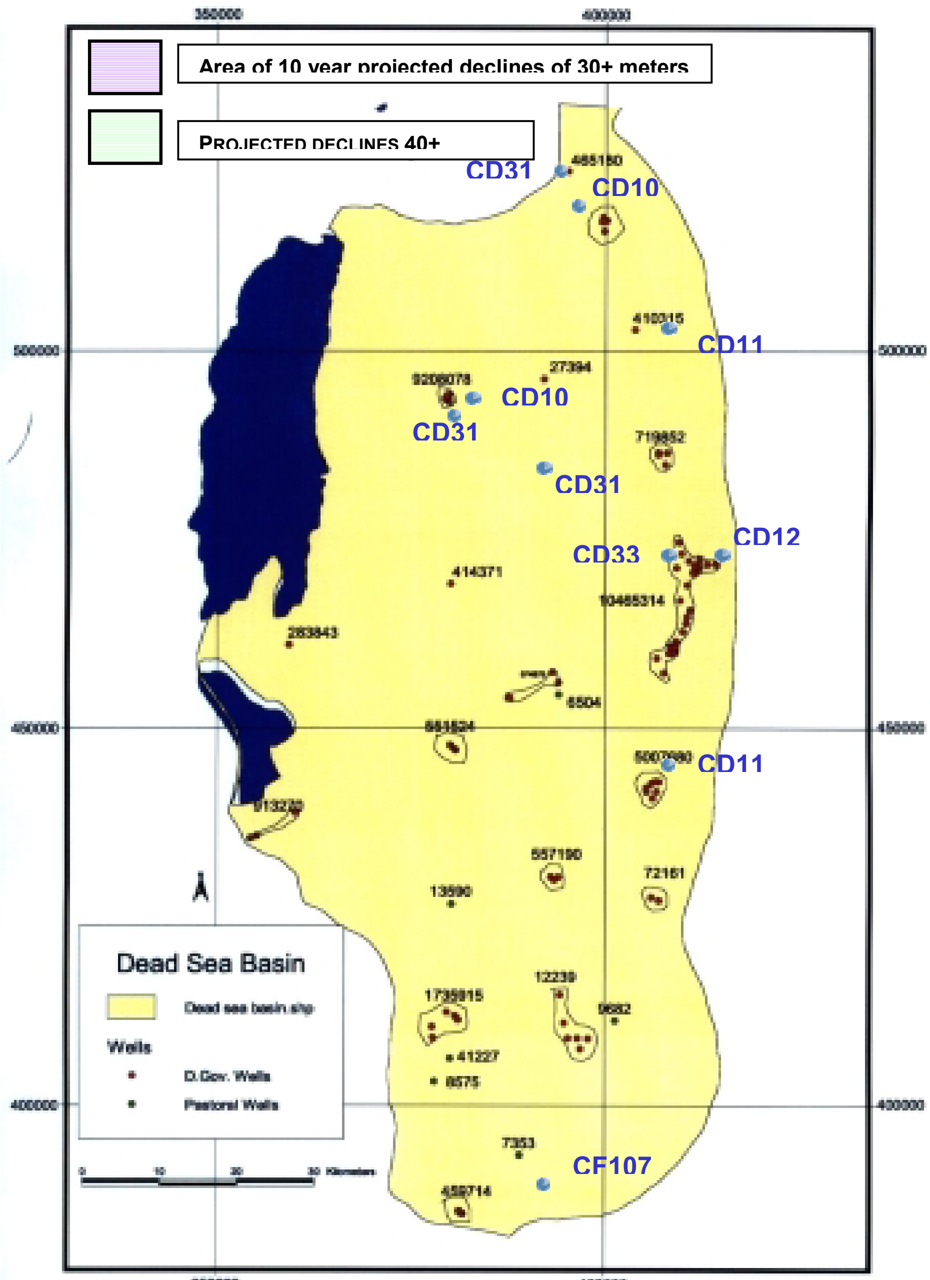


Table IV-8. Brackish Groundwater Resources in the Middle and Upper Aquifer Systems

Groundwater Basin	Aquifer	Storage Amount of Nonrenewable (Billion m^3)	Assume Safe Yield of Renewable (MCM/yr)	Salinity Range (mg/l TDS)
Azraq	A7/B2 (North to Central)	46		1,000 to 2,500
	A7/B2 (South)		10 to 12	1,000 to 1,700
	Kurnub	42		1,350 to 3,000
Jordan Valley	All		16	1,000 to 2,500
Dead Sea	A7/B2		9 to 12	1,000 to 1,700
Wadi Araba (North & South)	Al		8	1,000 to 7,000
Jafer	A7/B2	1.7		1,000 to 4,000
	Kurnub	12		1,400 to 3,000
	Khreim	88		1,200 to >10,000
Sirhan	B4		5	1,000 to 2,500
	A7/B2	32		4,500 to 7,000
Hammad	B4/B5		7	1,000 to 3,000
	A7/B2	16		1,500 to 3,200
Total		**237.7**	**55 to 60**	1,000 to >10,000-

Source: After "Assessment of Brackish Groundwater in Jordan, WQIC, 1998"

Table IV-9. Summary of the Brackish Groundwater Potential

1. Renewable[a]	Safe Yield : 55MCM/a to 60MCM/a
2. Nonrenewable/Flowing[b]	Exploitable Amount : 265MCM/a to 300MCM/a
3. Nonrenewable/Stagnant[a]	Exploitable Volume : 24billion cubic meter*

Source : "Assessment of Brackish Groundwater in Jordan, WQIC, 1998" and JICA 1995

* 10% of the total storage amount

a: The depth to the aquifers and thickness of aquifers greatly differ place to place

b: The thickness of the deep aquifer system is more than 1,000 m including Ram/Disi Aquifer

The impact of overextraction is exemplified in the case of the Amman-Zarqa Basin (AZB) aquifers, which receive an annual recharge of 87 MCM and represent 30 percent of the nation's renewable groundwater resources of 276 MCM/yr (ARD, 2001). A significant part of the recharge is groundwater inflow from Syria. Increasing overpumping since the 1980s has reached more than 70 percent in 1998 and continues to increase. As a result, significant water-level declines and salinity increases have occurred in the Dulayl area. Springs near Sukhna have dried up and water levels and water quality have deteriorated in parts of North Badiya. A groundwater modeling study (ARD, 2001) indicates that continued overpumping of groundwater in the AZB highlands over the next 20 years would cause groundwater quality to deteriorate, with drawdowns that would average 0.5 meters per year. Seventy percent of the wells in the Hashimiya–Dulayl-Hallabat area would become dry.

Overpumping constitutes a severe threat to this vital resource. It affects not only the water levels and, in turn, the need for increased energy for pumping. Further, yields of the wells are being reduced, necessitating deepening of them and/or lowering of the pumps. Reduced pressures due to drawdown generally lead to intrusion from adjacent or lower water bodies that may have inferior quality. Once an aquifer is exhausted, it could require many years without pumping to recover; once an aquifer becomes saline, its production capacity may never be restored.

The dependence of the Yarmouk River flow on water management, carried out in the Golan Province, was discussed above. Further depletion of groundwater reserves in the upper catchment of this river will have serious effects on the availability of water downstream. The flow of springs will dry up and the base flow will diminish seriously. More than 2,500 wells are reported to be operating in the area. At the same time, the impoundment of surface water in a large number of small dams will reduce the available water even further.

The quantities stipulated in the Peace Agreement of 1964 have not materialized in their totality, and it is uncertain if quantities stipulated in more recent agreements will be available in the future. Thus, for political reasons as well as for technical reasons, the local groundwater resources should be prudently managed to enable strategic reserves not only to meet the ever-increasing water demands but also to meet possible reductions caused externally.

I. SUMMARY OF SUSTAINABLE RESOURCE POTENTIAL

The projected available water supply is shown in Table IV-10. This projection assumes that the shared nature of most surface water resources and political considerations will not further limit the ability to bring these resources into use.

The JICA Water Resources Management Master Plan (2001) projects an increase of available water resources from 890 MCM available in 1998 to 1,289 MCM by 2020. JICA assumed a reduction of groundwater production to estimated safe yield levels and the bringing on stream of nonconventional water resources, including treated wastewater as reclaimed water and desalination of brackish water (see Table IV-11). The assumed surface water resources development of 446 MCM would be about 67 percent of the available surface water potential of 662 MCM indicated on Table IV-2, which, although possible, would require a considerable investment program.

Table IV-10. Projected Available Water Supply[1]
(MCM/yr)

	1990	2000	2010	2020
SURFACE	324	375	505	505
Renewable Groundwater	434*	407	325	285
Fossil Groundwater	63	61	140	140
Reclaimed. Wastewater	35	87	141	200
Brackish Water	0	0	15	40
Peace Treaty	0	30	50	50
Lower Jordan	0	0	30	30
Total	**865**	**960**	**1206**	**1250**

1: With no further reductions by Syria
*actual use and includes over-pumping
Source: MWI (World Bank report 1997)

Table IV-11. Water Resources Development, as per the Water Resources Management Master Plan (after JICA, 2001) (MCM)

	Source	1998	2020	Remarks
Conventional Water	SURFACE WATER	303	446	Maximum utilization of available potential, optimistic that Syrian situation will be resolved
	Peace Water	33	90	
	Renewable Groundwater	420	275	Reduction of abstraction needed due to over-draft
	Fossil Fresh Groundwater	70	130	
Non-conventional Water	Desalinized Water	0	102	Brackish water potential is large; but expensive to process and thus used as supplemental or stop-gap supply
	Treated Wastewater	64	246	Maximum utilization should be done; potential will increase.
Total		**890**	**1289**	

Table IV-12 shows the projected rise of the water demand until the year 2020 (JICA, 2001). This projection is based on the assumption that there would be some demand control and that, although the population growth assumed was high, the per capita consumption would be controlled at a level of 129 lcd. The industrial water demand would increase threefold by 2020, water demand for tourism would increase 11 times, and the irrigation water demand would remain stable at about 620 MCM/yr. A reallocation of water was indicated in the Master Plan by diverting reclaimed wastewater to agriculture and reducing abstraction for the same purpose from the uplands.

The JICA Master Plan proposed a balancing of the projected demands with the available water resources potential. In reality, the realization of this would require careful strategic planning, political will, effective control and management of demand, and timely completion of planned water resources development projects, accompanied by the necessary funding. This will come about only if strong and effective technical institutions are set up, including a good water resources monitoring and control unit and a well-staffed planning unit that could have access to reliable and accurate information. Time-sensitive information for water resources and financial data accompanied by socioeconomic information would be required.

Table IV-12. Water Demand/Water Resources Management Master Plan—Scenario 1* (after JICA, 2001)
(MCM)

Demand Sector	1998	2020	Remarks
Municipal and Tourism	**242**	**517**	Consumption rate restricted to 129 lcd
Industrial water	**43**	**130**	Minimum amount needs to be allocated for economic development.
Irrigation water - **Jordan Rift Valley** - **Upland**	**563** 262 301	**642** 401 241	Present use to be secured; reduction of upland irrigation to reduce overdraft; Disi water for M&I of Amman only.
Total	**848**	**1289**	

*Scenario 1: Demand control model based on the base water balance proposed by World Bank.

J. THE RED-DEAD PROJECT

This project has received a lot of attention recently since it purports to:

- Save the Dead Sea from extinction in view of the observed trend of a one-meter drop of water level per year due to the reduced quantities of fresh water being discharged to it as a result of upstream development of water resources, and

- Offer the potential for desalination of seawater, taking advantage of the head for direct desalination operation, and hydropower generation that could be accomplished by the 400 m drop of water.

The project would involve the laying of a 12-km long pipeline of 64 m^3/s capacity to transfer, after pumping, water from the Red Sea at Aqaba to an elevation of 126 m above mean sea level. From there, the sea water would be released and flow by gravity through a 189-km long pipeline to a point 100 m above sea level, and from there discharge to the Dead Sea surface 400 m below mean sea level. The drop would allow energy recovery that could be used for desalination for supplying fresh water to Jordan (66 percent) and to Israel and Palestine.

Although this project could be among the ultimate projects that could help resolve the water scarcity in the region, the magnitude, scope, and costs involved fall beyond the scope of this report. This project is of regional character and does not fall within the framework of USAID's Strategic Objective 2. An environmental assessment for analysis of alternatives could be undertaken with the World Bank as coordinator and USAID and other donors contributing.

SECTION V:
DEMANDS ON WATER RESOURCES

SECTION V: DEMANDS ON WATER RESOURCES

This section discusses estimates of water demand as well as uncertainties associated with those estimates.

A. RATIONALE FOR USAID INVESTMENTS, 1995 TO 2002

Estimates of historic water uses and demand by sector were summarized in a paper drawn up by USAID (Setta Tutundjian, April 2001, *Water Resources in Jordan*). Excerpted sections below, documenting the deficits and rationing carried out over the past decade by municipalities, illustrate the basis for the focus of the SO2 program, embedded in IR 2.1 and IR 2.2, over the past five to seven years.

The SO2 water-sector evaluation team judges that the emphasis and momentum for construction of facilities to conserve the bulk water supply through measures to control and reduce unaccounted-for water (UFW), IR 2.1, will of necessity continue into and through the 2004 to 2009 period of the USAID strategy for water resources, SO2. In like manner, the past emphasis on treating and reclaiming municipal and industrial wastewater (IR 2.3) will of necessity be pursued into the 2004 to 2009 budget period, as these treated waters will be, in part, reclaimed to reduce the fresh water irrigation demand.

To accomplish a continuing program of water conservation, it is vital that USAID realize continuing budgets for the water sector that match the medium ($60 million) to high ($100 million) annual investment schedule discussed in Section VIII. These ongoing water-supply projects and programs are directed toward the potable water-distribution systems, including pipes, reservoirs, valves, pump stations, and associated infrastructure.

1. Municipal Water Use

The USAID report provides the following information regarding municipal water use during 1999, and identifies the growth in the use of water from 1980 through 1998.

"In 1999, the water consumption of the domestic sector was approximately 231.5 MCM, around 29 percent of total water used in the country. [*Approximately*] 79 percent of the water used for domestic purposes is groundwater since, with the exception of the Yarmouk River water pumped to Amman, all drinking water in Jordan is groundwater (including springs).

"Demand in most urban areas cannot be met during more than half of the year. Consequently, water supplies are provided on an intermittent basis 8 months a year (currently said to be year-round). This shortage in water supplies is aggravated by the rapid increase in population, the inefficiency of the water distribution system, and the inadequate infrastructure.

"The average daily supply for domestic use is 126 liters/capita/day, of this [*amount*], 55 percent [*some say 70 percent*] is unaccounted for water [*UFW*]. Hence, the (actual) per capita consumption is between 60 and 90 liters/day [*or less*]. Reducing UFW is one of the best means to augment municipal water supplies and improve the financial viability of water supply services."

Table V-1 shows an estimate of groundwater and surface water uses in 1999. Most of the total water used, or 65 percent, was for irrigation. Groundwater was the principal source of all water uses: municipal, irrigation, industrial, and rural and isolated areas.

Table V-1. Groundwater and Surface Water Uses in 1999, MCM

Uses	Groundwater	Surface Water	Total	Percent
Municipal	183	49	231	29
Irrigation (*treated effluent included in surface water*)	256	265	521	65
Industrial	35.5	2.1	37.6	5
Rural & Isolated Areas (*usually not included when citing water uses*)	7.3	4	11.3	1
Total	481	320	801	100

Source: Tutundjian, April 2001 (after MWI 1998).

The USAID report provides the following information regarding industrial and agricultural water use.

2. Industrial Water Use

"Industry consumes a mere 5 percent of the water supply. Most of this demand is in the southern three governorates. [*At Aqaba City, the industrial component comprises some 60 percent of total water consumption; it is an important fact to be addressed later in this report.*] More than half the industrial use of water is in the potash and phosphate industry, with much of the remainder for electrical power plants.

"As Jordan pursues rapid economic growth…[*much of the growth of employment and gross domestic product*] is anticipated [*to occur*] in the industrial sector… The accession [*of Jordan*] to the World Trade Organization [*WTO*], the Free Trade Agreement [*FTA*] with the U.S., and the [*establishment of*] Qualified Industrial Zones (QIZ) [*could contribute substantially to economic growth*]. Currently, there are 10 QIZs; four of them are not operational yet. The rest are at an average capacity of 40 percent. Accordingly, it is foreseen that the demand for water by the industrial sector will steadily increase over the coming years.

"The electricity generating plant in Aqaba, which produced 40 percent of Jordan's energy, obtains water from the Aqaba municipal supply, i.e., from Disi well fields. The other major power plant is the Hussein plant in the Zarqa Basin, which generates about one third of Jordan's electricity; the water in its wells require reverse osmosis and ion exchange to produce water of adequate quality for cooling.

"Two major development projects are planned in the future to meet the growing municipal and industrial demand [*especially in Amman and the northern governorates*], the Disi conveyor (100 MCM/year) and the Ma'in treatment and pipeline project (45 MCM/year)."

MWI projections of industrial water demand increase from 37.6 MCM per year in 1999 to 81 MCM by 2005, 99 MCM by 2010, and to as much as 146 MCM in 2020. By the year 2020, industrial water demand is projected to total some 9 to 12 percent of water demand.

For this reason, the SO2 water-sector evaluation team suggests that USAID finance an advisory mission and study staffed with experts from U.S. industry and industry consultants. The consultants would review the processes of the key industries of Jordan and suggest cost-effective potentials for modifying industrial processes to promote reuse and reductions of influent water.

Box V-1

INDUSTRIAL WATER-DEMAND REDUCTION PROJECT

Purpose: The purpose of this activity is to suggest cost-effective potentials for modifying industrial processes to promote internal reuse and recycling of process water and to achieve reductions of influent water.

Associated Ongoing and Planned Activities of USAID: This initiative, if it is to be executed, should occur in the near term. Experts would be tasked to evaluate completed and ongoing USAID-sponsored studies and suggest activities important for inclusion in a statement of work (SOW) for Phase II of the water reuse project that is planned to start during FY 2004. The SOW is planned to include operations at Aqaba, the industrial zones, and industries of major industrial cities and in the countryside.

Scope: This proposed USAID initiative could be accomplished by a technical assistance team of, say, three experts from U.S. industry and industrial consultants, each making two visits for one and a half months. Such a level of effort could require a budget of $300,000.

Table V-2 shows projected water demand for three primary users. Agricultural use dominates water demand during each of the forecasted years.

Table V-2. Projected Water Demand, MCM

	2005	2010	2020
Municipal	382 (28.9%)	434 (30.2 %)	611 (37.1%)
Industrial	81 (6.1%)	99 (6.9 %)	146 (8.9 %)
Agricultural	858 (65.0%)	904 (63.0 %)	890 (54.0 %)
Total	1,321	1,436	1,647

Source: after Tutundjian, April 2001.

The USAID report provides the following information regarding historical agricultural water use.

3. Agricultural Water Use

"Agriculture consumes about 65 percent of all water use. There are 52,700 irrigated hectares in the highlands and desert area, and 31,600 irrigated hectares in the Jordan Valley and Southern Ghors. These [*total agricultural demands*] account for about 53 percent of groundwater use in Jordan.

"Privately managed farms in the highlands are mostly irrigated from private groundwater wells, while the irrigated area in the desert [*especially Aqaba Governorate in Southern Jordan*] is irrigated by fossil groundwater from the Disi Aquifer. Table [V-3] sums up water used for irrigation.

Table V-3. Growth of Water Used for Irrigation Over Past 20 Years, MCM

Water Type	**1980**	**1995**	**1998**
Surface Water	147 (49.0%)	256 (42.3%)	282 (46.2%)
Groundwater	138 (46.0%)	291 (48.1%)	258 (42.2%)
Recycled Water	15 (5.0%)	58 (9.6%)	71 (11.6%)
Total	300	605	611

"The publicly managed irrigation system in the Jordan Valley uses mostly surface and recycled wastewater whereby irrigation water is supplied to farmers by KAC [*King Abdullah Canal*]. Furthermore, there are around 195 privately managed agricultural wells in the Jordan Valley and Southern Ghors. In 1997 to 1999, the average annual abstraction or pumpage from the Jordan Valley and Southern Ghors wells, including Jordan Valley Authority wells, was approximately 25 MCM.

"Water availability in Jordan is becoming scarcer, and competition between the three [*major*] sectors: municipal, industrial, agricultural, is intensifying. Reducing the existing irrigated area to save water [*for allocation outside the agricultural sector*] is politically difficult, with painful social consequences. However, reducing the irrigated area is not the only option for saving water as improving on-farm water management and adopting modern technologies can save water [*for irrigating additional agricultural land already authorized for agriculture in the Jordan Valley, and/or for reallocation to other water sectors*]. These two factors can reduce the amount of water used by agriculture, releasing much needed water to the municipal and industrial sectors, without reducing agricultural output. [*USAID-funded Irrigation Advisory Service pilot studies in 1998 to 2001 indicated that irrigation scheduling could save as much as 20 percent of the delivered water to the farm with an increase of up to 7 percent in vegetable crop yields, and improvements in crop size and uniformity, in the Jordan Valley*.]"

B. MWI Estimates of Gross Water Demand and Potential Amelioration of Those Demands

1. Situation

The MWI estimates of water demand are assumed to be maximums without accounting for the several initiatives to conserve and decrease the quantities of delivered water. The SO2 water-sector evaluation team sets out below what the team considers to be the upper level of water demand. The team then grossly evaluates initiatives to reduce those demands.

Following the evaluations of these potentials for demand reduction, the team attempted to reconcile the reduced demand potentials with the three water-demand scenarios proposed in the JICA report (JICA, December 2001, *The Study on Water Resources Management in the Hashemite Kingdom of Jordan*). Based on the resulting overview of water demand, the evaluation team was able to reconcile demand and supply in Section VI of this report and to suggest appropriate USAID interventions for the period 2003 to 2009. Highlighted is the important need for establishment of capable, well-staffed Central Planning Unit within MWI.

2. MWI Projections of Water Demand

MWI has been compiling information on water supply and water demand for decades. MWI projects that despite its proposed water sector investment program through 2011 of $2.5 billion, Jordan will face sizeable water deficits (MWI, February 2002, *Water Sector Planning & Associated Investment Program*, 2002–2011). MWI estimates that the water deficit will grow from about 224 MCM in 1995 to 437 MCM by 2020. As noted, the evaluation team assumes these are gross estimates, which do not include conservation and reclaimed-water replacements.

