ASIAN DEVELOPMENT BANK

PCR: PAK 24189

PROJECT COMPLETION REPORT

ON THE

KOTRI BARRAGE REHABILITATION PROJECT
(Loan 1101-PAK[SF])

IN THE

ISLAMIC REPUBLIC OF PAKISTAN

December 2003

CURRENCY EQUIVALENTS
(as of 31 October 2003)

Currency Unit – Pakistan Rupees (PRs)

		At Appraisal (July 1991)	At Project Completion (October 2003)
Pre1.00	=	$0.0405	$0.0174
$1.00	=	Rs24.65	57.625

ABBREVIATIONS

ADB	–	Asian Development Bank
BME	–	benefit monitoring and evaluation
DFID	–	Department of International Development
EA	–	executing agency
EIRR	–	economic internal rate of return
ha	–	hectare
IPD	–	Irrigation and Power Department
NDP	–	National Drainage Program
O&M	–	operation and maintenance
PCR	–	project completion report
SDR	–	special drawing rights

NOTES

(i) The fiscal year (FY) of the Government ends on 30 June.

(ii) In this report, "$" refers to US dollars.

CONTENTS

BASIC DATA

A. Loan Identification

1.	Country	Pakistan
2.	Loan Number	1101-PAK(SF)
3.	Project Title	Kotri Barrage Rehabilitation
4.	Borrower	Government of Pakistan
5.	Executing Agency	Government of Sindh through its Irrigation and Power Department
6.	Amount of Loan	SDR14.958 million
7.	Project Completion Report Number	PCR:PAK 786

B. Loan Data

1.	Appraisal	
	– Date Started	8 June 1990
	– Date Completed	21 June 1990
2.	Loan Negotiations	
	– Date Started	19 August 1991
	– Date Completed	21 August 1991
3.	Date of Board Approval	26 September 1991
4.	Date of Loan Agreement	20 December 1991
5.	Date of Loan Effectiveness	
	– In Loan Agreement	19 March 1992
	– Actual	17 December 1992
	– Number of Extensions	5
6.	Closing Date	
	– In Loan Agreement	30 June 1997
	– Actual	27 November 2000
	– Number of Extensions	2
7.	Terms of Loan	
	– Service Charge	1%
	– Maturity (number of years)	35
	– Grace Period (number of years)	10

8. Disbursements

a. Dates

Initial Disbursement	Final Disbursement	Time Interval
22 February 1994	27 November 2000	6 years, 9 months
Effective Date	**Original Closing Date**	**Time Interval**
17 December 1992	30 June 1997	4 years, 6 months

b. Amount (SDR)

Category		Original Allocation	Last Revised Allocation	Amount Disbursed	Undisbursed Balance	Amount Cancelled
1	Civil Works	3,377,000	9,925,444	8,242,534	1,682,910	1,682,910
2	Supplies and Materials	5,258,000	2,859,428	2,698,838	160,590	160,590
3	Vehicles and Equipment	12,000	18,535	13,973	4,562	4,562
4	Local Currency Expenditure	3,440,000				
A	Civil Works - 2,351,000					
B	Administration (Part H) - 159,000		225,593	269,567	(43,974)	(43,974)
C	Unallocated: Categories 4A & 4B - 930,000					
5	Service Charge During Construction	421,000	469,000	469,000		
6	Unallocated	2,450,000				
99I	Imprest Fund – Irrigation & Power Department					
	Total	14,958,000	13,498,000	11,693,911	1,804,088	1,804,088

Source: Asian Development Bank – Loan Financial Information System.

Local Costs (Financed)
- Amount $3,010,141
- Percent of Local Costs 61.09%
- Percent of Total Cost 14.00%

C. Project Data

1. Project Cost ($ million)

Cost	Appraisal Estimate	Actual
Foreign Exchange Cost	21.650	20.022
Local Currency Cost	29.150	19.997
Total	50.800	40.019

Source: Asian Development Bank – Loan Financial Information System.

2. Financing Plan ($ million)

Cost	Appraisal Estimate	Actual
Implementation Costs		
Borrower-Financed	15.100	7.505
ADB-Financed	20.000	16.710
ODA	15.700	15.804
Total	50.800	40.019

ADB = Asian Development Bank, ODA =Overseas Development Administration.

Source: Asian Development Bank – Loan Financial Information System.

3. Cost Breakdown by Project Component ($ million)

a. Appraisal Estimates

	Appraisal Estimate						
	ADB		ODA		Government		
Component	Foreign	Local	Foreign	Local	Foreign	Local	Total
1. Civil Works	4.515	3.144	2.960	6.251	0	2.608	19.478
2. Supplies and Materials	7.030	0	0	0		9.243	16.273
3. Consulting Services	0	0	2.123	0.498	0	0	2.621
4. Vehicles and Equipment	0.016	0	0	0	0	0.031	0.047
5. Administration	0	0.212	0	0	0	0	0.212
Total Base Cost	**11.561**	**3.356**	**5.083**	**6.749**	**0**	**11.882**	**38.631**
Physical Contingencies	1.392	0.427	0.335	0.743	0	1.259	4.156
Price Escalation	1.883	0.817	0.832	1.957	0	1.959	7.448
Service Charge During Construction	0.563	0	0	0	0	0	0.563
Total Project Cost	**15.400**	**4.600**	**6.250**	**9.450**	**0**	**15.100**	**50.800**

Source: Asian Development Bank – Loan Financial Information System.

b. Actual Expenditures

	Actual						
	ADB		ODA		Government		
Component	Foreign	Local	Foreign	Local	Foreign	Local	Total
1. Civil Works	9.069	2.594	4.162	8.542	0	0.592	24.959
2. Supplies and Materials	3.960	0	0	0	0	6.884	10.844
3. Consulting Services	0	0	2.160	0.940	0	0	3,100
4. Vehicles and Equipment	0.021	0	0	0	0	0.029	0.050
5. Administration	0	0.416	0	0	0	0	0.416
Total Base Cost	**13.050**	**3.010**	**6.322**	**9.482**	**0**	**7.505**	**39.369**
Physical Contingencies	0	0	0	0	0	0	0
Price Escalation	0	0	0	0	0	0	0
Service Charge During Construction	0.650	0	0	0	0	0	0.650
Total Project Cost	**13.700**	**3.010**	**6.322**	**9.482**	**0**	**7.505**	**40.019**

Source: Asian Development Bank – Loan Financial Information System.

4. Project Schedule

Item	Appraisal Estimate	Actual
Date of Contract with Consultants	March 1992	30 October 1992
Completion of Engineering Designs	June 1991	April 1993
Civil Works Contract		
Date of Award		22 November 1993
Completion of Work		29 January 2000
Equipment and Supplies		
Dates		
First Procurement	March 1992	21 November 1993
Last Procurement		01 November 1998
Other Milestones		
First Extension of Loan Closing Date		31 December 1999
First Partial Cancellation		23 December 1999
Final Cancellation of Undisbursed Loan Balance		27 November 2000

Source: Asian Development Bank – Loan Financial Information System.

5. Project Performance Report Ratings

Implementation Period	Ratings	
	Development Objectives	Implementation Progress
1 January 1993 to 31 December 1993	Satisfactory	Satisfactory
1 January 1994 to 31 December 1994	Satisfactory	Satisfactory
1 January 1995 to 31 December 1995	Satisfactory	Satisfactory
1 January 1996 to 31 December 1996	Satisfactory	Satisfactory
1 January 1997 to 31 December 1997	Satisfactory	Satisfactory
1 January 1998 to 31 December 1998	Satisfactory	Satisfactory
1 January 1999 to 31 December 1999	Satisfactory	Satisfactory
1 January 2000 to 30 June 2000	Satisfactory	Satisfactory

D. Data on Asian Development Bank Missions

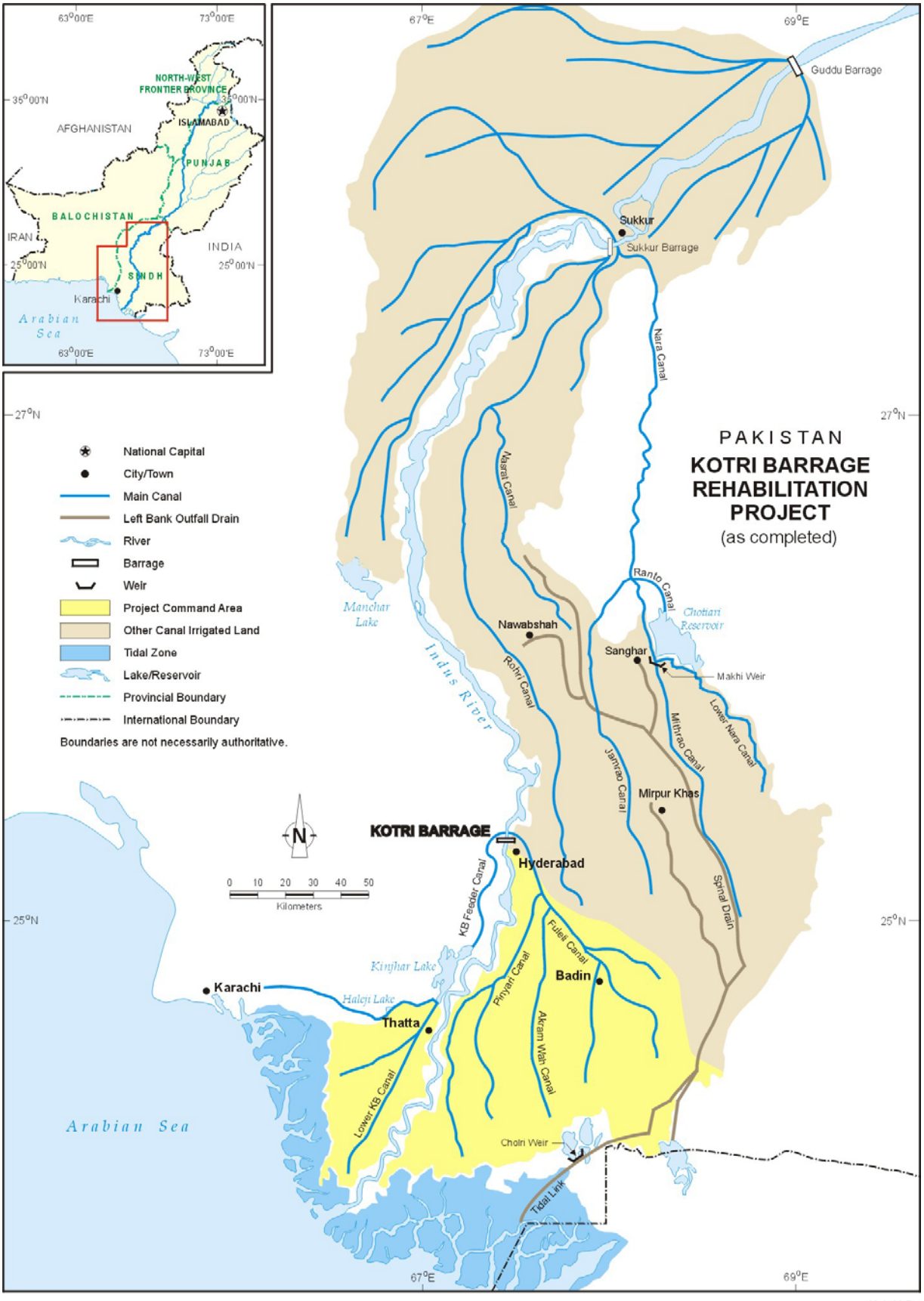
Name of Mission	Date	No. of Persons	No. of Person-Days	Specialization of Members[a]
Fact-Finding-cum-Appraisal Mission	08 – 21 June 1990	4	56	a, b, c, k
Tripartite Meeting	12 - January 1992	1	3	a
SPA Mission 1	12 – 17 Sept 1992	1	6	a
Inception Mission	22 Nov - 1 Dec 1994	1	10	a
Review Mission 1	25 – 31 May 1994	1	7	a
Review Mission 2	1– 10 Nov 1994	1	10	a
SPA Mission 2	18 June 1995	1	1	a
Midterm Review	21 – 30 Nov 1995	5	45	a, d, e, f, g
SPA Mission 3	12 – 13 June 1996	1	2	a
Portfolio Review	15 – 18 Aug 1996	3	12	a, h
Review Mission 3	11 – 17 Dec 1997	1	7	a
Review Mission 4	2 – 9 June 1998	3	24	a, i, j
Review Mission 5	30 Apr – 8 May 1999	1	9	a
Review Mission 6	10 – 19 June 2000	1	10	a
Project Completion Review	12 – 28 Sep 2003	4	56	i, k, l, m

SPA = Special Project Administration.

Note:

[a] a = Project Engineer, b = Programs Officer, c = Counsel, d = Project Administration Assistant, e = Pakistan Desk Officer (ODA), f = Engineering Adviser (Overseas Development Administration), g = Executive Officer (ODA), h = Project Implementation Officer (Pakistan Resident Mission), i = Project Economist, j = Assistant Project Analyst, k = Project Implementation Officer, l = Economist (Consultant), m = River Structural Engineer (Consultant).

[b] The project completion report was prepared by Ahsan Tayyab, Project Economist.


PAKISTAN
KOTRI BARRAGE REHABILITATION PROJECT
(as completed)
National Capital
City/Town
Main Canal
Left Bank Outfall Drain
River
Barrage
Weir
Project Command Area
Other Canal Irrigated Land
Tidal Zone
Lake/Reservoir
Provincial Boundary
International Boundary
Boundaries are not necessarily authoritative.
Guddu Barrage
Sukkur
Sukkur Barrage
Nara Canal
Nasrat Canal
Ranto Canal
Chotiari Reservoir
Manchar Lake
Nawabshah
Sanghar
Makhi Weir
Indus River
Rohri Canal
Lower Nara Canal
Mithrao Canal
Jamrao Canal
Mirpur Khas
KOTRI BARRAGE
Hyderabad
Spinal Drain
KB Feeder Canal
Fuleli Canal
Kinjhar Lake
Badin
Karachi
Haleji Lake
Pinyari Canal
Thatta
Akram Wah Canal
Lower KB Canal
Arabian Sea
Cholri Weir
Tidal Link
Kilometers
0 10 20 30 40 50
N
AFGHANISTAN
IRAN
INDIA
NORTH-WEST FRONTIER PROVINCE
ISLAMABAD
PUNJAB
BALOCHISTAN
SINDH
Karachi
Arabian Sea
63°00'E
73°00'E
35°00'N
25°00'N
67°E
69°E
27°N
25°N
03-3486 RM

I. PROJECT DESCRIPTION

A. Background and Rationale

1. Kotri Barrage[1] was constructed across the Indus River in the early 1950s primarily to irrigate 1.2 million ha of land in lower Sindh province. The barrage also supplies water to the city of Karachi.

2. Of three barrages built from 1932-1962 in Sindh province (Sukkur, Kotri, and Guddu), Kotri—just east of the city of Hyderabad and 120 kilometers (km) northeast of Karachi—is the farthest downstream. The barrage is 915 meters (m) long with 44 bays, and it incorporates a road bridge, a navigation lock for river traffic, and two fish ladders. Head regulators adjacent to the main barrage divert water into three outlets that feed four canals, three on the left bank and one on the right bank.

