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Report No: PAD979

INTERNATIONAL DEVELOPMENT ASSOCIATION

PROJECT APPRAISAL DOCUMENT

ON A

PROPOSED CREDIT

IN THE AMOUNT OF SDR 133.7 MILLION
(US\$188 MILLION EQUIVALENT)

TO THE

ISLAMIC REPUBLIC OF PAKISTAN

FOR A

SINDH BARRAGES IMPROVEMENT PROJECT

May 28, 2015

Water Global Practice
South Asia Region

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CURRENCY EQUIVALENTS
(Exchange Rate Effective as of April 30, 2015)

Currency Unit = Pakistan Rupee (PRs)
PKRs 101.69 = US\$1
US\$1.40642 = SDR 1

FISCAL YEAR

July 1 – June 30

Metric System

1 meter (m) = 3.280 feet 1 hectare (ha) = 2.470 acres
1 kilometer (km) = 0.620 miles 1 cubic meter (m³) = 35.310 cubic feet
1 million acre feet (MAF) = 1.234 billion cubic meters (BCM)
1 cubic foot per second (cfs) = 0.0283 cubic meters per second (m³/sec)

ABBREVIATIONS AND ACRONYMS

ADCP	Acoustic Doppler Current Profiler
BCM	Billion Cubic meters
BMO	Barrages Management Organization
CPS	Country Partnership Strategy
DA	Designated Account
EA	Environmental Assessment
ECP	Environmental Code of Practice
EIRR	Economic Internal Rate of Return
EMP	Environmental Management Plan
ESA	Environmental and Social Assessment
ESMP	Environmental and Social Management Plan
FM	Financial Management
GDP	Gross Domestic Product
GoP	Government of Pakistan
GoSindh	Government of Sindh
GRS	Grievance Redress Service
I&D	Irrigation and Drainage
ICB	International Competitive Bidding
ID	Irrigation Department
IDA	International Development Association
M&E	Monitoring and Evaluation
NCB	National Competitive Bidding
NGO	Nongovernmental Organization
O&M	Operation and Maintenance
PCMU	Project Coordination and Monitoring Unit
PDD	Planning and Development Department
PDO	Project Development Objective

PIC	Project Implementation Consultant
PMCA	Project Management Consultant/Procurement Agent
PMO	Project Management Office
POE	Panel of Experts
PSC	Project Steering Committee
RAP	Resettlement Action Plan
RPF	Resettlement Policy Framework
SAP	Social Action Plan
SDAP	Social Development Action Plan
SIDA	Sindh Irrigation and Drainage Authority
SORT	Systematic Operations Risk-Rating Tool
SMF	Social Management Framework
SWSIP	Sindh Water Sector Improvement Project

Regional Vice President:	Annette Dixon
Country Director:	Rachid Benmessaoud
Senior Global Practice Director:	Junaid Kamal Ahmad
Practice Manager:	Parameswaran Iyer
Task Team Leader:	Abdulhamid Azad

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PAD DATA SHEET*Pakistan**PK-Sindh Barrages Improvement Project (P131324)***PROJECT APPRAISAL DOCUMENT***SOUTH ASIA**0000009087*

Report No.: PAD979

Basic Information			
Project ID P131324	EA Category A - Full Assessment	Team Leader(s) Abdulhamid Azad	
Lending Instrument Investment Project Financing	Fragile and/or Capacity Constraints []		
	Financial Intermediaries []		
	Series of Projects []		
Project Implementation Start Date 01-Sep-2015	Project Implementation End Date 22-Jun-2020		
Expected Effectiveness Date 01-Sep-2015	Expected Closing Date 22-Dec-2020		
Joint IFC No			
Practice Manager/Manager Parameswaran Iyer	Senior Global Practice Director Junaid Kamal Ahmad	Country Director Rachid Benmessaoud	Regional Vice President Annette Dixon
Borrower: Economics Affairs Division, Government of Pakistan			
Responsible Agency: Sindh Irrigation and Power Department			
Contact: Telephone No.: 923008375557	Aijaz Shaikh	Title: Email: aijazshaikh59@hotmail.com	Project Director
Project Financing Data(in USD Million)			
[] Loan	[] IDA Grant	[] Guarantee	
[X] Credit	[] Grant	[] Other	
Total Project Cost:	208.00	Total Bank Financing:	188.00
Financing Gap:	0.00		
Financing Source		Amount	

BORROWER/RECIPIENT	20.00
International Development Association (IDA)	188.00
Total	208.00

Expected Disbursements (in USD Million)

Fiscal Year	2015	2016	2017	2018	2019	2020	2021	0000	0000	0000
Annual	0.00	6.00	20.00	35.00	40.00	40.00	47.00	0.00	0.00	0.00
Cumulative	0.00	6.00	26.00	61.00	101.00	141.00	188.00	0.00	0.00	0.00

Institutional Data

Practice Area (Lead)

Water

Contributing Practice Areas

Cross Cutting Topics

- Climate Change
- Fragile, Conflict & Violence
- Gender
- Jobs
- Public Private Partnership

Sectors / Climate Change

Sector (Maximum 5 and total % must equal 100)

Major Sector	Sector	%	Adaptation Co-benefits %	Mitigation Co-benefits %
Water, sanitation and flood protection	General water, sanitation and flood protection sector	70	100	
Agriculture, fishing, and forestry	Irrigation and drainage	30	100	
Total		100		

I certify that there is no Adaptation and Mitigation Climate Change Co-benefits information applicable to this project.

Themes

Theme (Maximum 5 and total % must equal 100)

Major theme	Theme	%
Environment and natural resources management	Water resource management	60

Rural development	Rural services and infrastructure	20
Social protection and risk management	Income Support for Old Age, Disability & Survivorship	10
Environment and natural resources management	Climate change	5
Environment and natural resources management	Other environment and natural resources management	5
Total		100

Proposed 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.

Components

Component Name	Cost (USD Millions)
Component A: Rehabilitation of the Guddu Barrage	195.00
Component B: Improved Barrage Operation	6.00
Component C: Project Management, Monitoring, and Evaluation	7.00

Systematic Operations Risk- Rating Tool (SORT)

Risk Category	Rating
1. Political and Governance	Substantial
2. Macroeconomic	Moderate
3. Sector Strategies and Policies	Substantial
4. Technical Design of Project or Program	Moderate
5. Institutional Capacity for Implementation and Sustainability	Moderate
6. Fiduciary	Substantial
7. Environment and Social	High
8. Stakeholders	Moderate
9. Other	Substantial
OVERALL	High

Compliance

Policy

Does the project depart from the CAS in content or in other significant respects?	Yes []	No [X]
Does the project require any waivers of Bank policies?	Yes []	No [X]
Have these been approved by Bank management?	Yes []	No [X]

Is approval for any policy waiver sought from the Board?		Yes []	No [X]
Does the project meet the Regional criteria for readiness for implementation?		Yes [X]	No []
Safeguard Policies Triggered by the Project			
	Yes	No	
Environmental Assessment OP/BP 4.01	X		
Natural Habitats OP/BP 4.04	X		
Forests OP/BP 4.36		X	
Pest Management OP 4.09		X	
Physical Cultural Resources OP/BP 4.11		X	
Indigenous Peoples OP/BP 4.10		X	
Involuntary Resettlement OP/BP 4.12	X		
Safety of Dams OP/BP 4.37	X		
Projects on International Waterways OP/BP 7.50	X		
Projects in Disputed Areas OP/BP 7.60		X	
Legal Covenants			
Name	Recurrent	Due Date	Frequency
Procurement Grievance Redress Mechanism		01-Dec-2015	
Description of Covenant			
The Recipient shall, or shall cause the Project Implementing Entity to strengthen, maintain and operate throughout the period of Project implementation, a procurement grievance redress mechanism for the handling of any stakeholder procurement related complaints arising out of the implementation of the Project activities.			
Name	Recurrent	Due Date	Frequency
Project additional staff		01-Nov-2015	
Description of Covenant			
The Project Implementing Entity shall recruit a project management consultant for the PCMU, Financial Management Specialist and a Communication Specialist for the PMO.			
Name	Recurrent	Due Date	Frequency
Annual Work Plan and Budget	X		Yearly
Description of Covenant			
The Project Implementing Entity shall furnish to the Association the annual work plans and budgets for the Association's review and approval			
Conditions			
Source Of Fund	Name	Type	

Description of Condition				
Team Composition				
Bank Staff				
Name	Role	Title	Specialization	Unit
Abdulhamid Azad	Team Leader (ADM Responsible)	Senior Irrigation Engineer		GWADR
Uzma Sadaf	Procurement Specialist	Senior Procurement Specialist		GGODR
Qurat ul Ain Hadi	Financial Management Specialist	Financial Management Specialist		GGODR
Anna Victoria Gyllerup	Team Member	Senior Operations Officer		GWADR
Anwar Ali Bhatti	Team Member	Financial Analyst		SACPK
Chaohua Zhang	Safeguards Specialist	Lead Social Development Specialist		GSURR
Chau-Ching Shen	Team Member	Senior Finance Officer		WFALN
Daisy Lopez Zita	Team Member	Finance Analyst		WFALN
Helene Bertaud	Counsel	Senior Counsel		LEGSO
Jaafar Sadok Friaa	Team Member	Program Leader		SACPK
Javaid Afzal	Safeguards Specialist	Senior Environmental Specialist		GENDR
Jose F. Molina	Team Member	Lead Financial Officer/Debt Capital Markets & CBP		FABBK
Masood Ahmad	Team Member	Lead Hydropower Specialist		GEEDR
Miki Terasawa	Safeguards Specialist	Social Development Specialist		GSURR
Mohammad Azhar Ul Haq	Team Member	Program Assistant		SACPK
Nagaraja Rao Harshadeep	Peer Reviewer	Senior Environmental Specialist		GENDR

Satoru Ueda	Peer Reviewer	Lead Dam Specialist		GWADR
Shabir Ahmad	Team Member	Senior Program Assistant		SACPK
Shahzad Sharjeel	Team Member	Senior Communications Officer	External Communication	SAREC
Shalmraj Ramraj	Team Member	Knowledge Management Analyst		WFADC
Venkatakrishnan Ramachandran	Team Member	Program Assistant		GFADR
Winston Yu	Peer Reviewer	Senior Water Resources Specialist		GWADR

Extended Team

Name	Title	Office Phone	Location
Altaf Iqbal	Economist		Lahore
Egle DeAngelis	Analyst - COSTAB		Rome
Imran un Haq	Resettlement and Environmental Specialist		Lahore
Mohammad Ehsan	Senior Civil Engineer, Consultant		Lahore
Nazar Mahar	Senior Monitoring and Evaluation Specialist		Karachi

Locations

Country	First Administrative Division	Location	Planned	Actual	Comments
Pakistan	Sindh	Sindh		X	

Consultants (Will be disclosed in the Monthly Operational Summary)

Consultants Required?	Consulting services to be determined
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I. STRATEGIC CONTEXT

A. Country Context

1. Pakistan has made progress in reducing poverty and improving shared prosperity over the last two decades. Progress, however, slowed between 2009 and 2011 due to two massive floods, conflict, and the global economic slowdown. A majority of the nation's poor people still live in rural areas.

2. Pakistan is becoming water-scarce with a growing gap between demand and supply. The future impacts of climate change will pose not just an environmental challenge but also a fundamental threat to economic development and the fight against poverty. Continuing business-as-usual is likely to contribute to Pakistan's economic woes. To close the gap between water supply and water demand, Pakistan is placing emphasis on modernizing its ageing hydraulic infrastructure and improving water resources management.

3. The water sector will remain a critical contributor to sustained economic development. The sector plays an essential role in supporting the economy, particularly agriculture. The irrigation and drainage system has a total investment value estimated at around US\$300 billion at current prices. Nearly 43 percent of the population gains employment from this system, it accounts for approximately US\$16 billion or nearly 25 percent of the gross domestic product (GDP), and contributes to over 60 percent of the exports. Due to the country's arid/semi-arid climate and high susceptibility to droughts, agriculture in Pakistan is predominantly (90 percent) irrigated and adequate irrigation infrastructure is critical. Sindh Province, in particular, contributes 23 percent to the agriculture GDP, and has high potential for further productive development.

4. It is estimated that the cost of revamping the entire water sector will cost approximately US\$35–40 billion. This demonstrates a major deficit in infrastructure investment, which must be overcome to accelerate economic growth. Addressing this financial deficit, however represents a daunting challenge, especially in the face of constrained public resources and aid flows, and limited private sector involvement.

5. **Sindh Province is home to over 52 million people** (24 percent of Pakistan's population). The province constitutes 18 percent of the country's land area, and 14 percent of the total cropped area. About 30–35 percent of Sindh's population lives below the poverty line, with the majority being rural. Sindh makes up a large portion (26 percent) of Pakistan's cultivated area and produces about a quarter (24 percent) of the major irrigated crops, such as cotton, rice, sugarcane, and wheat. The cultivable command area is about 5.1 million ha. The actual irrigated area varies from year to year, depending on the availability of canal water.

B. Sectoral and Institutional Context

6. **Water Resources.** Annual water availability is below 1,000 m³ per capita, with a growing gap between water demand and water availability. Water demand is projected to rise as a result of population growth at an annual rate of ten percent, reaching 338 billion cubic meters (BCM) by 2025. At the same time it is expected that water supply will remain at 236 BCM, resulting in a demand-supply gap of approximately 102 BCM.

7. **Climate Change.** The reliance on a single river basin system, the Indus, makes Pakistan's water resource base highly vulnerable to climate change. About 40–50 percent of the total average flow in the Indus system is fed by snow and glacial melt, with the remainder coming from monsoon rains over the plains. In the future, experts predict that temperature increases will be higher in the region, compared to global average increases. As a result, it is expected that intra-seasonal variability will increase the likelihood of extreme events such as droughts and floods. Given the implications of climate change on temperature and precipitation variations, Pakistan's water availability is projected to become more unreliable. Climate change, therefore, further confounds the challenge of dealing with variability of both excesses and scarcities and dealing with rapidly growing water demands (water for energy, agriculture, and people, and protection from floods) from a resource base that is likely to change substantially as the glaciers of the western Himalayas melt and monsoon patterns change.

8. **Irrigation and Drainage.** Pakistan relies on the Indus Basin Irrigation System for provision of water to all its sectors. The system consists of the Indus River and its tributaries, three major multi-purpose storage reservoirs, 19 barrages, 12 inter-river link canals, and 45 major irrigation canals (covering over 14 million ha). The annual Indus River volume is 177 BCM, of which about 128 BCM is diverted from the river system to canals. While public infrastructure has improved over the years, the existing irrigation and drainage infrastructure is rapidly ageing.

9. **Institutional Arrangements and Reforms.** Pakistan has a long and well-established tradition of water entitlements. The 1991 Provincial Water Accord established clear surface water entitlements for each province. Implicit in the accord is a set of water entitlements at the canal command level. In large areas of the system these entitlements serve as the basis for allocation of water among canal commands. There are also well-established rules for further distributing water to the distributary canals and canal outlets.

10. The water economy of Pakistan depends on the huge hydraulic infrastructure system. The major challenge which has to be addressed is the maintenance of what has been built. Many elements of the vast hydraulic system, such as the Guddu Barrage, are now reaching the end of their design lives and have to be rehabilitated. The Sindh Provincial Irrigation Department (ID) owns, controls, and operates the barrages, main canals, branch canals, distributaries, and minors. The farmers own and operate the lower tier, or the tertiary systems called water courses.

11. **There are several complementary Bank-funded projects in the irrigation and agriculture sector in Sindh province.** The ongoing Sindh Water Sector Improvement Project (SWSIP) supports the reform program under which three Area Water Boards were established, encompassing about 1.8 million hectares of land or 31 percent of the total irrigated area of Sindh. In addition, over 350 farmer organizations have been formed in Sindh, and management transfer agreements have been signed with over 300 of them. The reforms are being addressed through the establishment of efficient and sustainable irrigation and drainage institutions.

12. The recently approved Sindh Irrigated Agriculture Productivity Enhancement Project (US\$258 million) supports efficient management of scarce water resources at the tertiary and field level where water losses are highest together with promotion of high efficiency irrigation system and improved irrigation agronomy. Farmers would benefit from land improvements and from training in improved agronomic practices. In addition, 5,000 female-headed households and

landless farmers would benefit from high-efficiency irrigation kits for kitchen gardening. In addition the on-going Sindh Agricultural Growth Project (US\$91 million) is aiming at improving the productivity and market access of small and medium producers in selected commodity value chains. The introduction of good agricultural practices will substantially increase the quality of production and the potential for increased trade and higher incomes. This project is also financing capacity building of producers through technology development, technology dissemination, training and exposure. The project provides institutional development and supports to the Sindh's agricultural sector.

13. Barrages are strategic assets of Sindh and millions of people depend on the water that is controlled, diverted, and managed by them. Their continued operation and management require specific expertise, experience, decision making, and continuity. At present the three barrages in Sindh each have a Chief Engineer who performs two tasks: (a) barrage infrastructure management and operation; and (b) water flow monitoring and regulation to canals in respective command areas. However, given the importance of the barrages, and the increasing challenges of floods resulting from climate change, there is a need to further enhance institutional performance by ensuring availability of highly experienced staff with adequate budget, modern equipment, and latest technology. To meet this need it is proposed to establish a dedicated Barrage Management Organization (BMO) within the Irrigation Department. Key priorities of the BMO, beyond current activities, include development of an early warning system, barrage safety, environment and social impact mitigation, technical knowledge, and improved communications.

14. **Priorities for the Improvement of Barrages in Sindh.** Three large barrages were built between 1932 and 1962 on the Indus River in Sindh Province. The northern one, Guddu barrage, has developed major safety issues. The second one, Sukkur Barrage, is one of the oldest and serves about three million ha of agricultural land. Over the decades, it has also developed safety issues. Repairs on the Sukkur barrage are being carried out regularly. The last barrage (most southerly), the Kotri barrage, was rehabilitated in 2000. This project will finance rehabilitation of the Guddu barrage.

15. **Guddu barrage.** The primary function of the gated Guddu barrage is to service the irrigation of over one million ha of agricultural land by feeding the Beghari Sindh Feeder and the Desert Pat Feeder main canals on the right side of the river and the Ghotki Feeder on the left side. The barrage is also used for river control and flood management. It is also an important transport link across the Indus River and provides cooling water for the thermal power station at Guddu. Two major gas lines cross the barrage. The barrage was commissioned in 1962 and has now served for over 50 years. It consists of 65 gates. The gates, each weighing 55 tons, are of the 'fixed wheel' type and operate without counterweights.

16. **Rehabilitation and modernization of Guddu.** The Guddu barrage constitutes the most strategic component of the large Indus Basin Irrigation System. The effective operations and structural stability are important for agricultural production and for averting potential disaster during floods. Climate variability will further add risks by changing the frequency and intensity of extreme events such as floods and droughts. There are serious operational difficulties and safety issues. The most severe problems include: (a) up to 60 percent of the steel used for the 65 gates on the main barrage are badly rusted; and (b) the lifting mechanisms are badly corroded, with a strong possibility of failure. Since the rate of corrosion cannot be slowed it is considered likely that the

gates will fail during normal operation. There is already a risk now that the gates may fail during a flood event that necessitates opening and closing. Such a failure will progressively affect water supplies to all the irrigated areas supplied by the barrage. Structural and operational interventions are therefore required to manage flows to the off-taking canals.

C. Higher Level Objectives to which the Project Contributes

17. **Consistency with the Government Vision of 2025.** The project is consistent with Vision 2025, which aims at transforming Pakistan into a developed and export-led economy with strong social values by promoting inclusiveness, peace and security, and greater inter-provincial harmony. The project contributes to the following ‘pillars’ of Vision 2025: sustained and inclusive higher growth, private-sector-led growth, and modernization of existing infrastructure. The Government of Pakistan and Government of Sindh (GoSindh) have both highlighted commercial agriculture and market linkages as priority investments for the agriculture sector. GoSindh has also prioritized investments in support of small and medium farmers and in value chains that will positively impact women. Through the ongoing Sindh Agricultural Growth Project the Bank will provide technical assistance to help Pakistan in its agricultural policy analysis and design with a view to increasing agricultural competitiveness and expanding rural livelihoods. The Sindh Agricultural Sector Development Strategy and the Irrigation Strategy to be developed will form a key contribution to longer-term sector growth and setting priorities for investment and future programming for Government as well as development partners including the Bank.

