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Report No: ICR00001482

IMPLEMENTATION COMPLETION AND RESULTS REPORT
(Credit No. 3774-YEM)

ON A

CREDIT

IN THE AMOUNT OF SDR 17.6 MILLION
(US$24 MILLION EQUIVALENT)

TO THE

REPUBLIC OF YEMEN

FOR A

SANA'A BASIN WATER MANAGEMENT PROJECT

December 27, 2010

Sustainable Development Department
Middle East and North Africa Region

CURRENCY EQUIVALENTS

(Exchange Rate Effective June 30, 2010)

Currency Unit = YR
YR 1.00 = US$0.005
US$1.5563 = SDR 1
US$ 1.00 = YR200

FISCAL YEAR

January 1 – December 31

ABBREVIATIONS AND ACRONYMS

AOPP	Action Oriented Policy Paper
APL	Adaptable Program Lending
CAS	Country Assistance Strategy
DCA	Development Credit Agreement
DPP	Department of Plant Protection
DSRP	Dam Safety Review Panel
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
EPA	Environment Protection Authority
ERR	Economic Rate of Return
GDI	General Directorate of Irrigation
GOY	Government of Yemen
ICR	Implementation Completion and Results
IDA	International Development Association
IPAC	Information and Public Awareness Campaign
IWRM	Integrated Water Resources Management
MAI	Ministry of Agriculture and Irrigation
M&E	Monitoring and Evaluation
MOPHP	Ministry of Public Health and Population
MWE	Ministry of Water and Environment
NPV	Net Present Value
NWRA	National Water Resources Authority
NWRA-SB	NWRA Sana'a Branch
NWS	Net Water Savings
O&M	Operation and Maintenance
PAD	Project Appraisal Document
PCU	Project Coordination Unit
PDO	Project Development Objective
PSC	Project Steering Committee
SBC	Sana'a Basin Committee
SBWMP	Sana'a Basin Water Management Project
SMT	Social Mobilization Team
SWAp	Sector Wide Approach
TS-SBC	Technical Secretariat of the Sana'a Basin Committee
WRM	Water Resources Management
WSSP	Water Sector Support Project
WUA	Water User Association
WUG	Water User Group
WWTP	Waste Water Treatment Plant

Vice President:	Shamshad Akhtar
Country Director:	A. David Craig
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Project Team Leader:	Yoshiharu Kobayashi
ICR Team Leader:	Yoshiharu Kobayashi

YEMEN, REPUBLIC OF

Sana'a Basin Water Management Project

CONTENTS

A. Basic Information

Country:	Yemen, Republic of	Project Name:	Sana'a Basin Water Management Project
Project ID:	P064981	L/C/TF Number(s):	IDA-37740
ICR Date:	12/28/2010	ICR Type:	Core ICR
Lending Instrument:	APL	Borrower:	GOVERNMENT OF YEMEN
Original Total Commitment:	XDR 17.6M	Disbursed Amount:	XDR 17.6M
Revised Amount:	XDR 17.6M		
Environmental Category: A			
Implementing Agencies: Ministry of Water and Environment			
Cofinanciers and Other External Partners:			

B. Key Dates

Process	Date	Process	Original Date	Revised / Actual Date(s)
Concept Review:	01/31/2000	Effectiveness:	12/22/2003	12/22/2003
Appraisal:	03/11/2003	Restructuring(s):		03/29/2010
Approval:	06/03/2003	Mid-term Review:	10/30/2006	11/25/2006
		Closing:	06/30/2009	06/30/2010

C. Ratings Summary

C.1 Performance Rating by ICR

Outcomes:	Moderately Satisfactory
Risk to Development Outcome:	Substantial
Bank Performance:	Moderately Satisfactory
Borrower Performance:	Moderately Satisfactory

C.2 Detailed Ratings of Bank and Borrower Performance (by ICR)

Bank	Ratings	Borrower	Ratings
Quality at Entry:	Moderately Unsatisfactory	Government:	Moderately Unsatisfactory
Quality of Supervision:	Satisfactory	Implementing Agency/Agencies:	Satisfactory
Overall Bank Performance:	Moderately Satisfactory	**Overall Borrower Performance:**	Moderately Satisfactory

C.3 Quality at Entry and Implementation Performance Indicators			
Implementation Performance	**Indicators**	**QAG Assessments (if any)**	**Rating**
Potential Problem Project at any time (Yes/No):	No	Quality at Entry (QEA):	None
Problem Project at any time (Yes/No):	Yes	Quality of Supervision (QSA):	None
DO rating before Closing/Inactive status:	Satisfactory		

D. Sector and Theme Codes		
	Original	**Actual**
Sector Code (as % of total Bank financing)		
Agricultural extension and research	20	15
Crops	30	5
Irrigation and drainage	50	80
Theme Code (as % of total Bank financing)		
Rural services and infrastructure	33	45
Water resource management	67	55

E. Bank Staff		
Positions	**At ICR**	**At Approval**
Vice President:	Shamshad Akhtar	Jean-Louis Sarbib
Country Director:	David Craig	Mahmood A. Ayub
Sector Manager:	Francis Ato Brown	M. Salah Darghouth
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F. Results Framework Analysis

Project Development Objectives (from Project Appraisal Document**)**
The project development objective (PDO) is to increase both the quantity and the useful life of the available water resources within the Sanaa Basin by increasing the efficiency of agricultural water use and accelerating aquifer recharge, so as to allow time for a gradual shift to a less water-based rural economy.

Revised Project Development Objectives (as approved by original approving authority)
There was no revision of the project development objectives.

(a) PDO Indicator(s)

Indicator	Baseline Value	Original Target Values (from approval documents)	Formally Revised Target Values	Actual Value Achieved at Completion or Target Years
Indicator 1 :	Reduced amount of groundwater used for irrigation of crops in the project areas.			
Value quantitative or Qualitative)	0	7 million m3		14.8 million m3
Date achieved	06/30/2003	06/30/2009		06/30/2010
Comments (incl. % achievement)	Demand management activities of the project contributed to reducing the irrigation water requirement by improving irrigation efficiency from 40 - 50% to 70 - 90 %. The project achieved more than 200% of the target.			
Indicator 2 :	Increased recharge of groundwater aquifers by rehabilitation and construction of dams.			
Value quantitative or Qualitative)	0	1 million m3		1.2 million m3
Date achieved	06/30/2003	06/30/2009		06/30/2010
Comments (incl. % achievement)	Supply management activities contributed to increasing the recharge of shallow groundwater aquifers by increasing seepage from rainwater harvesting through the rehabilitation of 10 dams, reconstruction of 1 dam and construction of check dams.			

(b) Intermediate Outcome Indicator(s)

Indicator	Baseline Value	Original Target Values (from approval documents)	Formally Revised Target Values	Actual Value Achieved at Completion or Target Years
Indicator 1 :	Area covered by improved irrigation systems in the project areas.			
Value (quantitative or Qualitative)	0	4,000 ha		4,130 ha
Date achieved	06/30/2003	06/30/2009		06/30/2010
Comments (incl. % achievement)	The improved irrigation systems have reduced the water conveyance loss by replacing earthen canal with pipes and significantly improved water application efficiency by placing localized irrigation systems. The project achieved 118% of the target.			
Indicator 2 :	Percentage of farmers in functioning water user associations (WUAs) out of the total number of farmers participating in the project.			
Value (quantitative or Qualitative)	0	80%		90%

Date achieved	06/30/2003	06/30/2009		06/30/2010
Comments (incl. % achievement)	Out of 52 WUAs (consisting of 1,149 WUGs with 11,546 farmers) established, 48 WUAs are functioning.			
Indicator 3 :	Percentage of irrigated area expanded by participating farmers in the project areas.			
Value (quantitative or Qualitative)	0	0		Less than 5%
Date achieved	06/30/2003	06/30/2009		06/30/2010
Comments (incl. % achievement)	It was estimated that expansion of irrigation area is less than 5% according to the WUAs' report in the project areas.			
Indicator 4 :	Functioning operation and maintenance (O&M) of the rehabilitated and new dams.			
Value (quantitative or Qualitative)	No operation and maintenance (O&M)	O&M of dams functioning		100% of O&M of dams functioning satisfactorily
Date achieved	06/30/2003	06/30/2009		06/30/2010
Comments (incl. % achievement)	Beneficiaries of 10 rehabilitated dams and 2 new dams were organized into 12 WUAs for carrying out necessary O&M of dams, mainly desilting of sediment of the dams to increase the infiltration of stored water into groundwater aquifers.			
Indicator 5 :	Approval of bylaws to the Water Law.			
Value (quantitative or Qualitative)	No bylaw to the Water Law is prepared.	Appropriate bylaws to the Water Law and regulatory framework will be in place and applied.		The bylaws to the Water Law were prepared and submitted for approval by the Cabinet.
Date achieved	06/30/2003	06/30/2009		06/30/2010
Comments (incl. % achievement)	The project provided technical assistance in drafting the bylaws in the beginning of the project implementation. However, weak commitment of the Government to enforce the Water Law has been delaying approval of this critical bylaw to the Water Law.			
Indicator 6 :	Completion of licensing and registration of wells in the project areas.			
Value (quantitative or Qualitative)	Licensing and registration of wells are nil or very limited.	Licensing and registering wells will be completed.		The registration of 100% of wells of project beneficiaries was completed.
Date achieved	06/30/2003	06/30/2009		06/30/2010
Comments (incl. % achievement)	Weak institutional capacity of NWRA-Sanaa Branch and lack of support from law enforcement officers have been delaying licensing process.			
Indicator 7 :	Groundwater aquifer recharge monitoring systems established.			
Value (quantitative	No recharge monitoring systems exist.	Basin-wide recharge		Basin-wide recharge

or Qualitative)		monitoring systems (including modeling) fully functioning.		monitoring systems are yet to be established.
Date achieved	06/30/2003	06/30/2009		06/30/2010
Comments (incl. % achievement)	The project established a dam recharge monitoring system. However, basin-wide recharge monitoring systems are planned to be established under the WSSP.			
Indicator 8 :	Water conservation attitudes in all segments of populations in the Sanaa basin.			
Value (quantitative or Qualitative)	Baseline survey.	Observable changes in water conservation attitudes in all segments of populations in the Sanaa basin.		A baseline survey was carried out in 2006 and a follow-up impact survey in 2008.
Date achieved	06/30/2003	06/30/2009		06/30/2010
Comments (incl. % achievement)	According to the survey results, there is significant improvement in attitude toward water saving in all segments of populations in the Sanaa basin as a result of information and public awareness campaign.			
Indicator 9 :	Establishment of the environmental resource team.			
Value (quantitative or Qualitative)	No environmental resource team exists.	The environmental resource team is in place and functioning.		The environmental resources team was in place and functioning.
Date achieved	06/30/2003	06/30/2009		06/30/2010
Comments (incl. % achievement)	The environmental resource team was established within the PCU and functioning throughout the project implementation.			
Indicator 10 :	Rehabilitation of unsafe dams.			
Value (quantitative or Qualitative)	Existing dams are unsafe and need rehabilitation.	A total of 11 dams are fully rehabilitated and safe.		The 10 dams were fully rehabilitated and 1 dam was reconstructed to increase safety.
Date achieved	06/30/2003	06/30/2009		06/30/2010
Comments (incl. % achievement)	As part of supply management, the project rehabilitated 10 dams and reconstructed 1 collapsed dam to increase groundwater recharge capacity and improve safety of the dams.			
Indicator 11 :	Implementing an integrated pest management (IPM) plan			
Value (quantitative or Qualitative)	No IPM plan exists.	IPM plans for grapes and qat were prepared and implemented.		IPM plans for qat and grapes were prepared and successfully implemented.
Date achieved	06/30/2003	06/30/2009		06/30/2010
Comments (incl. %	IPM for grapes and qat were prepared and successfully implemented in the pilot project areas for demonstration to other farmers.			

achievement)	

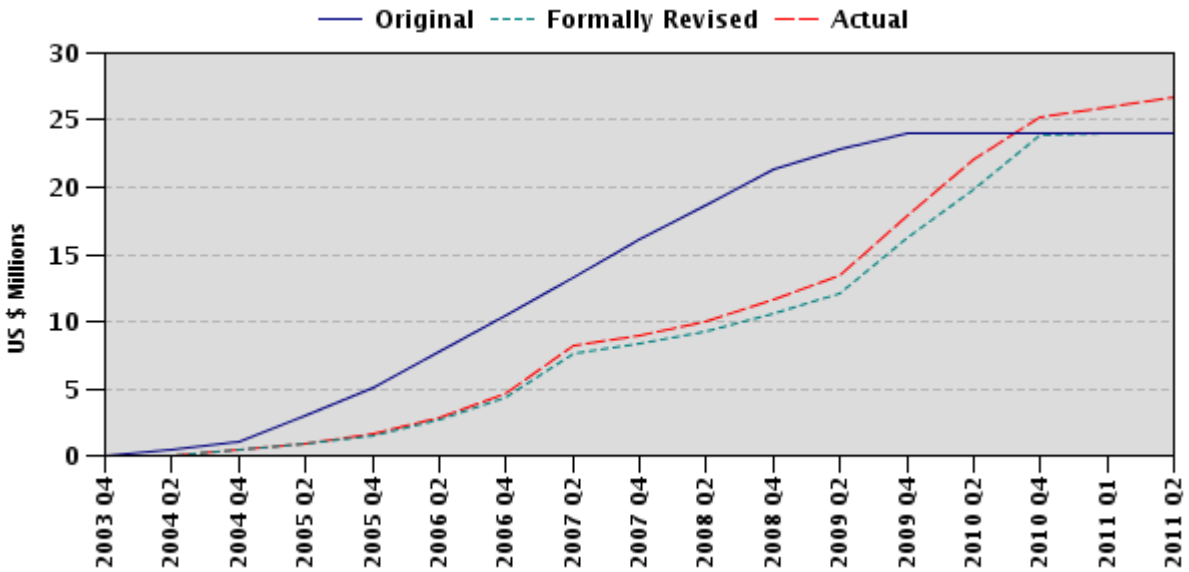
G. Ratings of Project Performance in ISRs

No.	Date ISR Archived	DO	IP	Actual Disbursements (USD millions)
1	06/26/2003	Satisfactory	Satisfactory	0.00
2	12/18/2003	Satisfactory	Satisfactory	0.00
3	04/26/2004	Satisfactory	Satisfactory	0.50
4	10/04/2004	Satisfactory	Satisfactory	0.50
5	03/11/2005	Moderately Satisfactory	Moderately Satisfactory	1.34
6	07/28/2005	Satisfactory	Satisfactory	1.62
7	12/05/2005	Satisfactory	Satisfactory	2.75
8	06/22/2006	Satisfactory	Satisfactory	4.67
9	12/20/2006	Moderately Satisfactory	Moderately Unsatisfactory	7.99
10	04/18/2007	Moderately Satisfactory	Moderately Satisfactory	8.59
11	11/04/2007	Moderately Satisfactory	Moderately Satisfactory	9.58
12	04/01/2008	Moderately Satisfactory	Moderately Satisfactory	10.99
13	07/31/2008	Moderately Satisfactory	Moderately Satisfactory	12.00
14	03/14/2009	Satisfactory	Satisfactory	14.97
15	07/08/2009	Satisfactory	Satisfactory	17.97
16	02/24/2010	Satisfactory	Satisfactory	23.07
17	11/02/2010	Satisfactory	Satisfactory	26.75

H. Restructuring (if any)

Restructuring Date(s)	Board Approved PDO Change	ISR Ratings at Restructuring		Amount Disbursed at Restructuring in USD millions	Reason for Restructuring & Key Changes Made
		DO	IP		
03/29/2010	N	S	S	23.80	Reallocation of the credit proceeds among categories. Introduction of Community Participation as a method of procurement for goods and works.

I. Disbursement Profile



1. Project Context, Development Objectives and Design

1.1 Context at Appraisal (brief summary of country and sector background, rationale for IDA assistance): Yemen has low and limited freshwater availability, with no perennial rivers: water comes from rainfall, springs, seasonal flash floods (spate), and groundwater. Its availability of 115m^3/capita/year is among the lowest in the world, compared to the already-low MNA average of 1,250 m^3/capita/year. Moreover, this water scarcity is exacerbated by significant physical and temporal variations and water allocation problems and a rapid population growth. Unlike the other Arab countries, desalination is not a viable option for most of Yemen since much of the population lives in the highlands, far from and high above the coast. In the highlands, groundwater is almost non-renewable (being pumped at an average rate one and a half times that of natural recharge, and in certain cases this rate is up to four times), and hence it is quickly declining, as fast as 5 m/year in Sana'a Basin. Water availability in Sana'a City, capital of Yemen, is one of the scarcest in the world. The option of bringing in water from outside the basin has been studied, and found highly uneconomical and socially controversial.

Yemen's limited water supply has been rapidly depleted throughout the last 3 decades, due to expansion of irrigated agriculture, which escalated after introducing drilling rigs and energized pumps, encouraged by the diesel subsidy, and due to the rise of competing demands from urban users. Use of groundwater to grow *qat*[1] has been a particularly significant feature in the highlands. This agricultural revolution has brought some prosperity to rural areas in terms of income. However, energy subsidies[2] and restrictions on *qat* import from abroad have resulted in high *qat* internal prices, which have deprived farmers of the opportunity for crop diversification and export competitiveness country-wide, reducing the economic return from irrigation.

The International Development Association's (IDA's) longstanding involvement in the water sector in Yemen put it at the forefront for the Sana'a Basin water management reform agenda. The IDA was the principal partner of the Government of Yemen (GOY) in the water resources management (WRM) and strategy since it worked with the GOY and other donors on the 1997 Water Sector Review and assisted in the development and discussion of the National Water Strategy. The IDA-assisted Taiz Water Supply Pilot Project tested approaches to integrated water resources management (IWRM), which provided valuable lessons for preparing the Sana'a Basin Water Management Project (SBWMP).

1.2 Original Project Development Objectives (PDO): The PDO was to increase both the quantity and the useful life of the available water resources within the Sana'a Basin by increasing the efficiency of agricultural water use and accelerating aquifer recharge, so as to allow time for a gradual shift to a less water-based rural economy, by the following:

(i) Conserve water by introducing farmers to modern irrigation/improved equipment and methods that may save up to 40% of water (demand management).

(ii) Change pumping and water use behavior in the basin through a comprehensive information and public awareness campaign (IPAC) that would touch all segments of the basin population (demand management).

