E4716 V2

Government of Sindh, Pakistan
Irrigation Department

Sindh Barrages Improvement Project – Guddu Barrage Rehabilitation

ENVIRONMENTAL AND SOCIAL ASSESSMENT

EXECUTIVE SUMMARY

Report by Independent Environmental Consultants
(Reviewed Draft for Disclosure)

December 2014

Contents

List of Tables and Figures

List of Acronyms

Ac	Acre
CEAP	Construction Environmental Action Plan
CIA	Cumulative Impact Assessment
CO_2	Carbon dioxide
CSC	Construction Supervision Consultant
Cumec	Cubic meters per second
Cusec	Cubic feet per second
dB	Decibels
ECP	Environmental code of Practice
EHS	Environmental Health and Safety
EIA	Environmental Impact Assessment
ESA	Environmental and Social Assessment
ESIA	Environmental and Social Impact Assessment
ESMP	Environmental and Social Management Plan
g	Peak ground acceleration
GDP	Gross Domestic Product
GoS	Government of Sindh
IBIS	Indus Basin Irrigation System
IEE	Initial Environmental Examination
IFC	International Finance Corporation
IRSA	Indus River System Authority
IUCN	International Union for Conservation of Nature
GRC	Grievance Redress Committee
Ha	Hectare
HIV/AIDS	Human Immunodeficiency Virus/ Acquired Immunodeficiency Syndrome
MEC	Monitoring and Evaluation Consultant
MAF	Million Acre Foot
NEQS	National Environmental Quality Standards
OFWMP	On Farm Water Management Project
OP	Operational Policies
PMO	Project Management Office
POE	Panel of Experts
RAMSAR	Convention on Wetlands Signed in Ramsar Iran
RPF	Resettlement Policy Framework
SEPA	Sindh Environmental Protection Act
Sindh-EPA	Sindh Environmental Protection Agency
SID	Sindh Irrigation Department
SAP	Social Action Plan
SMF	Social Management Framework
SSESA	Strategic Sector Environmental and Social Assessment
t	Tonne, metric ton
WCA	Watercourse Associations
USD	United States Dollar
WAA	Water Apportionment Accord
WAPDA	Water and Power Development Authority
WBG	World Bank Group
WSIP	Water Sector Improvement Project
WWF	World Wide Fund for Nature

Conversions

British Units	Metric Units	Metric Units	British Units
1 ft	0.305 m	1 m	3.28 ft
1 mile	1.609 km	1 km	0.621 miles
1 cusec	0.283 cumec	1 cumec	35.315 cusec
1 ac	0.405 Ha	1 ha	2.47 ac

1. Introduction

The Sindh Barrages Improvement Project (the Project) is a proposed project, by the Government of Sindh (GoS), for rehabilitation of the fifty year old Guddu barrage to enhance its useful life to safeguard the reliable supply of irrigation water to about 1.05 million ha[1]. The project is located Kashmore district of Sindh province. The Project has three major interventions: (a) replacement of barrage gates and canal head regulators, and some structural repairs to enhance the life of the barrage; (b) strengthening and extension of river training works for modification of river flows and for Improved flood protection; and (c) construction of a new left pocket divide wall to prevent conveyance of sedimentation to the canals. A comprehensive Environmental and Social Assessment (ESA) has been carried out for the Project and presented in a main ESA report. This Executive Summary presents a summary of the potential environmental and social impacts of the Project as described in the ESA. Mitigation measures are described and included in environmental and social management plan (ESMP) to address potential impacts as well as to enhance the environmental and social benefits of the project.

1.1. Background

Agriculture is the mainstay of Sindh economy. About 60 percent of 42 million Sindh population live in rural areas and mainly depend on agriculture and related activities for their livelihood. About 30-35 percent of Sindh's population lives below poverty line, and a majority of the poor are rural. Pakistan produces over 108 million tonnes of agricultural commodities worth over USD 13 billion annually. Sindh contributes about 23 percent to country's agriculture Gross Domestic Product (GDP). In recent decades, agriculture's contribution to Pakistan's GDP has declined; however, it still accounts for 21.6 percent of GDP. Agriculture GDP consists of 32.8 percent major crops, 11.1 percent minor crops, 53.2 percent livestock, 2.9 percent fisheries and forestry. Through its production, agriculture contributes 60 percent to the country's export earnings and 45 percent of the nation's labor force. Pakistan is among the top 20 global producers in over 48 different agricultural commodities and Sindh substantially contribute towards production of rice, sugarcane, wheat and cotton.

Irrigation is critical for agriculture in Sindh. Rainfed agriculture is not possible in Sindh since it falls under 'hot desert climate' (Koeppan classification), where annual rainfall is very low (about 100 mm) compared to annual potential evapotranspiration (over 2200 mm). About 78 percent of groundwater in Sindh is generally saline (except along Indus) and not suitable for irrigation. Thus without canal irrigation, agriculture is not possible in Sindh. Even before construction of barrages, for centuries some areas in Sindh had depended on flood waters of Indus for agriculture through its old Inundation Canal Systems (artificial inundation canals that were linked to Indus and received water when there were high flows or floods). Inundation canals generally provided uncertain and precarious supplies during crucial sowing and maturity periods. Further, due to upstream construction of barrages, this region received only marginal supplies for inundation canals.

Indus Basin Irrigation System and barrages in Sindh. Pakistan's agricultural sector is almost wholly dependent on irrigation, particularly the Indus Basin Irrigation System (IBIS). IBIS accounts for approximately USD 300 billion of investment (at current rates), 22 percent of the country's GDP, 65 percent of its employment, and 70 percent of its export earnings. Sindh is the primary beneficiary of IBIS with three large barrages built on the Indus River. First barrage Sukkur was commissioned in 1932 followed by Kotri and Guddu in 1955 and 1962, respectively. These three barrages divert about 59 billion cubic meters of water to a cultivable command area

[1] The potential command area of Guddu barrage is about 1.39 million ha, but actual irrigation area is about 1.05 million ha and the same is considered for economic analysis of the project.

of about 5.1 million ha. Besides transforming desolate and barren lands of Sindh in to green fields and fertile depository of grain, these barrages were also instrumental for establishment of agro-based and agro-allied industry to open and provide new vistas of employment and job opportunities for the expanding population of Sindh.

Barrages in Sindh are also strategic hydraulic assets. Barrages are used to raise the water level in the river so that irrigation water can be diverted to the main and link canals by gravity for various uses. Barrages in Sindh are also used for river control and flood management, act as a source of water supply for all sectors of the economy, function as bridges over rivers, and are often used for utility crossings such as gas pipelines. Therefore, the condition and the safe and reliable operation of the barrages have far-reaching implications for the livelihood and economic growth of all segments of society in Sindh.

Need for improvement of Sindh barrages. After decades of their useful life, all three barrages in Sindh have developed major safety issues. Kotri barrage was rehabilitated in 2000 and feasibility study for rehabilitation of Guddu barrage has recently completed and the study of Sukkur barrage is in progress. The feasibility study of Guddu barrage has identified 60 percent corrosion of steel in all the barrage gates and canals' head regulator gates; some deterioration in the superstructure, and defects in lifting mechanism. In general the river training works of the barrage are lower than required to withstand super flood water levels. In addition, the current configuration of the approach to the barrage is resulting in sedimentation upstream of the barrage which reduces the capacity of the barrage to pass flood waters in the Indus and results in sediment being conveyed to offtaking canals on the left bank and reducing their capacity to carry irrigation supplies. Since the rate of corrosion cannot be slowed down, it is considered likely that the gates will fail during normal operation within next 5 years. There is already a risk now that the gates may fail in case of a flood event that necessitates frequent opening and closing. Such a failure is likely to be catastrophic, affecting water supplies to all the irrigated areas supplied by the barrage.

1.2. The Proposed Project

The feasibility study cum detailed design of the Guddu barrage rehabilitation, including Environmental and Social Impact Assessment (ESIA), has been prepared during 2011-2014 by an international consulting firm Mott MacDonald Ltd. UK in association with Mott MacDonald Pakistan. Financial assistance for the study was provided by the World Bank under the Sindh Water Sector Improvement Project (WSIP). Sindh Irrigation Department (SID) is the executing agency of the Project.

Location: Guddu barrage is located at longitude 69.71' E and latitude 27.42' N across the River Indus some 16 km from Kashmore, 130 km from Rahimyar Khan, 190 km from Sukkur, and 630 km from Karachi. The Barrage is accessible by paved road from all these cities. The nearest airports to the barrage are Rahimyar Khan and Sukkur. The location map of Guddu barrage is shown in Figure 1.

Guddu Barrage: The barrage is 1355 m (4445 ft.) long and is now considered to pass flood discharges of 34,000 cumec (1.2 million cusec). It consists of 64 gates (with 18.3 m or 60 ft span) and a navigation gate (with 15.2 m or 50 ft span). The barrage was constructed at a location where the Indus was meandering and the river width was 11 to 13 km. Hence about 40 km of river training works, through guide bunds (6 km), spurs (14 km) and marginal bunds (25 km on left bank and 8 km on right bank), were built on the upstream of the barrage. The barrage has two fish passes to facilitate the migration of hilsa (locally known as palla). The barrage has four canals, two on the left bank (Ghotki Feeder and Rainee canal) and two on the right bank (Begari Sindh Feeder and Desert Pat Feeder). The barrage provide irrigation water to about 1.05 million ha of agriculture lands of Jacobabad, Larkana and Sukkur districts of Sindh and the

Nasirabad district of Balochistan directly benefitting about 0.35 million farming households[2] and about 3 million rural population living in these four districts[3]. The canals also provide water to several industries, WAPDA`s Guddu thermal power plant and drinking water to several villages. The barrage is also an important transport link across the Indus. Two major gas pipelines from Sui Fields cross the barrage to link with Multan-Sukkur main gas pipeline. The barrage was commissioned in 1962 and has now seen over fifty years of active service.

Proposed rehabilitation and modernization of Guddu barrage: The physical works that are proposed for the rehabilitation scheme are as follows:

- Replacement of the 65 barrage gates and 25 main canal head regulator gates
- Rehabilitation of the mechanical and electrical equipment for operating the barrage gates;
- Provision of equipment for the future operation and maintenance of the barrage, including a workshop;
- Minor concrete works to the barrage and canal head work civil structures where spalling and honeycombing of concrete are noticed;
- Rehabilitation of 40 km of existing river training works upstream of the barrage, which include strengthening of guide bunds, spurs and marginal bunds, and raising of marginal bunds for improved flood protection;
- Construction of 1200 m length of spur as an extension of an existing spur located at 4 km upstream of the barrage to improve the river approach conditions;
- Construction of a 455 m length of new left pocket divide wall (350 m on upstream of the barrage and 105 m on downstream) for sediment management;
- Construction of a staff colony (with an office, 32 houses, a school, a mosque and a health unit) for use during and after the barrage rehabilitation

Implementation of the project: The project will be implemented over a period of five years. The construction works will be mainly carried out during October to May when the river flows are low.

1.3. The Environmental and Social Assessment

Studies and basic data: This ESA is based on field studies and data collected between 2011 and 2014 by the consultant team charged with the design of the project and their report on 'Environmental and Social Impact Assessment (ESIA) of Guddu Barrage Rehabilitation Project' and SID's 'Social Management Framework' (SMF), which are also disclosed on SID website along with the ESA reports. A team of independent consultants was retained by SID to validate design consultants reports and prepare independent ESA report as per guidelines of World Bank. The role and scope of work of the independent consultants is described further in section 1.4 below.

Contents of the present document: After a description of the Sindh and Pakistani legal and administrative framework and the applicable World Bank policies in chapter 2, a project description is presented in chapter 3, followed by a discussion of project alternatives in chapter 4. A description of the physical, biological and socio-economic environment is given in chapter 5. Potential adverse effects of the project are described in chapter 6 and potential cumulative impacts and concerns associated with other barrages of Sindh are presented in chapter 7.

[2] Based on socioeconomic survey of 2757 farming households in the project area, average landholding size per household is found to be about 3 ha. About 51 percent households hold 1 to 5 acres, 34 percent hold 5.1 to 12.5 acres, 12 percent hold 12.6 to 25 acres, and 3 percent hold over 25 acres

[3] According to Pakistan Bureau of Statistics, total population of these four districts in 1998 was 4,506,905, in which rural population was 3,101,966 and it is assumed that all these rural population directly or indirectly depend on the agriculture for their livelihood.

Possible mitigating measures to offset, reduce or compensate potential negative impacts of the project are included in the Environmental and Social Management Plan (ESMP) that is summarized in chapter 8; these measures are presented in more detail in the accompanying ESA. Finally, chapter 9 provides an overview of all stakeholder consultations and activities for disclosure and access to the information.

1.4. Composition of Study Team

Independent consultants: SID engaged a team of independent consultants – Dr. Venkata Nukala (Environmental Specialist, Team Leader), Dr. Masud Karim (Cumulative Impact Assessment Specialist), Dr. Najam Khurshid (Ecologist), Dr. Muhammad Saleh Soomro (Water Resources Specialist) – to assess the environmental and social impacts of the project, and to prepare the main ESA report and this Executive Summary. During the ESA process, the independent consultants regularly interacted with the design consultant, carried out their own field visits, participated in consultations, and conducted their independent analysis and impact assessment.

Environmental and social study team (Design Consultant): The study was conducted by a team of specialists in environment, water quality, social and gender. The environmental team members included Dr. Muhammad Ashraf Bodla, Mr. Numair Aman, Ms. Afia Hussain, Mr. Omer Rasheed, Mr. Afzal Khan, Mr. Azmat Beg, Mr. Muhammad Hanif and Mr. Sam Jewers. The Social team included Mr. M. Rahim Junejo, Mr. Rana Saleem, Mr. Abdul Hafeez, Mr. Mujeeb ur Rehman, Mr. Mohammad Juman and Ms. Shagufta Shah.

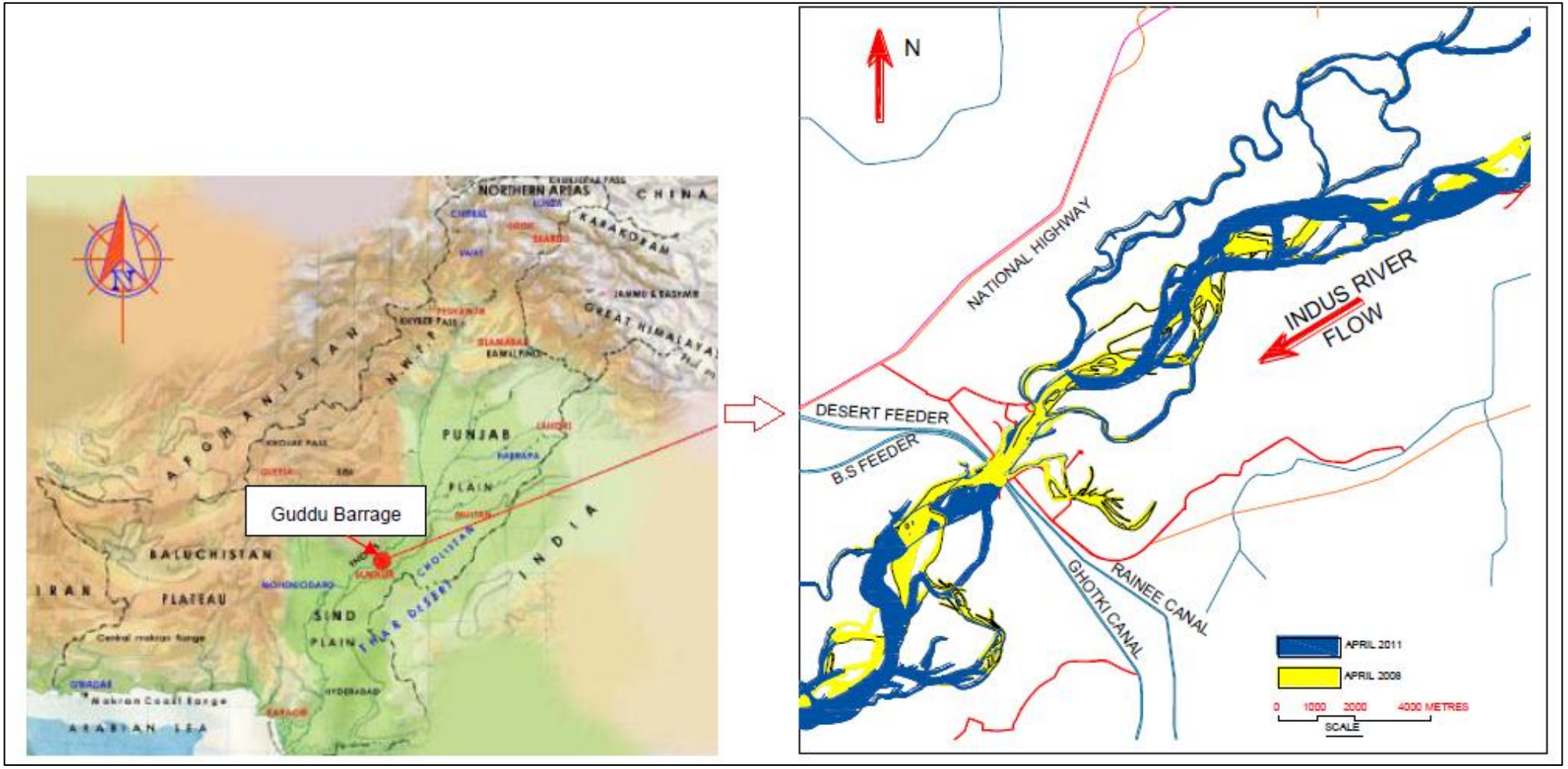


Figure 1: Location of Guddu Barrage in Pakistan

2. Policy, Legal and Administrative Framework

2.1. Applicable Legislation and Policies in Sindh, Pakistan

Sindh Environmental Protection Act, 2014: The Sindh Environmental Protection Act (SEPA) enacted on March 20, 2014. SEPA is the basic legislative tool empowering the Sindh government to frame regulations for the protection of the environment. The Act provides the framework for protection and conservation of species, wildlife habitats and biodiversity, conservation of renewable resources, establishment of standards for the quality of the ambient air, water and land, establishment of Environmental Tribunals, appointment of Environmental Magistrates, Initial Environmental Examination (IEE) and Environmental Impact Assessment (EIA) approval. It also describes the powers and functions of the Sindh Environmental Protection Agency (Sindh EPA). The requirement to conduct environmental IEE or EIA before commencing developmental projects is a requirement under this Act.