3. By the 1980s, a number of serious operational difficulties were evident in the barrage. The most severe problem was the corrosion of the 43 main barrage gates, each 6.4 m high, 18.3 m wide and weighing 36 tons (t). During 1987-1989, the Overseas Development Administration (DFID)[2] of the United Kingdom funded studies on the rehabilitation of the Kotri Barrage, including replacing the gates, conducting repairs, and removing operational limitations. The studies recommended an accelerated rehabilitation program to avoid gate failure, prevent damage to the structure, and avert serious loss of irrigation and water supplies.

4. Because of the magnitude of the works, the Sindh government approached ADB about cofinancing, with DFID, a proposed program to rehabilitate Kotri Barrage. ADB fielded a reconnaissance mission in April 1990, and a combined fact-finding and appraisal mission in June 1990. On 26 September 1991, ADB approved the Kotri Barrage Rehabilitation Project (the Project) and a loan of SDR14.958 million ($20 million equivalent). DFID cofinanced the Project with a grant of $15.7 million equivalent, while the Government of Pakistan committed $15.1 million equivalent. DFID's grant financed supervisory consultants and one civil works contract for the replacement of barrage gates and replacement and refurbishment of regulator gates.

B. Objectives and Scope

5. The Project focused on remedial civil works. The primary objective was to replace the rapidly deteriorating barrage gates and rehabilitate the main structure. By acting quickly, the Project aimed to avoid structural failure as well as the potentially disastrous loss of farm production, water supply and livelihood.

6. The secondary objectives were: (i) to repair important components of the barrage structure, including the barrage roadway bridge deck, and remove operational limitations; and (ii) to raise the working head of the barrage pond by 0.61 m to improve diversion for the KB Feeder Canal (the right bank canal that supplies water to Karachi) and the three left bank canal systems.

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[1] A barrage is a barrier structure that serves to divert rather than primarily store water as a dam.

[2] ODA became the Department for International Development (DFID) in 1997. The acronym DFID is used throughout the document to represent both entities.

7. The Project had four categories: (i) the rehabilitation of barrage and appurtenant structures, (ii) vehicles and equipment, (iii) consulting services and training, and (iv) institutional strengthening of the Irrigation and Power Department (IPD). The scope of work did not include broader issues related to the downstream command or wider social or gender concerns.

II. EVALUATION OF DESIGN AND IMPLEMENTATION

A. Relevance of Design and Formulation

8. The Project was consistent with Pakistan development policies and ADB strategic objectives[3] to support agriculture production, rural income and employment. If the rehabilitation been deferred, the irrigation system would have deteriorated or ceased to function for indefinite periods. Given the size of the Irrigation service area of the Kotri Barrage and dependence on irrigation,[4] inaction could have resulted in gate failure with disturbing consequences for the regional economy.

9. The project feasibility studies by DFID-financed consultants were generally satisfactory. A plan was formulated to avert gate failure and rehabilitate the Kotri Barrage diversion structure. For the Project's secondary objective of improving the capacity of the barrage to operate at a higher pond level, the preparatory work was less advanced. Studies continued during the Project, and the feasibility analysis was completed in 1995. The amount of work was larger than envisaged at appraisal and required a change of scope and extension.

10. One of the weaknesses of the feasibility studies was its handling of the problem created by the angled river approach to the barrage was a weakness. Potential solutions for straightening the approach flow were modeled, but a solution was not advocated because an economic justification was not found. By deferring action, however, the problem has gotten steadily worse and the remedy has gotten more expensive (paras. 19, 70).

11. Neither the feasibility studies nor the Appraisal Report[5] (Appraisal, September 1991) incorporated several aspects now expected in project design. First, there was no logical framework. The project components were designed as the physical works, rather than inputs in support of a component. Second, a benefit monitoring and evaluation provision was not included in the Project. Third, a provision for stakeholder review to encourage participation and ownership was lacking. Given the urgency with which the Project was formulated, these deficiencies were understandable. However, to derive the full benefits from the barrage rehabilitation, distribution-level deficiencies (physical, organizational, and financial) in the irrigation system also needed attention, but they were not addressed.

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[3] The Government's plans at the time emphasized (i) increasing grain and sugar production and reducing the need for imports, and (ii) improved productivity through the use of high-quality inputs and cultural practices. ADB's strategic thrust was to support agricultural growth by increasing productivity from existing irrigation infrastructure, rather than developing new irrigation systems.

[4] Sindh is hot and arid, and irrigation is essential for most crop production.

[5] ADB. 1991. *Report and Recommendation of the President to the Board of Directors on a Proposed Loan to Pakistan for the Kotri Barrage Rehabilitation Project*. Manila.

B. Project Outputs

12. The Project, which was carried out in two phases, consisted of two main outputs. Restoring safe and reliable operations to the barrage, including its roadway, was the first output. The second involved removing operating limitations on the head of the barrage, including raising the levels of control structures and strengthening the barrage so it could function beyond the original design[6] head differential at a higher pond level.

13. The first phase of works included (i) replacing the main barrage gates and lock gates by ones 0.61 m higher, and rehabilitating the accessories; (ii) refurbishing canal head regulator gates, a canal lock gate, and the associated deckings; (iii) replacing the barrage road bridge; (iv) repairing selected upstream and downstream pavements of the barrage; (v) raising the barrage divide walls and armoring the guide banks to a higher elevation; and (vi) repairing canal sub-regulator gates and accessories. The works were accomplished as envisaged, and the quality was satisfactory (Appendix 1).

14. In the second phase, studies were completed in September 1995 on operating the barrage above the original head differential design and at a higher pond level. The recommended program of works was larger than envisioned at appraisal, but still attainable with the project resources. Loan savings were identified, and ADB approved a change of scope and project extension in October 1996.

15. The second-phase works began in July 1997 and included drilling, grouting, and increasing the concrete thickness to add weight to the downstream portion of the barrage. The works were completed in January 2000. The new operating head differential was tested in September 2000, during the season with the highest river flows. The remedial works were successful.[7]

16. The loan financed vehicles and equipment, which were deployed to support the Project (Appendix 2). The IPD at Kotri Barrage continues to use them. Consultants were used in design, construction supervision, management and training. Approximately 146 person-months of international input and 573 person-months of domestic input were provided at the site.[8] Lastly, strengthening the institutional capacity of IPD was accomplished by providing an office and housing, as well as in-class and on-the-job training, for IPD staff.

17. The Project accomplished the outcome envisaged at appraisal. By averting a gate failure, downstream agricultural livelihood and production losses were avoided. By installing higher gates and support structures and strengthening the structure, the barrage can now operate at a higher pond level. As a result, irrigation supplies have

[6] The barrage was originally designed to operate at a maximum difference of 9.45 m between upstream and downstream water levels. However, due to seepage and the potential damage to the structure, the head differential had to be restricted to 7.32 m, resulting in lower pond levels and shortages for the off-taking canals. Under the Project, the head differential was to be raised to 9.76 m instead of the 9.45 of the original design. This would raise the normal pond level from the reduced level 20.73 m above mean sea level to the reduced level of 21.34 m above mean sea level. In October 2000, the barrage was tested and successfully held the maximum head differential of 9.76 m for 48 hours.

[7] The project completion report (PCR) mission visited during a period of high capacity flows. However, the PCR mission was unable to inspect the works of the downstream concrete weighting, since the foot of the structure was submerged, which is normal for the period of monsoon rains.

[8] An additional 136 person-months was claimed for UK-based staff.

been stabilized and improved. Due to the higher operating pond, the barrage has the capacity to increase water supply to Karachi.

18. Despite these accomplishments, several areas still need to be addressed to maximize the impact of the Project. First, operations and maintenance (O&M) funding is inadequate for the rehabilitated structure and the downstream service area (paras. 55-56).

19. Second, the river approach remains a concern (para. 10). During the Project, a slipway[9] was constructed on the right side of the river approach for launching a pontoon to deliver the new gates to the barrage. This launching area protrudes into the river on the right bank, accentuating the accumulation of silt and vegetative colonization. If left unattended, this will compromise the ability to safely pass floods.[10]

20. Third, the capacity to deliver more water to Karachi will be realized only if the conveyance structure, Kalri Baghar Feeder Canal, is remodeled so that it can carry the increased discharge. While a government project for this purpose has been approved, the designated funding source is the province (Sindh). To date, funding has been inadequate to complete the remodeling in any reasonable time frame.

C. Project Costs

21. The final cost of the Project was $40.0 million, which was 79% of the appraised estimate of $50.8 million. Excluding physical and price contingencies, the appraised figure totaled $39.2 million. The actual ADB loan amounted to $16.7 million, $3.3 million less than the appraisal figure of $20.0 million. Appendix 3 summarizes the project expenditure by year.

22. The cost savings resulted from foreign exchange appreciation and some contract savings. At appraisal, the Project provided for high foreign[11] and low domestic rates of price contingencies. However, international inflation was negative for 1993-2000, with prices declining by an average of 1.1% per year. Over the same period, Pakistan's domestic inflation averaged 9% (versus the appraised average of 4% per year) and the Pakistan rupee fell in value by 43%. The appraised provision for physical contingencies was 11%, which was high for relatively known works in barrage rehabilitation. Two partial loan cancellations were effected: one for $2 million on 23 December 1999, and the balance $2.3 million upon loan closing.

[9] The slipway is the launching area for a large and technically fitted pontoon boat that was constructed to (i) deliver and install the 44 main barrage gates, and (ii) install the bulkhead gates, which seal off the main gate areas for de-watering and servicing with regular O&M.

[10] Since the barrage diverts rather than stores water, this does not have a significant impact on normal irrigation operations. The implications are more important for floods. The original design was to pass a 1 in 70 year flood.

[11] 10% for 1991, 8% for 1992, and 6% for 1993-1996.

Table 1: Project Cost and Financing

Source	Appraisal		Actual	
	$ Million	Percent	$ Million	Percent
ADB	20.0	39	16.7	42
DFID	15.7	31	15.8	39
Government	15.1	30	7.5	19
Total	50.8	100	40.0	100

Including Service Charge
ADB = Asian Development Bank, DFID = Department for International Development.
Source: Asian Development Bank estimates.

23. ADB financed 42% of the Project, compared with a 39% estimate at appraisal. DFID's share rose to 39% from an appraised estimate of 31%. The increased ADB share reflects the utilization of its loan savings to finance a large portion of the works to remove operational limitations of the barrage—a program that required a change in scope. DFID's increased share in the Project resulted from increased shares in the costs of its financed subcomponents (one civil works contract and the supervisory consultant services). Within that framework, the government share dropped to 19% from 30% .

D. Disbursements

24. The disbursement schedule at appraisal was reasonably formulated. As forecast, disbursement was to peak in the second year and then taper off. Actual disbursement peaked again, however, due to the change of scope and the second phase of works to remove the barrage operating head limitations. An imprest account was employed under the Project. The loan account was closed on 27 November 2000, and the unutilized balance of $2.3 million was canceled. Annual contract awards and disbursements are shown in Appendix 4. The final status of loan utilization is shown in Appendix 5.

E. Project Schedule

25. ADB loan effectiveness was delayed due to the inability of the cofinancier (DFID) and Government to conclude agreement, which was a cross-effectiveness condition for the ADB loan (paras. 36-39). However, project preparation proceeded as DFID extended the feasibility study consultant to facilitate issuing contract and tender documents. In October 1992, the supervisory consultant responsible for the preparatory studies was appointed following competitive bidding.

26. The main civil works contract was awarded in November of 1993. Work started in February of 1994 and was completed in November 1997. The works included (i) fabrication and replacement of the main gates and rehabilitation of appurtenant structures, (ii) construction and launching of a pontoon and bulkhead gates required for the replacement of the main gates, and (iii) rehabilitation of the barrage road bridge.

27. The contractor's initial program for the replacement of the main gates and construction of the pontoon facilities was delayed.[12] Slow government action in opening

[12] Delays were due to design differences and need for approvals, difficulty in recruiting welders, prolonged subcontractor negotiations, subcontractor piling plant breakdowns, adverse weather, and political unrest.

a letter of credit for paying suppliers also delayed the delivery of materials. The first bulkhead gate[13] was not launched by pontoon until January 1995. Eventually, however, the contractor made up for the early delays with swifter progress later, and the last of the barrage main gates were replaced by January 1997. Work on the roadway bridge, contingent on the opening of an alternate road, started in July 1995 and was completed in June 1997.

28. Delays also were reported on minor contracts undertaken by local contractors for the construction of office and residential buildings. Unusual rainfall and "unrest" at the project site in 1994 and 1995 were cited as reasons.

29. The studies by the supervisory consultant on removing operational head limitations were completed in September 1995. However, a change of scope and loan extension were required to accomplish the works. On 16 October 1996, ADB approved the change in scope. The contract for the works to remove head limitations was signed 1 August 1997, almost 2 years after the completion of studies.

30. Weather and high tailwaters during two construction periods delayed the work to remove the head limitations of the barrage. However, after approval of an extension, physical completion was achieved by January 2000. The rehabilitated barrage's new capacities were tested successfully in September 2000, when sufficient inflows were present.

31. Some of the project delays had mitigating circumstances. First, DFID held out on an important principle—designating the supervisory consultant as project engineer—that delayed loan effectiveness. The government resisted this approach until seeing which consultant was competitively selected, which resulted in the loss of one winter construction period. Second, while the initial performance of the main contractor was disappointing, adjustments were made and lost time was recouped. Although starting at a later date, the main works of the Project were accomplished within the time span envisaged at appraisal. Third, the feasibility analysis on removing operating head limitations of the barrage, which was not finished until late 1995, was not available at the start of the Project. The required separate scope of work, along with weather setbacks, effectively added 3 years to the Project.

32. Under normal circumstances, allowing more time for start-up activities might have been in order. However, the Project aimed to avert an impending gate failure. Consequently, the work plan was advanced within this framework, and the implementation period was not unreasonable. The schedule of implementation is shown in Appendix 6.

F. Implementation Arrangements

33. The Project was implemented satisfactorily and generally according to the arrangements envisaged at appraisal. The Executing Agency (EA) was the Sindh provincial government, while its Implementing Agency (IA) was the IPD. The chief engineer, IPD Kotri Barrage, coordinated day-to-day execution of the Project. The

[13] The bulkhead gate fits up against the barrage structure to seal off the bay containing the barrage gate. With the area de-watered, the old gate was cut up and removed before installation of the new, higher gate. Use of the bulkhead gate is also intended for annual routine maintenance.

project consultant, who was also designated the project engineer, assisted and trained the IPD. International and domestic contractors executed the works.

34. The IPD secretary chaired a project review committee, which met semiannually and was attended by other key government departments. Notice of the meetings was issued, and ADB and DFID officers attended from occasionally, especially at critical junctures during project implementation.

35. A project benefit monitoring and evaluation (BME) exercise was incorporated into the last stages of the Project. Because the BME came at the close of the Project and was contracted to an outside party, EA did not take ownership of it and did not incorporate the results into its management information system.

G. Conditions and Covenants

36. The cross-effectiveness requirement with the government-DFID agreement delayed loan effectiveness. After ADB approved the loan on 26 September 1991, loan effectiveness was scheduled for 19 March 1992. However, five extensions were made before the loan became effective on 17 December 1992.

37. The difficulties in the government-DFID negotiations centered on the DFID's insistence that the supervisory consultant be designated as the project engineer, rather than the government representative of chief engineer, IPD Kotri. Even after opening up to the DFID position, the government would not commit until the supervisory consultant had been selected through a competitive process.