(iii) Accelerate recharge, in order to save precipitation run-off from evaporation (supply management).

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[1] *Qat* is a leafy narcotic. More than 70% of Yemeni men and more than 30% of Yemeni women consume *qat*.

[2] Domestic fuel prices are about 60% below international prices, and energy subsidies amounted in 2009 to about 20 % of the overall public expenditures, and fuel subsidies up to 8% of gross domestic product.

(iv) Obtain a better understanding of the basin's hydraulic situation through systematic monitoring, leading to improved water management (institutional development).

(v) Build a strong and sustainable institutional base for central and local water basin management, including water regulation and enforcement, planning and water allocation, which may be replicated in other basins (institutional development).

1.3 Revised PDO: The PDO was not revised.

1.4 Main Beneficiaries: The primary target groups were farmers receiving subsidized irrigation modernization support from the project and farmers using groundwater recharged by rehabilitation of the dams and construction of spate breaks and check dams. People living downstream of the rehabilitated dams would be also protected from dam failures. Those who have houses and farmlands next to *wadi*[3] would benefit from *wadi* bank protection works. Farmers who use the saved water from the aquifers are also indirect beneficiaries. However, the ultimate beneficiary of the water savings in the basin would be the population living in Sana'a City. Without the project intervention, they would have to relocate to other cities due to scarcity of drinking water in the future.

1.5 Original Components (as approved):

Component 1: Demand Management and Irrigation Improvement (US$11.7 million) aimed to achieve water savings and conservation in agriculture by increasing the efficiency of water use for irrigation through introduction of modern irrigation technologies. It would focus on all or part of 10 selected sub-basins: out of 12,500 ha irrigated lands, the project initial target was 4,000 ha.

Component 2: Supply Management and Recharge Improvement (US$10.2 million) would enhance and accelerate groundwater recharge through mostly small conventional dams, sub-surface dams, and other structures. It was expected that farmers would pump from shallow aquifers instead of the deep aquifers which are critical sources of drinking water for urban and rural domestic use. The project would: (i) build five recharge structures, including 4 dams and a series of low cascading check structures. Other potentially viable recharge technologies, such as underground dams to catch sub-surface flows in *wadis*, spate breakers and water harvesting structures, would also be studied; (ii) rehabilitate existing hill dams to prevent potential dam failure as well as to recover recharge capacity diminished by accumulated sediments; and (iii) establish dam management systems through strengthening capacity of the General Directorate of Irrigation (GDI) of the Ministry of Agriculture and Irrigation's (MAI).

Component 3: Institutional Development and Capacity Building (US$3.2 million) included:

(i) Regulatory Framework Development and Application: Given the flaws of the Water Law, the project would support and assist National Water Resources Authority (NWRA) with the drafting and finalizing of bylaws and regulations to mitigate some of the shortcomings of the law. Subsequently, regulatory systems and procedures for water rights management, including for registration and permit of well users and drillers, would be developed and applied.

(ii) Basin Water Management: The NWRA-Sana'a Branch (NWRA-SB) would assume responsibility for overall basin-wide water resources investigation, regulation and monitoring, including delegation to user groups and monitoring of the regulatory system, overview and execution of water resources research and monitoring programs in coordination with other

[3] A dry riverbed that contains water only during times of heavy rain or simply an intermittent stream.

responsible agencies and stakeholder groups. It would also include supporting the evolution and operation of the Sana'a Basin Committee (SBC) in an equitable and sustainable development and use of the basin's water resources.

(iii) Basin Hydrological and Water Resources Investigation and Monitoring: Systems would be developed through community management to monitor and record climate, rainfall, *wadi* flows and groundwater levels. Investigations and studies would include: (a) analysis of project impacts through dam and other *wadi* structures on aquifer recharge and groundwater levels; (b) exploratory deep boreholes; (c) physical surveys and laboratory testing for aquifer modeling to gain a better understanding of the basin's hydro-geological characteristics and of the groundwater balance; (d) satellite imagery/aerial photography at three points in time during implementation to analyze and quantify impacts on cropped and irrigated areas; and (e) field level water balance assessment at similar intervals to determine the effects of irrigation system improvement on water use.

Component 4: Information and Public Awareness Campaign (US$1.2 million) would be carried out by the NWRA-SB through a specially-staffed IPAC unit in close collaboration with Technical Secretariat of the SBC (TS-SBC). It would consist of an intense program to convey nuanced messages of water conservation to well-targeted population segments using a wide range of media (TV, radio, newspapers, seminars and focus group discussions).

Component 5: Environmental Management Plan and Mitigation Program (US$0.7 million) aimed at improving the overall environmental situation of the Sana'a Basin, notably through water resources conservation, pollution prevention and improving environmental health conditions. Evaluation carried out under the environmental impact assessment (EIA) concluded that other than Dam Safety, Involuntary Resettlement, and Pest Management, none of the safeguards were triggered. A model Pest Management Program for *qat* would be prepared within six months of effectiveness.

Component 6: Project Management and Monitoring (US$1.5 million) would support costs associated with project implementation and monitoring activities including capacity building, procurement of office equipment and vehicles, office operation cost, project staff salary, etc.

Component 7: Phase II Project Preparation (US$1.5 million) would be done during the second half of the project period on the basis of achievement of Phase I of the SBWMP and subject to the findings of the project mid-term review and other assessments.

1.6 Revised Components: There was no formal revision of the components. However, component level targets were attuned in agreement with the IDA during the mid-term review to comply with beneficiaries' priorities. The project monitoring indicators were updated based on these revised targets and recorded in the aide memoires. No supplemental letter was sent as a result of the change in targets. As such, the targets used for assessment in this ICR are those from the Project Appraisal Document (PAD)

1.7 Other significant changes (in design, scope and scale, implementation arrangements and schedule, and funding allocations): At appraisal it was expected that the SBC, over time, would be transformed into Sana'a Basin Agency to become the *Coordinator* of the basin IWRM activities; and the project partner agencies that were responsible for each complementary activity would be strengthened as the GOY's existing line institutional structure. This process did not materialize as expected due to insufficient GOY commitment to the planned reform agenda. In the early stage of the project implementation, the Ministry of Water and Environment (MWE)

was created and the TS-SBC was designated as the Project Coordination Unit (PCU) without any change in its function.

During the course of implementation in 2007, it was decided to consider farmer installation of conveyance pipes and localized irrigation[4] equipment using equipment supply contracts, with outcome-based incentive structure for farmers. This new mechanism for transferring the responsibility of installing conveyance and distribution systems to farmers worked well and improved the pace of installation. The PCU carried out such contracts without being aware of the need for revision of the Development Credit Agreement (DCA) in carrying out community contracts. When this issue was noted, the Republic of Yemen (ROY) requested amendment to the DCA and the amendment was signed on March 27, 2010.[5]

Plans for the SBWMP Phase II and the adaptable program lending (APL) approach were changed in response to the decision to prepare a multi-donor Water Sector Support Project (WSSP), which would fund water sector interventions including the continuation and expansion of the activities piloted by the SBWMP. Allocation under Component 7 was used to help prepare the WSSP.

At the request of the ROY, the IDA agreed in June 2009 to a 6-month extension of the credit Closing Date from June 30, 2009 to December 31, 2009. This extension was needed to complete works on the rehabilitation of the dams. Another 6-month extension of the credit Closing Date from December 31, 2009 to June 30, 2010 was requested by the ROY and approved by the IDA in December 2009 to complete the remaining small contracts. Moreover, reallocation of credit proceeds and inclusion of "community participation" clause in the DCA was requested by the ROY and approved by the IDA in March 2010.

2. Key Factors Affecting Implementation and Outcomes

2.1 Project Preparation, Design, and Quality at Entry: The overall project objectives were consistent with both the current Country Assistance Strategy (CAS) and the National Water Sector Strategy and the Investment Plan in the country. The project was identified by the GOY and supported by the IDA due to the seriousness of Yemen's water scarcity in which the CAS of August 6, 2002, highlighted the sustainability of water resources as being one of the key objectives for IDA assistance, with emphasis placed on improving water management for environmental sustainability and economic growth.

Lessons learned from earlier IDA-financed projects such as the Land and Water Conservation Project had been highlighted in the PAD, such as the avoidance of expansion of irrigated areas, which has been mitigated by inclusion of beneficiary contracts to be enforced by the local community, and the need to encourage farmers to take up project activities by providing a

[4] Localized irrigation is a system where water is distributed under low pressure through a piped network such as drip irrigation, sprinkler irrigation and bubbler irrigation.

[5] A total of 452 contracts valued at US$2.04 million (IDA financing amount US$1.739 million) had already been signed before March 27, 2010 under community contracting. In May 2010, the ROY requested that IDA approve financing of these 452 contracts. IDA carried out post procurement review and physical inspection of 91 contracts, equivalent to a sample size of about 20%, signed by the project before March 27, 2010. The review noted deviations from established shopping procedures; however, considering that this was community participation approach (community contracting), the IDA exercised more flexibility and concluded that the procurement procedures used by the Borrower were in accordance with the Community Contracting Guidelines. Consequently, the IDA approved the reimbursement of these 452 contracts following the merit-based review.

subsidy and using social mobilization to persuade farmers to take up modern irrigation technologies. These were successfully taken up and implemented by the project. The PAD correctly identified Yemen's weak Water Law and institutional arrangements (particularly the NWRA-SB) as high risks for the project, but it overestimated the feasibility of the risk mitigation measures proposed, i.e. rapid preparation and adoption of detailed by-laws to strengthen the Water Law and effective capacity building for the NWRA-SB.

The project as designed had seven components involving intensive coordination and stakeholder involvement including several agencies and line ministries. This required a wide base of coordination which did not readily exist in the country. The project design underestimated the difficulty the project would face in implementing its multiple physical activities (i.e. improvements in irrigation, and rehabilitation/construction of dams) given the number, organizational structure, and weakness in capacity of the GOY institutions involved in water resources management. Moreover, the creation of the MWE in May 2003, three months before the DCA was signed, also complicated coordination among implementing agencies.

It was a mistake in project design to establish the disbursement condition requiring improvement of the quality of effluent and sludge from the Sana'a wastewater treatment plant (WWTP) since this was outside the scope of the project interventions and it turned out to be much more difficult than expected. The condition was never met and the IDA finally had to waive it in order to allow disbursements of civil works under component 2.

The project design underestimated the investments in time and human resources necessary for effective community and social mobilization, particularly for overcoming local skepticism, distrust, and lack of understanding of the project, before the project's physical operations in irrigation improvement and dam construction could begin. This led to significant delays in the early stage of project implementation.

2.2 Implementation (including any project changes/restructuring, mid-term review, Project at Risk status, and actions taken, as applicable): At mid-term review, three problems were evident: (i) farmers were not interested in rehabilitating existing piped conveyance systems but rather preferred to start new systems; (ii) there was slow progress on the delivery of irrigation systems; and (iii) farmers lacked the motivation to join the community management water organizations. The project made changes to accommodate the demand of beneficiaries: reducing the upgrading of existing irrigation systems from 1,660 ha to 150 ha and increasing the conversion of open channels to piped conveyance systems from 600 ha to 2,190 ha. In response to the slow delivery of the irrigation systems and the request of the beneficiaries, the contracts of the five installation companies were terminated and the WUAs were allowed to install the conveyance pipes by themselves, supervise installation of the localized irrigation systems by a plumber, and enable farmers to make in-kind contributions of labor.[6] Requests for assistance were also channeled through WUAs. The piped-conveyance system for transferring pumped groundwater irrigation supplies to the field was well accepted by beneficiaries and there was considerable demand which had been generated for the larger area in all the project 22 basins due to the considerable savings in pumping time, cost of pumping and reduced irrigation water usage.

[6] The poor performance of contractors in installation of piped conveyance and localized irrigation systems made farmers dissatisfied with their works and high costs. This resulted in slow progress in installing of the modern irrigation systems during the first 3 years because the beneficiaries were reluctant to introduce them due to poor reputation.

The slow progress in implementing the irrigation component during the early stage of implementation was also due to lack of farmer's interest in joining the water user groups (WUGs) and WUAs.[7] The formation of the WUGs/WUAs was a prerequisite to beneficiaries and the farmers were not familiar with such associations. In the case of conveyance pipes there was preference for ground polyethylene pipes. However, the PAD clearly indicated the conveyance pipes should be buried polyvinyl chloride pipes to avoid farmers' moving them outside the intended areas of irrigation and thus expanding cultivated areas. The social mobilization teams (SMTs) had to play a very active role to explain the benefits of localized irrigation systems through the WUGs and WUAs. This was finally accepted after intensive awareness-raising campaigns and demonstrations.

The civil works for component 2 were considerably delayed because of several reasons. Firstly, the Sana'a WWTP quality improvements of effluents were not complied with as required by the environmental management plan (EMP) and set out in the DCA. Secondly, there were significant delays in consultants' works[8] and the submission of documents such as designs, drawings and tender documents to the project management. Thirdly, there were delays in establishing WUAs to perform the O&M of the 10 rehabilitated dams as well as the newly constructed Beryan recharge dam. This required a more intensive effort of the SMT and the IPAC staff to persuade the farmers of the benefits of forming WUAs. Fourthly, beneficiaries frequently intervened in the contractor's work leading to delays on construction contracts including the stoppage of work.[9] Contractors were also not given facilities to move rocks and other materials for construction work and were made to go far to obtain the raw materials for construction. The consultants were generally unable to be present on site due to a deteriorating security situation. Local authorities and district authorities were not able to intervene on time to enable works to proceed[10] and keep implementation on schedule.

The four new dams envisaged at appraisal were not built because they were found not feasible. The project constructed a series of check dams and one new dam (Beryan) at the site of an existing dam which was destroyed by earlier floods. Also, three subsurface dams were not constructed due to encroachment of urbanization to the planned construction sites.

2.3 Monitoring and Evaluation (M&E) Design, Implementation and Utilization: M&E activities were initiated in 2003 following the completion of a baseline study by consultants and through ad hoc efforts by the various project teams in an uncoordinated manner. A more coherent system was started in March 2005 with the support of an international consultant and later, with the incorporation of a local M&E Specialist in the PCU in February 2006. M&E reports slowly evolved into more complete and timely management tools as indicators monitoring movement towards the achievement of PDOs were incorporated. At closing, 16 quarterly progress reports were submitted since 2006, as well as several monthly reports. Around 50 outcome and results-

[7] The project supported the establishment of WUGs, usually farmers sharing a single well, and WUAs usually serving a single village, in addition to provision of technical assistance, training and extension.

[8] A consulting firm was engaged to provide overall coordination of component 2; however, they were found to be underperforming in their tasks and their contract was terminated. Unfortunately, no replacement was found to take over the overall coordination role for the activities under the component.

[9] Main requests were inclusion of works which were not in the contract in addition to frequent requests that contractors should employ local labor or hire machinery available from the beneficiaries.

[10] In some cases, this seems to have been due to incomplete inclusion of stakeholders in planning, and lack of understanding and agreement. However, in other cases, this seems to be due to opportunistic behavior with various persons trying to take advantage of the project to obtain additional benefits.

based indicators for the SBWMP covering all seven components were followed providing a good sense of project performance. Project implementation was monitored using these monitoring indicators which were updated quarterly by the PCU. This data was reviewed by the project steering committee as well as IDA missions and used as the basis for supervision of project implementation.

2.4 Safeguard and Fiduciary Compliance (focusing on issues and their resolution): The following summarizes the safeguard and fiduciary issues raised and the actions taken to ensure safeguard and fiduciary compliance.

Pest Management (OP 4.09) – Although the project did not directly promote the use of pesticides or other agricultural chemicals, the EIA recognized the public health concerns posed by the use of these chemicals by farmers in the basin and recommended the implementation of integrated pest management (IPM) plans in order to address them. The EMP indicated that the project would support the mitigation activities of the Ministry of Public Health and Population (MOPHP) through funding and institution building, particularly IPM for *qat* and grapes. The project also supported public education promoting good sanitation and personal hygiene practices in order to reduce exposure to water-based disease vectors. The project supported the MOPHP's Bilharzias Control Project during 2006 in four project districts.

Safety of Dams (OP/BP 4.37) – The EMP recommended preparation of O&M plans and emergency preparedness plans, and establishment of a dam safety review panel (DSRP) to supervise design and construction. The project established and trained 12 WUAs to carry out annual de-silting of reservoirs. The GDI undertakes regular inspection of all dam structures to ensure their integrity and report any potential failures to the responsible authorities in addition to monitoring any speedy repairs and rectifications of any faults. The DSRP reviewed dam designs prepared by two international consulting firms and the GDI and monitored construction/ rehabilitation works. The DSRP provided technical reports based on its review of the dam designs and 6 visits to the dam sites before, during, and after rehabilitation/construction. The DSRP also reviewed the O&M and dam safety manuals, the emergency preparedness plans for each dam and start-up operations, and concluded that project intervention has considerably improved the stability and safety of the 11 dams; however, continuing technical supervision and adequate funding for O&M is essential for dam safety.

Involuntary Resettlement (OP/BP 4.12) – The project design originally included construction of five new dams and a Resettlement Framework was prepared. Four of the new dams were not built. One was built at the *Wadi* Bahman as a series of check dams and another new dam was built in the site of a previously collapsed dam, so no land acquisition was required. As with other IDA-funded projects in rural Yemen, the customary system of donating land for public interest projects has been used for WUA offices, for which land title was formally transferred to the GOY. This process has been based on thorough consultation and prior, informed, consent. In this context it must be recalled that no formal legislation is applied in rural areas, and the IDA approach is therefore based upon well-established community level systems where project affected persons donate land and where no cash compensation is involved.[11]

[11] As emphasized by the June 2009 safeguard review mission to Yemen, the voluntary land donation - if the land is considered small - may be deemed appropriate *in the Yemeni context.* It should however be emphasized that this is dependent upon a well-documented land acquisition and negotiation process.

Procurement –The project did not envisage participation of local communities in the procurement of goods and works and the DCA did not provide procurement through community contracting. During implementation, slow progress on the delivery of irrigation systems was noted, and it was decided to involve community in procurement of irrigation systems. As explained in section 1.7 and footnote 9, the IDA had to carry out a post procurement review of a sample of these contracts followed by physical inspection of actual delivery in the field. This problem would have been avoided, if the need for community participation in procurement had been identified in the beginning and adequate time and resources had been planned for community mobilization which is a rather very major effort. Although there was lack of formal procedures in modifying the DCA for community contracts, project staff satisfactorily carried out procurement in line with the IDA's guidelines, which was recorded in IDA mission Aide memoires.