Figure V-1 shows the projected water demand for three major sectors: agriculture, municipal, and industrial. The agricultural sector remains the predominant user of water over time, although combined municipal and industrial water demand is nearly equivalent by 2020.

Figure V-1. Projected Water Demand of Three Major Sectors

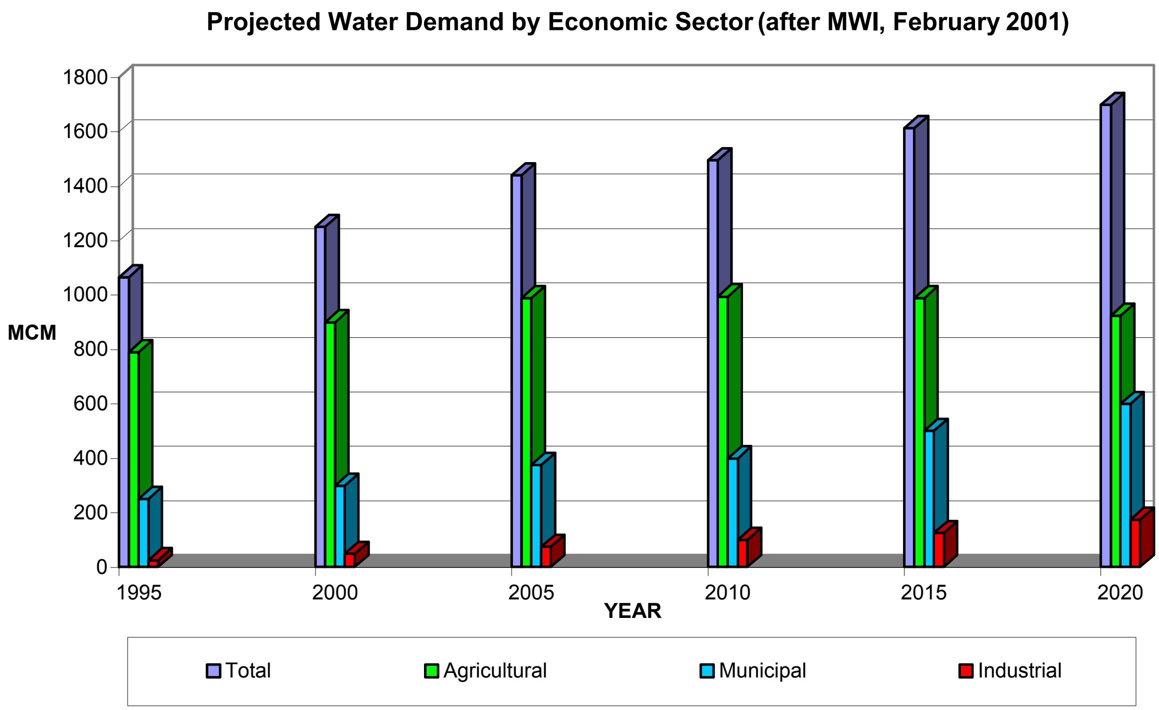


Table V-4 summarizes the MWI water demand forecast as included in the report by the World Bank (February 15, 2001, *The Hashemite Kingdom of Jordan Water Sector Review Update, Main Report*).

Table V-4. Growth in Water Demand Requirements, MCM/year

Year	Municipal and Industrial Demand	Agricultural Demand	Total Demand
1998	342	863	1205
2005	463	858	1321
2010	533	904	1436
2015	639	897	1536
2020	757	890	1647

Source: World Bank, February 15, 2001.

3. Potentials for Reduction of Water Demand

This subsection discusses reduction of groundwater demand, effects of rehabilitation and replacement of municipal water distribution systems, and reduction of industrial and agricultural water demands for source or fresh water.

a. Reduction of Groundwater Demand

Several initiatives have been identified to reduce the demand for fresh rechargeable groundwater. The SO2 water-sector evaluation team is not judging the political, economic, or technical efficacy of these proposed initiatives, but merely notes their potentials and their possible effects on future demand directly from groundwater and surface water sources. There is an urgent need to carry forward a highlands groundwater demonstration project that addresses as many of the five initiatives in one location as possible. As noted in Section VIII, a USAID initiative should be launched (see Box V-1, Section V).

An ARD report (*MWI Water Resources Policy Support, Summary of the Water Resource Policy Support Activity*, 9 August 1999 to 8 August 2001) proposed groundwater management options for reducing groundwater abstraction:

- ***Irrigation advisory service.*** ARD estimates that this option could save 15 to 20 percent of pumped groundwater being used for irrigation per year. About 5 MCM/year could be saved due to increased irrigation efficiency; there should be no decrease of irrigated land.

- ***Wells buy-out.*** ARD estimates that this option could reduce abstraction for irrigation by 15 to 20 MCM/year under a voluntary scheme. ARD estimates that approximately 2,500 on-farm and off-farm jobs could be lost as a result of this option. This option, in the opinion of the SO2 evaluation team, would be difficult to implement with equity and fairness.

- ***Enforcement of abstraction limits.*** ARD estimates that this option could reduce abstraction for irrigation by 10 to 15 MCM/year. ARD estimates that approximately 1,800 on-farm and off-farm jobs could be lost as a result of this option.

- ***Exchange of fresh groundwater with reclaimed water.*** ARD estimates that this option could save 15 MCM/year, comprised of approximately 10 MCM from irrigation and 5 MCM from industrial use.

- ***Municipal and industrial reduction.*** ARD estimates that this option could save approximately 30 MCM/year from two sources: 10 MCM/year as regained unaccounted-for water and 20 MCM/year replaced by new water supplies such as Disi, Wehda, Zara-Ma'in, and Amman-Zarqa Basin brackish water sources.

** All the listed ARD proposed groundwater over abstraction reduction scenarios should be tested through a groundwater pilot study on a specified watershed or basin.*

b. Probable Effects of Rehabilitation and Replacement of Municipal Water Distribution Systems

Municipal water systems countrywide lose large percentages of supply as unaccounted-for water due to physical water losses and unbilled water. Perhaps 55 to 70 percent of water delivered to the municipal water distribution systems in Amman, Aqaba, and Irbid are unaccounted for and thus are not billed. It is anticipated that rehabilitation of the physical system would result in recovery of one-half the estimated UFW. For example, if Amman now receives 100 MCM, of which 55 to 70 percent is UFW, the USAID physical rehabilitation program may serve to reduce present-day water demand by 25 MCM. The saved water would immediately reduce demand on fresh water sources, and it would be available to satisfy unrealized or current demand or future demand increments due to population increase or increased standard of living.

c. Reduction of Industrial Water Demand

As discussed above, the MWI projection of industrial water demand is relatively small as a percentage of the total, but it is a much lager part of demand in Aqaba City and environs. By the year 2020, industrial water demand countrywide will total some 9 to 12 percent of demand.

Industrial water demand reduction, based on process modification, generally is industry- and resource-dependent, and may range from some 10 percent in bulk minerals industries to as much as 90 percent in fabrication industries (witness recent developments in the semi-conductor and electronics industries worldwide). Large reductions of fresh water demand may be realized by replacing fresh water with reclaimed water. This already is being considered for quarrying and bulk mineral industries in Aqaba, where fresh water demand may be reduced by as much as 50 to 90 percent. A study is proposed for execution in the near term to provide input to the planned Phase II statements of work for reuse of reclaimed water and management of watersheds (see Box V-2, Section V).

d. Reduction in Irrigation Water Demand

As discussed above, irrigation is expected to continue to consume more than 50 percent of the total water supply over the next 20 years. Irrigation demand for fresh water can be significantly reduced by the further implementation of physical and management measures to achieve higher irrigation efficiencies, particularly in the highlands where efficiency improvements will support the same hectarage while reducing water demand. Earlier programs centered in the Jordan Valley demonstrated that reductions of future per-hectare demand may range from 10 to 20 percent of the on-farm water demand. It is noted, however, that saved water generally is used for irrigating fallow hectarage. USAID currently is contracting for a new project that will address the further improvement of irrigation efficiency in the Jordan Valley and in the Amman-Zarqa Basin There also is scope in the Jordan Valley to conserve important quantities of water through improvements of the main and primary canals. Irrigation demand for fresh water may be further decreased by improvements in the use of reclaimed water.

C. JICA VARIABLE ESTIMATES

Future water demand was estimated for three scenarios considering different population growth rates and per capita consumption rates, along with other assumptions (JICA, December 2001, *The Study on Water Resources Management in the Hashemite Kingdom of Jordan*). The tables in this subsection come from that JICA report. The SO2 evaluation team presents this information for illustrative purposes only, as government allocation policies are dynamic and all policies and assumptions were not checked or verified.

The JICA report addresses three water demand scenarios, which are used throughout the following discussion, as follows:

Scenario 1: Demand control model based on the World Bank/MWI water balance, 2001

- Municipal water: Large population growth rate, per capita consumption rate of 128 lcd (liters per capita per day); about 2.1 times increase of consumption between 1998 and 2020 (501 MCM/yr in 2020)
- Industrial water: About 3.3 times increase by 2020 (130 MCM/yr in 2020)
- Touristic water: About 11 times increase by 2020 (16 MCM/yr in 2020)
- Irrigation water: About 14 percent increase by 2020 (630 MCM/yr in 2020)

Scenario 2: High demand model based on the political target and high development rate of industrial sector and agricultural development plan

- Municipal water: Large population growth rate, per capita consumption rate of 150 lcd; about 2.5 times increase of consumption between 1998 and 2020 (587 MCM/yr in 2020)
- Industrial water: About 4.3 times increase by 2020 (168 MCM/yr in 2020)
- Touristic water: About 15 times increase by 2020 (21 MCM/yr in 2020)
- Irrigation water: About 75 percent increase by 2020 (963 MCM/yr in 2020 with 300 MCM/yr increment) based on agricultural schemes of JVA and MOA as "target demand"

Scenario 3: Variation model of Scenario 1 using low population growth rate and a higher per capita consumption rate of 150 lcd

- Municipal water: Low population growth rate, per capita consumption rate of 150 lcd; about 2.2 times increase of consumption between 1998 and 2020 (510 MCM/yr)
- Industrial water: About 3.4 times increase by 2020 (132 MCM/yr)
- Touristic water: About 12 times increase by 2002 (17 MCM/yr)
- Irrigation water: About 14 percent increase by 2020 (630 MCM/yr)

1. Water Demand Summary

Table V-5 summarizes the water demand projection scenarios for plan year 2020. The demand projections were made for these scenarios and calculated using the demand calculation module on the "Digital National Master Plan," recently developed by MWI. As shown in Figure V-2, demands of Scenarios 1 and 3 would be satisfied by projected water supply as postulated in the JICA report. Scenario 2, which would provide municipal, industrial, touristic, and irrigation demand close to that projected by MWI, would substantially exceed foreseeable water supply.

Table V-5. Summary of Water Demand Projection Scenarios for Plan Year 2020 (JICA, December 2001)

Water-Demand Scenario	Municipal Water Demand, 2020		Industrial Water Demand (5,6)	Touristic Water Demand (5,6)	Total of Municipal, Industrial, Touristic Demand	Irrigation Demand Water (7)
1	Population:	9,180,000, predicted by MWI (1)	Increase rate: 4.2-1.1 %/yr (4)	Increase rate: 5.0-2.5 %/yr	647 MCM/yr	630 MCM/yr
	Water Supply (3)	128 lcd				
	501 MCM/yr		130 MCM/yr	16 MCM/yr		
2	Population:	9,240,000, predicted by MWI (1)	Increase rate: 5.3-4.6 %/yr	Increase rate: 8.4-8.3 %/yr	777 MCM/yr	963 MCM/yr
	Water Supply (3):	150 lcd (4)				
	587 MCM/yr		169 MCM/yr	21 MCM/yr		
3	Population:	7,990,000, predicted by Statistics Bureau (2)	Increase rate: 2.9 %/yr	Increase rate: 5.5-3.0 %/yr	659 MCM/yr	630 MCM/yr
	Water Supply (3):	150 lcd 4)				
	510 MCM/yr		132 MCM/yr	17 MCM/yr		

(1) Projection of population used by MWI to formulate projects.
(2) The figure used by the population projection agency (Department of Statistics) with accounting for the population control policy of the Government.
(3) Water supply is the quantity actually supplied to consumers exclusive of physical loss.
(4) 150 lcd is the target value of municipal water supply that MWI set; it is considered by the evaluation team to be an excellent goal.
(5) The rates of industrial and touristic demand increases represent forecasted change during the plan period 1998 to 2020.
(6) In addition to the regular increase, irregular increase also was considered based on specific development projects.
(7) Water demand for agriculture in Scenarios 1 and 3 was residual water amount after securing the municipal, industrial, and touristic water demand; it still is greater by 14 percent than current demand.

JICA examined three scenarios of future water demand for municipal, industrial, and touristic water use, as summarized in Table V-6.

Table V-6. Summary of Water Demand Projection Scenarios for Plan Target Year 2020, by Sector (JICA, December 2001)

Projected Water Demand Scenario-1 (MCM)

Water Demand	1998	2005	2010	2015	2020
Municipal	237	273	368	445	501
Industrial	39	76	94	114	130
Touristic	1	7	11	16	16
Irrigation	623	694	703	670	630
Total	900	1,050	1,176	1,245	1,277

Projected Water Demand Scenario-2 (MCM)

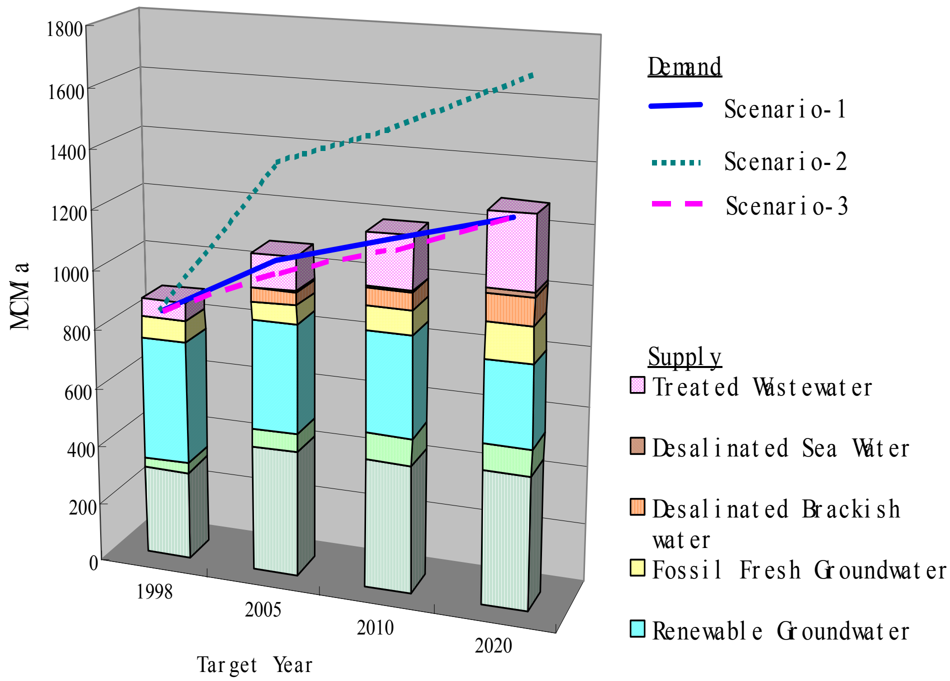
Water Demand	1998	2005	2010	2015	2020
Municipal	237	273	368	493	587
Industrial	39	80	102	134	169
Touristic	1	11	17	19	21
Irrigation	623	981	1,002	992	963
Total	900	1,345	1,489	1,638	1,740

Projected Water Demand Scenario-3 (MCM)

Water Demand	1998	2005	2010	2015	2020
Municipal	237	260	341	443	510
Industrial	39	72	89	110	132
Touristic	1	10	16	17	17
Irrigation	623	694	703	670	630
Total	900	1,036	1,149	1,240	1,289

Figure V-2 on the next page shows the main characteristics of the three water demand scenarios, as well as the projected supply side. The use of the figure is for illustrative purposes only; there is no implied endorsement of the mix of water supply projects shown. Scenario 2 provides for the highest municipal, industrial, touristic, and irrigation demand.

Figure V-2. Balance Between Water Supply and Water Demand for Three Target Years (MCM/yr; JICA, December 2001)



2. Population and Municipal Water Demand

Two gross factors, other than population forecasts, largely determine future water demand projections. They are the liters per capita per day (lcd) required at the tap and the losses that are expected to occur in the distribution system between the water treatment plant and the tap. Details used in the development of the JICA scenarios are shown in Table V-7.

Table V-7. Municipal Water Supply Projection by Target Year and Scenario, lcd (JICA, December 2001)

Water Demand Scenario 1

Year	Municipal Water Supply		Physical Loss Rate, Percentage
	Actual Consumption	Consumption with Physical Loss	
1998	102	136	25
2005	101	126	20
2010	124	146	15
2015	130	153	15
2020	128	151	15

Water Demand Scenarios 2 and 3

Year	Municipal Water Supply		Physical Loss Rate, Percentage
	Actual Consumption	Consumption with Physical Loss	
1998	102	136	25
2005	101	126	20
2010	124	146	15
2015	144	169	15
2020	150	176	15

Table V-8 shows municipal water demand projections by target year and scenario, as MCM. Scenario 1 forecasts a municipal demand of a little over 500 MCM in 2020, more than double the 1998 demand. Scenario 2 forecasts a municipal demand of approximately 590 MCM in 2020, nearly 2.5 times the 1998 demand. Scenario 3 forecasts a municipal demand of about 510 MCM in 2020, a level between Scenarios 1 and 2, and about 2.15 times the 1998 demand.

Table V-8. Municipal Water Demand Projection by Target Year and Water-Demand Scenario, in MCM (JICA, December 2001)

Scenario	1998	2005	2010	2015	2020	1998/2020 Factor
1	237.06	272.67	367.51	445.12	501.26	2.1
2	237.06	272.67	367.62	493.07	587.40	2.5
3	237.06	260.36	340.65	443.39	510.05	2.2

3. Industrial Water Demand

Table V-9 shows industrial water demand projections by target year and scenario, as MCM. Note that Scenario 2 shows the greatest demand at 169 MCM in 2020, or 4.3 times the 1998 demand. Scenarios 1 and 3 show a similar demand of approximately 131 MCM in 2020, or about 3.4 times the 1998 demand.

Table V-9. Industrial Water Demand Projection by Target Year and Water-Demand Scenario, in MCM (JICA, December 2001)

Scenario	1998	2005	2010	2015	2020	1998/2020 Factor
1	38.95	76.08	94.13	113.55	130.21	3.3
2	38.95	80.07	101.57	133.94	168.66	4.3
3	38.95	71.85	88.68	109.85	132.28	3.4

The SO2 water-sector evaluation team is convinced that the 2020 demand levels for industrial use can be significantly reduced if measures are taken in accord with the program proposed in the box later in this section.

4. Irrigation Water Demand

Irrigation demand is dealt with below on the basis of governorates. These data are presented in case USAID should visualize a need to address some issues based on equity among the governorates. Irrigation represents the largest demand in terms of quantity and as a percentage of total water demand over the foreseeable future. Thus, the SO2 evaluation team presents in Table V-10 an aggregated program of irrigation of JVA, MOA, and MWI as derived for the JICA report. It shows irrigated area (IA) increasing by 22,000 hectares or 25 percent between 1998 and 2010.

Consequently, water demand for irrigation would increase nearly 47 MCM between 1998 and 2020. There is no explanation for this, but it does not appear reasonable in view of the fact that MWI anticipates annual deficits exceeding 200 MCM during that period. JICA selected two strategies to project irrigation water demand. Table V-11 shows irrigation water demand projections by target year and water allocation based on the MWI water management plan. The table represents the irrigation component of Scenarios 1 and 3; both are based on the policy of the government. That policy proposes to continue the current water supply of approximately 600 MCM/year.

The irrigation demand actually projected was approximately 630 MCM in 2020 for Scenarios 1 and 3.

Table V-10. Target Irrigation Water Demand and Irrigated Areas in 12 Governorates, Irrigated Area (1,000 Ha) and Water Supply and Demand (MCM/year), JICA Scenario 2 (JICA, December 2001)

Governorate	1998		2005		2010		2015		2020	
	IA	WS	IA	WD	IA	WD	IA	WD	IA	WD
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	14.2	148	17.2	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
Mid/ High Land	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	955?	101.9	981	106.5	1,002	106.5	992	106.5	963

Based on the agricultural development plans of JVA and MOA, MWI computed the irrigation water demand using GTZ/MWI demand modules. See JICA Main Report for assumptions.
IA = Irrigated Area (1,000 Ha), WS = Water Supply (MCM/year), WD = Water Demand (MCM/year), ? = Missing or uncertain

JICA selected another strategy to project irrigation water demand for Scenario 2. Scenario 2 is illustrated in Table V-10, which is based on the "target demand" fulfilling the maximum agricultural development schemes using JVA and MOA agricultural plans in the Jordan Rift Valley and the Up/Mid Land (Highland), respectively. These demands are only "Target Demands for Irrigation Water." The combined demand of 963 MCM in 2020 cannot be met under the current or future constraints on water supplies. Such supply would require water desalination projects on a large scale. The incredibly high costs of such water production could never be justified on the basis of agricultural economics. This is so particularly in view of the resistance of irrigators to pay any water tariff.

Table V-11. Irrigation Water Demand Projection Based on the Water Allocation, in MCM/year, JICA Scenarios 1 and 3 (JICA, December 2001)

Governorate	2005	2010	2015	2020
Amman	42.1	41.9	40.8	39.1
Zarqa	65.2	60.0	58.1	53.8
Mafraq	50.5	44.7	41.3	36.4
Irbid	150.5	167.4	166.5	167.4
Ajulun	6.8	7.7	8.3	8.6
Jerash	11.9	11.8	11.3	11.1
Balqa	213.1	233.6	219.9	197.3
Madaba	8.1	8.9	9.2	9.5
Karak	67.8	72.6	71.9	72.4
Ma'an	46.4	26.9	23.8	13.4
Tafielah	11.6	11.4	11.4	11.5
Aqaba	19.6	16.2	7.2	9.2
Total	693.9	703.3	669.8	629.6

D. ABSOLUTE MINIMUM IRRIGATION — WATER DEMAND REQUIREMENTS

According to JICA (December 2001), it would be possible to keep the policy of maintaining the present gross quantity of irrigation through the target years (2020) if treated wastewater would be reused for achieving reduction of groundwater abstraction. Table V-12 shows the irrigation water demand projections in the 12 governorates under this case. Again, over the near term, 2005 to 2015, the level of projected irrigation demand is very high and inconsistent with the available water supply.