38. During a tripartite meeting on 12-14 January 1992, ADB endorsed the DFID position on designating the supervisory consultant as project engineer.[14] On a second issue of contention between DFID and the government, ADB had supported the government during loan negotiations on using non-standard contractual arrangements. Those arrangements would have allowed a subcontractor under the Project to sign two agreements, one with the government and one with main contractor. Following input from DFID, ADB reversed its position at the tripartite meeting and asserted that the non-standard contractual arrangements were unworkable without significant legal input. The government agreed to revert to the standard Federation Internationale des Ingenieurs Conseils model, under which only one subcontractor agreement would be signed between the main contractor and the subcontractor.

39. The government showed good compliance with all loan covenants, except for the one on providing an adequate O&M budget (Appendix 8). At the PCR wrap-up meeting, ADB stated that deficient O&M funding was a serious omission, and that the government was in noncompliance with the pertinent loan covenant.[15] In response, the government of Sindh's Finance Department pledged to provide IPD with the required O&M budget. As follow-up, the ADB mission requested that regular documentation be provided.

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[14] The designation of project engineer vests authority to approve designs, verify material and works quality, and certify payment. These powers are sometime vested in the client.

[15] Loan Agreement Schedule 6, para. 6. b.: "...the Borrower and Sindh shall ensure that ... (b) sufficient resources are made available on a timely basis to fund necessary operation and maintenance expenditures for the Kotri Barrage, as required to ensure the integrity of the barrage structure and continued operation during the working life of the gates."

H. Consultant Recruitment and Procurement

40. DFID financed the supervisory consultant, who was competitively selected. The supervisory consultant, who earlier had authored the feasibility study, provided design and supervision of the works. For the project BME study, a local entity was contracted after local competitive bidding.

41. Procurement was carried out as envisaged at appraisal. The main civil works on the barrage were executed under three contracts through international competitive bidding. Supplies and materials were procured under another contract through international competitive bidding. Smaller works, including raising the divide walls leading to the barrage, armoring the guide banks, and constructing supporting office and residential sites, were done under local competitive bidding.

I. Performance of Consultants, Contractors, and Suppliers

42. The supervisory consultant's performance was generally satisfactory. The consultant prepared designs and tender documents, and supervised project implementation. The supervisory consultant also was designated as project engineer. Given the technical nature of the works, this designation expedited project activities by granting the supervisory consultant the authority to sign off on designs and certify payments. The Project was completed without major delay and within cost estimates. The supervisory consultant also provided a detailed O&M manual and training to IPD (Appendix 8). One shortcoming, however, was the supervisory consultant's failure to appreciate the potential for deterioration in the river approach to the barrage over time, as well as the deterioration caused by the construction of the slipway.

43. The project BME consultant executed a survey and compiled the results. ADB provided a terms of reference outline. However, without further guidance and interaction with the local consultant, the BME consultant's report was deficient. The report provided some indicators of interest, but it did not present analysis in a format that could be used in evaluation. The result was partly satisfactory.

44. The performance of the other contractors and suppliers engaged under the Project was satisfactory. The main contractor for the civil works had difficulties at the start and fell behind schedule, but made up for the lost time later with improved progress. Other contractors encountered only minor delays in implementation. Inspection reports in IPD files show that the quality of works and materials was satisfactory. The assessment was confirmed by ADB's PCR mission.

J. Performance of the Borrower and the Executing Agency

45. The performance of the Borrower and EA during implementation was satisfactory. IPD coordinated well with the cofinanciers, the supervisory consultant, and contractors; supported cofinancier missions and provided unrestricted access to project records; and provided the required contingent of staff for the Project (Appendix 9). The government convened regular meetings of a project review committee, and extended notice and invitation to the cofinanciers.

K. Performance of ADB

46. ADB supervised the Project effectively, fielding 11 missions from inception through loan closing. Early in the Project, when the challenges were greatest, ADB averaged two missions per year. Mission frequency decreased later to one per year. ADB supervision also benefited from continuity in project officers. Only two project officers—both civil engineers—served throughout implementation. ADB was responsive to the EA concerns and coordinated with the other cofinancier.

47. Fielding the PCR mission almost 3 years after loan closing was a shortcoming in ADB implementation. Such a delay risks losing the benefit of (i) institutional memory (in ADB and the EA) and (ii) file information needed for evaluation. Had ADB's PCR mission been involved soon after project closing, it would have been able to flag the deficient O&M financing from the government and request a remedy. Instead, 3 years passed with O&M not being properly financed. However, part of the reason for the delay was the ADB reorganization, which involved merging divisions and transferring key personnel. As a result, a backlog of PCRs grew.

48. ADB's supervision during the implementation period was assessed as highly satisfactory. However, including the post-project lapse on fielding the PCR and monitoring O&M, the overall ADB performance was rated as satisfactory.

49. From before the Project through project completion, DFID played an important role as confinancier. DFID financed the feasibility studies leading up to the Project, and then extended the services of the consultant to prepare contract and tender documents through the delayed start of the Project. This continuity helped avert costly lapses that would have resulted from additional delays in loan effectiveness.

50. During the Project, DFID financed the main rehabilitation works of the barrage and the services of the supervisory consultant. Towards the end of the Project, however, DFID's participation lapsed in some key areas. During the monitoring mission of May 1998, DFID confirmed the approval of funding to procure desilting equipment. Further, DFID agreed in principle to fund a new computer system for technical monitoring of barrage gauges. DFID did not deliver on these recorded commitments. In addition, DFID indicated that it would consider funding a mobile crane. However, DFID did not follow through, and the equipment is still needed. Overall, though, DFID's contributions outweigh the end-of-project shortcomings, and its performance is rated as satisfactory.

III. EVALUATION OF PERFORMANCE

A. Relevance

51. The Project was relevant. By taking timely action, a possible system failure and consequent disruption in irrigation services were averted. The Project stabilized irrigation and increased water supplies slightly.[16] These achievements supported the Government of Pakistan's goal of producing of grains, sugar, and oil seeds, and reducing imports. They also supported a more secure irrigation environment, in which farmers feel more confident in employing improved cultural practices and high-quality inputs—another goal

[16] Since 1997/98, an average increase in supply of 1.5% has been recorded by IPD.

of the Government. For ADB, the Project was consistent with its focus on investing in existing irrigation infrastructure to support agriculture growth, rather than developing new systems and areas.

B. Efficacy in Achievement of Purpose

52. The project program was focused, and essential measures were taken in a timely manner. The project inputs were effectively deployed to achieve the objectives. The barrage gates were replaced, the appurtenant structures rehabilitated, and the capacity of the structure strengthened. The Project effectively attained its purpose and outputs.

C. Efficiency in Achievement of Outputs and Purpose

53. The Project was generally efficient in achieving its outcome. The envisaged outputs were attained for less than the appraisal cost. However, all the gates were replaced at once, even though half of them had more than a decade of estimated life left. This wholesale replacement with higher gates was done in anticipation of increasing the water supply to Karachi. However, since complementary water system projects for Karachi were not completed, the earlier-than-needed replacement of some gates could be considered a loss. Still, the increased water supply is available for irrigation.

54. The reevaluated economic rate of return for the Project was 16%. The benefits consisted of avoiding projected losses, which would be caused by (i) inaction and periodic gate failures and replacements, and (ii) decrease in agricultural production. The reevaluated return rate was lower than the economic rate of return of 26% at appraisal, which had assumed the probability of avoided losses from the early 1990s onwards. The reevaluation took into account the fact that no gate failures occurred and, based on experience, discounted the probability-of-failure assessments at appraisal (Appendix 10). Instead of using the appraisal's assumption that gate failure was virtually assured by 1995, the PCR analysis assumed that it would be 5 years after project completion in 2000, before reaching that probability. The PCR analysis also assumed 5-year intervals between breakdowns.

D. Preliminary Assessment of Sustainability

55. Since loan closing in November 2000, the Kotri Barrage O&M program, which was formulated during the Project, has been inadequately funded. As a result, the sustainability of the Project is somewhat uncertain. If current funding levels were to continue, the estimated 35-year life of the Project would be shortened and a deferred-maintenance project probably would be needed in 15-20 years.

56. While not within the scope of the Project, the O&M of the downstream distribution system also was found to be inadequate. This situation, a systemic problem in irrigation areas in Pakistan, will erode project benefits unless corrective measures are taken. Institutional reforms aimed at empowering farmer organizations in O&M are being implemented on a trial basis in Pakistan. However, the political and bureaucratic will to support the program is lacking (Appendix 11). Unless changes are instituted for the Kotri command, the deterioration of irrigation system canals will present a deferred

maintenance problem, and cultivation areas and irrigation efficiencies most likely will decline.[17]

E. Environmental, Sociocultural, and Other Impacts

57. Raising the pond level by 0.61 m has had no appreciable effect on the environment. The barrage crest and waterway width, which are the same as in the original design, still govern the ability to pass flood. Increasing the capacity of the barrage to accommodate the raised pond level will create higher local water for short periods of time. However, the water normally will remain within the historical flood plain, as it did during the flooding prior to the rehabilitation. ADB's PCR mission visited the upstream pond area of Kotri Barrage to inspect changes due to a higher pond level. No environmental problems were visible. Since the barrage is a diversion structure, it will not have an impact on the lower Indus delta and sea water intrusion. That situation is more closely related to storage and new diversion schemes in the upper Indus (Appendix 12).

58. The social and environmental gains consisted of securing a future free from imminent barrage failure and the consequential abrupt loss of irrigation, drinking water, and livelihood. All downstream households probably would suffer from a barrage failure. However, the poor are particularly vulnerable to disasters since they live at the margins without the reserves to sustain them through bad times.

59. Women were noticeably absent from the irrigation hierarchy and institutions. Association of women was evident only under the O&M institutional reforms in two of the four canal systems of Kotri Barrage Command. The Sindh Irrigation Development Authority has a gender specialist who enlists women to become active in the farmer organizations. Women are active in farming and cropping.

60. The Project had a positive institutional impact on the participating staff of the IPD. By working closely with the supervisory consultant and administering a technical program of works, they gained confidence and experience, as well as on-the-job and in-class training.

IV. OVERALL ASSESSMENT AND RECOMMENDATIONS

A. Overall Assessment

61. The Project achieved its objectives and was implemented largely as conceived. A change of scope and extension were required to remove the operational limitations of the barrage. However, this was achieved without any additional resources. The benefits of averting a barrage failure and stabilizing water supply were realized. The Project was implemented without major delay and under budget. However, sustainability remains in question for the rehabilitated headworks and downstream command. Additional costs were incurred to raise operating levels and increase the amount of water diverted for Karachi. The benefits from these investments have not been realized due to bottlenecks in other projects. Finally, the worsening river approach needs to be redressed to restore

[17] Estimates on area losses range from 1% to 2% per year over the long term.

the barrage's full capacity to pass floods. After considering all these factors, the Project was rated as successful.

62. Because of the uncertainty over future O&M budgets, the durability of the Project could be in question. However, the deterioration of the gates leading to the Project probably owed more to age—they had last about 40 years—than deficient O&M. Deficient O&M resources probably will marginally decrease performance and increase spending on deferred maintenance programs, rather than result in any imminent breakdown.

B. Lessons Learned

63. Several of the Project's successes can be attributed to simplicity. The Project benefited from a straightforward design: one Implementing Agency and a focused set of objectives and activities. In addition, the loan covenants were limited in number and reasonable .

64. Several characteristics of the Project participants also strengthened implementation. First, the designation of the supervisory consultant as project engineer provided technical and administrative advantages that expedited progress. Second, without DFID's grant to cofinance the Project, this designation of the supervisory consultant would have been unlikely. Grant financing also made possible the extensive consulting services (14% of project costs). When consultants are financed from loan proceeds, the government is more likely to reduce their input. Third, the continuity in ADB project officers contributed to the success. Fourth, the Project benefited from the government's decentralized implementation and provincial ownership.

65. By building upon previous investments in irrigation, the Project demonstrated that rehabilitation could produce solid economic returns with limited social and environmental problems. However, to ensure that the gains are sustainable, building O&M capacity throughout the system should be given a high priority.

66. The project BME, a frequent area of concern in projects, was partially satisfactory.[18] The shortcomings were not necessarily in the execution of the BME surveys by local consultants. The deficiencies were partly due to (i) inadequate ADB communication of its information and evaluation needs, and (ii) a lack of guidance to the local consultants in conducting the surveys. To this end, more ADB involvement in these surveys is advisable if they are to provide useful input into ADB evaluations.

[18] Late in the Project, in an attempt to institute the BME, ADB requested the EA to take measures for an evaluation survey. ADB also supplied a satisfactory outline terms of reference for a BME consultant scope of work. However, the selected BME consultant, seemingly unfamiliar with ADB evaluation methodology and needs, produced output that had limited value to ADB evaluation and had limited application for regular updating by the EA.

67. Significant institutional reforms were introduced in irrigation management, but government commitment and funding have been lacking.[19] Without significant improvements to O&M, projects are likely to repeat cycles of deferred maintenance and rehabilitation.

C. Recommendations

68. The Government committed to meeting the annual O&M funding requirements for the completed Project. An officer in the Pakistan Resident Mission should follow up regularly on the compliance with this commitment. Government compliance could also be linked to the processing of future ADB technical assistance, programs, and projects in the province.

69. Due to the size and importance of the barrage, an independent panel of experts should inspect the structure every 5 years[20] to supplement the annual inspection by staff at the barrage.

70. The angled river approach to the barrage and the construction of a launch area[21] has resulted in (i) silt deposits on the right bank, (ii) uneven discharge across the barrage, and (iii) a compromised capacity to pass floods. IPD should initiate modeling studies, and then fund a program of remedial works.

71. Several future investment opportunities for ADB emerged from the Project. ADB could consider a follow-on investment in the Kotri Barrage canal system, alongside a capacity-building program for implementing O&M institutional reforms. ADB could also consider financing other provincial packages of similar scale to rehabilitate barrages, upgrade canal systems, and improve water conservation. The recent Water Sector Strategy[22] provides a framework for the sector and a list of priority investment projects (Appendix 13). However, to ensure sustainability and avoid a recurring cycle of deferred maintenance, O&M reforms that ensure a participatory approach, transparency, accountability, and beneficiary-finance are essential.[23]

72. One of the justifications for raising the pond level of Kotri Barrage was to increase water supplies for Karachi. While the increased capacity has been achieved, conveyance remains inadequate. The government should secure adequate funding to increase the discharge capacity of Kalri Baghar Feeder Canal and the Kinjhar Lake. Otherwise, poorly synchronized project work at the barrage, in the conveyance canal,

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[19] The development of farmer organizations, water boards and provincial irrigation development authorities are part of institutional, management, and financial reforms supported under the National Drainage Program. However, key political and bureaucratic interests have not supported this initiative. Loan No. 1413-PAK. ADB. 1995. *Report and Recommendation of the President to the Board of Directors on a Proposed Loan to the Islamic Republic of Pakistan for the National Drainage Sector Project*. Manila for $140 million, was approved 12 Dec 1995.

[20] This practice is currently employed for dams. The inspecting body could be drawn from a panel of technically qualified consultants and/or peers within government (Water and Power Development Authority (WAPDA) or engineers from other IPD-managed projects of comparably-sized headworks).