18. Pakistan adopted a National Climate Change Policy in 2012, with the overall goal of promoting climate-resilient development, as well as mainstreaming climate change issues within various sectors of the economy through the implementation of adaptation and mitigation measures. The objectives of the policy are cognizant of linkages between sustained economic growth and challenges of climate change, and aim to respond to these challenges by ensuring water security and food security.

19. **Consistency with the Country Partnership Strategy¹ (FY15–19).** The project is fully aligned with the Country Partnership Strategy (CPS), which has the overarching goal of helping Pakistan accelerate poverty reduction and shared prosperity. The major expected impact of the project will be sustained agricultural production and farm incomes in the barrage command area. **Table 1** lists the result areas and outcomes of the CPS that the project will contribute to.

Table 1: Project Impact on the CPS

Result Area (RA)	Outcome	Project Contribution
Private Sector Development (RA 2)	Increased productivity in farms (outcome 2.2)	Sustained agricultural production on 1.2 million ha benefiting 370,000 farm families.

¹ Country Partnership Strategy for the Islamic Republic of Pakistan (FY2015-2019) discussed by the World Bank Board on May 1st, 2014, World Bank (Report No. 84645-PK)

Result Area (RA)	Outcome	Project Contribution
Inclusion (RA 3)	Increased resilience to disasters in targeted regions (outcome 3.3)	Emergency Preparedness Plan prepared and implemented for Guddu barrage.
Service Delivery (RA 4)	Adoption of performance and transparency mechanism in selected institutions (outcome 4.4)	Improved performance and transparency within the Provincial ID in Sindh for improved irrigation service delivery at the barrage level. Service delivery monitored through users satisfaction surveys and citizens' feedback

20. **Contribution to Bank Twin Goals of Reduced Poverty and Increased Shared Prosperity.** The project includes structural and non-structural activities which promote equitable distribution of irrigation water and therefore provide a boost to shared prosperity. It will not only sustain farmers' income, but also reduce their vulnerability to future droughts. In addition, the project will have climate change benefits through the reduction of greenhouse gas by sustaining gravity-fed irrigation water supply rather than pumped irrigation.

21. The major employment in the area is from the agriculture sector and as general laborers. The education and income level in the project and surrounding area is typically low. The income of a large population of the project area is below the official poverty line. The result of social survey indicates a low level of household income although the better off households are generally those associated with agriculture sector including livestock.

22. Agriculture is commonly practiced in the project and surrounding area, with a number of small farmers working on owned or rented land growing sugarcane, rice, cotton, and vegetables as well as grazing livestock. Women and girls are commonly involved in all aspects of agriculture. Access to social amenities in the project and surrounding area is low. Electricity supply is available. However, access to gas supply, drinking water, sewerage, and drainage and health care facilities is very limited. As the groundwater in the command area is saline and not suitable for drinking, much of rural population depend on canal water. Partial or complete failure of the Guddu barrage can cause widespread flooding and interruption of water supplies, resulting in a disastrous setback to the economy and the lives of the people in the area.

II. PROJECT DEVELOPMENT OBJECTIVES

A. Project Development Objective

23. **The project development objectives (PDO)** 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.

B. Project Beneficiaries.

24. The primary beneficiaries include (a) over 2.6 million people, across 1.2 million ha of irrigated land in Kashmore, Ghotki, Jacobabad, Sukkur, and Shikarpur districts of Sindh, and Nasirabad and Jafarabad districts of Baluchistan, who will receive reliable supply of water and (b) local communities in flood-vulnerable areas who will benefit from improvement in flood management and reduction in risks of embankment breaches; since the capacity of the barrage to pass flood waters will be improved.

25. Indirect beneficiaries include (a) urban households, industry, and public agencies that depend on water diverted through the Guddu canals that will continue to have reliable water supply; (b) people who rely on the Guddu thermal power plants, which will have reliable water supply for electricity generation; (c) communities who use the Guddu bridge as the means to cross the Indus River; (d) people who depend on the two major gas lines from the Sui Fields which cross the barrage to link with the Multan-Sukkur pipeline; and (e) temporary and permanent labors engaged in the rehabilitation-related construction work.

C. PDO Level Results Indicators.

26. Progress toward achieving the development objective will be measured through the key performance indicators:

- Direct project beneficiaries (number) of which female ((%)
- Reliable supply of irrigation water without reductions in flows (BCM)
- Barrage and canal head regulator gates operating reliably (%)
- Guddu barrage meets defined safety standards (yes/no)
- BMO established and functional (yes/no)

27. The intermediate indicators include: (a) 25 main canal head regulator gates replaced; (b) 65 barrage gates and mechanical lifting equipment replaced; (c) dividing wall constructed; (d) river training works implemented; (e) environmental and social plan satisfactorily implemented; (f) Dolphin conservation and management plan satisfactorily prepared and implemented; and (g) grievances registered related to delivery of the project benefits that are actually addressed.

III. PROJECT DESCRIPTION

A. Project Components

28. **Component A: Rehabilitation of the Guddu Barrage (US\$195 million).** This component will support rehabilitation of the barrage and its associated structures. The component will finance:

- Gate replacement works to improve the regulation and the flow of the barrage. This includes replacing all 65 main barrage steel gates (the gates weigh 55 tons each), 25 main canal head regulator gates (the gates weigh 25 tons each), and hoist gears including all mechanical and electrical equipment.

- Concrete repairs along the upstream gate grooves and rehabilitation of both fish ladders.
- Removal of the left pocket dividing wall and construction of a new left pocket dividing wall to widen the left pocket and improve its ability to reduce the quantities of sediment entering the Ghotki Feeder canal.
- River training works through construction of a left-bank spur to promote favorable river approach conditions to the barrage and strengthen the upstream existing river training works.
- Staff 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.
- Implementation of the environmental and social management plan (ESMP).
- Consulting services for construction supervision, quality control, and construction management support.

29. **Component B: Improved Barrage Operation (US\$6 million).** This component will support the establishment of the BMO and modernization and improvements to the barrage O&M. Institutionally this will include undertaking a study to design the BMO structure, defining roles and responsibilities, and moving towards a more service oriented culture. Technically the Bank will finance necessary upgrades to the monitoring instrumentation, such as piezometers, gate-positioning and water measurement equipment, replacement of surveillance and maintenance boats, and procurement of hydrographic equipment. The project will support workshops and provide a stock of spare parts, for use in maintenance activities. The instrument monitoring system for the barrage will be renovated, and the operations staff will be equipped with an updated operation, maintenance, and surveillance manual.

30. **Component C: Project Management, Monitoring, and Evaluation (US\$7 million).** This component will support the coordination of all project-related activities as well as training and technical assistance in procurement, financial, social and environmental safeguards, and communication. This component will also finance the independent Panel of Experts (POE), who will review, monitor, evaluate, and help guide the rehabilitation process with regards to the safety of the barrage.

31. The component will also support implementation of an information dissemination and communication program, particularly regarding possible canal closures, citizens' engagement and feedback, and the implementation of safeguard-related action plans. A communication strategy has been developed, which specifies the information and messages that will be conveyed regarding interruption of water supply (if any), channels for citizen's feedback and the blind Dolphin conservation management plans including communication means, timings, and the corresponding frequency. Considering the low literacy rate in the project area and diversity of spoken languages in the canal command area (Sindhi, Balochi, Urdu, and Siraki), consultation is the most effective means of communication. Consultation will also ensure feedback from the citizens, men and women alike.

B. Project Cost and Financing

32. Project cost and financing requirements for the investment components are presented in **Table 2**. The costs (see Annex 3 for more details) are based on the detailed survey, hydraulic

modelling, condition assessment, and detailed engineering designs. Cost estimates for the gates and the mechanical and electrical equipment are a combination of budget prices from manufacturers and prices from previous similar projects such as Balloki barrage, Jinnah barrage, Tarbela dam, and the ongoing SWSIP. The prices are built up to provide budget installed prices. Price and physical contingencies are added to these costs. Recent lessons learned on cost overrun from the SWSIP have been incorporated during the preparation of cost estimates. Cost estimates for the civil works have been prepared using market rates for material, plant, and labor derived from a project-specific rate analysis for Sindh Province. Quantities for the river training works contract have been derived from detailed engineering designs.

Table 2. Component-wise Cost Estimates

Project Component	Total	GoSindh	IDA
	US\$ million		
Component A: Rehabilitation of the Guddu Barrage	195	20	175
Component B: Improved Barrage Operation	6	0	6
Component C: Project Management, Monitoring, and Evaluation	7	0	7
Total Cost	208	20	188

C. Lessons Learned and Reflected in the Project Design

33. The project design draws on lessons learned from rehabilitation of infrastructure projects both in and outside Pakistan, primarily the Taunsa barrage and the Jinnah barrage in Pakistan. Bank-wide experience in China, India and Egypt has shown that rehabilitation of damaged infrastructure is necessary, otherwise further damage could lead to failure of infrastructure. This can put strategic assets, people and property at risk. Therefore, the underlying premise of the project is to provide protection against failure of the Guddu barrage. Other lessons from the recent portfolio review and good practices incorporated into the project are the following:

- (a) The project design uses rigorous hydrological and hydraulic analyses. In-depth assessments undertaken, include hydraulic and sediment modeling studies and physical modeling.
- (b) The proposed institutional transition to establish the Barrage Management Organization within the Irrigation Department builds on lessons learned from the Punjab Barrage Project and will help to enhance long term institutional capacity and sustainability.
- (c) Based on the lessons learned from the Sindh Water Sector Improvement Project in which there was a problem with cost overrun, great care has been taken to provide for all contingencies. Moreover, in every Implementation Status Report the cost and cost development will be discussed.
- (d) The detailed design and bidding documents of key works have been completed. The project works are implemented through large civil works contracts following the best contract management models –whereby competent consultant with adequate resources provide construction supervision and quality assurance.

- (e) There have been extensive prior consultations with various stakeholders and alternatives have been considered – all to minimize adverse effects and to select the most cost-effective and sustainable interventions. An independent environmental impacts assessment has been completed.
- (f) The feasibility study including construction plans have been reviewed by an Independent Panel of Experts to identify and minimize negative effects during construction and operation such as possible interruptions of irrigation water supply.
- (g) Strong government leadership has been secured and the Project Management Office (PMO) is properly staffed with minimum staff turnover expected— all of which is indispensable to effective project preparation and implementation.

D. Alternatives Considered and Reasons for Rejection

34. **No intervention.** Failure of the Guddu barrage can cause widespread flooding and interruption of water supplies, resulting in a disastrous setback to the economy and the lives of the people in the area. Thus, ‘no intervention’ is not an option. The alternative of carrying out the repairs through intensive maintenance during regular closure periods was considered and not found viable.

35. **Refurbish versus replacement of gates.** The option of refurbishing the existing gates has been considered. However, the results of the investigations found that the gates, with the exception of the downstream lock gate, are at the end of their serviceable life. The work that will be required to bring the existing gates to a viable condition for reuse is substantial and certainly uneconomical as they require substantial replacement of sections and addition of further strengthening parts on site.

36. **Placement of ‘like-for-like’ gates.** The feasibility study shows that the gates should be replaced on a ‘like-for-like’ basis as the current gate design is sufficiently modern. There is possibly some saving as modern structural design is more efficient than that of the 1960s. With ‘like-for-like’ gate replacement, the gate travel will remain as is, and thus, the capacity of the barrage will be unaffected. The project would not raise the operational water level nor supply taller gates than the original design.

37. **Barrage regulator control system.** Several options have been considered for the rehabilitation of the Guddu barrage regulator control system. In considering the options, the feasibility study took into account the importance of maintaining power operations, number and skill level of barrage staff, and the likelihood that future expenditure on maintenance will not be significantly increased. Analysis shows that the option to rehabilitate the barrage using instrumentation and control, similar to the existing arrangement, provides the most reliable and most flexible solution. This is because it will accommodate multiple failures and still allow powered operation of gates.

IV. IMPLEMENTATION

38. **Institutional and Implementation Arrangements.** The PMO under the ID will be the implementing agency, while the Project Coordination and Management Unit (PCMU) of the

Planning and Development Department (PDD) shall provide coordination, monitoring of citizens' feedback, and evaluation. It is anticipated that during implementation the PMO will be developed into the BMO within the ID. This proposal is based on experience in Punjab where a similar arrangement is proving successful. The proposed BMO will bring all functions related to barrage infrastructure maintenance, operations, and modernization under one office—in a phased manner. GoSindh will first establish a PMO for the implementation of the Guddu barrage rehabilitation. In addition to project coordination, the PMO will coordinate relevant studies and assessments for the establishment of the BMO. The functions of the PMO would be merged into the BMO during project implementation.

39. The transition of the PMO into the BMO will be approached with care, after detailed analysis of current laws, notifications, budgetary process, accountabilities, skills/expertise available (and requirements), functional analysis of barrages maintenance/construction, and canal management in the command areas. The project will support GoSindh in the transition. The BMO will have a cadre of technical and administrative staff covering the entire spectrum of barrage infrastructure maintenance, operation, and management.

40. The PMO will be responsible for project implementation including technical, operational, financial management (FM), and overseeing the technical assistance and training program. The PMO has been established since the start of project preparation and is headed by an experienced project director with four units. The detailed institutional arrangements are provided in Annex 3.

41. The PCMU shall provide coordination and monitor citizens' engagement and evaluation. It will coordinate the work of the Project Steering Committee (PSC), and the POE. The PCMU will be supported by a Project Management Consultants (PMC) for bid evaluation and contract management. The Transparency International Pakistan will act as an observer in bid openings.

42. **Results Monitoring and Evaluation.** The key outcome indicators and intermediary indicators are provided in Annex 1. Data will be collected for each of the indicators by the PMO and the PCMU. The PMO will also be responsible for reporting the progress to the Bank.

43. The PMO will submit bi-annual reports in an appropriate format to GoSindh, the PSC, and the Bank. The bi-annual report will cover the progress and expected completion dates for civil works and equipment supply contracts, progress on institutional components, implementation of Social Development Action Plan (SDAP) and Environmental Management Plan (EMP,) training and studies, and activities of the PMOs project implementation, M&E, procurement, and financial consultants.

44. The PMO will prepare annual reports of project implementation. The report will cover (a) the progress of each component, implementation of key features of the EMP, key performance indicators, operation of project facilities, and financial statements; and (b) the Annual Work Plan for implementation. A mid-term review of the project will be undertaken. An Implementation Completion Report will be submitted to the Bank no later than six months after the project closing date.

45. The M&E consultants will provide the PMO with support to evaluate the project's impact, including the implementation and monitoring of the EMP and the Social Action Plan (SAP). The

M&E studies will evaluate the success in project implementation in terms of meeting the project’s objectives, and assess its physical, hydrological, environmental, social, and economic impacts. The M&E activities will provide continuous feedback to the PSC on the project’s performance, so that appropriate management actions can be undertaken in a timely manner.

46. **Sustainability.** The proposed rehabilitation is needed, not as a consequence of lack of O&M, but rather as a result of natural ageing of the infrastructure. The Guddu barrage was commissioned in 1962 and has been in operation for over 50 years. The proposed rehabilitation project will eliminate possible sources of failure and potentially give the structure another 50 years of life. Instruments will be installed to monitor the performance of the barrage structure and foundations. Under Component B, technical assistance would be provided to further strengthen the institutional capacity in barrage safety, modern instrumentation, better water and sediment measurement, climate change knowledge, and environmental and citizens feedback aspects.

47. From the point of view of financial sustainability, the O&M costs of Guddu barrage (US\$704,000) is low compared to revenue generated from irrigation water supply. Therefore, funding O&M costs is not an issue as these are more than adequately covered through the tariffs and revenue collected.

48. **Client’s commitment.** The government’s commitment to the project is evident through the resources it has allocated to the project. During project preparation, GoSindh assured that (a) a PMO has been established in the ID and core staff appointed during the project preparation, and they will continue for at least three to four years; (b) an independent POE has been established; (c) a procurement plan has been prepared with adequate packaging of the works contract including goods and a consultancy; and (d) a communication strategy has been finalized.

V. KEY RISKS AND MITIGATION MEASURES

A. Overall Risk Rating and Explanation of Key Risks

Risks	Rating
Political and Governance	Substantial
Macroeconomic	Moderate
Sector Strategies and Policies	Substantial
Technical Design of Project	Moderate
Institutional Capacity for Implementation and Sustainability	Moderate
Fiduciary	Substantial
Environment and Social	High
Stakeholders	Moderate
Other – Security	Substantial
Overall	High

49. The overall risk rating for the project is high. This is due to the environmental issues, the operating and security environment, and the large contracts involved. Systematic Operations Risk-Rating Tool (SORT) assessment is presented in Annex 5. The project’s design has been developed through feasibility studies, environmental and social assessment studies, and detailed engineering designs, and the works are primarily rehabilitation and modernization. To mitigate the high risk,

the project design involves Bank's supervision which includes bi-annual supervision missions and transaction based disbursement method. The risks should be considered in the context of the substantial benefits of sustaining agricultural production and avoiding a catastrophic failure of the barrage.

VI. APPRAISAL SUMMARY

50. **Economic Analysis.** For estimating the project's principal benefits, two different models have been developed: one under the typical approach based upon avoided losses in the production of irrigated crops due to the declining ability of the barrage to divert water from the Indus River (Scenario I); and the other considering catastrophic failure of barrage gates at any time after five years from now (Scenario II). Scenario I only assumes a gradual decline of the ability of the barrage for reliable irrigation and considers that the feeder canals' performance will decline and agricultural production in the Guddu barrage command area will reduce linearly over the course of 25 years at the rate of one percent per year.

51. While estimating benefits under Scenario II it is assumed that in the absence of corrective measures the barrage will catastrophically fail, partially or fully, at some point of time in the future, thereby incurring agricultural losses in the year of failure and in following years, temporary disruption of the Guddu thermal power station and of the already overstressed power supply, and additional capital costs required for emergency repair works to restore cooling water supplies to the thermal power station. The analysis is based upon the assumption that either (a) the barrage will continue to operate as at present with an inadequate pond height—as long as the gates do not collapse, the situation will remain the same and there will be no additional benefits or costs; or (b) the barrage will fail. If the barrage fails there will be no flow in the feeder canals for some time until emergency repairs can be done and there will be a sudden reduction in agricultural and power output. Details of estimates and assumptions for both the scenarios are set out in Annex 7.

52. **Production Impacts.** The project only concerns the rehabilitation of the existing barrage and will by itself not result in increased agricultural production or productivity in its command area. Under Scenario I, if no rehabilitation works are done, the agriculture production will decrease over 30 years from the present level of production.

53. **Beneficiary Households.** Average farm size in the geographical area of the project has been estimated as 3.3 ha². This indicates that the total number of beneficiary households will be more than 370,000. Assuming the average size of a family as seven persons, the project would yield benefits to about 2.6 million persons.

54. **Employment Impacts.** With reduction in the cropped area over time, a large number of laborers engaged in farming will be affected, which is at present estimated at about 19.1 million person days per annum. In addition, the project will generate direct employment and indirect employment in construction activities under the project.

55. **Poverty Impact.** Under Scenario I, it is likely that the continued decline in irrigation reliability would have a more serious impact on poorer farming families with land at the tail end of canals. In that the project would allow these families to have reliable irrigation services, it does

² Agriculture Census 2010-Sindh Report, data used for the six districts in the project area.

therefore have a significant poverty reduction benefit in addition to the employment opportunities during construction.

56. Based upon the analysis of avoiding agricultural loss (Scenario I), the economic internal rate of return (EIRR) is 17 percent for the base case as shown in Table 3. For economic analysis, assuming catastrophic failure of barrage gates (Scenario II), 19 separate EIRRs have been calculated, one each for a different year of possible failure between project year 5 and project year 20. Because the EIRR calculation is based on a discounted cash flow, these EIRRs are smaller the longer it takes for the failure to happen.

57. The result of the base case and sensitivity analysis indicate that the EIRR value is robust, not very sensitive to changes in costs and benefits, and in all but the most extreme cases always above the cut off rate, assumed as a 12 percent opportunity cost of capital. All project costs have been considered, valued in economic terms, and defrayed over the project construction period of five years.

