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Report No: PAD 2701

INTERNATIONAL DEVELOPMENT ASSOCIATION

PROJECT PAPER

ON A

PROPOSED ADDITIONAL CREDIT

IN THE AMOUNT OF SDR96.3 MILLION
(US$140.0 MILLION EQUIVALENT)

TO THE

ISLAMIC REPUBLIC OF PAKISTAN

FOR A

SINDH BARRAGES IMPROVEMENT PROJECT RESTRUCTURING AND ADDITIONAL FINANCING

May 4, 2018

Water Global Practice
South Asia Region

CURRENCY EQUIVALENTS

Exchange Rate Effective March 31, 2018

Currency Unit :	Pakistani Rupee (PKR)
PKR 115.73 =	US$1
SDR1=	US $1.45

FISCAL YEAR: July 1- June 30

ABBREVIATIONS AND ACRONYMS

AF	Additional Financing
BMU	Barrage Monitoring Unit
CIA	Cumulative Impact Assessment
CPS	Country Partnership Strategy
DA	Designated Account
EIRR	Economic Internal Rate of Return
ESA	Environmental and Social Assessment
EX-ACT	Ex-Ante Carbon-balance Tool
FM	Financial Management
FO	Farmers' Organization
GHG	Greenhouse Gas
GoSindh	Government of Sindh
GRM	Grievance Redress Mechanism
ID	Irrigation Department of the Government of Sindh
IFR	Interim Financial Report
NPV	Net Present Value
OP/BP	Operational Policy/Bank Procedure
O&M	Operation and Maintenance
PCMU	Project Coordination and Monitoring Unit
PDO	Project Development Objective
PMO	Project Management Office
POE	Panel of Experts
PSC	Project Steering Committee
RAP	Resettlement Action Plan
SCADA	Supervisory Control and Data Acquisition
RPF	Resettlement Policy Framework
SBIP	Sindh Barrages Improvement Project
SEPA	Sindh Environmental Protection Agency
SMF	Social Management Framework
TORs	Terms of reference
WSIP	Water Sector Improvement Project

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ADDITIONAL FINANCING DATA SHEET
ISLAMIC REPUBLIC OF PAKISTAN
SINDH BARRAGES IMPROVEMENT PROJECT ADDITIONAL FINANCING (P162117)
SOUTH ASIA
WATER GLOBAL PRACTICE

BASIC INFORMATION – PARENT (PK-Sindh Barrages Improvement Project - P131324)

Country	Product Line	Team Leader(s)		
Pakistan	IBRD/IDA	Toru Konishi		
Project ID	**Financing Instrument**	**Resp CC**	**Req CC**	**Practice Area (Lead)**
P131324	Investment Project Financing	GWA06 (9396)	SACPK (1539)	Water

Implementing Agency: Sindh Irrigation and Power Department

Is this a regionally tagged project?
No

Bank/IFC Collaboration
No

Approval Date	Closing Date		Original Environmental Assessment Category	Current EA Category
19-Jun-2015	22-Dec-2020		Full Assessment (A)	Full Assessment (A)

[ ] Situations of Urgent Need or Capacity Constraints	[ ] Financial Intermediaries (FI)
[ ] Series of Projects (SOP)	[ ] Project-Based Guarantees

Development Objective(s)

The project development objectives are to improve the reliability and safety of the Guddu barrage and strengthen the Sindh Irrigation Department's capacity to operate and manage the barrage.

Ratings (from Parent ISR)

	Implementation				Latest ISR
	30-Sep-2015	13-Apr-2016	30-Dec-2016	15-Jun-2017	12-Oct-2017
Progress towards achievement of PDO	S	MS	MS	MS	MS
Overall Implementation Progress (IP)	S	MS	MS	MU	MS
Overall Safeguards Rating	S	S	S	MS	S
Overall Risk	H	H	S	S	S

BASIC INFORMATION – ADDITIONAL FINANCING (Sindh Barrages Improvement Project AF - P162117)

Project ID	Project Name	Additional Financing Type	Urgent Need or Capacity Constraints
P162117	Sindh Barrages Improvement Project AF	Scale Up	
Financing instrument	Product line	Approval Date	
Investment Project Financing	IBRD/IDA	25-May-2018	
Projected Date of Full Disbursement	Bank/IFC Collaboration		
31-Oct-2024	No		

Is this a regionally tagged project?	
No	
[ ] Situations of Urgent Need or Capacity Constraints	[ ] Financial Intermediaries (FI)
[ ] Series of Projects (SOP)	[ ] Project-Based Guarantees
[ ] Disbursement-linked Indicators (DLIs)	[ ] Contingent Emergency Response Component

	(CERC)
[ ] Alternative Procurement Arrangements (APA)	

Disbursement Summary (from Parent ISR)

Source of Funds	Net Commitments	Total Disbursed	Remaining Balance	Disbursed
IBRD				%
IDA	188.00	24.29	163.21	13 %
Grants				%

PROJECT FINANCING DATA – ADDITIONAL FINANCING (Sindh Barrages Improvement Project AF - P162117)

FINANCING DATA (US$, Millions)

SUMMARY

Total Project Cost	152.20
Total Financing	152.20
of which IBRD/IDA	140.00
Financing Gap	0.00

DETAILS

World Bank Group Financing

International Development Association (IDA)	140.00
IDA Credit	140.00

Non-World Bank Group Financing

Counterpart Funding	12.20
Borrower	12.20

COMPLIANCE

Policy

Does the project depart from the CPF in content or in other significant respects?

[ ] Yes [✓] No

Does the project require any other Policy waiver(s)?

[ ] Yes [✓] No

INSTITUTIONAL DATA

Practice Area (Lead)

Water

Contributing Practice Areas

Climate Change and Disaster Screening

This operation has been screened for short and long-term climate change and disaster risks

Gender Tag

Does the project plan to undertake any of the following?

a. Analysis to identify Project-relevant gaps between males and females, especially in light of country gaps identified through SCD and CPF

Yes

b. Specific action(s) to address the gender gaps identified in (a) and/or to improve women or men's empowerment

Yes

c. Include Indicators in results framework to monitor outcomes from actions identified in (b)

Yes

PROJECT TEAM

Bank Staff

Name	Role	Specialization	Unit
Toru Konishi	Team Leader (ADM Responsible)	Water Resources	GWA06
Uzma Sadaf	Procurement Specialist (ADM Responsible)	Procurement	GGOPZ
Qurat ul Ain Hadi	Financial Management Specialist	FM	GGOAP
Akiko Nakagawa	Team Member	Climate Change	GCCRA
Anwar Ali Bhatti	Team Member	Financial Management	SACPK
Cecilia Belita	Team Member	Operations	GWASO
Huma Zafar	Team Member	Operations	SACPK
Juan Carlos Alvarez	Counsel	Legal	LEGES
Lucson Pierre-Charles	Team Member	Program Assistance	GWA06
Miki Terasawa	Social Safeguards Specialist	Social Safeguards	GSU06
Mohammad Yasin	Team Member	Program Assistance	SACPK
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Seble Berhanu	Counsel	Legal	LEGES
Shabir Ahmad	Team Member	Program Assistance	SACPK
Syed Usman Javaid	Team Member	Operations	SACPK
Takeaki Sato	Environmental Safeguards Specialist	Environmental Safeguards	OPSES
Victor Manuel Ordonez Conde	Team Member	Disbursement	WFACS
Zakia B. Chummun	Team Member	Operations	GWA09

Extended Team

Name	Title	Organization	Location
Altaf Iqbal	Economist		Lahore
Barry Trembath			
Philippe Floch	Water resources Consultant	Consultant	

PAKISTAN

SINDH BARRAGES IMPROVEMENT PROJECT AF

TABLE OF CONTENT

I. BACKGROUND AND RATIONALE FOR ADDITIONAL FINANCING

1. This Project Paper seeks the approval of the Executive Directors to provide an additional financing (AF) in an amount of US$140.0 million equivalent to the Islamic Republic of Pakistan for a Sindh Barrages Improvement Project AF (P162117).

2. Pakistan, with an estimated population of over 207 million people, is the world's sixth most populous country. In recent years, it has achieved continued GDP growth and substantially reduced poverty. Provisional official estimates suggest that the GDP grew by 5.8 percent for FY17/18, up from 5.4 percent in FY16/17, and the government growth target for FY19 is 6.2 percent. Fiscal and external imbalances may, however, erode these gains in future if not addressed. The national poverty headcount declined from 64.3 percent in FY02 to 29.5 percent in FY14, however, inequality persists and the country continues to rank low on the human development index, at 147th out of 188 countries. The rehabilitation works will address some of the challenges faced by the country, in particular in the Province of Sindh.

3. The additional financing is sought to scale up activities under the original project, Sindh Barrages Improvement Project (SBIP, P131324), whose scope at present is limited to rehabilitating and modernizing Guddu Barrage. With the AF, the project will also support the rehabilitation and modernization of Sukkur Barrage, which has been identified as an urgent matter. The proposed AF will also support improving the operation and maintenance (O&M) of the three barrages over the Indus River in Sindh Province—Guddu, Sukkur and Kotri Barrages—through better coordination and monitoring. The total estimated amount of the additional finance required under the AF is US$152.2 million, which will be financed by the proposed AF (US$140.0 million) and incremental counterpart funds (US$12.2 million)[1].

4. Concurrent with the AF, the project would be restructured to (a) change the project development objective (PDO) to reflect the expanded scope of the project; (b) modify the results framework with the new project scope and objectives; (c) extend the closing date of the original project from December 22, 2020 to December 31, 2021, and set June 30, 2024 as the closing date of the proposed AF, to ensure completion of all activities and achievement of the PDO; (d) revise the implementation schedule; and (e) modify project components and costs.

5. *Current Project Description and Implementation.* The SBIP was approved by the Board on June 19, 2015, with the original credit of US$188 million equivalent. It became effective on November 5, 2015, and is scheduled to close on December 22, 2020. The PDO is *to improve the reliability and safety of the Guddu Barrage and strengthen the Sindh Irrigation Department's capacity to operate and manage the barrage*. The project reflects the importance of the Indus River to Sindh's economy. More than 90 percent of Sindh's agricultural production depends on irrigation from the Indus River, which is the only reliable and substantial source of water for the province. Without irrigation, agricultural production in most areas in the province will not be possible, because of the arid to semi-arid climate and low and variable rainfall. To manage water flow into the main canals, three barrages (in order from upstream to downstream), Guddu, Sukkur, and Kotri, were

[1] Total estimated cost for additional activities proposed under AF is US$172.2 million, of which US$20.0 million would be financed by the cost savings incurred by the original SBIP. Therefore, the proposed AF would finance the balance of US$152.2 million.

constructed in 1963, 1932 and 1958, respectively. This project finances the rehabilitation of the Guddu Barrage to prolong its design life. The project also supports the modernization of and improvements to the barrage operation and maintenance (O&M) of the barrages. The project is also aligned with the Bank's overall engagement in Sindh, which includes a scaled-up engagement in service delivery in Karachi.

6. As of March 31, 2018, implementation of the project is on track and all covenants are complied with. The Project Management Office (PMO), established in the Irrigation Department (ID) for execution of the project, is fully staffed and has adequate procurement and financial management capacity, and the civil works to rehabilitate and modernize Guddu Barrage are under implementation. The PMO is supported by the Project Coordination and Monitoring Unit (PCMU), which has been established under the Planning and Development Department of the Government of Sindh (GoSindh), to facilitate implementation of SBIP and another Bank-supported project, Water Sector Improvement Project (WSIP). The current ratings of SBIP are Moderately Satisfactory (MS) for both Development Objective (DO) and Implementation Progress (IP). The IP rating had been Moderately Unsatisfactory (MU) for four months in 2017 because of delays in procurement but was upgraded to MS in October 2017 following their resolution. Total disbursements as of March 31, 2018, were approximately US$25.0 million. However, commitments under the original project have exceeded US$130.0 million, mainly because of successful procurement of the two large civil works contracts for Guddu Barrage. In the meantime, savings of about US$20 million have materialized, as the actual costs of these two large contracts were lower than the appraisal estimate. The current ratings for procurement is MS, and financial management is Satisfactory (S). All audit reports are unqualified and current.

7. The project is in Category A in terms of social and environmental safeguards, and the current social and environmental safeguards performance ratings are S. The original project triggered the following safeguards policies: OP 4.01, *Environmental Assessment*; OP 4.04, *Natural Habitat*; OP 4.12, *Involuntary Resettlement*; OP 4.37, *Safety of Dams;* and OP 7.50, *Projects on International Waterways*.[2] The project is in compliance with its Environmental and Social Assessment (ESA) and the Resettlement Policy Framework (RPF), which are the site-specific safeguards instruments prepared for Guddu Barrage at appraisal.

8. *Rationale for Additional Financing.* In parallel to the rehabilitation works for Guddu Barrage, the GoSindh considered the need to modernize the current water management schemes in the lower Indus River and carried out a diagnostic analysis and feasibility study on the current status of Sukkur Barrage. The study was undertaken as part of the Bank-financed Water Sector Improvement Project Additional Financing (WSIP AF, P131325). Sukkur Barrage is one of the most important and strategic structures of the Indus basin irrigation system. Located about 170 kilometers downstream of Guddu Barrage, Sukkur Barrage supplies water to seven large canals on the left and right banks with total command area of approximately 3.2 million hectares whose annual agricultural production is worth about US$2.29 billion; thus, it is considered a lifeline for Sindh. The analysis revealed that Sukkur Barrage, which was constructed in 1932, needed rehabilitation and modernization, particularly related to its capacity for flood passage and diversion of adequate amounts of water to the seven irrigation canals.