[21] A large pontoon was constructed to transport, install, and service the 36 t main barrage gates. For most of the year, the pontoon is in dry dock.

[22] ADB. 1998. *Technical Assistance to Pakistan for the Water Resources Strategy Study*. Manila. The ADB-financed Water Sector Strategy identifies a significant number of projects that could fit this description.

[23] One approach is the development of farmer organizations, water boards and provincial irrigation development authorities – all part of institutional reforms started under. Loan No.1413-PAK: *National Drainage Sector Project,* for $140 million, approved on 12 Dec 1995.

and within the city system will result in investment redundancies and losses (Appendix 14).

73. IPD at Kotri Barrage should compile and publish an annual report on its operations. Topics could include summaries of technical, organizational, financial, agricultural, and beneficial aspects of operations. This report would provide a valuable documentary record for management, staff, outside reviewers, and the public.

ACHIEVEMENT OF WORKS

Contract No.	Description	Status
1	Main contract: fabrication and installation of main barrage and lock gates, and replacement of combined channel lock gates; refurbishment of regulator gates; rehabilitation of road bridge; and construction of slipway and moorings for pontoon and bulkhead gates	Accomplished
2	Bulkhead gates and pontoon: final design, fabrication, commissioning and operation of bulkhead gates and pontoon throughout the contract period	Accomplished, but unutilized since 2000 for lack of O&M funds[a]
3	Materials supply: procurement of principal materials for contracts K2A and K2E to include high grade steel plate, universal beams, steel sheet, rollers, steel ropes, hand railing and flooring, cranes, hoists and motors	Accomplished
4	Concrete remedial works and regulator rehabilitation: replacement of barrage gate bridge decking, raising head regulator hoist platforms, and rehabilitation of sub-regulators	Accomplished, at savings
5	Raising of divide walls and armoring of guide banks	Accomplished
6	Construction of office and residential accommodation, and roads, and provision of water supply, and electrification services at site	Accomplished
7	Removal of head limitation: exploratory drilling to determine the thickness of concrete in the downstream pavement; concrete weighting to downstream pavement; void drilling and grouting; resurfacing of the downstream glacis	Accomplished, at substantial savings

[a] The pontoon and bulkhead gates were designed to be used in the annual O&M program to fully service barrage bays and gates each year. The lack of use will not only affect the O&M of the barrage, but by lying idle, the equipment will itself become dysfunctional with time. The staff trained to operate the technical equipment will also lose familiarity and know-how without deployment of the equipment.

PROCUREMENT OF VEHICLES AND EQUIPMENT		
Component or Item	**Target at Appraisal (no.)**	**Actual (no.)**
Vehicles		
Lightweight 4-Wheel Drive, Jeep Type	2	4
Office Equipment		
Computer	1	1
Photocopier	1	1
Typewriter	4	2
Facsimile Machine	1	0
Plan Print Machine	1	0
Calculators	12	0
Air Conditioner	1	0
Furniture	one set	one set
Desks		
Chairs		
Filing Cabinets		
Drawing Tables		
Bookshelves		

Source: ADB Project Files; Irrigation and Power Department's records.

ANNUAL EXPENDITURES - 1993 - 2000
(rupees million)

	ADB		ODA/DFID		Government		Total Cost	
Year	US$ Equiv[a/]	In PRs	US$ Equiv	In PRs	US$ Equiv	In PRs	US$ Equiv	In PRs
1993/94	2.573	29.567	1.907	57.310	1.095	32.905	3.987	119.782
1994/95	5.196	191.123	3.061	94.036	5.085	156.220	14.366	441.379
1995/96	1.112	60.484	3.335	113.926	0.515	17.602	5.620	192.012
1996/97	2.047	59.475	2.795	111.867	0.370	14.822	4.652	186.164
1997/98	2.140	65.100	0.967	42.510	0.227	9.996	2.677	117.606
1998/99	1.276	94.654	3.489	160.080	0.103	4.740	5.655	259.474
1999/00	1.716	55.674	0.250	12.956	0.108	5.611	1.434	74.241
Total	**16.060**	**556.077**	**15.804**	**592.685**	**7.505**	**241.896**	**39.369**	**1,390.658**

ADB = Asian Development Bank, DFID = Department of International Development, ODA = Overseas Development Administration.
[a] Excludes service charge during construction amounting to $650,294.00.
Source: ADB US$ equivalent based on actual annual disbursements; expenditure in rupees provided by the Executing Agency.

ANNUAL CONTRACT AWARDS AND DISBURSEMENTS BY CATEGORY

($)

Category	Allocation	1993	1994	1995	1996	1997	1998	1999	2000	Cumulative Total[a]
A. Annual Contract Awards										
1. Civil Works	11,662,626	4,611,942	1,908,009	292,161	1,256,837	3,424,329	122,993	46,355	—	11,662,626
2. Supplies and Materials	3,960,427	4,072,824	(394,909)	(34,722)	267,694	(400)	39,380	10,560	—	3,960,427
3. Vehicles and Equipment	20,552	—	17,255	2,614	683	—	—	—	—	20,552
4. Administration – Local Expenditures (Part H)	416,527	—	34,720	20,269	1,009	—	168,519	52,773	139,237	416,527
5. Service Charge During Construction	650,294	—	—	—	—	—	—	—	—	—
6. Unallocated	—	—	—	—	—	—	—	—	—	—
7 Imprest Fund – Irrigation and Power Department	—	—	—	—	—	—	—	—	—	—
Total	**16,710,426**	**8,684,766**	**1,565,075**	**280,322**	**1,526,223**	**3,423,929**	**330,892**	**109,688**	**139,237**	**16,060,132**
B. Annual Disbursements										
1. Civil Works	11,662,626	—	3,186,481	1,602,107	1,644,252	2,148,545	945,696	1,401,040	734,505	11,662,626
2. SUPPLIES AND MATERIALS	3,960,427	—	2,350,781	674,458	772,929	25,763	129,598	6,898	—	3,960,427
3. VEHICLES AND EQUIPMENT	20,552	—	17,255	2,614	683	0	0	—	—	20,552
4. ADMINISTRATION – LOCAL EXPENDITURES (PART H)	416,527	—	141,361	20,269	1,010	0	118,518	55,942	79,427	416,527
5. SERVICE CHARGE DURING CONSTRUCTION	650,294	—	3,038	60,031	83,060	103,888	118,233	139,973	142,071	650,294
6. UNALLOCATED	—	—	—	—	—	—	—	—	—	—
7 IMPREST FUND – IRRIGATION AND POWER DEPARTMENT	—	—	445,445	—	—	—	—	—	(445,445)	—
TOTAL	**16,710,426**	—	**6,144,361**	**2,359,479**	**2,501,934**	**2,278,196**	**1,312,045**	**1,603,853**	**510,558**	**16,710,426**

[a] Under contract awards, the "Total" excludes service charge during construction amounting to $650,294.

Source: Asian Development Bank – Loan Financial Information System

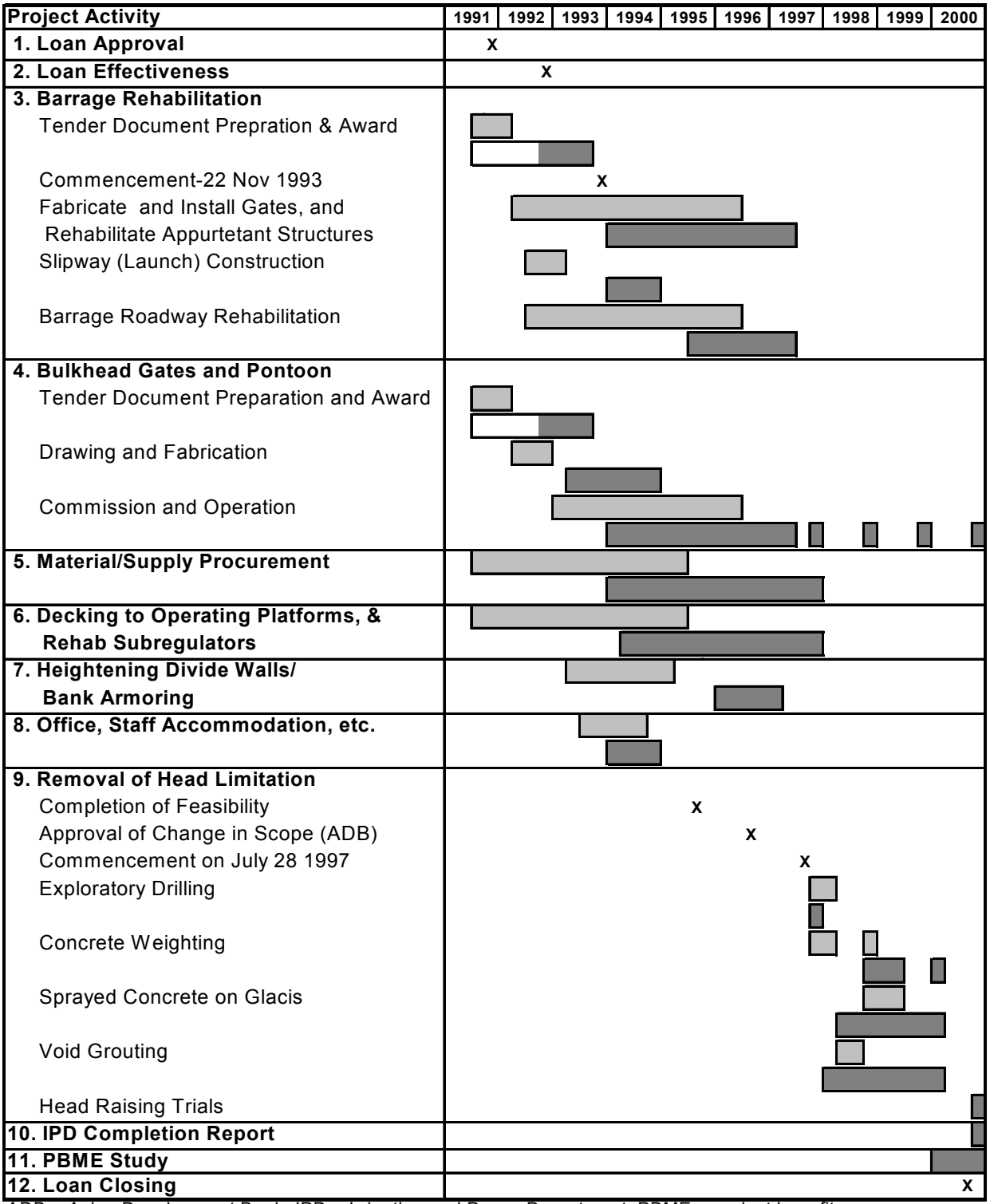
STATUS OF LOAN UTILIZATION
AS OF 31 AUGUST 2003

Amounts in $

Category		Allocation ($)	Total Contracts	Uncontracted Balance	Total Disburseda/	Undisbursed Contract	Undisbursed Loan Balance
I.	**Civil Works**	11,662,626	11,662,626	0	11,662,626	0	0
II.	**Supplies and Materials**	3,960,427	3,960,427	0	3,960,427	0	0
III.	**Vehicles and Equipment**	20,552	20,552	0	20,552	0	0
IV.	**Administration - Local Expenditures (Part H)**	416,527	416,527	0	416,527	0	0
V.	**Service Charge During Construction**	650,294	0	650,294	650,294	(650,294)	0
VI.	**Unallocated**	0	0	0	0	0	0
99I	**Imprest Fund - Irrigation & Power Department**	0	0	0	0	0	0
	Total	**16,710,426**	**16,060,132**	**650,294**	**16,710,426**	**(650,294)**	0

[a] US$ equivalent of SDB11,693,911 (net of cancellation) at the time of loan closing.
Source: Asian Development Bank – Loan Financial Information System.

APPRAISED AND ACTUAL IMPLEMENTATION SCHEDULE



ADB = Asian Development Bank, IPD = Irrigation and Power Department, PBME = project benefit monitoring and evaluation.

Planned

Feasibilty Consultants Extended (by ODA)

Actual

Source: Asian Development Bank estimates.

STATUS OF COMPLIANCE WITH LOAN COVENANTS
(As of 30 November 2000)

Loan Covenants	Reference	Status of Compliance/Remarks
The Government of Pakistan (the Borrower) shall cause the Sindh provincial government and the IA (IA) to carry out the Project with due diligence and efficiency, and in conformity with sound administrative, financial, engineering, irrigation, environmental, operational and management practices.	Loan Agreement (LA) Article IV Section 4.01(a)	Complied.
The Borrower shall make available to Sindh and the IA, promptly as needed, the funds, facilities, services, land and other resources that are required, in addition to the proceeds of the loan, to carry out of the Project.	LA, Article IV Section 4.02	Complied.
The Borrower shall have obtained the official development assistance (ODA) grant or shall have made other arrangements satisfactory to Asian Development Bank (ADB) to commit the provision of the funds intended to be provided by the ODA grant.	LA, Article VI Section 6.01(a)	Complied.
The approval of the Planning Commission Proforma I (PC-1) for the Project by the Executive Committee of the National Economic Council (ECNEC) of the Borrower shall have been granted.	LA, Article VI Section 6.01(b)	Complied (June 1990); Revised PC-1 (Dec 1995).
I. General Implementation Arrangements A. Implementing Agency		
The Irrigation and Power Department (IPD) shall be the IA and as such shall be responsible for the overall execution, supervision and coordination of the Project. Day-to-day implementation activities shall be coordinated through the chief engineer (irrigation), Kotri Barrage (CE).	LA, Schedule 6, para. 1	Complied.
B. Project Coordination		
The Project Review Committee (PRC), which has been established under the chairmanship of the IPD secretary, shall meet semiannually to review the implementation and progress of the Project. The Borrower shall ensure that the other members of the PRC shall comprise representatives from Sindh's Department of Finance and Planning and Development Department (PD&D). The CE shall act as secretary of the PRC. ADB and ODA shall be invited to send observers to the semiannual meetings of the PRC.	LA, Schedule 6 para. 2	Complied.

Loan Covenants	Reference	Status of Compliance/Remarks
C. Procurement Committee		
IPD shall coordinate international procurement of supplies and materials financed out of the proceeds of the loan in accordance with the provisions of Schedule 4 to this Loan Agreement. For this purpose, prior to the calling of tenders, a procurement committee shall be established in IPD under the chairmanship of the IPD secretary and shall include representatives from PD&D, as well as from Sindh's Finance and Industry Departments. The competent authority in IPD will approve the award of contractors' services.	LA, Schedule 6 para. 3	Complied. .
II. Other Implementation Aspects		
A. Land Acquisition		
All lands, rights in land and other privileges thereon required for the Project shall be promptly acquired or otherwise made available so as to ensure timely Project implementation.	LA Schedule 6 para. 4	Complied.
B. Project Imprest Account		
To expedite project implementation through a timely release of funds, ADB may deposit portions of the proceeds of the loan into a Project imprest account to be established by IPD. Withdrawals may be made for the payment of eligible local currency expenditures under the Project. The Project's imprest account shall be established, operated and liquidated in accordance with ADB's *Guidelines on Imprest Fund and Statement of Expenditures Procedures*.	LA Schedule 6 para. 5	Complied.
C. Financial Matters; Operation and Maintenance		
Without limiting the generality of Section 4.02 of the Loan Agreement and Section 2.02 of the Project Agreement, the Borrower and Sindh shall ensure that (i) the Annual Development Program shall have an adequate budget for capital expenditures under the Project; and (ii) sufficient resources are made available on a timely basis to fund necessary operation and maintenance (O&M) expenditures for the Kotri Barrage, as required to ensure the integrity of the barrage structure and continued operation during the working life of the gates.	LA Schedule 6 para. 6	(a) Complied. (b) Not Complied. At PCR wrap-up meeting, Government gave assurances of meeting increased O&M funding requirements.