Other Relevant Legislation in Sindh: legislation and regulations relevant to the proposed project are listed below

- Sindh Wildlife Protection Ordinance (2001)
- Wild Birds and Animals Protection Act (1912)
- Sindh Fisheries Ordinance (1980)
- The Sindh Water Management Ordinance (2002)

Other Relevant Legislation in Pakistan: Other legislation and regulations relevant to the proposed project are listed below.

- Pakistan Environmental Protection Act (1997) establishes the general conditions, prohibitions, and enforcement for the prevention and control of pollution and the promotion of sustainable development in the country. It also describes and delineates the powers and functions of the Pakistan Environmental Protection Council, Pakistan Environmental Protection Agency (Pak-EPA), provincial Environmental Protection Agencies (EPAs), and Environmental Tribunals. In particular, the Act creates the authority for delegation of environmental management functions to the provincial EPAs;
- Pakistan Penal Code (1860) deals with offences against public interests, e.g., to control noise, toxic emissions and disposal of effluents;
- Land Acquisition Act (1894);
- Factories Act (1934) provides regulations for safe handling and disposal of toxic and hazardous materials by contractors;
- Protection of Trees Act (1949) prohibits cutting and logging of trees planted by the Forest Department along roads and canals;
- Antiquity Act (1975) protects antiquities and empowers the GoP to prohibit excavation and construction works in any area that may contain objects of archaeological or cultural historic value;
- Motor Vehicle Ordinance (1965) empowers licensing and other authorities to regulate traffic rules, speed and weight limits and vehicle use;
- Labor Laws: labor rights are provided in the Constitution of Pakistan; various acts and ordinances provide additional rules for working hours, minimum working age and conditions of employment;
- Highway Safety Ordinance (2000) includes provisions for licensing and registration of vehicles and construction equipment;

- Local Government Ordinance (2001) deals with enforcement of laws for land use, conservation of natural vegetation, air, water, disposal of solid waste and wastewater effluents, public health and safety; and

Regulations and Guidelines: The regulations and guidelines relevant for the present ESA are listed below.

- Pakistan EPA Initial Environmental Examination (IEE) and EIA Regulations (2000);
- National Environmental Quality Standards (NEQS) (2000), with updates in October 2010;
- Guidelines for the Preparation and Review of Environmental Reports (1997);
- Guidelines for Public Consultations (1997);
- Guidelines for Sensitive and Critical Areas (1997); and
- Policy and procedures for filing, review and approval of Environmental Assessments (2000).

Relevant National Policies and Plans: The national policies relevant to the proposed project and its environmental and social assessment are briefly described below.

- The National Conservation Strategy (1992) was adopted as the guiding environmental policy for Pakistan. A Mid-Term Review was undertaken in 2000. The Mid-Term Review concluded that the achievements under the Strategy had been primarily awareness raising and institution building, and that future initiatives should emphasize improvements in implementation capacity;
- The National Environmental Policy was adopted in 2005 and provides broad guidelines to the federal, provincial and local governments in addressing environmental concerns and cross-sectoral issues such as poverty, health, trade and local governance. To achieve its objectives, the Policy directs the Ministry of Environment and provincial and local governments to develop plans for its implementation; and
- The National Environmental Action Plan was adopted in 2001 with the stated objective of alleviating poverty through environmental projects.

International Treaties signed by Pakistan: Pakistan is a signatory to a number of international environment-related treaties, conventions, declarations and protocols. The following are the relevant international treaties and conventions to which Pakistan is a party:

- Convention on Biological Diversity, Rio de Janeiro (1992);
- United Nations Framework Convention on Climate Change, Rio de Janeiro (1992);
- Vienna Convention for the Protection of the Ozone Layer, Montreal (1987);
- Convention on Wetlands of International importance especially as Waterfowl Habitat, Ramsar (1971) and its amending protocol, Paris (1982);
- Convention on Conservation of Migratory Species of Wild Animals (1979);
- Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), Washington (1973);
- Convention concerning the Protection of World Culture and Natural Heritage (World Heritage Convention) (1972);
- International Plant Protection Convention (1951); and
- Kyoto Protocol (1997) and Copenhagen Accord (2009) on climate change.

2.2. Environmental Procedures

Environmental Impact Assessment: In accordance with the Sindh Environmental Protection Act of 2014 and the Pak-EPA IEE and EIA Regulations, 2000, an EIA is required for major barrage rehabilitation projects.

EIA Approval: The owner of the project, i.e., SID shall submit EIA to the provincial environmental authority, Sindh-EPA. After submission of the EIA report, a thirty (30) day period for public comment shall be provided. The assessment will be completed within a period of ninety days from receipt of the complete documents, and earlier than this wherever practicable. Following the completion of public hearing, if required, and the provision of any further data from the proponent, the decision shall be made and conveyed thirty days thereafter.

2.3. World Bank Safeguard Policies

The World Bank's environmental and social safeguard policies relevant to the project include the following:

Environmental Assessment (OP 4.01): The proposed project involves civil and mechanical rehabilitation works of an existing barrage on Indus River with a potential to effect irrigation supplies and downstream dolphin habitat and hence can be screened as Category A project. The World Bank requires an environmental and social assessment for all environmental screening "Category A" projects proposed for Bank financing, in order to ensure that these projects are environmentally and socially sound and sustainable. In accordance with the requirements of Operational Policy (OP) 4.01, environmental and social assessment has been carried out and ESMP prepared to mitigate or minimize all potential adverse environmental and social impacts. Significant environmental issues were already mainstreamed in the project planning and design by adopting water borne construction (using barges) instead of traditional cofferdam approach to avoid disruptions to irrigation supplies and to reduce environmental footprints.

Natural Habitat (OP 4.04): The Indus River between the Guddu and Sukkur barrages is the nationally designated game reserve for Indus River dolphin and also a RAMSAR wetland of international importance. This part of the river contains large population of dolphins. Impacts of construction activities on dolphins were assessed and mitigation measures are proposed in ESMP. A dolphin conservation and management plan is prepared to strengthen the ongoing conservation activities.

Safety of Dams (OP 4.37): Barrages are major hydraulic structures across rivers and are susceptible to failures due to earth quakes and floods. The dam safety Policy is triggered and an action plan has been developed, including establishment of an independent panel of experts to review the project design and preparation of emergency preparedness plan.

International Waterways (OP 7.50): The project is located on the Indus River, which is an international waterway shared by Afghanistan, China, India and Pakistan. Therefore OP 7.50 is applicable and hence the project will require a riparian notification consistent with the policy. However, the proposed project will not have any impacts on the riparian countries.

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 this Executive Summary have been disclosed at SID website and World Bank Info Shop in addition to sharing them with the stakeholders including the local community.

In addition, the following policies and guidelines have been taken into account in the project design:

Environmental Health and Safety Guidelines: The World Bank Group Environment, Health, and Safety (EHS) General Guidelines (2007) contain performance levels and measures for development of industrial projects that are considered to be achievable in new facilities at reasonable costs by existing technology.

Gender Policy (OP 4.20): The World Bank's Gender Policy aims to reduce gender disparities and enhance women's participation in the economic development of member countries. During the ESA, gender aspects have been considered and women's participation has been ensured as far as possible while carrying out the stakeholder consultations.

Environmental and social policies of the World Bank that are not applicable to the project include:

Pest Management (OP 4.09): No pesticides, herbicide or fungicides will be used in any of the project activities and hence this policy is not applicable. To address the increased use of pesticides in Sindh, a pesticide management plan has been implemented under the World Bank funded Sindh On Farm Water Management Project (OFWMP),

Indigenous People (OP 4.10): This policy has defined Indigenous Peoples for policy application as well as the planning process to be followed if a Bank-funded project affects Indigenous Peoples. In Pakistan, the World Bank has concluded through its operational experiences that only Kalash people in Chitral district of Khyber Pakhtunkhwa province meet the definition of Indigenous Peoples as described in this policy. Since no Kalash people live in the project area, this policy is not applicable.

Physical Cultural Resources (OP 4.11): There are no known cultural or archaeological heritage sites within the project area. However procedures dealing with "chance finds" are to be included in the bidding documents for the construction contracts.

Involuntary Resettlement (OP 4.12): No land acquisition is required for the Project. However temporary land acquisition might be required for the contractor for placement of workers camp and construction yard. A resettlement policy framework (RPF) has been prepared by the SID to guide the planning and implementation of compensatory measures in line with relevant Pakistani laws and OP 4.12.

Forestry (OP 4.36): The policy recognizes the need to reduce deforestation and promote sustainable forest conservation and management in reducing poverty. No forests are located in the project area and hence this policy is not applicable.

Projects in Disputed Areas (OP 7.60): Projects in disputed areas may raise a number of delicate problems affecting relations not only between the Bank and its member countries, but also between the borrower and one or more neighboring countries. This policy is not applicable, since the project is not located in or near any disputed territory.

2.4. Compliance Status with Pakistani Legislation and World Bank Policies

The present compliance status of the project with Sindh and Pakistani legislation and World Bank safeguard policies is indicated in Table 1.

Table 1: Compliance of Project with GoS Legislation and World Bank Safeguard Policies

	Legislation/Policy	Actions Taken to Comply
GoS and GoP	Sindh Environmental Protection Act, 20014	SID has submitted the ESA reports to Sindh-EPA in November 2014 and approval from Sindh EPA is expected by January 2015.
	International	Verification of protected sites, Red List and protection of vulnerable habitats.

	Legislation/Policy	Actions Taken to Comply
	treaties	
	Public information and disclosure	The Executive Summary of the ESA has been translated to Sindhi and is available at the Guddu Barrage office in Guddu, along with other project information. The draft ESA report has been disclosed on SID's website. Stakeholder consultation workshops are held in Guddu and Sukkur to disclose the project information and ESA to the public in October 2014.
World Bank	Early screening and Scoping	Scoping consultations were held in the project area in November 2011.
	Participatory approach	Workshops, consultation meetings and focus group discussions were held.
	Integrate environmental and social assessment	Natural environment, public health, and social aspects are integrated in planning documents.
	Natural Habitats	Verification of protected sites and ecosystems, Red List and endangered flora and fauna has been done. Discussions with Sindh Wildlife Department and conservation NGOs (WWF, IUCN) were held on potential impacts and mitigation or compensation measures.
	Risk assessment	Health and safety risks for population and workers are identified in the ESA and will be included in an Occupational Health and Safety Plan; Environmental Code of Practices (ECP) – occupational health, labor – will be included in tender documents; an Emergency Preparedness Plan is prepared for barrage operations.
	Climate Change and floods	Impact of climate change effects are considered in estimating future flows and evaluation of super floods. River training works design considered to withstand and accommodate to these flows for 100 year return flood.
	Cumulative Impacts	Cumulative impact assessment has been conducted as part of the ESA to cover the impacts of all existing barrages in Indus and focused on the impact of barrages in Sindh (Guddu, Sukkur and Kotri).
	Alternatives	Alternatives considered included: the "without project" case; alternatives to gates replacements; flood protection, river training and construction techniques.
	Pollution	Baseline survey of environmental quality has been carried out. Stricter environmental standards were applied and ECPs will be included in contractors' bidding documents.
	Physical Cultural Resources	No physical cultural resources are located in the project impact area. Chance find procedures will be included in bidding documents.
	Gender	Gender consultations were carried out during ESA.
	Public Health	Public health aspects were studied.
	Consultation and access to information	Consultations have been held in all the project villages and with all the relevant stakeholders. The draft ESA report has been disclosed to the stakeholders in consultation meetings in October 2014. The Executive Summary report is translated in Sindhi and is available through Guddu Barrage office at the project site. The reports (in English and Sindhi) have also been made available in public libraries and were posted to SID's website on 10 November 2014. The ESA, its Summary, and Social Management Framework were also sent to the World Bank InfoShop.

3. Project Description

3.1. Background

Key Features of the Guddu Barrage. Construction of Guddu barrage was started in 1957 and was commissioned in 1962. Total width of the barrage between the two abutments is 1,355 m, comprising of 54 gated bays in the main weir, 7 gated bays in the right pocket (under sluices between the divide wall and right abutment) and 4 gated bays (1 for navigation and 3 under sluices) in the left pocket (between the divide wall and left abutment). All the bays have a clear width of 18.29 m (60ft), except navigational bay which has 15.24 m (50ft) width. The under sluices are used to flush out sediment. On the upstream, there are 135.6 m and 266 m long divide walls on left hand and right hand side respectively. 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 bunds, upstream marginal bunds 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 (at gate numbers 7 and 61). The upstream right guide bund is 2,439 m long while downstream right guide bund is 384 m long. The upstream left guide bund is 2,492 m long while downstream left guide bund is 404m long. The barrage was built at a site where Indus is meandering and the river width varies from 11 to 13km. In addition to the guide bunds, about 14 km of spurs are constructed on upstream for river training and sediment control. A 6.7 m wide road bridge along with a 0.91 m wide sidewalk on each side provides the means of transportation across the bridge. Two major gas pipelines from Sui Fields cross the barrage to link with Multan-Sukkur main gas pipeline. Layout of the barrage river training works and the barrage is shown in Figure 2 and Figure 3.

Barrage irrigation function. Initially three off-take canals were built along with the barrage: Beghari Sindh Feeder and Desert Pat Feeder on right bank, and Ghotki Feeder on left bank. A fourth canal called Rainee Canal was constructed later in 2006 on the left bank. The command areas lie in the lands of Jacobabad, Larkana and Sukkur districts of Sindh and the Nasirabad district of Balochistan. These districts are situated in desert climate where crop production is only feasible with irrigation. The cumulative commanded area of four canals is 1.39 million ha. About 3 million people in rural areas of these four districts inhabit the command areas of the four canals, and their livelihoods depend directly or indirectly on the irrigation supplies of these canals. About 0.35 million farm households directly benefit from these irrigation waters. The canals also supply water to Guddu thermal power plant, two fertilizer factories, five sugar factories and several rice mills. Canal water is also being extensively used for drinking purpose in several villages that are underlain by saline groundwater of Desert Pat Feeder command area. The canals are generally closed annually during month of April and May for about 4 to 6 weeks for maintenance works. However, Beghari Sindh Feeder Canal will be closed for about 6 months during October to May.

Barrage flood discharge function. The Guddu barrage has been designed to pass a maximum discharge of 31,432 cumec (1,100,000 cusec). Since its construction, the barrage has safely passed a flood discharge that exceeded this limit five times, with maximum being 33,971 cumec (1,199,672 cusec) on August 15, 1976. Presently, the barrage is now considered safe for passing 34,000 cumec (1,200,000 cusec). Hydrological analysis conducted as part of the preparation of this project show the design flood (100 year return period) to be about 36,000 cumec (1,270,000 cusec).

3.2. Assessment on Current Condition of Guddu Barrage

Current condition of barrage gates. The condition assessment carried out under the feasibility study indicates that there are serious operational difficulties and safety issues with the barrage,

the most severe problems include (a) up to 60% of the steel of the 65 gates on the main barrage is badly corroded, (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 down it is considered likely that the gates will fail during normal operation within 5 years. There is already a risk now that the gates may fail in case of a flood event that necessitates opening and closing. Such a failure is likely to be catastrophic, affecting water supplies to all the irrigated areas supplied by the barrage.

Current condition of river training works. The condition and adequacy of the existing river training works, such as guide bunds, spurs, and marginal bunds have been assessed in detail. The condition of river training works have generally been found to be in acceptable physical condition but with the need for remedial action to some of the stone protection to the slopes and some additional apron protection to the spurs and guide bunds. The upstream marginal bunds have also been assessed in respect of their adequacy to safely contain the design flood discharge and increased flows due to climate change and it has been found that raising in some areas is required to adequate freeboard to a 100 year return flood.