Table 3. Summary of Results - Economic Analysis

Description	Scenario I: Agriculture Benefits			Scenario II: Catastrophic Failure
	EIRR	BC Ratio	NPV (12% Discount Rate) US\$, millions	EIRR Computed for Each Year Over 30 Years
Base Case	17%	1.7	94	EIRR comes to 37% if it occurs five years from now, 15% if it occurs after ten years from now, and 12% if the barrage sustains for twelve years from now.
Costs increase by 10%	16%	1.5	80	
Benefits decrease by 10%	15%	1.5	71	
Simultaneous increase in costs and decrease in benefits by 10%	14%	1.4	57	

58. **Fiscal Impact.** The cultivated area of Sindh province is about 5.1 million hectares. According to the tax mobilization plan the total agriculture-related tax collection (land tax/agricultural income tax, water rate (*abiiana*), local cess, drainage cess, and other land revenue) amounted to PRs 780 million in 2012–13, or about PRs 250 per hectare per year. In case of catastrophic failure of the Guddu barrage this analysis assumes that 2.3 seasons will be lost, which is equivalent to 1.15 agricultural years. The total loss of agriculture-related tax revenue for the 1.2 million hectares of the command area of the barrage would amount to some PRs 311 million (US\$3.1 million).

59. The lower annual de-silting costs due to the proposed new dividing wall will reduce the burden on the government by some USD\$410,000; over the 30-year project life this amounts to a present value of US\$2.55 million. The current maintenance budget of US\$708,000, which was inadequate under the present conditions, is considered adequate after renovation of the barrage due to the use of less maintenance intensive materials. In the short term, the fiscal impact of the project will be neutral, given that the government’s contribution to project costs primarily comprises salaries of existing district office staff and field team members. In the medium to long term, the

potential positive fiscal impact of the project will be substantial, mainly due to (a) increased output, income, and employment, resulting in increased tax revenues and (b) multiplier effects due to increased disposable income of the project beneficiaries, resulting in increased demand for goods and services, which is expected to generate additional income and employment effects.

60. **Technical.** The project is confined to a single site and from a technical point of view the works are not complex or extraordinarily challenging. Such barrages have been recently rehabilitated or newly constructed in Pakistan. Works are being designed by competent international consultants. The project involves mechanical and civil works on the existing barrage structure (rehabilitation), and no new works are included. By far the largest element of these works is the removal and replacement of the 65 barrage gates and 25 head regulator gates. A detailed inspection of each gate shows that wear and tear on the gates, rollers, and hoists is considerable and the probability of failure is evident. Considering that it will take about five years for the project to be completed and for all the gates and mechanical equipment to be replaced, the proposed project needs to proceed, so that the gates are replaced before any failure can occur. The project would not raise the operational water level nor supply taller gates than the original design.

61. All the underlying analyses and final designs are prepared according to international standards; these include hydrologic analysis, hydraulic analysis, seismic analysis, sedimentation studies, material tests, and strengths of material to be used for construction. The fine tuning of the design will continue until the bidding documents are issued. One critical activity is checking the robustness of the design to longer return period floods and prior to completion of detailed design the consultant will assess the impact of a 1 in 300 year flood. The Panel of Experts has been established and will remain involved during the construction period, to deal with the technical design and construction issues. The execution of the construction works according to the planned schedule in a timely manner without closure is key challenge. Measures are taken for proper construction planning and methodology to avoid disruption of flows to the three main canals and the river system downstream. A communications strategy has been formulated.

Financial Management (FM).

62. The PMO will be responsible for maintaining the FM arrangements during project implementation. An assessment of the FM capacity was carried out by the Bank during appraisal. The assessment concluded that the use of the country system, implementation of enhanced internal control arrangements, and capacity building of the project's FM staff will further strengthen the FM arrangements. The FM risk of the project is assessed as substantial because FM arrangements will be implemented after the project effectiveness. However, the risk is partly mitigated by the fact that the ID and PDD have significant experience of implementing large infrastructure and donor-financed projects. The Bank will provide support to the PMO in setting up detailed arrangements and key actions that may be required to prepare them for this function.

63. The project financial statements audited by and received together with the audit report and management letter from the Auditor General of Pakistan will be provided to the Bank within six months of the end of each fiscal year.

64. **Disbursement arrangements.** Disbursement will be made according to the transaction-based disbursement procedures that include the use of Statements of Expenditures (SOEs) and/or

Summary Sheets. Detailed FM arrangements are available under implementation arrangement in Annex 3.

Procurement.

65. Procurement for the project will be carried out in accordance with (a) the World Bank's Guidelines: Procurement under IBRD Loans and IDA Credits" updated July 2014; (b) Guidelines: Selection and Employment of Consultants by IDA Borrowers updated July 2014; ; (c) Guidelines on Preventing and Combating Fraud and Corruption in Projects Financed by IBRD Loans and IDA Credits and Grants", dated October 15, 2006 (revised in January 2011); and (d) the provision stipulated in the Financing Agreement. The ID has considerable experience in procurement and executing large civil works contracts. A satisfactory procurement plan has been prepared. PMO is the implementing entity and has a procurement and contracts management section within the Engineering Unit. PCMU/PMC will be supporting PMO in various activities and will provide guidance in procurement and contract management.

66. The works are packaged into three large contracts: (a) barrage works including replacement of electrical and hydro-mechanical equipment and construction of the dividing wall; (b) river training works; and (c) renovation of staff and O&M offices. This will help in attracting competent international contractors with the capacity to carry out such work in a timely manner. The construction supervision and quality assurance will be carried out by international consultants. There will be a few consultancy assignments, including for construction supervision and M&E. Due to the size of the procurement involved and the country environment the procurement risk is rated substantial. See Annex 3 for more details.

Social (including Safeguards).

67. Overall, the project is expected to provide positive social impact by maintaining reliable supply of water to more than 370,000 farm households and reducing communities' vulnerability against barrage failure. A Social Management Framework (SMF) had been prepared and disclosed, with objectives to provide an overall planning and implementing guidance to address social issues arising during the course of the project planning and implementation, including possible land acquisition and resettlement, disruption of water supply due to possible extended canal closure, and overall communication with stakeholders. The SMF is composed of (a) a Resettlement Policy Framework, (b) a Social Action Plan, and (c) a communication strategy.

68. **Involuntary Resettlement - OP/BP 4.12.** The project is not expected to require any land acquisition or resettlement. The RPF is prepared to guide resettlement planning for any unanticipated land acquisition and resettlement impacts during the course of the project implementation.

69. **Gender-informed design.** Under the ongoing SWSIP, women's participation in farmers' organizations has increased. In the Results Framework of the SWSIP, monitoring of gender distribution by the PCMU has been included in the core sector indicators. In addition under the on-going Sindh Agricultural Growth Project and recently approved Sindh Irrigated Agriculture Improvement Project women participation is expected to increase.

70. **Citizen engagement.** Communication with various stakeholders has played a key role in design of the project and it will continue to do so throughout the project implementation for operational efficiency and development effectiveness. In terms of internal communication, environment and social safeguards, monitoring and evaluation, and grievance redress functions will be supported through provision of outreach platforms for continuous engagement with stakeholders and relaying their feedback. External communication will systematically capture and disseminate project progress, highlight achievements, and keep all stakeholders engaged for broadening support and appreciation of irrigation reforms, particularly the importance of rehabilitation and modernization of irrigation infrastructure. The project will implement proactive citizen feedback mechanisms and water user's satisfaction surveys and other such proactive information and communication technologies-based means of engagement with citizens, and direct and indirect project beneficiaries.

Environment (including Safeguards).

71. The ID carried out a comprehensive Environmental and Social Assessment (ESA) for the project. The Guddu barrage has been in operation for more than 50 years and the proposed works will not alter the current operational regime of the barrage. The proposed project activities are likely to be limited to the existing footprints of the barrage; hence, most of the impacts are temporary in nature and limited to the construction period. The project will result in the increased life of the structure, which will ensure safeguarding the livelihoods of 2.6 million people in the barrage command area, besides ensuring a number of other environmental and social co-benefits.

72. **Natural Habitats - OP 4.04** is triggered. During construction the proposed project could potentially have adverse effects on the dolphin game reserve located between the Guddu and Sukkur barrages. This is in addition to the existing threats such as the reduction of prey base due to use of small-size mesh nets; poaching for their oil for use in 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. Impacts of construction activities on dolphins have been assessed in the ESA and mitigation measures have been proposed. The project will support the preparation of a dolphin conservation and management plan to strengthen the ongoing conservation activities. The dolphin game reserve was declared a Ramsar site (wetland of international importance) in the year 2000. The project has therefore been screened as Category A under the Bank's Environmental Assessment Policy (OP 4.01). Environmental health and safety guidelines have been taken into account in the project design.

73. **Mitigating climate risks.** A Climate Change Risk Assessment has been completed (on file). In light of this assessment, structural interventions, improved monitoring, adaptive management, and operation and maintenance measures have been recommended to improve the resilience of the structure to future climate change. The project activities will enhance adaptation to climate change in irrigation water management through the improvement in the hydraulic infrastructure and improved river training work.

Other Safeguards Policies Triggered

74. **Safety of Dams - OP 4.37.** The dam safety policy is triggered since barrages are major hydraulic structures. The POE has reviewed the detailed engineering designs and its safety aspects.

The POE will continue to remain involved throughout the life of the project. An emergency preparedness plan and an updated operational plan have been prepared.

75. **International Waterways - OP 7.50.** The project involves rehabilitation of existing barrage facilities. It does not involve works and activities that would exceed the original scheme, change its nature, or alter or expand its scope and extent to make it appear a new or different scheme. The project falls within the exception to the notification requirements set forth in paragraph 7(a) of OP 7.50. This analysis was approved by the Regional Vice President.

76. **Access to information.** This policy sets out the Bank's requirements for disclosing and sharing information. The policy reaffirms the Bank's commitment to transparency and accountability in its activities for promoting development effectiveness and poverty reduction. The ESA report and executive summary have been disclosed on the ID's project website (www.sbp.org.pk) and through the World Bank InfoShop on 12 January 2015 in addition to sharing the report with the stakeholders.

World Bank Grievance Redress.

77. 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 www.worldbank.org/grs. For information on how to submit complaints to the World Bank Inspection Panel, please visit www.inspectionpanel.org.

ANNEX 1: RESULTS FRAMEWORK AND MONITORING

Country: Pakistan

PK-Sindh Barrages Improvement Project: P131324

Results Framework

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

Project Development Objective Indicator	Core	Unit of Measure	Baseline	2016	2017	2018	2019	2020	2021	Frequency	Data source/ Methodology	Responsibility for data collection
Direct project beneficiaries (number), of which female (%)	X	Number (million), %	0	0	0	0	0	2.6 (50%)	2.6 (50%)	Annually	Progress Report	PMO/PCMU
Reliable supply of irrigation water without any reduction in flows		BCM	11.2	11.2	11.2	11.2	11.2	11.2	11.2	Annually	ID based on <i>Kharif</i> and <i>Rabi</i>	PMO/PCMU
Barrage and canal head regulator gates operating reliably		%	0	0	10%	25%	50%	100%	100%	Annually	Progress Report	PMO/PCMU
Guddu barrage meets defined safety standards		Yes/No	No	No	No	No	No	Yes	Yes	Annually	Reports by POE	PMO/PCMU
BMO established and functional		Yes/No	No	No	No	No	No	Yes	Yes	Annually	Progress Report	PMO/PCMU
Intermediate Results												
Main barrage gates and mechanical lifting equipment replaced		Number	0	0	16	32	49	65	65	Bi-Annual	Progress Report	PMO/PCMU
Main canal head regulator gates replaced		Number	0	0	6	12	25			Bi-Annual	Progress Report	PMO/PCMU
Dividing wall constructed		%	0	0	25	50	75	100		Bi-Annual	Progress Report	PMO/PCMU

Project Development Objective Indicator	Core	Unit of Measure	Baseline	2016	2017	2018	2019	2020	2021	Frequency	Data source/ Methodology	Responsibility for data collection
River training works implemented		%	0	0	0	25	50	100	100	Bi-Annual	Progress Report	PMO/PCMU
Staff and O&M offices constructed		%	0	25	100					Bi-Annual	Progress Report	PMO/PCMU
Environmental and social plan satisfactorily implemented		Yes/No	0	Yes	Yes	Yes	Yes	Yes	Yes	Bi-Annual	Progress Report	PMO/PCMU
Dolphin Conservation and Management Plan satisfactorily implemented		Yes/No	n.a.	Yes	Yes	Yes	Yes	Yes	Yes	Bi-Annual	Progress Report	PMO/PCMU
Emergency Preparedness Plan prepared in a consultative manner		Yes/No	No	No	No	No	Yes	Yes	Yes	Bi-Annual	Progress Report	PMO/PCMU
Grievances registered related to delivery of project benefits that are actually addressed	X	%	n.a.	90	90	90	90	90	90	Bi-Annual	Progress Report	PMO/PCMU

Indicator Description

Project Development Objective Indicators

Indicator Name	Description (indicator definition etc.)	Frequency	Data Source / Methodology	Responsibility for Data Collection
Direct project beneficiaries	Direct beneficiaries are people or groups who directly derive benefits from an intervention. Please note that this indicator requires supplemental information. Supplemental Value: Female beneficiaries (percentage). Based on the assessment and definition of direct project beneficiaries, specify what proportion of the direct project beneficiaries are female. This indicator is calculated as a percentage.	Annually	Progress Report	PMO/PCMU
Female beneficiaries	Based on the assessment and definition of direct project beneficiaries, specify what percentage of the beneficiaries are female.			PMO/PCMU
Reliable supply of irrigation water without reductions in flows	Reliable supply to the irrigated areas served with no reduction in water flow compared to the baseline of 11.2 BCM/annually. Establish reliable rating curves for each canal. Use of portable ADCPs to allow the ratings to be reviewed. Measure (% of rating curve updates achieved each year)	Annually	Progress Report	PMO/PCMU
Barrage and canal head gates operating reliably within the required operating time	Barrage and canal head gates operating reliably within the required operating time as per Standard Operating Procedures	Annually	Progress report	PMO/PCMU

<p>Guddu barrage meets defined safety standards</p>	<ul style="list-style-type: none"> (i) Guddu barrage is rehabilitated to pass design flood safely and provide centralized flow to protect scouring of left marginal bund; (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); (v) Barrage emergency handling protocols and procedures established and training provided; 	<p>Annually</p>	<p>Progress report verified by the Panel of Experts</p>	<p>PMO/Panel of Experts</p>
<p>Barrage Management Organization established and functional</p>	<p>Functional is defined as:</p> <ul style="list-style-type: none"> (i) BMO adequately staffed; (ii) Adequate budget available for BMO operations; (iii) Performance of all the functions as per the mandate regarding the barrage infrastructure management and operation; (iv) Continuous water flow monitoring and regulation to canals in respective command areas. 	<p>Annually</p>	<p>Progress report</p>	<p>PMO/PCMU</p>

Intermediate Results Indicators

Indicator Name	Description (indicator definition etc.)	Frequency	Data Source / Methodology	Responsibility for Data Collection
Main barrage gates and mechanical lifting equipment replaced	No description provided.	Bi-Annual	Progress report	PMO/PCMU
Main canal head regulator gates replaced	No description provided.	Bi-Annual	Progress report	PMO/PCMU
Staff and O&M offices constructed	Staff colony constructed with offices and residential units.	Bi-Annual	Progress report	PMO/PCMU
Environmental and social plan satisfactorily implemented	<p>Site-specific plans will be prepared and implemented to manage and mitigate/reverse potential adverse environmental impacts: (a) Erosion, Sediment and Drainage Control Plan; (b) Pollution Prevention Plan; (c) Waste Disposal and Effluent Management Plan; (d) Traffic Management Plan; (e) Borrow Area Management and Restoration Plan; (f) Occupational Health and Safety Plan; (g) Protection of the Gas Pipeline; (h) Drinking Water Supply and Sanitation Plan; (i) Management Plan for Protection of Flora and Fauna; (j) Construction Camp Management Plan; (k) Fuel and Hazardous Substances Management Plan; (l) In-stream Construction Works Management Plan; (m) Emergency Preparedness Plan; and (n) Communication Plan.</p> <p>Satisfactory implementation means at least 80% of agreed annual activities implemented during the year. Quality of implementation satisfactory as verified by</p>	Bi-Annual	Progress Report	PMO/PCMU

	Monitoring and Evaluation Consultants and WB Implementation Support Missions			
Dolphin Conservation and Management Plan satisfactory implemented	At least 80% of agreed annual activities implemented. Quality of implementation satisfactory as verified by the Monitoring and Evaluation Consultants and World Bank Implementation Support Missions	Bi-Annual	Progress Report	PMO/PCMU
Emergency Preparedness Plan finalized in a consultative manner	Consultative approach will include village meetings; consultations with political/local leaders; focus group discussions; consultation workshops	Bi-Annual	Progress Report	PMO/PCMU
Grievances registered related to delivery of project benefits addressed (%)	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.	Bi-Annual	Progress Report	PMO/PCMU

ANNEX 2: DETAILED PROJECT DESCRIPTION

Background

1. The Guddu Barrage is the first of three barrages constructed across the Indus River in Sindh Province. It is located about 13 km (8 miles) north-east of Kashmore district of Sindh Province, 630 km from the city of Karachi, and 190 km from Sukkur. The barrage is accessible by road from these cities. The Taunsa barrage in Punjab Province is located upstream of the Guddu barrage.
2. **Key Features of the Guddu Barrage** are listed in Table 2.1.

Table 2. 1: Guddu Barrage Features

Length of barrage	1,355	m
No. of gates in main weir (each 55 tons)	51	
No. of gates in right pocket (each 75 tons)	7	
No. of gates in left pocket (each 75 tons)	6	
No. of navigation locks (each 100 tons)	1	
Discharge Capacity		
Barrage designed discharge (headwork)	31,149	m ³ /sec
Barrage designed flood discharge	33,980	m ³ /sec
Desert Pat Feeder	376	m ³ /sec
Beghari Sind Feeder	418	m ³ /sec
Ghotki Feeder	240	m ³ /sec
Command and Irrigated Area		
Desert Pat Feeder (left bank)	434,911	ha
Beghari Sind Feeder (left bank)	388,036	ha
Ghotki Feeder (right bank)	402,541	ha
Total Irrigated Area	1,225,488	ha
No. of direct beneficiaries served (based on an average of 3.3 ha per household)	370,000	household

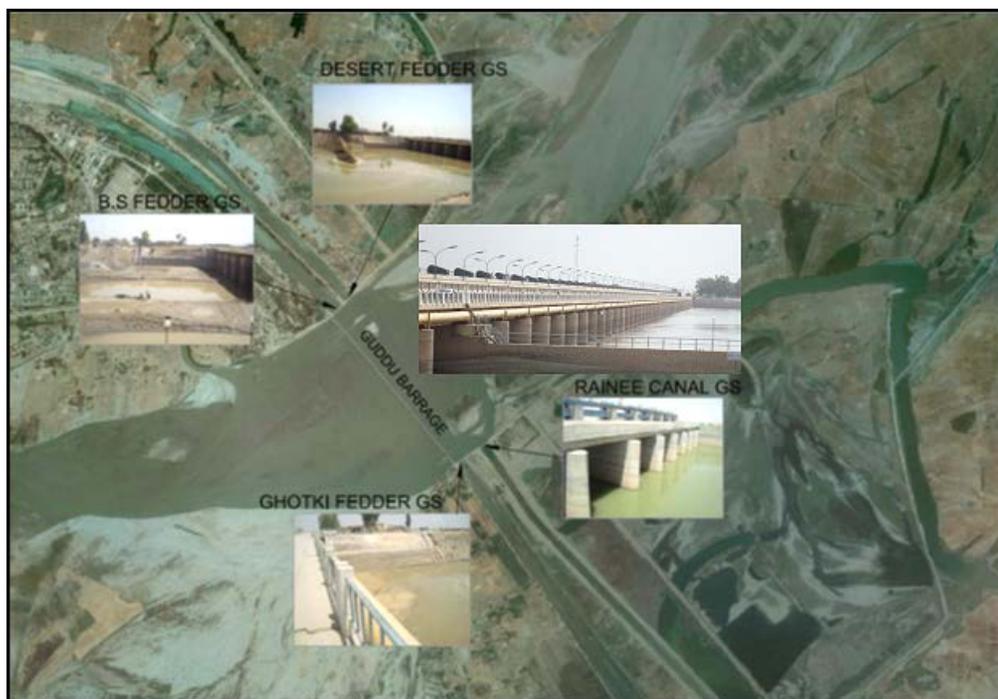
3. **Barrage flood discharge function.** The Guddu Barrage has been designed to pass a maximum discharge of 31,150 m³/s. Since its construction, the barrage has safely passed flood discharge that exceeded this limit in five instances, with the maximum being 33,950 m³/s on August 15, 1976. Presently, the barrage is considered safe for passing 33,950 m³/s. For a 1-in-100 year design standard the discharge rate is 35,750 m³/s. There is uncertainty about the absolute reliability of historic flows gauged at the barrage. Training and equipment to be provided under the project will result in improved confidence in flow gauging and measurement.