[2] OP 7.50, *Projects on International Waterways*, was triggered, but an exception to notification was applied, because project investments primarily involved rehabilitating existing barrage facilities and had no impact on water use or the quality of water flows of the Indus River. The exception for the AF was approved by the RVP on January 30, 2018 and is available on project files.

9. According to the original design, Sukkur Barrage had a flood passage capacity of 1.5 million cusecs[3]. However, the right bank canals were drawing excessive silt and became unusable after a few years of operation; following a hydraulic model study conducted in 1938-41, the authorities decided to construct a silt excluder in the right bank canal and permanently close the 10 gates that were inoperable due to siltation. The design flood passage capacity was thus reduced to an estimated 0.9 million cusecs. Since then, there have been 11 flood events at Sukkur Barrage surpassing 0.9 million cusecs, six of which were more than 1.1 million cusecs. The largest flood, in 1976, was 1.2 million cusecs.

10. The passage of floods larger than the reduced design capacity of 0.9 million cusecs resulted in structural damage that required rehabilitation and repair works. The major repairs included reinforcement to concrete arches (1965), replacement of gates (1988), and emergency repair works in right pocket for damage to the barrage foundation in Spans No. 1 to 4 (2004). Subsequently, the WSIP AF-financed analysis confirmed the damage to the barrage structure. As part of the proposed rehabilitation and modernization works, mechanical and electrical work is needed to enable safer operation by raising the gates higher during large floods. The counterweight from gate hoisting should be removed to reduce deadweight and stress on the superstructure. Major dredging works should also be carried out to restore the flood capacity, which has been significantly reduced by the serious deposits of sediment. The analysis concluded that with these measures in place, the design flood passage capacity of the barrage would increase to 1.3 million cusecs, corresponding to a return period of nearly 100 years.

11. The flood events in 1976 and 2010 (1.14 million cusecs) caused breaches in the left and the right banks, respectively, between Guddu and Sukkur Barrages. These floods would have even been greater if the breaches had not happened. After 2010, the embankments of the Indus between the two barrages were strengthened and raised by approximately 1.2 meters, significantly reducing the risk of a breach. However, the embankment works has increased the risk that a flood surpassing 1.2 million cusecs will directly hit Sukkur Barrage causing the serious damages to the barrage and even operational failure, which would result in significant long-term impacts on the livelihoods of a large part of the population. The analysis carried out during preparation also suggested that opening at least 6 out of the 10 permanently closed barrage gates and modifying the river training works would allow better sediment control and passage of extremely large floods as high as 1.5 million cusecs, with the possible increase in height of a limited length of bund walls along the upstream Indus river to protect Sukkur and Rohri cities. In light of possible climate change impacts, the risk of such a large flood, or an even larger one, cannot be ignored in the long term; therefore, it is critical to secure resilience against large floods. The GoSindh Review Panel has decided that a more detailed physical model study at an international hydraulics laboratory, which would also cover the seven main canal intakes of Sukkur Barrage, and a more detailed flood hydrology assessment that covers climate change impacts, are required before implementing large-scale modifications in the existing river training works. This decision has been endorsed by the Panel of Experts (POE) for the proposed AF.

II. DESCRIPTION OF ADDITIONAL FINANCING

12. The original PDO will be refined to *strengthen the Sindh Irrigation Department's capacity to operate and manage barrages and improve the reliability and safety of Guddu and Sukkur Barrages in the Province of Sindh.* The proposed AF is to assist the ID in developing a coherent system to manage the three barrages as one

[3] Cusec: cubic feet per second. 1 cusec = 0.0028317 cubic meters per second

integrated system, in terms of water allocation, sediment management, and maintenance, and also to extend additional rehabilitation support to Sukkur Barrage. New activities under the proposed AF will include (a) rehabilitation and modernization of Sukkur Barrage, (b) support for the integrated O&M of the three barrages in Sindh Province, (c) critical studies to improve coordination and management of the three barrages, and (d) better management of the riverine habitats of the main Indus between Guddu and Sukkur Barrages. The PDO indicators and the results framework will be revised (as detailed in Section VIII). The Sukkur Barrage rehabilitation will be undertaken in two phases. The proposed AF will finance urgent rehabilitation and critical modernization works and technical studies (Phase 1), including detailed studies to prepare for Phase 2 (detailed in *Technical* section of Section IV). To ensure completion of Guddu Barrage rehabilitation and Phase 1 works for Sukkur Barrage, the proposed AF will have a closing date of June 30, 2024. The project components will be restructured as follows, including two new components (detailed in Annex 1).

Component A. Rehabilitation of Guddu and Sukkur Barrages (Original: US$ 195.0 million, Revised: US$302.9 million base cost). With the restructuring and the proposed AF, this component would support the rehabilitation of Sukkur Barrage as well as Guddu Barrage. Therefore, this component will have two sub-components: Component A-1: Rehabilitation of Guddu Barrage (US$168.0 million base cost), and Component A-2: Rehabilitation of Sukkur Barrage (US$134.9 million base cost). Works pertaining to Sukkur Barrage will include structural repairs, dredging, modernization of electro-mechanical works, and de-silting of the critical portions of the three right bank canals. The component will also support implementation of environment and social safeguards.

Component B. Improved Barrage Operation (Original: US$6.0 million, Revised: US$9.0 million base cost). Originally, this component was to provide technical assistance and equipment support to facilitate the O&M of Guddu Barrage. Under the proposed AF, the scope will be enlarged to include Sukkur Barrage. This component will support improved coordination among the three barrages in terms of monitoring and management. In particular, it will (a) refine the O&M and emergency preparedness plans for the Guddu and Sukkur Barrages, in coordination with Kotri Barrage; (b) support the Barrage Monitoring Unit (BMU) in developing an integrated system of measurement and monitoring of water extraction among the 14 main canals supported by the three barrages; (c) develop an O&M plan and an emergency preparedness plan for Kotri Barrage; and (d) provide critical equipment and logistics facilities for the three barrages.

Component C. Technical Studies. (proposed new component: US$6.5 million base cost). This new component will help deepen GoSindh's technical understanding of barrages and prepare for Phase 2. In particular, it will support (a) a preparation study for Phase 2 river training works, including (i) a study on climate change impacts, to assess the likelihood of a large flood and potential impacts on the barrages in determining the optimal design flood passage capacity and identifying several options considering social, environmental and economic aspects; (ii) a detailed hydraulics model study to determine the optimal design for the riverbank training and the need to raise the height of the bund wall, which would lead to the formulation of the follow-up works; and (iii) a feasibility study, environmental and social impacts assessment, and detailed design to prepare for Phase 2; (b) a safety assessment for Kotri Barrage, to include an inventory assessment; the identification of critical needs for repairs, rehabilitation, and upgrading; and the development of an O&M plan; and (c) the development of sediment transport monitoring and modeling, which will be the basis for improving barrage operations.

Component D. River Basin Water Resources and Riverine Management (proposed new component:

US$4.5 million base cost). The Social Action Plan, which was included in the original project under Component A, will be upgraded as a stand-alone component to sharpen the focus on the water-related environmental and social issues in the 170-km stretch of the Indus between Sukkur and Guddu Barrages, which also is a designated Ramsar site. In particular, this component will comprise activities supporting (a) dolphin management and conservation, (b) community fisheries co-management, (c) river bank rehabilitation, (d) sustainable agriculture, (e) technical studies (e.g., design for dolphin passage gates), (f) education and awareness-raising, and (g) water quality and pollutant studies. This component will be implemented in collaborations with the Sindh Environmental Protection Agency (SEPA), Forestry and Wildlife Department, Agriculture Department, and Fishery Department.

Component E. Project Management, Monitoring, and Evaluation (Original: US$7.0 million, Revised US$9.5 million base cost). In principle, the activities under this component remains the same, but the scope will be enlarged to support Sukkur Barrage rehabilitation. This component will support the incremental operating costs for maintaining the PMO and PCMU throughout the extended project implementation period, including technical assistance to guide the procurement activities and monitor the civil works progress; training; monitoring and evaluation of the project's results framework and overall project impacts, fiduciary and safeguard compliances; and annual external audit.

13. *Project Cost.* The revised costs, reflecting the changes in components and activities and the AF allocations, are outlined in the Table (overall project costs detailed in Table A1.1 in the Annex 1).

Table 1. Component Costs (US$ million)

	Original Project		*Additional Financing*		*Total Bank Financing: Original + AF*
Project Costs by Component	***Total Original Project Cost***	***Total Original Bank Financing***	***Total AF Project Cost***	***Total Bank AF***	
Component A. Rehabilitation of Guddu and Sukkur Barrages	195.0	175.0	107.9	99.3	274.3
Component B. Improved Barrage Operation	6.0	6.0	3.0	3.0	9.0
Component C. Technical Studies	-	-	6.5	6.5	6.5
Component D. Riverine Management	-	-	4.5	4.5	4.5
Component E. Project Management	7.0	7.0	2.5	1.6	8.6
Price and Physical Contingency	-	-	27.8	25.1	25.1
TOTAL	**208.0**	**188.0**	**152.2**	**140.0**	**328.0**

14. *Alignment with Higher Objectives.* The proposed AF is aligned with the World Bank's Country Partnership Strategy (CPS) FY15-20 and with the twin goals of ending extreme poverty and promoting shared prosperity. It supports Results Area II, Private Sector Development, specifically CPS Outcome 2.2, Increased Productivity in Farms in Selected Irrigation Schemes by providing stable water distribution and supporting sustainable agricultural production in the barrage command areas. The proposed AF is also aligned with the Government's Vision 2025 and supports the CPS cross-cutting themes, such as climate and resilience, governance, and gender. There is a strong development rationale for the public-sector support for the proposed AF. The Bank has experience supporting the design and implementation of similar programs, such as Punjab Barrages Improvement Project Phases 1 and 2 (P096745), which also built Punjab Irrigation Department's capacity in water resources and irrigation system management and rehabilitated Jinnah Barrage.

III. KEY RISKS

15. *Potential Risks and Mitigation.* The overall risk rating for the proposed AF project is Substantial, as was the risk rating for the original project. Key risks specific to the proposed AF project include political and governance, sector policies, institutional capacity, fiduciary, and social and environmental safeguards as summarized below.

- *Political and governance* risk: Elections in the first year of the program may slowdown decision making at the provincial government level, however this is not expected to impact the project which has broad political buy in, as rehabilitation of Sindh's barrages is a priority and is accorded high priority across political boundaries.

- *Sector Policies* risks are rated Substantial. Poor O&M and overall weak governance in water management are the key risks for the sustainability of the irrigation and water resources management sector. The Bank-financed WSIP is currently supporting the preparation of a draft Sindh Irrigation Management Strategy to address these risks and establish priorities. The proposed AF will also contribute to strengthening governance in water allocation by supporting the BMU in monitoring the outflows to all 14 main canals supported by the three barrages.

- *Institutional Capacity and Fiduciary Management* risks are Substantial, even though the PMO has been recently strengthened and am adequate number of staff has been recruited. Further mitigation measures under the proposed AF will include continued engagement of the PCMU, use of independent consultants to supervise works, and close monitoring and timely provision of implementation support by the Bank.

- *Environmental and Social* risks are also rated as Substantial, considering that the stretch of the Indus between Guddu and Sukkur Barrages is a sensitive and critical habitat of Indus blind dolphins and other species. To mitigate environmental risks, a site-specific environmental management plan, including dolphin monitoring and management activity, is being implemented under the original project. Additionally, a new component dedicated to supporting improved environmental and social management of the habitat (Component D) is proposed under the AF.

IV. APPRAISAL SUMMARY

A. Economic and Financial (if applicable) Analysis

16. The economic analysis for Sukkur Barrage rehabilitation uses an approach similar to that adopted for the Guddu Barrage rehabilitation at appraisal: analyzing a scenario based on avoiding losses in production due to deterioration of the barrage operation, which was highly likely if there were no project. The table below shows that the actual irrigation area had already been reduced from nominal 3.2 million hectares to 2.14 million hectares in year 2002. By 2005, the area was further reduced to 1.77 million hectares, where it has remained[4]

[4] This is the latest information that is officially available to the public.

(while there is no official information since 2010, reportedly the same areas have been maintained).

Table 2: Irrigated Area in the Command of Sukkur Barrage

Period	*Irrigated Area (million ha)*	*Change over Year*
2002	2.14	
2003	2.03	-5.5%
2004	2.03	0.0%
2005	1.77	-12.9%
2006	1.77	0.2%
2007	1.76	-0.7%
2008	1.77	0.5%
2009	1.77	0.0%

Source: Development Statistics of Sindh 2015, issued by Bureau of Statistics, Government of Sindh.