Table V-12. Irrigation Water Demand Projections in the 12 Governorates (JICA, December 2001)

Governorate	2005		2010		2015		2020	
	Area Ha	Demand MCM/yr	Area Ha	Demand MCM/yr	Area Ha	Demand MCM/yr	Area Ha	Demand MCM/yr
Amman	3,170	42.1	3,087	41.9	2,865	40.8	2,668	39.1
Zarqa	4,773	65.2	4,417	60.0	4,132	58.0	3,830	53.8
Mafraq	4,936	50.4	4,351	44.6	4,002	41.2	3,509	36.3
Irbid	13,315	146.7	14,464	155.3	14,959	162.1	15,987	163.2
Ajulun	611	6.8	690	7.7	763	8.3	819	8.6
Jerash	1,011	11.6	1,056	11.7	1,009	10.9	1,018	10.7
Balqa	13,381	213.1	15,093	230.9	13,977	210.5	12,730	188.4
Madaba	906	8.1	973	8.9	929	9.2	936	9.5
Karak	9,882	67.8	10,806	71.2	10,763	70.8	10,662	69.2
Ma'an	4,671	46.3	2,496	26.7	2,083	23.5	931	13.4
Tafielah	407	5.4	421	5.7	420	5.7	469	6.3
Aqaba	1,614	19.5	1,242	16.1	612	7.2	664	8.2
Total	58,677	682.8	59,095	680.8	56,513	648.4	54,222	606.7

Note: MWI computation was modified according to the water allocation by JICA (2001).

E. SUMMARY OF IMPLIED USAID INITIATIVES

- Initiatives under consideration that could reduce fresh water demand include:
- Irrigation Advisory Service to increase irrigation efficiency, possibly without decreasing land irrigated.
- Wells buy-out to reduce irrigated land, an uncertain proposition.
- Enforcement of abstraction limits both directly by regulation and by tariffs to reduce demands.
- Reduction of fresh groundwater pumpage through use of reclaimed water for both irrigation and industry.
- Reduction of pumped and treated municipal water by regaining UFW.
- Provision of municipal and industrial water from brackish water sources through desalination.

- Industrial process modification and industrial water recycling and reuse to reduce demand for potable supply.

1. Schematic Illustrations of Projected Water Demands

Figure V-3 illustrates projected municipal demand to be supplied directly from groundwater and from rivers and wadis (i.e., fresh water), including decreased demand due to improvements to municipal distribution systems and demand reductions because of improved billing. For example, improved billing and collection would reduce demand for fresh water within municipalities where too many residents and municipal employees indiscriminately use potable water for irrigating lawns, trees, and bushes. This irrigation malpractice is not the only profligate use of municipal water that could be controlled by improved billing and collection. Treatment and distribution of municipal water could be reduced by 25 percent or more just due to widespread implementation of system improvement and demand reduction measures. USAID is pursuing this goal under SO2 for the 1997 through 2003 plan period.

Figure V-4 illustrates projected irrigation fresh water demand. Also shown is the potential for lesser fresh water demand due to use of more reclaimed water and implementation of irrigation efficiency initiatives. Significant reductions of fresh water demand for irrigation may be realized if all demand-reduction measures are implemented.

Figure V-5 illustrates the projected total water demand by sector. Note that irrigation demand generally comprises most of the projected water demand in the country, but it may be surpassed by municipal water demand in the long term.

The SO2 water-sector evaluation team suggests that USAID finance a study to map irrigable land and envision buy-out of selected irrigation wells and consolidation of *isolated* farms, especially in the highlands. The study would investigate drilling and operation of irrigation wells, spaced on sound hydrogeologic principles and integrated through an irrigation pipeline network to provide irrigation water. A desirable outcome would be specific recommendations to buy out selected wells, consolidate patchwork or isolated irrigated farms, establishan irrigation water distribution network, and preserve agricultural production in governorates, which already have agricultural production. This initiative does not necessarily anticipate a reduction of irrigated area outside the Jordan Valley.

Box V-2

STUDY OF FARMLAND CONSOLIDATION

The purpose of this activity would be to study the feasibility of consolidating isolated farms (especially in the highlands), buying out selected wells, and establishing an irrigation pipeline network to provide irrigation water to consolidated farms. Consolidation of isolated farms, if feasible, would be expected to provide irrigation to farms more efficiently than under current conditions. This proposed USAID study initiative could be accomplished by a technical assistance team of, say, one expert from the United States and two local staff assigned for 18 months. Such a level of effort could require a budget of $300,000.

Figure V-3. Schematic of Projected Municipal Demand from Fresh Water Sources

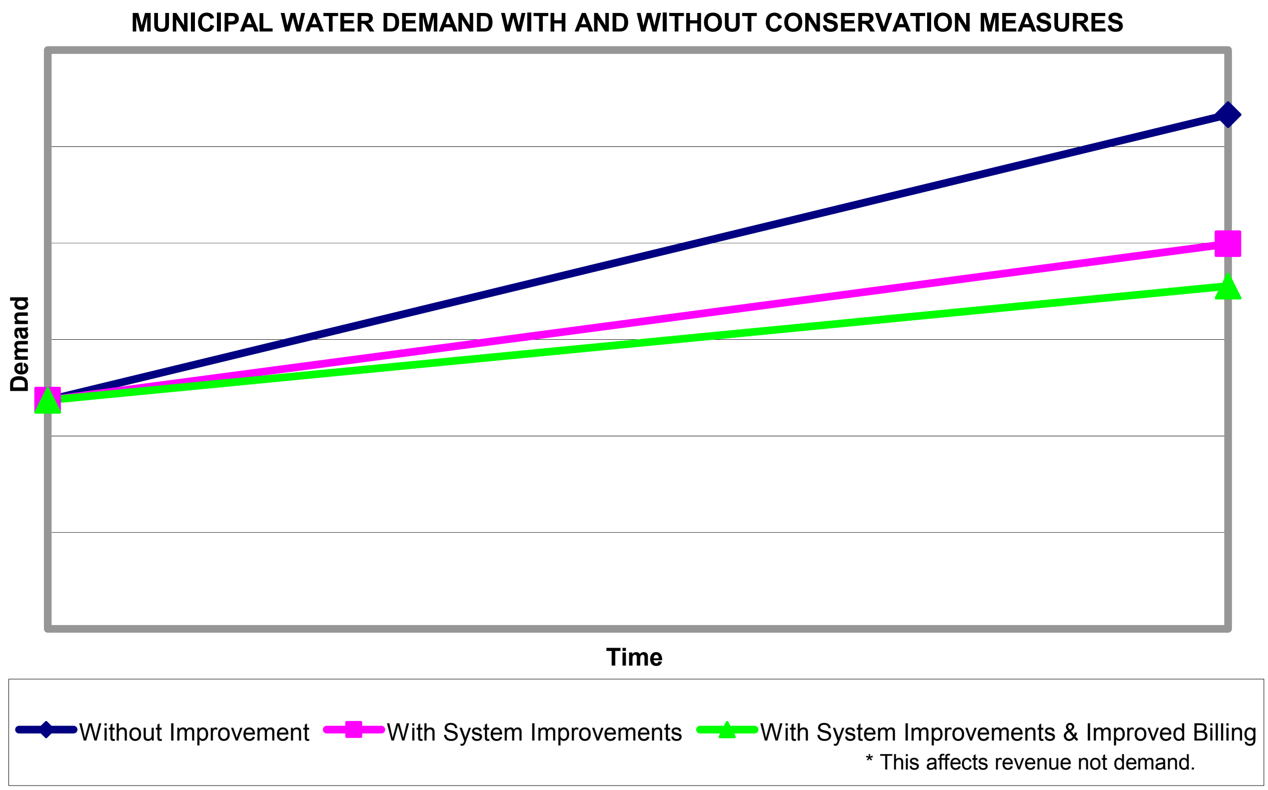


Figure V-4. Schematic of Projected Irrigation Fresh Water Demand

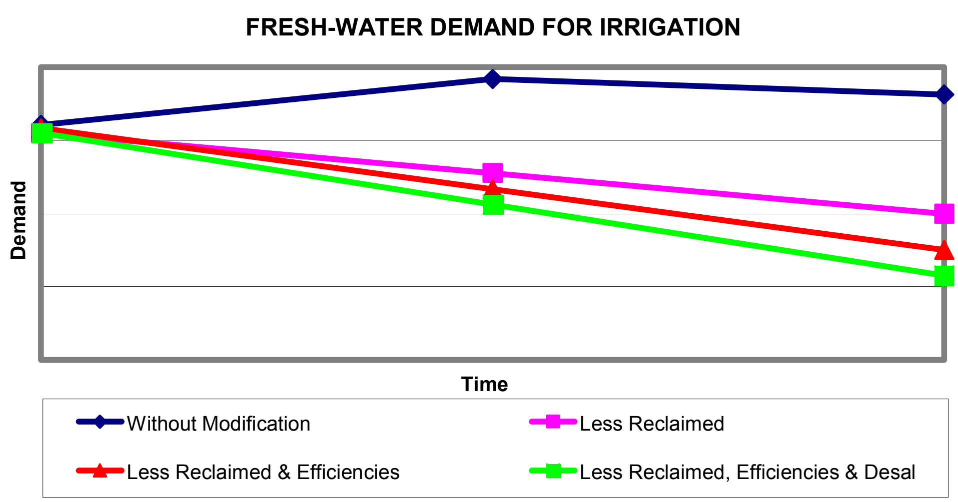
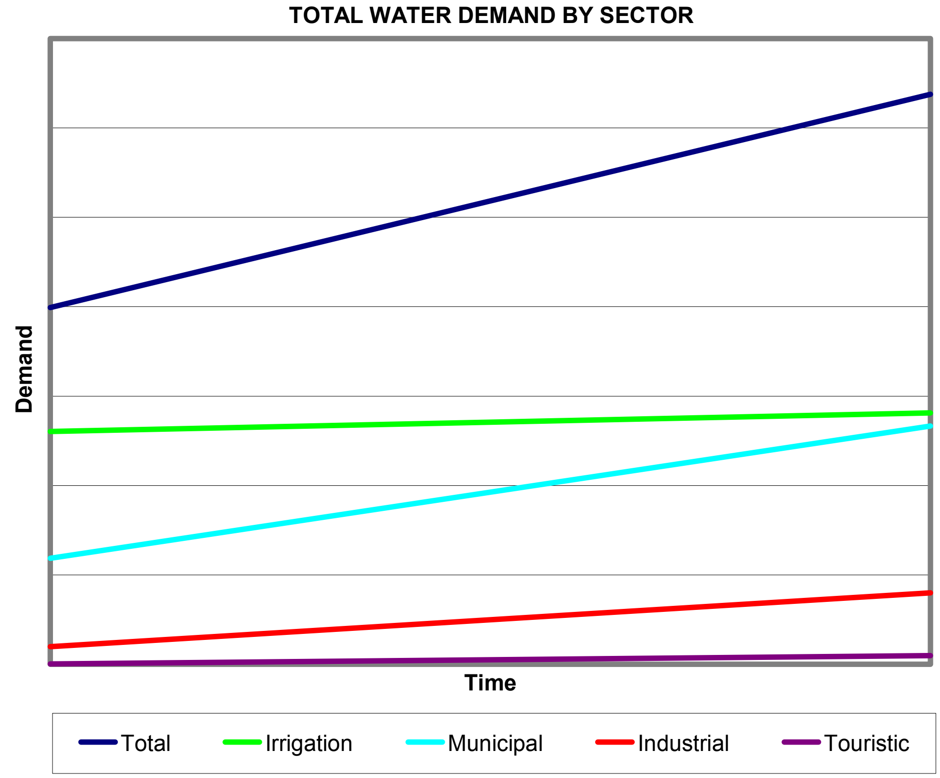


Figure V-5. Schematic Projected Water Demand by Sector



SECTION VI:
RECONCILIATION OF
WATER SUPPLY AND DEMAND

SECTION VI: RECONCILIATION OF WATER SUPPLY AND DEMAND

A. THE POTENTIAL GAP BETWEEN ESTIMATED SUPPLY AND DEMAND

The available water resources of the country have been presented in Section IV, together with estimates of the “safe yield” of the aquifers. Demands, present and projected, as well as potentials for reducing demand, were presented in Section V. It is obvious that the available water resources per capita per year of about 170 to 190 m^3 are among the lowest in the world, and with the present population growth rate these are expected to fall even further, possibly below 100 m^3/capita/year by 2020.

Already there is a substantial deficit between the available resources and demand, estimated at 300 MCM/yr, which would be 430 MCM/yr if the overdraft from the highland aquifers were considered. This deficit is about 45 percent of the total water resources available.

Projections of the quantities of the future available supply differ due to the amount of investment that would be required for mobilizing additional resources and considering varying interpretations and political conditions and agreements with neighboring countries. In addition estimates of the demand differ mainly due to the population forecast that is projected. There are, however, important potentials for reductions of demand for fresh water (water from streams and fresh water aquifers), especially with regard to irrigation in the highlands. Also, the projected rates of increase of demand by industry may be reduced depending on future initiatives.

Concern regarding the growing gap between availability of supply and demand for water enters into all of the evaluations. This concern is heightened due to the lack of realistic, moderately expensive solutions that would reconcile this gap between relatively unfettered growth of demand and anticipated supply.

Tables VI-1 and VI-2 and Figure VI-1 present projections of the supply and demand, for five-year time increments, on the basis of information provided by MWI as included in the World Bank report of 1997 and by JICA in 2001, respectively. The JICA projections were made with the assumption that the demand would be fully controlled through the proposed Water Resources Management Plan and that the water supply would be augmented by a number of water development projects as recommended in its Water Development Plan. Under these circumstances, JICA succeeded in closing the gap by 2020. But for this to be accomplished, massive investment would be required, along with implementation of an effective program of water demand management and control. Both preconditions will require great care, efficiency, and resolve and considerable political will to be accomplished.

B. SCENARIO TO CLOSE GAP

According to the projection as per Table VI-1, the deficit will still be on the order of 238 MCM/yr by 2005, while the deficit (Table VI-2) will grow to the alarming level of 850 by 2020 if the Water Resources Management Plan (WRMP) proposed by JICA, Scenario 1, is not implemented.

The Government of Jordan has implemented several smaller projects. Several major schemes have been planned and are scheduled to start within the next few years.

Table VI-1. Summary of Demand and Supply Projections* (MCM/yr)

	Sector	**2000**	**2005**	**2010**	**2015**	**2020**
Supply	M&I	343	455	525	548	587
	Agriculture	617	714	681	677	663
	Total	960	1169	1206	1225	1250
Demand	M&I	466	507	557	650	758
	Agriculture	791	900	900	900	900
	Total	1257	1407	1457	1550	1658
Deficit	**M&I**	**123**	**52**	**32**	**102**	**171**
	Agriculture	**174**	**86**	**219**	**223**	**237**
	Total	**297**	**238**	**251**	**325**	**408**

* With few policy constraints
Source: World Bank report, 1997 (based on data of MWI)

Table VI-2. Summary of Demand[1] and Supply[2]
(Projections under Scenario 1[3] following plans proposed by JICA, 2001) (MCM/yr)

	With Scenario 1, JICA WRMP				**Totals (2020) without JICA Development and Management Plans**
	SECTOR	**2005**	**2010**	**2020**	
Supply	M&I				
	Agriculture				
	Total	**1,054**	**1,185**	**1,289**	**890**
Demand	M&I	**356**	**473**	**648**	**777**
	Agriculture	**694**	**703**	**641**	**963**
	Total	**1,050**	**1,176**	**1,289**	**1740**
Deficit	**M&I**				
	Agriculture				
	Total	**(+4)**	**(+9)**	**0**	**(-850)**

[1] Assuming that the Water Resources Management Plan proposed by JICA is implemented
[2] Assuming that the Water Resources Development Plan proposed by JICA is implemented
[3] Applies to demand projections; basic scenario established by World Bank and MWI.

It is clear that the Government of Jordan needs to follow a policy that addresses three fundamental considerations. The first would be to manage demand and conserve water to the highest possible level. The second would be to develop available water resources and mobilize them to their maximum sustainable production. The third would be to clearly define "sustainable," along with all of its implications, with regard to surface water and the groundwater resources. It will require a considerable effort from all concerned — users, technocrats, politicians, and diplomats — to succeed in balancing the demand with the supply in such a way that no resource is lost in the process.

A policy of maximizing water availability has been pursued. The constraints to this policy with regard to surface water resources have been the great costs involved and the difficulties in developing regional water resources shared with other countries. These constraints will continue into the future, adding to the concern about the availability of supply to be developed in phase with the growing demand.

Gross overexploitation of the groundwater resources is the major constraint to further development of groundwater from rechargeable aquifers. Intensive reservoir and groundwater developments in the Golan Province of Syria is another important growing constraint to future availability of surface water.

C. PROJECTED WATER AVAILABILITY

Projected available water supply from all sources is shown in Table VI-3 and Figure VI-1 over five-year time increments. The supply is differentiated between renewable supply and supply that is made available by overdraft of the groundwater and by the gradual tapping of the nonrenewable "fossil" groundwater.

Table VI-3. Projected Water Supply Sources and Quantities (World Bank, 1997) (MCM/yr)

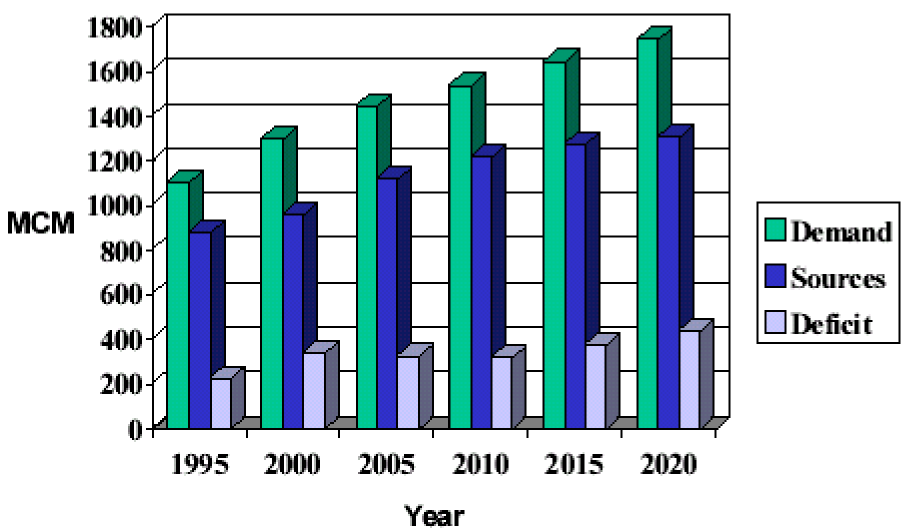
Source	2000		2005		2010		2015		2020	
	R[1]	O/F[2]	R[1]	O/F[2]	R[1]	O/F[2]	R[1]	O/F[2]	R[1]	O/F[2]
Groundwater	277	130	277	58	277	48	277	28	277	8
Surface water	220		270		270		270		270	
Wastewater reuse	87		114		141		170		200	
Yarmouk River	155		235		235		235		235	
Lower Jordan side wadis	0		30		30		30		30	
Peace Treaty (50 MCM)	30		50		50		50		50	
Disi Groundwater	0	61	0	130	0	140	0	140	0	140
Brackish Groundwater	0		5		15		25		40	
Total	**769**	**191**	**981**	**188**	**1018**	**188**	**1057**	**168**	**1102**	**148**
Total supply	**960**		**1169**		**1206**		**1225**		**1250**	

[1] Renewable water resources.
[2] Overdraft or fossil water resources.

The World Bank (1997) estimated that annual renewable water supply would increase from 769 MCM in 2000 to 1,102 MCM by 2020. The increase would be due mainly to the development of the surface water resources of the Yarmouk River through the Unity Dam, the gradual increase of wastewater (reclaimed water) reuse, and the desalination of brackish water. A small increase was expected to be accomplished through the full implementation of the Peace Treaty agreement, hopefully reaching the stipulated 50 MCM from Israel. The renewable groundwater supply was expected to remain steady at the safe yield limit of 277. About one-third of the new supply would depend on Israel honoring the Treaty agreement and on Syria restraining upstream use in its catchment of the Yarmouk River. Of equal importance to the future renewable supplies would be the gradual buildup of reclaimed water reuse that makes up the other one-third of the additional supplies. The remaining quantity would be made up by further surface water resources development and the increasing desalination of brackish waters.

Quantities of supply from overdraft and fossil water (O/F) should decrease from 191 MCM in 2000 to 148 MCM by 2020. The current annual overdraft of groundwater was projected to be gradually phased out from about 130 MCM to 8 MCM by 2020, as additional resources would be made available.

Figure VI-1. Total Demand, Available Sources, and Deficit in MCM/yr (after MWI "Water Sector Planning and Associated Investment Program 2002–2011")



This reduction of groundwater overdraft would require effective groundwater monitoring, pricing, and regulation. The continued availability of the renewable groundwater quantities greatly depends on the success of this activity.

The remaining supply would be derived from the Disi Aquifer, which could increase from a current pumpage rate of 61 MCM to an assumed steady supply of 140 MCM that would continue for 40 to 50 years.

D. PROJECTED WATER DEMAND

The projected water demand by sector is shown in Table VI–4 on the basis of MWI projections and as quoted in the World Bank's report of 1997.