4. **Barrage irrigation function.** There are four off-take canals: (a) Beghari Sindh Feeder (right bank) with a designed supply discharge of 418 m³/s; (b) Desert Pat Feeder (right bank) of

376 m³/s; (c) Ghotki Feeder (left bank) of 240 m³/s and (d) Raine Canal (left bank) of 280 m³/s. Raine Canal is designed as a flood canal. The command areas lie in the Ghotki, R.Y.Khan, Jacobabad, Nasirabad, Jafarabad, Sukkur, and Shikarapur districts of Sindh. These districts are situated in an arid/desert zone where crop production is only feasible with irrigation. The cumulative command area of the Beghari Sindh Feeder, the Desert Pat Feeder, and the Ghotki Feeder is one million hectares. About five million people in these seven districts inhabit the command areas of the three canals, and their livelihoods depend directly or indirectly on the irrigation supplies of these canals.

5. Around 78 percent of the area in Sindh province is underlain by saline groundwater, which is unsuitable for irrigation, drinking, cattle consumption, and domestic uses. Therefore, canal water is the major water source for drinking, cattle consumption, and domestic uses in the command areas of three canals.

Figure 2.1: Aerial View of the Guddu Barrage



6. The total width of the barrage between the two abutments is 1,355 meters. The under sluices are used to flush out sediment. On the upstream there are divide walls on the left and right side. There are two fish ladders in the outer piers of both pockets. The barrage has a silt excluder each on the left and right under sluices. Flow of the Indus River is guided by two downstream and upstream guide banks, upstream marginal embankments on both sides, and two flank walls (abutments) on the left and the right flanks. Each of the two divide walls has an adjoining fish ladder. A road bridge along with a foot path on each side provides the means of transportation across the barrage.

7. **Issues with the Guddu Barrage.** The construction of the barrage started in 1956–57 and completed in 1962–63. Prior to the construction of the barrage, the river meandered within the ‘river belt’ width of 10–13 km. The barrage was constructed on the right side of the ‘river belt’ by diverting and keeping the flow to the left side during construction. After completion of the structure the river flow was diverted through the barrage structure.

8. For ensuring the flow through the barrage structure, training works comprising a T-head spurs upstream of the barrage were constructed. Later on, a J-head spurs upstream of the barrage, were constructed. The river continued to meander and change its approach within the guide bunds; however, there was no significant adverse effect on operation of the barrage and regulators of the off-taking canals until 1981. In recent years, shoals have formed; particularly on the left side the shoals have become big in size and are progressing toward the barrage. By 2005, the left side shoals reached within 500 feet of the barrage, causing disruption to the operation of the Ghotki Feeder. However, it has been noticed that the river has changed its trend of increasing the left shoal and since the flood season of 2006 has started eroding it.

9. A river survey shows that the flow has started shifting to the left. It has been noted in 2008 that a shoal about 2000 feet upstream adjoining the right guide bund has started forming. While the river approach presents no immediate threat to the integrity of the barrage, measures are required to promote a more centralized and equitable river approach to both pockets.

10. **Climate change and other long term issues.** A Climate Change Risk Assessment has been completed to assess the impacts of climate change and other long term issues at Guddu Barrage. In light of this assessment, structural interventions, improved monitoring, adaptive management, and operation and maintenance measures have been recommended to improve the resilience of the structure to future climate change.

11. Climate change is expected to increase the occurrence of extreme climatic events (such as floods and reduced flows during low flow periods). The main risks from climate change at the barrage are from changes in flow patterns; however, there are also potential impacts from increases in extreme wind events and extreme temperature (for example, water temperature effects on aquatic ecology). Flow extremes may be mitigated to some extent by increased regulation of the upstream river, which will result from future planned dam schemes on the Indus and its tributaries.

12. Increased magnitude and frequency of peak flood flows may result in an increased demand on the upstream embankment system to contain flood discharges. Also, of some concern is the steady rise in downstream water levels at the barrage which indicate a rate of accretion of about a foot per decade. This either means that the capacity of the barrage is reduced or floods must be passed at a higher upstream water level. A freeboard provision of six feet is proposed for the embankment crests to accommodate these aspects over the lifetime of the current rehabilitation. Rehabilitation of river training works will increase their resilience and ability to meet a potentially increased frequency of service demand in the future. The gate rehabilitation will safeguard reliable operation and enhance water management during high flow conditions.

13. During times of low flow, there are already challenges to water supply and the upstream pond is occasionally operated at a high level to overcome siltation in the upper reaches of the off taking canals. The recommendations for the structural and operational interventions, including the

widening of the left pocket are based partly on improved management of sediment. 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 climate change. The gate rehabilitation will improve operation and enhance water management during low flow conditions. Adaptive capacity has been built into the project design.

14. **Component A: Rehabilitation of the Guddu Barrage (US\$195 million).** This component will support rehabilitation of the barrage and its associated structures. The works have been determined based on (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 component will finance:

- (a) Gate replacement works (US\$88 million) 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, replacement of barrage lighting, repairs to the barrage lifting bridge and safety barriers, and rehabilitation of the three main canal head regulators.
- (b) Concrete repairs (US\$6 million) along the upstream gate grooves and rehabilitation of both fish ladders.
- (c) Removal of the left pocket divide wall and construction of a new left pocket divide wall (US\$38 million) to widen the left pocket and improve its ability to reduce the quantities of sediment entering the Ghotki Feeder canal.
- (d) River training works (US\$46 million) through construction of a left-bank spur to promote favorable river approach conditions to the barrage and strengthen the upstream existing river training works.
- (e) Staff offices for the O&M staff (US\$4 million) at the Guddu Barrage including a laboratory, residential buildings, dispensary, mosque, recreational facilities, access roads, and all supporting service infrastructure. Also included is the construction of a new office at Sukkur and the rehabilitation of residences
- (f) Implementation of environmental and social plan (US\$6 million).
- (g) Consulting services (US\$7 million) for construction supervision, quality control, and construction management support.

15. **Barrage and head regulators gates.** The gates of the Guddu barrage are the ‘fixed wheel type. The gates are without counterweights and are suspended by chains which are operated by gears installed in a hoist at the top of the piers. Each gate runs on eight wheels (or rollers), four on each side of the gate, which in turn transfer the horizontal load to the pier via an embedded steel beam. Guide rollers and buffers on either end of the gate restrain the gate laterally. The gates are electrically operated with a 4.0 KW motor mounted on a mobile trolley, running on rails. The gates can also be operated manually. For electrical operation, there are seven electrical trolleys running on rails. The gear boxes are located on each side of the gate connected through a winch shaft. The gates are lifted by chains.

16. The head regulator gates are also of the fixed wheel type. However, they are fitted with counterweights to reduce the hoist effort required. The gates are hoisted by means of a steel rope

at each end of the gate. Each head regulator gate runs on eight wheels (or rollers), four on each side of the gate which in turn transfer the horizontal load to the pier via an embedded steel beam. Guide rollers and buffers on either end of the gate restrain the gate laterally. The gates are electrically operated with 3.2 KW motor mounted on a mobile railed trolley. The gates can also be operated manually. The gear boxes are located on each side of the gate and are connected through a winch shaft.

17. **Condition assessment of barrage gates:** A detailed condition assessment of the current gates was undertaken which included taking measurements of material thickness using an ultrasonic meter to assess material loss due to corrosion over the life of the structure. The inspection was limited to accessible areas of the gate structure and it is quite possible that higher levels of material loss could be evident in more inaccessible areas, since these are also inaccessible for maintenance. It was noted that it was not possible to repaint the underside of the bottom girder element during the maintenance being undertaken at the time of the inspection and, therefore, this part may not have been recoated since its original installation in the 1960's. Therefore, it is quite likely that the level of corrosion on this face is higher than on parts where recoating is possible and has been carried out occasionally during the life of the structure. Due to the uneven surface the instrument was applied to, the layers of corrosion on the gate surface, and many layers of coating applied to the gate, the readings from the thickness gauge can be assumed to be high compared to the actual amount of remaining steel. Historical drawings show the skin plate thickness was originally 12 mm.

18. Currently stress levels within the gates are already in excess of the allowable design stresses during normal operation and the margin of safety will continue to reduce as the gates continue to corrode. Given that parts of the gates are unable to be maintained it is unlikely that the rate of corrosion can be slowed without considerable investment in maintenance works and therefore it is considered likely that the gates will be at risk of failure during normal operation. A failure in this event is likely to be catastrophic and will result in uncontrollable flow through the affected bay which will be difficult to recover and it will likely be some months before proper control of the pond level could be regained.

19. **Concrete repairs.** The barrage and head regulator concrete structures are in fair condition considering the cumulative service of the barrage. There is evidence of minor spalling around some of the barrage gate grooves, and poor cover to reinforcement and minor honeycombing of concrete under the road bridge deck. Concrete repairs are also needed to the fish ladders.

20. **Divide wall and sedimentation.** Options have been examined to construct a traditional reinforced concrete left pocket divide wall with block-work protection and sheet piles toes, within a series of cofferdams. These have not been taken forward for the following reasons: (a) to maintain irrigation supplies within the tight confines of the pocket, it would be necessary to install a series of cofferdams, leading to an increase in the construction program, and limited construction windows as the cofferdams would need to be removed for each monsoon season; (b) geometric constraints make installing a cofferdam at the interface between the divide wall and the barrage extremely difficult; and (c) dewatering of the cofferdams would be a significant undertaking, even during the closure period. Instead it is proposed to use sheet piles for most of the upstream wall as were adopted for the Rainee canal divide wall extension. These may be installed without the use of cofferdams, thereby allowing irrigation supplies to be maintained throughout the works. The

construction of the new divide wall will enable effective still pond operation and regular flushing operations to occur in the left pocket, thus significantly reducing the silt load in the off-taking canals.

21. **River training works.** The river training works comprise flood banks (termed marginal bunds) linking the structure to the high ground on either side of the flood plain; curved upstream approach bunds (termed guide bunds); and upstream embankment spurs to help improve the hydraulic approach conditions. The river upstream of Guddu is an active flood plain about 10–15km (6–10 miles) wide. River training works have been constructed upstream and downstream of the existing barrage to channelize river flow, prevent overtopping of structures, and protect existing infrastructure downstream of the barrage. Based on the physical and numerical modelling studies carried out the following recommendations for the river training works associated with the barrage will be undertaken:

- (a) Construction of a new spur on the left bank spur complex, to improve the hydraulic approach conditions to the barrage.
- (b) Repairs, rehabilitation, and raising of the existing spurs and guide bunds.
- (c) Reinstatement of a freeboard to the marginal bunds upstream of the barrage to accommodate the 1:100 year return period flood event.

22. **Staff and O&M offices.** During the rehabilitation of the Guddu barrage a staff colony will be required for use by the client and consultant's site supervision staff. The colony is proposed on the right bank downstream of the barrage, in an area currently occupied by derelict park land which is owned by the ID. Upon completion of the project the colony will be handed over to the ID, GoSindh for the use of barrage operations staff. The total area of the proposed colony is about 13.75 acres. The colony will include residential buildings, offices, a laboratory, dispensary, mosque, recreational facilities, access roads, and all supporting service infrastructure. Also included are the construction of a new office at Sukkur and the rehabilitation of residences.

23. **Implementation of environmental and social plan.** As the project involves large-scale construction on the Indus River and irrigation systems and the possibility of interruption of canal supplies for a short or long duration, the project is categorized as environmental Category A, requiring thorough environmental and social assessment, analysis, development of social impact and environmental management plans, consultations and disclosure, and their diligent implementation and monitoring.

24. This component also covers implementation of the Dolphin Conservation and Management Plan to address the issues currently threatening the dolphin reserve, including population surveys, threat assessment, and capacity building; development of a sustainable fisheries management plan; establishment of dolphin rescue units; and education and awareness programs. This component will support the communications strategy for the project including consultations in the project area and command area. There are no foreseen resettlement requirements as a result of the proposed project; however, under the implementation of the environmental plan and the SAP a contingency allowance is made for the preparation of RAPs.

25. **Component B: Improved Barrage Operation (US\$6 million).** This component will support the establishment of the BMO and modernization and improvements to the barrage O&M.

Institutionally this will include undertaking a study to design the BMO structure, defining roles and responsibilities, and moving towards a more service oriented culture.

26. The performance monitoring, safety evaluation, and operation of the barrage system can be carried out by monitoring the following parameters at certain regular intervals: water levels at barrage, at selected locations in the river, and downstream of canal head regulators; flow measurement of the river; periodic bathymetric survey of the river bed to assess sediment deposit and scour in general and at critical locations; measurement of concentration and gradation of sediments in flowing water during different flow conditions in river monitoring system; and measurement of uplift pressures in barrage and head regulators. These parameters are not adequately being monitored and recorded. For modernization of the monitoring and control system there is a need to upgrade the monitoring system to modern standards. This component will support modernization and improvements to the barrage O&M. This will include necessary upgrades to the instrument monitoring systems such as piezometers, gate positioning and water measurement equipment (acoustic Doppler current profilers), replacement of surveillance and maintenance boats, and procurement of hydrographic equipment. The project will provide new covered workshops and a stock of spare parts for maintenance activities. The instrument monitoring system for the barrage will be renovated and the operating staff will be equipped with an upgraded operation, maintenance, and surveillance manual.

27. During the construction of the barrage and head regulators, standpipe piezometers were installed at various locations to monitor the subsurface stability of the structures. These piezometers are observed by dipping the various piezometers on a fortnightly basis during the flood season and on a monthly basis in the low flow season. A review of the data collected has identified widespread damage to the piezometers. Those piezometers reading in error shall be rehabilitated, or where the level of damage prohibits rehabilitation, options for their replacement shall be investigated. In addition, a line of new piezometers will be installed along the left and right pocket walls and single piezometers at intermediate locations on the main barrage axis and on the head-regulators.

28. To develop and maintain reliable rating curves downstream of the head regulators and barrage itself, Acoustic Doppler Current Profilers (ADCPs) are to be provided. As part of the civil works contract, a boat mounted ADCP is to be provided to a work boat to allow recording of depth soundings and flow measurements in the Indus River, downstream of the barrage. Two portable ADCPs shall also be provided to allow depth soundings and flow measurement to be taken in the canal downstream of the head regulators. Measurements are to be taken as required to obtain rating curves of suitable accuracy. Readings will be accompanied by water level measurements upstream and downstream of the structure wherever gauges are provided, and by an accurate record of gate positions at the time of measurement.

29. **Component C: Project Management, Monitoring and Evaluation (US\$7 million).** This component will support the coordination of all project-related activities as well as training and technical assistance in procurement, financial, social and environmental safeguards, and communication. Activities will include the establishment of an independent POE to review, monitor, evaluate, and help guide the rehabilitation process with regard to the safety of the barrage.

30. The component will also support implementation of an information dissemination and communication program, particularly regarding possible canal closures and the implementation of safeguard-related action plans. A communication strategy has been developed, which specifies the information and message to be conveyed, communication means, timings, and the corresponding frequency. Considering the low literacy rate in the project area and diversity of spoken languages in the command area (Sindhi, Balochi, Urdu, and Siraki), consultation is the most effective means of communication. Consultation also ensures feedback from the citizens.

Construction Planning and Sequencing of Works

Table 2.2: Summary of Construction Planning and Sequencing of Works

Package	Description	Type	Cost (US\$, million)
1	Barrage works, including replacement of electrical and hydro mechanical equipment, and modification to left divide wall	ICB	137
2	River training works	ICB	46
3	Renovation and construction of staff residents and O&M offices	NCB	4
Total			187

Note: NCB - National Competitive Bidding

31. **Contract 1: Barrage works.** The barrage civil engineering works consist of remodeling of the left pocket, involving: (a) removal of the old divide wall; (b) construction of a new divide wall; and (c) minor civil repairs to the barrage and head regulator structures. The barrage civil engineering works will be completed in three working seasons.

32. **Replacement of gates.** The replacing of the barrage gates is a complex activity and involves replacement of the barrage and head regulator gates through possibly moveable bulkhead gates which will be floated to the work area guided by boats. However, the contractor will be required to propose his own methodologies. It is planned to manufacture four sets of bulk head gates (upstream and downstream). Three sets will be earmarked for replacing the barrage gates; the remaining set will be used for replacing the gates for the three head regulators, namely the Beghari Sindh Feeder, the Desert Pat Feeder and the Ghotki Feeder.

33. **Contract 2: River training works.** The river training works comprise raising the crest and restoring the embankment widths and spurs upstream and downstream of the right side and left side of the river. The right of the river includes: (a) a guide bund; (b) marginal bunds both upstream and downstream; (c) a T-spur; and (d) a TJ-spur. The left of the river includes: (a) a guide bund; (b) a marginal bund upstream; (c) a T-spur; (d) a J-spur; and (e) construction of a single new spur on the left bank. The river training works contract will be carried out over a period of three years.

34. **Contract 3: Colony and building works.** These works include construction of a colony for supervisory consultants' staff on the barrage site during the construction period and later

handing over the offices and residential buildings to the Sindh ID. Also included are the construction of a new office at Sukkur and the rehabilitation of residences. The barrage colony will be constructed in seven months including the mobilization period of one month after the award of the contract, before the commencement of the remaining two contracts.

Sequencing of Works

35. The construction is planned to be completed in five calendar years. The construction works inside the river will be primarily between October to May/June while the period between June and September, when the river flow is highest, will be used for preparation for the following construction year. The main contract will be awarded in a manner such that the contractor is mobilized in time to prepare for the first working season (October to June). The gates will be replaced during the period from October to May when the flows are normal in the river and there is no flood.

Possible Construction Methodology

Figure 2.2: Stages of Guddu Barrage Rehabilitation

Bulkhead Gate Installation



To allow replacement of the barrage gates, temporary bulkhead gates are to be installed across the gate bays. The bulkhead gates will be launched into the river from a docking area and guided to the barrage using work boats. Before fitting the bulkhead gates a receiving layer of sandbags will be placed by divers at the base of the gate bay, to provide support and to assist with sealing. Mechanical supports may also be required to support the top of the gate. The number of bulkhead gates required will depend upon the contractor's methodology, but similar sized projects have been completed with four gate bays being worked on at one time.

Removal of Gates



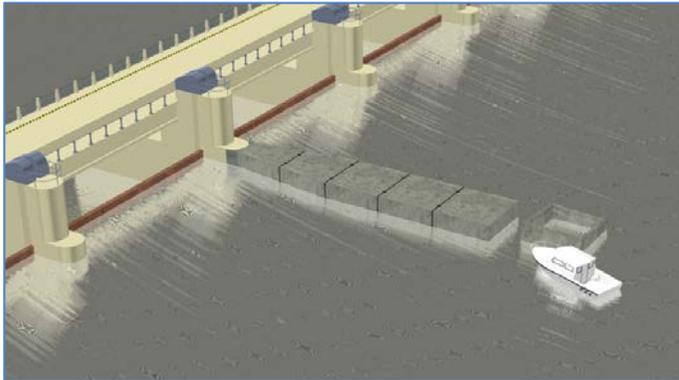
Once the bulkhead gates are in position, pumps will be used to drain the working area. The temporary pumping system will likely comprise electric submersible pumps and a diesel generator. Particular care will be taken to prevent fuel spillage from the diesel generator. Smaller items such as the existing hoist gear will be disassembled in position and removed from site on a truck. Larger items such as the chains and gearboxes will be removed by a barge mounted crane located upstream of the barrage. Scaffolding will be required to disassemble the gates. The existing gates will be cut and lifted out by the barge mounted crane and removed from site.