Loan Covenants	Reference	Status of Compliance/Remarks
D. Project Security Arrangements		
Sindh shall provide, or cause to be provided, adequate security measures at the site (should these be needed), to ensure the safety of project personnel and timely implementation of the works.	LA Schedule 6 para. 7	Complied.
E. Contingency Planning		
Within 1 month after the effective date, IPD shall draw up and furnish to ADB contingency plans in case of gate failure at Kotri Barrage prior to or during gate rehabilitation.	LA Schedule 6 para. 8	Complied.
F. Completion of Hyderabad By-Pass		
As the barrage bridge deck will be closed during deck replacement, the Borrower shall take all necessary actions to expedite the work schedule for work on the Hyderabad Bypass bridge downstream of the Kotri barrage. The Borrower shall also take steps to accelerate its commissioning date so as to provide an alternative crossing of the Indus River, and to alleviate traffic congestion during the implementation period of the contract.	LA Schedule 6 para. 9	Complied.
Project Agreement		
Sindh shall carry out, or cause the IA to carry out, the Project with due diligence and efficiency, and in conformity with sound administrative, financial, engineering, irrigation, environmental, and operational practices.	Project Agreement (PA), Article II Section 2.01	Complied.
In carrying out the Project, the IA shall employ competent and qualified consultants and contractors, acceptable to ADB, to an extent and upon terms and conditions satisfactory to ADB.	PA Article II Section 2.03(a)	Complied.
Except as ADB may otherwise agree, all goods and services to be financed out of the proceeds of the loan shall be procured in accordance with the provisions of Schedule 4 and Schedule 5 to the Loan Agreement. ADB may refuse to finance a contract where goods or services have not been procured under procedures substantially in accordance with those agreed between the Borrower and ADB, or where the terms and conditions of the contract are not satisfactory to ADB.	PA Article II Section 2.03(b)	Complied.

Loan Covenants	Reference	Status of Compliance/Remarks
Sindh shall carry out, or cause the IA to carry out the Project in accordance with plans, design standards, specifications, work schedules and construction methods acceptable to ADB. Sindh shall furnish, or cause the IA to furnish, to ADB, promptly after their preparation, such plans, design standards, specifications and work schedules, and any material modifications subsequently made therein, in such detail as ADB shall reasonably request.	PA Article II Section 2.04	Complied.
Sindh shall take out and maintain, or cause the IA to take out and maintain, with responsible insurers, or make or cause to be made other arrangements satisfactory to ADB, insurance of the project facilities to such extent and against such risks and in such amounts as shall be consistent with sound practices.	PA Article II Section 2.05(a)	Complied.
Without limiting the generality of the foregoing, Sindh undertakes to insure, or cause the IA to insure, the goods to be imported for the Project and to be financed out of the proceeds of the loan against hazards incident to the acquisition, transportation and delivery thereof to the place of use or installation. For such insurance, any indemnity shall be payable in a currency freely usable to replace or repair such goods.	PA Article II Section 2.05(b)	Complied.
Sindh shall maintain, or cause the IA to maintain, records and accounts adequate to identify the goods and services and other items of expenditure financed out of the proceeds of the loan; to disclose the use thereof in Parts B to H of the Project; to record the progress of Parts B to H of the Project (including the cost thereof) and to reflect, in accordance with consistently maintained sound accounting principles, its operations and financial condition.	PA Article II Section 2.06	Complied.
The IA shall furnish to ADB all such reports and information as ADB shall reasonably request concerning (i) the loan and the expenditure of the proceeds thereof; (ii) the goods and services and other items of expenditure financed out of such proceeds; (iii) the Project; (iv) to the extent relevant to the Project, its financial condition; and (v) any other matters relating to the purposes of the loan.	PA Article II Section 2.08(a)	Complied.

Loan Covenants	Reference	Status of Compliance/Remarks
Sindh shall furnish to ADB, or cause the IA to furnish to ADB, until project completion, monthly physical progress reports and consolidated quarterly reports on the execution of the Project and on the operation and management of the project facilities. Such reports shall be submitted in such form and in such detail and within such a period as ADB shall reasonably request. The reports shall indicate, among other things, progress made and problems encountered during the month or quarter under review, steps taken or proposed to be taken to remedy these problems, and proposed program of activities and expected progress during the following month or quarter.	PA Article II Section 2.08(b)	Complied.
Promptly after physical completion of the Project, but in any event not later than 3 months thereafter or such later date as ADB may agree for this purpose, Sindh shall prepare and furnish to ADB a report, in such form and in such detail as ADB shall reasonably request, on the execution and initial operation of the Project, including its cost, the performance by Sindh and the IA of their obligations under this Project Agreement, and the accomplishment of the purposes of the loan.	PA Article II Section 2.08(c)	Complied.
Sindh shall (i) maintain, or cause the IA to maintain, separate accounts for Parts B to H of the Project; (ii) have such accounts and related financial statements (balance sheet, statement of income and expenses, and related statements) audited annually, in accordance with sound auditing standards, by auditors acceptable to ADB; and (iii) furnish to ADB, promptly after their preparation, but in any event not later than 6 months after the close of such accounts and financial statements, and not later than 9 months after the close of the fiscal year to which they relate, certified copies of such audited accounts and financial statements and the report of the auditors relating thereto, all in English.	PA Article II Section 2.09	Complied.

SUMMARY OF TRAINING

Description of Course	No. of Participants	Trainee Days
Trainings Undertaken by IPD Staff		
1. CS-1 - Project Management, Course No. 1	13	91
2. CS-2 - Supervision of Construction Course No. 2	17	119
3. ToT - Training of Trainers	9	72
4. Piezometer (Computer Training)	5	25
5. OM1 - Introduction to O&M Manual and Gates andHoists	14	98
6. OM2 - Regulation, Bunds, and Structures	9	72
7. OM3 - Bulkhead Head Gates, Electrics, Colony, Emergency Procedures, and Safe Working Procedures	15	135
8. OM4 - Paint Training Program	19	133

CS = IPD = Irrigation and Power Department, O&M = operation and maintenance
Source: Project Files; Executing Agency's record.

PROJECT STAFF

Name of Posts	Target at Appraisal (no.)	Actual (no.)
Executive Engineer (BPS-18)	1	1
Subdivisional Officers	2	—
Subengineer (BPS-11)	6	6
Assistant Executive Engineer	—	2
Accounting and General Support Staff	20	—
Divisional Accountant (BPS-13)	—	1
Assistant Head Clerk (BPS-11)	—	1
Draughtsman (BPS-10)	—	1
Accounts Clerk (BPS-7)	—	1
Senior Clerks (BPS-6)	—	4
Junior Clerks (BPS-5)	—	6
Tracer (BPS-5)	—	1
Naib Qasid (BPS-1)	—	5

BPS = Basic Pay Scale.
Source: Irrigation and Power Department's Project Records.

ECONOMIC ANALYSIS

A. Introduction

1. The Kotri Barrage diverts water from the Indus River to irrigate agriculture in lower Sindh Province. The Project was implemented to forestall a structural failure, and consequent loss of production, livelihood, and drinking water supply. This analysis portrays the future with- and without-scenarios, and determines the difference attributable to the Project. Costs were combined with the benefit stream, and the Project's economic internal rate of return and net present value were calculated. Sensitivity analysis tested key parameters and assumptions underpinning the assessment.

B. Approach and Methodology

2. Information to support the analysis was gathered in the field and supplemented by secondary sources and a final evaluation survey. The following assumptions were employed in the analysis:

- A world price numeraire was used for the pricing framework with a constant price year of 2003.
- Values of tradable commodities are derived from border pricing. For wheat, rice, and cotton, export parity pricing was employed. For sugar, urea, and diammonium phosphate, import parity pricing was used.
- For non-traded items, a standard conversion factor (SCF) of 0.9 was applied, consistent with other recent evaluations in country. A shadow wage rate factor of 0.75 was applied to non-skilled labor to reflect unemployment and underemployment in the rural project area.
- Transfer payments such as taxes, duties, and interest are excluded from the economic analysis.

C. Benefit Analysis

1. Quantified Benefits

3. The benefit stream was estimated by comparing future production over the life of the Project against what would have been lost by not undertaking the Project. The value consisted of production saved, plus some minor gain in production due to increased water supplies. Two scenarios were constructed.

2. Future with Stable Irrigation

4. The first scenario drew from the current situation of irrigated agriculture in the command area. About 480,000 hectares (ha) are irrigated over two main seasons. The main crops are rice, wheat, sugarcane, cotton, and fodder. Unit crop budgets are constructed based on yields, inputs, labor and miscellaneous costs. Farmgate prices (Table A10.1) were employed in the financial valuations, whereas the financial prices and costs were converted to economic values for the economic analysis. The derived economic prices for tradables are shown in Table A10.2. Crop areas, yields, and values were combined to derive the value of command production

(Table A10.3). However, because of operation and maintenance (O&M) deficiencies in the system, the future production was expected to decline by about 1% per year. On the other hand, the rehabilitation also heightened the gate levels and improved function. The result was a slight increase in the supply of water, which supports additional cultivation of approximately 15,700 ha in summer season (rice) and 20,800 ha over the winter season (wheat).

3. Future Without Secure Barrage

5. The second scenario portrays the situation if the Project were not undertaken. This would be a future with imminent gate failure with potential for undermining the barrage superstructure. Under this scenario, intermittent failures were foreseen, with ad hoc repairs attempted.

6. **Feasibility Study and Appraisal Approach**. In the 1991 appraisal, technical experts evaluated the risk of failure of the gates (each weighing 36 tons [t]). According to their assessment, 12 of the 43 gates had a life expectancy of 5–10 years, while nine gates had up to 12 years and 23 were expected to be serviceable for about 17 years (provided remedial measures were followed). Table A10.4 was constructed to assist in predicting the outcome of not undertaking rehabilitation of the barrage.

7. In assessing the cost to society, the probability of gate failure was tied to the impact on crop production. Crop cultivation is highly dependent on irrigation in Sindh and the Kotri command. Loss of water would cause widespread damage to crops. However, the degree of damage would vary slightly depending on the cropping season.

8. The technicians further ascribed a probability distribution to the likelihood of gate failure within the year. Autumn, at the end of the monsoon, was ascribed as the most probable period for a breakdown (35%), followed by summer (25%), and then winter and spring (20% each). During each period, a different cropping regime and standing value[24] is in place. Those standing crop values were combined with the seasonal probability of breakdown within the year, along with an assessed yield reduction, to give a weighted value for the standing crop that could be lost in a given year due to a gate failure.

9. This weighted value was then combined with the annual probability of gate failure (in Table A10.4) to determine the projected value of the crop that would be lost by not undertaking the Project. Up to 1995, the projected cumulative probability of gate failure was 104%; by 1995, gate failure was seen as almost certain in any year from then on. From this point forward, the appraisal analysis took an annual loss as one half of the calculated standing crop value every year.

10. **Reassessed Without-Project Scenario**. Under the appraisal implementation schedule, the barrage gates were to be replaced from 1993 to 1996. However, the Project lost the first winter season of construction due delays in achieving loan effectiveness, which was followed by additional work program delays. By 1995, only seven gates had been replaced, with the balance finished in 1997. Yet, despite predicted breakdowns during this period, no gates failed. Even with an allowance for the replaced gates, the barrage passed through more than 220% cumulative probability of gate failure without incident. Either the command was very fortunate, or the risk of gate failure was overstated.

[24] The standing value is the value of the crop prior to undertaking harvest and post harvest processing—activities viewed as unlikely for a stressed and wasted crop.

11. This analysis affirmed the latter, but also acknowledged the inclination to conservatism in the face of a grave threat. The PCR analysis resulted in a more conservative without-project assessment by claiming fewer probable gate failures, with a much-delayed onset and longer intervals in between.

12. The PCR assumed the same seasonal probability within the cropping year for a gate failure that was employed at appraisal. These seasonal probabilities were then multiplied by the predominant standing crop value at the time, along with an assessed yield loss, to arrive at a weighted crop loss figure for the year. Again, the standing crop value was less than the crop value that included harvest and post-harvest activities (Table A10.5). This seasonally weighted annual crop loss for a gate-failure year was then multiplied by the reassessed probability of gate failure to determine the lost production due to not undertaking the Project.

13. The feasibility study experts had predicted that, without remedial work, gate failure almost certainly would occur every year from 1995 onwards. In the PCR analysis, the without-project probability of gate failure started at one-in-five in 2001 and increased linearly to full probability in 2005. After that, gate failure was seen to occur only once in 5 years. This approach, acknowledging human ingenuity and ability to bridge gaps, was thought to be more reasonable.

14. Table A10.6 shows the determination of incremental benefits. Under the restated without-project probability of gate failure in Column 3, risk starts at 20% in 2001 and climbs to 100% by 2005. Gate failure is assumed to occur on average once in 5-year intervals thereafter. Column 4 shows the corresponding standing crop loss value associated with the probable events. Rather than remaining constant, the figures are calculated as shares of the current year's standing crop value. In Column 5, the associated cost of repair is calculated as the actual project cost of gate replacement divided by the total number of gates (43), with a 20% markup for the overhead of installing each gate separately. The without-project value of baseline production is shown in Column 6. Due to inadequate O&M, system deterioration is captured with a 1% annual decline in production area. Column 7 sums the without-project effects.

15. Column 8 portrays the with-project baseline production, again shrinking at 1% per year due to the limited commitment to O&M. In Column 9, the value of the increased area brought into production by additional water supply is shown. It is phased in over a 5-year period, and like the baseline production, it deteriorates by 1% per year. Column 10 sums the with-project effects, while Column 11 shows the incremental benefit between with- and without-project valuations.

4. Non-quantified Benefits

16. In addition to irrigation, households in the command and adjacent settled areas get water from the Kotri system. This household use was not quantified. The Kotri system also supplies a large share of Karachi's water, and is planned on as an important source for the future. However, a lack of coordination of projects has resulted in unutilized Kotri Barrage capacity to supply Karachi with additional water. The conveyance channel to Karachi needs substantial upgrading to utilize the expanded supply generated by the Project. Based on funding to date, it could be many years before that task is accomplished.

17. Other communities adjacent to the Kotri command and some power manufacturing firms also draw water for domestic supplies. However, these amounts are not significant compared to the irrigation and releases downstream.

18. Livestock rearing is common in the farmed areas of the command. Fodder crops are grown and other grasses collected for animals. The availability of water from the Kotri Barrage canals supports the sustenance of the livestock population.

D. Costs

19. For the economic analysis, the costs were broken down into three categories: (i) civil works; (ii) design, supervision and administration, and (iii) imported material and supplies. Specific conversion factors were determined based on foreign and domestic components and share of unskilled labor.