Current status on sedimentation control. The left bank pocket divide wall is not effectively controlling the sedimentation for combined discharge for the Ghotki and Rainee canals. Currently a shoal is formed in the left pocket near the divide wall and high levels of sediment are passed into the Ghotki Feeder Canal reducing its flow capacity. If the current trends of sedimentation continue to takes place in the left pocket of the barrage off-taking canals, the irrigation carrying capacity of these canals will be completely lost in next 25 years. To avoid further siltation in this pocket and to facilitate effective flushing operations, the left pocket should be widened to a total of 7 bays by constructing a new left pocket divide wall.

Current status on river morphology. The river flow approaching the barrage appears to have become relatively stable, but during floods flow pattern tends to shift from left to right. For improved equal distribution of flow across the barrage to both right and left pockets additional river training works are required on the upstream.

3.3. Project Objective

The main development objective of Guddu Barrage rehabilitation project is to safeguard the reliable supply of irrigation water to about 1.05 million ha thus benefitting directly about 0.35 million farm households and 3 million population. This will be achieved through enhancing the life of the barrage through replacement of gates and strengthening of river training works improved flood protection and sediment management.

3.4. Project Components

(a) Component A: Rehabilitation of Guddu Barrage (USD 171 million). This component will support all civil and mechanical works proposed for rehabilitation of the barrage and its associated structures. The component will finance the following:

Barrage improvements. The works will include gate replacement works to improve the regulation and the flow of the barrage. This includes replacing all 65 main barrage steel gates (the gates are 18.3 m wide and 6.6 m high and weigh 55 tons each), 25 main canal head regulator gates (the gates are 7.3m wide and 3.8m high and weigh 25 tons each) and hoist gears. 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.

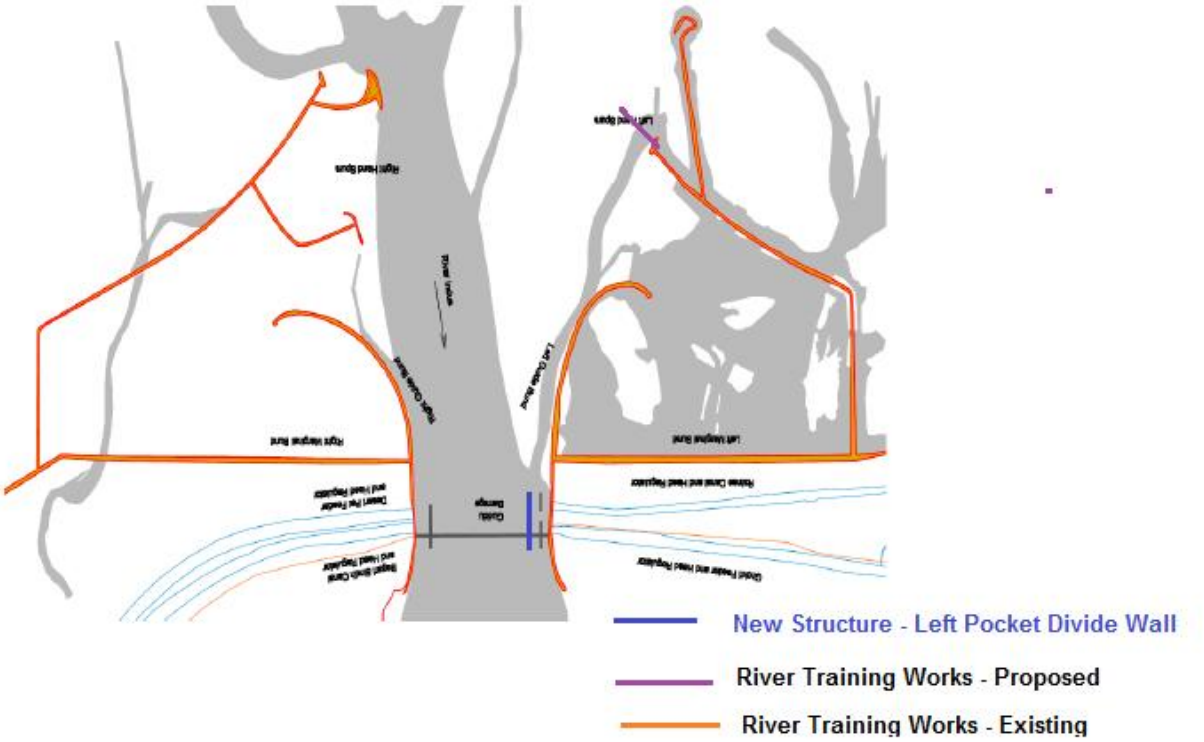


Figure 2: Layout of Guddu Barrage Project

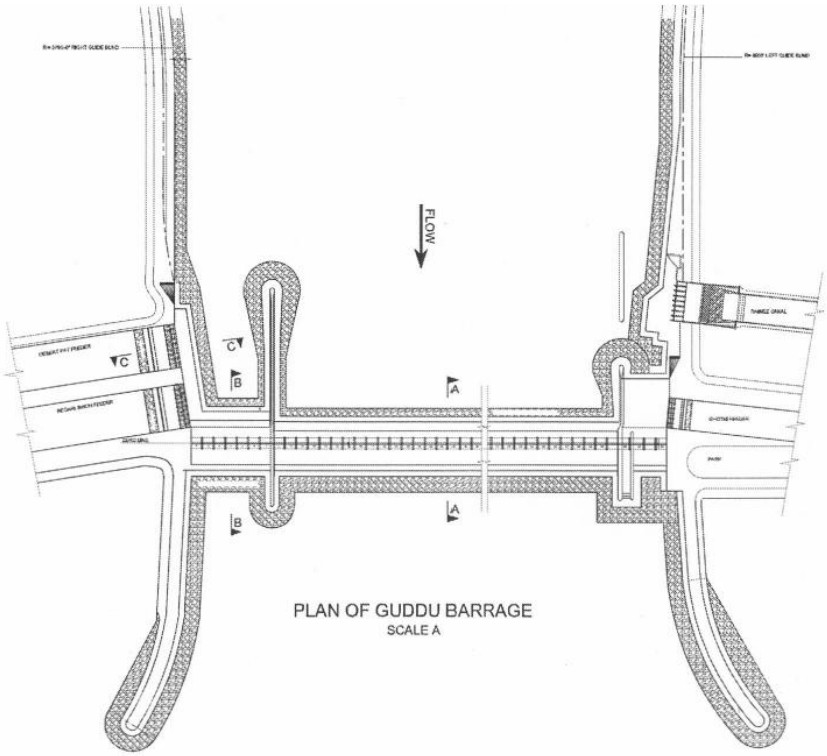


Figure 3: Existing Layout and sections of Guddu barrage

Construction of a new left pocket divide wall. A 455 m length of new left pocket divide wall will be constructed at gate 7 to control the passage of sediments in to the canals. The length of the wall on upstream of the barrage is 350 m and downstream is 105 m. The existing divide wall located away from the barrage near Rainee canal will be no longer required and will be dismantled.

Strengthening of existing river training works. The existing left hand side river training structure located about 4 km upstream of the barrage will be extended for another 1200m in to the river. At some locations, the guide bunds and spurs will be provided with stone protection to the slopes and some additional apron protection. The Upstream Left Marginal Bund, the Upstream Right Marginal Bund, and parts of the left and right spur complexes (total about 40 km) will be raised in those areas where there is inadequate freeboard in order to withstand extreme flood events up to 36,000 cumec.

Construction of office and staff colony. A new office, a laboratory, a guest house, 32 residences and associated water supply and sanitation structure and social facilities, including a primary school, a dispensary and a mosque, will be built for the barrage operation staff in the premises of barrage colony site located 200 m away from the right bank of the barrage. In addition some temporary facilities such as construction yard, labor camp will have to be constructed by the construction contractor.

Construction Supervision and Contract Management: This component will cover the cost of consulting services including construction supervision, contract administration, and quality control, preparation of any additional designs bidding documents and monitoring and evaluation.

(b) Component B: Improved Barrage Operation, Improvement (USD 23 million)

Upgrades to the instrument monitoring systems and replacement of O&M Equipment. This component will support modernization and improvements to the barrage operation and maintenance. This will include necessary upgrades to the instrument monitoring systems such as piezometers, gate positioning and gauging, training and capacity building for staff, 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. This component will lead to upgrading of the operating facilities with a higher level of control and improved operation & maintenance.

Implementation of social and environmental management Plans. The environmental and social management plan (ESMP) includes measures to strengthen conservation measures in dolphin's game reserve, management of hilsa migration, and implementation of monitoring plan. To complement ESMP, a Social Management Framework (SMF) was also developed as a separate document to mitigate potential social impacts, facilitate communication, and support local area development. Construction related environmental issues will be addressed in the construction contracts, thus the cost of such measures is included in construction costs.

Sindh Barrages Future Studies. This component supports future studies for other barrage projects in Sindh Province, the terms of reference for which are currently being defined.

(c) Component C: Project Management Coordination and Monitoring and Evaluation, and training (USD 6.5 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 Panel of Experts (POEs) to review, monitor, evaluate, and help guide the rehabilitation process with regard to the safety of the barrage.

3.5. Construction Methodology

Generally the replacement of gates in other barrage rehabilitation projects in Pakistan was carried out by constructing cofferdams on the upstream side to create a dry workspace around gates. This approach requires closure of the canals during replacement of canal gates and barrage gates in the pockets. Extended periods of closure will severely affect the agriculture in the command area. Hence in this project, it is proposed to install temporary bulkhead gates across the gate bays on the upstream side to create dry work space instead of cofferdams. The bulkhead gates will be launched into the river from a docking area and guided to the barrage using work-boats. Prior to fitting of the bulkhead gates, a receiving layer of sandbags will be placed by divers in the base of the gate bay, to provide support and to assist with sealing. Once the bulkhead gates are in position, the water from the barrage gate and bulkhead gate will be drained out. The existing gates will be cut up and lifted out by the barge mounted crane located upstream of the barrage and removed from site and will be sold as scrap to steel industries. The new gates will be installed using the barge mounted crane. Prior to removing the bulkhead gates the new gate will be tested and commissioned to ensure proper operation. The proposed construction methodology is further explained in Annex 1 with help of some visuals.

3.6. Construction Material and Sources

During the construction, a large amount of construction material will be required. This will include earth fill, rock, concrete, steel, paint, rubber seals, cement, sand, and aggregates. The aggregate will be obtained from the existing government approved quarry sites located at Rohri, 150 km from the barrage site on the way to Sukkur, while earth fill will be taken from within the marginal bunds of the barrage. The cement would be brought from cement factories located near Hyderabad while steel may be procured from Karachi. Average labour requirement per day is 200 while peak time requirement estimated to be 400. Unskilled workers will be mainly hired locally. A workers camp will be established by the contractor near the barrage away from the local villages with sufficient amenities.

3.7. Construction Schedule

The construction is planned to be completed in five years. The construction works inside the river will be mainly carried out during October to May/June while the period between June and September, when the river flows are highest, will be used for preparation for the following construction year. The project will be implemented under 3 separate contracts, the contract package 1 includes construction of staff colony, package 2 covers works associated with the barrage such as replacement of gates and construction of left bank divide wall, and package 3 covers river training works. Because of the shortage of adequate accommodation at Guddu it is important that the staff colony is constructed in the initial six months of the construction phase under Contract Package 1 so that the facilities are in place for the supervision team before the main construction contracts begin.

3.8. Project Cost

The estimated project cost is shown in Table 2.

Table 2: Overall Estimate of Project Cost (Dollars)

Project Components	Project cost, million USD
A. Rehabilitation of Guddu Barrage	171.4
B. Improved Barrage Operation, Improvement	23.0
C. Project Management Coordination, Construction Supervision, and Monitoring and Evaluation, and technical assistance and training	6.5
Total Costs	**200.9**

4. Project Alternatives

4.1. No Project alternative

Current condition of Guddu barrage. Guddu barrage has already completed fifty years of active service. Details of the current condition of the barrage and associated facilities are explained in Section 3.2. The major issues are (i) severe corrosion of gates and lifting mechanism, which may fail the barrage gates in a span of five years; (ii) poor condition of the switch panels and power distribution network requiring immediate replacement; (iii) absence of power backup system in operation in case of power failures; (iv) some areas of upstream embankments with insufficient freeboard to the 100 year flood water level; and (v) sedimentation across the barrage and in the off taking canals is such that they will lose their capacity to irrigate within 25 years.

Consequences of not carrying out any rehabilitation and improvement works. Failure of gate lifting mechanism is likely to be catastrophic, affecting irrigation supply to the entire command area of 1.05 million ha. This in turn will affect livelihood of about 0.35 million farming households and 3 million people living in the command area. Decrease of supply in canals due to sedimentation will reduce the crop productivity, particularly the production of cotton and rice which require irrigation throughout their life cycle. About a 1.5% decrease in irrigation flows is expected annually, resulting in a cumulative reduction in cropping intensity of 37.5% over 25 years. The annual loss of crop due to this reduction in flows is initially estimated at USD 13 million, increasing by the same amount year on year. Hence not carrying out any rehabilitation works will severely affect the economy of the region and the country at large. The alternative of doing business as usual by carrying out intensive repairs and maintenance during regular canal closure periods was considered to be not viable.

4.2. Refurbish versus replacement of gates

Option to refurbish 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 would be required to bring the existing gates to working condition for reuse is substantial and environmentally not safe due to risk of failure and also certainly uneconomical as this will require substantial replacement of sections and additional spare parts on site.

4.3. Placement of like for like gates

The feasibility study shows the gates should be replaced on a like for like basis as the current gate design is sufficiently modern. There is a possibility of saving by using modern structural design, since they are more efficient than those of the 1960's, however this may offset by additional requirement to raise the operating pond level to 260 ft which would necessitate a slightly taller gate; the main weir gates would be 4.5 ft taller and the scour gates approximately 3ft taller than the existing gates. With like for like gate replacement, the gate travel would remain "as it is", and thus capacity, of the barrage will be unaffected. Environmentally and socially also the like for like gate replacement avoid additional land acquisition for the additional pondage area and thereby impact on the natural terrestrial and aquatic habitat.

4.4. Barrage Regulator Control System

Several options have been considered for the rehabilitation of the barrage regulator control system. In considering these options, the feasibility took into account the importance of maintaining power operations, number and skill level of barrage staff and the unlikelihood that future expenditure on maintenance will be significantly increased. Analysis shows that the option to rehabilitate barrage using instrumentation and control similar to the existing arrangement

(compared to centralized control or remote control options) provides the most reliable and most flexible solution. This is because it will accommodate multiple failures and still allow powered operation of gates. The existing motor drive trolleys can be replaced by an appropriate number of new trolleys with the design updated to include modern control and braking as well as ancillaries such as task lighting. It would also be possible, if required, that one or more trolleys be powered by a small petrol engine making operation without electricity possible although it is also envisaged that a permanent standby generator would be available so to an extent this would be a double redundancy. The option of using instruments and control system similar to the existing arrangement is the least cost option due to the smaller number of motors and associated equipment required.

4.5. Alternatives for Rehabilitation of River Training Works for Improved Flood Protection

Seven alternatives were studied for improved flood protection. Alternative 1 includes strengthening of all existing river training structures and raising of marginal bunds to withstand a 100 year return flood. Alternatives 2, 3, 4 cover various methods of discharging floodwaters through left marginal bund by allowing controlled breaches, but all these alternatives are rejected due to requirement of inundation of large areas of agricultural lands and settlements. Alternative 5 includes construction of an underground siphon through left bank to divert water from upstream to downstream, which is a technically challenging and expensive. Alternative 6 and 7 includes construction of new marginal bunds and widening of existing barrage through construction of new gates, and both these options are rejected due to their high capital cost and huge land acquisition requirements and higher environmental impacts. Alternative 1 on strengthening and raising the current marginal bunds is chosen since it is technically robust, economically cheaper, no requirement of land acquisition and lesser environmental footprints.

4.6. Alternatives for Additional River Training Works

Numerical modelling has been carried out for various configurations of additional river training works, to control the river flow equally between left and right pockets and also to address sedimentation issues. Based on the modeling study five alternatives are chosen for further study through a physical model. A scale hydraulic model of the barrage was constructed in a laboratory at Hyderabad to study river training and sediment management alternatives recommended by the numerical models. These include extension of existing spurs, construction of new spurs and combination of both these options, and also construction of a new divide wall in the middle of the river. The option of extension of left bank spur for another 1200m is found to be environmentally advantageous alternative due to its shorter length compared to other options due to lesser requirement of borrow material and limited construction activities. This option is also technically and economically advantageous.

4.7. Alternatives to Sediment Management to offtaking Canals

Various alternatives for sediment management were also studied using numerical modeling and finally two alternatives were recommended for further investigation through the physical model. These are (i) construction of a new pocket divide wall between 7^{th} and 8^{th} gate bay; and (ii) join the gap in the existing divide wall located 3^{rd} and 4^{th} gate bay. Both the numerical and physical models confirm that the construction of a new divide wall will be more advantageous for reducing the velocities in the left pocket and controlling sediment flow in to the canals and hence recommended for this project. However construction of new a divide wall will have some additional environmental impacts, such as risk of dolphins' collision with motor boats and risk of water pollution in the dolphin game reserve, compared to other alternative due to instream construction activities on the downstream of the barrage and mitigation measures are proposed in ESMP to address these impacts.