Table VI-4. Projected "Unrestricted" Water Demand by Sector and Sources of Supply (MCM/yr)

Source	2000		2005		2010		2015		2020	
	M&I	**Agr.**	M&I	**Agr.**	M&I	**Agr.**	M&I	**Agr.**	M&I	**Agr.**
Groundwater	223	184	190	145	190	135	190	115	190	95
Surface water	30	190	50	220	50	220	50	220	50	220
Wastewater reuse[1]	2	85		114	10	131	13	157	27	173
Yarmouk River	41	114	65	170	90	145	90	145	90	145
Lower Jordan				30		30		30		30
Peace Treaty (50 MCM)	30		50		50		50		50	
Disi Groundwater	17	44	95	35	120	20	130	10	140	
Brackish Groundwater	0		5		15		25		40	
Total	**343**	**617**	**455**	**714**	**525**	**681**	**548**	**677**	**587**	**663**
Demand Met	**960**		**1169**		**1206**		**1225**		**1250**	
Deficit	**123**	**174**	**52**	**186**	**32**	**219**	**102**	**223**	**171**	**237**
Total Demand	**1257**		**1407**		**1457**		**1550**		**1658**	

M&I = municipal and industrial consumption; Agr. = irrigated agriculture.
[1] Wastewater reuse under M&I refers to industry. Source: World Bank Report, 1997 after MWI projections.

The assumed parameters for this evaluation are shown in Table VI-5. The population growth has been assumed to decline in time from a high 3.4 percent in 2000 to 2.5 percent by 2020. This is based on the general trend in a society with an improving standard of living and assumes political stability in the region. This would result in a population of 9.1 million by 2020, a serious increase from the 5.1 million of 2000. The quantity of water dedicated to municipal use would nearly double, 343 MCM in the year 2000 rising to 663 MCM in 2020. The other parameter affecting this estimation would be the gradual increase in the consumption rate per capita per day, which, for planning purposes, was allowed to increase from the current rate of 135 lcd to 155 lcd by 2020. Finally, the quantity dedicated to irrigated agriculture was assumed to rise 15 percent between the year 2000 and 2005 and then decrease some 8 percent between 2005 and 2020. Irrigated land would increase at first from a current 54,500 hectares to 59,500 by 2005, and then drop gradually to 56,000 hectares by 2020.

Even this relatively moderate increase of irrigated area and water use is questioned in view of the scarcity of water, the competition for water among the various sectors, the buildup of industry, and the small contribution of agriculture to the national gross domestic product (GNP).

The annual municipal and industrial (M&I) demand would increase from 343 MCM in 2000 to 587 MCM by 2020 and, although the deficit at first would drop to a low 32 MCM (less than the 64 MCM increase assumed for agriculture) in 2010, from there on it would increase rapidly to a deficit of 171 MCM by 2020. During this 20-year time horizon there would be a major shift from use of renewable groundwater resources to a greater dependence on "fossil" and desalinated brackish groundwater. Use of renewable groundwater for irrigated agriculture would decrease by 50 percent from 184 MCM in 2000 to 95 MCM in 2020. Use of Disi "fossil" water would rise from 17 MCM to 140 MCM over the 20-year period.

The high unaccounted-for water (UFW) loss of about 55 percent needs to be reduced if the quoted per capita per day rates are to be met. Continuing rehabilitation of old distribution systems and domestic plumbing fixtures should contribute to satisfaction of the rising urban demand and to improvement of the financial viability of water supply services.

Some one-third of the source of supply for irrigation should shift from renewable and fossil groundwater to surface water, from Unity Dam, and to increased availability of reclaimed water. However, the deficit in irrigation demand would remain high, increasing from 174 MCM in 2000 to 237 MCM in 2020, mainly due to the limited water resources and the competing demand by other sectors. Irrigation accounts for some 65 percent of all of the water used currently and, even though there would be a modest demand increase, projected share for agriculture would decrease to just over 50 percent of total water supply by 2020.

Table VI-5. Assumed Future Conditions for Demand Estimation

Indices	2000	2005	2010	2015	2020
Population growth rate (%)	3.4	3.1	2.9	2.7	2.5
Total population (millions)	5.1	6.0	7.0	8.1	9.3
M&I consumed (lcd)	135	140	145	150	155
Irrigated (ha '000)	54.5	59.5	57.8	55.0	56.0

Source: World Bank Report, 1997 after MWI projections.

The current average irrigation efficiency was estimated at 55 percent (World Bank report, 1997), which is quite low for a water-scarce country. It also was noted that in the indices used for projecting irrigation demand, no further improvement in irrigation efficiency has been envisaged. Since reducing the existing area of irrigation likely would be difficult, efforts should be made to improve irrigation efficiency, conserve much-needed water resources, and curb deficits in the demand for agricultural water.

E. Immediate Actions Needed to Achieve Reconciliation of Water Supply and Demand

Irrigation accounts for the greatest part of all water used. The expressed policy of the government is to contain the increasing demand for irrigation and control further expansion of irrigation areas. Already, the conveyance and distribution efficiency is quite high (60 to 90 percent). The same cannot be said about on-farm irrigation efficiencies. The reported countrywide irrigation efficiency of 55 percent could be improved dramatically resulting in significant savings of water. A new by-law scheduled to be implemented in January 2003 calls for charges on groundwater utilization for irrigation that should encourage efficiency and promote changes in cropping patterns. Thus, the water demand for agriculture should be controlled through:

- Limitations on expansion of irrigated areas (possibly limited to areas that will receive reclaimed water or spill water from new dams).
- Adjustment of prices for irrigation water that would reflect its cost to produce.
- Implementation of the new by-law for charging for groundwater used for agriculture.
- Establishment of Groundwater Study, Monitoring and Enforcement Units.
- Incentives for employing efficient irrigation systems.
- Extension services for providing farmers with plans/drawings and assisting with installation of improved irrigation systems.
- Change of cropping patterns to less-water-consuming crops and introduction of crops that could be planted earlier in the wet season and thus require a shorter irrigation season.
- Water demand management.
- Replacement of drinking-quality water used in irrigation with reclaimed water, where possible, both in the Jordan Valley and on the highlands.

The **Municipal** demand for water is expanding rapidly, as shown in Table VI-4, from some 343 MCM in 2000 to an estimated 587 MCM by 2020. The UFW is reported to be about 55 percent, although higher figures are often reported. Already the existing infrastructure and available developed supplies cannot meet the demand in most urban areas.

Given that the government has an expressed policy towards giving priority to domestic use, plans and investment should be made for adequately meeting this growing demand on an as-needed basis. Of equal importance to the development of new sources, the following need to be continued or expanded:

- Price adjustment for water consumed to reflect its true cost.
- Reduction of UFW by rehabilitation of old distribution systems and assistance to identify and rectify losses of water within households.
- Continued program to promote public awareness of the need for water conservation.
- Water demand management strategies targeted toward reduction of demand.
- Incentives for use of local water of marginal quality for purposes other than drinking, such as gardening and car washing.

Some 65 MCM per annum of **reclaimed wastewater** is currently being treated and discharged into watercourses or used directly for irrigation. The quantity of available wastewater is increasing proportionally with population growth. In view of the priority given to domestic supply, wastewater should be available at a high level of reliability. Currently, there are problems with the salinity of wastewater due to the low quantities provided for municipal supply and to the evaporation effect from the waste stabilization ponds. This, together with the nonsatisfactory treatment of wastewater by some overloaded plants, impacts the potential for irrigation use and most cropping patterns. Since the quality of treated wastewater is improving even as it is growing in volume, the following will need to be continued, expanded, or undertaken anew:

- Improve the quality of treated effluent.
- Demonstrate across the country, through pilot schemes, the suitability of this water for irrigation of a range of crops.
- Reduce the reliance on existing overexploited sources of fresh water for irrigation and for industry .
- Change cropping patterns to those that are suitable for the quality of the reclaimed water, such as fodder crops.
- Plan and construct wastewater treatment facilities in all governorates and incorporate the capability to use reclaimed water in the plans.

F. MAJOR WATER INVESTMENTS TO ACHIEVE RECONCILIATION OF SUPPLY TO DEMAND

In addition to improved irrigation efficiencies, rehabilitation of municipal networks, reduction of unaccounted-for water, and effective reuse of reclaimed water in agriculture, several major water development schemes are being planned to cope with the growing demand. These include:

- Development of the well field tapping the fossil groundwater reserves at Disi–Mudawara and the conveyance system to transfer 100 to 120 MCM/yr of water to the Greater Amman area for M&I use.
- Projects to augment supply on the basis of the Peace Treaty agreement.
- The Southern Ghor Integrated Water Resources Development project, which would yield up to 55 MCM/yr for irrigated agriculture and industrial use.
- Construction of the Wehda (Unity) Dam on the Yarmouk River, projected to provide some 85 MCM/yr mainly for M&I and for irrigation purposes.
- Continuation on the restructuring and rehabilitation of the municipal water networks in Amman, Irbid, and other major cities.
- Desalination of brackish groundwater from deep aquifers for uses other than agriculture.

The future **surface water** development projects are shown in Table VI-6. Twenty-four dams with a total storage capacity of about 203 MCM have already been completed. The surface water thus developed (by 2002) by dams and intakes amounted to 316 MCM. With the new potential projects, some additional 130 MCM/yr are expected to be developed, bringing the total to 446 MCM/yr by 2020. This quantity is about 70 percent of the available surface water if the 30 MCM of saline water of Wadi Mujib is included. Water from Wadi Mujib will be desalinated and counted with the brackish water resources, as discussed later. The surface water development listed in Table VI-6 is deemed as the maximum limit for safe development under prevailing climatic conditions and for other economic reasons.

Table VI-6. Planned Surface Water Development Projects (after JICA 2001)

Project Name	Completion Year	Quantity to be Development (MCM/yr)	Remarks
Mujib Dam	2003	12	In progress
Feedan Dam	2004	3	
Al Wehda Dam	2005	93	Financing Available
Small dams (Ibn Hamad, Karak, Meddien)	2008	7	
Water Harvesting, Badia Region	2011 – 2020	15	
Total Incremental Water to Be Developed		**130**	
Already Developed		**316**	
Total Surface Water by 2020		**446**	

The location of the main existing and planned dams is shown on Figure IV-2 in Section IV.

The **Peace Water** taken from the headworks at Lake Tiberias and conveyed to King Abdullah Canal is currently 33 MCM/yr. Part of this is in lieu of desalinated water, which has been delayed in being supplied by Israel to Jordan. About 30 MCM/yr of surface water is scheduled to be developed by constructing small dams along the Jordan River and on side wadis and is to be conveyed to Jordan.

Table VI-7 shows the development projects for the **fossil fresh groundwater** and Figure VI-2 shows the general location of the fossil groundwater aquifers. The major fossil water aquifer is the Ram Group Aquifer, exploited mainly at Disi-Mudawara Basin since the aquifer there is at shallower depth. The estimates concerning the available reserves vary, but it is reported that an annual abstraction of about 155 to 225 MCM could be sustained for 40 to 100 years. The "Disi Amman Conveyor" consists of the fossil fresh water development and its conveyance from Disi to Amman. Any new wells or well fields should be so located and configured to create a northwesterly groundwater gradient along the Jordan–Saudi Arabia border.

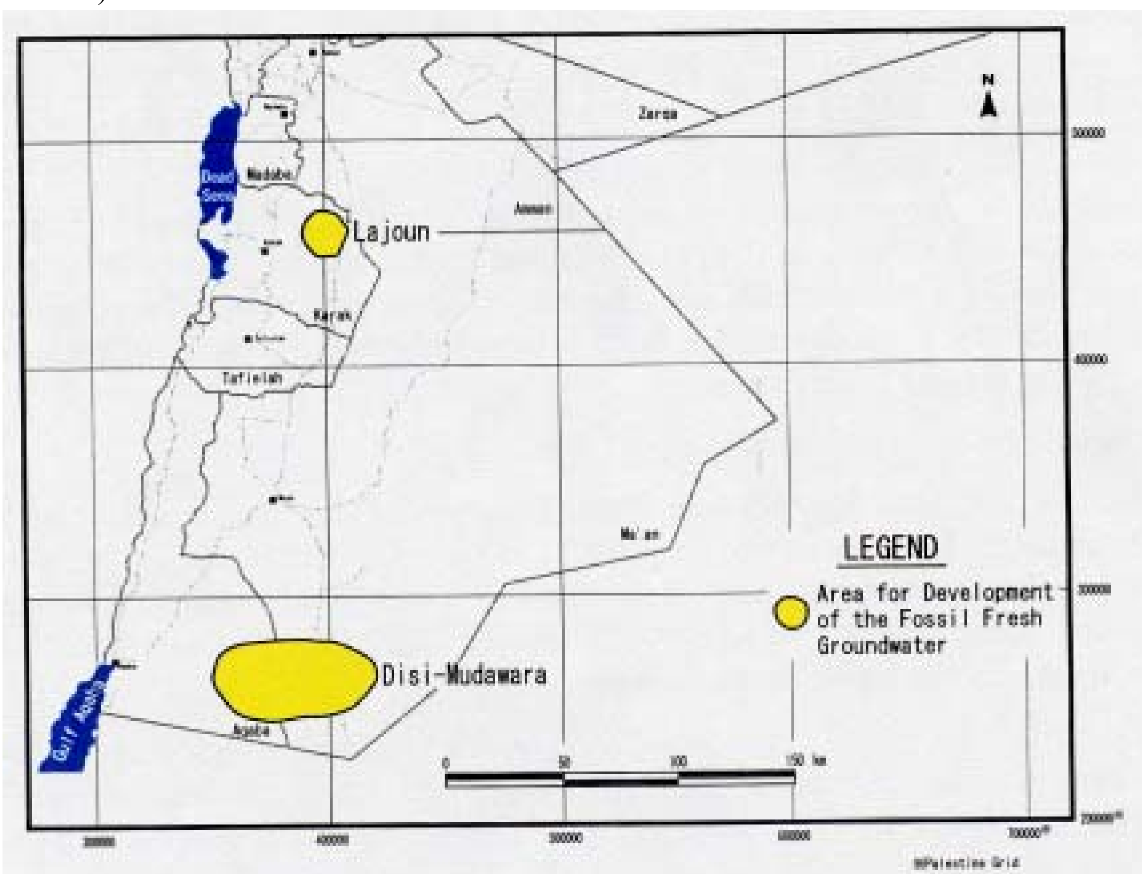
Another fossil water development project that is currently under development is at the Lajoun area in the Karak Governorate, where 10 MCM/yr is to be developed and conveyed to Amman.

Table VI-7. Fossil Fresh Groundwater Development Projects

Fossil Aquifer	Quantity (MCM/y)	Developed by	Remarks
Lajoun	(11)	2000 – 2005	Quantity not verified yet
Disi	65 27 38	1998 2006 – 2010 2020	Disi Amman Conveyor, 130 MCM/y 2006 - 2020
Total	**130**	**2020**	

Source: JICA 2001

Figure VI-2. Location of Fossil Fresh Groundwater Development Projects
(after JICA)



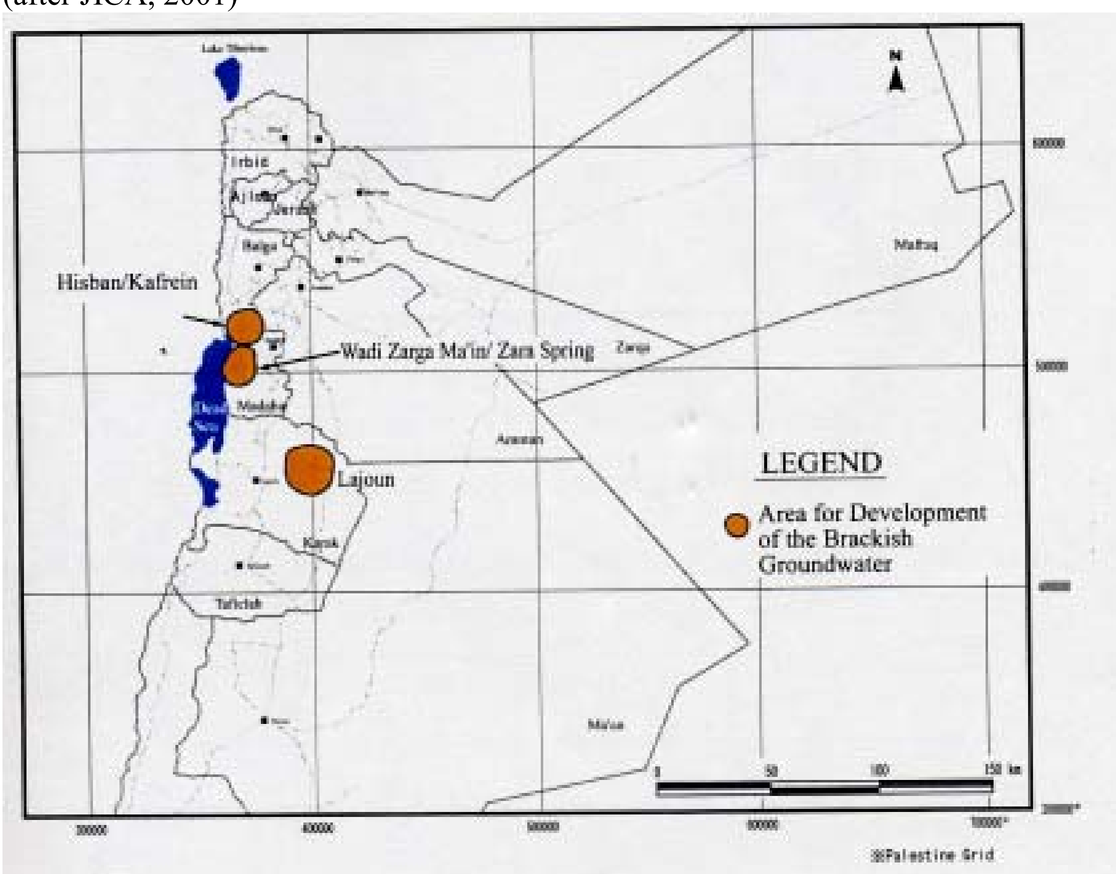
Brackish groundwater, including brackish spring water, with salinity ranging from 1,000 to 10,000 ppm in TDS, has not been fully studied or exploited. The Mujib-Zara and Zarqa Ma'in are incorporated in the "Saline Water Treatment, Conveyance to Amman" project, which is currently under study by USAID. A list of the brackish groundwater development projects is shown in Table VI-8, and their locations are shown on Figure VI-3. A total of 20 MCM/yr are envisaged to be developed by 2005, 53 MCM by 2010, and 85 MCM by 2020.

Table VI-8. Brackish Groundwater Development Projects (after JICA, 2001)

Location	Quantity (MCM/y)	Developed by	Remarks
Karak	13 23	2006–2010 2011–2020	By JICA, M&I
Balqa	20 20 9	2005 2006–2010 2011–2020	- Wadi Zarqa Ma'in/Zara - - springs, plus 23 MCM of Wadi Mujib (USAID) - Hisban/Kafrein for Amman
Total	**85**	**2020**	

A total of 19 **wastewater treatment plants** were in operation by 2001, treating some 218,000 m^3/d or 80 MCM/yr, and are shown in Table IV-4 and on Figure IV-1 of Section IV. The As Samra Treatment Plant, serving the Greater Amman area, passes some three-quarters of the total flow.

Figure VI-3. Location of Brackish Groundwater Development Projects
(after JICA, 2001)



As has already been discussed, quality problems make reuse of reclaimed water challenging. The use of reclaimed water for irrigation without dilution with fresh water has not been widely accepted. The quantity currently used is about 50 MCM per year, or approximately 8 percent of available irrigation supply. Fifteen MCM are used for restricted irrigation and the remainder, 35 MCM, for unrestricted irrigation in the Jordan Valley after blending with fresh water.

Three scenarios of water demand were developed (JICA, 2001) on the basis of varying rates of population growth and various levels of per capita consumption. The associated future availability of treated wastewater was estimated to increase from 64 MCM/yr in 2000 to 170 MCM by 2010, and to about 250 MCM by 2020.

The increase of demand for municipal water in the metropolitan and other densely populated areas will require **intergovernorate water transfers** and extensive pipelines to transport developed water resources to areas of higher demand. The current interbasin transfer network is limited mainly to the King Abdullah Canal and to the transfer of water from the Balqa Governorate to Amman through the high lift pumping system. Additional transfer lines, as shown in Figure VI -4, will need to be constructed to enable the supply of water to meet the growing demand. Figure VI–4 also shows the main components of the Water Resources Management Plan. Figure VI-5 shows the locations of the most important components for water resources development as outlined in the Water Resources Management Plan by JICA in 2001.

The development of a **National Water Transfer Plan and System,** as discussed above, will facilitate the conveyance of water from developed sources to areas of high demand and will allow optimal allocation and distribution of the scarce water supplies. It also will facilitate the tapping of a variety of sources according to their capacity and enable proper planning for the distribution of water to meet distant demands. The same system could be used to operate the fossil groundwater reserves as needed on the occasion of droughts and/or during the transition period of developing other resources.

The potential role of the fossil water reservoirs as a strategic reserve needs to be investigated, possibly as an early project of the proposed Central Planning Unit of MWI.

The Strategic Objective 2 evaluation team recommends that as each component of a national pipeline system is developed, the pipelines should be made capable of conveying water in either direction. This pipeline system will also facilitate the wheeling of future supplies, such as that derived from a Red–Dead Sea project.

The conclusion reached by the World Bank mission in 1997 and by JICA in 2001 was that there are very limited other resources available for development. The desalination of brackish water needs to be tested by a pilot project. Possible supplies from deep aquifers need to be investigated and the Red Sea–Dead Sea link and desalination need to be studied for technical, economic, social, environmental and political soundness. Apart from desalination and the Red-Dead project, there are very limited future options to expand supply capacity. However, the possibilities for transfers of water from countries to the north should be reevaluated periodically.

Future demand will need to be constrained through demand management and reforms in sector administration concurrently with any augmentation of supplies and optimization of the use of existing supplies. This is illustrated schematically on Figures V-3 and V-4 of Section V.