17. The economic analysis and the greenhouse gas (GHG) analysis for the proposed AF were carried out for with- and without-project scenarios. In the absence of official information since 2010, it is conservatively assumed that under the without project scenario the existing irrigated area of 1.77 million ha would be maintained. Under the proposed AF, the irrigated area will eventually be restored to pre-2002 level of 2.14 million ha. No change is considered in the present levels of agricultural production, cropping patterns, land use, yields, and cropping intensity, or in factors as inputs (seed, fertilizers, pesticides, or labor) over the period of analysis. Thus, the quantifiable benefits of the barrage rehabilitation would be the prevention of crop losses and would be the difference in the value of agricultural outputs under the with- and without-project scenarios. The non-quantifiable and intangible benefits would be preventing the failure of the barrage, which would affect the livelihoods and incomes of a large number of direct beneficiaries, as well as the domestic and cattle water supplies to about 1.1 million people.[5] These intangible benefits are not included in estimating the economic internal rate of return (EIRR). because they are difficult to quantify.

18. *GHG Emission Analysis.* To assess the impacts of the proposed AF, the GHG analysis was carried out using the Ex-Ante Carbon-balance Tool (EX-ACT). The analysis quantifies the net carbon balance—that is, GHGs emitted or sequestered—as a result of the project compared to the without-project scenario. As was noted in the previous paragraph, no change in farming practices is envisaged. Accordingly, the input parameters for the EX-ACT were estimated, and the net carbon addition after rehabilitating the barrage has been estimated as 98,790 tCO_2e over a period of 26 years. In addition, there would be about 1,338.5 tCO_2e per year during the 4-year construction period.[6] Thus the total amount of GHG emissions over 30 years is estimated as 100,128 tCO_2e. The analysis also reveals that per-year GHG emission from the project would be 335 tCO_2e during construction and about 3,800 tCO_2e per year after the construction period, so that the GHG emissions from the project would be only 0.00019 percent of Pakistan's total 2016 GHG emissions during construction, and 0.0018 percent after construction.[7] Therefore, it is concluded that the proposed AF would have no significant impact due to GHG emissions at the national or at the global level. Following 2014 World Bank guidance, the

[5] Source: North Sindh Urban Services Corporation.
[6] Feasibility Study Report by the consultants
[7] In 2016, Pakistan's GHG emission was 178,013.8 CO_2ket increased from 96,367.7 CO_2ket in 1997 growing at an average annual rate of 3.28 percent (Source .knomia – World Data 2017)

economic cost of GHG emission has been valued at a social value of carbon that is increasing over time in real value from US$30 per tCO2eq in 2015 to US$65 per tCO_2eq in 2040. The economic analysis has been done with and without inclusion of value of CO_2eq and valued at both lower and upper bonds.

19. *Results of Economic Analysis.* The analysis estimated the EIRR and net present value (NPV), taking into account capital investment, O&M, and project management costs; converting the financial cost to the economic values; and defraying costs over the project construction period of four years. In addition, a shadow price of the CO_2 was included as an opportunity cost in estimating EIRRs using two different prices The EIRRs under all the scenarios indicated that the investment planned under the proposed AF is economically feasible and justified. Sensitivity analysis also proved the EIRRs robust. It is also demonstrated that additional investment would prevent the catastrophic failure of the barrage as well as the continually decreasing reliability of irrigation deliveries to the seven canals. The sensitivity analyses show that the project economic benefits are resilient to cost increases, benefits reductions, and delay in realizing benefits, with the EIRR remaining above 6 percent and the economic NPV remaining affirmative. Thus the analysis clearly confirms that the proposed AF is of adequate economic viability.

20. Lastly, to confirm the viability of the proposed AF vis-à-vis the future need for dredging works, a sensitivity analysis was undertaken considering the periodic needs for major dredging (US$20 million). The EIRR would drop from 16.3 percent (base case) to 14.4 percent if such large dredging works were required every eight years (see row (b) in Table 3). Therefore, there is an economic rationale to carrying out dredging works, even if they have to be repeated periodically. It should be noted that the project would provide dredgers to enable the operator to undertake periodic dredging on its own.

Table 3: Summary of Results

Sr.	*Description*	*Without GHG Benefits*		*With GHG Benefits*				*Remarks*
		IRR %	*NPV US$ Million*	*Lower ($ 30/t)*		*Upper ($ 65/t)*		
				IRR %	*NPV US$ Million*	*IRR %*	*NPV US$ Million*	
(a)	**Base Case**	16.3	193.3	16.2	192.4	16.2	191.4	This scenario considers actual data and historical trends for the irrigated area for both the with- and without-project situations.
1	Costs increases by 10%	15.3	184.7	15.3	183.8	15.2	182.7	
2	Benefits decreases by 10%	15.1	163.3	15.0	162.4	15.0	161.3	
3	Simultaneous increase in costs and decrease in benefits by 10%	14.1	154.6	14.1	153.7	14.1	152.7	
4	Benefits delay by 2 years	14.3	168.5	14.3	168.5	14.3	168.5	
(b)	**Cost Including for Dredging**	14.4	161.0	14.3	160.1	14.3	159.1	This scenario considers investment for
1	Costs increases by 10%	14.1	169.9	14.0	169.0	14.0	167.9	
2	Benefits decreases by 10%	13.1	131.0	13.1	130.1	13.1	129.0	

3	Simultaneous increase in costs and decrease in benefits by 10%	13.0	139.8	12.9	138.9	12.9	137.9	dredging, which would maintain the water depth and flow in the canals, and thus would also maintain the level of intensity and yields.
4	Benefits delay by 2 years	12.6	140.2	12.6	140.2	12.6	140.2	

Note: NPV has been estimated at 6 percent discount rate.

B. Technical

21. The following technical aspects were considered before finalizing the project scope of the proposed AF:

- *Construction of a new barrage.* Construction of a new barrage to replace Sukkur Barrage was considered but rejected, mainly because of the underlying soundness of the existing structure, including its foundations. While the barrage was constructed nearly 90 years ago, its overall condition is considered safe with the rehabilitation and safety improvement works to be undertaken under the project. The design flood passage capacity would be increased to 1.3 million cusecs, corresponding to a return period of nearly 100 years. In the future, the capacity could be further increased through additional riverbank training works. However, constructing a new barrage will most likely encounter technical, social, and environmental difficulties, including significant resettlement, as preliminary studies indicate that the alignment of the new intake and canals would likely go through existing cities.

- *Adopting a two-phased approach.* An extensive review by GoSindh and the Bank to determine the scope of support for Sukkur Barrage concluded that the support should be carried out in two phases. The proposed AF will support Phase 1, including detailed preparation works for Phase 2 works. Having recognized the importance of secure resilience against a possible large flood, GoSindh is committed to carry out the Phase 2 works with external financing and/or its own funds.

  - Phase 1 will focus on the critical and essential rehabilitation and modernization of the barrage superstructure damaged by past flood events, to increase the barrage's design flood passage capacity to 1.3 million cusecs without causing damage or disruption to irrigation services through the seven canals. The proposed works will include (a) critical structural rehabilitation and safety improvement works, (b) critical dredging and support for improved sediment management, and (c) essential modernization of electromechanical works and instrumentation modernization. In addition, in conjunction with the dredging works a detailed investigation will be carried out to examine any needs for additional support for the foundation of the 66 piers (Component A).

  - During Phase 1, preparation works will be carried out for Phase 2 under Component C. The works will include (a) a climate change study to assess the likelihood of a large flood of 1.5 million cusecs or greater in light of climate change, investigate the impacts of such a flood on Sukkur Barrage and

upstream bunds through both physical and numeric hydraulic modeling, and determine the design flood passage capacity; (b) a detailed physical model to determine optimal designs for river bank training works to be carried out in Phase 2 and to examine the need to raise the bund wall to protect Sukkur and Rohri Cities; and (c) a feasibility study for Phase 2 work, including detailed design and social and environment impact assessment, with particular attention to social impacts, including resettlement and land appropriation needed for the Phase 2 civil works.

- Phase 2 would support the implementation of river training works to increase the design flood passage capacity according to the climate change impact study (Component C) and improve sediment management on the right pocket that would be identified and prepared during Phase 1 (see below, *Detailed hydraulic model study for determining optimal shape of the riverbank training*). If found to be necessary, works to raise the bund wall would also be carried out. A preliminary estimate of the Phase 2 work costs is in the range of US$100-150 million.

- *Scope of physical works.* During the extensive technical review jointly conducted by GoSindh and the Bank during the preparation period, the scope of the proposed rehabilitation and modernization works under the proposed AF was duly determined, particularly by (a) rationalizing the dredging, considering the anticipated long-term impacts taking the underlying river morphology into consideration; (b) including de-silting in the critical areas in the right bank canals to maximize the project impacts; (c) including contingency for foundation repairs that could be found at inspection during implementation; (d) adopting the modernized gate structure that would eliminate counterweights to enable greater clearance and reduced stress to superstructure; and (e) sequencing phased activities in view of overall barrage safety and sustainability, by focusing on flood passage capacity and climate change.

- *Detailed hydraulic model study for determining optimal shape of the riverbank training.* It is apparent that the reduced flood passage capacity is a result of the permanent closure of the 10 gates. During preparation, a physical hydraulic model study was conducted in Hyderabad, Pakistan, to determine shapes of riverbank training that would increase flood passage capacity and reduce the sediment deposit by keeping some gates permanently open. The review concluded that an additional detailed hydraulic model study would be necessary, with the physical model including irrigation canal intakes. During some parts of the year, because of the river flow, more sediments accumulate on the left bank than on the right; however, the deposit of sediment in the left pocket is much less than that in the right pocket. This is most likely because the left bank canals are steeper than the right bank canals. Therefore, it has been decided that a detailed physical hydraulic model incorporating the canal intakes is needed to determine the optimal shape.

- *Dredging works.* The project technical review also concluded that the immediate dredging of the critical parts, particularly excavation of a large accumulated deposit in the area adjacent to the left bank, and dredging at both right and left pockets, would be required, along with provision of dredgers and support for an improved sediment management plan to reduce the frequency of extensive dredging in the future. The proposed dredging works would have only a temporary effect for an estimated period of 8-10 years, considering the magnitude of the sediment load in the Indus. However, the economic viability of the dredging works has been confirmed by the economic analysis described in the section above. Sediment monitoring and modeling would also be supported under Component C to deepen the understanding of the sediment issue in the Indus and help develop an operational plan that takes the

sediment aspects into account. Moreover, the project would provide dredgers for the operator to undertake periodic dredging work as part of regular O&M works.

- *Barrages management.* At the appraisal of the original project, the ID planned to establish a unit called Barrage Management Organization to operate, manage, and carry out maintenance works for all the three barrages. However, during implementation of the project, the ID decided instead to establish a Barrage Monitoring Unit (BMU) to monitor and supervise the operation of all three barrages and their outflows to the 14 main irrigation canals while each barrage would continue its day-to-day O&M. This change is because of the physical distances between the three barrages, and it provides a clear designation of accountability to the resident chief engineers. This arrangement is also in line with the overall direction of the reorganization of the ID to segregate the functions of policy, monitoring, and regulation from physical maintenance works. The ID established the BMU in April 2018. On the basis of this decision, the proposed AF will extend the support for the management of the three barrages to address the following issues: (a) need for an integrated management of the three barrages as one system; (b) need for a reliable and real-time monitoring system to measure inflows to the main canals; (c) management without understanding the dynamics and diversifying demands for water in light of urbanization and economic development in Sindh; and (d) sediment management. In particular, Component B was designed to support the physical establishment of the BMU and a monitoring system in Sukkur to oversee the management of the three barrages. The component will also help the BMU to develop a plan and procedures for O&M of the barrages, including a safety assessment of Kotri Barrage (Component C).

C. Financial Management

22. The proposed AF will require changes to the FM and disbursement arrangements. A separate designated account (DA) in US$ will be established for the proposed AF at the National Bank of Pakistan in Karachi. The account will be managed by the PMO and will be operated in accordance with the Revised Foreign Aid Assignment Account procedures, 2013, issued by the Finance Division and adopted by GoSindh. According to the revised procedures, all payments except for authorized petty cash will be notified in writing by the Project Director to the relevant branch of the National Bank of Pakistan, and will be made directly to the recipient through cross-checks. The ceiling for advances to the DA will be based on forecasts for two quarters of expenditures, and all disbursement methods (including advance, reimbursement, direct payment, and special commitment) will be available to the AF. IDA disbursements will be based on Interim Financial Reports (IFRs). The format and content of the IFR under the original financing will continue to be used under the AF.

23. The current FM arrangements and performance to date are satisfactory. FM is managed by a team composed of an FM manager and an accounting officer. With the anticipated increase in the amount of FM work, an additional account officer will be recruited. The project is currently using the Government Financial Management Information System, and the project financial information is reflected in the country system on a real-time basis. The project has no overdue project IFRs or audit reports, nor does it have any ineligible expenditures. The annual audit of the project is conducted by the Auditor General of Pakistan. The audited financial statements of the project for financial year 2016-17 were received and found acceptable by the Bank.

24. IDA financing for the proposed AF will remain at 90 percent of the civil works and 10 percent of the

goods, incremental operating costs, and consultants' fees.

D. Procurement

25. The procurements will be conducted following the World Bank Procurement Regulations for IPF Borrowers, dated July 2016 and revised in November 2017. Under the proposed AF, two works contracts and one major goods contract (dredgers) will be procured by the PMO. Other goods contracts will be identified as the project is implemented. The contract for the consulting firm that was competitively selected for the barrage design has a provision that upon successful completion of design services, the supervision component will be initiated on the basis of the provided cost parameters. The contract will then be negotiated with the design firm and finalized for the supervision component. Other consultancies to be acquired by the PMO will include studies related to river training works, climate change, and the Kotri Barrage safety assessment. Table 4 summarizes major procurements and their arrangements under the proposed AF. The PMO will continue with the procurement capacity of the original project and may hire an additional staff after six months for procurement support. The PCMU will oversee overall implementation. The procurement manual has been updated to document the roles and responsibilities of the PMO and PCMU. The Project Procurement Strategy for Development provides the procurement outlays of the identified contracts. With all these measures, the procurement risk rating remains Substantial, given the complex nature and size of the procurement package.