Installation of New Gates



The new gates will be installed in sections using the barge mounted crane. The sections will be joined together by welders working on scaffolding within the barrage bay. Factory fitted location marks, jigs and survey equipment will be used to verify accurate positioning of sections before welding. Following welding, inspection of the gate will take place. The gate sections will be coated using a paint system in the factory, apart from the areas adjacent to the required welds. These areas will be coated once the welding is completed. Before removing the bulkhead gates the new gate will be tested and commissioned to ensure proper operation and to check proper functioning of the seals.

Left Pocket Divide Wall



Construction of a new left pocket divide wall on the seventh gate bay is required, to allow the barrage to be operated as originally intended to remove silt from water entering the off-taking canals. To avoid interruption to irrigation supply, the new wall will be constructed without installing a cofferdam. Where the wall is installed over the existing barrage concrete apron, interlocking precast concrete caisson units will be launched from a slipway and floated out to the barrage using work boats. A receiving layer of sandbags will be placed by divers to provide support to the caissons which will be partially flooded so that they sink gently onto the barrage apron.

Mini Piling



To support the weight of the new wall and to avoid loading onto the existing barrage apron, the caissons will be supported on reinforced concrete mini-piles. The piles will be cored through steel casings inside the caisson units. Once the piling is completed, the caisson unit will be jacked up onto the piles so that it does not impart any weight onto the barrage apron. The interface between the caisson and the apron will then be filled with grout. Finishing works will be carried out to tie the caisson units laterally to one another and precast concrete caps will be placed to cover each caisson unit.

Cellular Sheet Pile Wall



Where the divide wall is to be installed away from the barrage apron, a cellular sheet pile wall will be constructed, either entirely using a marine plant, or on an island of dumped material to allow construction on a dry footing. A trench will be excavated in advance of the piling, where required, to remove obstructions. A template will be placed for each cell and the piles pitched and driven. The cells will then be progressively filled with sand. Rip-rap stone scour protection shall be placed around the periphery of the new divide wall. In parallel to these works, the existing left pocket divide wall extension, installed under the Rainee canal project will be removed.

Review by Panel of Experts (POE)

36. The ID has appointed a POE comprising three expert; one international gates expert and two national experts: hydrologist and hydraulic/structural (barrage) engineer. The POE visited the project site and reviewed the feasibility report and detailed designs prepared by an international consulting firm. The review included aspects of hydrology, climate change, stability analysis, safety assessment, hydro-mechanical installations, instrumentation, seismicity, pond level, physical and numerical modelling, operational guidelines, emergency preparedness plan, and project implementation and construction methodology.

37. The POE reviewed the detailed engineering designs and its safety aspects (report on file). The POE endorsed the proposed interventions: (i) replacement of barrage and canals head regulator gates including electrical and hydro mechanical equipment; (ii) modification to left divide wall; and (iii) river training works.

Project Cost

38. The total project cost is estimated at US\$208 million equivalent. The costs are based on the detailed survey, hydraulic modelling, and condition assessment and detailed engineering designs. Cost estimates for the gates and the mechanical and electrical equipment are a combination of budget prices from manufacturers and prices from previous similar projects such as Balloki barrage, Jinnah barrage, Tarbela dam, and the ongoing SWSIP. The prices are built up to provide budget installed prices. Price and physical contingencies are added to these costs. Recent lessons learned on cost overrun from the SWSIP have been incorporated during the preparation of cost estimates. Cost estimates for the civil works have been prepared using market rates for material, plant, and labor derived from a project-specific rate analysis for Sindh Province.

39. The principal price risk relates to the gates and the mechanical and electrical equipment. The project involves over 10,000 tons of steel (about 6,000 tons for the gates alone). Using tendered costs from Jinnah Barrage, Balloki Barrage, Tarbela Dam, and the SWSIP, cost curves in US\$. These have been used to estimate the cost of the proposed gate equipment items under the project contract. Using the February 2014 steel price for steel st37-2 plate (US\$980 per ton) provided by the Pakistan Steel Marketing Department, the approximate total value of raw steel material provided under the project is in the order of US\$10 million. The price sensitivity analysis has been carried out by increasing the aggregated price (including all costs, labour, transport, and fabrication) of major contract items involving raw steel by 20 percent. This results in a total price increase of US\$13 million.

40. There is residual price risk relating to the chosen construction method for the divide wall sheet piling and caisson units. The final design of these works will depend upon investigations carried out in the first stages of the construction contract and upon the selected contractor's methodology. A conservative approach has therefore been taken in designing and pricing these works. The construction method will likely be based upon the marine plant readily available to the selected contractor. In pricing the sheet piling work, a market quote has been obtained and a conservative, land-based approach has been assumed to avoid the vagaries of estimating construction using a marine-based plant. The works are medium risk. However, a conservative approach has been taken during the estimating process and the risk of significant variance in quantity or price is therefore considered medium-low.

41. Cost estimates for the civil works have been prepared using market rates for material, plant, and labour derived from a project-specific rate analysis for Sindh Province. The topographical survey used as a basis of measurement is a combination of the 2011 topographical survey carried out for this project and the as-built survey of the upstream left marginal bund carried out by the government. Residual quantity risks are associated with the resolution of the topographical survey carried out in 2011, which was limited due to the challenges posed by security.

42. A comprehensive survey has been allowed for at the start of the contract for the river training works. Part of the river training works involve replenishing underwater stone protection. It is likely that in some areas less replenishment than this will be required and in some areas a greater volume will be necessary, depending on local conditions, the nature of scour since 2011 and the level of annual replenishment under the ID maintenance program. An additional allowance has been made for rock stone which may be used as contingency supply during construction, if so required. A holistic approach will be adopted during the construction period to make best use of the volume of stone material provided for, to achieve the best standard of protection, without cost overrun. The risk of significant cost variance is therefore considered medium-low.

Table 2.3. Component-wise Cost Estimates

Project Component	Total	GoSindh	IDA
	US\$ million		
Component A: Rehabilitation of the Guddu Barrage			
A1. Gates replacement	60.0	6.0	54.0
A2. Mechanical and electrical equipment	28.0	3.0	25.0
A3. Main barrage repairs	6.0	0.6	5.4
A4. Modifications to the left pocket divide wall	38.0	4.0	34.0
A5. River training works	46.0	6.0	40.0
A6. Renovation and provision of staff offices	4.0	0.4	3.6
A7. Implementation of environmental and social management plan	6.0	0	6.0
A8. Construction supervision, quality control, and contract management	7.0	0	7.0
Subtotal (Component A)	195.0	20.0	175.0
Component B: Improved Barrage Operation			
B1. Upgrades to the instrument monitoring systems (piezometers) and replacement of O&M equipment (surveillance and maintenance boats, hydrographical and flow measurement equipment)	5.0	0	5.0
B2. Preparation of future barrage and irrigation improvement projects	1.0	0	1.0
Subtotal (Component B)	6.0	0	6.0
Component C: Project Management, Monitoring, and Evaluation			
C1. Project Management, Technical Assistance, and Training	5.0	0	5.0
C2. Monitoring and Evaluation	2.0	0	2.0
Subtotal (Component C)	7.0		7.0
Total Cost	208.0	20.0	188.0

Detailed Cost Estimates

Table 2.3. Component Wise Quantities and Cost Estimates by Year

Components	Unit	Quantities					Total	Unit Cost US\$, 000	Costs (US\$, 000) Including Contingencies					Total
		Y1	Y2	Y3	Y4	Y5			Y1	Y2	Y3	Y4	Y5	
Component A: Rehabilitation of Guddu Barrage														
A1. Gates replacement														
Main barrage gates	Gate	0	16	16	17	16	65	805	0	12880	12880	13685	12880	52,325
Head regulator gates	Gate	0	6	6	7	6	25	307	0	1842	1842	2149	1842	7,675
A2. Mechanical and electrical equipment														
Main barrage hoist machinery and associated equipment	Per gate bay	0	0	32	32	0	64	382	0	0	12224	12224	0	24,448
Head regulator hoist machinery and associated equipment	Per gate bay	0	0	12	12	0	24	148	0	0	1776	1776	0	3,552
A3. Main barrage repairs														
Structural repairs	% complete	0	25	35	40		100	1s	0	1457.5	2040.5	2332	0	5,830
Rehabilitation of piezometers	Number	0	6	6	5		17	10	0	60	60	50	0	170
A4. Modifications to the left pocket divide wall														
Demolition and dismantling of divide wall	Per foot	0	480	0	0	0	480	3	0	1440	0	0		1,440
Sheet piling for cellular wall	Per foot	0	240	240	240	240	960	30	0	7200	7200	7200	7200	28,800
Stonework	100 ft ³	0	4,425	4,425	4,425	4,425	17,700	0.32	-	1,416	1,416	1,416	1,416	5,664
Concrete	100 ft ³	0	387.5	387.5	387.5	387.5	1550	1.36	0	527	527	527	527	2,108
A5. River training works														
Earthwork	1,000 ft ³	-		38,100	34,570	-	72,670	0.15	0	0	5,715	5,186	0	10,901
Stonework	100 ft ³	-		135,000	135,000	-	270,000	0.13	0	0	17,550	17,550	0	35,100

Components	Unit	Quantities					Total	Unit Cost US\$, 000	Costs (US\$, 000) Including Contingencies					Total	
		Y1	Y2	Y3	Y4	Y5			Y1	Y2	Y3	Y4	Y5		
A6. Renovation of staff and O&M offices															
Building works - Guddu	Sq ft. complete	16,300	16,300	-	-	-	32,600	0.08	1304	1304	0	0	0	2,608	
Building works - Sukkur	%	50	50				1	1400	700	700	0	0	0	1,400	
A7. Implementation of social and environmental plans	%	20	20	20	20	20	100		1200	1200	1200	1200	1200	6,000	
A8. Construction supervision and contract management	Person month	175	180	200	200	120	875	8	1400	1440	1600	1600	960	7,000	
Component B: Improved Barrage Operation															
B1. Upgrades to O&M equipment															
Workshop equipment	%	100					100	700	700					700	
Work boats	Number		2				2	1050		2100				2,100	
Training	Number	15	15	15	13	11	69	18	270	270	270	234	198	1,242	
Acoustic Doppler Current Profiler	Number	0	8	0	0	0	8	45		360	0	0	0	360	
Miscellaneous items	%	20	20	20	20	20	100	400	80	80	80	80	80	400	
Vehicles for operational staff	Number	4					4	49	196					196	
B2. Preparation of future projects	%		25	25	25	25	100	1,000		250	250	250	250	1,000	
Component C: Project Management and M&E															
C1. Project management, technical assistance and training	%	20	20	20	20	20	100	5000	1,000	1,000	1,000	1,000	1,000	5,000	
C2. Monitoring and evaluation of the project impact	%	20	20	20	20	20	100	2000	400	400	400	400	400	2,000	
Total									7,250	21,205	82,753	83,581	13,321	208,000	

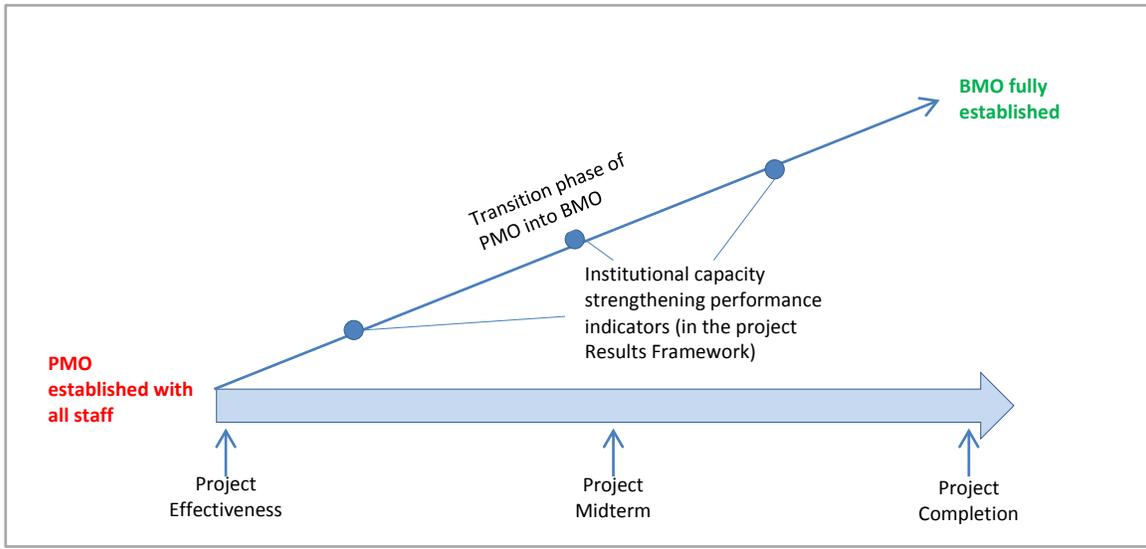
ANNEX 3: IMPLEMENTATION ARRANGEMENTS

A Strategic Approach to Barrage Management in Sindh

1. The provincial government has been managing and maintaining barrages/canals since 1897 when the first institutional arrangement was put in place. The historic legacy of initially managing canals and later barrages in Sindh for some 117 years has established a sound foundation and given a clear understanding to beneficiaries and the public in general about the system's operation and institutional framework. Therefore, tradition plays a very strong role in the management of canals and water regulation in the province. The project will, therefore, utilize as much as possible the existing system and setup and will only support new initiatives when there is a clear ownership and commitment from GoSindh and the stakeholders.
2. Barrages are considered strategic assets and there is unanimous agreement among the stakeholders that such infrastructure assets should be managed by a highly experienced cadre of staff with adequate budget, modern equipment, and using the latest technology. Such an arrangement is particularly required due to the recent increase in the frequency and severity of floods and their likely recurrence due to climate change. Therefore, a reliable early warning system, environment and social impact mitigation, advanced technology, and communications are seen as new key priorities to be adopted. The proposal of establishment of a BMO in the ID is based on Punjab, where experience has been good so far for such an approach.
3. Currently, all barrages have Chief Engineers who perform two broad tasks: (a) barrage infrastructure management and operation; and (b) water flow monitoring and regulation to canals in respective command areas. The proposed BMO will bring all functions related to barrage infrastructure maintenance, operations, and modernization under one office—in a phased manner. First, GoSindh will establish a PMO for implementation of the Guddu Barrage rehabilitation. In addition to project coordination, the PMO will coordinate analysis, relevant studies, and assessments for establishment of the BMO. If feasible, the functions of the PMO will be merged into the BMO during project implementation.
4. The transition of the PMO into the BMO will be approached with care after detailed analysis of current laws, notifications, the budgetary process, accountabilities, skills/expertise available (and required), functional analysis of barrage maintenance/construction, and canal management in the command areas.

5. The project will support GoSindh in the transition. The BMO will have a cadre of technical and administrative staff covering the entire spectrum of barrage infrastructure maintenance, operation, and management, financed from GoSindh’s recurrent budget. Based on the detailed analysis and assessment, GoSindh will identify any incremental cost of organizational reform, benefits of the investment (incremental cost), and efficiency gains. Figure 3.1 shows key steps for PMO’s transition into the BMO.

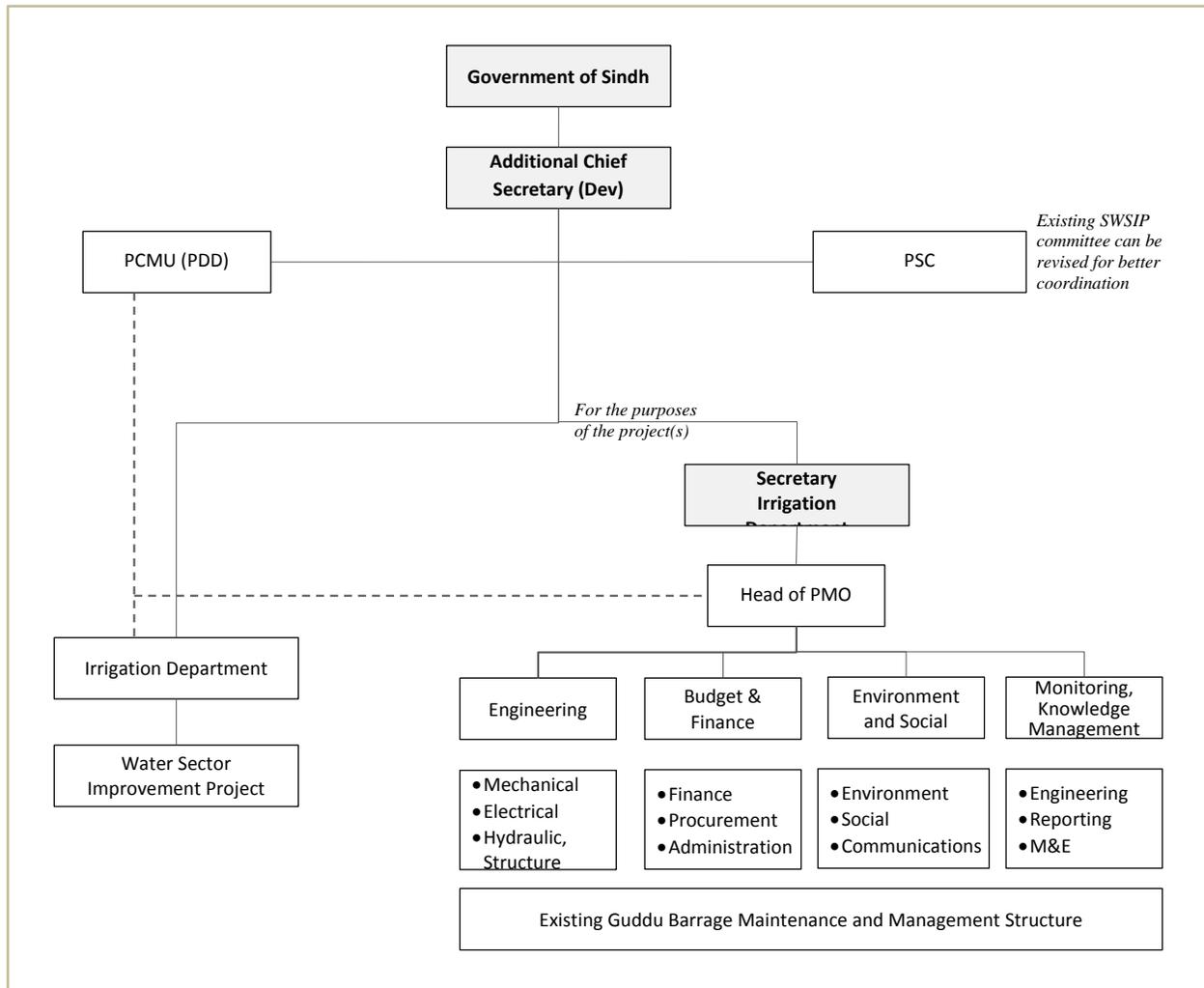
Figure 3.1 PMO to BMO Transition



6. The analytical work for the establishment of the BMO will be supported under Component C of the project but it will not tie the BMO’s actual establishment to the rehabilitation of the Guddu Barrage—the primary objective of the project.

7. **Overall project management.** The proposed project implementation arrangements are shown in figure 3.2. GoSindh will have overall responsibility for project management and coordination through its PDD. The existing PSC would provide the forum for overall guidance, policy advice, coordination of the project activities, and addressing the inter-agency issues. The ID of GoSindh will be responsible for the execution and implementation of the project through the already established PMO. The implementation arrangements as set out below:

Figure 3.2 Proposed Organogram



8. The existing PSC set up under the SWSIP will be maintained to oversee this project, provide policy-level guidance, and inter-agency coordination for the project. The PSC is chaired by the Additional Chief Secretary, PDD. The Secretary of the ID, Secretary of Finance, Secretary of Agriculture, Secretary of Environment, Secretary of Public Health Engineering, Secretary of Forestry and Wildlife, and representatives of the local/district administration will serve as its members. The PCMU will act as the secretary of the PSC.

9. The PCMU established under the PDD will monitor and coordinate all project implementation activities. It will continue to play the role of the secretary of the steering committee and donor relation management. It will be responsible for supervising citizens’ feedback, project monitoring and evaluation studies, and supervision of the overall project EMP as well as the social plans. For M&E studies an independent consultant will be recruited under component C of the project. The project management consultants (component C) will be based in the PCMU.