Figure VI-4. Locations of the Main Projects for the Management of Water Resources (after JICA, 2001)

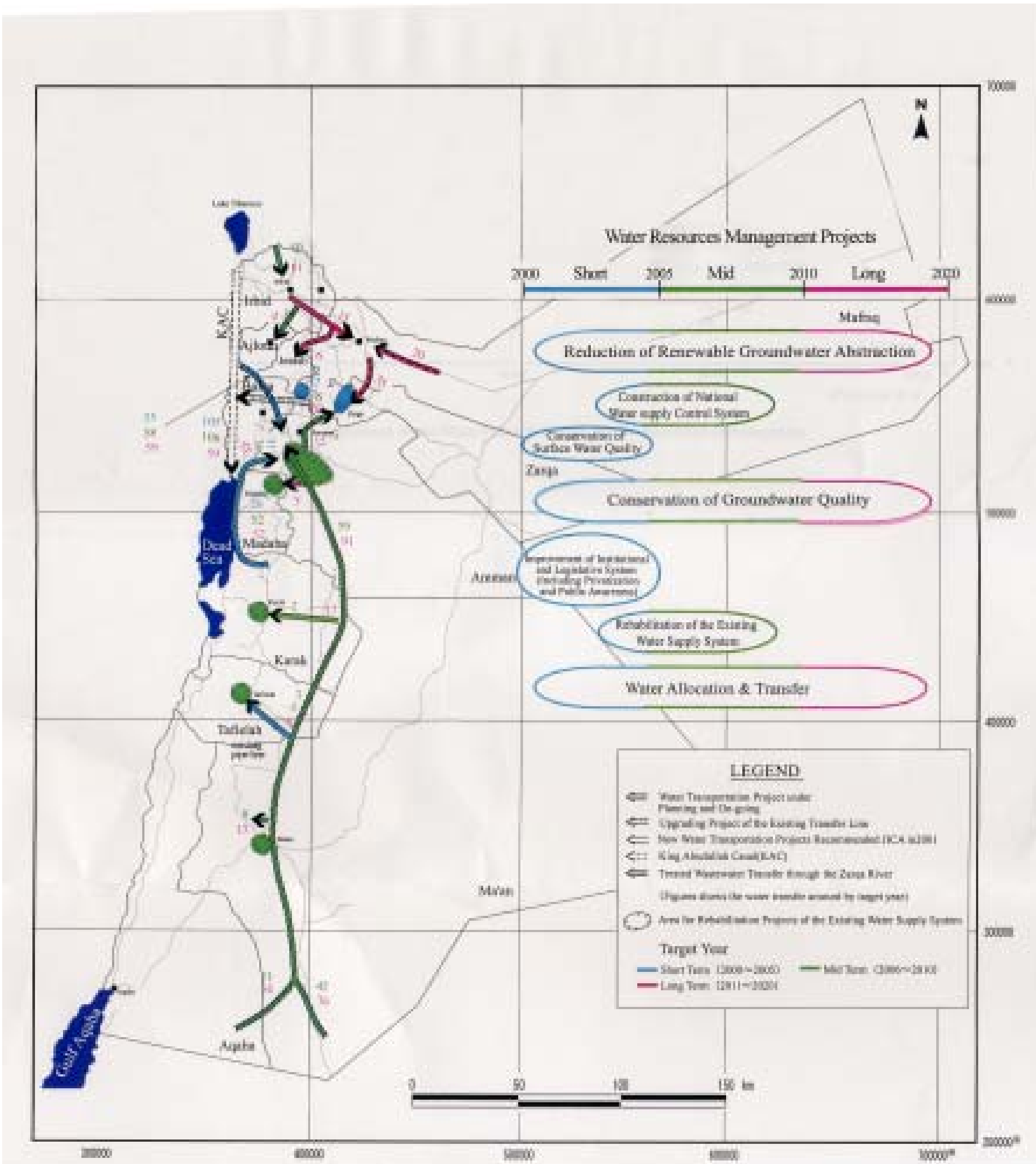
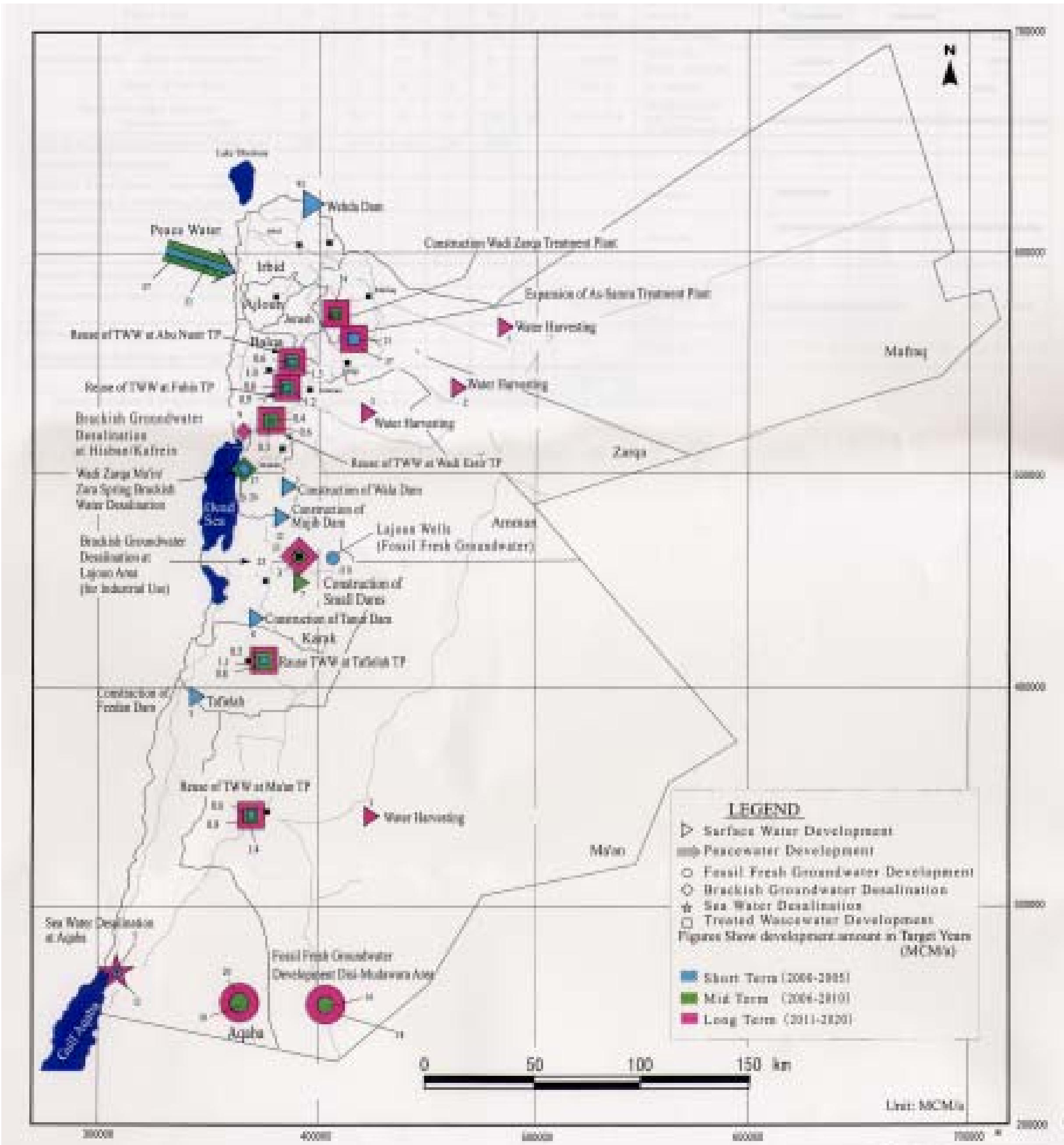


Figure VI-5. Locations of the Main Projects for Water Resources Development (after JICA, 2001)



SECTION VII:
EVALUATION OF
STRATEGIC OBJECTIVE 2

SECTION VII: EVALUATION OF SO2

This section of the report presents responses to the three sets of specific questions posed by USAID in its Statement of Work for the evaluation team.

A. USAID ACTIVITIES SINCE 1995 IN VIEW OF CURRENT SITUATION

1. Is the current SO2 still needed?

The assessment team recommends that the wording of the current Strategic Objective 2: "Improved Water Resources Management" be amended to "Improved Water Sector Management for Resource Sustainability."

The current SO2 seeks to improve water sector institutions and to increase conservation through the construction and improvement of water and wastewater infrastructure. Initiatives have focused on several areas where there is potential to conserve and make available large volumes of water at attractive unit costs, even as environmental objectives are achieved. The addition of sustainability will not impede the important ongoing program based on a conservation objective. Emphasis on sustainability will serve to conserve fresh river and groundwater resources

The suggested modification of emphasis of discussion under the Strategic Objective should emphasize technical and financial sustainability of the water sector.

2. What is the greatest challenge facing this sector in the next five years?

There is a trio of challenges facing this sector during the next five years:

- Development and conservation of adequate additional water resources,
- Preservation and conservation of existing surface water and groundwater resources, and
- Financial sustainability of the water sector.

3. Is there a need to alter the general focus for FY 2004–2009? How?

USAID needs to assist MWI with its approach to the allocation of water. Planning and water allocation are critical components to achieving sustainability.

The general focus has been good and the assessment team suggests more emphasis on allocation through establishment of strong institutional monitoring, planning, and enforcement capacity for FY 2004–2009.

Section III of this report details team recommendations.

4. Are there gaps in the water sector in Jordan to be considered in SO2?

There are inequities within the water sector due to the fact that it is physically and financially impossible to address deficiencies of water supply and wastewater equally across the country. USAID has, rightly in our view, provided large grants to catalyze programs that could not be and would not have been undertaken were USAID resources partitioned to achieve equity in all parts of the country. Large volumes of water are being used and misused in concentrated population centers and on lands favorable for irrigation. SO2 has focused on these areas. It represents the best return on investment and it has the greatest favorable impact on water use and availability.

In its Action Plan, MWI has assigned priorities that provide a sanctioned agenda for addressing inequities or gaps. The effects of any perceived gaps can be dealt with and partially alleviated through greater coordination among USAID and other donors and through the joint development of a needs assessment. The evaluation team has looked at the companion programs of other donors in trying to identify possible considerations for the continuing SO2 program

For example: The USAID activity for the Greater Amman Wastewater Services (2003–2006) is complemented by the GTZ Sewage Pipeline Amman–As Samara (2001–2006) and the Water Supply Greater Amman II (2001–2006). Similarly, the USAID Zara Ma'in Water System Project (2000–2005) is complemented by the JICA project, Upgrading Ma'in Wastewater Treatment Plant (2003-2004). Timelines at the end of this section demonstrate the sequence over time of various ongoing and future activities of the various donors (USAID, GTZ/KfW, JICA), including the Deloitte Institutional Improvement Action Plan.

A donor coordination committee currently is operating in country. Although only two meetings have been conducted, the effective coordination of challenges, issues, and project activities appears to be working. A needs assessment and/or a parallel donor activity schedule should be developed since USAID is focusing on larger projects (e.g., As Samra wastewater treatment plant). USAID may want to initiate more frequent contacts to ensure that critical inadequacies in the parallel programs are not creating gaps.

The needs assessment is important because not everyone has the same level of water and wastewater treatment. For example, several communities, such as the Al-Alamiah Second Residential Phase in Aqaba, reportedly have an inadequate wastewater collection system, while Aqaba's Third and Fifth Residential Phase reportedly requires rehabilitation of its wastewater collection system. In addition, several of the United Nations Relief and Works Agency (UNRWA), government, and unauthorized refugee camps, including Baqa'a, Souf, Jerash, Talbieh, Souchna (northeast of Amman), and Shilalah, as well as the Old City of Aqaba, reportedly require water and wastewater infrastructure.

5. Is there a need to expand or narrow the focus of SO2? Why?

Yes, there is a need to expand the focus of SO2 from one of conservation to both conservation and the sustaining of the basic "fresh" water resources of the Yarmouk River and the rechargeable fresh water aquifers.

6. Are the DAI study recommendations appropriate?

There is a lack of other options in terms of wastewater treatment. The DAI program was general and spoke of initiatives in terms of readily accepted needs but with no specificity. The report primarily states the pros and cons of waste stabilization ponds and activated sludge systems.

Low-cost, low-tech wastewater treatment was not discussed. Recommendations and priorities were made, but the basis to support the recommendations was not clear. DAI's assessment in the section on priority of projects, as discussed in the JICA report on Water Resources Management, was useful for comparison of selection criteria to those suggested in this evaluation report.

7. Is there a more appropriate mix of recommendations?

The evaluation team recommends that SO2 needs more emphasis under IR 2.1, Stronger Water Sector Institutions, in the areas of Planning, Surface and Groundwater Monitoring, Surface Water Resources and Demand Evaluations, and Financial Infrastructure Strengthening. See paragraph D of Section III of this report for our recommendations regarding the objective and thrust of the institutional program for MWI. The objective is to transform WAJ and JVA, along with the new units to be formed, into an autonomous utility for wholesale water supply to Town and Village Water Boards. These organizational units, utility, and boards would distribute water to end-users and be responsible for their own finances, operations and maintenance, capital costs and replacements, and staffing (see Section III, D).

A much-scaled-down MWI would formulate and administer national water policy, finance and construct large infrastructure water projects (such as a countrywide conveyance system and the Red-Dead desalination project, preferably for turnover to the utility for operation and maintenance under its budget), allocate water, regulate the utility and local distribution entities, and contract for planning and project formulation for major infrastructure projects (see Box III-3, Section III).

8. What is a possible USAID follow-on water sector assistance strategy (plan) under different funding scenarios?

Possible USAID interventions (2003–2008) are discussed in Section VIII under different funding scenarios:

- Low funding — USAID should focus on institutional support to achieve sustainability of water resource.
- Higher funding —USAID interventions should be screened based on selection criteria elaborated under the Part C, Question 2 to guide project selection.

Funding levels are suggested for each of the three IRs at varying percentages depending on the level of financial resources available.

B. EVALUATION OF WATER SECTOR AND PRESENT OPTIONS

1. Is each activity contributing significantly to the SO2 objective?

Yes. The team's interviews with ministry and agency officials and project managers and stakeholders indicate that the completed and ongoing projects are realizing maximum quantity (MCM) of developed and saved water at the probable lowest unit cost.

2. Is each activity reaching its targeted population?

Yes. The activities to date are reaching the targeted urban population and rural farmers by virtue of project location. Urban programs are focused on large population centers; there are, however, many other areas in the water and wastewater sector that are not served. These may be addressed in the future by USAID, or USAID may stimulate donors with smaller budgets to work in some of these needy areas. Among the yet-to-be-addressed needs are those of refugee camps, which are not receiving services, and, several communities, such as the Al-Alamiah Second Residential Phase in Aqaba, that reportedly have an inadequate wastewater collection system.

3. Are all the needed areas covered by the activities?

Yes. The USAID program is successfully addressing the large water volume issues. There is a need for, or consideration should be given to, USAID initiatives to address local water management and use of low-cost, low-tech wastewater treatment technology. See Section II, Part E of this report for a description of use of constructed wetlands.

Cash transfer should be considered for continued institutional enhancements, and a Middle East Water Partnership Grants Program should be considered (see Box II-2, Section II).

4. Is there a need for a different mix of activities that will contribute more to the objective?

Yes. Interviews conducted by the evaluation team indicate that activities generated out of the past activities will continue to contribute in a balanced manner to SO2. See above for the team's suggestion on an appropriate mix of projects.

5. Does the approach used for each project/activity present the best available alternative to address the problem in the sector?

Yes. Interviews conducted by the evaluation team with ministry and agency officials and project managers and stakeholders, and review of the performance indicators, indicate that USAID has done an outstanding job in conserving millions of cubic meters (MCM) of water that will increasingly be made available over the next few years as a result of USAID activities. These activities include increased technical efficiency in irrigation (1997), improvements to the Zai water treatment plant, rehabilitation of contaminated springs and wells, restructuring/rehabilitation of the Amman water network to decrease leakage, and increased capacity to treat wastewater to national standards required for reuse as irrigation water.

C. Evaluation of Environment in Which SO2 Operates

1. Are there gaps in overall assistance in this sector? What are they? What more or different could USAID be doing in this area (environment)?

The program is doing very well politically, environmentally, and socially.

From a political perspective, the program has reached not only the higher levels of the Ministry of Water and Irrigation but also the Council of Ministers and the higher council.

From an economic perspective, because the program has been a grant in aid, Jordan has been able to do many things in the water sector that it could not do otherwise for the conservation and development of water. USAID's Cash-Transfer Program (CTP) has been very effective in addressing politically sensitive issues, such as increase of water tariffs for irrigation. In one year, USAID was able to do this through the CTP as a Condition Precedent (CP), requiring that tariffs be in place prior to disbursement of funding.

From an environmental perspective, the Government of Jordan has completed the National Environmental Strategy (NES) for Jordan and the Jordan Country Study on Biological Diversity (1998). The Legislative Council, in addition to drafting environmental laws, has approved creation of a Ministry of Environment. These laws are now on their way to the Council of Ministers for approval. Once approved, the new legislation will be sent to the King of Jordan for Royal Decree. Once this decision is taken, there will be a gap in institutional capacity of the new Ministry of Environment. USAID should consider, in the future SO2 program under IR2.1, including activities to support capacity building of local staff through technical assistance and training.

2. What is the appropriate balance for USAID programming in institutional and technical support versus infrastructure support?

The evaluation team has recommended a program in Sections III and VIII of this report, including suggestions for an appropriate program of institutional activities in support of IR 2.1. Among the recommendations is that USAID adopt and use criteria for selection of projects under each Intermediate Result. A suggested set of criteria follows:

Threshold Criterion

A threshold or fatal criterion observed in the rankings posits that no major construction project would be considered unless it was included in MWI's August 2002 Action Plan. Further, with the passage of time, the Government of Jordan should amend and add to this list, perhaps at the suggestion of USAID.

Qualitative Criteria

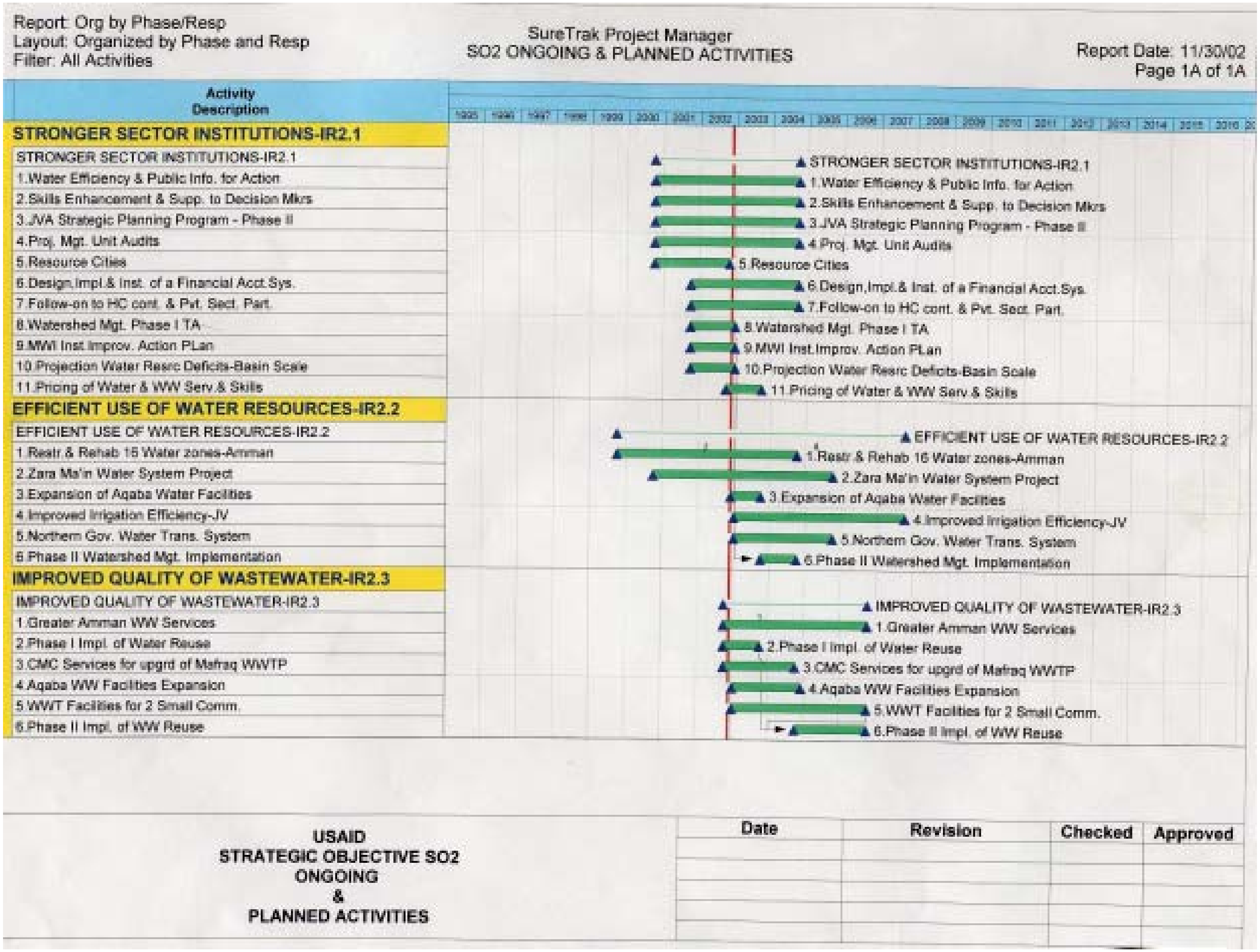
These criteria were used as relative values for a qualitative ranking of a dozen major construction projects for water supply and wastewater reclamation. Those listed have yet to be identified in

USAID's ongoing or anticipated projects. Data for the ranking were drawn in large part from the JICA Summary Report.

- Fund what now is in the pipeline.
- Fund those projects (wastewater treatment plants and water supply) that supply or make available the most MCM/year for the least unit cost and that promote the least adverse environmental impacts and the most favorable enhancements to the environment.
- Fund those activities that have the most favorable impacts on the social and economic welfare of the community.
- Fund those projects that provide equitable access to water and wastewater treatment among the governorates.
- Fund activities consistent with USAID policies. For example desalination facilities should not be funded before other, simpler, less costly projects. This is especially true due to the high capital and operations and maintenance costs and the complexities of operation.
- Select wastewater treatment plant projects that maximize the provision of mixed water/reclaimed water to *existing* farms.

Should support be focused by geographical areas or spread throughout Jordan? (i.e., should SO2 focus on certain cities/villages and complete everything needed for water and wastewater in those places?)