Table 4. Procurement Arrangements

SN	*Contract title*	*Estimated cost and risk rating*	*Bank oversight*	*Procurement approach*	*Selection method*	*Evaluation method*
1	Rehabilitation of Superstructure and Instrumentation and modernization of gate supporting structures	US$78 m Substantial	Prior	International	Pre-qualification ICB RFB	Lowest evaluated cost
2	Dredging	US$36 m Substantial	Prior	International	Pre-qualification ICB RFB	Lowest evaluated cost
3	Contract Management and Construction Supervision	US$9 m Low	Prior	International	QCBS (already signed for design component)	Negotiations on the signed contract, for the supervision component
4	Monitoring and Evaluation Consultancy	US$0.3 m Moderate	Post	National	CQS	Negotiated cost

5	Consultancy for Climate Change: Phase 2 Preparation Study	US$4 m Substantial	Prior	International	QCBS	Rated criteria
6	Safety Assessment on Kotri Barrage	US$0.5 m Substantial	Prior	International	QCBS	Rated criteria
7	Sediment Transport Modelling	US$0.3 m Moderate	Post	National	CQS	Negotiated cost
8	Dredger	US$1.5 m Substantial	Prior	International	ICB RFB	Lowest evaluated cost

E. Social (including Safeguards)

26. *Safeguards performance under SBIP.* The original project triggered OP/BP 4.12, *Involuntary Resettlement*. A Resettlement Policy Framework (RPF) was prepared as a part of the Social Management Framework (SMF). Also as part of the SMF, a communication strategy was prepared to set out strategic principles to reach out to different stakeholders (e.g., concerned communities in project and command areas, government officials, and local nongovernmental organizations), as well as internal communication to disseminate information about project implementation and obtain feedback from different stakeholders in a timely and coherent manner. The social safeguards performance has been satisfactory. A Resettlement Action Plan (RAP) was prepared according to the original RPF under ongoing river training works for Guddu Barrage. Sixteen households are being relocated, and the PMO is preparing for compensation payment for these households. No other negative social impacts have so far been observed.

27. *Safeguards policies under the proposed AF.* OP/BP 4.12 also applies to the proposed AF. However, no physical relocation is envisaged for the Sukkur Barrage works. The major impacts of the proposed AF will, therefore, be limited to land appropriation (both permanent and temporary) because of the dredging, limited access to farmlands, and temporary closure of the roads due to civil works. The barrage has a middle bank island as a part of the right bank silt excluder and two upstream shoals—the outer bank *bela* (shoal in local language) and left bank *bela*. These three areas consist of about 170 acres and are cultivated by encroachers. Also, five households reside on the middle bank island. Dredging will remove a small portion of the left bank *bela* (about 6 acres), where there is no ongoing cultivation. There also will be no impact on encroachers in the middle bank island or the outer bank *bela*, as dredging will be carried out around the island. During civil works, the PMO will ensure their privacy and safe access to the island or outer bank *bela*. In the right bank canals, about 300 households encroach on the embankments. The canal de-silting has limited impacts on these households, as it will be undertaken during regular canal closure and will thus be confined within the canals. The proposed AF will also support construction of public buildings, which will be built on land that belongs to, or will be acquired by, the Government. As a matter of principle, any government land/public land acquired should be free of squatters, competing claims, and other encumbrances. Mitigation measures and a compensation framework have been described in the AF Environment and Social Assessment (ESA) and the updated SBIP RPF/SMF. The communication strategy has also been updated in light of the proposed new component (Component D) to engage stakeholders directly for various livelihood support activities. During project implementation, site-specific RAPs will be prepared as appropriate and necessary. The PMO has a

dedicated team for safeguards (safeguards implementation arrangements are detailed under the *Environment* section below).

28. Although the social impacts under the proposed AF are limited, more significant impacts are envisaged under Phase 2 works, which mainly involve river bank training works and possibly reinforcement of the bund walls. In determining the final design, the social impacts, particularly resettlement, will be considered as an important factor in addition to the hydrological aspects. Further, a detailed environmental and social impacts assessment will be carried out as part of the preparation for Phase 2 works (Component C). The Bank will review and clear the terms of reference (TOR) before the commencement of the assessment, and will review and approve the final draft assessment.

29. *Citizen Engagement.* The proposed AF will promote citizen engagement on two fronts.

- *Proactive engagement of beneficiaries under Component D.* Furthermore, the PMO will engage beneficiaries in designing and implementing activities under Component D, which will support the concerned communities in carrying out training on fisheries and agriculture practices to improve the management of the riverine habitat; all activities related to fisheries and agriculture will be designed and implemented jointly with the concerned communities. The proposed AF will continue to measure the percentage of grievances registered and addressed at the project level (intermediate indicator).

- *Grievance redress mechanism (GRM).* Under the original project, the PMO developed a project-level GRM with two tracks: Community GRM (CGRM) to address complaints related to project implementation, including social and environment safeguards, and Procurement GRM (PGRM) to specifically address procurement-related complaints. Under the proposed AF, CGRM will continue to operate at the project level for all components. With the Sukkur Barrage rehabilitation ESA and the updated SMF, CGRM will also be strengthened, in particular, reaching out to women and tail-end farmers in the project and the command areas through regular consultations. Modes of outreach, which are stipulated in the updated SBIP communication strategy, include (a) pre-consultation with stakeholders and contractors to present the Environmental Code of Practice and construction plans; (b) in-depth monitoring and proactive consultation among communities that may be affected during construction; and (c) periodic consultation meetings to obtain feedback from Area Water Boards and Farmers' Organizations (FOs), which manage the main and distributary canals across the 14 main canals.

30. *Gender.* Following the Communication Strategy, the proposed AF envisages engaging female stakeholders in the project activities, particularly through (a) improving access to the project CGRM to file complaints, (b) providing training and obtaining feedback from the female focal groups established at the FOs within the command areas, and (c) encouraging participation in the sustainable agriculture and fisheries activities under Component D as detailed below.

- *Gender analysis in the project and the command areas.* In developing and updating safeguard instruments for the proposed AF, the PMO conducted consultations with women in the project and the command areas of Sukkur Barrage and analyzed potential project-related gaps between men and women. The gender analysis found that women were engaged in more than 50 percent of agriculture and livestock activities. Even in the fishing communities between Guddu and Sukkur Barrages, women

are in general not involved in fisheries but are engaged in agriculture activities, as other job opportunities are limited. Despite of their engagement, women have limited participation in decision-making related to agriculture. Also, compared to men in the project areas, women had lower literacy, limited mobility, and less access to the internet or mobile phones.[8] The analysis also found that women did not have adequate information on overall water management issues and had no venue in which to raise concerns about irrigation water delivery.

- *Improving women's access to CGRM.* Women's limited mobility or access to communication means makes it difficult to access the project's CGRM to express concerns and file complaints. The proposed AF will facilitate women's participation in the CGRM through continued consultations. The PMO has already recruited a female communication officer to ensure proactive outreach to women in the project area, particularly on issues related to resettlement, access, privacy, noise, and water and air pollution during civil works.

- *Providing training to and obtaining feedback from female stakeholders.* In command areas, most women are not FO members, thus, they do not participate in FO meetings to obtain information related to water management and delivery. To address these issues, the female communication officer will also engage women in the command areas by organizing women-only meetings to provide such information and obtain their concerns and feedback related to water availability. Further, in collaboration with local nongovernmental organizations and Sindh Irrigation and Drainage Authorities, the PCMU will also provide training on water management for female stakeholders. Focused engagement and training with these women will continue throughout project implementation, and the outcomes of the meetings will be published on the project website.

- *Promoting the participation of female stakeholders in riverine management.* Under Component D, special attention will be given to women in the fishing communities to strengthen their knowledge through assessing their current practices of agro-chemical use and providing training on best practices to minimize the impacts on women, children, and the environment. The women will also be encouraged to participate in training on aquaculture and nursery to explore new livelihood opportunities.

- *Monitoring and Evaluation.* The proposed AF will monitor women's participation through two intermediate indicators: (a) number of women who participated in water management consultations and training, and (b) number of participants in the riverine management program (% of which female).

31. *Labor.* The proposed AF project will require on average about 200 laborers per day, while the peak time requirement is estimated at 350. Unskilled workers (up to 65 percent of total requirements) will be mainly hired locally. About 40 to 60 skilled laborers will be brought in by contractors and will stay at contractors' colonies in suburban areas near Sukkur City. Therefore, the footprint will be small. These laborers will be trained in cultural sensitivity and community relations, according to the Environmental Code of Practice.

[8] According to the social assessment, women are responsible for about 65 percent of farm/crop activities and 50 percent of livestock rearing in the command area. However, their participation in decision-making in these activities is limited—about 3 percent and 13 percent, respectively. Women's literacy rate is about 30 percent lower than men's.

F. Environment (including Safeguards)

32. *Safeguards Performance under SBIP.* The PMO has a dedicated team for safeguards, and the GRM mechanism and procedures are functioning satisfactorily. No major negative environmental impacts have so far been observed.

33. *Safeguards Policies under the Proposed AF.* All Bank safeguard policies triggered by the SBIP and its environmental Category A rating will also apply to the proposed AF. The policies triggered by the proposed AF are summarized below.

- **OP/BP 4.01, *Environmental Assessment*.** The original operation was classified as Category A because of the major rehabilitation works on Guddu Barrage and potential impacts on the core habitat of the endangered Indus River dolphin, located immediately downstream of Guddu Barrage. The AF operation is in the same environmental Category. The proposed AF activities involve civil and mechanical rehabilitation works of the existing Sukkur Barrage on Indus River, with a potential to affect water quality and upstream dolphin habitat. To identify the impacts and put appropriate management measures in place, an ESA, including a Cumulative Impact Assessment, was conducted, and an Environmental and Social Management Plan was prepared as a part of the ESA to minimize and mitigate all potential adverse environmental and social impacts. The ESA was reviewed and cleared by the Regional Safeguard Adviser and disclosed in January 2018. Preliminary TORs for the four studies to be carried out under Component C contain adequate provisions for environmental and social safeguards aspects. The final TORs for these studies are subject to the Bank's review and clearance before the work begins.

- **OP 4.04, *Natural Habitats*.** This policy was triggered because the stretch of the Indus between Guddu and Sukkur Barrages is the protected area reserved for the endangered Indus blind dolphin (*Platanista gangetica minor*) and is a designated Ramsar site. The planned activities under the proposed AF project, together with ongoing activity to rehabilitate Guddu Barrage would potentially have adverse effects on the dolphins that would add to such existing threats as reduction of prey base through the use of small-sized mesh nets; poaching for their oil for traditional medicines; entanglement in fishing nets; stranding and mortality in the irrigation canals of Sukkur Barrage; and pollution in the river from domestic, agricultural, and industrial waters. The ESA indicated that neither significant conversion of critical natural habitat nor degradation of natural habitats is envisaged by the project. An Environmental Code of Practice for Dolphins Management from Construction Impacts was proposed as a key measure to mitigate the site-specific impacts of Sukkur Barrage rehabilitation. Under the original SBIP, as a part of the mitigation measures stipulated in the ESA, the Wildlife Department is implementing dolphin monitoring and management activities, including studies on the environmental flow from the two barrages and the design of fish ladders. Under the proposed AF project, this initiative will be scaled up to help GoSindh take the first comprehensive step to improve the conservation and management of the riverine habitats of this Indus stretch under Component D (refer Annex 1).

- **OP/BP 4.37, *Safety of Dams*.** This policy was triggered under the original SBIP, because of the nature of the project and because a barrage of this size falls into the category of a large dam. According to OP/BP 4.37, for work on existing dams, one or more independent dam specialists are required to (a) inspect and evaluate the safety, appurtenances, and performance history; (b) review and evaluate the operation

and maintenance procedures of the dam owner; and (c) provide a written report of findings and recommendations for any remedial work or safety-related measures necessary to upgrade the existing dam to an acceptable standard of safety. For high-hazard cases involving significant and complex remedial work, the Bank also requires that a panel of independent experts be employed on the same basis as for a new dam. To comply with this policy, GoSindh established a panel of experts (PoE) comprising four members (sediment, structure, hydrology, and electromechanics specialists), who reviewed and cleared the feasibility study for the Sukkur Barrage rehabilitation. The construction supervision and quality assurance arrangements are already in place, as the consulting firm engaged in the feasibility studies will be retained for detailed design and construction supervision/quality assistance. An instrumentation plan will be developed during the first year of implementation and will be sent to the Bank for review and no-objection. A draft O&M plan and emergency preparedness plan were prepared during preparation. These plans will be refined to include a clear coordination mechanism with Kotri and Guddu Barrages and will be finalized after incorporating feedback from stakeholders through consultation workshops.

- **OP/BP 7.50, *Projects on International Waterways*.** The policy is triggered because Guddu and Sukkur Barrages are on the Indus River, which is an international waterway as defined in OP 7.50. Like the original SBIP, the proposed AF project will carry out rehabilitation and modernization works without increasing the scope of the original works or increasing the command area. Therefore, an exception to the notification requirement stipulated in paragraph 8 of OP 7.50 was approved by the Regional Vice President on January 30, 2018.