20. For O&M, the recorded fund releases were used in the evaluation analysis. Sindh Province reportedly provided funds for only half the O&M requirements. For the rehabilitated headworks, the Finance Department has underfunded the Irrigation and Power Department's budget requests since project completion in 2000. The Government recently committed PRs7.74 million for the rehabilitated barrage. Annual expenditure for the distribution system has been PRs21.06 million. While that works out to about a dollar per ha of cultivated land, much of that amount goes to overhead (salaries, equipment, supplies, office, etc.) and not into the irrigation system. Budgeted O&M amounts are low.

E. Economic Internal Rate of Return

21. The benefit stream and costs are presented in Table A10.7. The net present value of the investment is PRs450 million (using a 12% discount rate), while the economic internal rate of return (EIRR) is 16%. The EIRR for the PCR is less than the appraisal 26% EIRR at appraisal, which assumed earlier losses avoided and a greater frequency. Still, these figures confirm that the Project has been a reasonably good investment, even after accounting for O&M deficiencies.

F. Sensitivity Analysis

22. A sensitivity analysis (Table A10.8) was undertaken for key areas of future concern.

23. While noting that the inadequate O&M is not calamitous—the barrage gates survived 40 years under the existing regime—Case 2 demonstrates that O&M spending would pay dividends. Case 3 shows the outcome if the headworks were to deteriorate from poor O&M to non-working condition by year 20, instead of enduring the 35-year life that is assumed. Because the effect is in the distant future, where financial discounting has greater impact, the EIRR drops by only 3%.

24. Case 4 portrays a situation of greater risk without-project that would involve greater losses avoided, implying a higher rate of return. The EIRR rises from the base case by 2 percentage points. Cases 5-8 highlight the sensitivity of the returns to agricultural prices. The switching value is negative 31%—a drop in prices that would drive the EIRR to 0%. A price decline of this nature is doubtful, however, because the production value is made up of about five main crops and numerous minor ones. The probability that they would all drop in unison is unlikely. Furthermore, the likelihood that they would all decline without farmers moving into other crops is even more dubious. Over time, farmers are likely to improve productivity and move to higher value crops. If prices or values increase by 10%, the Project EIRR rises to 19 percent. If prices or values rise by 20%, the EIRR increases to 21%.

25. While studied and modeled in the feasibility study prior to the Project, river training to address poor barrage approach and silt buildup was neither recommended nor undertaken. Three years after project completion, the problem has gotten progressively worse. In sensitivity Case 10, the impact of including a river training provision of PRs125 million on the overall investment was tested. Case 10 shows that including this relatively small amount (compared with the total project cost of PRs1.39 billion) would have had little impact on the Project's EIRR. Case 11 demonstrates the effect of the time value of money. If river training were undertaken at an increased cost today of PRs700 million, it would have only a slightly larger impact on EIRR than if the corrective measure was taken at the beginning of the Project. However, this probably oversimplifies the case. In addition to the civil works, new modeling studies and the mobilization of a new contractor would be required. These and other costs would have to be considered if the investment were made now.

5. Summary

26. The Project has had a significant impact by preventing a gate failure, and the consequent loss of production, livelihood, and drinking water supply. The Project ensured stability in irrigation supply, which encourages farmers to improve cultivation practices and market-oriented production. While avoiding a barrage shutdown undoubtedly benefited all farm households, it was probably especially important for the poor. Lacking the reserves to weather adversity, the poor are often hit hardest by disasters. In addition, as laborers and persons dependent on in-kind payment of agricultural produce, the poor would be especially vulnerable to intermittent and irregular system closings. Sindh Rural Development Project[25] (October 2002) provides an in-depth analysis of poverty, tenancy and the household farm. Two of the districts covered in that Project, Badin and Thatta, constitute the bulk of the Kotri Barrage command.

[25] ADB. 2002. *Report and Recommendation of the President to the Board of Directors on a Proposed Loan to Pakistan for the Sindh Rural Development Project.* Manila.

Table A10.1: Farmgate Prices 2003

Item	Financial PRs / unit	Economic PRs / unit
I. Outputs		
Main Outputs:		
Wheat	7.30 / kg	6.89 / kg
Rabi Fodder (berseem)	0.53 / kg	0.48 / kg
Kharif Fodder (maize)	0.53 / kg	0.48 / kg
Sugarcane	0.80 / kg	0.72 /
Paddy	5.20 / kg	5.24 / kg
Cotton	21.30 / kg	24.33 / kg
Oilseed	15.00 / kg	13.50 / kg
Legume	8.00 / kg	7.20 / kg
By-products:		
Wheat Straw	1.00 / kg	0.90 / kg
Rice Straw	0.60 / kg	0.54 / kg
Rice Bran	0.60 / kg	0.54 / kg
Cotton Stalks	0.80 / kg	0.72 / kg
Sugarcane Tops	0.60 / kg	0.54 / kg
II. Inputs		
Seed		
Wheat	10.00 / kg	9.00 / kg
Rabi Fodder (berseem)	71.00 / kg	63.90 / kg
Kharif Fodder (maize)	10.00 / kg	9.00 / kg
Sugarcane	1.25 / kg	1.13 / kg
Paddy	8.00 / kg	7.20 / kg
Cotton	30.00 / kg	27.00 / kg
Oilseed	9.00 / kg	8.10 / kg
Fertilizer/Agrochemical		
Urea	8.00 / kg	9.78 / kg
Diammonium Phosphate	15.00 / kg	12.98 / kg
Chemical	1,000.00 / ac	1,058.00 / ac
Farm Yard Manure	0.25 / kg	0.23 / kg
Labor / Power		
Tractor	500.00 / input-day	450.00 / input-day
Labor	60.00 / day	45.00 / day

ac = acre, kg = kilogram.

Source: University of Sindh, Jamshoro, Department of Agriculture Extensions, PCR Mission.

Table A10.2: Economic Pricing of Traded Commodities

Item	Factor	Unit	1995	2000	2003	2005	2010	2020
Rice - Export Parity		$/mt						
Rice, Thai, 5% Broken			270	201	199	203	208	208
Quality Adjustment Factor	0.82		221	165	163	166	171	171
Freight and Insurance								
Domestic border price (FOB Karachi)	PRs 58/$	PRs/mt	12,820	9,570	9,450	9,630	9,920	9,920
Less Port, Handling, and Losses[a]			1,100	1,000	1,000	1,000	1,000	1,000
Less Transport to Project Area[a]			230	230	230	230	230	230
Ex-Mill Value			11,490	8,340	8,220	8,400	8,690	8,690
Paddy Equivalent	50%		5,745	4,170	4,110	4,200	4,345	4,345
Plus Byproducts Value[ab]	25%		2,590	1,880	1,850	1,890	1,960	1,960
Less Milling Cost[a]			510	510	510	510	510	510
Value In-Mill			7,825	5,540	5,450	5,580	5,795	5,795
Less Local Transport and Handling, Farm to Mill[a]			210	210	210	210	210	210
Farmgate Price			7,615	5,330	5,240	5,370	5,585	5,585

mt = metric ton, FOB = free on board.

[a] Local cost adjusted by standard conversion factor.

[b] Byproducts include value of brokens, bran, tips, and husks.

Item	Factor	Unit	1995	2000	2003	2005	2010	2020
Sugar - Import Parity								
Sugar, FOB Carribean		$/mt	247	179	160	148	180	190
Plus Freight and Insurance			50	50	50	50	50	50
Domestic border price (CIF Karachi)	PRs 58/$	PRs/mt	17,240	13,300	12,180	11,510	13,360	13,920
Plus Port, Handling, and Losses[a]			950	870	850	830	870	880
Plus Transport to Project Area[a]			370	370	370	370	370	370
Ex-Mill Value of Sugar			18,560	14,540	13,400	12,710	14,600	15,170
Less Processing Cost[a]			5,100	5,100	5,100	5,100	5,100	5,100
Value of Raw Sugar			13,460	9,440	8,300	7,610	9,500	10,070
Cane Value (@9.5% Sugar Content)			1,280	900	790	720	900	960
Less Local Transport and Handling[a]			70	70	70	70	70	70
Farmgate Price			1,210	830	720	650	830	890

CIF = cost, insurance, freight, FOB = free on board, mt = metric ton.

[a] Local cost adjusted by standard conversion factor.

Item	Factor	Unit	1995	2000	2003	2005	2010	2020
Wheat - Export Parity		$/mt						
Wheat, US Gulf HRW			149	113	143	128	137	140
Quality Adjustment Factor	0.95		142	108	136	122	130	133
Freight and Insurance								
Domestic border price (FOB Karachi)	PRs 58/$	PRs/mt	8,240	6,260	7,890	7,080	7,540	7,710
Less Port, Handling, and Losses[a]			400	400	400	400	400	400
Less Transport to Project Area[a]			370	370	370	370	370	370
Local Market Value			7,470	5,490	7,120	6,310	6,770	6,940
Less Local Agent Commission	2%		130	100	130	110	120	120
Less Local Transport and Handling[a]	1.5%		100	70	100	90	90	90
Farmgate Price			7,240	5,320	6,890	6,110	6,560	6,730

FOB = free on board, HRW = Hard Red Winter, mt = metric ton, US = United States.

[a] Local cost adjusted by standard conversion factor.

Source: Asian Development Bank estimates.

Item	Factor	Unit	1995	2000	2003	2005	2010	2020
Cotton - Export Parity								
Cotton, CIF Europe		$/mt	1,791	1,295	1,301	1,309	1,335	1,297
Quality Adjustment Factor	0.97		1,737	1,256	1,262	1,269	1,295	1,258
Less Freight and Insurance			120	120	120	120	120	120
Domestic border price (FOB Karachi)	PRs 58/$	PRs/mt	93,790	65,890	66,240	66,640	68,150	66,000
Less Port, Handling, and Losses[a]			2,100	2,100	2,100	2,100	2,200	2,100
Less Transport to Project Area[a]			370	370	370	370	370	370
Ex-Ginnery Value of Lint			91,320	63,420	63,770	64,170	65,580	63,530
Seed Cotton Equivalent	33%		30,136	20,929	21,044	21,176	21,641	20,965
Cotton Seed Equivalent [ab]			5,140	5,140	5,140	5,140	5,140	5,140
Less Ginning Cost[a]			1,390	1,390	1,390	1,390	1,390	1,390
Value At-Ginnery			33,886	24,679	24,794	24,926	25,391	24,715
Less Local Transport and Handling, Farm to Mill[a]			460	460	460	460	460	460
Farmgate Price			33,426	24,219	24,334	24,466	24,931	24,255

CIF = cost, insurance, freight, FOB = free on board, mt = metric ton.
[a] Local cost adjusted by standard conversion factor.
[b] 0.6 mt per mt of seed cotton, at PRs 9,530/mt.

Item	Factor	Unit	1995	2000	2003	2005	2010	2020
Urea - Import Parity								
Urea, Bagged Eastern Europe		$/mt	178	100	130	125	118	118
Plus Freight and Insurance			25	25	25	25	25	25
Domestic border price (CIF Karachi)	PRs 58/$	PRs/mt	11,770	7,280	8,990	8,720	8,310	8,270
Less Port and Handlinga			280	280	280	280	280	280
Less Transport to Project Area[a]			370	370	370	370	370	370
Local Market Value			12,420	7,930	9,640	9,370	8,960	8,920
Less Local Transport and Handling[a]			140	140	140	140	140	140
Farmgate Price			12,560	8,070	9,780	9,510	9,100	9,060

CIF = cost, insurance, freight, FOB = free on board, mt = metric ton.
[a] Local cost adjusted by standard conversion factor.

Item	Factor	Unit	1995	2000	2003	2005	2010	2020
Diammonium Phosphate - Import Parity								
DAP, Bulk US Gulf		$/mt	182	153	177	168	161	158
Plus Freight and Insurance			30	30	30	30	30	30
Domestic border price (CIF Karachi)	PRs 58/$	PRs/mt	12,290	10,630	12,010	11,480	11,060	10,920
Less Port, Packing, and Handling[a]			460	460	460	460	460	460
Less Transport to Project Area[a]			370	370	370	370	370	370
Local Market Value			13,120	11,460	12,840	12,310	11,890	11,750
Less Local Transport and Handling[a]			140	140	140	140	140	140
Farmgate Price			13,260	11,600	12,980	12,450	12,030	11,890

FOB = free on board, mt = metric ton, US = United States.
[a] Local cost adjusted by standard conversion factor.
Source: Asian Development Bank estimates.

Table A10.3: Standing Crop Value (Economic Value)

Season/ Crop	Area (ha)	Yield (t/ha)	Cmnd Prdn (1,000 t)	Crop Value** (PRs/t)	Cmnd Prdn Value (PRs m)
Kharif (Apr-Sep)					
Rice	165,000	2.6	424	5,335	2,261
Sugarcane	76,800	58.8	4,513	699	3,156
Cotton	26,100	1.5	39	22,547	872
Fodder	29,400	21.5	632	428	271
Subtotal Kharif	**297,300**		**5,608**		**6,560**
Rabi (Oct-Mar)					
Wheat	64,700	2.2	145	6,591	958
Sugarcane	36,500	58.8	2,145	699	1,500
Fodder	16,700	18.0	301	400	120
Subtotal Rabi	**117,900**		**2,591**		**2,579**
Total	**415,200**		**8,198**		**9,139**

cmnd =command, ha = hectare, prdn = production, t = ton.

Note: Other crops excluded from valuation as being minor.

** Standing value of crop less harvest and postharvest activities

Source: Asian Development Bank estimates.

Table A10.4: Probability of Gate Failure

Year	(%)
1988	2.4
1989	3.4
1990	4.8
1991	6.4
1992	11.2
1993	24.4
1994	51.2
1995	93.5
1996	100.0
1997 on	100.0

Source: Appraisal Report, 1999

Table A10.5: Command Value of Probability-Weighted Losses

Season		Crop	Area (ha)	Average Yield (t/ha)	Cmnd Production (1,000 t)	Yield Reduction (%)	Crop Economic Value** (PRs/t)	Loss Estimate (PRs m)
Spring	20%	Sugarcane	76,800	58.8	4,513	30	699	189
Summer	25%	Sugarcane	76,800	58.8	4,513	25	699	197
		Rice	165,000	2.6	424	50	5,335	283
		Cotton	26,100	1.5	39	25	22,547	55
		Fodder	29,400	21.5	632	25	428	17
Autumn	35%	Rice	165,000	2.6	424	50	5,335	396
Winter	20%	Wheat	64,700	2.2	145	45	6,591	86
		Sugarcane	36,500	58.8	2,145	45	699	135
		Fodder	16,700	18.0	301	45	400	11
Total	**100%**							**1,369**

cmnd = command, ha = hectare, t = tons.
Note: Other crops excluded from valuation as being minor.
** Standing value of crop less harvest and postharvest activities.
Source: Asian Development Bank estimates.