USAID should consider equity, particularly for sustaining irrigation among governorates. USAID also should support small projects for appropriate wastewater treatment in isolated small areas, for example "Constructed Wetlands" (see Box II-1, Section II). Demonstration projects for the use of low-cost, low-tech wastewater treatment should be used as a model to be replicated for other villages and small communities throughout Jordan.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SO2 ONGOING & PLANNED ACTIVITIES
Report Date: 11/30/02
Page 1A of 1A
Activity Description
STRONGER SECTOR INSTITUTIONS-IR2.1
STRONGER SECTOR INSTITUTIONS-IR2.1
1.Water Efficiency & Public Info. for Action
2.Skills Enhancement & Supp. to Decision Mkrs
3.JVA Strategic Planning Program - Phase II
4.Proj. Mgt. Unit Audits
5.Resource Cities
6.Design,Impl.& Inst. of a Financial Acct.Sys.
7.Follow-on to HC cont. & Pvt. Sect. Part.
8.Watershed Mgt. Phase I TA
9.MWI Inst.Improv. Action PLan
10.Projection Water Resrc Deficits-Basin Scale
11.Pricing of Water & WW Serv.& Skills
EFFICIENT USE OF WATER RESOURCES-IR2.2
EFFICIENT USE OF WATER RESOURCES-IR2.2
1.Restr & Rehab 16 Water zones-Amman
2.Zara Ma'in Water System Project
3.Expansion of Aqaba Water Facilities
4.Improved Irrigation Efficiency-JV
5.Northern Gov. Water Trans. System
6.Phase II Watershed Mgt. Implementation
IMPROVED QUALITY OF WASTEWATER-IR2.3
IMPROVED QUALITY OF WASTEWATER-IR2.3
1.Greater Amman WW Services
2.Phase I Impl. of Water Reuse
3.CMC Services for upgrd of Mafraq WWTP
4.Aqaba WW Facilities Expansion
5.WWT Facilities for 2 Small Comm.
6.Phase II Impl. of WW Reuse
USAID
STRATEGIC OBJECTIVE SO2
ONGOING
&
PLANNED ACTIVITIES
Date
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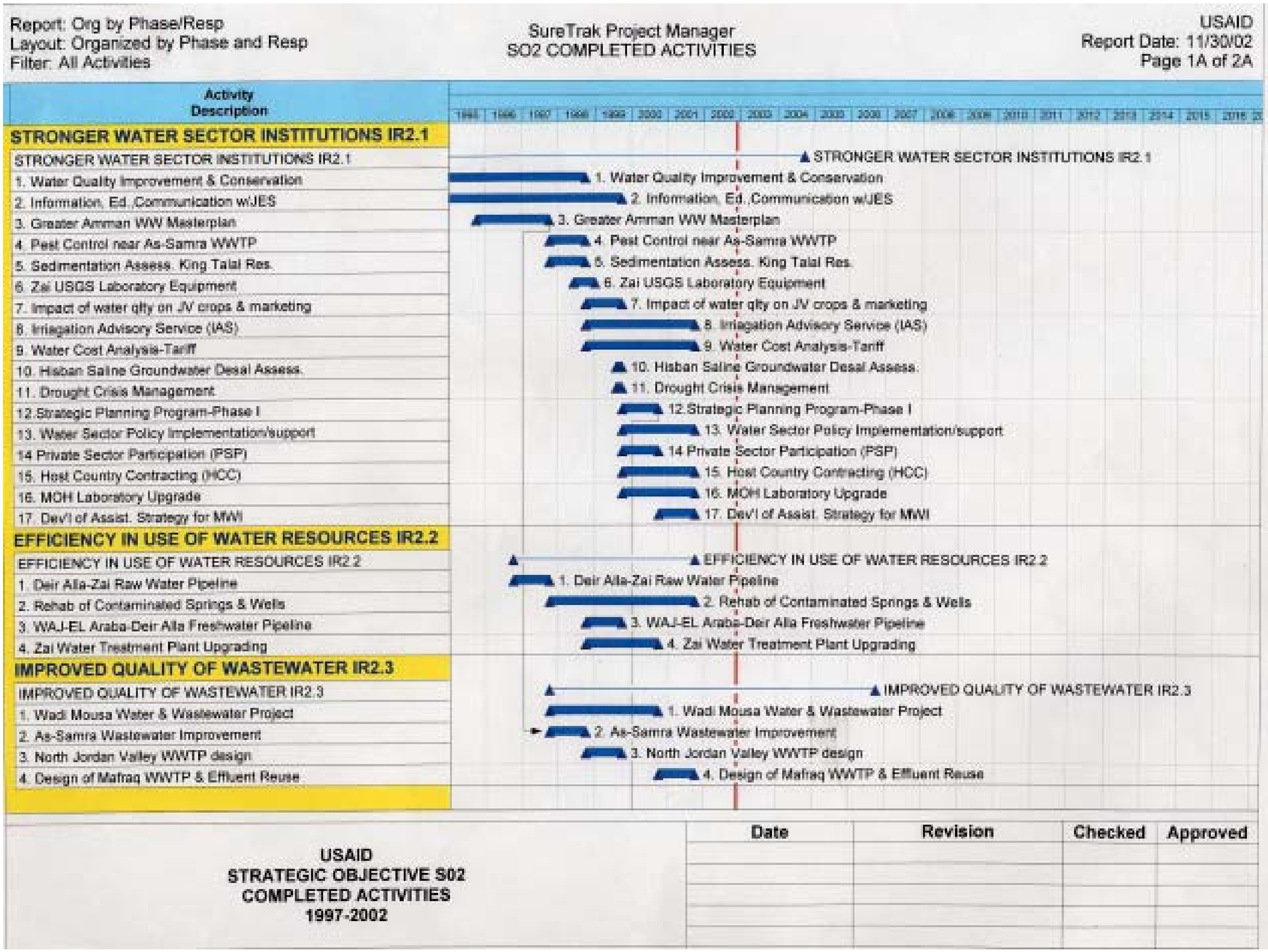
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SO2 COMPLETED ACTIVITIES
USAID
Report Date: 11/30/02
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Activity Description
STRONGER WATER SECTOR INSTITUTIONS IR2.1
STRONGER WATER SECTOR INSTITUTIONS IR2.1
1. Water Quality Improvement & Conservation
2. Information, Ed.,Communication w/JES
3. Greater Amman WW Masterplan
4. Pest Control near As-Samra WWTP
5. Sedimentation Assess. King Talal Res.
6. Zai USGS Laboratory Equipment
7. Impact of water qlty on JV crops & marketing
8. Irriagation Advisory Service (IAS)
9. Water Cost Analysis-Tariff
10. Hisban Saline Groundwater Desal Assess.
11. Drought Crisis Management
12.Strategic Planning Program-Phase I
13. Water Sector Policy Implementation/support
14 Private Sector Participation (PSP)
15. Host Country Contracting (HCC)
16. MOH Laboratory Upgrade
17. Dev'l of Assist. Strategy for MWI
EFFICIENCY IN USE OF WATER RESOURCES IR2.2
EFFICIENCY IN USE OF WATER RESOURCES IR2.2
1. Deir Alla-Zai Raw Water Pipeline
2. Rehab of Contaminated Springs & Wells
3. WAJ-EL Araba-Deir Alla Freshwater Pipeline
4. Zai Water Treatment Plant Upgrading
IMPROVED QUALITY OF WASTEWATER IR2.3
IMPROVED QUALITY OF WASTEWATER IR2.3
1. Wadi Mousa Water & Wastewater Project
2. As-Samra Wastewater Improvement
3. North Jordan Valley WWTP design
4. Design of Mafraq WWTP & Effluent Reuse
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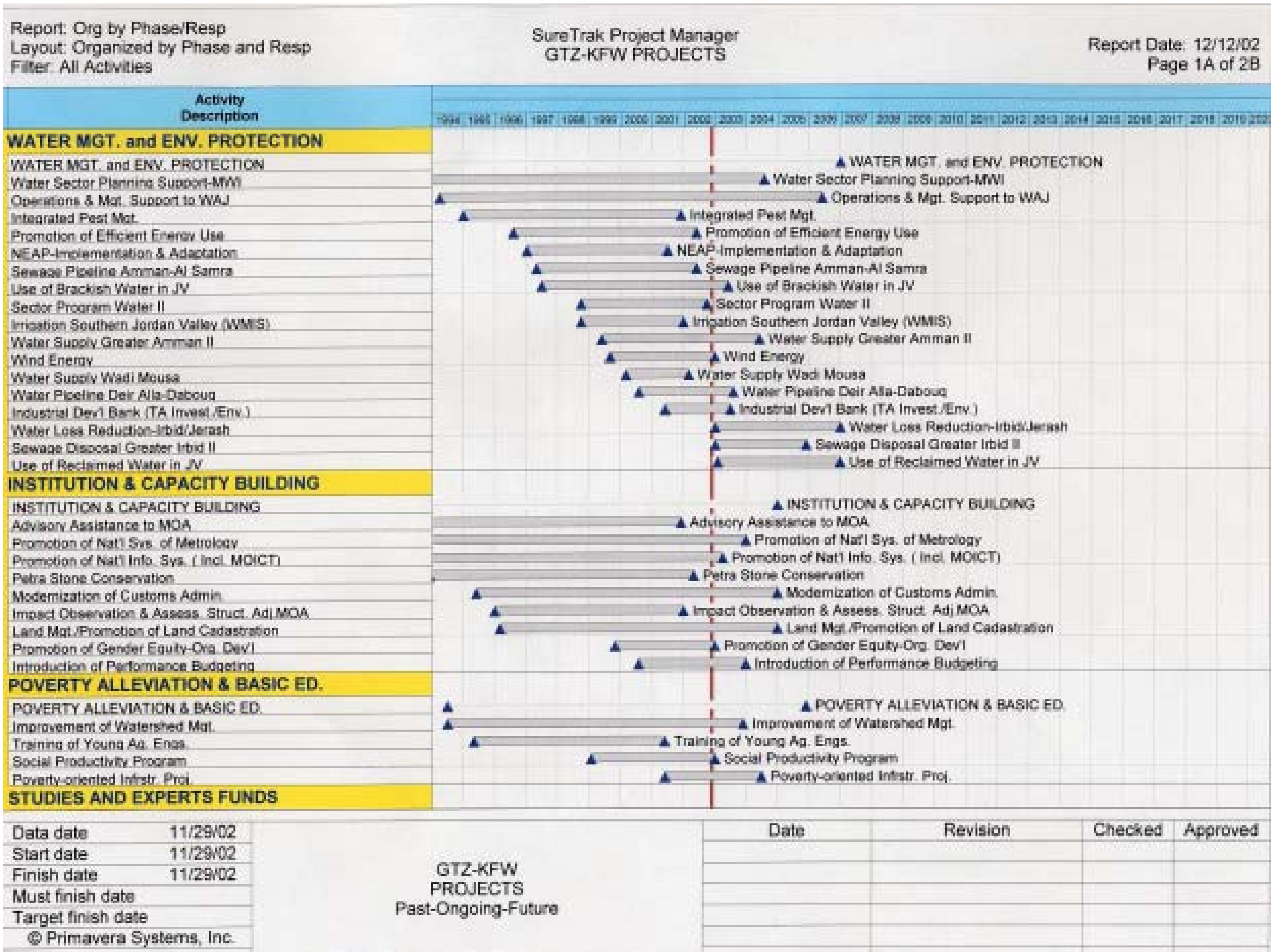
USAID
STRATEGIC OBJECTIVE S02
COMPLETED ACTIVITIES
1997-2002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GTZ-KFW PROJECTS
Report Date: 12/12/02
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Activity Description
WATER MGT. and ENV. PROTECTION
WATER MGT. and ENV. PROTECTION
Water Sector Planning Support-MWI
Operations & Mgt. Support to WAJ
Integrated Pest Mgt.
Promotion of Efficient Energy Use
NEAP-Implementation & Adaptation
Sewage Pipeline Amman-Al Samra
Use of Brackish Water in JV
Sector Program Water II
Irrigation Southern Jordan Valley (WMIS)
Water Supply Greater Amman II
Wind Energy
Water Supply Wadi Mousa
Water Pipeline Deir Alla-Dabouq
Industrial Dev'l Bank (TA Invest./Env.)
Water Loss Reduction-Irbid/Jerash
Sewage Disposal Greater Irbid II
Use of Reclaimed Water in JV
INSTITUTION & CAPACITY BUILDING
INSTITUTION & CAPACITY BUILDING
Advisory Assistance to MOA
Promotion of Nat'l Sys. of Metrology
Promotion of Nat'l Info. Sys. (Incl. MOICT)
Petra Stone Conservation
Modernization of Customs Admin.
Impact Observation & Assess. Struct. Adj.MOA
Land Mgt./Promotion of Land Cadastration
Promotion of Gender Equity-Org. Dev'l
Introduction of Performance Budgeting
POVERTY ALLEVIATION & BASIC ED.
POVERTY ALLEVIATION & BASIC ED.
Improvement of Watershed Mgt.
Training of Young Ag. Engs.
Social Productivity Program
Poverty-oriented Infrstr. Proj.
STUDIES AND EXPERTS FUNDS
Data date 11/29/02
Start date 11/29/02
Finish date 11/29/02
Must finish date
Target finish date
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GTZ-KFW
PROJECTS
Past-Ongoing-Future
Date
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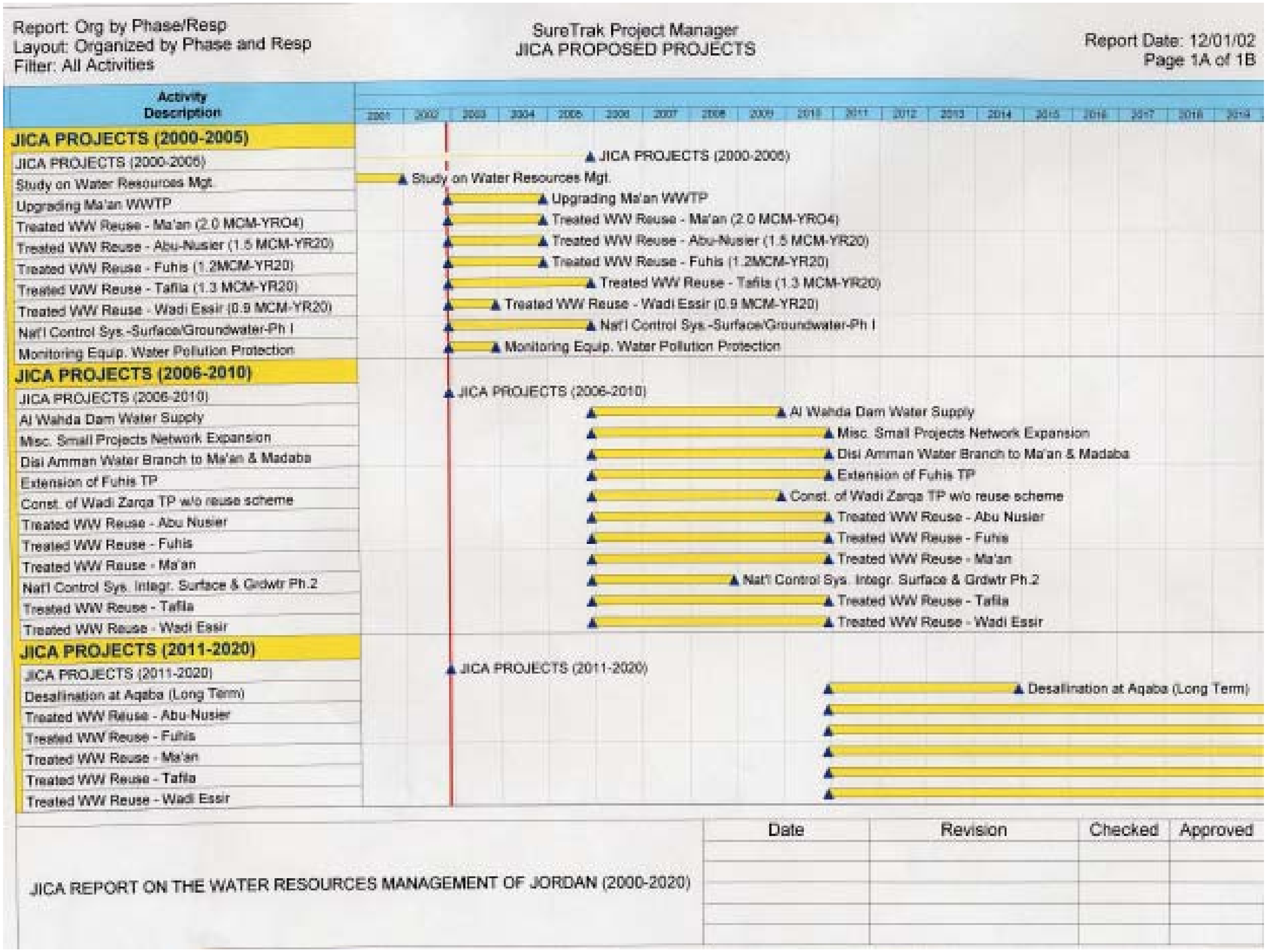
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JICA PROPOSED PROJECTS
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Page 1A of 1B
Activity Description
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
JICA PROJECTS (2000-2005)
JICA PROJECTS (2000-2005)
Study on Water Resources Mgt.
Upgrading Ma'an WWTP
Treated WW Reuse - Ma'an (2.0 MCM-YRO4)
Treated WW Reuse - Abu-Nusier (1.5 MCM-YR20)
Treated WW Reuse - Fuhis (1.2MCM-YR20)
Treated WW Reuse - Tafila (1.3 MCM-YR20)
Treated WW Reuse - Wadi Essir (0.9 MCM-YR20)
Nat'l Control Sys.-Surface/Groundwater-Ph I
Monitoring Equip. Water Pollution Protection
JICA PROJECTS (2006-2010)
JICA PROJECTS (2006-2010)
Al Wahda Dam Water Supply
Misc. Small Projects Network Expansion
Disi Amman Water Branch to Ma'an & Madaba
Extension of Fuhis TP
Const. of Wadi Zarqa TP w/o reuse scheme
Treated WW Reuse - Abu Nusier
Treated WW Reuse - Fuhis
Treated WW Reuse - Ma'an
Nat'l Control Sys. Integr. Surface & Grdwtr Ph.2
Treated WW Reuse - Tafila
Treated WW Reuse - Wadi Essir
JICA PROJECTS (2011-2020)
JICA PROJECTS (2011-2020)
Desalination at Aqaba (Long Term)
Treated WW Reuse - Abu-Nusier
Treated WW Reuse - Fuhis
Treated WW Reuse - Ma'an
Treated WW Reuse - Tafila
Treated WW Reuse - Wadi Essir
JICA REPORT ON THE WATER RESOURCES MANAGEMENT OF JORDAN (2000-2020)
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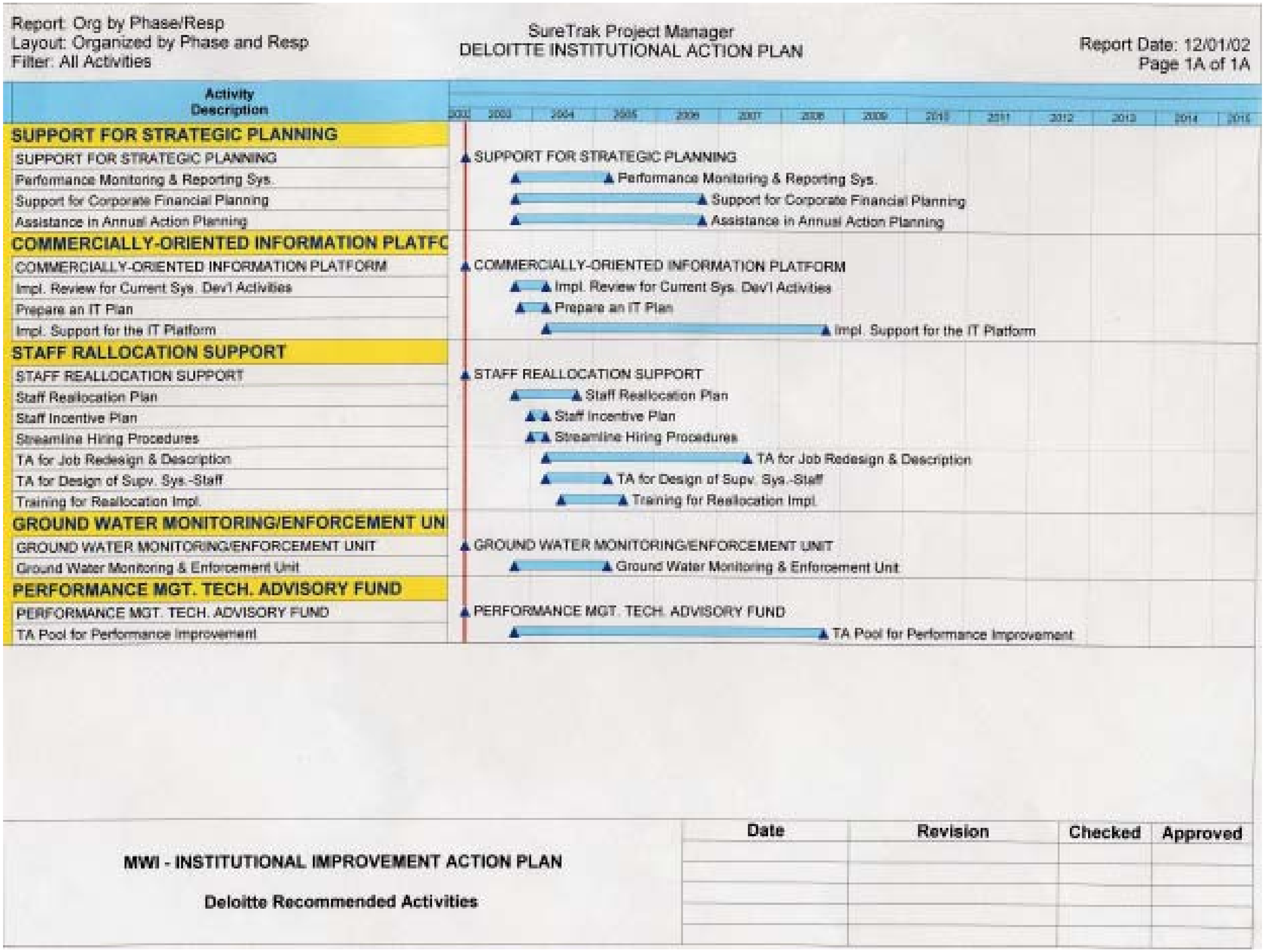
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DELOITTE INSTITUTIONAL ACTION PLAN
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Activity Description
2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015
SUPPORT FOR STRATEGIC PLANNING
SUPPORT FOR STRATEGIC PLANNING
Performance Monitoring & Reporting Sys.
Support for Corporate Financial Planning
Assistance in Annual Action Planning
COMMERCIALLY-ORIENTED INFORMATION PLATFC
COMMERCIALLY-ORIENTED INFORMATION PLATFORM
Impl. Review for Current Sys. Dev'l Activities
Prepare an IT Plan
Impl. Support for the IT Platform
STAFF RALLOCATION SUPPORT
STAFF REALLOCATION SUPPORT
Staff Reallocation Plan
Staff Incentive Plan
Streamline Hiring Procedures
TA for Job Redesign & Description
TA for Design of Supv. Sys.-Staff
Training for Reallocation Impl.
GROUND WATER MONITORING/ENFORCEMENT UN
GROUND WATER MONITORING/ENFORCEMENT UNIT
Ground Water Monitoring & Enforcement Unit
PERFORMANCE MGT. TECH. ADVISORY FUND
PERFORMANCE MGT. TECH. ADVISORY FUND
TA Pool for Performance Improvement
MWI - INSTITUTIONAL IMPROVEMENT ACTION PLAN
Deloitte Recommended Activities
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SECTION VIII:
POTENTIAL USAID INTERVENTIONS

SECTION VIII: POTENTIAL USAID INTERVENTIONS

The theme of the USAID program for the five-year plan period, 2004 to 2009, could be:

Water is a national resource that has the potential to contribute to the national economy.