34. *GHG Emission Analysis.* To assess the impacts of the proposed AF project, the GHG analysis was carried out using the Ex-Ante Carbon-balance Tool (EX-ACT). SBIP concerns only the rehabilitation of the existing barrages and mainly involves rehabilitation works. Farming is already carried out in the command areas, and the project will help farmers maintain the present level of yield and intensity, which otherwise would diminish. Therefore, the AF project would not lead to a major increase in fertilizer or pesticide applications. However, with project conditions, it is assumed that 50 percent of project farmers would use a little more fertilizer and pesticides to improve yields because they would have assured, timely, and adequate water supply for irrigated agriculture. The net carbon addition over a period of 25 years is estimated at 162,220 tCO_2e (approximately 7,613 tCO_2e per year).

35. *Update on the Institutional Framework and Instruments for Safeguards.* The PMO will continue to be responsible for safeguards compliance under the proposed AF. There are dedicated environment and social safeguards staff for the original project. With the proposed AF, the PMO will set up an environment and social unit, headed by a director who will be responsible for compliance with overall safeguards measures. The PCMU will also support overall safeguards compliance. The Wildlife Department, with its expertise and long experience as the competent authority, will carry out activities related to dolphin monitoring and rescue, a measure specified under the ESA. A memorandum of understanding has been signed between the Wildlife Department and the ID. The team of experts who assisted GoSindh in preparing ESAs for both Guddu and Sukkur Barrages will be retained to monitor overall safeguard compliance throughout the implementation period. The environment and social unit will also be responsible for the implementation of Component D (River Basin Water Resources and Riverine Management). The unit will hire an ecologist, who will support day-to-day implementation.

36. *Climate Change: Vulnerability Assessment.* A key dimension of vulnerability in South Asia is associated with increased exposure to climatic and hydrological hazards, including storms, floods, and droughts. Through increased flood and drought risks, it is likely that climate change will have a serious adverse impact on Pakistan, which ranks 7th in terms of climate risk, and continues to be one of the most flood and drought prone countries in the South Asia Region. Within Pakistan, Sindh province, located in most downstream parts of the Indus river basin, is most vulnerable. Sindh is almost exclusively dependent on surface water inflows and already faces serious pressures, both in terms of water quantity (floods and droughts) but also water quality. In 2010, when the most serious flood hit Pakistan, and lower Sindh, including Sukkur, experienced serious damages; more than 400 people were killed and about 2.5 million people required emergency relief.

37. Climate change is expected to exacerbate the frequency and severity of flood and drought and would pose even more serious threat to Sindh. Coupled with on-going and future upstream developments and projected population growth, climate change will also likely result in increased drought risks which could trigger increased water and livelihood insecurity through loss of agriculture productions, which depends on irrigation from the three barrages in Sindh. Under such contexts, Guddu and Sukkur Barrages would play even a more vital role to increase resilience against floods, while ensuring adequate supply of water under changing supply scenarios. The barrages are in need of repair, rehabilitation and modernization to eliminate the risk of operational and structural failure, and increase their operational efficiency, and such actions are imminently required.

38. The proposed AF will contribute to increased climate change resilience. It intends to support both structural and non-structural measures to increase resilience against more intense and frequent flood and drought events anticipated under climate change scenarios, and a preliminary assessment by the Bank's Climate Change Group has assessed climate co-benefits to be 94 percent of the project financing. In particular, the proposed AF would first aim at increasing the design flood passage capacity of Sukkur Barrage from 0.9 million cusecs to 1.3 million cusecs, reducing the risk that the barrage or upstream bunds might fail resulting in suspension of water delivery to the seven main canals covering about 3.2 million hectares. Further, the proposed AF will also help improve operation and maintenance of the barrages thus increasing the sustainability of the barrages. Furthermore, through a series of technical studies, the proposed AF would also deepen the GoSindh's understanding on the likelihood of large floods in the lower Indus areas and potential impacts of such floods on the barrages, while also developing mitigation measures to reduce the risk of damage and failure.

39. In support of climate change adaptation, Components A will physically improve the barrages' structures and facilities whereas Component C will support the ID to improve its operational capacity of the barrages. Further Component C will support critical studies that are directly related to climate change. Component E, which aims at improving the management of the 170 kilometer stretch between Guddu and Sukkur Barrages would also contribute towards ecosystem-based adaptation, as the stretch is a designated Ramsar site containing a few endangered species, and environmental degradation may likely exacerbate under anticipated impacts of climate change, as the hydrology changes and resulting impact on the eco-system and the services they provide. Early during project preparation, a climate change screening assessment determined that the risks associated with climate change for this project are medium to low.

40. *Consultation and Disclosure.* The design consultant conducted extensive initial consultations on the Sukkur ESA in 2012-14 with communities in the project and command areas, governmental organizations, and

the POE. Additional consultations were held in Sukkur, Kotri (downstream), and Karachi in August and November 2017 by the independent EA experts, who provided the scope of the proposed AF, anticipated social and environmental impacts, and a summary of the safeguards measures. The consultations confirmed broad support by stakeholders, and consequently the ESA has been updated, taking into account key points made during the consultations. The updated ESA (English, Urdu, and Sindhi versions) was disclosed at the PCMU and PMO head offices in Karachi and the PMO's field office in Sukkur, as well as its site office in Guddu, on January 3, 2018, and on the Bank's external website on January 17, 2018. The Integrated Safeguards Data Sheet was also sent to the Bank's external website on March 28, 2018, for disclosure.

G. Other Safeguard Policies (if applicable)

41. None triggered.

H. Readiness for Implementation

42. The proposed AF is ready for implementation. The institutional arrangements covering implementation, coordination, and oversight are already in place and functional, as the original project is being implemented. A procurement plan for the first 18 months has been prepared and found satisfactory to the Bank, indicating that the procurement of civil works, goods, and technical assistance totaling more than US$120 million will commence during the first year. Further, the consulting firm engaged in preparing the feasibility study is currently finalizing the detailed design and procurement documents and expects to complete them in late May 2018. Upon satisfactory completion of these documents, the firm would continue to be engaged for supervision of the civil works once the proposed AF is approved.

V. WORLD BANK GRIEVANCE REDRESS

43. Communities and individuals who believe that they are adversely affected by a World Bank (WB) supported project may submit complaints to existing project-level grievance redress mechanisms or the WB's Grievance Redress Service (GRS). The GRS ensures that complaints received are promptly reviewed in order to address project-related concerns. Project affected communities and individuals may submit their complaint to the WB's independent Inspection Panel which determines whether harm occurred, or could occur, as a result of WB non-compliance with its policies and procedures. Complaints may be submitted at any time after concerns have been brought directly to the World Bank's attention, and Bank Management has been given an opportunity to respond. For information on how to submit complaints to the World Bank's corporate Grievance Redress Service (GRS), please visit *http://www.worldbank.org/en/projects-operations/products-and-services/grievance-redress-service*. For information on how to submit complaints to the World Bank Inspection Panel, please visit *www.inspectionpanel.org*

VI. SUMMARY TABLE OF CHANGES

	Changed	Not Changed
Change in Project's Development Objectives	✓	
Change in Results Framework	✓	
Change in Components and Cost	✓	
Change in Loan Closing Date(s)	✓	
Change in Disbursements Arrangements	✓	
Change in Implementing Agency		✓
Cancellations Proposed		✓
Reallocation between Disbursement Categories		✓
Change in Safeguard Policies Triggered		✓
Change of EA category		✓
Change in Legal Covenants		✓
Change in Institutional Arrangements		✓
Change in Financial Management		✓
Change in Procurement		✓
Other Change(s)		✓

VII. DETAILED CHANGE(S)

PROJECT DEVELOPMENT OBJECTIVE

Current PDO

The project development objectives are to improve the reliability and safety of the Guddu barrage and strengthen the Sindh Irrigation Department's capacity to operate and manage the barrage.

Proposed New PDO

The PDO will be revised to strengthen the Sindh Irrigation Department's capacity to operate and manage barrages and improve the reliability and safety of Guddu and Sukkur Barrages in the Province of Sindh.

RESULTS FRAMEWORK

Project Development Objective Indicators

Reliable supply of water into the 10 main canals supported by Guddu and Sukkur Barrages
Unit of Measure: Cubic Meter(m3)
Indicator Type: Custom

	Baseline	Actual (Current)	End Target	Action
Value	39.70	39.70	43.70	Revised
Date	26-Mar-2015	22-Nov-2017	30-Jun-2024	

Barrage Monitoring Unit functional
Unit of Measure: Yes/No
Indicator Type: Custom

	Baseline	Actual (Current)	End Target	Action
Value	No	No	Yes	Revised
Date	26-Mar-2015	05-May-2017	30-Jun-2024	

Direct project beneficiaries
Unit of Measure: Number
Indicator Type: Custom

	Baseline	Actual (Current)	End Target	Action
Value	0.00	0.00	2.60	Marked for Deletion
Date	26-Mar-2015	15-May-2017	22-Dec-2020	

Female beneficiaries
Unit of Measure: Number
Indicator Type: Custom Supplement

	Baseline	Actual (Current)	End Target	Action
Value	0.00	0.00	2,700,000.00	Marked for Deletion

The three barrages operated under improved O&M plans
Unit of Measure: Number
Indicator Type: Custom

	Baseline	Actual (Current)	End Target	Action
Value	0.00	0.00	3.00	Revised
Date	20-Apr-2015	22-Nov-2017	30-Jun-2024	

Increased design flood passage capacity for Guddu Barrage (cusec)
Unit of Measure: Number
Indicator Type: Custom

	Baseline	Actual (Current)	End Target	Action
Value	900,000.00	900,000.00	1,300,000.00	Revised
Date	20-Apr-2015	22-Nov-2017	30-Jun-2024	

Increased design flood passage capacity for Sukkur Barrage (cusec)
Unit of Measure: Number
Indicator Type: Custom

	Baseline	Actual (Current)	End Target	Action
Value	900,000.00	900,000.00	1,300,000.00	New
Date	01-Feb-2018	31-Mar-2018	30-Jun-2024	

Intermediate Indicators

Main barrage gates and mechanical lifting equipment replaced
Unit of Measure: Number
Indicator Type: Custom

	Baseline	Actual (Current)	End Target	Action
Value	0.00	0.00	65.00	Marked for Deletion
Date	26-Mar-2015	15-May-2017	22-Dec-2020	

Main canal head regulator gates replaced
Unit of Measure: Number
Indicator Type: Custom

	Baseline	Actual (Current)	End Target	Action
Value	0.00	0.00	25.00	Marked for Deletion
Date	26-Mar-2015	15-May-2017	22-Dec-2020	

Improved Habitat Management between Guddu and Sukkur Barrages satisfactorily implemented
Unit of Measure: Yes/No
Indicator Type: Custom

	Baseline	Actual (Current)	End Target	Action
Value	No	No	Yes	Revised
Date	26-Mar-2015	22-Nov-2017	30-Jun-2024	

Dolphin Conservation and Management Plan satisfactory implemented
Unit of Measure: Yes/No
Indicator Type: Custom

	Baseline	Actual (Current)	End Target	Action
Value	No	No	Yes	Marked for Deletion
Date	26-Mar-2015	15-May-2017	22-Dec-2020	

Grievances registered related to delivery of project benefits addressed (%)
Unit of Measure: Percentage
Indicator Type: Custom

	Baseline	Actual (Current)	End Target	Action
Value	0.00	100.00	90.00	Revised
Date	26-Mar-2015	22-Nov-2017	30-Jun-2024	

Grievances related to delivery of project benefits that are addressed-(number)
Unit of Measure: Number
Indicator Type: Custom Supplement

	Baseline	Actual (Current)	End Target	Action
Value	0.00	0.00	0.00	Marked for Deletion

Emergency Preparedness Plan finalized in a consultative manner
Unit of Measure: Yes/No
Indicator Type: Custom

	Baseline	Actual (Current)	End Target	Action
Value	No	No	Yes	Revised
Date	20-Apr-2015	15-May-2017	30-Jun-2024	

Percentage of planned rehabilitation and modernization works for Guddu and Sukkur Barrages completed
Unit of Measure: Percentage
Indicator Type: Custom

	Baseline	Actual (Current)	End Target	Action
Value	0.00	3.00	100.00	New
Date	22-Nov-2017	31-Mar-2018	30-Jun-2024	

Sukkur and Guddu Barrages operating reliably
Unit of Measure: Yes/No
Indicator Type: Custom

	Baseline	Actual (Current)	End Target	Action
Value	No	No	Yes	New
Date	22-Nov-2017	31-Mar-2018	30-Jun-2024	

Number of women participated in water management consultations and training
Unit of Measure: Number
Indicator Type: Custom

	Baseline	Actual (Current)	End Target	Action
Value	0.00	0.00	160.00	New
Date	16-Nov-2017	31-Mar-2018	30-Jun-2024	

No of participants in the riverine management program
Unit of Measure: Number
Indicator Type: Custom

	Baseline	Actual (Current)	End Target	Action
Value	0.00	0.00	800.00	New
Date	16-Nov-2017	31-Mar-2018	30-Jun-2024	