Table A10.6: Calculation of Benefit Stream

Year		Benefit Stream								
		Predicted Probability of Gate Failure[a] (%)	Without Project Estimated Loss of Standing Crop Due to Gate Failure[b] (PRs million)	Single Gate Failure Replacement (probability weighted) (PRs million)	Without Project Baseline Production Value (PRs million)	Without Project Net Production (PRs million)	With Project Baseline Production (PRs million)	Increased Production from Additional Irrigation Supply (PRs million)	With Project Net Production (PRs million)	Incremental Benefit (PRs million)
1	1993	—	—	—	10,234	10,234	10,234	—	10,234	0
2	1994	—	—	—	10,132	10,132	10,132	—	10,132	0
3	1995	—	—	—	10,031	10,031	10,031	—	10,031	0
4	1996	—	—	—	9,930	9,930	9,930	—	9,930	0
5	1997	—	—	—	9,831	9,831	9,831	—	9,831	0
6	1998	—	—	—	9,733	9,733	9,733	—	9,733	0
7	1999	—	—	—	9,635	9,635	9,635	—	9,635	0
8	2000	—	—	—	9,539	9,539	9,539	—	9,551	11
9	2001	20	253	3	9,444	9,188	9,444	23	9,467	278
10	2002	40	500	5	9,349	8,844	9,349	34	9,384	540
11	2003	60	743	8	9,256	8,505	9,256	46	9,301	796
12	2004	80	980	11	9,163	8,172	9,163	57	9,220	1,048
13	2005	100	1,213	14	9,072	7,845	9,072	57	9,128	1,283
14	2006	—	—	—	8,981	8,981	8,981	56	9,037	56
15	2007	—	—	—	8,891	8,891	8,891	55	8,947	55
16	2008	—	—	—	8,802	8,802	8,802	55	8,857	55
17	2009	—	—	—	8,714	8,714	8,714	54	8,768	54
18	2010	100	1,154	14	8,627	7,460	8,627	54	8,681	1,221
19	2011	—	—	—	8,541	8,541	8,541	53	8,594	53
20	2012	—	—	—	8,455	8,455	8,455	53	8,508	53
21	2013	—	—	—	8,371	8,371	8,371	52	8,423	52
22	2014	—	—	—	8,287	8,287	8,287	52	8,339	52
23	2015	100	1,097	14	8,204	7,094	8,204	51	8,255	1,162
24	2016	—	—	—	8,122	8,122	8,122	51	8,173	51
25	2017	—	—	—	8,041	8,041	8,041	50	8,091	50
26	2018	—	—	—	7,961	7,961	7,9611	50	8,010	50
27	2019	—	—	—	7,881	7,881	7,881	49	7,930	49
28	2020	100	1,043	14	7,802	6,745	7,802	49	7,851	1,106
29	2021	—	—	—	7,724	7,724	7,724	48	7,772	48
30	2022	—	—	—	7,647	7,647	7,647	48	7,695	48
31	2023	—	—	—	7,570	7,570	7,570	47	7,618	47
32	2024	—	—	—	7,495	7,495	7,495	47	7,541	47
33	2025	100	992	14	7,420	6,414	7,420	46	7,466	1,052
34	2026	—	—	—	7,346	7,346	7,346	46	7,391	46
35	2027	—	—	—	7,272	7,272	7,272	45	7,317	45
36	2028	—	—	—	7,199	7,199	7,199	45	7,244	45
37	2029	—	—	—	7,127	7,127	7,127	44	7,172	44
38	2030	100	944	14	7,056	6,099	7,056	44	7,100	1,001

[a] PCR re-assessed probabilities
[b] PCR re-assessed probabilities of gate failure.
Source: Asian Development Bank Estimates

Table A10.7: Project Incremental Net Benefits

	Year	Benefits	Costs						Net
		Incremental Benefit (PRs million)	Survey, Design, and Admin. (PRs million)	Materials and Equipment Import (PRs million)	Civil Works (PRs million)	O&M Headworks (PRs million)	O&M Distribution System (PRs million)	Total Costs (PRs million)	Net Benefit (PRs million)
	1988								
	1989								
	1990								
	1991								
	1992								
1	1993	0	10	8	47	7	19	92	(92)
2	1994	0	45	34	204	7	19	310	(310)
3	1995	0	46	35	207	7	19	314	(314)
4	1996	0	26	20	118	7	19	190	(190)
5	1997	0	20	15	91	7	19	152	(152)
6	1998	0	24	19	111	7	19	180	(180)
7	1999	0	21	16	96	7	19	160	(160)
8	2000	11	5	4	21	7	19	56	(44)
9	2001	278	0	0	0	7	19	26	252
10	2002	540	0	0	0	7	19	26	514
11	2003	796	0	0	0	7	19	26	771
12	2004	1,048	0	0	0	7	19	26	1,022
13	2005	1,283	0	0	0	7	19	26	1,257
14	2006	56	0	0	0	7	19	26	30
15	2007	55	0	0	0	7	19	26	30
16	2008	55	0	0	0	7	19	26	29
17	2009	54	0	0	0	7	19	26	28
18	2010	1,221	0	0	0	7	19	26	1,195
19	2011	53	0	0	0	7	19	26	27
20	2012	53	0	0	0	7	19	26	27
21	2013	52	0	0	0	7	19	26	26
22	2014	52	0	0	0	7	19	26	26
23	2015	1,162	0	0	0	7	19	26	1,136
24	2016	51	0	0	0	7	19	26	25
25	2017	50	0	0	0	7	19	26	24
26	2018	50	0	0	0	7	19	26	24
27	2019	49	0	0	0	7	19	26	23
28	2020	1,106	0	0	0	7	19	26	1,080
29	2021	48	0	0	0	7	19	26	22
30	2022	48	0	0	0	7	19	26	22
31	2023	47	0	0	0	7	19	26	21
32	2024	47	0	0	0	7	19	26	21
33	2025	1,052	0	0	0	7	19	26	1,026
34	2026	46	0	0	0	7	19	26	20
35	2027	45	0	0	0	7	19	26	19
36	2028	45	0	0	0	7	19	26	19
37	2029	44	0	0	0	7	19	26	19
38	2030	1,001	0	0	0	7	19	26	975
	NPV@ 12%								450
	EIRR								16%

O&M = operation and maintenance, PRs = Pakistan rupees.
Source: Asian Development Bank estimates.

Table A10.8 Sensitivity Analysis

No.	Description	EIRR
1.	Base case	16%
2.	O&M increased to recommended higher rates of PRs 10.9 million for the headworks, and PRs 42.18 million (doubled) for the system, and the 1% decline per year in system is avoided	33%
3.	Case of "deferred maintenance" on headworks. After 15 years, incremental benefits decrease linearly over five years to 0 by year 20	14%
4.	Case of increased assessment of risk in without-Project scenario; gate failure within three years of 2000, and every three years thereafter	18%
5.	Case of decreasing prices 10%	13%
6.	Case of decreasing prices 31%	0%
7.	Case of increasing prices 10%	19%
8.	Case of increasing prices 20%	21%
9.	Case of valuing capacity to supply water to Karachi at opportunity cost of irrigated area	17%
10.	Case of including river training at the beginning of Project at estimate of about PRs 125 million	15%
11.	Case of undertaking river training now at estimate of about PRs 700 million	14%

EIRR = economic internal rate of return, O&M = operation and maintenance, PRs = Pakistan Rupees.
Source: Asian Development Bank estimates.

INSTITUTIONAL REFORMS FOR OPERATIONS AND MAINTENANCE INTRODUCED UNDER THE NATIONAL DRAINAGE PROGRAM

1. A number of studies in the 1990s observed that the public sector institutions in the water sector in Pakistan were not performing well financially, and their operations were not sustainable. The provincial irrigation departments were responsible for the management of the irrigation, drainage and flood protection systems above the watercourse level. However, the provincial governments were unable to provide adequate funds, in part due to a low level of recovery of water charges.

2. In the past 10 years, the average annual expenditure on operation and maintenance (O&M) was estimated to be 28% short of requirements. Provisions and budget releases were inadequate to meet O&M requirements. In Sindh Province, the average releases for O&M were estimated to be only 52% of the requirements. Because of the inadequate funds, the condition of the infrastructure deteriorated. In response, two national irrigation system rehabilitation projects were undertaken from 1988 to 1997 to restore part of the irrigation and drainage infrastructure to designed levels. The National Drainage Program[1] is being implemented to rehabilitate the drainage system.

3. Public sector institutions have been unable to recover O&M costs because of inadequate assessment and poor collection of user charges. While expenditures by the irrigation departments have been increasing steadily, assessed revenues from water charges has remained at about the same levels between 1993-94 and 2002-03. As a result, the deficit in the O&M budget has increased to more than six times the assessed revenue from water charges. Due to the stagnant collection, the subsidies for O&M have risen steadily. In 2002-2003 the O&M subsidy was PRs3.79 billion, which translates to PRs744 per hectare (ha) of cultivated command area (CCA). The expanding gap between O&M expenditure and water charge collections is unsustainable. Measures for controlling O&M expenditures and increasing revenue from water charges must be a priority.

4. In consultation with the provinces, the Government of Pakistan developed a strategy in August 1995 for institutional reforms in the water sector. The strategy envisaged:

- Provincial irrigation departments would be transformed into autonomous, self-accounting and self-financing provincial irrigation and drainage authorities (PIDAs)

- Below the PIDAs, financially self-accounting area water boards (AWBs) would be created, preferably along canal commands, for managing and operating the irrigation and drainage systems. Farmers and leading professionals would be represented on the boards of directors of the AWBs.

- Below the AWBs, farmers would be encouraged to form water users organizations at minor canal or distributary level. Based on the results of pilot projects, a model for the formation of water users organizations would be developed.

5. By providing a new institutional basis for effective management of infrastructure, the institutional reforms aimed to arrest and reverse the degradation of the irrigation and drainage

[1] The national program is being supported by Loan No.1413-PAK: *National Drainage Sector Project*. Manila for $140 million, approved on12 Dec 1995.

system. The reforms would also ensure the long-term financial viability of investment in the sector. Four themes underpinned the strategy:

- the need to shift operational control of the system from a central Government line department to decentralized and quasi-autonomous state-owned and farmer managed agencies;

- the need to make these agencies increasingly dependent on their own sources of revenue, at least for their recurrent and operating expenditures and to some extent for system investment;

- the introduction of significant user representation into system management to ensure its service-orientation, enhance transparency in water and financial accounting, and to ensure user willingness to carry increased system costs;

- the creation of a system of entitlements (or water rights) to ensure equity in water distribution.

6. The Sindh Irrigation and Drainage Authority (SIDA) Act was passed in 1997. The Sindh Water Management Ordinance replaced the act in 2002, and removed some of its shortcomings. SIDA was established with jurisdiction initially over three canal commands (Nara Canal, Ghotki Feeder, and Fuleli/Akram Wah canals), and AWBs were notified. Below the AWBs, farmer organizations will be formed at the distributary or minor canal level to take over responsibility of O&M and collect water charges under formal irrigation and drainage management transfer (IDMT) agreements. More than 1,200 farmer organizations are to be established in the 14 canal commands or AWBs of Sindh Province to manage O&M and collect water charges. SIDA's jurisdiction would be gradually expanded to the entire province, with AWBs established on the 14 canal commands. Simultaneously, the irrigation departments' jurisdiction and role would gradually diminish until it holds only regulatory responsibilities. These upper tier reforms are envisaged to take about 10 years to be implemented throughout the irrigation system.

7. The functions to be assigned to the AWBs generally include:

- formulating and implementing policies to achieve effective, economical and efficient utilization of irrigation water;

- ensuring that the AWB becomes fully operational as a self-supporting and financially self-sustaining entity within 7-10 years from the date of its constitution;

- planning, designing, constructing, operating and maintaining the irrigation, drainage and flood control infrastructure within its territorial jurisdiction.

8. The functions to be assigned to farmer organizations generally include:

- managing, operating, maintaining and improving the irrigation and drainage infrastructure;

- supplying the water equitably and efficiently to all users;

- receiving the drainage effluent from the area, and conveying it to the designated nodal points;

- assessing and collecting the water rates and drainage cess[2] from the beneficiaries, and paying the agreed amounts to the AWB;

- settling disputes among members.

9. The progress on the institutional reforms has been slow. In Sindh, 192 farmer organizations (162 in Nara Canal AWB, 12 in Left Bank canals AWB, and 10 in Ghotki Feeder AWB) have been established. Formal IDMT agreements have been concluded with 112 farmer organizations. Improvements in the pace and quality of social mobilization and capacity building are needed.

10. In sum, the purpose of these reforms was to build accountability, transparency, efficiency and equity into the management of irrigation infrastructure and water supply. While the reforms were well conceived, significant weaknesses have constrained progress. First, farmer groups need training in management, financial reporting, assessment, collections, institutional organization, and technical operations, among other areas. These are not short-term training areas that can be provided by target-driven, government-provided seminars over several days. The training needs are long-term, requiring sustained resources and support. Second, the large landholders that are positioned to receive water at below cost have no incentive to see the new system work. They also have the political power to influence outcome. Third, the transition envisaged would marginalize the irrigation departments' authorities and resources, and supplant current government revenue collectors. So while the current O&M system clearly is not working, the new system is facing resistance from a number of vested interests. A sustained commitment over the long term is required to give the reforms a chance to overcome opposition and succeed.

[2] Cess is a tax levied by the Government on the use of drainage facilities.

PROVINCIAL WATER ALLOCATION, KOTRI BARRAGE WATER BALANCE, AND QUALITY OF WATER

I. Water Apportionment Accord

1. The 1991 Water Apportionment Accord (the Accord) is the basis for the distribution of water in the provinces. The implementation of the Accord is monitored by the Indus River System Authority (IRSA), which has five members (one from the federal Government and one each from the provinces). The head office of IRSA is in Islamabad. The provincial water allocations according to the 1991 Accord are shown in Table A12.1.

Table A12.1: Water Accord Allocation in Provinces

	Water Distribution in MAF		
Province	**Kharif[a]**	**Rabi[b]**	**Total**
Punjab	37.07	18.87	55.94
Sindh	33.94	14.82	48.76
NWFP	3.48	2.30	5.78
Balochistan	2.85	1.02	3.87
Sub-total	**77.34**	**37.01**	**114.35**
Civil Canals in NWFP	1.80	1.20	3.00
Total Allocation	**79.14**	**38.21**	**117.35**
Total (BCM)	97.63	47.14	144.77

[a] – April to September; [b] – October to March.
BCM = billion cubic meters; MAF: million acre feet; NWFP = Northwest Frontier Project
Source: Water Apportionment Accord 1991.

2. Other significant provisions of the Accord include:

- The balance of river supplies including flood supplies and future storages shall be distributed according to the following proportions:

Punjab	Sindh	NWFP	Balochistan
37%	37%	14%	12%

- Industrial and urban water supplies for Karachi will be given priority.
- The need for storage, wherever feasible on the Indus and other rivers, will be an area of future agricultural development.
- To check saline intrusion, certain minimum flows to the sea below Kotri are needed. Sindh viewed the optimum level as 10 million acre feet (MAF), while other studies indicated lower or higher figures. Further studies will be undertaken to determine the minimum escapage needs downstream of Kotri.
- The provinces can undertake projects within their agreed shares without any restrictions.
- The operation of the reservoirs would give priority to the irrigation uses of the provinces.

3. Enforcement of the Accord generally was amicable. However, considerable controversy remains between provinces on sharing surpluses and deficits. A culture of mistrust has developed.

4. The Accord allocation of 114.35 MAF excluding the allocation for Northwest Frontier Project (NWFP) civil canals, is 9-10% higher than the average historic usage in the Indus Basin prior to the Accord. Even after the accord, the average usage has remained near the historic average of 103-104 MAF. Presumably, the allocations were fixed at a higher level on the assumption that additional storage would be constructed in the system. That construction has not been undertaken.