Financial Management – The project faced the problem of high staff turnover in the financial management unit until the mid-term review. As a result of the midterm review, the project management team was changed under the new project director. A new financial manger improved submission of the financial management reports, prepared an acceptable disbursement plan and budget for the project, and formulated an acceptable financial management manual including accounting policies and procedures and necessary control to be applied. In the latter half of the project implementation, financial management was carried out satisfactorily.

2.5 Post-completion Operation/Next Phase: Over time the PCU has developed an effective way to work with WUGs and WUAs in implementing project activities. The project has carried out a thorough approach to consultation, supported by well-qualified SMTs. The post-project sustainability of WUAs will be supported by the WSSP through establishment of a WUA unit in the NIP. However, in order to make the WUGs and WUAs more sustainable after project completion, a different approach is needed. Ways of addressing this include (i) avoiding unrealistic expectations about perpetual GOY financial support, and (ii) a two-phase approach, which is used under the Social Fund for Development Project, combining (a) intensive participation in implementation with simpler organization for routine O&M and (b) much stronger efforts to develop community water management, based on local institutions including district councils.

By-laws to the Water Law would provide a legal framework for WUAs and basin committees, but these have not yet been issued. The current draft by-laws propose many duties and responsibilities for WUGs/WUAs, societies and unions, but do not provide proportionate attention to ensuring that they have the legal authority to carry out their responsibilities. Review of the draft bylaws indicates that they may still not clearly and specifically empower WUAs to establish mandatory fees, create and enforce rules, and impose penalties including fines or restricting access to water. If the goal is to have a legal framework that enables effective water governance, then the by-laws should explicitly and specifically provide WUAs with the legal authority to make and enforce rules that apply to all users sharing the resource, empowering WUAs to carry out their responsibilities.

The project design did not address the issue of expanding non-agricultural activities, and little has been done within the project to understand or assist diversification into other income generating activities. Some attention has been paid to agricultural extension, but facilitating changes to other crops and improved marketing was not a major area of activity. Therefore, the project offers few lessons regarding adaptation to water scarcity through economic

diversification. Project experience and stakeholder views do indicate that there is large demand and major potential benefits if more agricultural extension services could be provided. Economic diversification and alternative income generation activities would be key issues to be addressed for sustainable development of rural communities under the WSSP.

3. Assessment of Outcomes

3.1 *Relevance of Objectives, Design and Implementation:* The PDO was and is still highly relevant. The National Water Sector Strategy and Investment Program of the GOY (updated December 2008), aims at "sustainable and efficient use of the nation's scarce water resources", which promotes IWRM as a means to attain this. The current CAS (April 2009) recommends that forceful preventive action be taken to slow down the depletion of water resources. Although the project design was in general sound and pertinent for attaining the PDO, risks and mitigating measures related to the regulatory framework enforcement proved to be inadequate.

3.2 *Achievement of Project Development Objectives (details on outputs in Annex 4):* The project exceeded the two PDO indicators attaining more than 200% of the annual water savings target by improved efficiency of agricultural water use and also attaining 120% of the annual recharge target by recharge dam rehabilitation. The reduced groundwater use and increased recharge of groundwater aquifers promoted by the project have definitely contributed to increase quantity and the useful life of the available water resources within Sana'a Basin. This has provided a good foundation for expanding support for these activities under the WSSP. However, the project failed to put in place the planned institutional, legal and regulatory framework to test and validate the model for its expansion to the rest of the basin, which needs to be followed up under the WSSP.

3.3 *Efficiency (Net Present Value/Economic Rate of Return and Financial Rate of Return):* While at appraisal the ERR was estimated at 19.7%, at closing this indicator was estimated at 16.9%, considering a 20-year time frame.[12] As water use and irrigation costs in the project area has been reduced by almost one third (from 47 to 32 million m^3 of water) irrigation costs also were reduced accordingly. Together with crop yield increases, it resulted in productivity of water being doubled from YR64/m^3 to YR132/m^3. The overall Net Present Value (NPV) was estimated at closing at US$7.45 million (55% of the appraisal estimate), using 10% as discount rate (see Table 1 below).

Table 1. Economic Indicators

Economic Impact	Indicators	
	ERR	NPV
At Appraisal (PAD)	19.7%	US$13.6 million
At Completion (ICR)	16.9%	US$7.45 million

[12] All project components' costs were considered in the analysis, including those for which their specific benefits were not quantified (institutional development and capacity building; information and public awareness campaign; environment management and mitigation program; project management; and next phase project preparation studies). No shadow pricing for foreign exchange was performed since the official exchange rate broadly reflect the equilibrium rate. The only corrections introduced on market prices for the economic analysis were: (i) a 1.4 conversion factor for irrigation costs was applied due to the subsidized cost of diesel fuel; and (ii) a 0.8 conversion factor for rural labor, given the high rates of underemployment in rural areas in the Sana'a Basin.

These result indicators do not consider the economic value of water savings from the installation of modern localized irrigation systems (about 14 million m^3/year), which if added at its economic value (using the residual imputation method), the overall ERR of the project increases to 29.6%. In addition to saving water, the project had a positive impact on farmers' incomes, as crop yields and quality of produce improved with the improved conveyance and localized irrigation systems, and labor and pumping costs decreased. Estimations at closing indicate that farmer's incomes have increased on average by: (i) 13% in the case of improved conveyance; and (ii) 39% when modern localized irrigation systems were adopted. Annex 3 provides a detailed presentation of the methodology used for the analysis and the results obtained based on the observations and interviews with beneficiaries in the field. Given these results, it can be said that the project attained its economic and financial goals satisfactorily, validating the water use efficiency measures that are expected to continue to be adopted by farmers in the basin.

3.4 *Justification of Overall Outcome Rating:* **Rating: Moderately Satisfactory**

Both PDO indicators' targets were exceeded at project completion and most of intermediate outcomes targets were achieved. However, lack of results in developing a strong and sustainable institutional basis for central and local water basin management means that there is limited demonstrative progress in slowing down depletion of groundwater in the Sana'a Basin aquifers, the APL Program Purpose and CAS Goal. As a result of weak control in well drilling and water abstraction, aquifer depletion is still continuing at a rapid rate. While the project investments are found to be economically and financially feasible, their sustainability is still questionable because of the life of fossil aquifers is still highly endangered. Therefore, the WSSP should continue SBWMP's effort to find successful ways to govern groundwater, shift agriculture to balanced use of shallow aquifers, adapt livelihoods to a less-water based rural economy, and ensure safe reliable domestic water supplies for urban and rural people.

3.5 *Overarching Themes, Other Outcomes and Impacts:*

(i) Poverty Impacts, Gender Aspects, and Social Development: Poverty reduction was not an explicit project objective for the SBWMP. The benefits from improving irrigation efficiency and from recharge improvement have helped to mitigate some impacts of aquifer depletion and to increase incomes. Although detailed information on poor farmers as proportion of beneficiaries was not available, installation of modern irrigation through WUAs with community contracting and in-kind labor contributions did make investment in irrigation efficiency more affordable for poorer farmers.

The project developed women's WUGs and WUAs, which helped improve awareness of the risks of water depletion, and understanding of ways to conserve water in agriculture and domestic use. Although this approach was effective, given the high degree of gender segregation in Yemeni society, the sustainability of these organizations is uncertain. The ICR mission confirmed that there is substantial acceptance that women should have a major role in future water management activities in the communities and the National Women's Union should provide guidance and support to women's activities in water management.

While project staff initially met with skepticism and hostility about project benefits and objectives, the project eventually developed good working relationships with farmers and local leaders, within which debate, open discussion, and negotiation seem to function well. Patience, diplomacy and consistency in project implementation have developed the social capital of trust between stakeholders and project staff. This is further indicated by the high degree of satisfaction

with the project's approach and desire that this be continued. However, for community water management, the emphasis was on having WUAs promote compliance with regulations prohibiting unlicensed well drilling. There seems to have been relatively little recognition or support for developing other local activities to protect domestic water supplies, regulate land and water rights, resolve water-related disputes, and adapt collectively to increasing water scarcity. Given the lack of success of top-down regulatory approaches pursued during the SBWMP, much greater attention should be given to community-based governance, with specific support through technical advice and enforcement under the WSSP.

(ii) Institutional Change/Strengthening: Although the project attained most of physical targets, it relied heavily on contractual staff and project modalities, and so did little to enhance the capacity of the main water agencies including MWE, NWRA, NWRA-SB, and SBC. This is attributable to lack of (a) qualified staff; (b) staff incentives; (c) proper management; (d) budget allocation; (e) morale; and (f) leadership. Despite various training programs carried out under the project, the impact of the training seems minimal.

Water user participation could be sustained and scaled up through increased attention to the development of IWRM at the community and district/sub-basin levels. Great potential exists for providing information and facilitation to help stakeholders assess their situation, consider options, prepare action plans and carry out integrated community water management, with support from the WSSP. A participatory water assessment process should focus on assuring access to drinking water sources, avoiding harmful addition of wells and expansion of irrigation, promoting efficient use of water, more intensive recharge and management of shallow aquifers, and helping communities adapt to increasing water scarcity, including through livelihood diversification. Participatory water management at the village and district levels would be part of decentralized basin WRM, working under the guidance of the SBC.

(iii) Other Unintended Outcomes and Impacts: Improvements in irrigation efficiency are making irrigated agriculture more profitable. Without limits on abstraction, they may accelerate aquifer depletion. The net impact of the project may thus vary, depending on the extent to which "savings" by project farmers are offset by more intensive irrigation, more irrigation by other farmers, and continued overuse of wells that otherwise might not have been worthwhile to use or deepen. Within the project areas, this has not been observed yet but may happen if there is not proper control of groundwater by WUAs.

For rehabilitation of recharge dams, in some cases increased recharge upstream aquifers may reduce water available to those further downstream, shifting its location. While Yemen has a long history of managing rights to surface water, understanding of and institutions for regulating rights to groundwater are less well developed. Consultation during design and implementation was sought to address issues of upstream and downstream water rights where they have been raised by stakeholders and tried to find equitable solutions within the respective WUAs.

3.6 Summary of Findings of Beneficiary Survey and/or Stakeholder: Annex 6 summarizes some key points from the Sana'a Basin Water Conference, held during the ICR Mission, which reviewed project achievements and discussed proposals for second phase activities under the WSSP. The conference recommended that activities piloted by the SBWMP be continued under the WSSP, emphasizing the need for concerned agencies to integrate their implementation. Recommendations for adjustment include: (i) increasing the role of district councils and WUAs in sub-basin governance; (ii) simplifying procedures for well licensing and handling violations;

(iii) tightening regulatory control over drilling rigs; (iv) greatly strengthening NWRA-SB; and (v) engaging in public-private partnerships for water supply.

4. Assessment of Risk to Development Outcome. Rating*:* Significant

One of the critical risks identified at appraisal was the possible expansion of irrigated agriculture as a result of savings in water using the more efficient irrigation systems. The main mitigation measure has been "contract agreement" signed by beneficiaries and to be enforced by community management institutions. Few violations have reported to have taken place. Another risk was the unlicensed drilling of wells in the Sana'a Basin. During the period of 2005-2009, 614 wells were illegally dug in the Sana'a Basin while only 106 wells had been licensed. This clearly shows serious lack of governance in the Sana'a Basin and the project failed to succeed in improving the regulatory framework and developing effective enforcement.

If the water saved by beneficiary farmers is being used by others, there will be little net benefit to society and sustainable aquifer management. Achieving an impact requires scaling up the use of modern irrigation technologies and limiting groundwater abstraction by controlling drilling of new wells and halting expansion of irrigated areas. The only feasible way to this probably requires a combination of vigorous development of bottom-up community WRM and more effective regulation by NWRA, security officials and a functioning judicial system. Given the difficulty of the problems and the limited political commitment shown to date, NWRA's task to support IWRM seems impossible, unless and until there is a substantial change in political support and drastic improvements in the capacity of NWRA headquarters and branches.

A further risk foreseen at appraisal was that the Sana'a WWTP's lack of improvement could cause a health hazard and risk aquifer pollution. The PAD grossly underestimated the risk of failure to improve the WWTP in a timely manner, rating it as medium risk, as well as the mitigation measure proposed, i.e. the GOY's commitment to improve it. The result of the monitoring quality of waste water from the Sana'a WWTP showed no improvement, meaning that the risk has not been mitigated by the project.

The need to ensure an appropriate GOY role in O&M for dams, particularly large dams whose failure could have serious consequences for life and property, was not adequately recognized. The PAD says that there would be routine inspection of dams to review safety and performance, but assumes that all O&M will be done by beneficiaries. Plans for O&M, particularly for medium and large scale structures, should not assume that all O&M tasks could or should be done by farmers, and instead should be based on a realistic assessment of the capacity of GOY institutions, and on an appropriate combination of responsibilities. This should recognize the technical capacities of the local government, the institutional capacities of communities, and the financial constraints of farmers, WUAs, and GOY agencies; particularly the obstacles that both agencies and WUAs typically face in mobilizing resources for preventive maintenance that would be technically and economically advisable but is often at a high risk of being neglected.

5. Assessment of IDA and Borrower Performance

5.1 IDA

(a) IDA Performance in Ensuring Quality at Entry. **Rating: Moderately Unsatisfactory**

While extensive and valuable work was done during preparation of the project, and the strategy was sound, the institutional arrangements did not consider, and were greatly disrupted, by the

establishment of the MWE, something the IDA and other donors were aware of and supported. The potential problems resulting from conflict between the MAI and MWE were not adequately anticipated and adequate mitigating measures were not prepared. The Sana'a WWTP conditionality was not pertinent since it was beyond the PCU's capacity to solve. The planned new recharge dams under the supply management component were not adequately assessed at appraisal.

(b) Quality of Supervision: **Rating: Satisfactory**

A total of 12 IDA supervision missions were carried out twice a year. In order to deal with difficult policy issues including institutional reform, major effort of the supervision missions were focused on the donor coordination and the preparation the WSSP from mid-2007 to mid-2009. The issues identified in the mission aide memoires were clearly stated in the management letters and followed up by the next missions until they were resolved. With close monitoring of disbursement by the IDA, almost full disbursement was attained at the end of credit closure.

(c) Justification of Rating for Overall IDA Performance: **Rating: Moderately Satisfactory**

The IDA has promptly responded to queries from the PCU and other GOY agencies on implementation issues and procurement and financial management aspects of the project, which was appreciated by the GOY. The disappointing results from the third component, including the deficiencies concerning the creation of the institutional, legal and regulatory framework, test drilling and basin modeling may be primarily the responsibility of the Borrower or contractors, but IDA missions could have been more active to help the PCU overcome the problems. In consideration of these, overall IDA performance is rated as "Moderately Satisfactory".

5.2 Borrower Performance

(a) Government Performance: **Rating: Moderately Unsatisfactory**

In spite of the continuous support of GOY authorities, on the ground the GOY was not able to fulfill several commitments necessary for the full success of the project. Firstly, the disbursement condition of the DCA stating that the GOY would carry out the improvement of the Sana'a WWTP within a year, was not complied with, which made it necessary for the IDA after continuous delays, to remove the condition in order to unlock and proceed with the project investments. Secondly while the project provided assistance in preparation of the by-laws for the Water Law since the early stage of the project, the by-laws have not yet been ratified by the GOY, which significantly affected the performance of the project as there was a legal inability to assure effective enforcement of the required regulations. Thirdly, the project could not strengthen water agencies as planned because of insufficient commitment of the GOY to enforce their active participation and to create the enabling settings. It is crucial for the GOY to beef-up its commitment to improving water governance in Yemen in order to save limited fossil groundwater to the next generations.

(b) Implementing Agency or Agencies Performance: **Rating: Satisfactory**

The PCU (see 1.7) faced difficulties in relation with NWRA and the GDI in the early stage of project implementation. This had been resolved by replacing PCU Director. Under the strong leadership of the new PCU Director, the PCU staff was committed to the project implementation, which is evident by the achievements of their strong teamwork. Their commitment to the work, in spite of their initial inexperience with project implementation, contributed to the success of the

SBWMP. Although the PCU managed to attain most of their project targets, NWRA-SB was not able to assume their responsibilities and role as expected.

(c) Justification of Rating for Overall Borrower Performance: Rating*:* **Moderately Satisfactory**

Although the GOY's performance was "Moderately Unsatisfactory", the satisfactory performance of the PCU especially at the second part of the project implementation allowed for recovering most of the time lost, far exceeding expectations at the mid-term review.

6. Lessons Learned

Strategic Approach – Implementation of effective groundwater governance, particularly control over well drilling and groundwater use, as part of IWRM by NWRA and communities requires strong commitment and support of the GOY and stakeholders, particularly water users. The approach should be more focused on critical sub-basins and on more specific and achievable objectives such as: (i) assuring access to drinking water, protecting the deep aquifer for the highest priority needs; (ii) improving recharge and balanced usage of shallow aquifers; and (iii) expanding non-irrigation livelihoods. Local communities need to assume the leading role, supported by technical advice and well-targeted enforcement of the GOY.

Institutional Complexity – Projects should not underestimate the difficulty in implementing activities in the water sector in Yemen given the number, organizational structure, and weakness in capacity of GOY institutions involved in IWRM.

Community Mobilization – Projects should not underestimate the time and human resources necessary to achieve effective community and social mobilization, especially in the development of local understanding, support and capacity to cooperate in implementation, as reflected in the functioning of local organizations, so that investments in IWRM can succeed. Well-qualified SMTs are able to develop local understanding from scratch, grow good working relationships, and develop strong capacity. Objectives and indicators should shift from an overemphasis on formal WUAs to a recognition of the range of different kinds and scales of organization, and performance indicators related to the specific ways in which local collective action helps to achieve project objectives, e.g., through building understanding and support for the project efforts; coordinating action by users in planning and implementation; and developing norms, monitoring, and enforcement of local self-regulation for groundwater governance.

Pilot Demonstration – Demonstration of new irrigation technologies to improve irrigation efficiency in pilot farms was very effective in expanding modern irrigation in rural Yemen.

Conditionality – Projects should avoid establishing legal conditions or requirements that are clearly beyond the scope of the project to deliver (2.1 on page 5).

Community Contracts – Timely action would have been better in recognizing the need for amending the DCA when it was decided (2007) to consider farmer installation of localized irrigation equipment using equipment supply contracts, with outcome-based incentive structure for farmers. This new mechanism for transferring the responsibility of installing conveyance and distribution system to farmers worked very well with improvement in the pace of installation.