% of which female
Unit of Measure: Percentage
Indicator Type: Custom Supplement

	Baseline	Actual (Current)	End Target	Action
Value	0.00	0.00	30.00	New

COMPONENTS

Current Component Name	Current Cost (US$, millions)	Action	Proposed Component Name	Proposed Cost (US$, millions)
Component A: Rehabilitation of the Guddu Barrage	195.00	Revised	Component A: Rehabilitation of Guddu and Sukkur Barrages	302.90
Component B: Improved Barrage Operation	6.00	Revised	Component B: Improved Barrage Operation	9.00
Component C: Project Management, Monitoring, and Evaluation	7.00	Revised	Component C: Technical Studies	6.50
	0.00	New	Component D: River basin water resources and riverine management	4.50
	0.00	New	Component E: Project management, Monitoring and Evaluation	9.50
	0.00	New	Price and Physical Contingency	27.80
TOTAL	**208.00**			**360.20**

LOAN CLOSING DATE(S)

Ln/Cr/Tf	Status	Original Closing	Current Closing(s)	Proposed Closing	Proposed Deadline for Withdrawal Applications
IDA-56840	Effective	22-Dec-2020	22-Dec-2020	31-Dec-2021	30-Apr-2022

DISBURSEMENT ARRANGEMENTS

Change in Disbursement Arrangements

Yes

Expected Disbursements (in US$, millions)

Fiscal Year	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024

Annual	0.00	2.79	12.00	9.50	47.70	104.50	46.50	55.00	30.00	20.01
Cumulative	0.00	2.79	14.79	24.29	71.99	176.49	222.99	277.99	307.99	328.00

SYSTEMATIC OPERATIONS RISK-RATING TOOL (SORT)

Risk Category	Latest ISR Rating	Current Rating
Political and Governance	Substantial	Substantial
Macroeconomic	Substantial	Substantial
Sector Strategies and Policies	Substantial	Substantial
Technical Design of Project or Program	Moderate	Moderate
Institutional Capacity for Implementation and Sustainability	High	High
Fiduciary	Substantial	Substantial
Environment and Social	Substantial	Substantial
Stakeholders	Moderate	Moderate
Other	Substantial	Moderate
Overall	Substantial	Substantial

LEGAL COVENANTS – Sindh Barrages Improvement Project AF (P162117)

Sections and Description
Safeguards. The Recipient shall ensure, and cause the Project Implementing Entity to ensure, that all terms of reference for any technical assistance or studies carried out under the Project are consistent with, and pay due attention to, the Association Policies, as well as the Recipient's and the Project Implementing Entity's own laws relating to the environment and social aspects. The Recipient shall ensure, and cause the Project Implementing Entity to ensure, that the Project shall be implemented in accordance with the guidelines, procedures, timetables and other specifications set forth in the Safeguard Documents.
Midterm Reviews. The Recipient shall carry out jointly with the Association and the Project Implementing Entity, a midterm review of the Project to assess the status of Project implementation, as measured against the Project's key performance Indicators and thelegal covenants included in the legal agreements.
PSC/PMO/PCMU. The Project Implementing Entity has established and shall maintain throughout the period of Project implementation: (a) the Project Steering Committee ("PSC") with composition and terms of reference satisfactory to the Association responsible for, inter alia, the provision of overall guidance and coordination among different stakeholders; (b) the Project Coordination and Management Unit ("PCMU") with composition and terms of reference satisfactory to the Association responsible for coordination, monitoring of citizens' feedback, and evaluation; and (c) the Project Management Office ("PMO") with composition and terms of reference satisfactory to the Association, responsible for, inter alia, Project implementation including technical, operational, financial

management, and oversight of the technical assistance and training program. It shall also coordinate the analysis, studies and assessment for the establishment of the BMU.

Conditions

VIII. RESULTS FRAMEWORK AND MONITORING

Results Framework
COUNTRY : Pakistan
Sindh Barrages Improvement Project AF

Project Development Objectives

The PDO will be revised to strengthen the Sindh Irrigation Department's capacity to operate and manage barrages and improve the reliability and safety of Guddu and Sukkur Barrages in the Province of Sindh.

Project Development Objective Indicators

Action	Indicator Name	Core	Unit of Measure	Baseline	End Target	Frequency	Data Source / Methodology	Responsibility for Data Collection
Revised	Name: Reliable supply of water into the 10 main canals supported by Guddu and Sukkur Barrages		Cubic Meter(m3)	39.70	43.70			
Description: Reliable supply to the irrigated areas served with no reduction in water flow from Guddu and Sukkur Barrages compared to the baseline of 39.7 BCM/annually (Guddu is 9.0 and Sukkur is 30.7). Establish reliable rating curves for each canal. Use of portable Acoustic Doppler Current Profilers (ADCPs) to allow the ratings to be reviewed.								
Revised	Name: Barrage Monitoring Unit functional		Yes/No	No	Yes			

Description: Functional is defined as: (i) BMU adequately staffed; (ii) Adequate budget available for BMU operations; (iii) Performance of all the functions as per the mandate regarding the barrage infrastructure management and operation; and (iv) Continuous water flow monitoring and regulation to the 14 main canals.								
Revised	**Name:** The three barrages operated under improved O&M plans		Number	0.00	3.00			
Description: O&M plans will be updated for Guddu and Sukkur Barrages and will be developed for Kotri Barrage under Component B.								
Revised	**Name:** Increased design flood passage capacity for Guddu Barrage (cusec)		Number	900,000.00	1,300,000.00			
Description: The flood passage capacity after the rehabilitation and modernization works would be confirmed by the design engineers, and verified by the POE								
New	**Name:** Increased design flood passage capacity for Sukkur Barrage (cusec)		Number	900,000.00	1,300,000.00			
Description: The flood passage capacity after the rehabilitation and modernization works would be confirmed by the design engineers, and verified by the POE								

Intermediate Results Indicators

Action	Indicator Name	Core	Unit of Measure	Baseline	End Target	Frequency	Data Source / Methodology	Responsibility for Data Collection
Revised	**Name:** Improved Habitat Management between Guddu and Sukkur Barrages satisfactorily implemented		Yes/No	No	Yes	Annually	PoE	PMO
Description: Satisfactory implementation means at least 80% of agreed annual activities implemented during the year. Quality of implementation satisfactory as verified by Monitoring and Evaluation Consultants and WB Implementation Support Missions.								
Revised	**Name:** Grievances registered related to delivery of project benefits addressed (%)		Percentage	0.00	90.00	Annually	Progress Report	PMO
Description: This indicator measures the transparency and accountability mechanisms established by the project so the target beneficiaries have trust in the process and are willing to participate, and feel that their grievances are attended to promptly. It is understood that local sensitivities and tensions will not allow grievance or redress mechanisms to be established in all projects.								
Revised	**Name:** Emergency Preparedness Plan finalized in a consultative manner		Yes/No	No	Yes	Annually	PoE	PMO
Description: Consultative approach will include village meetings; consultations with political/local leaders; focus group discussions; consultation workshops								
New	**Name:** Percentage of		Percentage	0.00	100.00	Annually	PoE Report	PMO

	planned rehabilitation and modernization works for Guddu and Sukkur Barrages completed							
Description: Planned works for Guddu Barrage include: (a) modernization of 65 gate structures and associated mechanical works, and (d) river training. Those for Sukkur Barrage include: (a) increase height of 56 gate structures and associated mechanical works, (b) modernization of electrical works, (c) repairs and replacement of the 165 main canal regulators, and (d) inspection of and repair to, if necessary, the 66 foundations.								
New	**Name:** Sukkur and Guddu Barrages operating reliably		Yes/No	No	Yes	Annually	Progress Report	PMO
Description: Barrage gates operating reliably within the required operating time as per Standard Operating Procedures for both Sukkur and Guddu Barrrages, considering (i) standard operation procedures prepared for Guddu and Sukkur Barrages, (ii) uplift pressures upstream and downstream of barrage measured and continuously monitored (with at least 95% of piezometers functional) ensuring control and safe barrage operation; (iii) continuous record of water measurement data; (iv) adequate security staff and equipment (Surveillance cameras; Security staff and law enforcement agencies pickets patrolling provided); and (v) barrage emergency handling protocols and procedures established and training provided; and (vi) demonstrating the flood passage capacity of at least 1.2 million cusecs.								
New	**Name:** Number of women participated in water management consultations and training		Number	0.00	160.00	Annually	Progress Report	PMO
Description: Consultative approach will include village meetings; consultations with political/local leaders; focus group discussions; consultation workshops								
New	**Name:** No of participants in the		Number	0.00	800.00	Annually	Progress Report	PMO

	riverine management program							
New	% of which female		Percentage	0.00	30.00	Annually	Progress Report	PMO
Description: Number of women and men participating in various activities in the riverine management program, including dolphin awareness outreach through consultations								

Target Values

Project Development Objective Indicators

Action	Indicator Name	Baseline	End Target
Revised	Reliable supply of water into the 10 main canals supported by Guddu and Sukkur Barrages	39.70	43.70
Revised	Barrage Monitoring Unit functional	No	Y
Revised	The three barrages operated under improved O&M plans	0.00	3.00
Revised	Increased design flood passage capacity for Guddu Barrage (cusec)	900,000.00	1,300,000.00
New	Increased design flood passage capacity for Sukkur Barrage (cusec)	900,000.00	1,300,000.00

Intermediate Results Indicators

Action	Indicator Name	Baseline	End Target
Revised	Improved Habitat Management between Guddu and Sukkur Barrages satisfactorily implemented	No	Y
Revised	Grievances registered related to delivery of project benefits addressed (%)	0.00	90.00
Revised	Emergency Preparedness Plan finalized in a consultative manner	No	Y
New	Percentage of planned rehabilitation and modernization works for Guddu and Sukkur Barrages completed	0.00	100.00

New	Sukkur and Guddu Barrages operating reliably	No	Y
New	Number of women participated in water management consultations and training	0.00	160.00
New	No of participants in the riverine management program	0.00	800.00
New	% of which female	0.00	30.00

Annex 1

Detailed Project Descriptions
PAKISTAN – Sindh Barrages Improvement Project Additional Financing

1. The proposed AF will primarily support the rehabilitation and modernization works of Sukkur Barrage, which has been identified as high priority during the implementation of the original project. The original project and the proposed AF together will support the rehabilitation and modernization of Sukkur and Guddu Barrages. Further, the proposed AF will support coordinated management of the three barrages (Guddu, Sukkur, and Kotri), and integrated monitoring will be supported to build the three barrages toward an integral Indus Basin irrigation and water management system in Sindh Province.

2. *Guddu Barrage Rehabilitation and Modernization.* Constructed in 1963, Guddu Barrage is the second-oldest barrage built across the Indus River in Pakistan. It is located about 13 km (8 miles) northeast of Kashmore District of Sindh Province, 630 km from Karachi and 190 km from Sukkur City and is accessible by road from these cities. Guddu Barrage has four main irrigation canals: (a) Beghari Sindh Feeder (right bank) with a design supply discharge of 418 m^3/s; (b) Desert Pat Feeder (right bank) of 376 m^3/s flowing into Balochistan; (c) Ghotki Feeder (left bank) of 240 m^3/s; and (d) Rainee Canal (left bank) of 280 m^3/s.

3. To ensure adequate flood passage capacity, the original project supports river training works of Guddu Barrage, particularly reinforcement of the embankment and modernization of the gate structures. This work also ensures six feet of freeboard for the embankment crests, which is the standard for all barrages over the Indus in Pakistan. Further, the original project supports widening of the left pocket area, based partly on improved sediment management. These measures, combined with regular canal maintenance, will improve the ability of the barrage to supply water in the event of reduced flows due to potential climate change impacts. They will also ensure flood passage capacity at its target of 1.3 million cusecs.

4. *Sukkur Barrage Rehabilitation and Modernization.* Sukkur Barrage, constructed in 1932, is the first barrage over the Indus in Pakistan, located 362 kilometers northeast of Karachi. The barrage is about 170 km (100 miles) downstream of Guddu Barrage and about 480 km (300 miles) upstream of Kotri Barrage. The Sukkur Barrage is a 66-span main barrage, 4725 ft. (approx. 1.4 km) wide. It is mainly of stone masonry construction with reinforced concrete arches spanning 60-ft. (18.3 m) openings for the two bridge decks: the upper deck for operating the gates, and the lower road deck. The canal head regulator structures on both banks control flow in the three right bank canals and four left bank canals.

5. The Sukkur Barrage is divided into three sections: right under-sluices, central weir portion and left under-sluices. The right and left under-sluices have 5 and 7 bays, respectively, and are separated from the main weir by right and left divide walls. The central section is further divided into six compartments of 9 spans each. The compartments are separated from one another and from the under-sluices by abutment piers that are 25 ft. wide and 97 ft. long. The ordinary piers between the spans are 10 ft. wide and 77 ft. long. Abutment Pier # 32 is 190 ft. long and is provided with eight pipes for monitoring uplift pressures. The barrage bays are regulated by means of steel gates. The gates are

ordinarily operated by electric power but can also be operated by hand. The piers support two separate bridges: the gate bridge is on the upstream end of the piers, at a higher level than the road bridge on the downstream side. The gate bridge consists of two separate reinforced cement concrete arches, one 8 ft. wide and the other 5 ft. wide, with a gap of 13 ft. in between, where the barrage gates and their counterweights work. This bridge carries the hoisting equipment. The road bridge, 25 ft. wide, is on the downstream end of the piers and is constructed with reinforced cement concrete arches. The layout plan of Sukkur Barrage is shown in Figure A1.1.