10. The PMO set up during project preparation shall continue to manage implementation of the project with some modifications. The PMO is headed by a project director with four

subordinate units. Key specialists will be recruited as needed. Most of the units have been staffed with qualified personnel already.

- a) The Engineering Unit will oversee the work of the consultants on design and construction supervision matters. The head of the Engineering Unit will spend about half of his time at the site to provide coordination between the PMO and the supervising consultant and will also support the POE. For civil works contracts, the project director will serve as the 'Employer', and the PICs will serve as the 'Engineer' for construction supervision.
- b) The PICs will support the PMO in construction supervision, contract management, and project management. At the site, a 'Resident Engineer', appointed by the consultant, with a team of specialists and inspectors will supervise the contractor.
- c) The Budget and Finance Unit will be responsible for all project-related procurement, FM, and disbursement.
- d) The Environment and Social Unit will supervise compliance with the EMP and SAP and together with the Engineering Unit implement the communication strategy. The M&E consultants will provide support to supervision of implementation of the EMP/RAP would also report to the PCMU.
- e) The Monitoring and Knowledge Management Unit will coordinate all monitoring and progress reporting of works at the Guddu barrage including the EMP and RAP. The head of the unit will be accountable for timely reporting of verified progress as well as on the results indicators in the project results framework and will work with other units and departments to consolidate all progress reports for management, the government, and the Bank. It will be critical that the unit ensures that data on the project results indicators are reported on time after verification/validation, as this would be essential for the Bank to rate project performance.
- f) In addition, the unit will carry out two more functions: (a) research, consolidate, and disseminate latest global/local knowledge available. This can be done through blogs by experienced staff and events to which experts are invited to share their experience. Relevant existing training institutes will be engaged to prepare an in-service (perhaps mandatory) training of barrage/canal staff, which will be rolled out when the BMO is established. The current M&E capacity is adequate to report on the project results indicators but requires improvement in the area of results verification.
- g) For project impact evaluation studies, independent third-party consultants will be recruited under Component C of the project. The M&E consultants would be responsible for monitoring the project impact as well as supervision of the EAP and SAP implementation. The M&E consultants will review the baseline and then provide reports every six months on the progress on the indicators as well any other issues which may arise during project implementation.
- h) As under the ongoing SWSIP the Food and Agriculture Organization team would act as the PMC. The PMC will be based in the PCMU under the PDD. The PMC to be appointed for the duration of the project will be responsible for preparation of the request for proposal, review of the terms of reference, short listing of consultants, evaluation of technical and financial proposals, award of the contract

after obtaining the necessary clearance from GoSindh and the Bank and contract management support.

11. SIDA will be responsible for operation and management of the Ghotki command area. SIDA will also implement the Gender Action Plan and provide information on citizens' feedback.

12. **Sindh Wildlife Department** will be responsible for the Dolphin Conservation and Management Plan in addressing the issues currently threatening the dolphin reserve, including population surveys, threat assessment, capacity building, development of a sustainable fisheries management plan, establishment of dolphin rescue units, and education and awareness programs.

13. **Project Implementation Period.** The project will be implemented over a period of five years starting from June, 22, 2015. The target date for completion of all project works is by June 22, 2020 and the loan closing date will be December 22, 2020.

14. **Financial Management.** An FM assessment was carried out. A qualified professional accountants with adequate experience will be hired in the PMO with terms of reference agreed with the Bank. Reporting to the project director, the FM specialist will lead the FM functions with the assistance of two account officers. The FM specialist will be held responsible for the design of the accounting and internal control system.

Action	Date due by	Responsible
Appointment and placement of FM specialist as per TORs agreed with the Bank.	November, 2015	PMO

15. To ensure that the project maintains a satisfactory FM system through the project's life the following activities will be undertaken. The overall FM risk for the project is substantial and it will be reassessed after implementation of the mitigating measures.

FM Activity	Frequency
Desk and/or On site visits: Review of overall operation of the FM system including transaction reviews, Interim financial reports review. Monitoring of actions taken on issues highlighted in audit reports, auditors' management letters, and other reports.	Quarterly reviews in the first year and subsequent semi-annual reviews.
Capacity building support: FM training sessions	At the start of project and as and when needed during implementation.

16. **Budgeting.** The project is part of the Public Sector Development Program and is reflected in the provincial government's budget. GoSindh rules and procedures for budgeting apply accordingly. A separate cost center is assigned in the government budgeting system. The annual budget for the project will be prepared on the basis of planned activities, identified in the

procurement plan and will be timely communicated to the PDD for the allocation of the GoSindh share.

17. **Fund Flow and Disbursement Arrangement.** Disbursement methods for the project will include reimbursement, advance, direct payment and special commitment. To ensure that funds are readily available for project implementation, the project will open maintain, and operate a USD Designated Account (DA) in the National Bank of Pakistan (NBP). Deposits into, and payments from the DA, will be made in accordance with the provisions stated in the financing agreement and disbursement letter. *However, the use of designated account and Advance disbursement method will be available to this project only after the issue of lapsed loan currently in the Pakistan portfolio is resolved.*

18. Disbursement under this credit will be made according to the transaction-based disbursement procedures that include the use of statements of expenditures and/or summary sheet. The statement of expenditure and summary sheet based on the category mentioned in the table below shall form the basis of disbursement. Once the project’s capacity is raised to a satisfactory level, the project may then switch to report based disbursement and a set of IFRs will form the basis of disbursement. Withdrawal applications and replenishments of the DA will be prepared and sent by authorized signatories. The project will also maintain a local currency Assignment Account, with the NBP, in order to disburse counterpart funds for the eligible expenditure. The PMO will be held responsible for ensuring the release of counter-part funds six months in advance, based on the budget allocation.

IDA Financing under Eligible Expenditures, Inclusive of Taxes

Category	Amount of the Financing Allocated (US\$)	Percentage of Expenditures to be Financed (Inclusive of Taxes)
Works, goods, services, training, and workshops and incremental operating cost	188,000,000	90% of works and 100% of all other items
Total	188,000,000	

19. Government contributions of US\$20 million will be used to only cover 10% of civil works of the project.

20. For large civil works and consultancies where the payments are relatively large and are in foreign currencies, direct payment method will be used. The PMO will submit a withdrawal application along with supporting documents and the Bank will disburse funds to the supplier or contractor. The minimum value for direct payments will be documented in the disbursement letter. For direct payments, the Bank will require certified copies of the original records at the time of the request for payment.

21. **Accounting and Maintenance of Accounting Records.** Project accounts will be maintained on a cash basis, supported with appropriate records and procedures to track

commitments and to safeguard assets. Separate books of accounts in Pakistani rupees and in U.S. dollars will be maintained for the project using chart of accounts under the New Accounting Model. The Project books of accounts will be maintained in the Government Financial Management Information System (GFMIS). The FM staff at the project will timely report the third party payments to Auditor General (AG) Sindh and will reconcile the accounts with AG office on regular basis.

22. **Internal Control and Internal Audit Arrangements.** Internal controls are the process by which an organization governs its activities to effectively and efficiently accomplish its task. It includes whole system of controls such as, financial, procurement, asset management, record management and payroll control. Financial Management Specialist is responsible for preparing and implementing Financial Management Manual including internal control policies and procedures. The Financial Management Framework for the project is governed by the respective rules/procedures of the Government of Sindh and the World Bank. Government internal control system for expenditure is based on a series of GoSindh regulations, including the New Accounting Model, General Financial Rules, Treasury Orders 1922, Sindh Government Rules of Business 1986 and Delegation of Financial Powers and other regulations, instructions and orders issued by the Ministry of Finance and Accountant General Pakistan Revenues (AGPR) from time to time. All payments will be made by crossed checks jointly signed by two officials and adequately vouched with relevant invoices and claims approved by the competent authority before the assigned accounting staff could initiate a payment request.

23. **Interim Financial Reporting Arrangements.** The recipient shall prepare and furnish to the Bank, not later than 45 days after the end of six months, interim financial reports for the project, in form and substance satisfactory to the Bank.

24. **External Audit Arrangements.** The external audit conducted by the Supreme Audit Institution, that is, the Office of the Auditor General of Pakistan, will be acceptable to the Bank. The auditor will express an opinion on the project's annual financial statements prepared in accordance with International Public Sector Accounting Standards – Cash Basis of Accounting. The audited financial statements along with the management letter for each period shall be furnished to the Bank not later than six months after the end of the project fiscal year. Currently, the Irrigation Department is not implementing any Bank financed projects.

Procurement

25. All expected major procurement of works and consultants' services have been announced in the General Procurement Notice through the dgMarket, United Nations Development Business and the project's website.

26. **Special Measures for Dealing with Procurement Risks** In order to minimize procurement risks several measures are introduced for procurement. These measures include:

- (a) The ID has conducted some large civil works projects using ICB procedures and the staff in general is well versed with procurement and contract management practices. The PMO will be responsible for carrying out procurement under the project including the consulting services, works, and goods. The PMO with support of the PIC/PCMU/PMC will develop:

(a) a procurement documentation and filing systems, and a procurement database; and (b) a system for handling procurement related complaints.

(b) The PMO's project website will be used for providing a procurement plan, procurement notices, invitation to bid, bid documents, and RFPs as issued; latest information on procurement contracts, status of evaluation, complaints and actions taken, contract award, and performance under the contracts; and other relevant information related to procurement. The website will be accessible to all bidders and interested persons equally and free of charge.

(c) A credible system of handling complaints will be put in place by June 2015. The PMO will manage the complaint handling system with overall oversight by the PCMU and ID. This system will include maintenance of a database, a standard protocol with appropriate triggers for carrying out investigations, and taking action against involved parties. For ICB/international selection of consultants the Bank prescribed complaint redress mechanism will apply.

(d) The Bank will hold procurement trainings for the PMO staff for works, goods, and services soon after the negotiations are done.

(e) The Food and Agriculture Organization is acting as the PMC to support the contract management and procurement/selection process. It will be their responsibility to ensure that the issue and delays are identified and highlighted to the relevant authorities. The PMC will also help the PMO and PMCU in maintaining the complaint redress database. This arrangement has been carried forward from the SWSIP. Transparency International Pakistan shall act an observer in bid openings.

27. With these arrangements, the procurement under the project is likely to be effective and transparent resulting in smooth implementation of the project and the achievement of the project development objectives. The risk rating is substantial.

28. **Procurement of Works.** The major civil and electro-mechanical works will be procured through ICB procedures. The project consists of three main packages. The civil works contracts estimated to cost: (a) more than US\$3 million equivalent will be procured through ICB procedures. Prequalification will be mandatory for contracts estimated to cost more than US\$10 million equivalent; (b) up to US\$3 million equivalent will be procured through NCB procedures using the bidding documents approved by the Bank; (c) up to US\$100,000 equivalent per contract may be procured through shopping procedures or community based contract procedure, using the procedures and contract formats agreed with the Bank.

29. **Procurement of Goods.** Goods procured under this project will include office equipment, field vehicles, and some field equipment. Goods contract estimated to cost; (a) more than US \$ 600,000 will be procured through ICB procedures. Domestic preference will be allowed for local manufacturers on ICB contracts; (b) US\$600,000 per contract may be procured through NCB procedures acceptable to the Bank; (c) up to US\$100,000 equivalent per contract and all operational vehicles may be procured following shopping procedures.

30. **Additional provisions when using National Competitive Bidding (NCB) procedures.** The following additional procedures will apply to all procurement of goods and works under NCB, to ensure economy, efficiency, transparency, and broad consistency with the provisions of Section 1 of the guidelines:

- (a) Invitation to bid shall be advertised in at least one national newspaper with wide circulation, at least 30 days before the deadline for the submission of bids.
- (b) Bid documents will be made available, by mail or in person, to all who are willing to pay the required fee.
- (c) Foreign bidders will not be precluded from bidding and no preference of any kind will be given to national bidders in the bidding process. Bidding will not be restricted to pre-registered firms.
- (d) Qualification criteria will be stated in the bidding documents.
- (e) Bids will be opened in public, immediately after the deadline for submission of bids. Bids will not be rejected merely on the basis of a comparison with an official estimate without the prior concurrence of the Bank.
- (f) Before rejecting all bids and soliciting new bids, the Bank's prior concurrence will be obtained. Bids will be solicited and works contracts will be awarded on the basis of unit prices.
- (g) Contracts will not be awarded on the basis of nationally negotiated rates.
- (h) Single bids will also be considered for award. Post-bidding negotiations will not be allowed with the lowest evaluated or any other bidders.
- (i) A firm declared ineligible by the Bank, based on a determination by the Bank that the firm has engaged in corrupt, fraudulent, collusive, coercive, or obstructive practices in competing for or in executing a Bank-financed contract, will be ineligible to be awarded a Bank-financed contract during the period of time determined by the Bank.

31. **Selection of Individual Consultants.** Section V of the Consultant Guidelines shall be followed.

32. **Procurement Planning.** The procurement plan for the key contracts for goods, works, and consultants' services expected under the project is prepared by the PMO. Whenever possible, procurement of works, goods, and services will be packaged into large packages to attract good contractors. Procurement under the project will be carried out in accordance with the procurement plan and no procurement, regardless of the value, will be done by the implementing agency unless it has been approved under the procurement plan by the Bank. Procurement plans will be closely monitored and updated on a quarterly basis or as required, promptly conveyed to the Bank for its approval.

33. **Prior Review.** Thresholds for prior review are given below. These thresholds will be reviewed periodically and adjusted if required.

- (i) All ICB contracts for works and goods.
- (ii) All single source selection or direct contracts.
- (iii) First NCB contract for goods and works, regardless of value.
- (iv) First contract procured through shopping, and through community based contracting procedure.

- (v) The first consultants' services contract with consulting firms, irrespective of value, and thereafter all contracts with firms estimated to cost US\$300,000 equivalent or more

34. **Post Review.** All other contracts will be subject to post-review by the Bank. The PMO will send to the Bank a list of all contracts for post-review on a quarterly basis. Post-reviews shall be done annually. Such review of contracts below threshold will constitute a sample of about 20 percent of the contracts.

Detailed Procurement Arrangements

Works

Ref No.	Contract Description	Estimated Cost US\$ millions	Selection Method	Review by Bank	Expected Date of			Financier
					Bid Opening	Evaluation	Award	
G1	Barrage works	137	ICB	Yes	Nov.10, 2015	Nov. 30, 2015	Jan. 2016	Bank/GoSindh
G2	River training works	46	ICB	Yes	Nov 10, 2015	November 30, 2015	Jan. 2016	Bank/GoSindh
G3	Renovation and construction of staff residents and O&M offices	4	NCB	Yes	June 15, 2015	August 5, 2015	Sep. 2015	Bank/GoSindh

Services

Ref No.	Contract Description	Estimated Cost US\$ millions	Selection Method	Review By Bank	Expected Date			Financiers
					Proposal Submission	Evaluation	Award	
S1	Construction supervision	7	QCBS	Yes	Done	Done	August 2015	Bank
S2	Monitoring and evaluation services	2	QCBS	Yes	October 2015	November 2015	Dec. 2015	Bank

Environmental and Social Management Plan (ESMP)

35. **Environmental codes of practice.** A set of environmental codes of practice (ECPs) has been prepared for various environmental and social management aspects: ECP 1: Waste Management; ECP 2: Fuels and Hazardous Goods Management; ECP 3: Water Resources Management; ECP 4: Drainage Management; ECP 5: Soil Quality Management; ECP 6: Erosion and Sediment Control; ECP 7: Top Soil Management; ECP 8: Topography and Landscaping; ECP 9: Quarry Areas Development and Operation; ECP 10: Air Quality Management; ECP 11: Noise and Vibration Management; ECP 12: Protection of Flora; ECP 13: Protection of Fauna; ECP 14: Protection of Fisheries; ECP 15: Road Transport and Road Traffic Management; ECP 16: Construction Camp Management; ECP 17: Cultural and Religious Issues; ECP 18: Workers Health and Safety; The contractors will be contractually obligated to comply with these ECPs, presented in annex D of the main ESA.

36. **Site-specific plans.** The following site-specific plans will be prepared by the contractors to manage and mitigate/reverse potential adverse environmental impacts: (a) Erosion, Sediment and Drainage Control Plan; (b) Pollution Prevention Plan; (c) Waste Disposal and Effluent Management Plan; (d) Traffic Management Plan; (e) Borrow Area Management and Restoration Plan; (f) Occupational Health and Safety Plan; (g) Protection of the Gas Pipeline; (h) Drinking Water Supply and Sanitation Plan; (i) Management Plan for Protection of Flora and Fauna; (j) Construction Camp Management Plan; (k) Fuel and Hazardous Substances Management Plan; (l) In-stream Construction Works Management Plan; (m) Emergency Preparedness Plan; and (n) Communication Plan.

37. **Impact of underwater noise levels on dolphin's vocalization and behaviour:** For dolphins, sound serves three main functions: (a) it provides information about their environment, (b) it is used for communication, and (c) it enables the remote detection of prey. Vocalization of dolphins will be in the range of 125–173 dB at 1 m for whistles and 218–228 dB at 1 m for clicks. Piling on the downstream of the barrage will take place during the construction of the left pocket divide wall for an estimated period of one year. Pile drive generated underwater noise has the potential to impact dolphin populations as this noise is capable of masking the dolphins' vocalization. Underwater noise levels generated by vibratory pile drivers will be generally in the range of 170 to 185 dB at a distance of 10 m, while impact hammers produce noise levels in the range of 205 to 220 dB at a distance of 10 m. The use of vibratory hammers will be preferred for the construction of the divide wall. However, the final methodology for the installation of the sheet piles cannot be confirmed until the completion of preliminary ground investigations along the line of the divide wall. The investigations are proposed as part of the civil works contract. The threshold peak impulse source pressure for direct physical trauma in aquatic mammals is generally considered to be more than 200 dB and hence dolphins will not be expected to experience permanent hearing impairment from sound pressures generated by pile driving. However, effects on behavior are more likely.

38. Mitigation measures to reduce noise levels from piling and to minimize the impacts on dolphins include: (a) using vibratory hammers instead of impact hammers, and (b) monitoring an exclusion zone of about 500 m radius for at least 30 minutes before the start of piling.

39. **Risk of dolphin collision with construction vehicles:** During construction of the left bank divide wall, there will also be movement on the downstream of the barrage to transport personnel, fuel, and smaller construction material. There is a risk of collision between dolphins and motor boats. To avoid such risks, speeds of motor boats will be restricted to 15 km/hour in accordance with best international practices. Further movement of motor boats will be restricted to within 500 m downstream of the barrage. Pingers will also be used to chase away dolphins from the construction areas.

40. **Impacts on river habitat and water quality:** Construction of river training works, mainly the construction of the spur, may generate a sediment load in the river. Sediment concentrations above natural levels can cause mortality of planktons and fish; for fish, damaged gills and sediment clogging of gill chambers eventually leads to death, which in turn will influence the availability of dolphins' diet. Replacement of the barrage gates and canal head regulators, and construction of the left pocket divide wall will be carried out by using barge mounted cranes and rigs. Motor boats will be extensively used for transport of personnel, material, and fuel. There is a risk of water pollution from these activities through accidental spillage of fuels, hazardous material, and bilge water. Any such pollution events will seriously impact the downstream dolphin and fish habitat. According to the ESMP, the contractor will make booms, absorbents, and skimmers available onsite along with trained personnel to recover spilled oils from water surface. Greasing of the gates will be carried out in a dry working area. Painting of gates will be done on land and only after drying they will be fixed to the barrage. The bilge water will be collected, transported to the treatment sites, and then will be disposed after appropriate treatment.

41. **Impact of canal closures on water needs of the command area:** Bulkhead gates and construction through barge mounted cranes have been opted to avoid the need for construction of cofferdams and, thereby, the need for closure of the canals. In addition, gates will be replaced one by one without obstructing the canal flows through the other gates. Canals will not be closed except during their regular scheduled closure dates during the construction period.

42. **Risk of barrage failure by floods and earthquake and emergency preparedness plan:** Failure of a section of the barrage or its upstream river training structures would result in an uncontrolled release of water but the rate of water released into the river downstream will not cause flooding unless failure has occurred over a significant length of the barrage. This is due to the large width of the river channel relative to the barrage height. A draft emergency preparedness plan for the Guddu Barrage is prepared to deal with such incidents.