Qat – Increases in irrigation efficiency make *qat* more profitable and thereby worsen groundwater depletion, unless expansion of irrigated area and groundwater extraction can be limited effectively. *Qat* is problematic, as a major driver of aquifer depletion, for its impact on

expenditures and family welfare, for health risks from pesticides, etc. Since the IDA is supporting the GOY's *Qat* Reduction Program, it should not support activities that would undermine or counteract this. If the goal is to reduce water use in *qat* while not subsidizing irrigation equipment for *qat* farmers, then the existing farms could be supported by extension to increase irrigation efficiency and training for installing modern irrigation equipment.

Management Involvement – It is crucial for the Management to be involved in resolving the institutional issues of the Government in the early stage of the project implementation.

Involvement of GOY officials – GOY officials should be fully involved from project identification to appraisal phases. Involvement of national consultants during these stages as counterparts to the foreign consultants would lighten the burden of GOY officials but the chance of on-the-job training of GOY officials would be lost, which would result in delay in project start-up due to lack of capacity.

7. Comments on Issues Raised by Borrower/Implementing Agencies/Partners

(a) Borrower/implementing agencies: The issues raised by the implementing agencies are commented as follows.

- The preparation period of the SBWMP was too long (36 months) and risked changes in the political environment, which affected project scope and design. This is a valid comment and should be considered in the preparation of future projects in water sector.
- The project was too complex, involving seven components and multiple GOY institutions. Although IWRM requires wide areas of interventions, a future project could focus on fewer key areas of intervention to improve IWRM.
- The project's social mobilization and creation of community-based water management organizations delayed the physical operations compared to what had been planned, but ultimately led to better results, particularly once communities were more closely involved in implementation. The WSSP should avoid concentrating narrowly on physical progress and disbursement in a disintegrated way and ensure sufficient staff, budget, and time required for participation, institutional change and more sustainable results.
- The legal covenant on the Sana'a WWTP delayed implementation of project activities. Any covenant which is beyond the scope of the project to deliver should not be included in the DCA.

(b) Cofinanciers: None.

(c) Other partners and stakeholders: Project stakeholders include beneficiary farmers, line ministries, regional and local authorities, contractors, consultants, and professionals from a wide range of disciplines, both male and female. The PCU was always open to views and comments of the stakeholders through workshops, training, field visits, IPAC activities, and SMTs' direct contact with them, and took necessary action to resolve any issues raised, which was appreciated by majority of the stakeholders.

ANNEX 1: Project Costs and Financing

(a) Project Cost by Component (in US$ million equivalent)

Component	Appraisal estimate (US$ million)	Actual/latest estimate (US$ million)	Percentage of appraisal
1.Demand management and irrigation	9.90	10.27	104%
2. Supply Management and recharge	8.20	8.80	107%
3. Institutional development & Capacity building	2.80	3.82	136%
4. Information and public awareness .	1.00	0.94	94%
5. Environment Management	0.60	0.88	147%
6. Project Management, M&E and finance	1.30	1.10	85%
7. project Phase II preparation	1.20	0.96	80%
Total baseline cost	25.00	26.77	
Physical contingencies	2.70		
Price contingencies	2.30		
Total project Costs	30.00		
Total financing required	30.00		
IDA	24.00	26.77[13]	112%

(b) Financing

Source of funds	Appraisal estimate (US$ million)	Actual/latest estimate (US$ million)	Percentage of appraisal
Total Project	30.00	33.27	111%
Borrower	6.00	6.5	108%
International Development Association (IDA)	24.00	26.77	112%

[13] The total amount spent is larger than the original appraisal estimate because SDR has appreciated during project implementation. Out of the total credit amount of SDR17.6 million, only SDR1,650.07 was cancelled at project account closure.

ANNEX 2: Outputs by Component

Component 1: Demand Management and Irrigation Improvement

This component aimed to achieve water savings and conservation in irrigated agriculture by introducing modern irrigation systems and equipment in the Sana'a Basin. It was envisaged at appraisal that it would include upgrading of the existing piped systems (1,660 ha), conversion of open earth channels to piped delivery systems (166 ha), introduction of localized irrigation systems to farms already served by satisfactory piped delivery systems (1,960 ha), land leveling for areas where no localized irrigation systems are included (315 ha), construction of *wadi* bank protection works in some vulnerable reaches, use of plastic tunnels/covers for demonstration areas (10 ha) with localized irrigation systems. The component would also support functional community organizations such as WUGs and the establishment of WUAs at the village level, assistance in institutional development for community management in O&M systems, provision of capacity building for irrigation systems development and provision of extension and training programs.

Several modifications had to be made to this component, which is a result of insufficient assessment of requirements of potential beneficiaries at appraisal, including almost total cancellation of the upgrading of the existing piped systems (1,660 ha reduced to 150 ha of which only about 70 ha were implemented). This was replaced by increases in the conversion of earth channels to piped systems, which was preferred by beneficiaries (600 ha increased to 1,440 ha, and then to 3,048 ha by project closure). Localized irrigation systems met reluctance by beneficiaries in the early stage of project implementation; however, the project's active and effective awareness campaign convinced farmers of the benefits of these systems in water conservation and improved yields, resulted in 1,685 ha implemented by project closure representing 86% of the target envisaged at appraisal.

The *wadi* protection works were completed protecting about 315 ha of agricultural land, while the land leveling was cancelled due to lack of interest by farmers. The construction of small plastic tunnels was also cancelled and replaced by 58 green houses to demonstrate technology of protected culture using drip irrigation system (2.2 ha) with five such green houses having been given to the agricultural research center of Sana'a University.

This component was to develop community management of O&M of infrastructure implemented under the project which resulted in the successful establishment of 48 functioning WUAs, 1,149 WUGs for a total membership of 11,546 farmers. Of the WUAs 38 were found to be active and discharging their duties in a satisfactory manner as a result of which project management decided that to support the sustainability of these associations, it would be necessary to construct and provide basic furnishing for a small office cum a meeting room to house their activities. While the construction of WUA offices was not envisaged at appraisal, it nevertheless does provide a positive incentive for the WUAs to continue to function after project closure. This eliminates the need for them to pay most of the dues from members to rent accommodation and having negative cash flows which might result in discontinuing their activities soon after project closure.

WUAs contributed effectively to project implementation; however, their sustainability as currently developed is questionable. During the ICR mission, the Minister of Water and Environment, the Chairman of NWRA and others stressed the need to develop WUAs that can rely primarily on their own resources, and which do not expect to depend on continuing financial support from the GOY. WUAs, including those acting as aquifer management organizations,

need legal authority to levy fees on water users, not just those who volunteer to join and contribute. The Social Fund for Development Project uses a two-phase approach to community organization, with intensive involvement of many people during implementation, and much simpler organization for routine O&M afterwards. Such a two-phase model for organization could help to create more realistic expectations about what WUAs might continue to do. If WUAs, in whatever form, are providing specific useful services, such as protecting against illegal well drilling and other harmful activities, resolving disputes related to water, and helping farmers learn how to use water more efficiently and profitably, then this should provide a basis for financial support from water users, district councils and other sources.

Component 2: Supply Management and Recharge Improvement

This component aimed to enhance groundwater recharge through new artificial recharge schemes including 4 conventional dams, 3 sub-surface dams, a series of check dams, 20 spate breakers, water harvesting pits, and 2,500m terrace rehabilitation in addition to rehabilitation of the 11 existing conventional recharge dams. These would enhance recharge of the quaternary alluvial shallow aquifers so that farmers pump irrigation water from the shallow recharged aquifers to save the deeper Tawilah sandstone aquifer for drinking of the population of Sana'a City. The component also included institutional development, capacity building for community management of O&M of dams and recharge systems in addition to support in implementation of works through use of consulting services and works contracts.

Several modifications had to be made to this component, as a result of insufficient assessment of the situation at appraisal. These included the decision not to construct four new recharge dams based on the result of IDA review that the proposed new dams were not feasible investments at a time when the consultants' designs were at an advanced stage. The sub-surface dams were also cancelled because the planned dam sites had already been significantly influenced by urbanization of Sana'a City; however, no attempt was made to replace these by other locations, thus losing the opportunity of trying such an innovation in the Sana'a Basin.

The implementation of this component experienced serious delays due to the condition envisaged in the Schedule 1, Clause 3 of the DCA which stipulated that no expenditures will be disbursed under the Credit for civil works under Component 2 until the Borrower submitted evidence that the quality of the effluent and sludge produced by the Sana'a WWTP met the specifications agreed in the EMP. These requirements were not met by the other project causing considerable delays in commencement of civil works for this component.

Component 3: Institutional Development and Capacity Building

The original cost estimate for Component 3 was US$3.2 million, and about US$3.6 million was spent, 10% over the budget. It aimed at building a sound, efficient and sustainable institutional and managerial base for IWRM, both during the project period and beyond it. In contrast to the specific focus on the demand and supply management improvements of the first two components, this third component was intended to overarch and integrate sector-wide, basin-wide and project-wide aspects through: (i) adjustment of the water sector's legal, regulatory and monitoring framework and processes for NWRA Headquarters; (ii) basin water resources planning and management for NWRA-SB; (iii) capacity building for basin-based stakeholder water management and institutional development relating to the sub-basins' Water User Federation and the SBC; and (iv) development of specific hydro-geological and water resources monitoring and

investigation studies and capabilities with and for the NWRA-SB and MAI. The main output was expected to be an efficient and sustainable institutional and managerial groundwork pilot for basin-based IWRM that would be expanded nationwide in the following phases.

Although considerable progress was attained, most of the core expected results are still pending, and reasonable doubts remain about its overall completion, including the following issues: (i) the Cabinet approval of the groundwater regulatory by-laws, and its operational validation through enforcing the new policies with NWRA; (ii) testing and introduction of guidelines, systems and procedures for water rights recognition, registration, licensing and administration with and for the NWRA-SB; (iii) effective well and tanker registration with NWRA-SB; (iv) follow-up satellite imagery studies for monitoring changes in irrigated areas, cropping patterns and evapo-transpiration levels, which are crucial for project impact and water balance assessment analysis; (v) creation of the WUFs at the sub-basin and overall Sana'a Basin levels for participatory multi-source and multi-use IWRM; (vi) the drilling and testing of 3 exploratory wells to an approximate depth of 1,000 meters to obtain information about aquifers, and new sources of drinking water; and (vii) the development of institutional capacity in line agencies/ministries, and of synergies among partner agencies working in the water sector, including those under the MWE, MAI, NWRA, etc.

As a result of these shortcomings in the expected project achievements, while 106 wells were licensed during the period of 2005-9, 614 illegal wells were reported,[14] and groundwater depletion continues to increase in the Sana'a Basin. After 7 years of SBWMP support, the GOY is yet unable to enforce the new water legal framework, and control the random drilling which is undermining the most important resource for the livelihood of the people in the country.

Under Component 3, the international consultant has prepared water balances for the Sana'a Basin for 2007 and 2008, synthesizing earlier data and using new data collected during the assignment: (i) hydrological monitoring in 4 sub-basins; (ii) water balance estimations in 6 reservoirs based on field data in 2007 and 2008; and (iii) field water balance at the farm level (both furrow irrigation and localized irrigation techniques). The consultant summarized the annual water balances and compared them with the water balances prepared by JICA[15] (2006) and by GWMATE[16] (2003). The results show that the average annual depletion calculated by the consultant is higher than earlier estimations. This is caused by the lower values for the irrigation return flow used by the consultant. Although the annual water balances show differences, the overall conclusion is consistent and confirms the high level of depletion that has been taking place in the Sana'a Basin and consequently the urgent need to reduce the over-abstraction, which, in the Sana'a Basin, means that the consumptive use of groundwater (for domestic and agricultural use) exceeds the natural replenishment (recharge from rainfall and runoff). This depletion started in the 1980s and has grown to about 280 million m^3/year.

The assessment of water resources potential in the Sana'a Basin has synthesized information from a wide range of sources and provided a framework and starting point for further work. Unfortunately, it failed to provide clear information for a more accurate groundwater storage estimate required for decision-makers. Therefore, the following things still need to be carried out

[14] Cases of unlicensed drilling by drilling contractors are increasing and only few cases were referred to the prosecutor with minimum fines decided by the Courts. Consequently, the process has not taken off and remains ineffective.

[15] Japan International Cooperation Agency.

[16] Groundwater Management Advisory Team of the World Bank.

under the WSSP to improve the information that provides the basis for model calculations, refine the model as a tool to support management, and to present results so that they can be easily understood and used to help make decisions:

(a) Conduct additional deep drilling studies in the Tawilah Aquifer, including the portions outside the basin. Suitable analysis of cores, or (where cores are not feasible) of materials obtained during drilling, should be arranged in order to better understand the characteristics of the aquifer;

(b) Carry out additional data collection and analysis to understand porosity and specific yield, particularly for the Tawilah Sandstone Aquifer, how this varies in relation to faults and other factors, and the implications for estimating available water;

(c) Increase the number of wells and pumping test information used to estimate hydraulic conductivity parameters, including statistical assessment to exclude or suitably re-categorize values that are extreme or seem to belong to different distributions (for example hydraulic conductivity in gravels rather than sandy or silty alluvium). Additional data collection and analysis should be used to refine empirically based estimates of vertical conductivity as well as horizontal conductivity;

(d) Refine estimates of calibrated values for hydraulic conductivity, and analyze the implications for the distribution of impacts from continuing deepening of wells, from action to save water and for aquifer recharge (i.e. the extent to which benefits are retained locally or rapidly lost to other areas). The implications of faults and other structural features should be included in this analysis, as well as empirical analysis from areas where significant levels of water saving or recharge activities have been carried out; and

(e) Define priorities for the well monitoring program that would identify what kind of wells and what kind of data will be most useful for improving understanding and management of the aquifer. Among other things, this would emphasize wells with properly installed casing, and at relevant depths, to provide information that can be linked to specific aquifer units.

The groundwater model developed by the project consultant was used to simulate 4 scenarios for future water management as follows: (i) representing the present status based on the year 2005 and is based on maintaining status-quo and not introducing any management measures. A simulation of this situation at the year 2020 was made whereby the predicted water balance components for 2020 were computed for the continued present rate of pumping, under the same present rate of groundwater recharge; (ii) simulating the effect of water augmentation, i.e. the increase of groundwater recharge considering the ongoing NWRA activities related to recharge improvement and the GOY strategies to increase recharge; (iii) aiming at maximum sustainability by reducing consumption of water resources and increasing the groundwater potential, based on the WRM action plan for Sana'a Basin prepared by JICA in 2007; (iv) combining scenarios (ii) and (iii), and simulating the effect of the 2007 WRM action plan and the ongoing GOY plan for increasing recharge in some selected sub-basins.

Other scenarios may be needed to verify the impacts of specific management measures and strategies that may be defined in the follow-up phase of the Sana'a Basin IWRM under the WSSP. Estimates for sub-basins from the study do provide a framework for further data collection and analysis to support management actions fitted to the conditions of different sub-basins.

Component 4: Information and Public Awareness Campaign (IPAC)

The IPAC was well-designed, covering the full scope of stakeholders and outlined a program using multiple media. Much of this was done in a highly participatory manner, through workshops and training. In the project design framework, the objective of the IPAC activities was to change pumping and water use behavior in the basin. The key performance indicator was for IPAC to have generated observable changes in water conservation attitudes in all segments of populations in the Sana'a Basin. Data was to be collected through a scientific survey on behavioral changes compared to a baseline study.

IPAC team has carried out an energetic campaign using a wide range of media to reach targeted audiences. Awareness of the dangers of aquifer depletion and need for water conservation has improved significantly in urban and rural areas according to the results of pre- and post-project surveys. The campaign has covered the population segments identified in the PAD, including school administrators, teachers and students; imams and prayers in mosques; parliamentarians; journalists; small and large farmers; WUA leaders, women and men; industrial users; agricultural extension agents; and authors of educational books. This has been done through workshops, seminars and training activities. Training was provided to 52 members of WUA committees, 180 women, and 25 agricultural extension agents. Awareness materials produced by IPAC team include 5,000 copies of a cassette on the water situation in the Sana'a Basin; 15 quarterly newsletters; brochures; leaflets; pamphlets; 12 booklets on several topics; 2,000 calendars; a game; seven TV flashes; and three documentaries on the project, irrigation, and water saving. Specific awareness campaigns focused on 44 public schools, many mosques, and the project WUAs, as well as 37 women's WUAs that the IPAC team helped establish. Initial assessment forms (pre-test) had been distributed before several awareness programs, to be followed by later assessment and analysis to measure changes in community awareness. IPAC activities have been well integrated with and have closely supported other project activities, particularly irrigation modernization and WUA development. This has been a highly successful component of the project. During the ICR mission, stakeholders urged that the IPAC be continued and expanded, with even more attention to the specific needs of rural people.

Component 5: Environmental Management Plan and Mitigation Program

The EIA of the SBWMP identified a number of environmental and social issues to be raised by the project (i.e. design, construction, and operational issues; dam safety; pesticide management, environmental health; wastewater management; and resettlement/land acquisition) and recommended appropriate mitigation measures and monitoring activities in the EMP in order to address any potential adverse impacts. The EMP included measures to ensure adequate consideration of environmental impacts in the design, construction and operation of the project's physical interventions (particularly the dams). The design issues related mainly to the dams, their access roads, quarries and borrow pits, ensuring that their designs and sites took environmental impacts into account; avoided settlements, cultivated lands, cultural property, and valuable ecosystems; and met international design practices. The construction issues, involving short-term environmental risks and worker health and safety concerns, would be addressed in the environmental, health, and safety clauses included in the construction contracts. The operational issues, associated with the dams, would be addressed in agreements reached by farmer groups on the minimum releases necessary to protect the water rights of downstream users and the routine management of siltation problems in the reservoirs.