6. Seven canal systems were constructed along with the Sukkur Barrage for irrigated agriculture. Four canals offtake from the left bank: Khairpur West Canal, Rohri Canal, Khairpur East Canal, and Nara Canal. From the right bank, there are three canals: Dadu Canal, Rice Canal, and North Western Canal. According to the original design of the barrage, the total diversion into the seven canals was 47,530 cusecs. It has increased to 65,933 cusecs because of the development of irrigated agriculture in the command areas and the additional availability of storage water at Tarbela Dam. The command areas cover the Sindh Province districts of Sukkur, Shikarpur, Khairpur, Benazirabad, N. Feroze, Larkana, Sanghar, Dadu, Hyderabad, Mirpurkhas, Tando Allahyar, Matiari, and Tharparkar. These districts are situated in an arid/desert zone where crop production is feasible only with irrigation. The cumulative command area of these canals is about 3.2 million hectares. About 10 million people in these 13 districts inhabit the command areas of the seven canals, and their livelihoods depend directly or indirectly on the irrigation supplies of these canals. Figure A1.1 presents the overview of the barrage and the associated canals.

7. Four years after the barrage was commissioned in 1932, it was observed that the right bank canals were drawing excessive silt. Physical hydraulic model studies at, among other places, the Central Irrigation and Hydro-dynamic Research Station, Poona, India, indicated the need for modifications to the barrage: construction of a tail channel to serve as a silt excluder for the offtake canals at the right pocket. To accomplish this, 10 bays of the main barrage had to be closed, which reduced its design flood passage capacity from the original 1.5 million cusecs to 0.9 million cusecs, according to the assessment at that time. The offtake system on the right bank behaved well until the late 1980s, when the right-side withdrawal was further increased to meet growing demand, gradually reaching 28,000 cusecs. This resulted in increased sediment deposits in the right pocket and in the right bank canals, seriously choking the North Western and Rice Canals. Consequently, the silt exclusion capability of the training works installed in 1938 has been compromised, and the right bank canals are again suffering from excessive silt entry, much greater than the carrying capacity of the canals. This heavy sedimentation in the head reaches of the canals reduces their discharge capacity.

Figure A1.1. Plan View of Existing Barrage and River Training Works

8. *Increased Sedimentation.* The original design of the barrage, with left and right pockets as canal intakes/settling basin and a pond level of 194.5 ft., was based on cumulative withdrawals of 18,960 cusecs for the three right bank canals (Dadu, Rice and North Western Canals) and 28,583 cusecs for the four left bank canals (Khairpur West, Rohri, Khairpur East, and Nara Canals). The river training works were also designed to keep the same withdrawal requirements for the right bank canals. But as canal withdrawals increased over the years, the sedimentation problems at the right bank canals gradually resurfaced. The abilities of the right pocket/settling basin and the tail channel to remove sediment before discharging into the right bank canals declined. At present, the right bank canals carry about 55 percent more flows than originally designed, and the left bank canals carry about 30 percent more.

9. The increase in canal offtakes required changes in barrage operation rules. The barrage pond level was gradually increased, up to the existing maximum level of 200 ft., increasing the sedimentation even further. The left and right pockets started to fill rapidly with sediment, while pronounced increases in sedimentation in the main river upstream of the barrage occurred. Additionally, political pressure demanding a continuous flow of water in the canals prevents regular flushing of the pockets to remove deposited sediment from the left and right pockets. Therefore, additional sediment deposition occurs in the pockets and irrigation canals. Recent low flows in the Indus (lower than historic flows), combined with the increased operating water level, exacerbate sedimentation upstream of the barrage and at the offtakes. Overall, the ineffective sediment management at the barrage and intakes, and the resulting excessive silting in the right-side canals makes it extremely difficult to deliver the required water

supplies to the tail end of these canals.

10. *Increasing Flood Intensities and Reduced Flood Capacity.* After extensive flood protection works and construction of bunds (levees) on both sides of River Indus, the spreading of river flows had been reduced, resulting in a marked increase in flood discharges at the barrage, starting with a flood of 1.0 million cusecs in 1958. Since then, river flows have exceeded 0.9 million cusecs 11 times. Of these 11 floods, 6 were greater than 1.1 million cusecs, and the largest (in 1976) was 1.2 million cusecs. There were bund breaches upstream of Sukkur Barrage during this flood, indicating that the actual flood discharge was higher than 1.2 million cusecs. The flood of 2010 was also accompanied by a number of breaches upstream of the barrage, implying that the actual flood discharge could have been higher than the recorded 1.14 million cusecs at the barrage. However, it should be noted that the target discharge capacity of the Guddu Barrage is around 1.3 million cusecs, beyond which extraordinary floods could be breached upstream. The flood water would eventually go back to the main river, but much later than the peak flood arrival at the Sukkur Barrage.

11. Although the Sukkur Barrage has been able to pass floods up to 1.2 million cusecs without incurring serious damage to its structure and operation, major rehabilitation and refurbishment works had to be undertaken to ensure the structural and operational safety of the barrage. Much of the downstream scour protection needed strengthening or replacement after most of these floods. The reinforced concrete arches and stone masonry works have shown many cracks, cavities, and corrosion of reinforcement, and they need urgent rehabilitation to ensure the safety of the barrage and road bridge. This situation is expected to worsen in the future. Climate change studies indicate increased hydrologic variability and predict increases in the magnitudes of large floods. Therefore, inspection of the foundations and scour protection to identify and proactively carry out necessary repairs is critical, in addition to the proposed repair and modernization of the superstructure and electromechanical works.

12. *Possible Modification of the River Training.* Options for modifying the existing river training works to allow passage of a flood of 1.5 million cusecs have been studied. Numerical model studies were executed, supported by physical hydraulic model studies at the Soil & Hydraulics Research Laboratory, Hyderabad, to prepare a design opening the 10 gates that are currently blocked. However, because of scale effects, it was recommended to finalize the design with more detailed and comprehensive physical hydraulic model studies that will include the seven main channel offtakes. The studies will be carried out under the proposed AF (Component C) at an internationally renowned hydraulic laboratory that will also offer more space to build a physical model of adequate size.

13. *Dredging Upstream and Downstream of the Barrage and in Pockets.* To improve the operation of the Sukkur Barrage, including flood passage and water diversion to the seven canals, it is critical to dredge sediment upstream and downstream of the barrage and in the pockets. Such maintenance is best carried out periodically, and its optimal sequence will be determined by a detailed hydrological model study during implementation. Dredging of the pockets may only have to be carried out once, provided that the possible modifications to the river training works discussed in paragraph 12 find a way to successfully and effectively flush the left and right pockets periodically without hampering the diversion of water to the canals. Sedimentation upstream and downstream of Sukkur Barrage is bound to continue periodically, and the project will also provide dredgers to allow the operator to conduct dredging as part of periodic maintenance for securing the flood discharge capacity of the barrage

without causing a rise in backwater level along the upstream bunds.

14. *Repairs to Structure and Barrage Modernization.* The safety assessment of the barrage found that the reinforced concrete arches and stone masonry works have many cracks, cavities, and corrosion of reinforcement and need urgent rehabilitation to ensure the safety of the barrage and road bridge. The task of barrage repairs/refurbishment and modernization is considered essential in all respects. Continuing degradation in the condition of the masonry structure and reinforced cement concrete arches may lead to eventual failure of the superstructure. Moreover, detailed foundation inspections will be undertaken during project implementation in coordination with sediment dredging works during dry periods, and any required supporting measures will be carried out. Any failure to close the barrage gates or to open the regulator gates due to malfunctioning of the operating equipment or failure of outdated electrical systems can lead to a loss of pond level, resulting in loss of irrigation supplies during required repairs.

15. A new barrage, as an alternative to rehabilitation of the existing barrage, was also considered in the study. However, 10-12 years would normally be required for feasibility, detailed design, and construction of such a new barrage. It would be too risky to delay the critical rehabilitation and safety improvement works of the existing barrage. Thus, the study concluded that immediate rehabilitation of the existing barrage would be essential to ensure its operation before a study of a new barrage is undertaken.

16. With the activities planned under the proposed AF, the project will have the following components. The revised costs are base costs. Price and physical contingencies are included in the total costing in Table A1.1.

Component A. Rehabilitation of the Barrages (Original: US$195 million, Revised: US$302.9 million base cost). With the restructuring and the proposed AF, this component will support the rehabilitation of the Sukkur Barrage as well as Guddu Barrage. This component therefore will have two subcomponents: Subcomponent A-1: Rehabilitation of Guddu Barrage (base cost: US$168 million), and Subcomponent A-2: Rehabilitation of Sukkur Barrage (base cost: US$129.5 million).

(a) Subcomponent A-1: This subcomponent supports rehabilitation and modernization of Guddu Barrage and its associated structures. The works have been determined through (a) a detailed diagnostic assessment, (b) hydrological and sediment analysis studies including physical and numerical model studies, and (c) geotechnical, structural, and safety evaluation studies. The subcomponent will finance the following elements:

(i) Gate replacement works to improve the regulation and the flow of the barrage. This includes replacing all 65 main barrage steel gates (the gates are 18.3 m wide and 6.6 m high and weigh 55 tons each), 25 main canal head regulator gates (the gates are 7.3 m wide and 3.8 m high, and weigh 25 tons each), and hoist gears, including all mechanical and electrical equipment. It also includes providing new standby generators, electrical cabling, and switch gears; replacing barrage lighting; repairing the barrage lifting bridge and safety barriers; and rehabilitating the three main canal head regulators.

(ii) Concrete repairs along the upstream gate grooves and rehabilitation of both fish ladders.

(iii) Removal of the left pocket divide wall and construction of a new left pocket divide wall to widen the left pocket and improve its ability to reduce the quantities of sediment entering the Ghotki Feeder canal.

(iv) River training works through construction of a left-bank spur to promote favorable river approach conditions to the barrage and strengthen the existing upstream river training works.

(v) Offices for the O&M staff at the Guddu Barrage, including a laboratory, residential buildings, dispensary, mosque, recreational facilities, access roads, and all supporting service infrastructure. The construction also includes a new office at Sukkur and the rehabilitation of staff residences.

(vi) Implementation of the Environment and Social Management Plan for Guddu Barrage.

(vii) Supervision of the civil works, including quality control tests, etc.

(b) Subcomponent A-2: This subcomponent will support rehabilitation of Sukkur Barrage, its associated canal head regulators, and the associated structures. The works have been determined through (a) detailed inspections and partial destructive testing through testing of concrete/stone cores, (b) hydrological analysis, (c) geotechnical investigations and topographic/bathymetric surveys, and (d) dam safety studies for geotechnical, structural, and safety evaluations. The subcomponent will finance the following:

(i) Gates and mechanical works to improve flood handling capacity and maintenance of pond level. This includes raising the level of the underside of 56 operational barrage gates by 2 ft. for safer flood passage, and altering the gate-lifting mechanism by (1) removing the counterweight, (2) replacing the hoist control, rope, rope drum, and main gearbox unit, and installing powerful gate-lifting motors for each gate, (3) replacing roller trains and seals, and removing rust, and (4) applying corrosion protection after required repairs. It also includes replacing excessively corroded canal head regulator gates, rehabilitating the remaining gates, and replacing existing gate-lifting motors. In addition, caisson gates will be fabricated to manage the rehabilitation works without affecting flows in the main river or in canals.

(ii) Electrical works. This includes provision of new 11kV power supply line to the main incoming switchboard at left and right banks with the installation of 11/0.4 kV transformers, main incoming switchboards, and auxiliary switchboards to supply bays/group of barrage spans through local control panels. New auxiliary switchboards for canals on left and right banks with local control panels and a new diesel generator at left and right banks with main switchboard will also be installed.

(iii) Main barrage and canal head regulator repairs. This includes (1) repairs in 204 reinforced cement concrete arches and 165 stone masonry arches of canal head regulators, (2) drilling/grouting and repair of stone masonry in main piers and in arch spandrel filling, (3) new flooring at gate deck and asphalt topping on the barrage road, and (4) concrete jacketing of canal head regulator piers and concrete overlay immediately downstream of the

regulator. It will also include slope and scour protection works in canal transition lengths, right pocket, nose of outer bank and left divide wall, and upstream of the barrage, with reconstruction of the damaged portion of the outer bank.

(iv) Foundation inspection and repairs. This includes isolating the barrage foundation through cofferdams and carrying out any necessary repairs. The proposed cost includes the expenditure required for inspection and contingent provisions for identified repair works.

(v) Dredging works. This includes dredging/excavation from right pocket, approach and tail channels, left pocket and its approach from main river channel, and downstream of right pocket. It also includes de-silting/excavation from Dadu, Rice, and NW Canals on the right bank.

(vi) Procurement of dredgers for regular dredging/de-silting of barrage left and right pockets and canals to help reduce the accumulation of sediment.

(vii) Surveillance and supervisory control and data acquisition (SCADA). This will support installation and management of a SCADA System for the barrage and canal head regulators through a central control room. The system also includes video surveillance and telecommunication.

(viii) Instrumentation, monitoring, and control. This includes (1) replacing existing vibrating wire piezometer, (2) reactivating existing pressure pipes with installation of vibrating wire piezometer and additional vibrating wire piezometer on canal head regulators, (3) replacing staff gauges on main barrage and canal head regulators, and (4) installing tilt meters in all the piers of the Barrage. It will also set up permanent flow measuring stations at Sukkur Gorge, equipped with Automatic Data Acquisition System for all instrumentation, velocity and depth profiler with totalizer for flow measurement in canals, tug boat, motor boat, and launch.