5. As a result, the diversion of water since 1991 has not equaled the total allocation of 114.35 MAF. From 1991-92 to 1999-2000, the annual canal diversions have been between 94.46 MAF and 111.11 MAF, with an average of 105.03 MAF. The system is not capable of supplying the allocated amount of 114.35 MAF due to shortages in Rabi and the early Kharif season. The supply pattern is not expected to change in the near future, except that Kharif supplies to Sindh will increase by about 1.28 MAF after the full operation of the Rainee Canal, which is under construction.

6. Except for 1994-95 and 1999 onwards, Sindh Province received supplies exceeding its allocation during Rabi. In Kharif, Sindh experienced shortages during that period except in 1996-97. In the last few years, however, drought has caused the Rabi supplies to fall short of the requirements as the upstream reservoirs either could not be filled during summer or were drawn down in early Rabi to meet the shortages during the sowing season.

II. Water Availability at Kotri Barrage

7. Average water availability upstream of Kotri Barrage, releases below Kotri, and withdrawals of Kotri canals are shown in Table A12.2.

Table A12.2: Kotri Barrage Inflow, Outflow and Canal Diversions

Year/Season		River Flow at Kotri Barrage MAF		Kotri Canals Withdrawal MAF
		Upstream	Downstream	
Average MAF	Kharif	41.3	33.9	7.6
	Rabi	5.4	2.4	3.0
	Annual	46.7	36.3	10.5
Average BCM	Kharif	51.0	41.8	9.4

BCM = billion cubic meters; MAF = million acre feet.
Source: Office of the Chief Engineer, Kotri Barrage

III. Effect of the Kotri Barrage Rehabilitation Project on Water Availability

8. The Irrigation and Power Department has estimated the storage and savings in water due to removal of head limitations, which are summarised in Table A12.3.

Table A12.3: Water Savings Due to Kotri Barrage Rehabilitation

Year	Kharif Saving (MAF)	Rabi Saving (MAF)	Total saving (MAF)	% of total Diversion from Kotri Barrage
1996-97	(0.00980)	—	(0.00980)	0.08
1997-98	(0.05100)	(0.04030)	(0.09130)	0.81
1998-99	(0.03840)	(0.10210)	(0.14050)	1.24
1999-2000	(0.03700)	(0.07370)	(0.11070)	1.02
2000-01	(0.09240)	(0.12960)	(0.22200)	2.93
2001-02	(0.12474)	(0.02655)	(0.15130)	2.09
2002-03	(0.07490)	(0.01750)	(0.09250)	0.98

Source: Office of the Chief Engineer, Kotri Barrage.

9. The rehabilitation of the barrage and the removal of head limitations helped mitigate the impact of the drought years of 1998-2002. The additional water from the removal of head limitations peaked in 2000-2001, when about 0.222 MAF were saved. This savings were equivalent to about 2.93% of total canal diversions from Kotri Barrage. In 2001-2003, about 2.09% of additional water became available to the Kotri command.

IV. Effect of Thal and Other Flood Canals on Water Availability in Sindh

10. The Thal Flood Water Canal is under construction in the Punjab. Similarly, the Kachhi Canal for Balochistan and Rainee Canal for Sindh are also under construction to utilize surplus flows during the flood season. These canals will have an impact on water availability in Sindh and on the Kotri Barrage.

11. The construction of the Thal, Kachhi and Rainee Canals will not constrain the availability of water for irrigation in Sindh as well as at Kotri under normal flow conditions. The Water Allocation Accord will govern the flows, which will be regulated by IRSA. However, the average surplus flows going downstream from Kotri will be reduced by 3.127 MAF, or 8.6%, to 33.1 MAF. In years when flows below Kotri are below average, the percentage reduction may be higher. The downstream requirements below Kotri are still subject to negotiations. Studies to determine these requirements would consider the effect of Thal Flood Canal, Kachhi Canal and the Rainee Canal on the required releases below Kotri.

V. Water Quality

12. The Sindh Environmental Protection Agency surveyed water quality at 30 sites in Sindh under National Drainage Program (NDP). Samples were collected from 24 June to 18 July 2002. The average concentration of total dissolved solids (TDS) at Guddu, Sukkur, and Kotri was recorded as 177.9 milligrams per liter (mg/l), 181.3 mg/l, and 191.1 mg/l, respectively. At Sujawal, which is downstream from Kotri, the TDS concentration was 249.8 mg/l. Due to industrial waste discharges, heavy metals such as nickel, lead, zinc and cadmium also have been found in Indus water. The survey concluded that large volumes of putrescible liquid, being thrown in the Indus River, mainly from upcountry. Still, the water of the Indus River was found to

be satisfactory quality for irrigation. The chemical constituents of the water were within World Health Organization guidelines for drinking water. However, the presence of fecal contamination makes it unfit for drinking unless it is boiled and chlorinated. The study, which was carried out for a limited period in the summer during the drought period, needs to be extended to cover the high- and low-flow seasons.

WATER SECTOR DEVELOPMENT IN PAKISTAN

I. Water Policy and Investment Plans

1. The Government of Pakistan has prepared a Water Policy under the National Drainage Program–I (NDP).[1] In addition, the Ministry of Water and Power has prepared a Water Sector Strategy,[2] which also includes a Medium Term Investment Plan (MTIP). The Water Policy and the Water Strategy are awaiting approval of the Government.

2. The investments in the irrigation drainage and water resources development subsectors in Pakistan are based on the federal Ten Year Perspective Plan (TYPP) and Water and Power Development Authority (WAPDA) Vision 2025.

3. The TYPP envisages investing (i) PRs425.5 billion by 2011 on water resources development projects, including additional storage, irrigation and drainage systems; (ii) PRs10 billion on the Drought Relief Program; and (iii) about PRs484 billion on new hydroelectric projects. The major new water sector projects proposed for implementation during TYPP (2001-7) include Gomal Zam Dam, Mirani Dam, Greater Thal Canal, the raising of Mangla Dam, Right Bank Outfall Drain, Rainee Canal, Kachhi Canal, and the rehabilitation of barrages in Punjab. The major projects proposed for implementation beyond 2005-6 include Punjab Irrigation System Improvement Project, First Chashma Right Bank Lift, Sehwan Barrage Complex, Kurram Tangi Dam, Akhori, Dhok Pathan and Sanjwal Dams, Inter Provincial Spinal Drain, Small Dams in Barani Areas, and Flood Protection Sector Project III.

4. WAPDA has launched a water resource and hydropower development plan, called Vision 2025, to develop 64 million acre feet (MAF) of storage capacity and 27,000 megawatts (MW) of additional power generating capacity from hydropower and coal. Vision 2025 envisages an investment of about $50 billion over the next 25 years. The program is to be implemented in three phases. Phase I comprises fast-track projects to be completed in the first 5-7 years. Those projects include the construction of Gomal Zam Dam, Mirani Dam, Greater Thal Canal, Kacchi Canal, Rainee Canal, raising of Mangla Dam, Satpara Dam, Sabak Zai Dam, and the Right Bank Outfall Drain (RBODII) to discharge the saline drainage effluent from the Lower Indus Right Bank area to the sea. The feasibility study for the Basha Dam, Kurram Tangi Dam and Akhori Dam, and the detailed design of Sehwan Barrage and Chashma Right Bank Lift Canal, have started. These projects would have a storage capacity of about 5 MAF and would allow the cultivation of more than 2 million acres under cultivation, in addition to generating 332 MW of power.

II. Implementation Problems in Funded Projects

5. The implementation of several externally funded projects has been delayed. The implementation of NDP, which is cofinanced by Asian Development Bank (ADB), World Bank and Japan Bank for International Cooperation (JBIC), and the Second Flood Protection (Sector) Project,[3] financed by ADB, has been very slow. The ADB loan for Punjab Farmer-Managed

[1] The national program is being supported by Loan No. 1413-PAK: National Drainage (Sector) Project, for $140 million, approved 12 Dec 1995. The program is also cofinanced by the World Bank and JBIC.

[2] ADB. 1998. Techical Assistance to Pakistan for the Water Resources Strategy Study. Manila. The ADB-financed Water Sector Strategy identifies a significant number of projects that could fit this description.

[3] ADB. 1997. *Report and Recommendation of the President to the Board of Directors on a Proposed Loan to Pakistan for Second Flood Protection (Sector)*. Manila.

Irrigation Project (PFMIP) was cancelled, while loan negotiations with ADB for the Marala Ravi Link Canal Project financed were unsuccessful.

6. The $785 million NDP began in early 1998. The delays in implementation were caused by (i) changing priorities of the implementing agencies, (ii) a lack of commitment to the institutional reforms component, (iii) the absence of proper survey data, (iv) lengthy approval procedures, and (v) land acquisition problems. As a result, progress on the investment component has been very slow. Balochistan withdrew from the NDP, but rejoined recently. Though the project size was reduced to $450 million, the implementation progress remains very slow.

7. The Second Flood Protection (Sector) Project started in October 1999 with ADB assistance. However, ADB suspended the project loan in May 2001, causing a significant delay. After the Government satisfied ADB's concerns, the loan was restored in August 2001. The project was reformulated in November 2001 with a reduced scope of work, and it was scheduled to start in September 2003.

8. In March 1999, ADB approved a loan of SDR5.811 million for the PFMIP, and the loan became effective on 28 April 2000. The project was formulated to support and replicate the institutional reform initiatives under NDP. In May 2001, the Government informed ADB that the Punjab government could not implement the project with its existing design. When an agreement could not be reached on the reformulation of the project, the loan was cancelled.

9. A sector approach was used on the NDP and the Second Flood Protection (Sector) Project. The sector approach has several advantages over the normal project approach, because it can take on policy issues, leverage change, and provide flexibility. However, these two national-level projects still encountered major difficulties in implementation. In response, ADB might consider independent provincial program loans in the future, instead of one federal program with provincial components, to avoid allowing the reservations of one province effect the implementation in other provinces.

10. The processing and implementation problems of the recent past have resulted in slow growth of the Pakistan water sector from 1999 to 2001. External assistance to the sector has been substantially reduced during the last several years. However, the Government has made the water sector a high priority since 2001-2002. The need for external funding and support remains.

III. Development Options

11. Discussions about the water sector in Pakistan focus on the development of new irrigation areas. Too little attention is being paid to other aspects, including sustainability, equity, water conservation, and modernization and rehabilitation of barrages and irrigation systems.

12. The Kotri Barrage Rehabilitation Project accomplished its objectives without creating any social or environmental problems. It was a focused intervention that produced a high economic rate of return. For ADB, similar projects involving the rehabilitation of barrages and canal as well as water conservation offer an opportunity for investment. However, beneficiary participation is needed to ensure sustainability. The process of institutional reforms started under NDP also should be continued.

13. MTIP, included under the Water Sector Strategy, has a number of irrigation and drainage projects in the four provinces. The costs of these projects at 2000-2001 levels can be found in the Water Sector Strategy.

1. Sindh

a. Sehwan Barrage Complex
b. Mol Dam
c. North West Canal Remodelling Project
d. Lining of Distributaries and Minors in Sukkur Barrage
e. Assuring Water supply to Karachi
f. Water Conservation Project /On farm Water Management (OFWM)

2. Punjab

a. Small Dams in *Barani* Areas (areas where the primary source of irrigation is precipitation)
b. Punjab Irrigation System Improvement Project
c. Rehabilitation and Improvement of Barrages in Punjab
d. Jalalpur Canal Project
e. Dajal Branch Extension Project
f. Cholistan Project I
g. Harnessing Hill torrents in DG Khan
h. Shakargarh Canal Irrigation System
i. Lining of Distributaries and Minors in Punjab
j. Water Conservation Project/OFWM

3. NWFP

a. Munda Dam Multi-Purpose Project
b. Chashma Right Bank Canal 1st Lift
c. Kurram Tangi Multipurpose Project
d. Gopalam Irrigation Scheme
e. Water Conservation Project/OFWMP
f. Small Dams/Small Irrigation Schemes Project in NWFP

4. Balochistan

a. Extension of Pat Feeder Canal
b. Naulong Storage Dam Kacchi
c. Rehabilitation of Khushdil Khan Bund
d. Water Conservation Project/OFWM
e. Small Irrigation Schemes

REMODELLING OF KALRI BAGHAR FEEDER FOR WATER SUPPLY TO KARACHI

1. The Kotri Barrage diverts water into three outlets that feed four canals. Three of the canals are on the left bank of the Indus (Old Fuleli or Pinyari, New Fuleli, and Akram Wah), while the fourth is on the right bank (Kalri Baghar Feeder Canal). The Pinyari and New Fuleli were constructed as flood canals. While they are used for extensive irrigation today, they are non-perennial. The newer Akram Wah and Kalri Baghar Feeder canals (KB Feeder) are perennial flow canals.

2. One of the main reasons for raising the pond level of Kotri Barrage was to increase supplies to KB Feeder Canal for conveyance to Karachi. The water supply requirements of Karachi are projected to increase to 34 cubic meters per second (m^3/s) by 2005. The 60-kilometer (km) KB Feeder flows from the right bank of Kotri Barrage into the Kinjhar Lake from the north. This lake acts as a storage and sedimentation pond for the Karachi water supply. The Kinjhar-Guijo Canal then links up with the Greater Karachi Water Supply Scheme.

3. The design capacity of the KB Feeder is 257.7 m^3/s, which includes supplying 14.7 m^3/s for Karachi. The discharge capacity of the KB Feeder reportedly has been reduced to about 226.6 m^3/s due to silt buildup and the capacity limitation below the super passage of Baran Nai Nallah.

4. Karachi, which is getting 25.5 m^3/s through Kinjhar-Guijo Canal, needs an additional 8.5 m^3/s to meet the increased demand by 2005. About 10.8 m^3/s reportedly is being diverted already from irrigation. If an additional 8.5 m^3/s were diverted for supplying Karachi with drinking water, irrigation supplies for agricultural production would be constrained. One proposal calls for the capacity of KB Feeder be increased by 19.8 m^3/s to supply Karachi with the much-needed drinking water without taking away from irrigation supplies.

5. The Project Completion Review (PCR) mission of the Asian Development Bank (ADB) visited the KB Feeder leading to Kinjhar Lake. The mission observed that the canal has deteriorated due to deferred maintenance. It can handle only about 75-80% of the design discharge due to a silt buildup and clogging of the barrels below the Baran Nai crossing. To meet the additional requirements of Karachi, KB Feeder must be remodelled to allow more discharge to be passed. Urgent remedial actions are required to complete work on increasing the discharge capacity of KB Feeder Canal.

6. The Government of Pakistan recently approved for implementation a project for assuring the water supply for Karachi. Implementation is scheduled to take 6 years. However, the budget for the project, which is come from the provincial government, has been inadequate. At current funding rates, the project would take decades to complete. The project includes:

1. Repairing the Nai Baran super passage, increasing the capacity of KB Feeder Upper by another 20 cusecs to raise it to 277 cusecs, repairing canal lining and bank failure, and constructing debris traps;

2. Strengthening the Kinjhar lake banks;

3. Repairing Kinjhar Lake spillway.

7. Another project is underway to improve the capacity within the Karachi city water system, so that it can handle the increased load. The Water Loss Reduction and System

Strengthening Project is one of three projects aiming to increase the water supply to Karachi possible. The other two are the Kotri Barrage Rehabilitation Project (completed) and the Project for Assuring Water Supply for Karachi (para. 6) These complementary investments and project scopes of work need better coordination and synchronization to improve the Karachi water supply.