The outputs provided by the project included the following:

(a) Dam safety, for which the project established a DSRP, composed of three dam experts, to review dam design reports and visit the dam sites before, during, and after construction in order to ensure the safety of the 10 existing dams rehabilitated, the one new dam, and a series of check dams constructed under the project. The DSRP carried out a total of six missions, producing reports and recommendations;

(b) Integrated pest management, for which the project worked with MAI/DPP to promote implementation of IPM plans for grapes and qat, to reach thousands of farmers in the Sana'a Basin with IPM and pesticide management practices, and to strengthen the technical capacity of DPP staff and enhance its laboratory capabilities for pesticide residue testing;

(c) Environmental health, for which the project worked with the MOPHP and supported its Bilharzia Control Project, which assessed the incidence of bilharzias in school children in four project districts, eradicated the disease vectors in infected water bodies in those districts, and provided treatment for infected school children in the two highly infected districts;

(d) Public awareness and education, for which (as discussed under Component 4) the project produced general information and public awareness campaigns on water conservation and management; designed and produced public awareness materials (e.g. booklets, brochures, television spots); organized workshops, field days and seminars for targeted audiences (e.g. farmers, schools, mosques); and delivered a special awareness campaign for farmers affected by the effluent from the Sana'a WWTP; and

(e) Institutional development and capacity building in GOY institutions, for which the project provided training for staff of:

- the NWRA-SB, the GDI, and the MWE in topics ranging from IWRM, localized irrigation and water management, water rights and policies, water quality control, and water savings in irrigation management, to the design of awareness plans, the use of remote sensing and GIS, and the preparation of socio-economic studies;
- the Environmental Protection Authority in environmental impact assessment, monitoring and enforcement;
- the SBC in water rights and policies and integrated water resources management;
- the DPP in IPM practices and for laboratory staff in DPP in pesticide residue testing and analysis; and
- the Bilharzia Control Project of the MOPHP in *bilharzias* control and eradication programs.

The project's main issue related to Component 5 was improvements at the Sana'a WWTP. As discussed earlier, under the project, the GOY committed to improve the quality of the effluent and sludge from the Sana'a WWTP. In the end, this required decisions on major investments to improve the capacity and operation of the Sana'a WWTP by GOY institutions over which the project had no control. The project had to resort to short-term measures to protect public health, including awareness campaign and early warning system for the farm communities in the *wadi* below the WWTP, and to provision of laboratory equipment in order to improve laboratory analysis at the WWTP. The ICR mission learned that the much-needed physical and operational improvements at the WWTP are now underway and should be completed in the next two years.

It remains to be seen, however, if the desired improvements in the quality of the effluent and sludge will be realized. Any additional improvements that may be needed, as well as the construction of a second WWTP for Sana'a, could be addressed in an investment operation under the urban water supply and sanitation component of the WSSP. In any case, the urgent nature of the risks identified by the SBWMP remains - in terms of public health risks for the farm communities in the *wadi* below the WWTP and the risks of further contamination of the groundwater in the basin.

Component 6: Project Management and Monitoring

While the DCA provides that the SBC shall be responsible for project coordination, this role was shared by a newly formed PCU which was also responsible for monitoring as well as financial transactions of project activities. The PCU also took the supervision responsibility of demand management activities while the Dam Unit of GDI took the supervision responsibility of supply management activities and NWRA-SB for supervision of the institutional development and capacity building activities. IPAC and environment management were supervised by both PCU and NWRA-SB. The SBC, chaired by the Minister of the MWE, had overall authority over project activities and met regularly, being responsible for coordination and enforcement legal agreements.

After difficulties in the early years, project management by the PCU was quite effective. Monitoring of project implementation developed over time to track a broad range of progress indicators. Procurement and financial management enabled effective implementation in compliance with the IDA guidelines and procedures.

Component 7: Phase II Project Preparation

This component was to prepare the second phase of the SBWMP during the second half of the implementation period, based on the findings of the mid-term review and other water sector assessments. However, the subsequent agreements developed between the GOY and the IDA in the CAS of 2005 substituted the original idea by a water sector wide approach (SWAp) in order to integrate several IDA-financed operations under implementation within the water sector. Preparation of this SWAp operation was partially financed by this SBWMP component and successfully completed resulting in a US$350 million operation (WSSP). Project funds have also been used to develop a "Phase II" proposal outlining activities and budgets to continue and expand SBWMP activities under the WSSP.

ANNEX 3: Economic and Financial Analysis

Benefits and Costs

The SBWMP's expected main benefits were to: (i) increase the useful life of groundwater resources in the basin through net water savings (NWS) from the first four components; and (ii) decrease the likelihood of human and socio-economic losses due to dam failure (from the second component). Additional benefits, though not specifically included in the PDO, are increases in farmers' income through improved financial returns of irrigated agriculture (from first two components).

Increasing the useful life of groundwater resources in the Sana 'a Basin was the primary objective of the APL, of which the project was a first phase. The project aimed at: (i) improving the knowledge of the water balance and usable groundwater storage; and (ii) testing a combination of technical, financial, regulatory and institutional instruments aimed at increasing water availability (supply management) and decreasing water use (demand management). How much the project extended the useful life of groundwater resources, if any, is not known because still the groundwater imbalance and the exploitable groundwater storage are fraught with high degree of uncertainties; and the effect of the project on the aquifer system is still unknown as the horizontal expansion of irrigated agriculture was not monitored. The second objective was not achieved since the regulatory framework is still to be approved by the Cabinet, enforcement by the water authorities has not been strengthened, and mechanisms for community-level self-regulation and peer enforcement, as discussed in the PAD, have also not yet been well developed.

The PAD estimated project benefits by the aggregation, at the level of the basin, of estimated NWS and valuing them with the economic value according to their future use. NWS had been realized mainly from a decrease in the non-beneficial use of water (i.e., evaporation). It was attained by increasing the irrigation efficiency through the dissemination and validation of improved irrigation techniques, and through enhancing groundwater recharge from surface run-off by the construction and the rehabilitation of dams and other structures, while preventing irrigation expansion.

NWS have been quantified for the first two components, namely the irrigation improvement component (40% of project costs) and the groundwater recharge component (30% o f project costs). NWS were expected to reach about 8 million m^3/year at full development or about 5% of the current annual consumptive use and 6% of the current annual groundwater mining in the Sana'a Basin. Assuming a constant mining of the aquifer over time (129 million m^3/year), the project would extend the useful life of the aquifer by 5%.

The public awareness campaign (5% of project costs) and the legal and institutional development components (15% of project costs) were both critical to achieve these NWS by helping contain irrigation expansion and by encouraging the adoption of improved technology and management systems, including the proper O&M of infrastructure. The additional NWS from the public awareness campaign and the legal and institutional framework were not quantified even though they could be substantial, as their scope was not limited to the areas covered by project's physical investments, but included the entire Sana'a Basin concerning all water uses (not only irrigation). As more awareness of water scarcity in the basin is achieved and a proper regulatory system is in place, subsequent increased willingness and improved capacity of local communities and the GOY to counter the depletion of the aquifers would be facilitated.

Based on the field studies conducted during project preparation, it was estimated what could result from the project interventions. It was expected that about 4,000 ha could benefit from project first component (30% of the four areas of concentration, 17% of the entire basin); of which: (i) 600 ha would be converted from open earth canals into piped-conveyance systems; (ii) 1,700 ha of the existing piped conveyance would be rehabilitated; and (iii) 1,700 ha would require the installation of modern localized irrigation technologies. The project ended improving 4,877 ha (22% more than expected) with a different combination of interventions: (i) 3,117 ha converted from earth canal into piped-conveyance systems; (ii) 71 ha with rehabilitated piped conveyance; and (ii) 1,687 ha with installed modern localized irrigation systems.

The net annual water savings from irrigation improvement was expected to reach 7 million m^3 at full development and the achievement was doubled to about 14 million m^3. Net water savings from groundwater recharge were estimated at about 1 million m^3/year, of which 30% would come from the construction of 4 new dams and 70% from the rehabilitation and removal of accumulated silt in 11 existing dams. At closing, it is estimated by an independent expert study[17] that recharge was increased by 1.2 million m^3 (120% of the target), though many of the foreseen structures were not done for different reasons (mainly the 4 new dams, and the 3 sub-surface dams). This increased recharge is expected to be sustainable only if the infrastructure is properly maintained and silt is removed annually as part of the O&M works of the dams so that groundwater recharge potential is maintained. The prevention of potential socio-economic damage by a dam failure downstream of the rehabilitated dams has also been an important benefit of the project.

The economic value of water savings was estimated in the PAD considering that the irrigation sector accounted for 96% of consumptive use in the basin while the municipal and industrial sectors 4%. The economic value of water in agriculture was estimated at appraisal at US$0.26/$m^3$ using the residual imputation method (the value-added of water was calculated on the basis of crop and farm budgets and average cropping pattern in the project area). For this ICR evaluation, the same method was used for valuing water, but specifically referred to the project area. The cropping pattern was based on the aggregate beneficiaries' real cropped areas: *qat* being the main crop covering about 32% of the covered irrigated area, followed by vegetables (30%), grapes (18%), fruit trees (11%) and other crops (9%). Crop budgets have been prepared for the main crops based on representative farms in the project area. Agricultural technologies and input and output prices, were assumed to remain constant at 2010 values. Pumping cost although increasing over time, as the depth of the water table increases by an average of 4 to 10 meters/ year, were assumed also to remain constant in order not to overestimate results. Based on these assumptions, the average economic value-added by consumptive water used in irrigation was estimated at US$0.29 per m^3 for the ICR assessment. This economic value for water was used to quantify the benefits of the increased recharge of water to the shallow aquifers (Component 2).

Agricultural benefits From visits to the project area, it was possible to estimate that in addition to saving water, irrigation improvement had a significant positive impact on farmer revenues as crop yields and produce quality improved, and labor and pumping costs decreased. Yield increases are in the range from 10 to 30% in the case of the introduction of modern irrigation systems, and the reduction in the volume of water pumped and in costs of irrigation from 30 to

[17] *"Integrated Water Management for Small Catchments in Arid Mountainous Region – Yemen", Ahmed Mohamed Alderwish, Associate professor of Water Resources and Environment, Department of Earth and Environmental science, Sana'a University, 2010.*

50% depending on the type of irrigation improvement adopted. Yield increases in the case of improved conveyance systems were not included in the assessment exercise and only reductions in water pumped and irrigation costs in the order of 10 to 20% were quantified. The following Table 1 shows the main parameters and average budget indicators for the main crops in the project area, both before and after the project improvements were completed.

Table 1: Average Changes in Crop Budgets Before and After the Project

	Yields (kg/ha)		Production Costs ('000 YR/ha)		Net Income ('000 YR/ha)		
	Before	**After**	**Before**	**After**	**Before**	**After**	**Increase**
I. Conveyance							
Qat	1,000	1,000	1,045	894	1,956	2,106	8%
Grapes	15,000	15,000	1,135	953	966	1,148	19%
Peaches	800 bkts	800 bkts	798	746	270	347	29%
Tomato	15,000	15,000	980	890	270	359	33%
Maize	2,250	2,250	430	314	5	121	2,320%
II. Modern Irrigation							
Qat	1,000	1,100	1,069	945	1,932	2,455	27%
Grapes	15,000	18,000	1,114	1,034	986	1,486	51%
Peaches	800 bkts	969 bkts	798	706	270	575	113%
Tomato	15,000	18,000	981	883	268	617	130%
Maize	2,250	2,700	430	304	5	220	4,300%

As can be seen from the expected productivity gains and values detailed in Table 1, the estimations conservatively considered yield increases to be between 10 – 20% in the case of localized irrigation systems with production costs reductions of 7 – 29%. Resulting net incomes per cultivated ha would increase between 8 – 133% as a result of the combined effects of increased production and reduction in the irrigation costs (reduced labor and energy costs, etc.). In the case of maize, which is mainly a self-consumption crop, the starting net income was very low, and as such, shows increases of 23 to 43 fold. It can also be observed that net income from *qat* is more than double than those obtained with grapes and almost 10 times greater than the net income generated from vegetables or other fruits like peaches.

All project components' costs were considered in the analysis, including those for which their specific benefits were not quantified (institutional development and capacity building, information and public awareness, environment management and mitigation program, project management, and next phase project preparation studies).

Economic Rate of Return (ERR) Analysis

The ERR and NPV were calculated for the overall project based only on those benefits mainly derived from the irrigation improvement and groundwater recharge enhancement components. For the first component crop budgets were aggregated considering the areas occupied by each crop in the benefitted farmer land, following the pace of farmer/area incorporation to the modernization process as actually occurred under the project implementation period. No shadow pricing for foreign exchange was performed, since the official exchange rate broadly reflect the equilibrium exchange rate. The only corrections introduced on market prices for the economic analysis were: (i) a 1.4 conversion factor for irrigation costs was applied due to the subsidized

cost of diesel fuel; and (ii) a 0.8 conversion factor for rural labor, given the high rates of underemployment in rural areas in the Sana Basin.

As can be seen in Table 2, the overall project ERR was estimated at 16.9%, including all project components' costs, and the NPV at YR1,639 million (US$7.45 million). In the table, it is also shown that aggregated water used by benefited farmers has decreased from about 42 to 37 million m^3, and water productivity has increased from YR64/m^3 to YR132/m^3.

When the irrigation improvement component was considered alone, the ERR resulted in 42% and for the enhanced recharge component alone, a negative ERR was obtained. The latter is explained by the fact that two of its major benefits were not quantified, namely, the decreased risk in the potential damage of socio-economic infrastructure downstream, as well as the beneficiary participation in water resource management. The rehabilitation/construction of 11 dams, together with the strengthening of nonstructural dam safety measures such as monitoring of the dams safety, O&M of the dams and the development of emergency preparedness plans definitely contributes to the benefits of the project, but are difficult to value as: (i) no quantitative estimate is available on potential property damage; and (ii) no attempt was made to quantify the economic cost of human mortality and injuries. The dams rehabilitated were posing serious threats to downstream populations (estimated at about 5,450 people at appraisal) and their properties and would continue to be the case if they would have not been rehabilitated.

Table 2: Project Summary

ECONOMIC BUDGET (In YR Million)	Without Project	Years With Project							
	1 to 20	1	2	3	4	5	6	7	8 - 20
Main Production									
Grains	173	173	173	173	173	175	179	181	181
Fruits	2,411	2,411	2,411	2,411	2,411	2,468	2,581	2,637	2,637
Other	2,760	2,760	2,760	2,760	2,760	2,764	2,771	2,775	2,775
Vegetables	1,779	1,779	1,779	1,779	1,811	1,873	1,904	1,904	1,904
Forage	13	13	13	13	13	13	13	13	13
Sub-total Main Production	7,136	7,136	7,136	7,136	7,167	7,292	7,448	7,511	7,511
Other Benefits									
Water	-	-	-	6	16	26	35	45	45
INFLOWS	7,136	7,136	7,136	7,142	7,183	7,317	7,483	7,555	7,555
Production Cost									
Investment									
Project Investments (component 1)	**-**	**77**	**196**	**411**	**175**	**244**	**746**	**300**	**-**
Operating									
Purchased Inputs									
Seeds & Seedlings	21	21	21	21	21	21	21	21	21
Fertilizers	352	352	352	352	352	352	352	352	352
Pesticides	172	172	172	172	172	172	172	172	172
Irrigation Pumping	2,593	2,593	2,593	2,593	2,560	2,321	1,941	1,768	1,753
Other Inputs	519	519	519	519	527	552	576	584	584
Sub-Total Purchased Inputs	3,656	3,656	3,656	3,656	3,632	3,417	3,062	2,896	2,882
Labor									
Labor	449	449	449	449	445	440	435	433	433
Sub-total Operating Costs	4,105	4,105	4,105	4,105	4,077	3,857	3,497	3,329	3,314
Sub-Total Production Cost	4,105	4,182	4,301	4,515	4,252	4,101	4,243	3,629	3,314
Other Costs									
Project Investments (components 2-7)	**-**	**133**	**330**	**896**	**310**	**983**	**956**	**840**	**-**
OUTFLOWS	4,105	4,315	4,630	5,412	4,562	5,084	5,199	4,469	3,314
Cash Flow	3,031	2,821	2,505	1,731	2,621	2,234	2,284	3,086	4,241
Productivity of Irrigation Water (YR/'000 m3)	64	64	64	64	64	64	64	95	132	206%
IRR = 15.9%, NPV = 1,639.36									

Financial Analysis

Farm models were built to assess the project financial impact over typical farmers benefiting from the two major activities implemented under the irrigation improvement component (conversion of earth canals into a piped-conveyance system, and introduction of a modern localized irrigation system). Quantified benefits from irrigation improvements were assumed to be: (i) savings in pumping costs (both capital and O&M) as a result of improved conveyance and irrigation efficiency; and (ii) agricultural yield increases, based on observations made during the ICR mission field visits. Yield increases are resulting from a more adequate water supply to crops through the installation of localized (drip, bubbler, or sprinkler) irrigation systems and were conservatively assumed to be between 10 to 20%.

The following Tables 3 and 4 show the financial budgets for the farm models representing typical farmers of 0.5 ha, showing the average cropping patterns in the project area (*qat*, grapes, vegetables and maize). As shown in the tables, family benefits have increased in both cases representing the improved conveyance and the introduction of the modern irrigation systems by 13% and 39%, respectively. In the first case, benefits are due to reduction in irrigation costs, and in the second, due to the increases in yields and the reduction in irrigation costs.

Cost Recovery*:* Considerable levels of project subsidies to participating users have been applied under the SBWMP to: (i) accelerate participation in this first project, thereby having a strong demonstration effect; and (ii) serve as incentive to farmers to refrain from future use of the saved water and future expansion of irrigated areas. The levels of beneficiaries' contributions to capital costs were 25% in materials and 90% in installation costs for the modern localized irrigation systems; and 60% in materials and 100% in installation costs for the improved conveyance system. All O&M costs are borne by the direct beneficiaries. Both farm models include the corresponding investment and grants received by the project, and the resulting increments in net family benefits,

For the construction and rehabilitation of recharge dams, contribution from beneficiaries to the capital costs of dams was not foreseen. O&M costs that relate to dam structure performance and safety are the responsibility of the GDI. However, local beneficiary communities would undertake or arrange for: (i) dry season sediment removal from reservoirs for maintaining recharge benefits; and (ii) upkeep of dam and reservoir access roads.