And its corollary could be:

Water should neither be free nor sold at such low prices that the national budget must pay the major part of its development and delivery costs.

Even as many users are using water poorly and creating demands, ever more costly government projects and programs must meet those demands. At the same time that the Government of Jordan is struggling to increase sources of water, the unregulated use of groundwater is leading to the destruction of aquifers, and the unrestricted exploitation of water in the Golan Province of Syria is severely depleting the surface water supply of the Yarmouk River. Both the pricing/financial issue and the physical threat to the surface and groundwater resources require the implementation of projects and programs to achieve sustainability in each arena, financial and physical.

Funding levels for USAID's water resources program during the plan period are not known. Therefore, programs and projects are proposed according to priorities established after being filtered through qualitative criteria for three potential levels of financing.

A. SUSTAINABILITY

The achievement of sustainability can come about only if the many-faceted, ongoing reorganization of MWI leads to entities that can operate outside the civil service and as a business (see Section III). On the technical side, projects and programs will have to be formulated and implemented to reduce the pumping of upland wells by 25 to 50 percent. This will require investments on the plateau and major water development projects such as the Disi supply to Amman to offset a major reduction of the pumping of private and public wells. The situation along the Yarmouk River can be dealt with only through negotiation of a strong, verifiable, government-to-government agreement with Syria (see Box III-2, Section III).

1. Financial Sustainability

The prevailing situation is that revenue from the sale of water is so meager, especially that for irrigation water, that the Jordanian Treasury has to make substantial outlays just to support the bureaucratic and administrative costs. There is little or no money available for operations and maintenance, rehabilitation, equipment replacement, and new construction. Most of these monies are coming from foreign aid, loans, and, more recently, private-sector participation (PSP). There is no provision for the retirement of loans or for servicing the PSP financial requirements. Section III of this report proposes that USAID, during the plan period 2004 to 2009, implement initiatives to help WAJ and JVA to become an autonomous utility. The utility would be a bulk water supplier to self-sustaining Town Water and Sewerage Boards and Irrigation Associations for the distribution of M&I and irrigation water, respectively.

Sustainability in the financial arena also can be achieved only if water can be properly priced, quantities monitored, and tariffs collected by an organizational unit that has the capacity to hire, fire, and compensate employees fairly. In the institutional category of project budgetary presentation, initiatives are presented to support early development of a monitoring unit, the production of an information technology platform, and human resources capacity to match personnel assignments within MWI, WAJ, and JVA to skills required. The cost could be as much as $17 million over a five-year period

2. Technical Sustainability

Technical sustainability can be accomplished only with considerable institutional support to MWI. Initiatives are proposed for the creation of organizational units for planning, groundwater study, wastewater management and reuse, and technical monitoring capacity for both surface water and groundwater. Unlike the financial initiatives, which are totally institutional, the achievement of technical sustainability also will require a series of studies to be followed by feasibility studies, preparation of designs and contract documents, and construction of works. The formation of the groundwater study unit should be budgeted at $10 million over a five-year period. Approximately $7 million would be required for:

Establishment of a planning unit and expansion of the monitoring program from one for financial sustainability to one that also will support monitoring of aquifers, stream flow, and water reclamation for periodic revisions of water allocations.

The monitoring unit will carry out surveys, process all data, and enter them into the IT system. The planning unit will task the monitoring unit to make special surveys. It is expected that the results of the broad monitoring program will enable the planning unit to develop in-depth assessments of the total national water resources and to lay out allocations essential for controlling water use at a level equal to available supply. Initial results of this activity should be discussed at a high-level seminar of government officials with the intent of launching a water policy review and reform process.

A series of studies and small pilot/demonstration-style initiatives to study alternatives that in several instances would be follow-on activities to the ARD groundwater studies completed August 2001 and would be complementary financially, technically, and socially with commited USAID Phase II studies for wastewater reuse and management.

- Continue irrigation on the plateau after well pumpage is reduced by 25 to 50 percent. It is recommended that USAID reserve budgetary resources for the later years of the plan period to construct pipelines and to carry out farm consolidation to facilitate shutting down perhaps one-half of the irrigation wells even as the water is replaced with reclaimed water mixed with equal parts of groundwater (see Box V-2, Section V). ARD groundwater over abstraction reduction options and this recommendation should be tested.

- Determine potentials for greater reuse and recycling of industrial water through the study and proposed modifications to industrial processes (see Box V-1, Section V) through the industrial assessment proposed under Phase II of the wastewater reuse activity.
- Develop a land use plan for the Jordan Valley and Wadi Araba.
- Study alternative proposals associated with development of a national pipeline network with the Disi pipeline as the spine.
- Implement construction of wastewater treatment ponds as "wetlands," in isolated communities, designed to promote biodiversity as well as healthful, sanitary conditions (see Box II-1, Section II).
- Support a negotiating team for presenting studies to a Water Master, who would be empowered by both Syria and Jordan to facilitate an equitable allocation of Yarmouk River water (see Box III-2, Section III, C).
- Establish a regional water management training center.
- Determine if there is a conflict for exploitation of the Disi Aquifer between Saudi Arabia and Jordan. Identify future well and well field installations that could establish a groundwater gradient favorable to Jordan.
- Continue the Water Efficiency and Public Information for Action (WEPIA) program funded by USAID, which is related to water demand management. This program has been successfully engaged in promoting the use of water efficient technologies and developing public awareness and attitudes towards water consumption.

B. PRIORITY OF USAID INITIATIVES

The listing and priority ranking of projects is based on the initiatives identified in MWI's Action Plan for 2002. Ranking analyses presented in the JICA Summary Plan of 2001 were used in conjunction with the ranking criteria listed below to suggest priorities under three funding scenarios.

1. Evaluation Criteria

The philosophy that guided the direction of SO2 over the past five years has been the *conservation* of developed water through rehabilitation of municipal infrastructure and the reclamation of large quantities of water through the upgrading and building of wastewater treatment facilities. This focus is carrying over into the next plan period. The team has added, for the next plan period, the concept of *sustainability*. The selection criteria elaborated below are intended to account for both conservation and sustainability and at the same time work toward a national pipeline network that will permit transfer to every area of the country from any source.

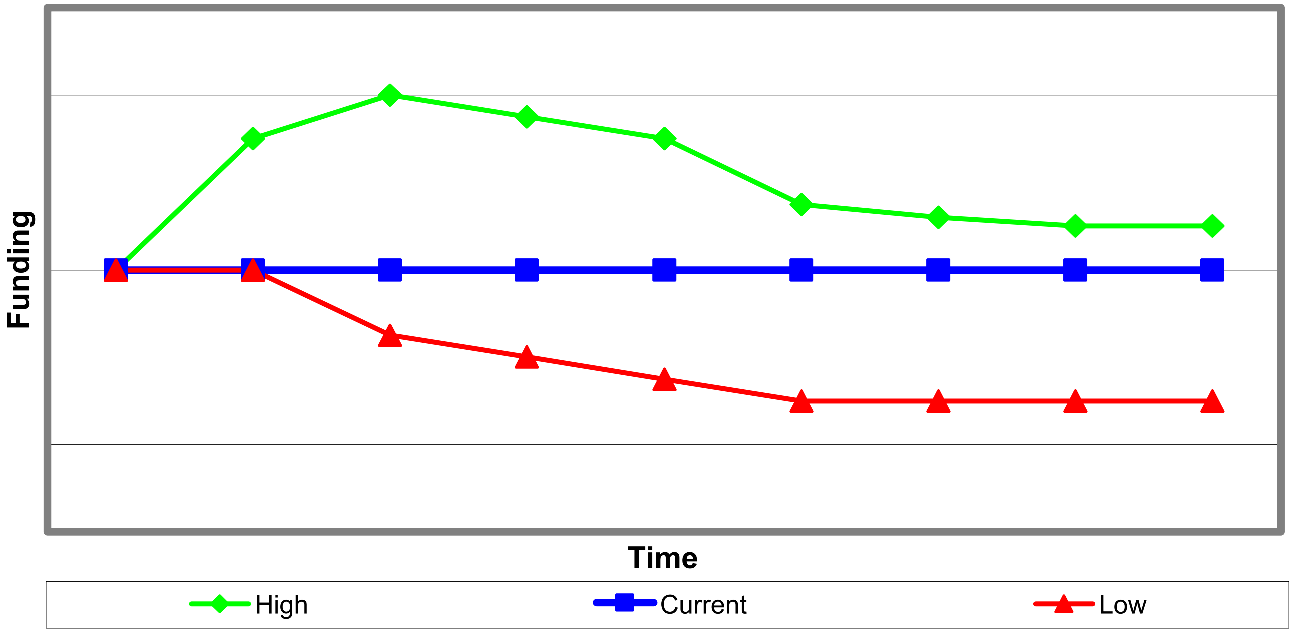
a. Threshold Criterion

A threshold or fatal criterion observed in the rankings posits that no major construction project would be considered unless it was included in MWI's August 2002 Action Plan or had been officially added to that list.

b. Qualitative Criteria

These criteria were used as relative values for a qualitative ranking of a dozen major construction projects for water supply and wastewater reclamation. Those listed have yet to be identified in USAID's ongoing or anticipated projects. Data for the ranking were drawn in large part from the JICA Summary Report.

Figure VIII-1
Funding Scenarios



- Fund what now is in the pipeline.
- Fund those projects (wastewater treatement plants and water supply) that supply or make available the most MCM/year for the least unit cost and that promote the least adverse environmental impacts and the most favorable enhancements to the environment.
- Fund those activities that have the most favorable impacts on the social and economic welfare of the community.
- Fund those projects that provide equitable access to water and wastewater treatment among the governorates.
- Fund activities consistent with USAID policies. For example, desalination facilities should not be funded before other, simpler, less costly projects. This is especially true due to the high capital and operations and maintenance costs and the complexities of operation.
- Select wastewater treatment plant projects that maximize the provision of mixed water/reclaimed water to existing farms.

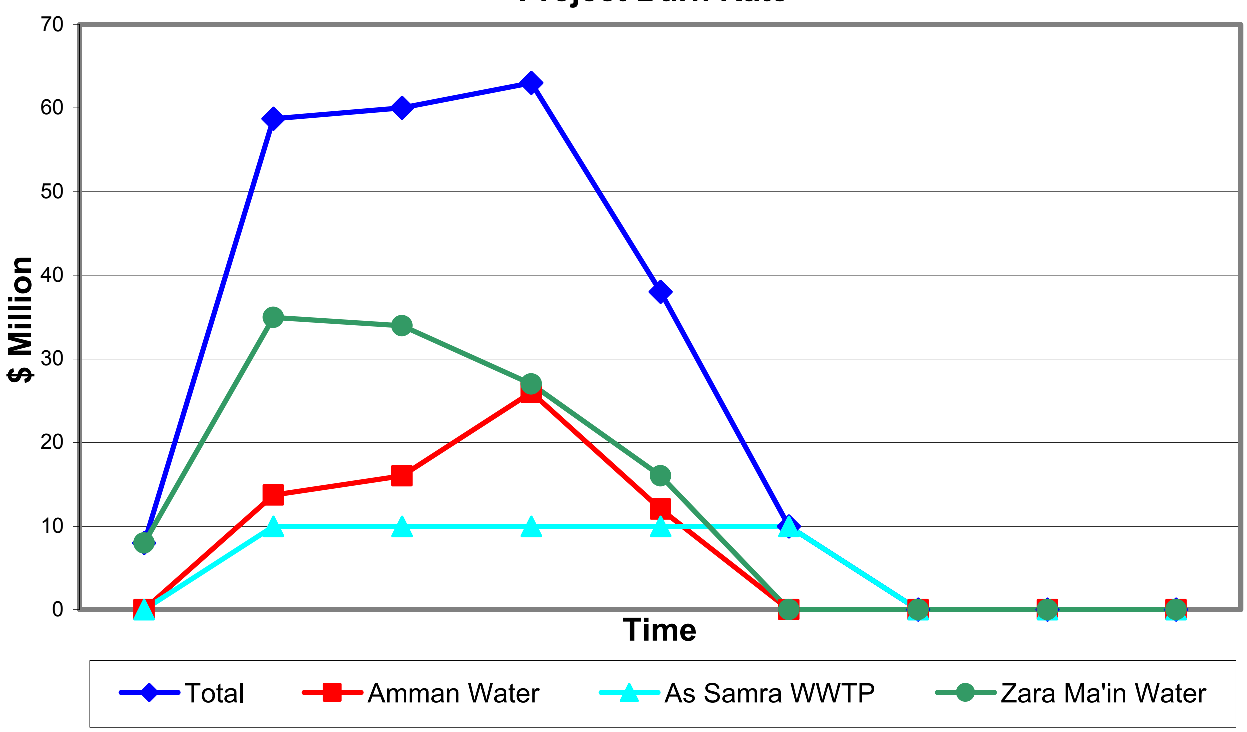
C. Initiatives Associated With Three Funding Scenarios

USAID/Jordan has no firm agency or congressional commitment of budgetary resources for the 2004–2009 period. It is even likely that some time during the plan period, allocations will be uneven. Figure VIII-1 is a schematic representation of what the total funding could look like with more money being available in the near term as compared to the out years. Figure VIII-2 shows what the potential burn rate could be for projects already in the pipeline and anticipated to start soon. The time period for the project activity burn rate is earlier and of shorter duration than is the time-scale for funding scenarios.

1. Carryover Projects

The burn rate accounts for both monies already available and committed and for approximately $26 million of additional funding that will be required by 2004 or later for the Zara Ma'in Water System Project.

Figure VIII-2
Project Burn Rate



USAID and MWI are considering two new projects that will require funding beginning in 2004. The first is the Northern Governorates Water Transmission System, which likely would require $20 million of USAID funding between the years 2004 and 2008. The second of these projects would require $20 million of USAID funding, again between 2004 and 2008, for the Expansion of Small Community WWT. These two projects and the additional funding for Zara Ma'in will require approximately $46 million of funding during the next plan period; they are categorized under the scenarios below as "carryover projects."

2. Critical Commitment Required for Achieving Sustainability in the Water Sector

To sustain the already developed water resources, surface and ground, and to achieve financial sustainability, MWI and its authorities must continue and accelerate their transition toward the formation of an autonomous utility for bulk water supply and a series of locally autonomous water distributors that take on the character of a business. Thus, it is critical that the proposed institutional initiatives be implemented during the plan period in the form proposed. If the initiatives are not implemented, works recently completed or now being built would deteriorate due to a lack of funding. In addition, the yield of water from the Yarmouk River and from the rechargeable aquifers would be greatly diminished. Thus, it is critical that most of the $30 to $35 million outlay suggested for institutional reform and for special studies should rank in priority along with the highest-ranked construction project.

The institutional initiatives and new units to be formed under the MWI umbrella are:

Table VIII-1

Institutional / new units	Time	U.S.$ (millions)
Corporate-type Strategic Management Capacity	3 years	1.6
Information Technology Platform for Water Sector	5 years	8.1
Human Resources Capacity to Rationalize and Reallocate Staff	5 years	5.4
Monitoring and Enforcement Unit for all Water, Ground and Surface	5 years	2.5
Analytical Unit for Groundwater Resource Assessment	5 years	10.0
Wastewater Management and Reuse Unit	2.5 years	Project funded
Central Planning Unit(s)	5 years	1.0
Performance Management Technical Advisory Fund	5 years	1.5
Special Studies	5 years	2.5

The institutional reform program, if fully implemented, would address almost every aspect of the MWI Action Plan not involving construction of facilities. The following are those numbered points that would be addressed:

- The establishment of a wastewater reuse unit at MWI/WAJ under the wastewater reuse project Phases I &II.
- Twenty-eight of the 29 initiatives of 1.0 – Institutional and Legal Issues; the exception would be that for farmer participation in retail water management, a project of GTZ.
- Most of the issues relating to 2.1 – Agricultural Water Use in Irrigated Areas.
- Eight initiatives under 3.1 – WAJ Water Tariffs section.
- Five initiatives under 3.3 – "Increase Efficiency."
- 3.3 – JVA Water Tariff initiative.
- The formulation of good management practices regarding the eight initiatives of 4.0 PSP.
- The eight initiatives relating to 5.0 – Information Systems.

Five special studies that were identified during the course of the study as being critical to conservation and preservation of the basic water resource are:

Table VIII-2

USAID Initiative	Time	US$ (Millions)
Industrial Water Demand Reduction Opinion Study	6 months	0.3
Reconnaissance-Level Study of Farmland Consolidation	1.5 years	0.3
Technical Support Pre-Negotiations Yarmouk River Allocation	1year	1.0
Project Preparation Constructed Wetlands	9 months	0.5
Study of Measures to Reverse Unfavorable Groundwater Gradients in the Disi Aquifer	6 months	0.4

3. Importance of the Disi-Amman Water Conveyor

The Disi-Amman Water Conveyor is listed by MWI as a PSP project. It should have the highest priority for construction because it will provide water of excellent quality to Amman at a time when there is great need to reduce overdraft of water from rechargeable aquifers on the plateau and it should facilitate the filling of the Unity reservoir even if the dam is completed during a drought period. In addition, the Disi pipeline will be an important link in the development of a national pipeline network. Should the Red–Dead or an alternative water transfer project be developed in the future, the Disi pipeline would be critical for the transfer of water back to the south. This would be done to conserve the Disi reservoir for emergencies or to supply water to the south if the Disi reservoir should by then have been mined out. It is certain that USAID would not contribute to the construction of the Disi conveyance project under the constraints of a Low Funding Scenario. As well, it is doubtful, but not certain, that USAID would provide finance construction even with funding at the medium to high level. Because of the importance of the conveyance to the sustainability of the highland aquifers, funding for the Disi conveyance and alternative investments are presented for the Medium and High Funding Scenarios.

4. List of Project Initiatives

Projects that address a range of issues and developments in the water sector are presented for the Medium and High Funding levels. Addressed are issues of equity geographically and by social and economic strata and developments for resource conservation. Several of the initiatives address more than one of the three IRs.

Each construction project was evaluated and assigned a qualitative ranking. This ranking was only notional; an example is presented for five wastewater treatment plants in the following table. Selection of wastewater treatment plant projects to be funded would, in the end, depend upon USAID/MWI consultations in consideration of the results of the ongoing USAID Phase I Implementation of Wastewater Reuse. Also, this analysis was not correlated with the plans of other donors other than as may have been listed in MWI's Action Plan and the timelines of projects shown in Section VII of this report (e.g., the GTZ timeline indicates an activity for use of reclaimed water in the Jordan Valley (2003–2006)).

a. Disi-Amman Water Conveyor

The cost of the project was estimated in the JICA report to total JD438 million. Should USAID commit funding for construction of the conveyance system, the SO2 evaluation team suggests that it be directed to parts of the project other than for procurement of pipe.

b. Conveyance of Water from Wehda Dam to Irbid

This would include treatment plant, transmission pumps, and transmission line. Project cost: $38.6 million to transport 20 MCM/yr.

c. Wastewater treatment plants for construction

Table VIII-3

Wastewater Treatment Plants Locations, Figure IV-1	JD (millions), JICA	U.S.$ (millions)
1. Aqaba South Coast	1.4	2.0
2 Al-Jeeza	11.0	15.7
3. Dead Sea Coast	7.0	10.0
4. Dir Alla	25.4	36.3
5. South Shouna	24.7	35.3

Companion to wastewater treatment plant construction could be an adjunct project to consolidate land holdings of well owners into blocks, with the consequence that piped reclaimed water could be conveyed economically for irrigation when mixed with well water. The objective would be to shut down 50 percent of the irrigation wells. USAID could reserve $10 million to $20 million for investment in one or more demonstration projects after the special study of irrigation on the highlands is completed.

d. Highlands Groundwater Reduction Assistance

Farmers are to be charged for groundwater extraction in the highlands. For the purposes of conserving groundwater, reducing groundwater abstraction, and providing incentives to farmers to participate in the new tariffs, the SO2 evaluation team suggests consideration of a substantial subsidy for irrigation equipment. This suggestion should be proved out during the study of options for shutting in wells in the highlands.

The subsidy would include micro-irrigation systems based on designs to be approved by an irrigation specialist unit within the MWI.

The benefits of this subsidy could include:

- Water conservation and the reduction of groundwater overdraft,
- Soil erosion control,
- Labor reduction,
- Pesticide migration control,
- Better fertilizer application,
- Improvement in crop quality, uniformity, and marketability, and
- Improved income to farmers.

With the above benefits having been realized, the farmers should be more willing to pay for groundwater they use. Since they would be using less water, they would have an improved income and they certainly would note the cooperative effort from the government to save water. Tangible benefits could accrue through qualifications for prizes and low-interest loans, training, preferential treatment for auxiliary water and agricultural programs, recognition in the local community, and educational information on system improvements and demand reductions to be made through payments.