4.8. Construction Methodology for Left Pocket Divide Wall

Two methodologies have been considered for the construction of the left pocket divide wall: (i) construction from river bed in the dry working area and (ii) construction from a waterborne plant. In the first alternative cofferdams need to be constructed around the construction areas and water would be pumped out to create a dry working area. This is standard method being followed in other barrage rehabilitation projects in Pakistan, but this option would require closure of a left bank canal (Ghotki feeder) for extended periods, which will seriously affect the irrigation, industrial and drinking water needs of the left bank command area. In the second alternative, the divide wall shall be installed from a waterborne plant (using a sheet piling rig mounted on a barge). This alternative removes completely the need for construction of cofferdams and closure of the Ghotki feeder canal and hence this alternative is recommended. The construction risks associated with water borne activities such as risk of water pollution, increased occupational health and safety risks and underwater noise levels are assessed in the ESA and appropriate mitigation measures are proposed in the ESMP.

5. Description of Environment

5.1. Physical Environment

Definition of the study area: The study area of the Project includes impact area of the project and its area of influence. The impact area of the Project includes all permanent and temporary areas (the footprint) that will be covered under rehabilitation works of the barrage, rehabilitation of river training works, colony and workers camp. On the upstream of the barrage, the impact area extends to 25 km along the left bank and 8 km on the right bank to cover the existing river training works on the upstream of the barrage and on downstream side it extends up to 0.5 km to cover the downstream construction area of left pocket divide wall. Along the banks, the impact area extends to 5 km away from the river to cover the areas that could be influenced by the impacts from construction works. Baseline environment data was collected for all these impact areas. The project influence area covered for impact assessment also broadly covers this impact area, but on the downstream it extends up to Sukkur barrage to cover the dolphin game reserve.

Physiography: The physiography in this area is dominated by characteristics of braided Indus river (meandering channels, temporary shoals and alluvial sand tracts), barrage pondage and floodplain agriculture. Indus upstream of Guddu is extensively braided with a width of 10 to 15 km with constantly shifting channels. The river carries water through its entire width during high flow season of June to September, while the water will be limited to few channels during remaining months. The barrage and its river training works narrowed the river at the barrage by 1.3 km and created a temporary pondage area on the upstream side during high flows and some permanent ponds near the spurs. Before construction of the Guddu barrage, the area is a desolated terrain with some agriculture in the floodplains, but the barrage transformed these barren lands in to vast agricultural tracts. Landuse in the project impact area is covered 35 percent by Indus (10% by active channels, 15% by river alluvium, 5% by stagnant water bodies, 5% by riverine scrublands), 60 percent by agriculture, 4 percent by settlements and 1 percent by barren or waste land that is not suitable for agriculture.

Climate: According to Koeppen climate classification, the Guddu area can be classified as ‘desert hot climate’ because of its low annual rainfall compared to potential evapotranspiration, and high temperatures. The average annual rainfall is about 100 mm with nearly 50 percent of rainfall falls in monsoon months of July and August. Average annual potential evapotranspiration is 2,200 mm. Between April to October, day time temperatures exceed 35 °C and during winter months the night time temperatures may drop up to 8 °C.

Geology: Indus and floodplains near Guddu barrage is underlain by very thick (more than 150 m) alluvial sand deposits over a basement of limestone and sandstone rocks. Surface soils are silty and clayey loams and contain adequate nutrients and drainage required for agricultural use.

Seismicity: The generalized “Seismic Zoning Map” of Pakistan, places Guddu Barrage just within the "Minor to Moderate Damage" (Zone 1) seismic category. For this zone, a peak ground acceleration of between 0.03 g and 0.1 g is to be considered for design of any hydraulic structures. For design of original Guddu barrage and for the current interventions, a conservative estimate of 0.1 g has been adopted by the design consultant.

Indus River: The Indus at Guddu drains an area of about 950,000 km^2 and generates a mean annual discharge of 6,682 cumec. The hydrograph of the river is strongly seasonal with a long low water season between October and May (low flow season) and a high water season between June and September (high flow season) – driven primarily by summer snowmelt in the upper catchment and monsoon rainfall. The river usually peaks in mid-August or early September. River flow upstream of Guddu barrage varies from a monthly average flow of

approximately 10,300 cumec (365,000 cusec) in August, to a monthly average flow of approximately 990 cumec (35,000 cusec) in December. The corresponding figures downstream of barrage are approximately 9,500 cumec (335,000 cusec) and 708 cumec (25,000 cusec) in August and December respectively. About 15,000 cumec of water is being diverted through four canals of Guddu (509 cumec through Beghari Sindh Feeder; 396 through Desert Feeder; 311 through Ghotki Feeder and 283 cumec through Rainee canal).

Floods: Floods in Indus generally occur due to heavy and prolonged storms and intensive/extreme glacier and snow melting. High discharges above 25,485 cumec (900,000 cusec) are termed as super floods. A number of such floods have been recorded historically near Guddu (1950, 1956, 1957, 1973, 1975, 1976, 1978, 1986, 1988, 1989, 1992, 1995, 2010 and 2011). Highest flow recorded so far at Guddu was 33,980 cumec in 1976. The Guddu barrage has been designed for 31,150 cumec and has safely passed all the historical floods. Flood frequency analysis and climate change assessment suggest the flood flows at Guddu will increase and the design discharge of river training works should be increased to 36,000 cumec to accommodate flood events of 100 year return period.

Groundwater: In the floodplain areas, the groundwater occurs at shallow depths (3.7 to 6.1 m) and is also being used extensively for drinking purposes. Though 80 percent of Sindh is underlain by saline groundwater, the groundwater in the floodplains is generally good due to regular recharge from Indus. Total dissolved solids of groundwater near the banks of Indus generally ranges from 186 to 276 mg/l and other chemical constituents are with in national drinking water quality standards. However coliform bacteria are noticed in all the tested groundwater samples due to shallow groundwater levels. At some places, groundwater is also being used for supplementing canal irrigation. The groundwater in command area of Desert Pat Feeder is saline and hence irrigation water is being used for drinking purposes.

Indus water quality: The water quality of the Indus is generally low in total dissolved solids, ranging from 60 mg/l in high flow season to 374 mg/l in low flow season. However, the turbidity levels are very high. The water from irrigation canals is also being used for drinking purpose in command area of Desert Pat Feeder, where the groundwater is saline.

Air quality: Air quality near the barrage area is found to be within national standards of ambient air quality. Concentrations of particulate matter are in the air ranges from 20 to 25 $\mu g/m^3$. Emissions from nearby Guddu Thermal Power Plant (a combined power cycle plant) are also found to be within the national emission standards.

Noise quality: Noise levels near the barrage are generally high due to vehicular traffic and have exceeded the national standards. The night time noise levels were found in the range of 50 to 66 dB, and day time noise levels were found in the rage of 45 to 60 dB.

Traffic on the barrage: The Guddu barrage provides only way of crossing the river for some considerable distance. The nearest river crossings on upstream is located about 230 km at DG Khan and downstream crossing is located about 190 km at Sukkur. Based on the traffic counts carried out in October 2011, the average daily traffic on the barrage is 3260, in which 40 percent are heavy vehicles. Peak hourly traffic is 225 vehicles per hour and rush hours are generally from 7 am to 6 pm.

5.2. Biological Environment

General Biodiversity: The Indus River and its riparian forests have a unique freshwater ecosystem that supports both terrestrial and aquatic biodiversity. In Sindh, 105 species of plants, 150 species of avifauna, 16 species of mammals, 15 species of reptiles, 4 species of amphibians and 67 species of fish are reported. Among the animal species only Indus River Dolphin (Platanista gangetica minor) is the endangered species located close to the barrage

area. Hilsa (Tenualosa ilisha) and Barramundi (Lates calcarifer) are the two migratory fish species and commercially very important fish species in Indus. Hilsa (locally known as palla) is an anadromous fish that lives in sea and migrate to Indus reportedly as far as up to Multan (located about 300 km upstream of Guddu) for breeding before construction of barrages. Construction of barrages has restricted the migration of Hilsa up to only Kotri barrage. Barramundi is a catadramous fish that lives in Indus (close to the coast) and migrates in to the sea for breeding.

Protected and sensitive areas: A 170 km stretch of the River Indus between two irrigation barrages Guddu and Sukkur is the designated national protected area for Indus dolphin, and is known as Indus Dolphin Game Reserve. The total area of the reserve is 125,000 ha and has a 3 km buffer zone on the floodplains. This dolphin game reserve was also declared as Ramsar site (wetland of international importance) in year 2000. According to recent estimates in 2011, the reserve holds a population of 918 dolphins. Where as in 1975, only 150 dolphins were recorded from this reserve signifying the conservation efforts carried out so far.

Terrestrial ecosystems and species recorded: The natural ecosystem in the project area was altered by the clearing of lands for cultivation and livestock grazing. Common tree species such as acacia and eucalyptus are generally planted along the margins of agricultural lands. Seasonally inundated floodplains within the marginal bunds of the barrage and shoals (locally known as belas) found to consists of 105 grass species (predominantly tamarix species), belonging to 81 genera and 36 families. These grasses are generally cut and carried for fodder. 86 species of birds were recorded. The riparian forests between Guddu and Sukkur along Indus are once reported to provide a habitat for fishing cat and hog deer (IUCN endangered) and smooth coated otter (IUCN vulnerable), but none of these species are now reported to be present in these areas due to conversion of these forests in to agricultural lands and plantation areas, and poaching. Otter population is reportedly declined by pesticide laden return flows from agricultural fields and development of fish farms along the Indus.

Aquatic ecosystems and species recorded: This Indus and its floodplains formed an unique ecosystem that supports wide variety of fish and most importantly Indus River Dolphin. During high flow season water covers the entire river width, as water recede some natural water ponds are developed in the depressions of floodplains. These stagnant pools are suitable habitat for water birds especially ducks and waders. The other aquatic species recorded are: two crustaceans, two water insects, 61 species of zooplankton and 7 species of Phytoplankton. Composition of phytoplankton is indicative of oligotrophic nature of the water.

Indus River Dolphin: The Indus River Dolphin (locally known as Bulhan) is one of four river dolphins of the world and used to inhabit Indus and its tributaries in Pakistan and India, but now most of their population is restricted to lower Indus. In a survey conducted in 2011 by Sindh Wildlife Department between Guddu and Sukkur barrages (170 km of protected area), 18 major schools of dolphins were noticed with a total population of 918 dolphins in which 804 were mature 47 were the young and 67 were juvenile. While in 500 km stretch between Sukkur and Kotri barrage only 29 dolphins were noticed. Dolphins are generally noticed in the deepest river channels where fish prey is high and are less common in secondary channels and small braids. During low flow season, high concentrations of dolphins are noticed in upstream pondage area of Sukkur barrage. Dolphins rely on vocals for communication and identification of prey because of their poor eyesight. There is no particular season for breeding of dolphins since calves are born at different times throughout the year, but appeared to be peak during July and August. The gestation period for the dolphins is approximately 10 months and a single calf is born every two years. Juveniles are weaned at around one year of age, but do not reach sexual maturity until around 10 years of age. This species is thought to live at least 28-30 years in the wild.

Current threats to dolphin population in the game reserve: Dolphin population in Indus is currently under threat of habitat fragmentation by the barrages, trapping in irrigation channels of Sukkur, reduced flows in the river during low flow season, sedimentation of the river beds, depletion of prey base, pollution from the agricultural return flows and municipal wastes, entanglement in fishing gears and poaching for their oil for use in traditional medicines.

Fish: Twenty two species of indigenous fish were identified from the barrage site. Carps, catfishes and snakeheads are the dominant fish species and represent most of the fish catch. Exotic species recorded are three species of tilapia and two species of Chinese carps. Submerged shoals and areas between guide bunds and spurs, where water velocities are low, are found to be suitable habitat for the fish for breeding.

Fisheries: Unlike other barrages in Pakistan, the Guddu barrage has no organized fisheries in the barrage pond area due to security concerns. Fishing in the downstream of the barrage is also found to be limited. Generally fishing is permitted under the government issued licenses. In 2011-2012, about 450 boat licenses were issued in Kashmore district. Some fishing activity is also noticed in the water pools in the floodplains. Legally fishing is not allowed in the months of June and July as this is the prime breeding season of carp fishes, but cat fishes are allowed to be fished during this season.

Bird Migration: The migration of water birds occurs in north-south direction and vice versa. The birds breeding in central Asia migrate to various destinations in Pakistan, following the Indus valley and plains down to the Indus delta. This flyway of migratory birds is a corridor of international importance, the so-called "Central Asian – South Asian Flyway." Large numbers of water birds and other birds like teal, pintail, mallard, gadwall, white-headed duck, and houbara bustard follow the Indus on their way towards the wetlands of southern Sindh, which are the most important major wintering grounds of migratory water birds in the region. Ten wetlands of Sindh have been designated as Ramsar Sites to provide safe refuge to these birds. Upstream and downstream of Guddu Barrage and its pond areas also provide an ample opportunity for migratory birds to roost and use as staging ground in winter. The shallow ponds are the attraction for ducks and waders while deep water areas provide food for fish eating birds. A total of 41 migratory bird species were recorded in the project area. Out of recorded species, 13 are abundant to the area, 23 are common, 2 are less common and 3 are rare. Two threatened bird species, Greater Spotted Eagle (IUCN vulnerable) and Long-tailed grass warbler (IUCN Pakistan vulnerable) are recorded near the barrage area.

5.3. Social and Economic Environment

Demography: in Kashmore district, population is about 1.1 million in 2008, population density is 175.6 persons per km^2 and average household size of 6. According to the survey conducted during feasibility study in 31 villages, the population in the project area is 37,410, comprising of 18,218 males and 19,192 females (49% female and 51% male). About 95 percent of population is Muslim. Though all population can speak Sindhi, Saraiki is the native language for 90 percent of population.

Education and literacy: According to the population census of 1998, about 23.66% of population in Kashmore district is literate. However, the literacy ratio is considerably lower within the project area, at just 6%. Male literacy is 9.8 percent and female literacy is 1.8 percent. Access to educational facilities is also poor. Out of 31 villages, 11 villages have primary schools in which only 4 schools offer admission to girls. During consultations, the local community expressed the strong need for primary schools in their villages.

Health situation: There are no basic health care facilities in all the 31 surveyed villages. The villagers have to go to the private clinics in nearby towns of Kashmore and Sadiqabad, and in case of serious illnesses, they have to go to district government hospitals at Rahimyar khan and

Ghotki. Both maternal and infant deaths are reported during delivery. Very few women attend hospitals for child birth, and deliveries are mainly attended by a midwife. According to district authorities, the infant mortality rates in Kashmore district is about 10% and the main causes are diarrhea, dysentery, and some communicable diseases. During consultations, the local community expressed that establishment of basic health care facilities in their villages is their priority need.

Economy and employment: Agriculture is the primary source of income for about 80 percent of the population in the project area. About 8 percent of population own or rent agricultural lands with an average landholding size for the household is about 3 ha. About 70 percent work as agricultural labourers. Livestock also significantly contributes to their income and each household own 3 to 4 cattle. While sources of income for the remaining 20 percent population is working as labourers in non agriculture sector in nearby towns, employment in nearby Guddu thermal power plant, small businesses, fishing, private and government jobs. Average household income of agriculture dependent household is Rs. 10,708 (USD 107) per month. Average per capita income from all sources is estimated to be approximately Rs 1,293 (USD 12.9) per month with 71 percent population have income below the official poverty line (inflation adjusted) of Rs. 1,406 (USD 14) per capita/month.

Agriculture: The land tenure system in Sindh has regulated ownership, tenancy and inheritance rights. The agricultural land is mostly inherited and with the passage of time it is divided further and further amongst the children resulting in shrinking sizes. The major crops grown are rice, sugarcane, cotton, sorghum and vegetables during the Kharif season (April to November) and wheat, oil seed, pulses and vegetables during Rabi season (April to October). The agriculture produce is sold in markets located at Kashmore, Khandhkot, Ubauro, Daharki and Ghotki.

Access to infrastructure: The project area is connected with the Indus highway on right side and left side it is connected with national highway which connects Karachi to Peshawar cities. Pakistan railway from Karachi to Islamabad passes close to the project area. There are good road connections with local towns and other areas within Sindh, Punjab and Baluchistan. Electricity and telephone including mobile phone facilities are available in this area.

5.4. Social and Cultural Aspects

Ethnicity and Culture: The dominant ethnic group in the barrage and surrounding area is the Mazari (50% of total population). Other tribes include Mirani (30%), Soomro (10%),Solongy (4%), Sheikh (3%) and the Chacher, Arain, Sher, Datsi, Malik, Indhar, Bhatti and Khosa (3%). The Mazari is a migrated tribe from Balochistan and others are mostly native tribes. After the construction of Guddu Barrage, Mazaris migrated from Balochistan and purchased the majority of land in the canal command areas and settled in the area, but have maintained the customs and traditions from the homeland. Mazaris and native tribes have different traditions and customs, and the way of life. Social organization in all villages is strongly based on Biradari (tribal) system, where each tribe has a tribal leader. The tribe leaders are mostly landlords and political leaders. All families belonging to the same tribe have strong interactions with one another but mostly remain separate from other tribes.