Table 3: Financial Budget for Small Farm Model (Improved Piped Conveyance System)

(In YR '000)	Without Project	With Project			
	1 to 20	1	2	3 to 20	
Main Production					
Grains	60.8	60.8	60.8	60.8	
Fruits	315.0	315.0	315.0	315.0	
Other	600.0	600.0	600.0	600.0	
Vegetables	187.4	187.4	187.4	187.4	
Forage	4.5	4.5	4.5	4.5	
Sub-total Main Production	1,167.7	1,167.7	1,167.7	1,167.7	
Production Cost					
Investment					
Project Investments	-	121.4	-	-	
Operating					
Seeds & Seedlings	3.1	3.1	3.1	3.1	
Fertilizers	46.7	46.7	46.7	46.7	
Pesticides	23.4	23.4	23.4	23.4	
Irrigation Pumping	286.4	286.4	242.3	198.1	
Other Inputs	138.8	138.8	138.9	138.9	
Sub-total Operating Costs	498.5	498.5	454.4	410.3	
Sub-Total Production Cost	498.5	619.9	454.4	410.3	
OUTFLOWS	498.5	619.9	454.4	410.3	
Cash Flow Before Financing	669.2	547.8	713.3	757.4	
Net Financing	-	574.5	4.4	-	
Cash Flow After Financing	669.2	1,122.2	717.7	757.4	
Change in Net Worth					
Contribution from own savings	-	370.1	-	-	
Residual value of					
Transfer to Next Period	-	-	-	-	
Sub-Total Change in Net Worth	-	-370.1	-	-	
Farm Family Benefits After Financing	669.2	752.2	717.7	757.4	113%
Returns per Family-Day of Labor	5.1	5.7	5.5	5.8	

IRR = None, NPV = 621.65

Table 4: Financial Budget for Small Farm Model (Localized Irrigation System)

FINANCIAL BUDGET (In YR '000)	Without Project	With Project			
	1 to 20	1	2	3 to 20	
Main Production					
Grains	60.8	60.8	66.8	72.9	
Fruits	315.0	315.0	346.5	378.0	
Other	600.0	600.0	630.0	660.0	
Vegetables	187.4	187.4	206.2	224.9	
Forage	4.5	4.5	5.1	5.7	
Sub-total Main Production	1,167.7	1,167.7	1,254.6	1,341.5	
Production Cost					
Investment					
Project Investments	-	550.0	-	-	
Operating					
Seeds & Seedlings	3.1	3.1	3.1	3.1	
Fertilizers	46.7	46.7	46.7	46.7	
Pesticides	23.4	23.4	23.4	23.4	
Irrigation Pumping	286.4	286.4	226.9	167.3	
Other Inputs	143.6	143.6	162.3	181.0	
Sub-total Operating Costs	503.3	503.3	462.4	421.5	
Sub-Total Production Cost	503.3	1,053.3	462.4	421.5	
OUTFLOWS	503.3	1,053.3	462.4	421.5	
Cash Flow Before Financing	664.4	114.4	792.2	920.0	
Net Financing	-	1,007.0	4.1	-	
Cash Flow After Financing	664.4	1,121.4	796.3	920.0	
Change in Net Worth					
Contribution from own savings	-	320.9	-	-	
Residual value of Transfer to Next Period	-	-	-	-	
Sub-Total Change in Net Worth	-	-320.9	-	-	
Farm Family Benefits After Financing	664.4	800.5	796.3	920.0	138%
Returns per Family-Day of Labor	5.2	6.3	6.6	8.0	

IRR = None, NPV = 1,702.81

ANNEX 4: IDA Lending and Implementation Support/Supervision Processes

(a) Task Team members

Names	Title	Unit	Responsibility/ Specialty
Lending			
Peter Koening	Sr. Water Resources Specialist	MNSRE	Task Team Leader
Satoru Ueda	Sr. Water Resources Specialist	MNSRE	Dam Specialist
Marie-Laure Lajaunie	Economist	MNSRE	Economic Evaluation
Vahid Alavian	Sr. Water Resources Specialist	MNSRE	Water Adviser
Arbi Ben-Achour	Sr. Social Scientist	MNSRE	Social Assessment
Samia Msadek	Sr. Financial Management Specialist	MNSRE	Financial Management Assessment
Afif Al Saqqaf	Financial Management Specialist	Sana'a Office	Financial Management Assessment
Majed El-Bayya	Sr. Procurement Specialist	Gaza Office	Procurement Assessment
Abdulgabbar Hasan Al Qattab	Procurement Specialist	Sana'a Office	Procurement Assessment
Josephine Salang	Program Assistant	MNSRE	Document Formatting/Preparation
Bob Boydell	International Environmental Specialist	Consultant	Environmental Assessment
Supervision			
Maher F. Abu-Taleb	Sr. Operations Officer	MNSRE	Task Team Leader
Yoshiharu Kobayashi	Sr. Water Resources Specialist	MNSWA	Task Team Leader
Knut Opsal	Sr. Social Scientist	MNSRE	Social Analysis
Mikael Sehul Mengesha	Sr. Procurement Specialist	Cairo Office	Procurement Review
Mohamed Yahia Ahmed Said Abd El Karim	Financial Management Specialist	Khartoum Office	Financial Management Review
Akram Abd El-Aziz Hussein El-Shorbagi	Sr. Financial Management Specialist	Cairo Office	Financial Management Review
Moad M. Alrubaidi	Financial Management Specialist	Sana'a Office	Financial Management Review
John Bryant Collier	Operations Officer	MNSRE	Environment Specialist
Abdul Salam Kaid Al-Zubayri	Water Resources Specialist	MNSRE	Water Resources
Tarek Hanafy Selim Kotb	Water Resources Management Specialist	Sana'a Office	Water Resources
Josephine G. Salang	Sr. Program Assistant	MNSRE	Document Formatting/Preparation
Rory C. O'Sullivan	Consultant	MNSRE	Quality Assurance
Sherif Kamel F. Arif	Regional Env. & Safeguards Adviser	MNSRE	Environment/Safeguards

(b) Staff Time and Cost

Stage of Project Cycle	Staff Time and Cost (IDA Budget Only)	
	No. of Staff Weeks	US$ Thousands (including travel and consultant costs)
Lending		
FY00	32.38	118.51
FY01	30.54	162.57
FY02	37.01	182.79
FY03	43.60	248.54
TOTAL:	**143.53**	**712.41**
Supervision/ICR		
FY01	0.16	0.15
FY02	4.31	2.26
FY03	4.73	3.37
FY04	24.07	112.65
FY05	25.25	117.42
FY06	29.98	117.58
FY07	22.04	95.73
FY08	20.96	100.72
FY09	18.97	98.82
FY10	23.65	136.87
FY11	5.05	25.58
TOTAL	**179.17**	**811.15**

ANNEX 5: Community Water Management: The Need for a Bottom-up Approach[18]

The SBWMP has achieved many things: improving public awareness of the dangers of aquifer depletion, using SMTs to involve stakeholders, engaging water users in installing efficient irrigation technologies and in carrying out civil works, reducing water use in irrigation while increasing yields and profits for farmers, and building and rehabilitating structures to recharge groundwater. Nevertheless, it also is important to note what has not been achieved and consider ways in which future action, particularly under the WSSP, might need to be changed in order to have more prospect of success.

The PAD stated that, under the current conditions in Yemen, the only feasible approach to controlling groundwater extraction would be through local self-regulation. It discussed a participatory approach involving water users. It supported working at multiple levels, from local to basin and to national. However, some of these aspects have not been fully applied in the SBWMP, as discussed in other parts of this ICR, the Action Oriented Policy Paper (AOPP),[19] and the Yemen WUA study. If some of the approaches used in the SBWMP are not changed, then there may be little prospect of success in improving water management and livelihoods.

1. Top-down licensing has failed. A primary strategy has been to require licensing of all wells, and prohibit drilling of unlicensed wells. A protection zone was enacted for the Sana'a Basin. However, unlicensed well drilling continues to be widespread. There has been little effective enforcement even when violations have been reported.

The strategy seems to be based on a presumption that it will be feasible to obtain compliance with licensing requirements, and that this would solve problems. Hypothetically, this might work if there were a strongly established rule of law, highly skilled bureaucracy, and relatively weak incentives to continue groundwater exploitation. However, the feasibility under current conditions in Yemen seems very questionable. The complexity of aquifers, limited information, and cost of investigations makes technical assessment of groundwater difficult, particularly in Yemen. Even with stronger regulatory framework, limited capacity of NWRA and other institutions could make it difficult to process applications in a timely way, avoid corruption and manipulation of the approval process, and prosecute violators through the formal legal system. Furthermore, many existing wells have already been drilled deep, resulting in a large installed capacity to extract groundwater.

Thus, the prospects for imposing licensing through a top-down process and relying on prohibition of unlicensed drilling to control groundwater over-extraction seem highly problematic. However, prevalent norms about well spacing, concern about protecting drinking water supplies, and increasing awareness of the dangers of aquifer depletion seem to create fertile conditions for promoting a community-based process to develop local regulation. One way to reinforce local efforts would be through the kind of simple, locally-based procedures for well-licensing, based on public, participatory review at the community and district levels, that have been piloted in Amran, and were discussed in the AOPP and in the Sana'a Basin Water Conference held on May 30-31, 2010, along with recognizing and supporting local consensus-

[18] There was no specific **beneficiary survey** for this ICR, and it was not required since this was not an intensive learning ICR. Hence, it was replaced by this Annex on **Participatory Water Management**.

[19] The AOPP was prepared by a group of consultants at the end of the project to evaluate achievements and the challenges at the threshold of the second phase under the WSSP.

building and action to strengthen community norms and self-governance related to groundwater, including drinking water access, well spacing to avoid harmful interference with the existing wells, efficient, non-wasteful irrigation practices, and balancing of public and private interests in groundwater use.

2. Well drilling is not "random." Frequently discussion is framed in terms of the problem being "random" or "haphazard" drilling of wells. This terminology can lead to confusion and misunderstanding about problems and solutions. Firstly, drilling is not random, because it is done by landowners based on their rights to land. Secondly, deep wells are expensive; so all those investing are very concerned to choose the location as well as possible. Thirdly, there seems to be an assumption that if drilling were done in an orderly, licensed way, there would be no problem. Given the economic incentives to use groundwater and the political context, even an orderly, fully licensed system might be unable to restrain rapid aquifer depletion. However, it is clear that there are local norms, particularly well spacing, which often help regulate well installation, and in many places there is growing support for tighter restriction. Since well drilling is not a "random" phenomenon and comprehensive control is not a realistic objective, interventions should be targeted at: (i) supporting local efforts to regulate wells and improve water governance; (ii) deterring investment by irrigators in the deepest, most expensive, and riskiest wells,[20] which pose the greatest threat to the availability of water for future potable use; and (iii) selecting those areas which offer the best prospects for shifting to more sustainable use and recharge of shallow aquifers.

3. Large basins are only one level of governance. Development of a SBC has been an important institutional objective. While many meetings have been held, stakeholders are not yet well represented. The SBC lacks authority over well drilling, water abstraction or finances. Furthermore, a basin-wide commission is distant from the level at which most important water use decisions are made. Large basins may be useful for coordinating some relatively macro-scale issues, and be a significant level within multi-level, multi-scale governance, but most problems are more likely to be managed effectively if addressed at a more local scale. The complexity and slow movement of groundwater mean that problems are most immediately felt by individual owners and communities, as are the impacts of remedies such as conservation and recharge. The potential for transferring water from agriculture to urban use also depends on specific local transactions, as it might be more systematically developed, (and as already occurs with tanker markets). To the extent that top-down actions by the SBC and GOY agencies are seen as vehicles for taking water away for urban use without compensation and denying it to agriculture, there is likely to be strong local opposition. Overemphasis on the basin level, without adequate attention to district and community level activity seems to have led to slow progress or even stagnation. At the same time, there seems to be much local demand and potential for community-based strategies to take meaningful steps to improve water management at more local levels.

4. Water users associate in many ways. Water users have played an important role in project implementation. WUGs and WUAs have processed requests for subsidized irrigation equipment, organized installation of piped conveyance systems and localized irrigation systems, and accepted responsibilities for O&M of recharge structures. Many groups have attempted to help prevent unauthorized well drilling; monitoring and reporting violations. Some have helped to

[20] Part of this would be to focus on controlling the more expensive and sophisticated drilling rigs needed for deeper drilling, as discussed in the AOPP and the Sana'a basin water conference.

monitor groundwater levels. However, the formal WUAs established by the project have depended on funding from project implementation, and mostly lack alternative sources of reliable local funding. They are not yet providing services that would assure steady funding from members, district councils or other local sources. There has been inadequate recognition that formal WUAs are only one of many forms of collective action for water management, which also includes traditional institutions for managing spate flows and springs, shared investment in wells, informal groups managing irrigation and water supply systems, and private sector water providers, in addition to formal bodies registered under the NGO Law, Cooperative Law or other laws. WUAs in their current form are not empowered; they lack explicit authority to enforce rules and fees necessary to govern the resource and are not yet well linked with district councils which could provide authoritative backing. Overemphasis is on a single form of organization, imposing an institutional monoculture, risks disrupting existing institutions that are playing important roles in providing services. A more effective strategy would be to weave together networks of diverse kinds of association, formal and informal, linking village, district, sub-basin and basin levels in a process of network governance.

5. Commons can be managed. A simplistic misapplication of ideas about "the tragedy of the commons" may lead to a presumption that individuals are doomed to overexploit resources or analysis as if the only remedies were privatization or centralized authority. Research has amply documented the capacity of communities to govern commons, given time and supportive conditions. The GOY may be able to provide a positive role, but it may be even more important that the GOY avoid disrupting or delegitimizing local institutions, and instead recognize and accept their potential. Water users are in a situation of repeated interaction, in which cooperation, based on communication, agreement, monitoring, and sanctions is often a superior strategy, even in tragedy of the commons[21] or prisoner's dilemmas.[22] Furthermore, the underlying situation may instead be that of a Stag Hunt (assurance game,) or a game of Harmony, where those who do not cooperate are worse off than those who cooperate, and where most people are ready to cooperate as long as they are sufficiently confident that others will also cooperate. More specifically, the relatively slow movement of groundwater means that individual users and communities retain many of the benefits of conservation, efficiency, and recharge, offering them incentives to work together. They are already embedded in networks of local institutions. Local conditions vary, there are no guarantees, and there are serious challenges to be overcome, but there are good reasons to expect that communities can work together to find solutions for governing shared water resources, especially if encouraged by suitable technical and regulatory support.

6. Water governance should not neglect the strengths of Yemeni culture. Water policy, programs, and projects have been primarily framed in the discourse of modern IWRM, relying on formal laws, national bureaucracies, and formal organizations, such as basin committees and WUAs. While theories of IWRM may emphasize stakeholder participation and integration with local ideas, this has not been adequately put into practice. There seems to have been inadequate recognition of the social capital that exists in the local institutions that already regulate land and water, resolve disputes, and organize collective action. Traditional spate irrigation systems have been built and rebuilt for centuries, relying on local resources and traditional leadership roles and

[21] A dilemma arising from the situation where people will deplete a shared limited resource even when it is clear that it is not in anyone's long-term interest for this to happen.

[22] A fundamental problem in game theory that demonstrates why people do not cooperate even if it is their best interests to do so.

rules. Although some of the problems posed by deep wells and motorized pumps are new, traditional Islamic principles of assuring access to drinking water, avoiding harm, avoiding waste, and balancing private and community benefit are highly applicable. If water management is perceived as requiring that people be educated to understand IWRM theories, and people are assumed to only act out of economic motives of efficiency and narrow, short-term, short-sighted self-interest, then the prospects may be dim. However, if the strengths of existing local governance institutions are better recognized, and local problem-solving facilitated, using multiple forms and levels of organization, aided with technical advice, appropriate funding, and enforcement for which there is local support, then the prospects appear much better.

Supporting community water governance. The issues discussed above concern some aspects of how project implementation has been understood and pursued. Both PADs for the SBWMP and WSSP show a deeper understanding which is consistent with participatory community-based approaches. As recognized in the SBWMP PAD, the only route to more effective and sustainable water governance is likely to lie through the development of local self-regulation, at the scale of villages and districts, which can be supported by technical advice and by enforcement of regulations consistent with rules that have been agreed to by communities of stakeholders. This requires much more attention to a bottom-up process to recognize the ways in which communities already regulate land and water resources and resolve disputes, improved information and participatory assessment of problems and potential solutions, and development of local consensus on ways to improve water management and ensure effective enforcement. Key elements of a strategy would include:

(a) **Convening**. Bringing people together and facilitating local assessment and problem solving in communities and district;

(b) **Informing**. Providing customized technical advice and training to help local people better understand their aquifers and catchments, and how management be improved;

(c) **Empowering**. Ensuring that local water governance has authority to make and enforce rules that apply to all water users, through suitable processes at multiple scales, within communities of irrigators sharing streams and aquifers, and within districts;

(d) **Enforcing**. Responding to local requests to prohibit drilling of wells that could harm other users and to prevent other unwise use of water resources; and

(e) **Funding.** Investments in aquifer recharge and in diversification of livelihoods beyond irrigated agriculture may yield widespread and longer-term benefits, but are risky, may not always pay off quickly, and may be beyond local capacity to finance; offering a role where outside investment can make a difference.

In simple terms, this can be summarized to say a bottom-up approach is needed that encourages, facilitates, informs, and helps enforce locally-driven water management. A much stronger emphasis on participatory water management could build on the successes of the SBWMP, in involving communities in implementation, increasing water efficiency, and improving awareness of the dangers of aquifer depletion. It could be designed to concentrate on developing local regulation, suitably backed by outside technical advice and enforcement, work on helping communities adapt to sustainable use of shallow aquifers and more diversified livelihoods, weave together multiple kinds of organizations at multiple levels into network governance

focused on problem-solving, and draw on the strengths of local communities in resource governance, dispute resolution, and moral reasoning.

ANNEX 6: Stakeholder Workshop Report and Results

The Sana'a Basin Water Conference held on May 30-31, 2010 brought together a range of project stakeholders to review progress and discuss future directions. Participants came from the MWE, MAI, parliament, district councils, water user associations, and universities.

Topics. Presentations on the first day covered the basin water assessment study, institutional development and capacity building for local communities and for planning and implementing agencies, raising public awareness, demand management and improvement of irrigation, supply management and aquifer recharge, environmental management, and an example of WUA experience. On the second day members of the team preparing an AOPP to assess results and make suggestions for a next phase of activities made presentations on water governance; water resources management; regulation; irrigation improvement; and meeting demand for water supply, followed by group and general discussions. Some main points from presentations and discussions are summarized below, and are discussed in more detail in the conference documents and the AOPP.

Governance. Governance accomplishments include establishing the SBC, involving local councils in water management, and setting up WUAs. While the SBC has been active, meeting 46 times, WUAs and civil society are not yet included and local councilors did not always attend. There is not yet an agreed basin plan and the SBC lacks authority to allocate finances and enforce decisions. It was recommended that local councils be empowered and given training and technical support to act as the intermediate level in local water resources management, for dispute resolution, discussion, and regulating illegal well drilling in partnership with the security forces. WUA capacity and prospects vary considerably, some helping prevent illegal drilling and others being more passive, set up largely to get project benefits. Women, who make up half of WUAs, should be more involved. Farmers should work together to manage water sustainably, acting to help stop unlicensed drilling, install modern equipment and use irrigation water more efficiently. WUAs and district councils should be supported by partnership with the NWRA-SB for: (i) information and joint development of sustainable management plans for sub-basins; (ii) empowerment for monitoring and self-regulation; (iii) capacity building; and (iv) investment funding.