43. **Climate change impacts and risks:** According to climate change predictions of Pakistan Meteorological Department, temperatures in Sindh are expected to increase to 2 °C by 2050 and 4 °C by the end of the century; and rainfall is going to be highly variable on a temporal and spatial scale. The climate change impacts on the Indus in Sindh are expected to have serious implications on the irrigation and the agriculture sector due to (a) reduced productivity of crops and livestock due to heat stress, (b) increased requirements of irrigation water, (c) uncertainty in availability of irrigation water, (d) shortage of irrigation water, (e) damages to crops and livestock from extreme climate events such as floods and droughts, and (f) further deterioration of the already degraded cultivated lands such as those suffering from water logging and salinity. Compounding these problems are the expected increased risks to the coastal areas and the Indus deltaic region due to sea level rise, coastal erosion, saline sea water intrusion, and increasing cyclonic activity in the

Arabian Sea. Implementation of the national climate change policy is paramount to address the potential climate change impacts.

44. **Cumulative Impact Assessment** The project also carried out a cumulative impact assessment to evaluate the combined effects of all the existing barrages in Sindh and proposed rehabilitation works at Guddu. The study focused on more relevant valued environmental components related to barrages in Sindh, which are dolphins, fish migration, and irrigation.

45. Construction of irrigation barrages between 1886 and 1971 has fragmented the dolphins' historical home range and confined them into a number of smaller river sections. Change of river flows in these river sections, particularly low flow discharges in winter have further significantly reduced their habitat range, required water depths and velocities, and availability of fish prey. There is a need for better management of water flows in the Indus during the winter season to maintain the habitat of dolphins, which is a responsibility of national level stakeholders and should be resolved within the framework of WAA.

46. Overall the hilsa fisheries are under severe stress and vulnerable to overexploitation. Serious attention is required to provide appropriate access for hilsa to the Indus River during migrations, and impose a ban on fishing during the upstream migration and the prevention of catching undersized fish. Fish ladders in the Kotri and Guddu Barrages must be rehabilitated to work effectively and a new fish pass should be installed in the Sukkur Barrage.

47. The barrages have transformed the arid barren lands of Sindh to vast agricultural lands and brought significant socioeconomic benefits to Sindh. However, poor irrigation efficiency is causing a lot of water wastage, contributing to water logging conditions, and also causing soil salinity and sodicity. This is in turn reducing soil fertility and crop yields. The main purpose of the barrage rehabilitation is to continue the sustained supply of water through the canals for irrigation in Sindh.

48. **Consultations and Disclosure.** Extensive consultations were carried out by the feasibility study team during the project preparation. Initial consultations were held at the early stages of project preparation (November 2011 to January 2012) to share the project objectives and terms of references of the proposed ESIA study. A second round of consultations was held during October to December 2013 to disclose the results of ESIA. Details of participants consulted are given in Table 6.1.

Table 3.3: Participants' Details from the ESIA Study

Activities	No. of Participants
Village wise meetings (31 villages)	526
Individual consultations (Political/local leaders/ officials participated)	21
Focus group discussions	245
Canal command area (43 minor and distributaries)	431
Consultation workshops by independent consultants	47
Total	1,270

Social Safeguards

49. To complement the ESMP, the SMF provides an overall planning and implementing guidance to address social issues arising during the course of the project planning and implementation, including possible land acquisition and resettlement, disruption of water supply due to possible extended canal closure and overall communication with stakeholders. The SMF is composed of the RPF, the Social Action Plan (SAP), and the Communication Strategy.

50. **Socioeconomic conditions in the project and command Area.** The primary beneficiaries include (a) over 2.6 million people, across 1.2 million ha of irrigated land in Kashmore, Ghotki, Jacobabad, Sukkur, and Shikarpur districts of Sindh, and Nasirabad and Jafarabad districts of Baluchistan, who will receive reliable supply of water (for example, through well-maintained canal flows) and (b) local communities in flood-vulnerable areas who will benefit from improvement in flood management and reduction in risks of embankment breaches; since the capacity of the barrage to pass flood waters will be improved. The population predominantly live in joint family units. Major tribes are the Mazari (50 percent) and the Mirani (30 percent). Sindhi is the primary language in the project area, while the literacy rate is as low as 6 percent. Tribal loyalties are strong in the area and tribal leaders in the project and surrounding area, are well respected and influential amongst the population. The area was troubled by a conflict between the Mazari and the neighboring Khosa tribe in 2010 and 2011, but following collaboration between the tribal leaders at the end of 2011, the situation has improved. The major employment in the area is from the agriculture sector and as general laborers. As a result of industrialization on the right bank of the Guddu barrage, a large number of unskilled laborers are available within the project and surrounding area. The education and income level in the project and surrounding area is typically low.

51. Agriculture is commonly practiced in the project and surrounding area, with a number of small farmers working on owned or rented land growing sugarcane, rice, cotton, and vegetables as well as grazing livestock. Women and girls are commonly involved in all aspects of agriculture. Access to social amenities in the project and surrounding area is low. Electricity supply is available. However, access to gas supply, drinking water (other than from ground water pumps installed by communities), sewerage, and drainage and health care facilities is very limited. A number of schools are available in the project and surrounding area but are generally lacking staff and/or resources.

52. As the ground water in the command area of the Desert Pat Feeder is saline and not suitable for drinking, much of the command area also depends on the canal water as their source of drinking water. The Guddu barrage also maintains a supply of irrigation water to the command area of the Beghari Sindh Feeder Canal from May to October only.

53. A camp will be established to accommodate up to 200 staff. The contractor will also establish a construction camp (including storage and batching plant), offices, and a workshop. Following completion of the project, the contractor will hand over the workshop to the client. The staff colony will be constructed on the right bank of the Guddu barrage.

54. The RPF is prepared in compliance with the laws of Pakistan and the Bank's safeguards policy on involuntary resettlement. In the event that involuntary resettlement issues are identified,

RAPs will be prepared consistent with this policy framework and will be submitted to the Bank for approval. The RPF specifies that implementation of any works requiring a RAP shall not commence before necessary measures for resettlement and compensation are in place according to steps identified in the RPF. These measures will include provision for compensation and other assistance required for relocation, before displacement, and preparation and provision of resettlement sites with adequate facilities, where required, and livelihood restoration measures. The RPF also provides details of eligibility criteria, categories of affected persons and methods to establish cut-off dates. An entitlement matrix has been included in the RPF to elaborate the types of losses, application, and definitions of entitled person and entitlement policy. Calculation for compensation payment and provision of different types of allowance, that is, transportation, livelihood, shifting for commercial structures, and vulnerable allowances has been specified in the RPF.

55. Following completion of the final designs, a reassessment of resettlement requirements will be required. Should this assessment identify any involuntary resettlement, the Bank's Operational Policy, OP 4.12, calls for the preparation of individual RAPs that must be consistent with the RPF. The RPF sets out complete procedures and guidelines for screening of involuntary resettlements and preparation and approvals for RAPs.

56. The SMF also includes an SAP. The SAP proposes a needs assessment to be carried out by the Environment and Social Unit of the PMO within the command area of the Guddu barrage as well as a number of measures to reduce the risk of any disruption of irrigation supplies to the command area due to the replacement of the head regulator gates of the main canals. Contingency measures are proposed to be implemented in the event of any disruption to irrigation supplies to reduce the impact of this disruption.

57. **Communication strategy.** A communication strategy has been included in the SMF to facilitate project implementation by engaging citizens in the project and command areas (primary stakeholders) through regular consultations. Government departments, private sector, and NGOs are secondary stakeholders that are important intermediaries in the project delivery process or those who influence or are indirectly affected by the project. Government departments include the Baluchistan Irrigation Department, as the command area extends to Nasirabad and Jafarabad districts of Baluchistan Province. A communication matrix has been developed, which specifies information and the message to be conveyed, communication means, timings, and the corresponding frequency. Considering the low literacy rate in the project area and diversity of spoken languages in the command area (Sindhi, Balochi, Urdu, and Siraki), consultation is the most effective means of communication, which also ensures feedback from the citizens.

58. **Implementation arrangements.** The Environmental and Social Unit will be responsible for SMF implementation with a dedicated communication section to implement the strategy. If required, RAPs will be prepared and implemented by the contractor as per the RFP. Internal monitoring will be undertaken by the PMO's M&E Unit. External, third party monitoring is provided by the M&E consultants of the project.

59. **Grievance redress mechanism.** A multistage grievance redress mechanism has been proposed in the SMF. The head of the PMO will chair a Grievance Redress Committee made up of relevant stakeholders whose aim will be to solve any impediments to implementation of any

RAPs as well as redress any grievances which may occur during implementation at the project level. The multistage approach specifies that the complaints will be properly recorded and acknowledgement of a written submission will be issued to the complainant within three working days. If not resolved earlier by the contractor or supervisory staff on site, grievances will be tabled for discussion/resolution during a committee meeting within one week of receipt of the written submission. If a grievance is not satisfactorily resolved by the Grievance Redress Committee, it will be referred for consideration by the head of the PMO within one week.

60. **Monitoring and evaluation.** Monitoring will be carried out both internally and externally. During internal monitoring, the information will be collected from the project site and assimilated in the form of a monthly progress report to assess the progress and results of the SMF implementation, and adjust the work progress, where necessary, in case of any delays or problems. The report shall be submitted to the head of the PMO. The M&E consultants to be appointed under the project will have environmental and social experts and shall carryout intermittent third party monitoring of the implementation of the SMF, any RAP against the proposed program, and the ESMP.

61. **Cost estimates.** The indicative cost estimates for the implementation of social and environmental plans is US\$6 million.

Results Monitoring and Evaluation.

62. The key outcome indicators and intermediary indicators are provided in Annex 1. Data will be collected for each of the indicators by the PMO and the PCMU. The PMO will also be responsible for reporting the progress to the Bank.

63. The PMO will submit bi-annual reports in an appropriate format to GoSindh, the PSC, and the Bank. The bi-annual report will cover the progress and expected completion dates for civil works and equipment supply contracts, progress on institutional components, implementation of Social Development Action Plan (SDAP) and Environmental Management Plan (EMP,) training and studies, and activities of the PMOs project implementation, M&E, procurement, and financial consultants.

64. The PMO will prepare annual reports of project implementation. The report will cover (a) the progress of each component, implementation of key features of the EMP, key performance indicators, operation of project facilities, and financial statements; and (b) the Annual Work Plan for implementation. A mid-term review of the project will be undertaken. An Implementation Completion Report will be submitted to the Bank no later than six months after the project closing date.

65. The M&E consultants will provide the PMO with support to evaluate the project's impact, including the implementation and monitoring of the EMP and the Social Action Plan (SAP). The M&E studies will evaluate the success in project implementation in terms of meeting the project's objectives, and assess its physical, hydrological, environmental, social, and economic impacts. The M&E activities will provide continuous feedback to the PSC on the project's performance, so that appropriate management actions can be undertaken in a timely manner.

ANNEX 4: IMPLEMENTATION SUPPORT PLAN

1. **Strategy and Approach for Implementation Support.** The strategy for implementation support has been developed to address the specialized needs of the project. The objective is to provide relevant, efficient, and timely support to the client for implementation of various activities under the project with an aim to promote flexibility in implementation and mitigate project risks as defined in the SORT. The following implementation support strategy and associated plan consistent with project design and risks is drawn for the project. The plan is tentative and flexible and will be revised during implementation and adjusted based on actual developments and needs on the ground. More importantly, the implementation plan should be adequately resourced.

- **Institutional Development and Preparation of Irrigation Strategy.** The Bank team will help the government in addressing the establishment of the BMO and will support the GoSindh in finalizing the irrigation strategy.
- **Technical Aspects.** The Bank team will provide support in the technical aspects of the project including the barrage safety aspects.
- **Procurement.** There will be three large civil works contracts procured by participating communities under this project particularly under Components A and B. Under the ongoing SWSIP to provide procurement expertise the Bank procurement team has been: providing training to members of the procurement committee and related staff in the regional project offices, as well as the project management consultant; reviewing procurement documents and providing timely feedback to the procurement committee; providing detailed guidance on the Bank's procurement guidelines to the procurement committee; and monitoring procurement progress against the detailed procurement plan developed by the PMO.
- **Communication and citizen engagement.** The Bank team will provide support for the implementation of the communication strategy.
- **Financial Management.** Bank supervision will review the project's FM system, including but not limited to accounting, reporting, and internal audit and controls. The supervision will also cover subprojects on a random sample basis. The Bank team will also work with the project management consultant to assist the PMO, district offices, and field teams in improving coordination among different departments and units for FM and reporting.
- **Environmental and Social Safeguards.** The Bank team will supervise and provide support to the PMO for the implementation of the agreed environmental and the social issues and safeguards, including support on the implementation of the dolphin conservation plan, communication strategy, and citizens' feedback.
- **Anti-Corruption.** The Bank team supported by the FM and procurement teams will supervise the implementation of the agreed governance, procurement aspects, and plans.

Implementation Support Plan

2. Some of the Bank team members will be based in the country office, some in Washington, and others in country offices in the region to ensure timely, efficient, and effective implementation support to the client. Supervision and monitoring support to the PMO will be mainly provided by the team members in the country office, especially for the first 18 months. Formal supervision

and field trips will be carried out semiannually. The main focus of implementation support is summarized in Table 4.1.

Table 4.1. Focus of Implementation Support

Time	Focus	Resource Estimate	Staff Weeks
First year of the project implementation	Technical expertise	Barrage specialist	4
	Fiduciary expertise	Procurement and FM specialist	6
	Social expertise	Social/Gender/RAP specialist	4
	Environmental expertise	Environmental specialist	3
	Institutional and capacity building	Institutional development specialist	2
	Communication and citizens engagement	Communication specialist	2
	Dam safety specialist	Dam safety specialist	2
	Team leader	Task team leader	10
Year 2–6	Technical expertise	Civil/hydraulic engineer	4
	Fiduciary expertise	Procurement and FM specialist	4
	Social expertise	Social/Gender/RAP specialist	4
	Environmental expertise	Environmental specialist	3
	Communication and citizens engagement	Communication specialist	2
	Institutional and capacity building	Institutional specialist	2
	Economics expertise	Agriculture economist	2
	Dam safety	Dam safety specialist	2
Team leader	Task Team Leader	10	

3. The staff skills mix required is summarized in Table 4.2.

Table 4.2. Staff Skills Mix

Skills Needed	Number of Staff Weeks per year	Number of Trips	Comments
Task team leader/engineer	8	Field trips as required	International
Institutional development specialist	2	Field trips as required	International
Senior Communication Specialist	2	Field trips as required	Country office
Dam safety specialist	2	Field trips as required	International
Monitoring and evaluation	2	Field trips as required	International
Social development specialist	3	Field trips as required	Country office
Environmental specialist	3	Field trips as required	Country office
Procurement	4	Field trips as required	Country office
FM specialist	3	Field trips as required	Country office

ANNEX 5: SYSTEMATIC OPERATIONS RISK-RATING TOOL (SORT)

Risk Category	Rating	Explanation of the Rating	Proposed Mitigation
Political and governance	Substantial	<p>Political risk is a critical element of any investment in Sindh province. Maintaining the delicate political balance between the two major parties has been a higher priority than governance reforms. In addition, in spite of the strong hold of key political parties, fluctuation in the center of gravity of the political leadership is a reality in Sindh. Recent political changes have created some optimism for renewed reform opportunities in Sindh; and that competition between provinces will bear pressure on the provincial government to perform. Rehabilitation of Sindh's barrages is a priority for the provincial government and accorded high priority across political boundaries. Potential flooding through failure of the barrages remains a very real possibility.</p>	<p>At the moment there are strong counterparts in place for the project. The project steering committee chaired by the secretary of the PDD will ensure coordination.</p>
Macro-economic	Moderate	<p>The country's external and fiscal situation remains highly vulnerable. International reserves are low and fiscal deficit remains large as progress on revenue mobilization, elimination of power subsidies, and public debt reduction is slow.</p>	<p>Detailed costing has been developed based on the detailed design and taking into consideration experience from recent similar projects. In addition, Price and Physical Contingencies of 10% each have been included in the costing.</p> <p>The O&M costs of Guddu barrage is low compared to revenue generated from irrigation water supply. Therefore, funding O&M costs is not an issue as these are</p>

Risk Category	Rating	Explanation of the Rating	Proposed Mitigation
			covered through the tariffs and revenue collected.
Sector strategies and policies	Substantial	The project is consistent with government's vision. However there are inadequate recent sector strategies and policies in terms of agriculture and water.	A new irrigation sector strategy is under preparation. Through the ongoing Sindh Agricultural Growth Project the Bank will provide technical assistance to help Pakistan in its agricultural policy analysis and design with a view to increasing agricultural competitiveness and expanding rural livelihoods. The Sindh Agricultural Sector Development Strategy and the Irrigation Strategy will form a key contribution to longer-term sector growth and setting priorities for investment and future programming for Government as well as development partners including the Bank
Technical design of project	Moderate	Technically the works are not overly complex. The real challenge is in executing the construction works according to the planned schedule in a timely manner without extensive closure. Delays in project implementation particularly civil works may take place due to engineering or climate related factors	Detailed designs for all works have been prepared jointly by international and national engineering firms. Construction will be planned and scheduled carefully for optimal alignment between design and implementation process. Timing will also be laid out to make the best use of the dry season construction periods.
Institutional capacity for implementation and sustainability	Moderate	ID and PDD (PCMU) have significant experience of implementing large infrastructure and donor financed projects. Irrigation Department has conducted some large civil works projects using ICB procedures of various funding agencies. The staff in general is well versed with good procurement and contract management practices.	Under Component B, technical assistance would be provided to further strengthen the institutional capacity in barrage safety, modern instrumentation, better water and sediment measurement climate change knowledge, and environmental and citizens feedback aspects. From the point of view of financial sustainability, the O&M costs of Guddu barrage is low

Risk Category	Rating	Explanation of the Rating	Proposed Mitigation
			<p>compared to revenue generated from irrigation water supply. Therefore, funding O&M costs is not an issue as these are covered through the tariffs and revenue collected.</p>
Fiduciary	Substantial	<p>The fiduciary risk is assessed as substantial because of the country context, the fact that financial management arrangements are not yet established, and based on the inherent risks associated with procurement of large scale infrastructure projects.</p>	<p>Bank will continuously support training and professional development programs to strengthen skills and capacities of staff handling FM and procurement. Transaction based disbursement method will mitigate the inherent risk associated with large procurement. Bank will support the client in implementation of an effective procurement monitoring mechanism. Bank will support the client on financial management during implementation. Qualified professional accountants with adequate experience in financial management of large infrastructure projects, will be hired in the PMO with terms of reference agreed with the Bank.</p>
Environment and social	High	<p>The project is Category A. The project may impact on flora and fauna; the Indus River between the Guddu and Sukkur barrages is an important game reserve and habitat for the Indus or Blind Dolphin. This part of the river contains a large population of dolphins.</p>	<p>The rehabilitation work under the project will safeguard the continued operation of Guddu barrage by prolonging the useful life of the structure and continue uninterrupted water supply to the irrigation network of Sindh. An independent EIA has been undertaken during project preparation. The project will finalize the emergency preparedness plan, an SDAP, and an EMP. The ESIA reports have recommended a study on the dolphin conservation</p>

Risk Category	Rating	Explanation of the Rating	Proposed Mitigation
			<p>action plan and will be awarded soon after the project is approved by the Bank.</p> <p>The project will not require any land acquisition or resettlement. The RPF is prepared to guide resettlement planning for any unanticipated land acquisition and resettlement impacts during the course of the project implementation. The proposed activities are limited to the existing footprints of the barrage and no additional land acquisition is required, hence most of the impacts from the proposed activities are temporary in nature and limited to the construction period.</p>
Stakeholders	Moderate	There may be interruption in the supply of water during construction, resulting in possible resistance by stakeholders who may be impacted by it.	Communication plans have been developed to ensure that the public is well-informed about the project activities at all times. Both traditional and non-traditional methods of communication will be employed to convey messages to the stakeholders. The stakeholder assessment and consultation has been carried out with direct project beneficiaries during project preparation and will continue during implementation to ensure that information about the rehabilitation work is available to the stakeholders, and that stakeholder concerns are taken into advisory during project design.
Others - Security	Substantial	The security situation remains unpredictable in much of the country and can deteriorate unexpectedly. This can have an impacts on the government's ability to deliver services and programs in certain areas and	Continue to be vigilant with regard to security readiness and adjustment of operational posture to minimize risks to staff; review and update security measures. Have flexible implementation arrangements that take into account access and