Tribal feuds and security: There are long standing feuds between Mazari and Khosa tribes and between Solangi and Khosa tribes, which have resulted into killings and counter killings in these areas. Generally tensions will be high during election time, when different tribal leaders represent different political parties. However after 2011, the conflicts have been reduced due to intervention from the political leaders. Generally new comers to the project area will be viewed as suspicious if they were not properly introduced by their tribal leaders. Besides tribal conflicts, law and order situation is worse outside a radius of 5 km from the barrage, away from the

relative security provided by the police and rangers guarding the barrage and power station, due to dacoity and kidnappings.

Social structure and role of women: The status of women in the project area is acutely disadvantaged. Women bear a disproportionately high share of burden of poverty; have unequal access to economic options and social services lower endowments of land and other productive assets. Women are fully responsible for household activities and also take an active part in the field and livestock activities, and thus support the household income generation. However, women have no role in the decision making like marriage of children, sale and purchase of property and animals, decision regarding schooling of children and to attend social factions. Less than 2 percent of women were found to be educated.

Physical cultural resources: There are no sites of historical or archaeological importance is located in the project area. There are seven mosques and three graveyards located close to the proposed worksites.

6. Potential Impacts and Mitigation Measures

6.1. General

Guddu barrage has been in operation for more than 50 years and the proposed rehabilitation works will not alter the current operational regime of the barrage and hence will not create any additional impacts. 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 construction period. Based on the experience of rehabilitation of other barrage projects in Pakistan, many of the environmental issues, such as need for extended canal closures and barrage road closure for traffic, are mainstreamed in the project design (e.g. construction using bulkhead gates). Dolphin game reserve located immediately downstream of the barrage is the most significant receptor susceptible from impacts of the construction works. The overall positive impact of the project, which is the enhancement of the life of the barrage to safeguard the livelihoods of 3 million people in the command area through provision of irrigated water for 1.05 million ha, will be experienced countrywide.

6.2. Impact Assessment Methodology

Potential environmental and social impacts were identified on basis of review of feasibility study reports, field visits and stakeholder consultations. The significance of potential impacts was assessed using the following criteria:

Impact Magnitude: The potential impacts of the project have been categorized as major, moderate, minor or negligible based on consideration of the parameters such as: (a) duration of the impact; (b) spatial extent of the impact; (c) reversibility; (d) likelihood; and € legal standards and established professional criteria.

Sensitivity of Receptor: The sensitivity of a receptor has been determined based on review of the population (including proximity/numbers/vulnerability) and presence of features on the site or the surrounding area. Each detailed assessment has defined sensitivity in relation to the topic.

Assigning Significance: Following the assessment of magnitude, the quality and sensitivity of the receiving environment or potential receptor has been determined and the significance of each potential impact established using the impact significance matrix shown in Table 3.

Table 3: Significance of Impact Criteria

Magnitude of Impact	Sensitivity of Receptors			
	Very High	High	Medium	Low
Major	Critical	Major	Moderate	Minimal
Moderate	Major	Major	Moderate	Minimal
Minor	Moderate	Moderate	Minor	Minimal
Minimal	Minimal	Minimal	Minimal	Minimal

6.3. Summary of Assessed Impacts

The project's potential impacts and their significance have been assessed using the methodology described in Section 6.2 above. A summary of these impacts and their significance is presented in Table 4.

Table 4: Potential impacts and their significance

Impact from various activities	Phase	Sensitivity	Magnitude	Significance Prior to Mitigation	Mitigation and Enhancement Measure	Residual Significance
Environmental impacts during construction stage:						
Impact of canal closures on water needs of command area	Construction	Very high	Minor	Moderate adverse	• Replacement of gates using bulkhead gate technology, and construction of divide wall using sheet piles Replacement of gate by gate • No closure of canals for construction works	Minimal
Impact on river water quality in dolphin game reserve due to instream construction activities	Construction	Very high	Moderate	Major adverse	• Implementation of environmental code of practices (ECPs) to control risk of water pollution from oil spills • Emergency preparedness plan by contractors (e.g. booms and skimmers in place for separation of oil spills from river) • No disposal of bilge water from the barges in to the river	Minimal
Impact river habitat due to instream construction activities	Construction	Very high	Moderate	Major adverse	• Control of sediment flow from the construction activities • Implementation of ECPs • Silt curtains along river training works to control sediment runoff	Minimal
Impact of underwater noise levels from pile driving on dolphins vocalization and behavior	Construction	Very high	Moderate	Major adverse	• Use of vibratory hammers instead of impact hammers • Monitoring of underwater noise levels and use of bubble curtains around piles to reduce noise levels if required • 'soft start' (gradually ramping up sound levels) approach during drilling to chase away dolphins or use of pingers	Minimal
Risk of dolphin collision with construction vehicles	Construction	Very high	Minor	Moderate adverse	• Restrict the motor boat speeds to 15 km/hour • Restrict the boat movement below 500 m of the barrage	Minimal
Clearing of natural vegetation and trees	Construction	Medium	Moderate	Moderate adverse	• Replanting of trees at a rate of 5 new trees for each tree cut	Minimal
Disposal of replaced barrage gates and huge quantities of steel	Construction	Medium	Major	Moderate adverse	• Waste material such as steel and gate wheels and hoists will be sold to steel industry through open auction and finally will be transported to Lahore or Karachi to steel industries • Rubber seals will be sold to rubber industry through open auction	Minimal
Increased traffic on the barrage and local roads	Construction	High	Moderate	Major adverse	• Traffic Management Plan, including awareness raising and safety measures • Use of barge mounted cranes for replacement of gates	Minor adverse
Potential risk of soil and water pollution by construction works	Construction	Medium	Moderate	Moderate adverse	• Management plans for pollution prevention (e.g. sewage treatment) shall be prepared by Contractor • Implementation of ECPs by Contractor	Minimal

Impact from various activities	Phase	Sensitivity	Magnitude	Significance Prior to Mitigation	Mitigation and Enhancement Measure	Residual Significance
					• Compliance with NEQS on waste water discharges	
Air and noise pollution from construction and traffic	Construction	High	Moderate	Major adverse	• No construction activities during night time near the villages • Dust and noise control measures as per ECPs • Compliance with NEQS on vehicle and machinery emissions	Minimal
Impact on migratory and resident birds	Construction	Medium	Moderate	Moderate adverse	• Noise reduction from construction activities and compliance with ECPs • Awareness raising on protection of birds • Protection of bird nests before clearing of vegetation	Minimal
Risk of pollution from solid waste and waste effluents	Construction	Medium	Moderate	Moderate adverse	• Management plans for pollution prevention (e.g. landfill) shall be prepared by Contractor • Implementation of ECPs by Contractor • Disposal of hazardous waste through Sindh EPA certified contractors	Minimal
Impacts from borrow and quarry activities	Construction	Medium	Moderate	Moderate adverse	• No borrow areas in private or agricultural lands • Quarry material from government approved quarry sites • Implementation of ECPs by contractor	Minimal
Social Impacts during Construction:						
Temporary land acquisition by the contractor	Construction	Medium	Moderate	Moderate adverse	• Compliance with the resettlement policy framework prepared by the SID	Minor adverse
Generation of employment	Construction	Medium	Moderate	Moderate beneficial	• Employment for local workers and technicians	Moderate beneficial
Increased economic activity	Construction	Medium	Moderate	Moderate beneficial	• Establishment of new businesses and commercial enterprises; local employment	Moderate beneficial
Safety hazards due to increased traffic especially for children and elderly people	Construction	High	Moderate	Major adverse	• Traffic Management Plan addressing general access • Safety and security actions and procedures to protect local community	Minimal
Possible cultural conflicts between communities and workers and health impacts	Construction	Medium	Moderate	Moderate adverse	• Awareness campaign; Code of conduct for workers • Grievance mechanism	Minimal
increased risk of accidents, unsafe working conditions and health risks for workforce	Construction	High	Moderate	Major adverse	• Occupational Health and Safety Plan to be implemented • Emergency Preparedness Plan; Contractor follows IFC Performance; Standards on Labor and Working Conditions;	Minimal

Impact from various activities	Phase	Sensitivity	Magnitude	Significance Prior to Mitigation	Mitigation and Enhancement Measure	Residual Significance
					• Safety training for workers	
Security risks for construction workers	Construction	High	Moderate	Major adverse	• Continued consultations with the tribal leaders • Security at the work sites and camps • Identification cards to workers	
Environmental impacts during Operation and Maintenance:						
Risk of barrage failure due to earth quakes and floods	Operation	Very high	moderate	Major adverse	• Preparation of emergency preparedness plan	Minor adverse

6.4. Environmental impacts during Construction Stage

Impact of canal closures on water needs of the command area: In addition to cultivation of crops, canal water is also being used for drinking purposes in desert pat feeder canal command area where groundwater is saline, industrial purposes and livestock. Replacement of canal head regulators and construction of left pocket divide wall might require closure of the canals for extended periods if traditional construction approaches such as cofferdams around the canal gates are to be constructed to create a dry work area. If canals are closed, it will severely affect the irrigation and drinking water needs of the command area. In this project, an approach using bulkhead gates and construction through barge mounted cranes are recommended to avoid the need for construction of cofferdams and thereby need for closure of the canals. Further 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.

Impact on river water quality in dolphin game reserve: Replacement of barrage gates and canal head regulators, and construction of 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. The contractor will take utmost care to prevent such risks and will prepare an emergency preparedness plan to address these risks. The contractor will make booms, absorbents and skimmers available on site along with trained personnel to recover spilled oils from water surface. Greasing of the gates will be carried out in dry working area. Painting of gates will be done on the 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.

Impacts on river habitat: Construction of river training works, mainly the construction of the spur, may generate 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 dolphin's diet. Silt fences, sediment barriers or other devices will be provided along the river training works to prevent migration of silt in to the river. The sediment rich water from these areas will be passed through sediment basins before discharging in to the river. Discharges from batching plants, construction yards and construction camps in to the river will be contained. Any discharges to the river will be properly treated to comply with NEQS before discharging.

Impact of underwater noise levels on dolphin's vocalization and behaviour: For dolphins, sound serves three main functions: (i) it provides information about their environment, (ii) it is used for communication and (iii) it enables the remote detection of prey. The sounds generated by dolphins often extend beyond the range audible to the human ear. Vocalizations of Dolphins will be in range of 125-173 (dB at 1m) for whistles and 218-228 (dB at 1 m) for clicks. Piling on the downstream of the barrage takes place during the construction of 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 dolphin's vocalization. Underwater noise levels generated 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 shall 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 which 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 would not be expected to experience permanent hearing impairment from sound pressures generated by pile driving. However, effects on behavior are more likely. Behavioural studies conducted elsewhere on the impact of pile driving on dolphin indicated a temporary displacement from the area where pile drivers are operating and they returned close to normal once pile driving had ceased. Whilst for fish, adverse behavioural aspects occur at a noise level of 150 dB and physical injury may occur at 206 dB[4].

Mitigation measures to reduce noise levels from piling and to minimize the impacts on dolphins include (i) using vibratory hammers instead of impact hammers, (ii) monitoring an exclusion zone of about 500 m radius for at least 30 minute before the start of piling. If dolphins are observed in the exclusion zone, piling works will be delayed until they have left the area. If dolphins enter the exclusion zone after piling has commenced, piling works would cease until they have left; (iii) adoption of a 'soft start'; using a low energy start to the piling operations to give dolphins an opportunity to leave the area, (iv) gradually ramp up the sound levels to scare the dolphins and other cetaceans away before piling commences, (v) use pingers upstream and downstream to chase away dolphins, (vi) piling will be avoided in main calving period, which is July to August; and (vii) monitoring of underwater noise levels, and use of bubble curtains around the pile if required to reduce the noise levels.

Risk of dolphin collision with construction vehicles: Most of the water borne construction activities will be taken up on the upstream side of the barrage; hence motor boat traffic will be higher on the upstream side of the barrage. However, during construction of left bank divide wall, there will be also 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 followed in the North America. 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.

Clearing of natural vegetation and trees: About 260 trees, mostly acacia and eucalyptus, will be cut from the construction areas, mostly from the colony worksite. Small bushes and grasses will be cleared near the existing river training works. Loss of trees and natural vegetation will have an effect on the collection of firewood and some bird habitat. Tree planation, using indigenous species, will be carried out in the colony area at a ratio of 5 new trees per each tree cut. Landscaping will also be carried out in the colony and around the barrage area.

Disposal of barrage gates: Each barrage gate weighs about 50 t and replacement of all barrage gates and regulators produce a few thousand tonnes of scrap material. This will include about 610 t of steel and 90 numbers of gate wheels and gate hoists. In addition about 710 t of sheet pile and 1400 m length of rubber seal will need to be disposed. All scrap material will be sold to steel industries in Lahore and Karachi through an open auction. Similarly rubber material will be sold to rubber industries through an auction. None of these waste materials will be disposed at the site.

Increased traffic on the barrage and local access roads: The Guddu barrage is the only road connection on Indus for a considerable distance. The nearest bridge on Indus is located at a distance of 190 km at Sukkur. About 3,260 vehicles per day with a peak hourly traffic of 225 vehicles currently use the barrage for transportation of goods and passengers. The proposed construction approach, through usage of barge mounted cranes, avoids the need for the closures of barrage road for traffic. However during construction of the project, huge quantities of quarry material (0.76 million m^3 of rock and 0.42 million m^3 of stone) will be transported from

[4] National Oceanic and Atmosphere Administration, USA Criteria for Pile Driving and its Impact on Fish

Rohri to the project site through Sukkur – Guddu highway (Indus highway) and some of these vehicles will use the barrage to reach right bank. About 3000 tonnes of steel sheet piles will be transported from Karachi. It is expected that about 180 trucks per day will be used for transport of these material. In addition it is expected that about 280 trucks will be used within the construction areas for transport of concrete and earth fill material. Because of this additional traffic, the access roads to the barrage on both sides will experience traffic problems and safety hazards. If the barrage is also used to transport heavy equipment such as barrage gates to the right bank, the road on the barrage has to be closed for the public traffic for a few hours. To mitigate these problems the Contractors will be required to prepare a Traffic Management Plan coordinated and supervised by the PMO and in cooperation with the local authorities. This plan will include safety measures, traffic control measures, and provisions for repair of damage caused by project vehicles. Heavy equipment such as gates will be transported using barges instead of vehicles on barrage to minimize road disruption and need for road closure.

Potential risk of soil and water pollution: During construction there is a high risk of accidental spills and leakages from fuel and oil tanks, vehicles, machinery and stored chemicals that are used in construction areas, yards, batching plants, worker camps, and storage sites. These spills can pollute soils and contaminate surface and groundwater in the area. A Pollution Prevention Plan will be prepared by the contractor prior to the start of work. Proper baseline data of soil, air and quality of surface and groundwater will be collected in advance. Moreover the Contractor(s) will implement the measures prescribed in the ECPs, which will be included in the contracts. Contractors will take appropriate measures to avoid and contain any spillage and pollution of the soil and water resources both upstream and downstream of the barrage.

N**oise and air pollution from construction works and traffic**: Air and noise pollution may be caused by emissions from construction related traffic and machinery. A lot of noise and dust will be produced by earth works at marginal bunds, other machinery, concrete mixing, and traffic from trucks and vehicles. Noise levels at nearby villages may exceed the national standards. Air quality dispersion modeling study was carried out to assess the construction related air quality impacts, and the study predicted air quality will be within the ambient air quality standards of NEQS. Greenhouse gases from the construction activities are estimated to be 1,003 tons of CO_2/year. However, construction equipment and vehicles will be well maintained, so that emissions are minimal and comply with emission standards of NEQS. Dust generation from construction sites will be restricted as much as possible and water sprinkling will be carried out as appropriate, especially at those places where earthmoving, excavation and blasting will be carried out. Air and noise quality will be properly monitored, especially near the villages close to the construction areas (Bukhshan Shah Village near the colony and Ghot Abdul Rahman village near the construction camp). Detailed ECPs are included in the main ESA.

Impact on migratory and resident birds: Barrage pond area and nearby shoals and agricultural lands will act as wintering grounds for many migratory birds, and habitat for many resident birds. The birds, particularly greater spotted eagle and long-tailed grass warbler, the two threatened species could be affected due to movement of construction traffic, noise generated from construction activities, and removal of natural vegetation from the construction areas. However, due to the vast habitat range of these birds along Indus in Sindh and generally these birds are not confined to a particular location, impacts on these birds are expected to be minor. Noise from construction activities will be reduced by providing mufflers or acoustic enclosures for high noise generating equipment. Bird surveys will be carried out before vegetation removal for protection of nests. Construction workers will be prohibited from hunting of birds. Impacts on birds will be monitored as part of the overall biodiversity monitoring during construction.

Risk of pollution from solid waste and waste effluents: Six existing structures in the colony site need to be demolished before starting the construction works for colony. Demolition of these

structures generates debris. Further construction works also generate large quantities of excess materials from construction sites (concrete, discarded material) and wastes from workers camp and construction yards, including garbage, recyclable waste, food waste, and other debris. In addition small quantities of hazardous waste will be generated from maintenance activities, including contaminated soil, oil filters and other waste products. The Contractor will identify suitable sites for disposal of hazardous and non-hazardous waste. Debris from demolition of existing structures will be used for embankment protection, if found suitable. The selection will be done in consultation with the PMO and the local municipal authorities. Protocols and measures will be prescribed in the ECPs to be included in the contracts with the Contractors. Siting of any fuel and hazardous material storage sites, including refueling facilities, batching plants and construction yards are to be located outside the flood embankments and at least 500 m away from any residential areas. Hazardous waste will be disposed of through Sindh EPA certified contractors.