Water Resources Management. A comprehensive water resources assessment study has been completed, with a monitoring network set up and some data being collected and analyzed. A revised groundwater model was used to assess water balances separately for 22 sub-basins. While there is debate about some aspects of the study, it does provide a framework and starting point for further monitoring and analysis. A basin master plan needs to be adopted, and translated into a five-year plan and annual programs for financing and implementation. This should focus on sharpened objectives of ensuring affordable safe water for domestic and industrial use, sustainable farm incomes, and win-win transfers between uses, supported by a small but effective planning function in NWRA-SB.

A process for licensing wells has been developed, but only 106 wells were licensed from 2005 to 2009, while at least 614 illegal wells were recorded. Drilling firms are registered by NWRA headquarters, but control is not effective. Water by-laws have been prepared but not approved. Conclusions from the last five years are: (i) regulation will only work if farmers and WUAs cooperate as front line water managers; (ii) local councils work with them to control drilling rigs and illegal drilling; (iii) they should be supported by the SBC and by the highest level of the

GOY; and (iv) drillers should cooperate as professional businesses. Simple bottom up processes could be tried for license applications and controlling illegal drilling. WUAs could comment on license applications, with the local council ensuring due process, and the SBC making final decisions. WUAs would report illegal drilling to the local councils, which would halt drilling, and NWRA-SB and the local security departments would investigate. Violators' wells would be concreted and offending drillers and rigs blacklisted. At the same time, NWRA regulation should work to professionalize drillers, concentrating on the few rigs capable of drilling into the deeper sandstone aquifer.

Irrigation and Recharge. Piped conveyance systems have raised irrigation efficiency up to 60%, and localized delivery by bubblers, sprinklers and drip up to 80-90%, enabling farmers to pump 40% less water while increasing income by 10%, yielding water savings equal to 17 million m^3/year from 4,135 ha. If all 18,953 ha were modernized irrigation water use might drop from 221 million m^3 to 133 million m^3 and some sub-basins might return to living within the annual recharge. Project experience indicates that cascades of check dams and spate breakers provided a cost effective way to increase aquifer recharge. IPM for grapes and *qat* helped limit overuse of pesticides. Irrigation improvement needs to be economically justified and linked to sustainable water management, integrating water resources planning and management, support to WUAs, agricultural extension, and irrigation improvement, even if done through different agencies. Questions concern whether irrigation improvement should only be subsidized if the WUA signs up to a sustainable management plan for their area, and how *qat*, which covers more than half the irrigated area, should be handled.

Water Supply. Sana'a is the third fastest growing city in the world. The local corporation supplies only half the city's water needs, and the network is expanding only slowly. In total, public and private supply equal 50-60 million m^3, equivalent to annual recharge for the basin. The Local Corporation has 6 wells go dry each year, and drills ten new ones, at rising costs. Farm wells supply urban fringe areas and the tanker trade. In the long term, water supply in the Sana'a Basin has to come from the good quality water in the deep sandstone aquifer, which must be protected. Public/private partnerships should be developed, encouraging private suppliers to form an association, with light (self) regulation; public support for private network supply, and licensing WUAs to become water suppliers.

Institutional Capacity. Phase II implementation will require greatly enhanced institutional capacity, above all in the NWRA-SB, including planning and programming; water resources assessment; capacity building and empowerment support to the Basin Committee, local councils, and WUAs; public awareness; and regulation. This will require careful definition and regularization of functions; a management audit; increased operating budget; recruitment of experienced, highly qualified staff; improved work environment; clearly defined partnerships with stakeholders; and raising staff commitment and effectiveness through performance-based incentives, training, and conversion from contractual to staff status.

Discussion. There was substantial discussion, after presentations and in the discussion groups. Much of this added depth to the topics discussed, and asked for clarification on various points. Participants said that more of the presentations and materials should have been available in Arabic. Several participants said they had hoped for a format that took a more balanced approach to examining both achievements and problems of the project. In general, participants recommended that the activities piloted by the SBWMP should be continued under the WSSP,

and emphasized that shifting to implementation through permanent national agencies poses challenges, and that agencies must integrate implementation for the program to be successful.

Approaches recommended during the conference included:

(a) Expanding the role of district councils and WUAs (including both irrigation and water supply) in sub-basin water governance;

(b) Simplifying procedures for licensing wells and handling violations, involving WUAs, district councils, and the SBC;

(c) Tightening regulatory control over drilling rigs and professionalizing drillers, concentrating on the rigs capable of drilling into the deeper sandstone aquifer;

(d) Greatly strengthening the institutional capacity of the NWRA-SB; and

(e) Increasing public-private partnerships for improving water supply.

Some points on which there was significant debate included:

(a) Whether to subsidize irrigation modernization for qat;

(b) How much to expect from WUAs in controlling illegal drilling and how much should be done by security forces and NWRA;

(c) The role of dams in future water resources development; and

(d) Whether the SBC should be given authority over financial allocation and licensing wells.

ANNEX 7: Summary of Borrower's ICR and/or Comments on Draft ICR

The SBWMP was initially designed to be a 15-year APL (2004 – 2019). The APL is designed to be in three phases, each of about five years. The current project represented Phase I of this program (2004 - 2009). The main purpose of the program is essentially to assist the GOY in slowing down the depletion of groundwater in the Sana'a Basin aquifer to gain time for the GOY to convert the Sana'a Basin economy to less water intensive activities. There is no perennial surface runoff in the country and the Sana'a Basin entirely depends on groundwater for agriculture and human consumption. Intensive abstraction and low recharge of groundwater led groundwater to deplete at alarming rate which if not checked through appropriate measures, would have negative social, economic and environmental impacts on the farming communities in the rural areas of the basin and urban people, especially in Sana'a City.

Project Approach: The main features of the project approach focused on achieving: (i) slowdown of groundwater depletion by demand and supply management: (ii) change in pumping behavior with intensive information and awareness campaign among the farming community in the basin as well as the formation of WUGs/WUAs and providing capacity building for them to effectively participate in groundwater management; and (iii) acceleration of the shallow aquifer recharge and persuasion of farmers to use water in the shallow aquifer instead of the high quality water in the deep sandstone aquifer.

***Project Objectives*:** The main development objective of the SBWMP is to increase both the quantity and the useable life of the groundwater resources available in the Sana'a Basin, and so postpone the date at which extremely expensive new supplies may have to be brought in from outside the basin. To accomplish this objective the SBWMP would: (i) implement, test and develop "best practice" demand (primarily irrigation) and supply (primarily recharge) management methods in a limited area, for later application of lessons learnt in large-scale implementation throughout the Sana'a Basin, under the subsequent two phases of the program, (ii) rehabilitate and rebuild selected dams to improve downstream safety; and (iii) establish the regulatory, legal and institutional framework needed for more sustainable WRM in the basin.

***Status of Achievement of the SBWMP Development Objective*:** The overall objective of the SBWMP was consistent with the CAS of the IDA and the national water strategy and the irrigation policy in the GOY. The overall objective was achieved through the implementation of the project activities under the six components, each of which required intensive level of coordination and stakeholder involvement.

***Disbursement Profile*:** The financial information reveals that the actual annual as well the cumulative disbursement lagged behind up to 2008. The disbursement picked up significantly from 2009. This is attributable to the significant progress in the construction/rehabilitation of civil works under Component 2 as well as the procurement of pipes and equipment for improvement of water conveyance and localized irrigation systems under Component 1 to meet the large demand generated by SMTs and IPAC.

Project Benefits: Most of the activities implemented under Components 1 and 2 generated quantifiable as well as non-quantifiable benefits while the benefits generated as a result of the implementation of the activities under Components 3 and 4 were not quantifiable. In economic analysis, only quantifiable benefits of Components 1 and 2 were used as the entire project benefits.

***Non-quantifiable Benefits*:** The non-quantifiable benefits generated by the project include social benefits, institutional & capacity building benefits and environmental benefits as follows.

(a) Social benefits: The acceptance of the farming communities in the Sana'a Basin to contribute in cash to the investment to acquire water-saving modern irrigation systems gave them a sense of ownership of the systems, which has made them real partners in groundwater conservation in the basin. As a result, the beneficiary farmers have become more responsive to the mitigation measures that address the water scarcity problem in the Sana'a Basin. The project has also provided for technical and organizational support to local farmers well-based groups (WUGs) and to the established community groundwater user organizations (WUAs) at village level.

(b) Institutional benefits: The project established 52 WUAs (48 functioning) within the targeted areas of the basin. In addition, it provided the WUAs with infrastructural support and capacity building through organizing workshops/seminars, field days, and foreign study tours. The project contributed to improving the national implementation capabilities of the PCU staff through the recruitment and posting of international experts and international consulting firms who provided on-the-job training. The project also provided capacity building to a number of the staff of the implementing partners (NWRA-SB, NWRA, Dam Unit of MAI, DPP of MAI, and EPA) in terms of local and foreign training.

(c) Environmental Benefits: The project implemented environmental activities including IPM plans for *qat* and gapes, control of *bilharzias* in three districts, support for the Sana'a WWTP and red flag warning system for the users of effluent and sludge water produced by the WWTP.

***Quantifiable benefits*:**

***Component 1*:** The activities implemented under the three subcomponents of Component 1 generated quantifiable benefits in the form of irrigation water savings as a result of installation of the modern irrigation systems in farmers' fields, which also contributed to increasing farmer income through increase in crop yields and reduction of pumping costs (i.e. through saving of fuel, labor and energy). The saving of water by 21% was realized as a result of the upgrading of the existing piped system and the conversion of open canal system to piped conveyance system. Average water saving of 36% was also realized as a result of the introduction of localized irrigation systems.

***Component 2*:** The purpose of the supply management is to enhance groundwater recharge through rehabilitation/de-silting of the existing dams and construction of new dams. It was expected that farmers would pump groundwater from shallow aquifers rather than from the deep aquifers which are a critical source for drinking and domestic water needs for Sana'a City. In case of the existing dams, groundwater recharge potential was estimated by measuring the additional runoff that would have occurred before removing the silt. The revised project target included the reconstruction of one new dam and rehabilitation of the 10 existing dams, construction of 10 pits and 47 check dams.[23] The estimated recharge now stands at about 1.2 million m^3. These savings will materialize only if the infrastructure is properly maintained. It is

[23] A small dam less than 3 m built across a narrow wadi to increase recharge to shallow aquifers.

indeed critical that the silt is removed annually as part of the O&M works of the dam so that groundwater recharge potential is sustained.

Economic Evaluation of the Project Quantifiable Benefits: The quantifiable benefits used in the economic analysis include the value of net water saved and the increase in crop productivity per hectare as a result of the installation of the modern irrigation systems as well as the value of net water savings from groundwater recharge as a result of reconstruction of one new dam and rehabilitation of the 10 existing dams through de-silting and increasing the storage capacity. For the purpose of economic analysis, the net quantity of irrigation water saved under the demand management component and the supply management component will be valued at its opportunity cost (i.e. average weighted return to water YR/ m^3) for irrigation and for human consumption.

Economic Valuation of Net Water Saved: The irrigation water savings under the piped conveyance system and the localized irrigation systems used in the economic analysis are based on the field confirmation survey conducted by the SBWMP in 2008. The economic price/return to water is calculated as an average of weighted return to water used for irrigation of the main crops in the basin and the average price of water for human consumption in Sana'a City.

Economic Value of Incremental Production: The incremental value of crop production is calculated using the crop budgets and the with/without project approach and multiplying the incremental production value per hectare under improved conveyance systems and localized irrigation systems by the total area covered by each system, respectively. The increase in productivity for the different crops under the improved conveyance system and localized irrigation system is derived from the project reports.

Results of Economic Analysis: Based on the above, the economic analysis is carried out on the Component 1and on the project as a whole and the results are presented in the table below.

Economic parameter	**ERR as appraisal**	**ERR on Project Completion**
Demand management component	47%	51%
Project as a whole	19.7%	17%

Problems Encountered during the Implementation of the Activities of Component 1: Two project risks were quite evident at the midterm review. The first was slow progress on the delivery of the irrigation systems and the second was that farmers lacked the motivation to join the community water management organizations (i.e. WUGs/WUAs). Moreover, the other problems also aggravated the progress of adoption/installation of the localized irrigation systems including: (i) poor performance of the contractors for installation of the localized irrigation systems (as against the planned coverage of 400 ha by each of the five contractors, a total of only 460 ha were installed in more than two years); (ii) farmers' perception that their 10% contribution to the cost of installation in cash was very high; and (iii) significant delays in establishment of the WUAs in the basin.

Actions Taken to Address the Problems:

(a) In view of the unacceptable performance of the contractors and reluctance of the farmers to deal with the contractor, the PCU terminated the contracts of the contractors in

August 2008 after taking the approval of the project steering committee (PSC)[24] and the IDA.

(b) The PCU designed a revised installation mechanism acceptable to the farming communities, which was approved by the PSC and the IDA in 2008. The main features of the revised installation mechanism are as follows.

- The technical unit of the PCU will continue to carry out the survey and design of farmers' fields in which improved conveyance and/or localized irrigation systems to be installed;
- The project signs a contract of partnership with the WUAs to supervise the installation of the improved conveyance and/or localized irrigation systems; and
- The supervision and/or installation will be through the WUAs, thus recognizing the role of the WUAs in the farming community.

(c) The project management and its SMT and IPAC staff exerted enormous efforts to enlighten the farmers and raise their awareness on the importance of organizing themselves into WUGs/WUAs to get benefits from the project services. As a result of the continuous efforts of the SMTs and IPAC team, farmers gradually become more responsive and appreciative of the role of the WUGs/WUAs and started to join these community organizations.

Achievements under each Subcomponent of Component 1

The demand management and irrigation improvement component was designed with an objective to save water use in the agricultural sector. The satisfactory implementation of the activities under Component 1 and achieving the targets of each of its subcomponent determine to a large extent the project success in achieving its overall development objectives. The project targets and physical achievements under each of the subcomponents of Component 1 are presented in the table below.

Irrigation Systems	Project target in PAD (ha)	Revised project target (ha)	Achievements At completion (ha)	Achievement of the revised target
- Upgrading of the existing piped conveyance system	1,660	150	71	50%
- Conversion of open channels to piped conveyance systems	600	1,440 and further to 2189 ha	3,048	139%
- Localized irrigation systems	1,960	1,960	1,685	86%

Water savings realized: Annual water savings were calculated using savings in irrigation water consumption under each of the three water saving irrigation systems. The average water savings are derived from the previous studies conducted in the project area and the confirmation study carried in 2009 in the Sana'a Basin. The quantity of water saved up to June 2010 under upgrading of the conveyance system subcomponent, the conversion to piped system subcomponent and the localized irrigation system subcomponent amounted to 0.187 million m^3, 8.022 million m^3 and 6.667 million m^3, respectively.

[24] PSC was chaired by the Minister of MWE and held 54 times during project implementation.

Achievements under Other Farm-level Irrigation Protection and Improvement Measures:

Land leveling: The PCU requested the IDA to drop the land leveling activity since it was not considered as technically feasible under the project conditions. This was accepted by the IDA and recorded in the Aide-Memoire of February 2006.

Wadi Protection Work: *Wadi* protection work was based on the demand from WUAs who decide the location for the project intervention. The *wadi* protection work was implemented at project cost with no contribution from the beneficiaries. The target of protecting 315 ha was achieved.

Plastic Covers/Tunnels: This activity was cancelled because of lack of interest from the beneficiaries to take up this activity. This activity was replaced by procurement of greenhouses. A total of 58 greenhouses were procured by the project, of which 53 were purchased by farmers and installed under the direct supervision of the PCU.

Institutional Development for Community Management and O&M Systems: The SMTs worked very hard in forming WUGs/WUAs in the basin and successfully established 1,149 WUGs and 52 WUAs under Component 1 with a total membership of 11,546 farmers. Although the project provided capacity building training to WUA administrative committees and provided office buildings, sustainability of the WUAs has not been assured. The empowerment of the WUAs with clear cut clauses in the water law and ability of the WUAs to enforce these clauses is essential.

Achievements under the Supply Management & Recharge Improvement under Component 2:

Brief Background: The objective of this component is primarily to enhance groundwater recharge through the rehabilitation of the existing conventional dams, and construction of new conventional dams, as well as through the construction of sub-surface dams, check dams and other structures. It is expected that farmers would then pump from shallow aquifers rather than from the deep aquifers which are a critical source of drinking and domestic water supply for Sana'a city. A further objective is to effect safety improvements of the existing dams.

Problems Encountered before the Commencement of Implementation of the Activities under this Component: it is envisaged in the Schedule 1, Clause 3 of the DCA, that " No withdrawal should be made for expenditure under Category 1(a) and 2(a) – Civil works- unless and until the Borrower shall have submitted to the association evidence satisfactory to the association that the quality of the effluent and sludge produced by the Sana'a WWTP has met the specification agreed upon between the Borrower and the association and as set forth in the EMP. The above requirement was not immediately met by the management of the Sana'a WWTP and thus causing enormous delays in the commencement of the civil works under the supply management and recharge improvement component. The civil works started only after the IDA relaxed the above requirement. The requirement of forming Water Users Organization in the basin to perform the O&M of the rehabilitated dams posed a problem at the beginning. However with the intensive efforts of the SMT and the IPAC staff, twelve WUAs under component 2, were formed to perform the O&M of the rehabilitated dams but after considerable delays.

Problems Encountered during the Course of Implementation of Project Activities: The implementation of the civil works under the supply management and recharge improvement also suffered implementation delays. These delays were attributed to the very frequent interventions by the beneficiaries in the contractor's work and stoppage of their work for various reasons such as, to include work not originally included in the design and BOQ of the contract, employ labor

from their village/locality and other beneficiaries require the contractor to hire their machinery, etc.

Actions Taken to Address the Problem: The project management approached the local authorities including security to intervene. The local authorities in many instances resolved the dispute, but another dispute arose the next week with the same contractor. The PCU also tried to involve the local leaders to resolve these problems but with limited success.