The estimated cost of this initiative could be as high as $40 million based on 20,000 hectares in the highlands at a subsidized cost ($2,000 per hectare), plus $3 million to establish the irrigation design and implementation unit in MWI, for a total of $43 million.

e. Irrigation Rehabilitation Jordan Valley and Wadi Araba

It is not clear if the irrigation projects in the MWI Action Plan that seem to largely be rehabilitation of works in the Wadi Araba and the Jordan Valley are appropriate for USAID funding.

f. Rehabilitation of Water Supply Systems

- Water Loss Reduction in Irbid and Jerash
- Water Loss Reduction Program in Karak
- Rehabilitation of Zarqa Water Network

g. Dams

Small dams (Ibn Hamad, Karak, Meddien) 2008, 7 MCM/yr, $18.6 million

D. THE THREE FUNDING SCENARIOS

Three scenarios are presented for three levels of annual funding, with equal amounts being available each year. The levels are: 1) Low Funding at $10 million/year, 2) Medium Funding at $60 million/year, and 3) High Funding at $100 million/year. The projects and programs listed were drawn from the MWI Action Plan, JICA's Master Plan, and those initiatives that the team recognized as important during the evaluation.

1. Low Funding Scenario

With $10 million being available annually, there will be total resources of $50 million during the five-year plan period. In this case, USAID will have to make choices. About $26 million will be required for Zara Al Ma'in project completion. Then a choice will have to be made whether to finance some of the institutional work that is so important to sustainability or to finance the Expansion of Community Small Water Treatment Plants for $20 million and/or the Northern Governorates Water Transmission System for $20 million.

The SO2 team recommends that at least $20 million be dedicated to transformation of WAJ, JVA, and five new units to be formed in MWI to function as a self-sustaining, autonomous utility for providing bulk water supplies to Town and Village Water Boards and Irrigation Associations. The boards and associations would distribute water to end-users and be responsible for their own finances, operations and maintenance, capital costs and replacements, and staffing.

2. Medium Funding Scenario

With $60 million being available annually, a total funding level of $300 million will be available during the plan period. The SO2 evaluation team recommends that selection of projects and appropriate funding levels be based on the selection criteria listed in paragraph B.1.b. above. Following is an illustrative list of projects.

Table VIII-4

Projects	**$ Million with Disi**	**$ Million Without Disi**
Carry-over projects	46	46
Institutional projects	30	30
Special studies	3	3
Disi Conveyor at 12.5%	93	0
WWTPs	58	100
Land consolidation with Reclaimed Water Pipelines to Irrigation Well Fields at WWTPs	30	30
Constructed wetlands	7	7
Rehabilitation of water supply systems	9	9
Irrigation Réhabilitation	4	4
Groundwater Conservation Highlands	20	42
Small Dams	0	19
Middle East Water Partnership Grants Program	0	10
TOTAL	300	300

3. High Funding Scenario

With a funding level of $100 million annually, or $500 million total for five years, it would be possible for USAID to participate in the Disi conveyor project for, say, as much as 25 percent of total cost. This likely would make the project more certain as a PSP since it is understood that the Government of Jordan expects to contribute up to 50 percent. USAID could encounter problems at too high a level of funding should it not be possible to disaggregate pipe from the USAID portion of the project. Even at a 25 percent level, $174 million, there still would be some $123 million more for earmarking.

It may be that under this level of funding USAID should consider the inevitability of the need to explore desalination or major international water transfers.

E. Impacts of Funding Levels on USAID Input to the Water Sector

The SO2 program has considerable momentum and is poised to achieve dramatic results in the conservation of water being lost in municipal systems and the reclamation of wastewater to high standards of quality for reuse in agriculture. In addition, MWI has been partially convinced and is positioned for dramatic organizational restructuring to put the water sector on a businesslike footing. All of this progress will halt and regress if the funding for SO2 is not maintained for the next five years at least at a level of $50 to $60 million per year. Institutional reform and proper water pricing and allocation will not be truly effective with out the sweeping institutional reforms proposed to be finalized and institutionalized during the plan period, 2004–2009.

Second, the large program of investment on the highlands proposed for improving irrigation efficiency, effective use of reclaimed water, and farmer reeducation and persuasion is designed to persuade farmers to deal with water as a valued commodity that has to be bought at market price. This highlands program requires construction of not only irrigation facilities but also pipelines for the transport of reclaimed water and the scientific reordering and establishment of well fields. The long-term consequence will be to greatly prolong the life and usability of the rechargeable fresh water aquifers of the highlands

The Disi conveyance system also is key to saving the highlands aquifers. Once water arrives in Amman, there will no longer be a need to pump municipal supply from groundwater. Also, other water now being supplied to Amman will be released for alternative uses.

Annex A:
Abbreviations and Acronyms

ANNEX A:
ABBREVIATIONS AND ACRONYMS

ACM	Asbestos containing material
ADS	USAID Automated Directive Systems
AGTP	Ain Ghazal Treatment Plant
AHM	Acutely hazardous material
AID	Amman Industrial Estate
AMIR	Achievement of Market Friendly Initiatives and Results Program
ARD	Associates in Rural Development, Inc.
AS	Activated Sludge wastewater-treatment technology
ASEZA	Aqaba Special Economic Zone
AZB	Amman-Zarqa Basin
BEO	USAID Bureau Environmental Officer
BMP	Best Management Practices
BOD_5	Biochemical Oxygen Demand, 5-day, usually reported as milligrams per liter or kilograms per day
BOO	Build Operate Own
BOT	Build Operate Transfer
BPWA	Jordanian Business and Professional Women Association, a Non-Governmental Organization
BRDP	Badia Rural Development Project
CDC	U.S. Center for Disease Control
CDM	Camp, Dresser, McKee
CFR	U.S. Code of Federal Regulations
CIDA	Canadian International Development Agency
CIP	Capital Investment Program
COD	Chemical Oxygen Demand, usually reported as milligrams per liter or kilograms per day
COM	Jordanian Council (or Cabinet) of Ministers
COP	Chief of Party
CP	Condition Precedent of CTP
CSBE	Jordanian Center for the Study of the Built Environment, a Non-Governmental Organization
CSP	Country Strategic Plan
CTO	Contract Technical Officer (Project Manager)
CTP	USAID Cash-Transfer Program
DAI	Development Alternatives, Inc.
DEH	Directorate of Environmental Health
DFS	Directorate of Food Safety
DO	Dissolved Oxygen, usually reported as mg/L

DOE	Jordanian Department of the Environment at the Ministry of Municipal, Rural and Environmental Affairs
EA	Environmental Assessment
ECC	Economic Consultative Council
EHP	Environmental Health Project
EIRR	Economic Internal Rate of Return
EOO	USAID Economic Opportunities Office
EPA	Environmental Protection Agency
EPCRA	U.S. Emergency Planning and Community Right-to-know Act
ERC	Environmental Research Center of the Jordanian Royal Scientific Society
EU	European Union
FAA	U.S. Foreign Assistance Act
FAO	Food and Agricultural Organization
FAS	Financial Accounting System
FCC	Fecal Coliform Count
Fil	Jordanian unit of currency, equals 1/1,000 of a JD
FOE	Friends of the Environment, a Non-Governmental Organization
FY	Fiscal year
GAP	Good Agricultural Practices
GCEP	General Corporation for Environmental Protection
GDP	Gross Domestic Product
GEF	Global Environmental Facility
GIS	Geographic Information System
GMCC	Groundwater Management Consultative Committee
GMF	Groundwater Management Fund
GOJ	Government of Jordan
GPS	Global Positioning System
GS	Government Support
GTZ	Deutsche Gesellschaft fur Technische Zusammenarbeit (German Technical Cooperation)
HCC	Jordanian Haya Cultural Center, a Non-Governmental Organization
HDH	Hashmiyah-Dulayl-Hallabat area
IAS	Irrigation Advisory Service
IBRD	World Bank's International Bank for Reconstruction and Development
ID	Irrigation District
IEE	USAID Initial Environmental Examination
IIAP	Deloitte's MWI-Institutional Improvement Action Plan (draft, November 7, 2002)
ILWE	Institute of Land, Water and Environment at Hashemite University; includes Department of Environmental and Earth Sciences, Department of

	Land Management, and Department of Environment and Water Management
INWRDAM	Inter-Islamic Network on Water Resources Development and Management, under the umbrella of the Standing Committee on Scientific and Technological Cooperation of the Organization of the Islamic Conference
IPM	Integrated Pest Management
IQC	Indefinite Quantity Contract
IR	Intermediate Result, under USAID's Strategic Objective
IRG	International Resource Group
IRR	Internal Rate of Return
ISPAN	International Symposium on Parallel Architectures, Algorithms and Networks
IZ	Industrial Zone
JD	Jordanian dinar (currency), 1,000 Fils, equivalent to about US$ 1.42
JERDS	Jordanian Royal Ecological Diving Society, a Non-Government Organization
JES	Jordanian Environment Society, a Non-Government Organization
JICA	Japanese International Cooperation Agency
JISM	Jordanian Institution for Standards and Metrology
JOVAC	Jordan Valley Association for Agriculture and Commerce
JRVSC	Jordan River Valley Steering Committee
JUST	Jordan University of Science and Technology
JV	Jordan Valley; Joint Venture
JVA	Jordan Valley Authority
JWC	Jordanian-Israeli Joint Water Committee
KAC	King Abdullah Canal
KAD	King Abdullah Dam
KFW	Kerditansalt fur Wiederauflau
km^2	Square kilometer
km	Kilometer
KTD	King Talal Dam
KTR	King Talal Reservoir
lcd	Liter per capita per day
LEMA	Suez Lyonnaise de Eaux/ Arabtech Montgomery Watson, Lyonnaise des Eaux Management- Amman
LIMS	Laboratory Information Management System
LOF	Level of funding
lpcd	Liter per capita per day
LWM	Local-Water Management
m	Meter, or million
m^3	Cubic meter

m^3/c/yr	Cubic meter per capita per year
m^3/d	Cubic meter per day
m^3/s	Cubic meter per second
M&I	Municipal and Industrial
MC	Management contract
MCM	Million cubic meters (approximately 810 acre-feet)
MEO	USAID Mission Environmental Officer
mg/L	Milligram per liter
MIS	Management Information System
MIT	Municipal, industrial and touristic sectors
mm	Millimeter
MMREA	Jordanian Ministry of Municipal, Rural and Environmental Affairs
MOA	Jordanian Ministry of Agriculture
MOF	Jordanian Ministry of Finance
MOH	Jordanian Ministry of Health
MOP	Jordanian Ministry of Planning
MWI	Jordanian Ministry of Water and Irrigation
N/A	Not Applicable
NCARTT	Jordanian National Center for Agricultural Research and Technology Transfer
NEAP	Jordanian National Environmental Action Plan
NES	Jordanian National Environmental Strategy
NEWS	Jordanian National Environmental and Wildlife Society, a Non-Governmental Organization
NGO	Non-Governmental Organization
NPV	Net Present Value
NRA	Jordanian Natural Resources Authority
OIC	Organization of the Islamic Conference
O&M	Operation and maintenance
OMS	Operations & Management Support
PBWRC	Princess Basma Women's Resource Center
PHCI	USAID Primary Health Care Initiatives
PMU	Program and Management Unit
PSP	Private Sector Participation
QA	Quality Control
QC	Quality Assurance
QRACEST	Queen Rania Al-Abdullah Center for Environmental Sciences and Technology at the Jordan University of Science and Technology, formerly the Center for Environmental Sciences and Technology
RA	Rapid appraisal
RCRA	U.S. Resource Conservation and Recovery Act

RCSW	Rehabilitating Contaminated Wells and Springs
RFP	Request for Proposal
RS	Remote sensing
RSCN	Jordanian Royal Society for the Conservation of Nature, a Non-Government Organization
RSDSC	Red Sea-Dead Sea Canal project
RSS	Jordanian Royal Scientific Society
SCBA	Social cost benefit analysis
SEWRU	Strategic Environment and Water Resources Research Unit at the Al Al-Bayt University
SO	USAID Strategic Objective
SO2	USAID SO for Jordan's Water Sector, "Improved Water Resources Management"
SPP	Strategic Planning Program
TA	Technical assistance
TBD	To be determined
TDS	Total Dissolved Solids, usually reported as milligrams per liter
TOR	Terms of reference
TW&SB	Town Water and Sewage Board
UFW	Unaccounted for Water, applied to municipal water distribution losses due to pipe leaks and to unpaid takings
UN	United Nations
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational and Scientific Organization
UNRWA	United Nations Relief and Works Agency
UOJ	University of Jordan
U.S.	United States
USAID	U.S. Agency for International Development
USBR	U.S. Bureau of Reclamation
USGS	U.S. Geological Survey
WAJ	Water Authority of Jordan
WCA	Jordanian Water Conservation Association, a Non-Governmental Organization
WDM	Water-Demand Management
WERSC	Water and Environment Research and Study Center of the University of Jordan
WIS	Water Information System
WRE	USAID Office of Water Resources and Environment
WRMP	Water Resources Management Plan
WRPS	Water Resources Policy Support
WSD	Water Savings Device

WSM	Water-Supply Management
WQICP	USAID Water Quality Improvement and Conservation Project
WSP	Waste Stabilization Pond wastewater-treatment technology
WWG	Working Water Group
WWTP	Wastewater Treatment Plant
yr	Year

ANNEX B:
PERSONS CONTACTED

ANNEX B:
PERSONS CONTACTED

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38. Eng. Zafer Alem, Secretary General, JVA
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AQABA

44. Dr. Bilal Bashir, Comm. for Env., Reg. & Enf., Aqaba Special Econ. Zone Auth. (ASEZA)
45. Imad Zureikat, Director of Aqaba Governorate Water Authority
46. Jamal Reyati, Plant Manager, Aqaba Wastewater Lagoons Treatment Plant
47. Hamdalla Akram, Farm Manager, NGO Date Farm

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48. Dr. Andreas Kuck, Brackish Water Project (JVA), GTZ
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BIBLIOGRAPHY

BIBLIOGRAPHY

Al-Zabet, Tareq, 1999. Environmental Assessment and Optimization of Groundwater Resources Using Integrated Finite Element Flow and Brine Solute Transport Modeling COMBINED WITH G.I.S. Techniques. Ph.D. Dissertation, Hydrogeology and Environment, Hydrogeology and Environment Institute, Wuerzburg University (Germany).

_______________, Integrated Agricultural Management in the Jordan Valley using Telescopic Refinement Approach. United Arab Emirates University, Geology Department, Dubai, 8 p.

Associates in Rural Development, Inc. (ARD), May 2000. Outline Hydrogeology of the Amman-Zarqa Basin. Ministry of Water and Irrigation and USAID, Water Resources Policy Support: Groundwater Management Component, 13 p.

_______________, April 2001. Curtailment of Groundwater Use for Irrigated Agriculture in the Amman-Zarqa Basin Uplands: A Socio-Economic Analysis. By Dr. Amer Jabarin, University of Jordan; Ministry of Water and Irrigation and USAID, Water Resources Policy Support: Groundwater Management Component, 26 p.

_______________, May 2001. Assessment of Potential Use of Brackish Water for M&I Supply in Amman Zarqa Basin. Ministry of Water and Irrigation and USAID, Water Resources Policy Support: Groundwater Management Component, 13 p. and 5 appendices.

_______________, May 2001. Hydrogeological Impacts of Overpumping and Assessment of Groundwater Management in the Amman-Zarqa Highlands. Ministry of Water and Irrigation and USAID, Water Resources Policy Support: Groundwater Management Component, 49 p.

_______________, June 2001. Groundwater Abstraction Metering and Monitoring, Amman-Zarqa Basin. Ministry of Water and Irrigation and USAID, Water Resources Policy Support, Groundwater Management Component, 12 p.

_______________, June 2001. Rehabilitation and Upgrade of the Groundwater and Wadi Flow Monitoring Networks, Amman-Zarqa Basin. Ministry of Water and Irrigation and USAID, Water Resources Policy Support, Groundwater Management Component, 35 p.

_______________, June 11, 2001. Report of a Stakeholders Meeting which Reviewed Plans for Reducing Groundwater Use for Irrigation in the Amman-Zarqa Basin and Managing Water Reuse in the Amman-Zarqa Basin and Jordan Valley. Ministry of Water and Irrigation and USAID, Water Resources Policy Support, 6 p. and 9 annexes. At the Movenpick Hotel, Dead Sea.

_______________, July 12, 2001. Groundwater Management Action Plan for the Amman-Zarqa Basin Highlands. Ministry of Water and Irrigation and USAID, Water Resources Policy Support, Groundwater Management Component, 64 p.

_______________, July 12, 2001. Plan for Managing Water Reuse in the Amman-Zarqa Basin and the Jordan Valley, Final Report. Ministry of Water and Irrigation and USAID, Water Resources Policy Support, Water Reuse Component, 57 p.

_______________, August 2001. Summary of the Water Resource Policy Support Activity, 9 August 1999 to 8 August 2001. Ministry of Water and Irrigation and USAID, Water Resources Policy Support, 48 p.

_______________, April 18, 2002. Planning of Rapid Appraisal of Groundwater Use in the Amman-Zarqa Basin. Ministry of Water and Irrigation and USAID, Water Resources Policy Support, Groundwater Management Component, 22 p.

Brooks, David B., In Press. Less is more: Water demand management is not simple, but it is our best hope for heading off the coming world water crisis. Friends of the Earth, Canada.

_______________, 2002. Water: Local-Level Management. International Development Research Centre, In-Focus from Research to Policy Series, Ottawa, Canada, 70 p.

Central Bank of Jordan, Research Department, October 2002. Monthly Statistical Bulletin, Vol. 38, No. 10, 102+ p.

Deloitte Touche Tohmatsu Emerging Markets, November 7, 2002. DRAFT, Draft Report, MWI-Institutional Improvement Plan, Ministry of Water & Irrigation, The Hashemite Kingdom of Jordan and U.S. Agency for International Development/Jordan, 32 p.

Development Alternatives Inc. (DAI)/ Environ Consult Office (ECO), 22 September 200. DRAFT, Final Draft Report of Findings and Recommendations for Water Sector Component of USAID Strategic Plan for Jordan, 2002-2006, 50 p.

Djahanbani, Aman S., August 29, 2002. Request for Proposal (RFP) Number Jordan-02-011 Education and Information Program to Improve Irrigation Water Use Efficiency. USAID/Jordan, Regional Contracting Office, 71 p.

Federal Republic of Germany, April 21, 2002. Jordanian-German Development Cooperation Report. Amman, Jordan.

General Corporation for Environmental Protection (GCEP), United Nations Environmental Programme (UNEP) and Global Environment Facility (GEF), 1998.

Jordan Country Study on Biological Diversity, Project No. GF/6105-92-65/ GF/6105-92-02 (2991), 416 p.

Government of Jordan and Government of Israel, September 2002. Protecting the Dead Sea: Jordanian and Israeli Perspective. Presented to the World Summit on Sustainable Development, Johannesburg Summit 2002, Johannesburg, South Africa, 16 p.

Grohs, Roy J., 1999. Water and Jordan's Economic Future: The Ultimate Constraint on Jordan's Economic Growth? Presented to the Jordanian-American Business Association, 65 slides.

The Hashemite Kingdom of Jordan, Ministry of Water and Irrigation and Ministry of Planning, No date. Protecting the Dead Sea: Ancient Treasure, 21st Century Opportunity – The Jordanian Perspective, 19 p.

The Hashemite Kingdom of Jordan, Ministry of Water and Irrigation, Jordan Valley Authority, April 2002. Wala Dam, brochure.

The Hashemite Kingdom of Jordan, Ministry of Water and Irrigation, Amman, Jordan, 2002. Jordan's Water Strategy & Policies, 101 p.

_______________, Jordan, funded by Water Efficiency Public Information for Action Program (WEPIA) and Academy for Educational Development (AED), 2002. "A Race Against Time – Jordan's Water Crisis," a CD video.

_______________, February 2002. Water Sector Planning and Associated Investment Program, 2002-2001, ~450 p. (and CD ROM).

_______________, August 2002. Ministry of Water and Irrigation Action Plan. 13 p.

Nazzal, Yasser K., Mohammad Mansour, Mohammad Al Najjar, and Peter McCormick, March 2000. Wastewater Reuse Law and Standards in the Kingdom of Jordan. Ministry of Water and Irrigation, Amman, Jordan, 10 p.

Tutundjian, Setta, April 2001. Water Resources in Jordan. U.S. Agency for International Development, Amman, Jordan. U. S. Agency for International Development, Amman, Jordan, 96 p. (and CD ROM).

_______________, 2002. Assessment of Jordan's Water Sector, USAID Support to the Sector and Recommendations for Future Support. U.S. Agency for International Development, Amman, Jordan, 27 p.

_______________, July 18, 2002. Summary of USAID On-Going Activities the Water Sector in Jordan. U.S. Agency for International Development, Amman, Jordan, 13 p.

World Bank, October 15, 1997. The Hashemite Kingdom of Jordan, Water Sector Review (in two volumes). Volume I. Main Report and Annexes A-B; Volume II. Annexes C-N. Rural Development, Water and Environmental Groups, Middle East and North Africa Region.

_______________, February 15, 2001. The Hashemite Kingdom of Jordan, Water Sector Review Update, Main Report. Rural Development, Water and Environmental Groups, Middle East and North Africa Region, Report No. 21946JO, 19 p.

World Conservation Union, July 1991. National Environmental Strategy for Jordan: A Resource Book of Information and Guidelines for Action. Ministry of Municipal and Rural Affairs and the Environment, Department of Environment. Economic Press, Amman, Jordan, 225 p. plus annex.

Yachiyo Engineering Co., Ltd./Japan International Cooperation Agency, December 2001. Final Report, Main Report, Part–A, The Study on Water Resources Management in the Hashemite Kingdom of Jordan, Volume I. Hashemite Kingdom of Jordan, Ministry of Water and Irrigation, ~450 p.

_______________, December 2001. Final Report, Main Report, Part–B, The Study on Water Resources Management in the Hashemite Kingdom of Jordan, Volume II. Hashemite Kingdom of Jordan, Ministry of Water and Irrigation, ~450 p.

_______________, December 2001. Final Report, Summary Report, The Study on Water Resources Management in the Hashemite Kingdom of Jordan, Volume X. Hashemite Kingdom of Jordan, Ministry of Water and Irrigation, 158 p.