Impact from borrow and quarry activities: About 0.76 million m^3 of rock and 0.42 million m^3 of stone will be required for construction of river training works. The contractor shall use the government approved quarry sites for procurement of stones and aggregates. Contractor will obtain necessary government permits before procurement of this material. About 2 million m^3 of earth fill will be required the training works. Borrow areas will be developed within the barrage area (areas between upstream marginal bunds of the barrage) for extraction of earth material for these works. No private lands or agriculture lands will be used for borrowing. The borrow areas will be approved by PMO before development. The areas between marginal bunds will be filled with water during high flow season and will be dry during low flow season. Earth fill material will be excavated during low flow season when these areas are dry. Hence impacts associated with the extraction of sediments from these areas are expected to be temporary since they will be filled up by the sediments of the next flood season. Site restoration and landscaping will be carried out if the borrow areas are located outside the marginal bunds.

6.5. Social Impacts during Construction Stage

To complement ESMP, SID also developed a separate Social Management Framework (SMF) to mitigate social impacts in the project and command areas and share project benefit with these populations. SMF is composed of resettlement policy framework (RPF), social action plan (SAP), and communication strategy. The below summarizes potential impacts and use of these tools.

Temporary Land acquisition by the contractor: No private land is required on permanent basis for project interventions. However, about four acres of land may be required on temporary basis for contractor's camp and construction yard. A site that is not suitable for agriculture is identified near the upstream of the barrage on the left bank. Should land acquisition be required, SID will prepare resettlement action plan (RAP), including compensation details, according to RPF.

Generation of employment in the project area: About 200 skilled and non skilled workers will be required during construction on continuous basis for about 5 years, and about 400 workers during peak time. The project offers good opportunities for local residents to apply for employment as unskilled and skilled construction workers. Contractors are recommended to employ local workers and technicians to the extent possible. Employing local people will also diffuse the conflicts between migrant workers and local community. Populations in project and command areas will be notified about these opportunities, as described in the communication strategy.

Increased economic activity in the project area: The influx of migrant workforce will stimulate the local economy. There will be a higher demand for locally produced food, goods and services benefiting local farmers, and small businesses, such as hotels, shops, fruit sellers, tea cabins

and poultry stalls. Potential opportunities for local communities will be studied in details during the SAP needs assessments.

Safety hazards for children and elderly people due to increased traffic: The construction activities can potentially impact the residents of Guddu and nearby villages, particularly the movement and safety of school children. The increased use of trucks and other vehicles on barrage and local roads may increase risk of traffic accidents on pedestrians, particularly elderly people and children. The Traffic Management Plan that will be implemented will aim at ensuring access to residential areas, and preventing unsafe situations, especially near schools, housing areas, construction areas, camps and office. The proposed health unit will have appropriate medical services to treat emergency cases and trauma patients. The communication strategy complements awareness raising and information dissemination.

Possible cultural conflicts between communities and immigrant workforce and health impacts: There could be potential conflicts between the local community and immigrant workforce. Workers coming from different parts of Pakistan may have norms and values in social behavior and religion that differ from those of the resident population. The influx and accommodation of a large work force will result in increased concerns for the health and safety of local population. This situation will be addressed by an awareness campaign implemented in the beginning of the construction phase. The Contractors will be aware of the possibility and risks of miscommunications between local residents and workers, which easily could lead to conflicts. This should be prevented by raising awareness and implementing a Code of Conduct for the workers. The awareness campaign will also be aimed at the risk of interaction between the resident population and the construction work force, including the spreading of sexually transmitted diseases such as HIV/AIDS. The Contractor shall develop a Worker Code of Conduct to govern the behaviour of workers on site, in camps, and in local communities.

Increased risk of accidents for workforce: Since most of the construction activities will be carried out from the boats and barges in Indus, the Contractors and project management to pay close attention to the increased risk of accidents, unsafe working conditions and health risks. Construction workers associated with water borne construction and diving operation are particularly in risk if there is no proper safety protocols are in place. The Contractors should follow closely the International Finance Corporation (IFC) Performance Standard on Labor and Working Conditions, as well as EHS Guidelines. Special attention should be focused on safety training for workers to prevent and minimize accidents and also on how to deal with emergencies. Emergency response mechanism will be put in place for to rescue workers from drowning and providing immediate treatment to the injured workers. The proposed health facility in colony will be adequately equipped and properly staffed. Portable first aid stations or dispensaries shall be provided by the Contractor at camps and other strategic locations, to administer first aid treatment at any time required.

Security risks for construction workers: Contractor's personnel in the project area can be mistaken as members as rival tribes and could be attacked by local community. Contractor will develop communication channels, including regular consultations, to maintain close coordination with the leaders of the various tribes. Contractors shall provide adequate security to the construction workers at the site and camp. All contractors' staff shall be required to carry identification cards issued by the Contractor which clearly state the staff member's identification details and affiliation with the contractor and the project. Sindhi speaking staff must be available at all active work sites at all times in order to communicate with the local community.

6.6. Environmental Impacts during Operation and Maintenance

Risk of barrage failure by floods and earth quake 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 would not cause flooding unless failure 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 of Guddu barrage is prepared to deal with such incidents. The plan has specified the actors and actions in relation to the following chain of tasks: (a) detection and classification of any potential problem at the barrage site, (b) decision to notify and warn competent authorities, and (c) mobilization of response units when needed. This plan is attached with the design consultants ESIA report and disclosed at SID website.

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 end of the century and rainfall is going to be highly variable on temporal and spatial scale. Due to increased temperatures in the upstream catchment areas of Indus, Hindu Kush-Karakoram-Himalayan glaciers are expected to retreat causing increase in Indus river flows in next few decades due to increased glacier melt followed by decreased flows in the river. The climate change impacts on Indus in Sindh are expected to have serious implications on irrigation and agriculture sector due to (i) reduced productivity of crops and livestock due to heat stress, (ii) increased requirements of irrigation water, (iii) uncertainty in availability of irrigation water, (iv) shortage of irrigation water, (v) damages to crops and livestock from extreme climate events such as floods and droughts and (vi) further deterioration of the already degraded cultivated lands such as those suffering from water logging, salinity etc. 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. Nationwide climate change policy should be devised through legislation clearly defining the role of federation and provinces to address these climate change impacts.

7. Cumulative Impact Assessment

7.1. Objective

The GoS is planning to rehabilitate Guddu and Sukkur barrages. The objective of the current cumulative impact assessment (CIA) is to evaluate combined effects of all the existing barrages in Sindh and proposed rehabilitation works. The overall impacts of Indus Basin Irrigation System (IBIS) on the Indus delta were already well documented and recommendations for these impacts are also available. These are explained in Section 7.2 and hence not considered in this study. The study focus on more relevant valued environmental components (VECs) related to barrages in Sindh, which are dolphin, fish migration and irrigation.

7.2. Background

Indus Basin Irrigation System (IBIS): The irrigation system on Indus comprises 19 barrages and head works, 12 link canals, 43 commands and some 107,000 water courses. Locations of the barrages are shown in Figure 4. A Water Apportionment Accord (WAA) was signed by the four provinces of Pakistan in 1991 to share water resources in Indus. The Indus River System Authority (IRSA) was created as the regulatory authority for monitoring and distribution of the water sources of the Indus River in accordance to the WAA.

Consensus on the Minimum Required Escapages below Kotri : IRSA has appointed a team[5] in 2005 to assess the minimum required environmental flows released downstream of the Kotri barrage. The following aspects are identified for water escapages below Kotri Barrage: (i) salinity encroachment in the river, aquifer and coastal zone; (ii) requirement of coastal stability; (iii) requirement of a sustainable environment; (iv) fisheries; (v) prevention of salinity accumulation in Indus Basin.

Recommendations for escapage (environmental flow) below Kotri: The above review has recommended an escapage at Kotri Barrage of 5000 cusec (142 cumec or 0.3 MAF at Kotri) throughout the year to check seawater intrusion, accommodate the needs for fisheries and environmental sustainability, and to maintain the river channel. The riverine forests, riverine agriculture, pollution control and drinking water supply were considered to play marginal role and hence not considered for environmental flow. The study also recommended a total volume of 25 MAF in any 5 year period (an annual equivalent of 5 MAF) be released below Kotri as flood flows (during Kharif period) to maintain stable coast line and sustain mangrove vegetation. However these recommendations are not strictly followed. Water is generally released in years of floods and extraordinary quantities go down to the sea, whereas in other years flows are close to zero.

Measures by Government of Sindh: Release of environmental flows below Kotri and allotting the irrigation flows to various barrages is the responsibility of IRSA and national government. Authorities of Guddu barrage and SID have no role in making any decisions on their contributions towards release of these environmental flows. However, since 1990 the Government of Sindh has implemented out a number of projects to address some of these issues including:

(a) Sindh Water Sector Improvement Project (WSIP): With increasing population and development, the water demand in the Indus Basin is expected to increase. In future, substantial quantities of water can only come from reducing the losses in the irrigation

[5] The team was consisting of an international panel of experts to review three studies and give final recommendations. Study I: Water escapages below Kotri Barrage to check seawater intrusion; Study II: Water escapages downstream of the Kotri Barrage to address environmental concerns; Study III: Environmental concerns of all the four provinces..

system, which are now about 35-40 percent. A large part of the losses are in the watercourse command (over 40 percent) and the rest are field losses. To address these issues, the World Bank is assisting the GoS to improve irrigation productivity under which watercourses are strengthened to reduce delivery losses and high efficiency irrigation systems through participatory management. This project may indirectly help to release more flows on the downstream of the barrages due to reduction in wastage of irrigation water and thereby reduced diversion of water to irrigation canals.

(b) Preparation of a Master Plan for the Left Bank of Indus, Delta and Coastal Zone: GoS has been preparing a regional master plan to address the flooding issues and provide proper drainage to the area on the left bank of the Indus, including the delta and the coastal zone. This occurs through appropriate structural and non-structural measures, such as measures for retention and/or safe disposal of drainage, storm and flood water; and improvement of wetlands in the delta area and in the coastal zone, recognizing their environmental importance and considerable economic potential for local communities.

(c) On-Farm Water Management Project (OFWMP): GoS has implemented the On-Farm Water Management Project to better manage irrigation water by the farmers and increase agricultural productivity, supported by improved irrigation infrastructure, and service delivery.

(d) Sindh Coastal Area Development: Community organizations have been implementing the Sindh Coastal Area Development program under World Bank funded projects financed by the Pakistan Poverty Alleviation Fund. These projects address the specific problems in isolated coastal areas in the districts of Thatta and Badin, which are prone to regular natural and man-made disasters resulting from seawater intrusion, floods, and cyclones that contribute to destruction of livelihoods and widespread poverty and vulnerability.

Additional Interventions by the World Bank: In addition to supporting the above interventions of GoS, the World Bank also carrying the following studies:

(a) Strategic Sector Environmental and Social Assessment (SSESA): The Ministry of Water and Power has recently carried out SSESA with assistance of World Bank. The study objective is to look at the whole Indus Basin for sector wide environmental and social considerations, including cumulative impacts, to help in prioritizing investments in hydropower and storage development projects. The study has provided recommendations on developing a mechanism for monitoring and evaluating the environmental and social performance of storage and hydropower projects in Pakistan.

(b) Sediment Management Plan for the Indus Basin and Tarbela: The World Bank is assisting the GoP and WAPDA to get a better understanding of sediment management in the Indus basin and in the Tarbela reservoir. This would help to develop plans for movement of sediment downstream once the reservoir is filled. The downstream area is already seeing the impact of increased sediment flow since the amount of sediment deposited into the Tarbela reservoir is decreasing.

It is recommended that SID could manage these multiple projects in such a way that could lead to increased affordability to release environmental flows.

7.3. CIA in Context of Guddu Barrage

Study Boundaries: In the context of Guddu barrage, the spatial boundaries of cumulative impact assessment have been based on the jurisdiction of GoS. The spatial boundary is the Indus in Sindh and the projects considered for the assessment are the three barrages, Guddu,

Sukkur, and Kotri. According to GoS development plans, rehabilitation of Sukkur and Guddu barrages are considered as major developments in Indus in next 20 years.

Valued Environmental Components (VECs): With the consultations of various stakeholders, three VECs, (i) dolphin habitat fragmentation, (ii) hilsa migration and (iii) irrigation have been considered for CIA.

7.4. Dolphins Habitat Fragmentation

Baseline conditions and trend: In 1870's, the Indus dolphin inhabited the lower Indus and its four major tributaries, Jhelum, Chenab, Ravi and Sutlej. By the early 1990's, Indus dolphins had undergone an 80% reduction in the original range, having been extirpated from four tributaries and also in upper parts of Indus. They are now confined to five contiguous 'river sections' on the Indus main stem in Pakistan, separated by barrages, and in the Beas River (tributary of Sutlej) in India. Figure 4 shows the river sections where and when the dolphins were extirpated. According to a survey in 2006, there were 1,406 dolphins in Indus and 90 percent of them are located in the dolphin game reserve, between Guddu and Sukkur barrages. Other major concentrations were noticed between Chashma to Taunsa barrages. While in 1975, only 150 dolphins were recorded from the game reserve. The most recent counts conducted by Sindh Wildlife Department in 2011 found 918 dolphins in the game reserve, and 29 between Sukkur and Kotri barrages.

Cumulative Impacts: 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. Changes of river flows in these river sections, particularly low flow discharges in winter have further significantly reduced its habitat range, required water depths and velocities, and availability of fish prey. Studies on dolphin habitats in these river sections found, dolphins are still intact in those sections where the average monthly low flow discharges are 873 cumec (flow range is 205 to 1332 cumec) and dolphins were extirpated in the sections where average discharges are 227 cumec (range 0 to 1,076 cumec). Dolphin game reserve located between Guddu and Sukkur barrages is currently under threat from reduction of prey base; stranding and mortality in the irrigation canals of Sukkur; depletion of prey base due to use of small size mesh nets; poaching for their oil for use in traditional medicines; entanglement in fishing nets; and pollution from domestic, agricultural and industrial waters.

Recommendations: There is a need for better management of water flows in Indus during 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. During rehabilitation of Sukkur barrage, measures are to be taken to prevent entry of dolphins into canals through installation of screens in the canal gates or installation of dolphin deterrent devices such as pingers. SID will engage in consultations with federal government for better management of flood flows and minimum flows to preserve the aquatic biodiversity. Under the current project, a dolphin conservation and management plan is recommended to strengthen conservation measures in the dolphin game reserve. The plan will cover (i) detailed surveys on population status for two years covering both high flow and low flow season in each year, (ii) threat assessment surveys and develop mitigation plan, (iii) recommending no fishing zone in the river stretches that support breeding population, (iv) capacity building of the line government agencies and universities on dolphin research, conservation and management, (v) development of sustainable fishery management plan, (vi) involving local communities in dolphin conservation and management, (vii) supporting wildlife department in establishing rescue units to rescue dolphins stranded in canals, (viii) education and awareness programs, and (ix) conducting an international workshop in Karachi to learn and share dolphin conservation and management options.

7.5. Hilsa Fish Migration

Baseline Conditions and Trend: Hilsa, also called as 'palla' or 'shad' is an anadromous fish; migrate from sea to Indus for breeding, spawning and growth. Historically, early migration of hilsa in to the Indus was in between January and February and later migration was during summer and monsoon floods between April and July. Before the construction of barrages in Indus, hilsa was reported to travel a distance of 1,000 km up to Multan. After construction of Sukkur barrage in 1932, hilsa migration was limited to Sukkur barrage since it doesn't have any fish passes. Kotri and Guddu barrage, which were constructed in 1956 and 1962, have included fish passes to facilitate hilsa migration. Fish passes in Kotri barrage were not properly designed to facilitate migration of hilsa. Hence, after 1956 the migration of hilsa has been restricted up to Kotri barrage, 300 km from the sea. This obstruction has deprived hilsa of two-third of their previous spawning area. Hilsa fishery has been providing livelihood to a large number of fisherman in Sindh, some of them migrate to Kotri barrage area from Sukkur and Larkana districts.

Cumulative Impacts: When hilsa migration starts in January, there is hardly any water available in delta for hilsa to migrate to upstream. Annual hilsa catch have been reduced considerably from last four decades from 11,800 t in 1973 to 266 t in 2012. The declines in hilsa catch are primarily due to reduction in flows below Kotri, loss of its original migration range, and advent of motorized fishing boats.

Recommendations: The overall situation of hilsa fishery is in 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 undersized catch. Fish ladders in Kotri and Guddu barrages must be rehabilitated to work effectively and new fish pass should be installed in Sukkur barrage. Design of rehabilitation of fish passes should be based on detailed understanding of hilsa swimming capabilities and its biological needs. Further studies are recommended to understand the biological requirements of hilsa, especially on its swimming capacity and attraction velocities to a fishway, breeding habitats, spawning grounds, migration route, and depth of water requirement for migration etc.