Achievements under each Subcomponent of Component 2

Rehabilitation of Existing Recharge Dams: A total of 10 existing recharge dams were rehabilitated while Beryan Dam, which was originally planned to be rehabilitated, was reconstructed as a new recharge dam for security reason. A total of 10 ground pits were build for water harvesting. A total of 47 cascade check dams were built to increase recharge of flood in wadis. All these structures were handed over to the Dam Unit (DU) of the MAI.

Construction of New Recharge Dams and three Subsurface Dams: The construction of four new dams and three subsurface dams was cancelled by the PSC on the basis of the recommendation of the WB evaluation report in February 2007 and May 2008 respectively.

Institutional Development for Community Management, O&M of Dam and Recharge Systems: The SMTs have successfully supervised the formation of 68 WUGs which were consolidated in 12 WUAs. The responsibility of these WUGs/WUAs is to carry out the O&M and recharge system for the rehabilitated dams and the new constructed dam (Beryan dam). The scope of activities under the Component 2 is reduced and accordingly, it could be concluded that the overall objectives of Component 2, may be moderately achieved.

Achievements under each Subcomponent of Component 3

The Water Law and its By-laws: Amendments to the Water Law were approved by the Parliament in December 2006. The by-laws have been drafted and approved by the MWE in 2008. The bylaws were passed from the cabinet to the Ministry of Justice and are currently being reviewed in the Legal Department of the Ministry of Justice.

Well Registration and Licensing: With the project's assistance, NWRA-SB initiated the well registration process. Cases of violation of unlicensed drilling are increasing and only few cases of violations were referred to the prosecutor with minimum fines decided by the courts. Due to the lack of support from the highest level of the GOY, the well registration and licensing process was not fully implemented.

Capacity Building for Water Resource Planning and Management (NWRA-SB): The project supported NWRA-SB with office equipments, technical equipment for surface and groundwater monitoring, transportation, and the required budget for monitoring activities. The project provided capacity building through local and foreign training to technical staff in NWRA-SB and representatives of WUAs.

Local Technical Training: A total of 66 specialists from NWRA-SB (27 Nos.), PCU (23 Nos.), MAI (10 Nos.) and MWE (6 Nos.) benefited from local technical training organized by the project.

Local Farmers' Training: To raise the awareness and knowledge of the administrative committees of the WUAs on their future role in water resource management, the project

organized workshops and seminars for 181 members from the WUAs and officials from the local districts.

Regional Training: The PCU coordinated foreign training for the technical and management staff from the line ministries and representatives from the WUAs. A total of 58 representatives from the WUAs joined foreign study tours in addition to 25 staff members from PCU, 26 from NWRA-SB, 28 from GDI/MAI, 12 from EPA, 4 from SBC and 11 from MWE.

Hydro-Geological and Water Resources Monitoring and Investigation: The objective of this subcomponent was to setup and execute comprehensive hydrological and water resource monitoring and investigation program to achieve a better understanding and quantification of Sana'a Basin surface and groundwater resource availability. As a result of this study, it was expected to have a realistic estimation of the impact of water saving and aquifer recharge investments in the basin. An international consulting firm was contracted to carry out the following studies: (i) aquifer storage investigation and assessment; (ii) water balance estimation and sub-basin monitoring; (iii) groundwater modeling; and (iv) hydrological monitoring and analysis. The final study reports were submitted to NWRA-SB during 2009 – 2010. Another international consulting firm specialized in satellite imagery data analysis was contracted to carry out the satellite imagery study in 2006. The outcomes of the satellite imagery study were incorporated as an important input in the water balance and groundwater modeling studies. Since the final report was approved in 2008, it become evident that the remaining time for project closure in June 2009 would not allow the completion of a second study, which was not carried out. The overall assessment of outcome under this component is considered as moderately satisfactory.

Achievements under the IPAC Subcomponent:˜The IPAC team organized on continuous basis several workshops, field days and seminars as part of the awareness activities. The workshops and seminars reached out farmers and public schools and teachers at different targeted areas in the basin. The IPAC team also prepared and distributed several types of awareness material, which were distributed during their campaigns to the public at different events, including Al-Salsabil quarterly news letter, brochures, leaflets and pamphlets, the SBWMP annual calendar for 2007 and 2010, production of three films including, SBWMP documentary film, modern irrigation training film and domestic water saving film, etc.

Schools Awareness: The IPAC carried out school awareness campaigns aiming at explaining the current water situation in Sana'a Basin to students and teachers. The campaigns reached out 44 public schools in the basin. The students in many schools organized social/entertainment events (i.e. poetry, songs, plays, etc.) to the villagers on groundwater scarcity, mitigation measures, water saving technologies and the role of farming communities in groundwater conservations for sustainable livelihood in the basin.

Mosques Awareness: The PCU coordinated with most of the mosques' Imams in the basin and provided them with awareness publications and organized meeting with them to explain the critical water situation in Sana'a Basin to enable them to prepare typical speeches for Friday prayers. Each Imam in the Friday' speech explains the scarcity of groundwater in the basin and the mitigation measures to conserve water. These has been influential messages and highly accepted by the prayers.

Women Association Awareness: A total of 37 women associations in Sana'a Basin were established with support of IPAC team. The female specialist in the IPAC team has held a

number of meetings with each of the women WUAs. The female specialist distributed a variety of awareness material to the members of women associations during these meetings to raise their awareness and knowledge about the critical groundwater situation in the basin. In view of the above, it could fairly be concluded that the achievement of the objectives of this component is highly satisfactory.

Achievements under each Subcomponent of Component 4

Dam Safety, Siltation and Downstream Effects: The DSRP carried out six missions to the project and performed physical inspection of the rehabilitated dams The DSRP evaluated the status of each of the rehabilitated dams as satisfactory.

Public Health: The first phase of combating *bilharzias* was training of staff involved in the implementation of this activity. The second phase was field survey for the prevalence of *bilharzias* infections and vectors within the targeted districts. Public awareness program for mitigating the effect and avoidance of causes of *bilharzias* was jointly prepared by the MOPHP and EPA.

Land Acquisition and Involuntary Resettlement: No land acquisition was required for the infrastructure. Only small parcels of land required for WUA office buildings were contributed by beneficiary farmers.

Wastewater Treatment, Wastewater Reuse and Sludge Reuse: The environmental monitoring system continued gathering data of effluent and sludge of the Sana'a WWTP with no improvement whatsoever in terms of quality. The PCU provided the Sana'a WWTP with laboratory equipment for water quality analysis. A special red flag system was developed to send warning messages through mobile phones to around 200 farmers who are directly or indirectly using the wastewater from the WWTP. The red flag warning is sent out when the sewerage is released through the by-pass from the WTTP without treatment.

Pest Control and Pesticides Management: IPM Plans for *qat* and grapes were implemented in the Sana's basin with close cooperation with the specialists from MAI/DPP.

Awareness and Education: The SMTs held extensive stakeholder consultations, workshops and focus group meetings during project implementation which created momentum and trust between the stakeholders and project management.

Institutional Development and Capacity Building: As part of the EMP, a number of institutional and capacity building initiatives were taken and developed by the project with the concerned institutions and farmers in the project areas. These included, building the capacity of the NWRA-SB, assisting the MAI/DPP in developing the pesticides residue testing facilities and strengthening the EPA in its regulation and enforcement responsibilities.

Environmental Resource Team: An environmental management and monitoring specialist was seconded from EPA and placed in NWRA-SB. The environmental unit headed by a specialist from EPA was established and functioning since the commencement of the project activities.

Monitoring the Expansion of Irrigated Land: The SBWMP did not provide services for any newly developed land, and signed contracts with farmers for non-expansion of the irrigated area before providing them with modern irrigation systems. There are no evidences of expansion in the project area or the areas under the WUAs. However, no survey was carried out to confirm the adherence of the farmers to the tripartite agreement with farmers in the basin.

Almost all of the activities under the Component 4 were implemented in a satisfactory manner; however, the objective of improving the quality of the effluent and sludge from the Sana'a WWTP was not achieved. The project efforts to design and put in place a red flag warning system for the direct and indirect users are a positive step but may not be sufficient to mitigate the environmental risks associated with the by-pass from the WWTP.

Achievements under each Subcomponent of Component 5

Monitoring and Evaluation: **T**he M&E system functioned satisfactorily with quarterly progress reports produced on a regular basis. The data on the results based indicators was collected and frequently updated though no field surveys were conducted by the M&E unit.

Financial Management: The finance section discharges its duties satisfactorily as the project financial management reports were prepared and submitted to the IDA on time. The annual audit reports were also prepared and submitted to the IDA on time. Post review of the procurement of goods and civil works by IDA mission showed no violations or deficiencies.

Borrower Performance:

- The Borrower showed continuing political will to address WRM and conservation. This is manifested in the preparation and approval of the national water strategy, the enactment of the water law, and support the organization of a number of studies and workshops that addressed the WRM and conservation.
- The Borrower provided to the PCU adequate local budgets (investment and recurrent budgets) which are necessary for the timely implementation of the project activities. This ensures the Borrower commitment and ownership of the project.
- The PSC held 52 meetings. During these meetings, the PSC provided the needed support to the PCU as well as being responsive to the beneficiaries' and stakeholders' demands. The PSC was instrumental in addressing the project concerns objectively and responsibly.
- The level of coordination between the PCU and the project implementation partners was satisfactory. This level of productive coordination with the project partners contributed to the successful implementation of the project activities.
- The IPAC of the project was successful in generating observable changes in the behavior of the farming community and other stakeholders towards better understanding of the groundwater situation. The farming community in the basin became more aware of the scarcity of groundwater in the basin and the necessary mitigation measures to address this situation.
- The SMTs was instrumental in establishing 52 WUAs and provided the necessary capacity building to these WUAs to play their intended role in participatory management of the water resources in the basin. However, the sustainability of these WUAs needs more than just capacity building and the Borrower should promote the sustainability of the WUAs through self-reliance.

IDA Performance:

- The IDA launched 12 supervision missions, for total period of 3.9 months, during the course of project implementation. The missions comprised multi-disciplinary teams of

international experts/consultants (58 Nos.) who provided constructive and instrumental recommendations and technical guidance to the PCU.

- The objective flexibility in addressing the project constraints and needs by the IDA was an essential factor underlying the satisfactory completion of the project.
- The project design was complex as the project had seven components and their implementation required close coordination between the PCU and the other implementing partners including departments, directorates from other line ministries. "Coordination" would be nice and easy as a slogan but difficult to implement in Yemen context.
- The legal covenant that linked the commencement of the civil work of Component 2 with the improvement of the quality of wastewater sludge to international standard was difficult to achieve in a timely manner since this requirement was beyond the authority of the PCU. This led to serious delays during the start up of the project activities.

IDA - Borrower Relationship:

- The relationship between the IDA and the Borrower was productive, constructive and fruitful in terms of meeting the project needs and ultimately leading to substantial achievement of the project objectives.
- IDA missions had been objectively flexible in considering the Borrower's suggestions to modify and/or cancel some of the project activities which proved either technically not feasible or practically not appreciated by the targeted beneficiaries and the stakeholders.
- IDA flexibility is manifested in its agreement to the PSC/PCU and the targeted beneficiary's suggestion to modify the mechanism of installation of the improved conveyance and localized irrigation systems. The revised installation mechanism led to: (i) reducing installation cost; (ii) giving supervisory role to the WUAs in the installation process; and (iii) making farmers' contribution in kind (i.e. labor for excavation of trenches and back filling). The revised installation mechanism was widely accepted by the farming community and led to more adoption of water saving, modern irrigation technologies in farmers' fields.
- The IDA agreed to revise the targets of activities under Component 1 two times in response to farmers' demands. The revised targets were substantially achieved. This flexibility of the IDA significantly contributed to achieving the targets of Component 1.
- The PSC/PCU suggested to the IDA that some structures be cancelled under Component 2. After IDA experts evaluated such structures, the IDA agreed to cancel those structures.
- The PSC/PCU suggested and the IDA agreed to terminate: (i) the drilling contract because of the failed drilling of three boreholes in accordance with the specification envisaged in the contract; and (ii) the contract of the coordinating consulting firm because of deficiency in delivering the contracted services.
- The Borrower requested and the IDA agreed to reallocation of the credit proceeds three times during the project implementation (i.e. March 12, 2008, September 22, 2009, and March 22, 2010). This clearly reflects IDA's flexibility and understanding of the project implementation needs to achieve its objectives.

- The Borrower requested and the IDA agreed to extend the project closing date from the scheduled date of June 2009 to December 2009 and again to June 30, 2010 to complete ongoing works under Component 2 and to meet the high farmers, demand for improved conveyance and localized irrigation systems under Component 1. This reflects the mutual understanding of the Borrower and the IDA of the project needs.

Sustainability and Future Operation:

- The sustainability of the project activities is very likely, specially the activities of Component 1. This is because farmers realized the financial benefits as a result of installation of piped conveyance and localized irrigation systems, including savings in the pumping (fuel) costs and irrigation labor, and increased crop yields. In addition, the increased awareness of farmers about the scarcity of groundwater in the basin has prompted them to conserve this vital resource.
- There is considerable farmers' investment in acquiring water saving technologies in the basin (improved conveyance and localized irrigation systems). Since a sense of ownership by the beneficiaries to these systems has been generated, beneficiaries willingly accept the full responsibility to carry out the future maintenance of these systems. This reflects the beneficiaries' commitment to future O&M, which leads to the sustainability of these systems.
- The formation of the WUAs and their capacity building program are likely to contribute to the sustainability of project interventions in the basin. The program included: (i) awareness campaign to acquaint the beneficiary farmers with the scarcity of groundwater situation in the basin and the potential measures to reduce imminent risks; (ii) local training to the members of the WUAs in the form of workshops; and (iii) technical training on the maintenance of improved conveyance and localized irrigation systems.

Key Lessons Learned:

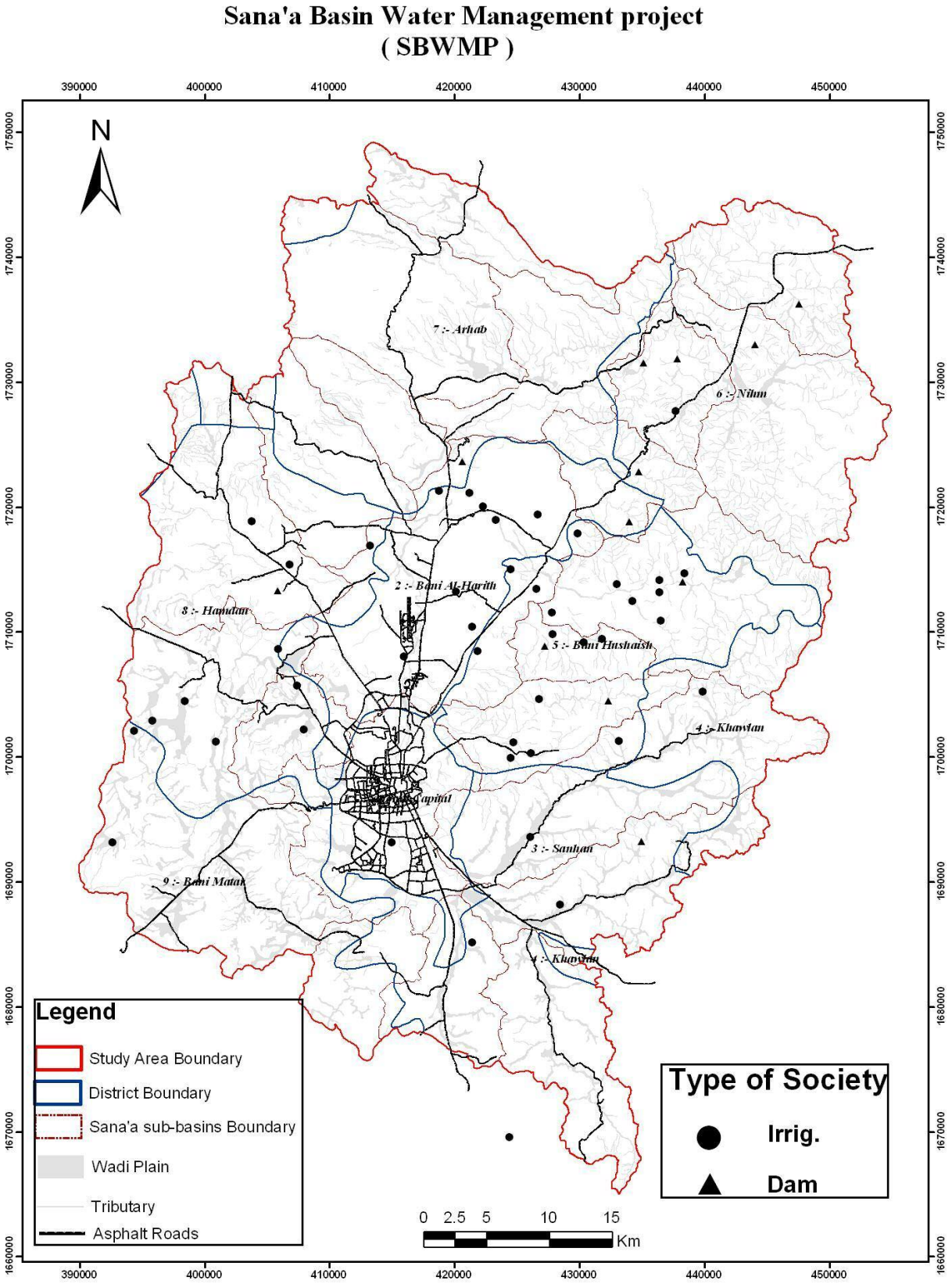
- Project designs need to be kept simple and in line with administrative capacity in the country. The project has diverse components involving the participation of several agencies/line ministries. Thus requiring a wide matrix of coordination which did not readily exist.
- Legal covenants should be carefully considered and that they should be implementable within a reasonable timeframe to avoid enormous implementation delays if not being met.
- The critical assumptions at entry should be seriously considered to avoid the unforeseen consequences of not being met.
- The national staff from the line ministries should be intensively involved during all stages of project preparation (i.e. from project identification, to project appraisal) instead of involving national consultants as counterparts to the foreign experts. This is important and may have serious implications during the course of project implementation.

ANNEX 8: Comments of Cofinanciers and Other Partners/Stakeholders

None

ANNEX 9: List of Supporting Documents

1. Project Concept Note, April 2000
2. Project Appraisal Document, April 2003
3. Credit Development Agreement (Cr. 3774-YEM), August 2003



Location of Societies for Pilot Studies in the Basin