(ix) Renovation of staff and O&M offices. This includes renovating existing Executive Engineer's Office at the barrage, new office building, workshop, mosque, officers' residences, and rest house.

(x) Implementation of Environmental and Social Management Plan for Sukkur Barrage.

(xi) Consulting services for procurement support, construction supervision, quality control, and construction management.

Component B. Improved Barrage Operation (Original: US$6.0 million, Revised: US$9.0 million base cost). As the original project envisaged, this component will support improved coordination in managing and monitoring the operation of the three barrages in Sindh Province. At the appraisal of the original project, the Irrigation Department (ID) planned to establish a unit called Barrage Management Office to operate, manage, and carry out maintenance works for all the three barrages. However, during implementation of the project, the ID has decided to establish a Barrage Monitoring Unit (BMU) in Sukkur to monitor, supervise, and coordinate the operation of all three barrages. Because of the physical distances among the three barrages, routine maintenance will be retained at each barrage, designating clear accountability to the resident chief engineers. This

arrangement is also in line with the overall direction of the reorganization of the ID to segregate the functions of policy, monitoring, and regulation from physical maintenance works. Under this component, the following activities, including goods, trainings, and technical assistance, will be carried out.

(a) Refinement of the O&M plans and emergency preparedness plans for the Guddu and Sukkur Barrages, in coordination with Kotri Barrage. During the preparation period, O&M plans for Guddu and Sukkur Barrages have been prepared independently as separate documents. Because of the connectivity among the three barrages, these plans will be upgraded to improve coordination among the three barrages, with attention to such factors as (i) water level at the location of each barrage and key points in the Indus during different seasons, (ii) concentration and gradation of sediments during different flow conditions, (iii) interaction of water extraction among the three barrages and potential social and environmental impacts, and (iv) sediment transport across the three barrages.

(b) Support the establishment of the BMU in Sukkur with (a) adequate office spaces and equipment, and (b) an integrated barrage operation monitoring system, with (i) instrumentation on the barrage structures, including piezometers, gate positioning and water measurement equipment and Acoustic Doppler Current Profilers, (ii) surveillance equipment (maintenance boats and hydrographic equipment), and (iii) flow measurement equipment for the 14 main canals.

(c) Preparation of an O&M plan and an emergency preparedness plan for Kotri Barrage. Based on the inventory assessment, the plans will (i) define a periodic maintenance, repair, rehabilitation, and replacement schedule and procedures, (ii) define the procedures to measure performance periodically, (iii) develop an optimal organizational structure and governance, (iv) estimate required financial and human resources, and (v) in coordination with Guddu and Sukkur Barrages, define the operational procedures if extremely high floods occur.

(d) Supporting equipment and logistics for operation and routine maintenance at the three barrages, including provision of dredgers, upgrading of the workshops, and provision of spare parts and monitoring equipment.

Component C. Technical Studies (Proposed new component: US$6.5 million base cost). This is a new component aimed at supporting GoSindh in deepening its technical understanding of particular issues pertaining to the barrages that have been identified during preparation of the proposed AF. The following activities will be undertaken under this component.

(a) Preparation for Phase 2 river training works. This activity will support the preparation for the river training works to be carried out during Phase 2:

- *Detailed study on the impacts of climate change.* The proposed AF aims at securing the operation and structure of Sukkur Barrage against a large flood of 1.3 million cusecs (a return period of nearly 100 years); however, there is a risk of even a larger flood surpassing 1.5 million cusecs (a return period of around 500 years under the current estimate),

particularly in light of climate change. Further, the demand side may also be affected by climate change as crop requirements would increase with rising temperatures. Also, increasing population and urbanization would increase the overall demand for water extraction from the three barrages. The study will first undertake an analysis of the likelihood and intensity of large floods, considering the change in the pace of the snowmelt and precipitation patterns, and identifying the impacts of such a large flood on the barrages, particularly on Guddu and Sukkur Barrages, which are located further upstream and will be directly hit by floods. The study will determine the likelihood of large floods, identify key operational issues among the three barrages, and determine the design of flood passage capacity with a few options, balancing the social, economic, and environmental factors. The study will also identify potential measures for increasing resilience such as flood escape facilities, in addition to reinforcement of the three barrages.

- *Physical hydraulic model study and feasibility study.* A physical hydrological model will be carried out to determine the design of the riverbank training works for the identified design flood passage capacity. In addition, the study will assess the risk of overtopping the current bund wall in Rohri and Sukkur cities and determine the design to reinforce the bund wall. Further, once the design was determined, a feasibility study will be carried out to confirm technical, environmental, and social feasibility. The feasibility study will give particular attention to the potential issues related to the social safeguards, particularly resettlement, and provide alternative options, if necessary.

- *Environmental and social safeguards impact assessment.* For the final recommended design, an environmental and social assessment will be carried out independently from the feasibility study. The assessment will set out anticipated environmental and social impacts in detail, including resettlement and land appropriation, identify mitigation measures, and estimate the associated costs. The TOR of the assessment and the draft final assessment are subject to the Bank's prior review and no-objection

- *Preparation of detailed design and procurement documents.* To facilitate the implementation of Phase 2 works, the proposed AF will also support the detailed design and preparation of the procurement documents.

(b) Safety assessment on Kotri Barrage. Kotri Barrage, constructed in 1955, is located near Hyderabad, downstream of Guddu and Sukkur Barrages. It feeds four canals (Karachi Canal on the right bank and Akrum Wah, Fulleli, and Pinyari on the left bank). The barrage has been under normal operation with routine maintenance and a few major repair and rehabilitation works in the past, including the replacement of the gates in the early 1990s. In the last decades, the demand for water in Karachi has increased substantially, because of rapid urbanization. As the barrage is critical to divert water to Karachi, GoSindh wishes to carry out a comprehensive safety and functional assessment similar to the one carried out for Sukkur Barrage and, if necessary, identify (i) the critical rehabilitation and repair measures to ensure the safety of the barrage, and (ii) necessary modernization works, particularly instrumentation and electromechanical works, to facilitate its operation. The study will carry out inventory analysis and physical inspection of the barrage structures and mechanical works, as well as a bathymetric survey to identify the barrage's current physical and functional status and

determine its capacity for water delivery. It will also analyze future demand and identify critical rehabilitation works and priority modernization of the barrage to secure its safety and meet future demands.

(c) Study on sediment transport modeling. Since the commencement of the operation of Sukkur Barrage some 85 years ago, the riverbed of the Indus has reportedly risen by 1.5 meters. Two large bridges have been built over the Indus between Kotri and Sukkur Barrages, and some impacts on sediment transport from these bridges are anticipated. Built on an activity under Component B to support the ID's effort to initiate sediment monitoring and improve its management in the three barrages, this activity will support development of a sediment transport and river morphology modeling to deepen understanding of the dynamic river morphology.

Component D. River Basin Water Resources and Riverine Management (proposed new component: US$4.5 million base cost). The Social Action Plan, which was included in the original project under Component A, will be upgraded as a stand-alone component to sharpen the focus on the water-related environmental and social issues in the 170-km stretch of the Indus between Sukkur and Guddu Barrages. As the management of this habitat requires an interdisciplinary approach, the component will aim at engaging departments pertaining to fisheries, forestry and wildlife, environment, agriculture, and irrigation. This component will comprise the following activities.

(a) Dolphin management and conservation. This activity will support periodic dolphin population surveys to monitor the population of the Indus River dolphin and identify the locations of major dolphin schools. Based on the population survey and consultation with local communities, no-fishing zones will be proposed. In addition, this component will support the Forest and Wildlife Department in establishing a permanent dolphin rescue team. The rescue program has been carried out between Guddu and Sukkur Barrages but lacks critical resources. The proposed AF will support setting up a formal dolphin rescue team through hiring new staff, purchasing rescue operation equipment, and providing training in dolphin rescue.

(b) Community fisheries co-management. A stock assessment will be carried out on the fish in the Indus between Guddu and Sukkur Barrages in order to estimate the sustainable amount of fish available for consumption of dolphins and capture fisheries by the concerned communities for various type of fish species. Based on the analysis and on consultation with community stakeholders engaged in fisheries, sustainable fishing practices will be promoted with demonstration activities.

(c) River bank rehabilitation. At critical areas in the stretch of the Indus between Guddu and Sukkur Barrages, the Forest Department will carry out habitat rehabilitation works, such as restoring fauna and physical cleanup, to reduce erosion, prevent further pollution, and conserve the riverine landscape.

(d) Sustainable agriculture. This activity will aim to raise farmers' awareness of sustainable agriculture in the riverine area through Farmers' Field Schools. In particular, the activity will establish Farmers' Field Schools targeting female farmers.

(e) Technical studies on key water-ecology issues, including design of fish passes and assessment of environmental flows between Guddu and Sukkur Barrages.

(f) Education and awareness raising. This activity will support an expanded outreach and education program for the general public, and particularly for youth and women, to raise awareness on the importance of restoring the riverine ecosystem.

(g) Water quality and pollutant studies. This activity aims to identify industries and agricultural practices discharging wastewater/pesticides into the river, determine suitable monitoring locations, and coordinate with owners of emission sources to introduce mitigation measures. It will be implemented in collaboration with SEPA, the Forestry and Wildlife Department, the Agriculture Department, and the Fishery Department.

The PMO will be responsible for the overall implementation of this component. Each of the activities will engage the relevant departments: the Forest and Wildlife Department, Fishery Department, Agriculture Department, and SEPA. Sector-specific activities will be entrusted to these departments through a memorandum of understanding, considering their responsibilities and expertise. The whole fiduciary responsibility will remain at the PMO. The PCMU, established at the Planning and Development Department, will monitor the implementation of this component and facilitate interdepartmental coordination.

This component will help establish the foundation on which GoSindh could build integrated riverine ecological conservation and management. In particular, this component will have the following tangible outputs: (a) permanent dolphin rescue team established and functional to conduct periodic dolphin population surveys and emergency rescue operations; (b) community fisheries co-management initiated in collaboration between the communities and the Fisheries Department; (c) rehabilitation of key riverine habitats for dolphins; (d) studies on the fish passes and environmental flow between Guddu and Sukkur Barrages completed; (e) educational and awareness raising program on riverine conservation and management conducted; and (f) major pollution sources of the river stretch identified and documented for further action by GoSindh.

Component E: Project Management, Monitoring and Evaluation (Original US$7.0 million, Revised US$9.5 million base cost). This component will continue to support the overall management of project, including procurement, financial, technical, and social and environmental safeguards. The component will finance (a) the incremental operating costs of the PMO and PCMU, including performance incentives for civil servants seconded to these entities, based on the performance targets agreed with the Bank; (b) the continued engagement of the technical POE to review the progress of the rehabilitation and modernization works for Guddu and Sukkur Barrages and provide timely guidance; (c) the continued engagement of key environmental and social experts to monitor compliance with the stipulated safeguards instruments; (d) proactive communication activities to the general public on the potential impacts and benefits of the project; (e) continued engagement of the PCMU to monitor and evaluate the project performance and impacts through monitoring and evaluation consultants and remote sensing, to oversee the procurement activities through international experts/firms, and to supervise the environmental and social safeguards and

implementation of technical assistance; and (f) the provision of critical trainings and technical assistance for the PMO, PCMU, and government staff related to general project management and administration, and technical matters pertaining to agriculture and water resources management.

17. The estimated cost and proposed financing are shown in Table A1.1.

Table A1.1: Estimated Revised Project Cost and Proposed Revised Financing

Project Component	Cost Million US$	Cost Sharing IDA Million US$	Cost Sharing Government Million US$
Component A - Rehabilitation of Barrages			
Component A-1: Rehabilitation of Guddu Barrage	168.0	153.0	15.0
Component A-2: Rehabilitation of Sukkur Barrage			
A1. Gates and Mechanical Works	32.7	29.1	3.6
A2. Electrical Works	6.5	5.9	0.6
A3. Main Barrage & Canal Head Regulator Rehabilitation	15.7	14.2	1.5
A4. Foundation Inspection and Rehabilitation/ Repairs (including contingency)	22.4	20.3	2.1
A5. Dredging	36.8	32.6	4.2
A6. Dredger	1.4	1.3	0.1
A7. Surveillance & SCADA	8.4	7.4	1.0
A8. Instrumentation, Monitoring & Control	1.8	1.6	0.2
A9. Renovation and Provision of Staff and O&M Offices	3.3	3.0	0.3
A10. Implementation of Environmental and Social Management Plan	0.7	0.7	-
A11. Construction Supervision, Quality Control and Contract Management	5.2	5.2	-
SubTotal Component A-2	**134.9**	**121.3**	**13.6**
Subtotal (Component A)	**302.9**	**274.3**	**28.6**
Component B: Improved Barrage Operation	9.0	9.0	0.0
Component C. Technical Studies	6.5	6.5	0.0
Component D: River Basin Water Resources & Riverine Management	4.5	4.5	0.0
Component E: Project Management and Monitoring and Evaluation	9.5	8.6	0.9
TOTAL Base Cost	**332.4**	**302.9**	**29.5**
Price Contingency	19.4	17.5	1.9
Physical Contingency	8.4	7.6	0.8
Grand TOTAL	**360.2**	**328.0**	**32.2**