7.6. Irrigation

Baseline Conditions and Trend: Before the construction of barrages, some parts of Sindh were irrigated by traditional inundation canal system. The farmers usually used to suffer due to their dependence on the inundation canals since they generally provide uncertain and precarious supplies during crucial sowing and maturity periods. The low precipitation prevented rain-fed large scale agriculture development in the province. Around 78% of the area in Sindh is underlain by saline groundwater, which is unsuitable for irrigation. The people adapted to low and poorly distributed rainfall through either living along river banks or by careful husbanding and management of local water resources. Irrigation infrastructure in Sindh was developed after construction of the barrages. The three barrages in Sindh divert approximately 59 BCM of water annually to the 14 main canals. These canal systems have an aggregate length of 21,445 km, which serve a gross command area) of 5.1 million ha. There are about 42,000 watercourses (tertiary channels), which have an aggregate length of about 120,000 km.

Cumulative Impacts: The barrages have transformed the arid barren lands of Sindh in to vast agricultural lands and brought significant socioeconomic benefits to Sindh. Crop productions in Sindh have been gradually increasing since last 60 years after the construction of barrages. Major food crops such as wheat, rice, maize, pearl millet, sorghum, and barley production in Sindh in 1981-82 was 3.83 million t and increased to 6.16 million t (about 61% increase) in 2008-09, on the other hand, cash crops such as, cotton, tobacco, sugarcane etc. production in 1981-

82 was 7.78 million t and increased to 13.84 million t (about 78% increase) in 2008-09. Sindh's contribution to Pakistan's agriculture GDP is 23% with its contribution of major products are: (a) Wheat, 15%, (b) Cotton, 23%, (c) Livestock, 28%, (d) Sugarcane, 31%, (e) Rice, 42%, and (f) Marine fish, 70%. On the other hand, poor irrigation efficiency is causing lot of water wastage, contributing to water logging conditions, and also causing soil salinity and sodicity. This is in turn reducing the soil fertility and crop yields. Sindh Government has been implementing Water Sector Improvement Project (WSIP) and On-Farm Water Management Project (OFWMP) to improve the efficiency and effectiveness of irrigation water distribution and drainage system for irrigation productivity. The projects implemented measures of reliability, equity and user satisfaction and better management of water and increased agricultural productivity by the farmers, supported by improved irrigation infrastructure, and service delivery.

Recommendations: The main purpose of the barrage rehabilitation is to continue the sustained supply through the canals for irrigation in Sindh. However, it is utmost important that the precious water is also used effectively by the farmers without wasting them. SID should take some of the successful initiatives by the OFWMP and WSIP and continue to implement them, which will help reducing the water consumption and hence improving waterlogging and salinity problems, reducing the use of pesticides, and allowing more flows to release downstream of Kotri barrage. The following initiatives should be taken by SID in all its command area as a continuous process: (i) Support small and medium size farmers in more productive use of waters; (ii) Provide trainings in efficient use of water, soil, crop management, alternate use of saved water etc.; and (iii) Improve the capacity and awareness of local organizations and to allow them to assume a bigger role. Enhance the role of Watercourse Associations (WCAs) beyond water courses improvement. OFWMP gave output based contracts to WCAs and they performed well in managing quality of lining of WCs and SID should continue these contracts to WCAs. The functions of the WCAs defined in Sindh Water Management Ordinance 2002 needs to be expanded to provide WCAs responsibility in promoting water productivity and establishing schedules of water delivery, allocation, distribution, and ensuring the members' entitlement (share of water) on time.

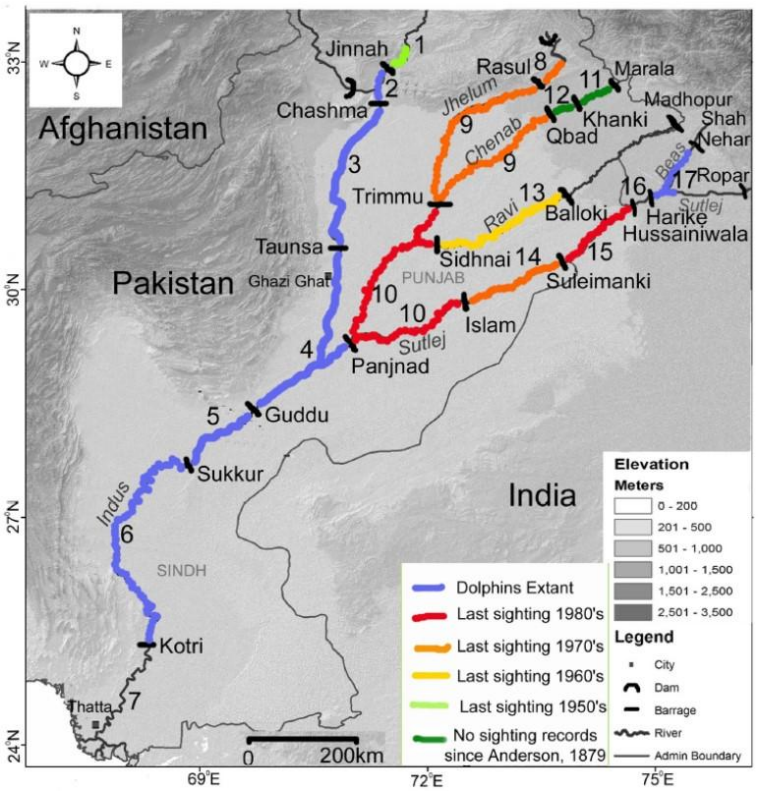


Figure 4: Lower Indus River system, barrages, time of river dolphins extant and extirpated

8. Environmental and Social Management Plan

8.1. General

Various categories of mitigation measures: The ESMP includes various categories of mitigation measures and plans: (i) generic and non site-specific measures in the form of environmental codes of practices (ECPs) presented in Annex D of the main ESA; (ii) project specific and to the extent possible, site-specific mitigation measures discussed in Chapter 6 and summarized in Table 8.1; (iii) construction environmental action plan (CEAP) with site-specific and contract-specific management plans to be prepared by various contractors; (iv) SMF; and (v) proposed plans to address cumulative impacts.

Inclusion of ESMP in contract documents: In order to make the Contractors fully aware of the implications of the ESMP and responsible for ensuring compliance, technical specifications in the tender documents will include compliance with mitigation measures proposed in ESA as well as IFC EHS guidelines. The Contractor must be made accountable through contract documents for the obligations regarding the environmental and social components of the project.

Construction of Environmental Action Plan: Contractors need to prepare site specific management plans to address various environmental issues, and to demonstrate the manner in which the Contractor will comply with the requirements of ECPs and ESMP. It will be reviewed and approved by construction supervision consultant (CSC) and project management office (PMO) before implementation of construction works.

8.2. Institutional Arrangements

The existing organogram of SID and the proposed organizational structure under PMO for implementation of ESMP and SMF is shown in Figure 5.

Project Management Office (PMO) would be responsible for all aspects of project implementation including technical, operational, financial management, and overseeing the implementation of ESMP. The PMO will include an Environmental and Social Unit (ESU), which will be headed by a director. The director will be supported by (i) Deputy Director Environment, (ii) Deputy Director Social and (iii) Deputy Director Communications. The responsibilities of the ESU are: (i) supervising, facilitating and coordinating implementation of environmental and social plans including ESMP and SMF; (ii) ensuring that contractors follow Sindh-EPA regulations, World Bank Safeguard Policies, and other requirements mentioned in the ESMP and SMF; (iii) identifying any issues of non-compliance and report these; (iv) suggesting mechanisms to link contractor performance in relation to the ESMP to the timing of financial payments, incentives or penalties; and (v) interacting with stakeholders for their concerns about the construction activities.

Construction Supervision Consultants (CSC) will be responsible for supervising the contractors for the implementation of ESMP. For this purpose, the CSC will appoint an environmental specialist, a social specialist, an ecologist and an occupational health and safety specialist and environmental inspectors to ensure the ESMP implementation during the project. They will supervise the contractor for the ESMP implementation, particularly the mitigation measures. They will also be responsible for implementing the monitoring of effects of these measures.

Contractors are also required to appoint an environmental officer, a health and safety officer, an ecologist (to deal with impacts of dolphin), a community liaison officer and a human resources officer at the site for the implementation of ESMP in the field, particularly the mitigation measures. The contractor will also be responsible for communicating with and training of its staff in the environmental/social aspects.

Monitoring and Evaluation Consultant (MEC) will be recruited by PMO to carry out independent monitoring of implementation of ESMP. The MEC will have environmental and social experts and shall carryout intermittent third party monitoring of the project

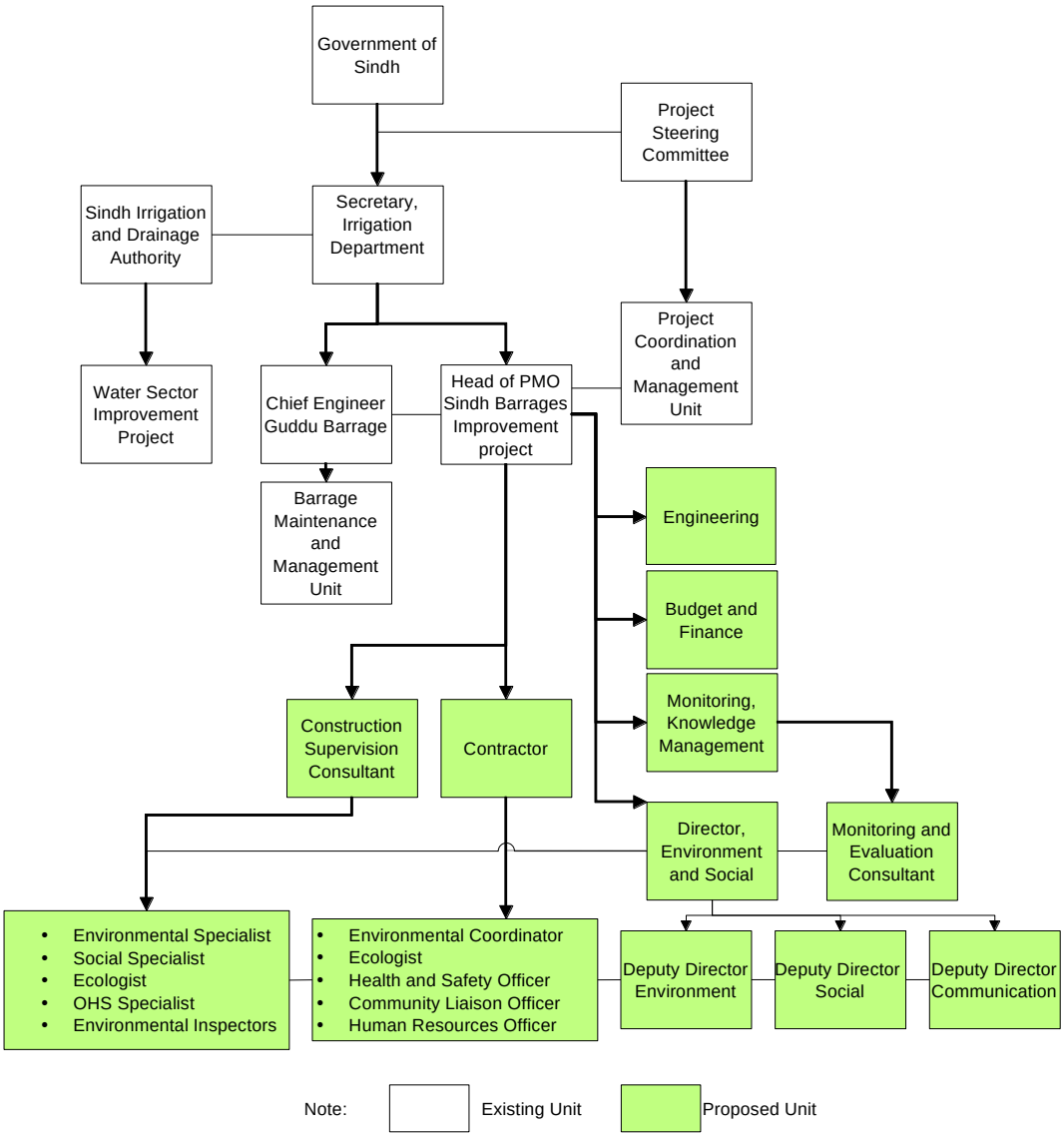


Figure 5: Proposed Institutional Structure for Implementation of ESMP

8.3. Environmental and Social Management

(a) 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.

(b) Site-specific Plans in CEAP

The following site-specific plans will be prepared by Contractors to manage and mitigate/reverse potential adverse environmental impacts:

Erosion, sediment and drainage control plan will be prepared by the contractor on the basis of ECP 4, 6 and 8, and the mitigation measures given in main ESA and ESIA. The Plan will be submitted to the CSC for review and approval before contractor mobilization.

Pollution Prevention Plan will be prepared and implemented by the Contractor on the basis of ECPs 1, 2, 10 11, and WBG EHS Guidelines (2007), as well as the mitigation plans given in main ESA and ESIA. The Plan will be submitted to the CSC for review and approval before contractor mobilization.

Waste Disposal and Effluent Management Plan will be prepared and implemented by the Contractor on the basis of ECPs 1, 2, 16, and WBG EHS Guidelines (2007), as well as the mitigation plans given in main ESA and ESIA. The Plan will be submitted to the CSC for review and approval before contractor mobilization.

Traffic Management Plan will be prepared by the Contractor on the basis of ECP 15 and also the mitigation plans given in main ESA and ESIA, after discussion with SID and authorities responsible for roads and traffic. The Plan will be submitted to the CSC for their review and approval before contractor mobilization. CSC will facilitate the integration and coordination of the plans prepared by various contractors to prepare an overall Plan.

Borrow Area Management and Restoration Plan for management and restoration of borrow areas will be prepared by the Contractor on the basis of ECPs 5, 6, 8, 9 and 10 and other requirements described in the mitigation plans. This Plan will aim at minimizing the environmental and social impacts during borrowing activities and restoring as much as possible the original natural situation of these sites by various measures (refill, leveling or smoothening). Restoration methodologies will be included in the Plan. The Plan will be approved by the CSC and PMO.

Occupational Health and Safety Plan will be prepared and implemented by the Contractor on the basis of the WBG EHS Guidelines (2007), ECP 18, and other relevant standards. The Plan will be submitted to the CSC for review and approval before contractor mobilization.

Protection of the Gas Pipeline will be prepared by the Contractor to ensure that the proposed rehabilitation works won't damage the gas pipeline along with the precautionary measures to be taken. This plan will be submitted to the CSC, PMO and Sui Southern Gas Pipeline Company for their review and approval.

Drinking Water Supply and Sanitation Plan: Separate water supply and sanitation provisions will be needed for the temporary facilities, labor camp and workshops, in order not to cause shortages and/or contamination. A Plan will be prepared by the Contractor on basis of ECP 16. The Plan will be submitted to the CSC for review and approval before contractor mobilization.

Management Plan for Protection of Flora and Fauna will be prepared by the Contractor on the basis of ECPs 12, 13 and 14 and mitigation measures proposed to address impacts on dolphins. The Plan will be submitted to the CSC for review and approval before contractor mobilization.

Construction Camp Management Plan will be prepared by the Contractor on the basis of ECP 16 and also the mitigation plans given in main ESA and ESIA. The Plan will include the camp layout, details of various facilities including supplies, storage, and disposal. The Plan will be submitted to the CSC for review and approval before camp establishment.

Fuel and Hazardous Substances Management Plan will be prepared by the Contractor on the basis of ECP 2 as well as the mitigation plans given in main ESA and ESIA and in accordance with the standard operating procedures, relevant guidelines, and where applicable, material safety data sheets. The Plan will include the procedures for handling oils and chemical spills. The Plan will be submitted to the CSC for review and approval before contractor mobilization.

Instream Construction Works Management Plan will be prepared by the contractor to address the environmental concerns associated with use of motor boats and barge mounted equipments on the basis of the mitigation measures given in ESA and ESIA. The plan will address risk of spills, collision with dolphins and safety of construction workers. The Plan will be submitted to the CSC for review and approval before contractor mobilization.

Emergency Preparedness Plan will be prepared by the Contractor after assessing potential risks and hazards that could be encountered during construction in the Indus and in the floods. The Plan will be submitted to the CSC for review and approval before contractor mobilization.

Communication Plan will be prepared by the contractor in line with the SMF communication strategy to demonstrate how they will communicate with local community leaders, provide details regarding employment opportunities at mobilization, and traffic management throughout the construction period. The contractor's communication plan should define a process for receiving, recording and responding to complaints and also monitoring of the success of any responsive action taken to prevent the escalation of any conflicts. The plan will be prepared in compliance with communication strategy provided in the Social Management Framework and Section 9.1,

(c) Social Management Framework (SMF)

Resettlement Policy Framework (RPF): The project doesn't require any land acquisition. However, as a part of SMF, a RPF has been prepared by SID in case of any unforeseen land acquisition is required for the project and also to guide temporary land acquisition by the contractors. The RPF presents (a) principles and legal framework applicable for mitigation of these losses; (b) eligibility and entitlement criteria, (c) valuation methods; and (d) process of preparation of resettlement action plan.