Risk Category	Rating	Explanation of the Rating	Proposed Mitigation
		<p>may pose a risk to Bank operations (for example, periodic office closings and restrictions on staff travel). Project cost can also increase due to security actions for the safety of workers.</p>	<p>movement restrictions and can quickly adapt to changing circumstances on the ground. Build in contingency costs for security actions.</p>
OVERALL	High		

ANNEX 6: ECONOMIC ANALYSIS

1. Because of its location of the barrage near the boundaries of Punjab, Balochistan, and Sindh, the barrage since construction has always been accorded a high strategic economic value.
2. At present there are serious operational difficulties and safety issues for sustainability of the Guddu Barrage. The most severe problems include: (a) up to 60 percent of the steel used for the 65 gates on the main barrage is badly rusted; (b) the lifting mechanisms are badly corroded, with a strong possibility of failure; (c) the switch panels and power distribution network are in extremely poor condition; and (d) there is no backup power supply system in case of power failures. Currently, stress levels within the gates are already in excess of the allowable design stresses during normal operation. Since the rate of corrosion cannot be slowed, it is considered likely that the gates will fail during normal operation within five to seven years. There is already a risk now that the gates may fail during a flood event that necessitates their opening and closing. Such a failure will progressively affect water supplies to all the irrigated areas supplied by the barrage.
3. Partial or complete failure of the Guddu Barrage can cause widespread flooding and interruption of water supplies, resulting in a disastrous setback to the economy and the lives of the people in the area. The risks should be considered in the context of substantial benefits of sustaining agricultural production and avoiding a catastrophic failure of the barrage. The benefits stemming from investment to rehabilitate the barrage will be both direct and indirect.
4. **Approach and Methodology.** The analysis has been carried out comparing the benefits under ‘with’ and ‘without’ project situations. For evaluating economic viability of the proposed investment, a model has been developed to calculate the EIRRs. Various sets of assumptions under ‘with’ and ‘without’ project/investment has been developed for determining the economic viability of the proposed investment.
5. **The ‘Without’ Project Situation:** It is assumed that no capital works will occur and the present level of maintenance will be continued. Further, the analysis considers two scenarios.
6. **Scenario I - Declining Benefits Approach:** The principal benefit derived by the project is avoided losses in the production of irrigated crops due to the declining ability of the barrage to divert water from the Indus River by raising the headwater pond upstream of the barrage. Although the gates of the barrage are in a precarious condition, catastrophic failure of the gates is not considered under this ‘without’ project scenario. This scenario only assumes a gradual decline of the ability of the barrage to raise water sufficiently for reliable irrigation. As a result the feeder canals performance will decline and agricultural production in the Guddu barrage command area is assumed to reduce linearly over the course of 25 years at the rate of one percent per year.
7. **Scenario II - Catastrophic Failure of the Barrage:** This scenario assumes that in the absence of corrective measures the barrage gates will catastrophically fail, partially or fully, at some point in the future, thereby incurring agricultural losses in the year of failure and in subsequent years, temporary disruption of the Guddu thermal power station and of the already overstressed power supply, and additional capital costs required for emergency repair works to restore cooling water

supplies. Thus the analysis under this scenario is based upon the assumption that either (a) the barrage will continue to operate as at present with an inadequate pond height—as long as the barrage gates do not collapse, the situation will remain the same with no additional benefits or costs; or (b) the barrage will fail. If the barrage fails, there will be insufficient flow in the feeder canals for some time until emergency repairs can be done and there will be a sudden reduction in agricultural and power output of the Guddu thermal power station.

8. **The ‘With’ Project Situation:** This project concerns the rehabilitation of the Guddu Barrage and will by itself not result in increased agricultural production or productivity in its command area. The rehabilitation works will maintain the command area as it is at present and will enable avoiding all potential agricultural and any other losses expected in the absence of the proposed investment. There will also be some savings in the cost of sediment removal and overall barrage O&M costs. The proposed rehabilitation project will eliminate possible sources of failure and potentially give the structure another 30 years of life without major rehabilitation works.

9. For the analysis, the comparisons of costs and benefits of the project have been made on the basis of quantifiable physical inputs and outputs. Incremental net benefits were estimated on the basis of the changes expected to occur and other conditions expected to prevail within targeted geographic areas under ‘without’ and ‘with’ project situations.

10. The following assumptions and approach have been used in the analysis:

- a. A standard conversion factor of 0.9 has been used for converting the cost of non-tradable goods to economic/shadow prices.
- b. The total base project cost is expended over a five year implementation period.
- c. All monetary values are expressed in U.S. dollars. Conversion rate: PRs 100 to one US\$.
- d. Both costs and benefits are valued at constant October 2014 price level.
- e. Period of analysis is taken as 30 years including five years of implementation period.

11. **Unquantified Benefits.** In the case of barrage failure, the losses due to interruptions in the service of the pipelines and the road have been omitted from the analysis on the assumption that temporary pipe and road bridges can be built in a short time. Other unquantified benefits result from avoided erosion, land reclamation, and securing infrastructure including two major gas pipelines from the Sui Fields which cross the barrage to link with the Multan-Sukker pipeline and the road connection, known as Guddu bridge, as the means to cross the Indus River.

12. Water supply of the two million people living in the command area of the Guddu Barrage will also be interrupted if failure of the barrage occurs, and temporary supply will have to be provided; also to water livestock. In addition, food relief will be required to avert a famine in this area.

13. The Guddu thermal power station (capacity of 1,300 MW), is of vital importance to the economy of the country. It is expected that cooling water supply will be restored on a priority basis by installing pumps but that the station will be out of use for one month.

14. There are annual savings expected in de-silting costs of the feeders, resulting from the proposed new dividing wall to form a left pocket with a seven bay width which is estimated at about US\$421,000, conservatively not included in the stream of benefits.

15. The required investment is about US\$208 million, spread over a five year implementation period. The current maintenance expenditures are about US\$708,000, which are inadequate under the present conditions. These have been considered adequate after renovation of the barrage due to the use of less maintenance intensive materials. Possible reduction in operation and maintenance has been ignored.³

16. Data on open market prices was collected through various sources for determining the farm-gate financial prices, including price bulletins issued by the GoSindh Agriculture Supply and Prices Department. Economic evaluation has been carried out using economic prices. Import parity prices for wheat and fertilizers and export parity prices for rice and cotton have been derived using commodity price data issued by the World Bank in December 2014. Whereas, the economic prices for the non-traded commodities have been adjusted by the standard conversion factor. Derivation of parity prices is included in Table 6.5 and the summary of prices used is given in Table 6.6.

Estimation of Benefits

Scenario I: Parameters and Assumptions under Declining Benefits Approach

17. The main project benefit is the saving in agricultural production which will otherwise be lost as a result of the steady decline in reliability of the irrigation system due to the worsening ability of the barrage to divert water from the Indus River. The command areas (net cultivatable areas) for the irrigation canals supplied by the Guddu Barrage are given in Table 6.1.

Table 6.1: Command Areas of Feeder Canals

	Acres	Ha
Irrigated Area	3,028,245	1,225,488
Desert Pat Feeder	1,074,688	434,911
Beghari Sindh Feeder	958,857	388,036
Ghotki Feeder	994,700	402,541

18. The estimated reduction in performance in Table 6.2 shows the gauged flow down the feeder canals over time, for the designed head pond level (255.5ft). Although the record with the irrigation department shows inter-seasonal variation (possibly due to silt removal) the steady net decrease in water conveyance capacity at the design pond head can be seen for each canal. It is reasonable to expect this decline in performance to accelerate significantly as the ability of the barrage to manage flows and limit sediment intake further deteriorates; however, a conservative assumption has been made in this regard that conveyance capacity will continue to decline at the level of one percent per year for all three canals, that is less than the average (1.4 percent) of decline already occurring.

³ It is known that the O&M cost will reduce to some extent after rehabilitation. The analysis conservatively, has not accounted for any reduction in O&M expenditure after gate renewal.

Table 6.2: Estimated Annual Reduction in Agricultural Benefits

Feeder Canal	Mean Annual Reduction in Capacity for Designed Head Pond Level Recorded (1965–2000) (cusecs)	Full Supply Discharge (cusecs)	Mean Annual Reduction in Capacity for Designed Head Pond Level Recorded Over the Last 50 Years (%)	Future Reduction in Crop Production (Linear Over 25 Years) (%)	Value of Crop Production Losses (US\$, millions)
Ghotki Canal	107	8,490	1.3	25	26
BeghariSindh Feeder	240	13,275	1.8	25	25
Desert Pat Feeder	162	14,764	1.1	25	28
			Average =1.4%	Total	79

19. **Crop Budgets.** Crop budgets have been developed to estimate per hectare net value of crops considering the level of inputs and yields prevailing in the project area as the basis for determining the value of reduced benefits in monetary terms. Data on crop yields have been taken as average for the last three years prevailing in the project area.

20. If no investment is made to rehabilitate the barrage, it is estimated that the value of lost agricultural production would reach the tune of US\$167 million per year in nominal prices by Year 30 (based on a one percent annual reduction over the 25-year period from Year 6 to 30). Estimation of the agriculture loss is presented in Table 6.7. The cash flow of costs and benefits to calculate the EIRR is presented in Table 6.8.

21. Based upon the analysis approach of avoiding agricultural loss (Scenario I), the results of the economic analysis is provided in Table 6.3.

Table 6.3: Results of Economic Analysis for Scenario I

Indicator (Base Case)	Value
Economic Internal Rate of Return (EIRR)	16%
Net Present Value @ 12% Discount Rate (US\$, millions)	94
Benefit/Cost Ratio @ 12% discount rate	1.4:1

Scenario II: Parameters and Assumptions under the Approach Considering Catastrophic Failure of the Barrage

22. This scenario and approach has precedents for its adoption in the analysis of projects addressing rehabilitation of barrages. The structure of Guddu barrage is considered to be in good condition, but the gates are so badly corroded that they are expected to fail between five and seven years from now (see paragraph 2), even under normal operation.

Estimation of Benefits by Avoiding Catastrophic Failure of the Barrage (Scenario II)

23. The economic benefit of the barrage rehabilitation will be the avoided crop losses as well as other losses due to interruption of the Guddu thermal power station on the right bank and other

services. The agricultural losses in the summer will result from the area under cotton cultivation in the three canal commands. By July the farmers will have invested in most of the inputs, and in the absence of barrage failure the crop will continue to mature. The crop value to be taken as an agricultural loss will therefore be the gross farm-gate value of two crops (raw cotton and rice) less the remaining costs for water management and harvesting for these crops. The loss in the *rabi* season will be the opportunity value of the wheat crop that cannot be planted because of the lack of irrigation. Crop budgets show per hectare net value of raw cotton as US\$1,100, for rice as US\$270 and for wheat as US\$140. The average cropping intensity for the *kharif* crops is about 40 percent for cotton and 38 percent of rice; and for *rabi* crop is 38 percent of wheat.

24. It is assumed that overall probability of any super flood is about ten percent with maximum (20 percent) in August and minimum (one percent) in October. The same is considered 10 percent in June; 15 percent in July; and five percent in September. A weighted average of probability of failure of barrage has been used for estimating the loss of *kharif* crops (cotton and rice). The analysis reveals that the loss of *kharif* crops will be about US\$314 million in the year of failure of the barrage. Moreover, the full crop losses, in case of catastrophic failure of the Guddu Barrage will be confined to one year (two crop seasons), thus the total agriculture loss has been estimated as US\$380 million.

25. In addition, an emergency reconstruction will be required, which will cost 40 percent more than the planned rehabilitation, including repair of damages to roads, railways, and housing, emergency pumping of cooling water for the Guddu thermal power station, and emergency drinking water supply and food relief, which amounts to about US\$263 million in economic terms.

26. The rate of return on the investment in barrage rehabilitation depends on when the assumed barrage failure will take place. If failure occurs five years from now the EIRR is 51 percent, ten years from now 15 percent, and 12 years from now 12 percent.

27. **Sensitivity Analysis.** The sensitivity of EIRR, for Scenario-I, is tested for different cases and the results are summarized in table 6.4.

Table 6.4: Summary of Results – Economic Analysis (Scenario I)

Declining Agriculture Benefits	EIRR	BC Ratio	NPV (12% Discount Rate) (US\$ millions)
Base case	16%	1.7	94
Costs increase by 10%	15%	1.5	80
Benefits decrease by 10%	15%	1.5	71
Simultaneous increase in costs and decrease in benefits by 10%	14%	1.4	57

28. Scenario II: Figure 6.1 shows the EIRR result corresponding to the year of catastrophic failure.

Figure 6.1: EIRR Corresponding to Year of Failure



29. **Conclusion.** Rehabilitation of the Guddu barrage is expected to yield economic and financial gains at the macro level as well as for individual households in the project area in particular, a large majority of which are dependent upon farming and agro-related business, directly or indirectly. The strengthening of the infrastructure will augment irrigation water supply for the integrated and optimal use of fresh/sweet water.

30. The results of the base case analysis and sensitivity analysis indicate that the value of the EIRR is robust, not very sensitive to changes in costs and benefits, and in all but the most extreme cases always above the cut off rate, assumed as a 12 percent opportunity cost of capital.

Project Impact

31. **Production Impacts.** This project only concerns the rehabilitation of the barrage and will by itself not result in increased agricultural production or productivity in its command area. However, it will have an impact upon the sustainability of the irrigation system and will benefit the rural population directly by avoiding agriculture loss as well as by sustaining the allied facilities of the Guddu thermal power station, roads, and bridges. Under Scenario I, if no rehabilitation works are done, the agriculture production will decrease in 30 years from the present level of production of rice 1.5 million tons to 0.4 million tons and of cotton from 1.2 million tons to about 0.3 million tons.

32. **Beneficiary Households.** The average farm size in the geographical area of the project has been estimated as 3.3 ha.⁴ This indicates that the total number of beneficiary households will be about 370,000. Assuming the average size of a family as seven persons,⁵ the project will yield benefits to about 2.6 million persons, annually.

33. **Employment Impacts.** With repair of the barrage, the command area of the feeder canals will sustain the large number of labor engaged in farming to continue at their work, which has been estimated as about 19 million person days per year. In addition, the project will generate

⁴ Agriculture Census 2010-Sindh Report, data used for the six districts in the project area.

⁵ Statistics of Sindh for 2010 calculates average family size in rural areas as seven persons.

direct and indirect employment in construction activities under the project over a period of five years.

34. **Poverty Impact.** Under Scenario I, it is likely that the continued decline in irrigation reliability will have a more serious impact on poorer farming families with land at the tail end of canals. In that the project will allow these families to have reliable irrigation services, it does therefore also have a significant poverty reduction benefit, in addition to the employment opportunities during construction.

Table 6.5: Derivation of Border Prices of Various commodities at November 2014 Price Level

Name of Commodity	Rice	Cotton	Wheat	Urea	DAP
Export or Import parity	Export	Export	Import	Import	Import
Projected Price in Current Dollars US\$/ton *	423	1,933	294	316	449
Quality Adjustment Factor **	1.00	0.97	1.00	1.00	1.00
World Market (adjusted) Equivalent US\$/ton	423	1,875	294	316	449
Transport and Insurance US\$/ton	40.00	40.00	40.00	40.00	40.00
CIF Karachi US\$/ton	383	1,835	334	356	489
Exchange Rate PKR/US\$	100.00	100.00	100.00	100.00	100.00
CIF/FOB Karachi PKR/ton	38,333	183,453	33,390	35,595	48,910
Port Charges, Storage and Handling PKR/ton	-1,370	-1,370	1,370	1,370	1,370
Value at Karachi Market PKR/ton	36,963	182,083	34,760	36,965	50,280
Transport & Handling to Project Area PKR/ton	-3,000	-3,000	3,000	3,000	3,000
Processed Value PKR/ton	33,963	179,083	37,760	39,965	53,280
Processing Ratio	0.66	0.33	0.40	1.00	1.00
Processing Charges PKR/ton	-1,606	-2,900	1,400		
Value of Byproduct PKR/ton	749	12,640	540		
Wholesale Value	21,559	68,838	17,044	39,965	53,280
Local Agent's Commission	-755	-688	170		
Transport from/to Farm	-266	-266	266	266	266
Value at Farm Gate PKR/ton	20,538	67,883	17,480	40,231	53,546
Economic Value at Farm Gate (PKR/kg)	20.538	67.88	17.48	40.23	53.55
Economic Value at Farm Gate (PKR/50kg Bag)			874.02	2,011.55	2,677.30
Economic Value at Farm Gate (PKR/Kg)				85.13	114.91

* Source: World Bank Price forecast December 2014, used average price for the last year at October 2014 price level

** Basmati has a higher value, IRRI-6 a lower value than the reference Thai 5% broken

Table 6.6: Summary of Prices of Agricultural Commodities

Description	Unit	Financial	Economic
Outputs			
Rice	PKR/kg	23.75	20.54
Cotton	PKR/kg	78.75	67.88
Cotton Sticks	PKR/kg	1.25	1.13
Rice Husk	PKR/kg	2.00	1.80
Inputs			
Seed			
Rice	PKR/kg	300	270
Cotton	PKR/kg	300	270
Fertilizers			
Nitrogen	PKR/kg	81.46	85.13
Phosphate	PKR/kg	151.29	114.91
Pesticides	PKR/ha	1,500	1,350
Manual Labor	PKR/day	510	459
Tractor Hire	PKR/hour	600	540

Table 6.7: Estimation of Agriculture Loss in the Absence of Proposed Investment

Assumed Reduction in Cropped Area Over 25 Years		
Desert Pat Feeder	25%	(1% per year)
Beghari Sindh Feeder	25%	(1% per year)
Ghotki Feeder	25%	(1% per year)
Net Value of Production at Present		
Cotton	110,683	PKR/ha
Cotton	1,107	US\$/ha
Rice	26,875	PKR/ha
Rice	269	US\$/ha
Percentage of Total Area		
Cotton	40%	
Rice	38%	
Value of Reduced Cropped Area		
Desert Pat Feeder	59	US\$ millions
Beghari Sindh Feeder	53	US\$ millions
Ghotki Feeder	55	US\$ millions
TOTAL	167	US\$ millions
	16.7	PKR billions

Table 6.8: Cash Flow of Costs and Benefits - Avoiding Agricultural Losses (Scenario I)
(US\$ millions)

Year	Capital Costs (US\$)	Factor Reducing Agriculture Benefits	Net Irrigation Benefits	Net Incremental Irrigation Benefits
1	5.0	0.0	0.0	-5.0
2	38.1	0.0	0.0	-38.1
3	79.5	0.0	0.0	-79.5
4	58.8	0.0	0.0	-58.8
5	12.4	0.0	0.0	-12.4
6	2.7	0.0	6.7	4.0
7	0.0	0.1	13.4	13.4
8	0.0	0.1	20.0	20.0
9	0.0	0.2	26.7	26.7
10	0.0	0.2	33.4	33.4
11	0.0	0.2	40.1	40.1
12	0.0	0.3	46.7	46.7
13	0.0	0.3	53.4	53.4
14	0.0	0.4	60.1	60.1
15	0.0	0.4	66.8	66.8
16	0.0	0.4	73.4	73.4
17	0.0	0.5	80.1	80.1
18	0.0	0.5	86.8	86.8
19	0.0	0.6	93.5	93.5
20	0.0	0.6	100.2	100.2
21	0.0	0.6	106.8	106.8
22	0.0	0.7	113.5	113.5
23	0.0	0.7	120.2	120.2
24	0.0	0.8	126.9	126.9
25	0.0	0.8	133.5	133.5
26	0.0	0.8	140.2	140.2
27	0.0	0.9	146.9	146.9
28	0.0	0.9	153.6	153.6
29	0.0	1.0	160.3	160.3
30	0.0	1.0	166.9	166.9
			EIRR	16.4%

ANNEX 7: MAP

Sindh Barrages Improvement Project