Social Action Plan (SAP): SAP was developed to mitigate potential project social impacts (such as potential extended canal closure) and support local area development. Access to basic health care and primary education is very poor in the villages surrounding Guddu barrage and primary consultations with the local community revealed that these are their priority needs. There are no health facilities in 31 villages of the project area, 11 villages have primary schools in which only 4 offer girls education. While the proposed health unit and school in the colony will also serve the local community, these could be enhanced through SAP. Detailed plans will be developed by CSC during implementation. Detailed plan of activities will be developed through needs assessments and further consultations in project and command areas.

Communication Strategy: A formal communication strategy is prepared for the project to lay out various communication needs and outreach tools and explain the responsibility of PMO to convey the awareness of the project impacts and its impacts to various stakeholders. A key aspect of this strategy shall be the communication of any project related impacts

(d) . Plans to Address Cumulative Impacts

Dolphin Conservation and Management Plan: Dolphin game reserve located between Guddu and Sukkur barrages is currently under threat from sedimentation of river bed and depletion of river biota, including fish, reducing the prey base; stranding and mortality in the irrigation canals; depletion of prey base due to use of small size mesh nets; poaching for oil; entanglement in fishing nets; and pollution from domestic, agricultural and industrial waters. SID will engage in consultations with the federal government for better management of flood flows and minimum flows to preserve the aquatic biodiversity. SID will carry out measures to prevent entry of dolphins in to canals during rehabilitation of Sukkur barrage. Further, a conservation and management plan will be carried out to address these issues and strengthen the conservation measures in dolphin game reserve. The plan will cover (i) detailed surveys on population status for two years covering both high flow and low flow season in each year, (ii) threat assessment surveys and develop mitigation plan, (iii) recommending no fishing zone in the river stretches that support breeding population, (iv) capacity building of the line government agencies and universities on dolphin research, conservation and management, (v) development of sustainable fishery management plan, (vi) involving local communities in dolphin conservation and management, (vii) supporting wildlife department in establishing rescue units to rescue dolphins stranded in canals, (viii) education and awareness programs, and (ix) conducting an international workshop in Karachi to learn and share dolphin conservation and management options.

Hilsa Migration Management Plan: Hilsa migration is obstructed by all barrages in Sindh. Fish ladders in Kotri and Guddu barrage were originally designed to facilitate migration of hilsa. Though Kotri barrage has fish ladders, they were not being used by hilsa and hence hilsa migration is restricted to below Kotri barrage. Sukkur has no fish pass. There are no detailed studies available on hilsa migration, its bio- hydrological requirements for migration (e.g. water velocities, water depths, water quality, habitat conditions, etc.) for design of effective fish passes. A study is recommended under this project to study hilsa migration and design of new fish pass at Kotri and rehabilitation designs for existing fish passes at Kotri and Sukkur. Based on the outcome of this study, SID will rehabilitate fish ladders in Kotri and Guddu barrages and built a new fish pass in Sukkur. SID will coordinate with other line departments to restrict catching during upstream migration and undersized hilsa.

Irrigation Efficiency Improvement: Improper and inefficient use of irrigation water by the farmers is causing lot of wastage of precious irrigation water, reduced crop productivity and water logging conditions. World Bank is supporting SID to address these issues through WSIP and OFWMP projects primarily through capacity building programs of the farmers' organizations. Similar programs should be extended to Guddu command area for improved efficiency in using irrigation water. These will include (i) support and training to farmers in more productive use of waters and crop management, and (ii) capacity building of the Watercourse Associations in promoting water productivity and establishing schedules of water delivery, allocation, distribution, and ensuring the members' entitlement (share of water) on time.

8.4. Overview of Impacts and Mitigating Measures

An overview of all impacts and mitigating measures, including responsibilities and monitoring requirements, is given in Table 5.

Table 5: Overview of Impacts and Mitigation

Impacts/Issues	Mitigation Measures	Time Frame	Cost (USD x 10^6)	Responsibility		Monitoring Indicators	Monitoring Frequency
				Implementation	Supervision		
GUDDU PROJECT (overall impacts)							
1 Rehabilitation of the barrage for enhancement of its life, sediment management and improved flood protection	- Desirable outcome of the project	2020 and after	Total of 171	Contractor	SID	- Performance of gates - sedimentation of canals	Yearly
ENVIRONMENTAL IMPACTS DURING CONSTRUCTION							
1 Impact on Irrigation Supply	- Use of bulkhead gates and barge mounted cranes and pile drivers	2015-2020	In budget of Contractor	Contractor	CSC, PMO	- Periods of canal closures	Permanent (throughout construction)
2 Impact on river water quality and dolphin game reserve	- Pollution prevention plan - Emergency preparedness plan	2015-2020	In budget of Contractor	Contractor	CSC, PMO, Wildlife department	- Plan ready and accepted - Water quality - Pollution incidents	Permanent
3 Impact on river habitat	- Sediment control and pollution prevention	2015-2020	In budget of Contractor	Contractor	CSC, PMO	- Water quality	quarterly
4 Impact of underwater noise levels on dolphins vocalization	- Use of vibratory hammers, chasing dolphins away from work areas, and monitoring	2018-2019	In budget of Contractor	Contractor	CSC, PMO	- Underwater noise	Monthly
5 Risk of dolphin collision with construction vehicles	Limit motor boat speeds to 15 km/hr	2018-2019	In budget of Contractor	Contractor	CSC, PMO	- Accident incidents	Monthly
6 Loss of natural vegetation and cutting of approximately 260 trees	- Replanting of 1300 trees near colony - Landscaping in the colony and barrage area	2015-2020	0.05	Contractor	CSC, PMO	- Number of trees planted - Number of trees survived	Quarterly
7 Disposal of replaced barrage gates	- Sold to steel industry as a scrap	2015-2020	In budget of Contractor	PMO	CSC, PMO	- Material quantity	Quarterly
8 Impacts of increased traffic on the barrage	- Implementation of traffic Management; safety measures	2015-2020	In budget of Contractor 0.02 (PMO budget)	Contractor	- CSC, PMO - Local authority	- Road status reports - Number of complaints	Monthly
9 Risk of soil and water pollution	- Pollution prevention plans and ECPs - Compliance with NEQS	2015-2020	In budget of Contractor	Contractor	CSC, PMO	- waste water quality	Quarterly
10 Impacts of air and noise pollution on residential areas	- No construction during night time	2015-2020	In budget of Contractor	Contractor	CSC, PMO	- Noise levels - Number of	Permanent

Impacts/Issues	Mitigation Measures	Time Frame	Cost (USD x 10^6)	Responsibility		Monitoring Indicators	Monitoring Frequency
				Implementation	Supervision		
and workers	- Compliance with NEQS					complaints	
11 Impact on migratory and resident birds from construction activities	- Noise reduction from construction works - Birds nest surveys before clearing of vegetation - Awareness raising	2015-2020	In budget of Contractor	Contractor	CSC, PMO,	- Number of incidents reported - Monitoring reports	Quarterly
12 Risk of pollution from solid waste and waste effluents	- Landfill sites, pollution prevention plans,	2015-2020	In budget of Contractor	Contractor	CSC, PMO	- Plan ready and accepted - Number of complaints	Permanent
13 Impacts from borrow and quarry activities	- Approved borrow areas - Protocols and measures prescribed in ECP - Permanent monitoring	2018-2020	In budget of Contractor	Contractor	CSC, PMO	- Approvals for quarry and borrow areas	Permanent
CONSTRUCTION STAGE: CONSTRUCTION-RELATED SOCIAL IMPACTS							
1 Temporary land acquisition for the construction works	Compliance with resettlement policy framework	2015-2020	In budget of Contractor	Contractor	CSC, PMO	Agreements with land owners	At the beginning of contract
2 Generation of employment in region	- Contractor attracting local workers and technicians	2015-20	In budget of Contractor	Contractor	CSC, PMO	Number of employed workers from region	Annually
3 Increased economic activity in the project area that will stimulate local economy	Indirect positive impact	2015-20	In budget of Contractor	Contractor	CSC, PMO	Social development indicators	Annually
4 Safety hazards and reduced mobility due to increased traffic especially for women, children and elderly people	- Implementation of Traffic Management Plan - Adequate facilities for emergencies	2015-2020	In budget of Contractor	Contractor	Local health services	- Plan ready and accepted - Number of accidents - Number of incidents	Permanent
5 Possible cultural conflict between communities and workers.	- Awareness campaign - Grievance mechanisms to address complaints from local community and in-migrants	2015-2020	In Contractors budget	Contractor	CSC, PMO, local leaders	Number of complaints	Permanent
6 Increased risk of accidents, unsafe working conditions and health risks for workforce	- Emergency Preparedness Plan - Contractor to follow IFC Performance Standards on	2015-2020	In budget of Contractor	Contractor	SID	Plan prepared and accepted	Permanent

Impacts/Issues	Mitigation Measures	Time Frame	Cost (USD x 10^6)	Responsibility		Monitoring Indicators	Monitoring Frequency
				Implementation	Supervision		
	Labor and Working Conditions - Safety training for workers						
7 Security risks for construction workers	- Consultation with local leaders - Security at work sites and camps	2015-2020	In budget of Contractor	Contractor	CSC, PMO	Plan prepared and accepted	Permanent
OPERATION AND MAINTENANCE STAGE: ENVIRONMENTAL IMPACTS							
2 Risk of barrage failures due to floods and earth quake	- Emergency preparedness plan	Permanent	SID annual budget	Chief Engineer, Guddu Barrage	SID	Approval and continuous update of plan	Annually
CUMULATIVE IMPACTS							
1 Dolphin conservation and management plan	- Surveys on dolphins status and threats and to prepare management plan - rescue teams for dolphins trapped in canals - capacity building and community involvement -Education and awareness programs	2016-2019	4.0	Consultants	SID	- Preparation of dolphin management plan - Status reports on conservation	Half yearly
2 Hilsa migration management	- Surveys on hilsa migration - designs for fish passes of Sukkur - designs for rehabilitation of fish passes at Kotri and Guddu community involvement -Education and awareness programs	2016-2019	Included in above budget	Consultants	SID	- Preparation of hilsa migration management plan - Designs of fish passes - Consultants reports	Half yearly
3 Irrigation efficiency improvement	- Training of farmer's organization	2015-2020	2.0	SIDA	SID	Irrigation efficiency	Annually

8.5. Monitoring Plan

Proposed monitoring plan to be carried during implementation of the project to ensure contractors compliance with the mitigation measures is given in Table 6 along with the monitoring indicators and frequency. CSC will be responsible for supervision of implementation of the plan. The total cost of monitoring has been estimated at USD 0.31 million. SMF implementation will be monitored by the NGO under the PMO supervision (arrangements detailed in SMF).

Table 6: Effects Monitoring Plan

Parameter	Means of Monitoring	Frequency	Responsible Agency	
			Implementation	Supervision
Surface water quality	Sampling and analysis of river water quality and waste water discharges for the parameters given in NEQS 2000	Quarterly	Contractor	CSC, PMO
		Annually	External Monitor (PMO through a nationally recognized laboratory)	CSC, PMO
	Spot measurements of pH, conductivity, turbidity; visual inspection of presence of petroleum products	Monthly	CSC	CSC, PMO
Groundwater quality	Sampling and analysis groundwater quality for drinking water	Quarterly	Contractor	CSC, PMO
		Annually	External Monitor (PMO through a nationally recognized laboratory)	CSC, PMO
Air Quality (dust, smoke)	Visual inspection to ensure good standard equipment is in use and dust suppression measures (sprinkling) are in place	Daily	Contractor	CSC, PMO
	Visual inspection to ensure dust suppression work plan is being implemented	Daily	Contractor	CSC, PMO
Air Quality (PM_{10}, NO_2, SO2, CO_2, CO)	Air quality monitoring for 24 hours for the parameters specified in NEQS 2000	Quarterly	Contractor	CSC, PMO
		Annually	External Monitor (PMO through a nationally recognized laboratory)	CSC, PMO
Emissions from plant and equipment	Visual inspection	Monthly	Contractor	CSC, PMO
Noise and vibration	24 hour noise monitoring	Quarterly	Contractor	CSC, PMO
	24 hour noise monitoring	Annually	External Monitor (through a nationally recognized laboratory)	CSC, PMO
	Spot measurements	Monthly	CSC	CSC, PMO
Waste Management	Visual inspection that solid waste is disposed of at designated sites	Monthly	Contractor	CSC, PMO
Spills from hydrocarbon and chemical storage	Visual inspection for leaks and spills	Monthly	Contractor	CSC, PMO
Operation of borrow sites	Visual inspection of quarry sites	Monthly	Contractor	CSC, PMO
Biodiversity monitoring	Collection of information on presence, seasonal behavior and biotope characteristics of dolphin, fish and migratory birds selected locations;	Half yearly	PMO through nationally recognized institute	CSC, PMO
Traffic safety	Visual inspection to ensure Traffic Management Plan is implemented	Monthly	Contractor	CSC, PMO

Parameter	Means of Monitoring	Frequency	Responsible Agency	
			Implementation	Supervision
Local roads	Visual inspection to ensure local roads are not damaged	Monthly	Contractor	CSC, PMO
Drinking water and sanitation	Ensuring construction workers are provided with safe water and sanitation facilities on site	Weekly	Contractor	CSC, PMO
Safety of workers	Usage of personal protective equipment	Monthly	Contractor	CSC, PMO
Erosion	Visual inspection in all areas where run-off leaves bare and at important drainage features (ditches, gullies, etc.) after major rainfall events	Weekly	Contractor	CSC, PMO
Reinstatement of work sites	Visual Inspection	After completion of all works	Contractor	CSC, PMO
Plantation	Visual inspection to ensure plantations are growing well	Monthly	Contractor	CSC, PMO, External Monitor
Dolphin	Status reports on implementation of dolphin conservation and management plan	Half yearly for 3 years	Study consultant	PMO
Hilsa	Status reports on preparation of hilsa migration management plans and implementation	Half yearly for 3 years	Study consultant	PMO

8.6. Capacity Building

The environmental and social trainings will help to ensure that the requirements of the ESMP are clearly understood and followed by all project personnel. The primary responsibility of providing these trainings to all project personnel will be that of the contractor and Supervision Consultants. The trainings will be provided to different professional groups separately such as managers, skilled personnel, unskilled labors, and camp staff. A budget of USD 0.017 million has been earmarked for capacity building.

8.7. Audits

Internal environmental audits will be held with an objective to review the effectiveness of environmental and social management of the project. It is proposed that CSC carry out these audits on a six-monthly basis. External third party environmental audits to be held by MEC to further review the effectiveness of environmental and social management of the project. These audits would be used to re-examine the continued appropriateness of the ESMP and to provide advice on any updates required.

8.8. Grievances

Grievances are actual or perceived problems that might give grounds for complaints. As a general policy, PMO will work proactively towards preventing grievances through the implementation of impact mitigation measures and community liaison activities that anticipate and address potential issues before they become grievances. The project will have a set grievance redress mechanism. A project level grievance redress committee (GRC) will be established for the project with head of PMO as the chairman and deputy director (social) of the PMO is as the secretary. The members of GRC will include representatives from community, contractors, CSC and local administration..

8.9. Reporting

Proper arrangements are necessary for recording, disseminating and responding to information that emerges from the various environmental monitoring and management programs. They are also necessary for rendering the environmental management systems "auditable." The CSC and PMO will prepare monthly and quarterly reports covering various aspects of the ESMP implementation including compliance and effects monitoring, capacity building, and grievance redressal. In addition CSC and PMO will also prepare semi-annual reporting for OHS related issues.

8.10. Cost of ESMP

The cost of implementing the ESMP is USD 10 million and SMF is USD 5 million. Details of ESMP and SMF costs are given in Table 7 and Table 8.

Table 7: ESMP Implementation Cost Estimates

	Description	**Estimated Cost (million USD)**
1	Implementation of EMP by Contractor	1.00
2	Environmental staff in CSC	0.75
3	Environmental staff in PMO	0.50
4	Internal auditing	0.25
5	External monitoring	0.25
6	Capacity building, institutional strengthening	0.25
7	Monitoring of air, noise and water quality	0.25
8	Tree plantation and landscaping	0.25
9	Biodiversity monitoring	0.25
10	Dolphin conservation and management plan and fish migration management plans (preparation and implementation)	4.00
11	Efficiency improvement in irrigation management	2.00
12	Contingencies	0.25
	Total	**10.00**

Table 8: SMF Cost Estimates

	Component	**Estimated Cost (million USD)**
1.	Resettlement Policy Framework (RAP preparation, possible land compensation)	1.00
2.	Social Action Plan	3.50
3.	Communication Strategy	0.50
4.	Total	5.00

9. Stakeholder Consultations and Disclosure

9.1. Overview

Extensive consultations were carried out by the feasibility study team during the project preparation. Initial consultations were held at the early stages of the project preparation (November 2011 to Jan 2012) to share the project objectives and terms of references of the proposed ESIA study. Second round of consultations were held during October to December 2013 to disclose the results of ESIA. Consultations involved multiple methods – for example, household level interviews, village wise meetings, focus group discussions and workshops. A medical camp for women in the project area was also organized by the feasibility study team to promote awareness on the project. Details of participants consulted are given in Table 9 and they include (i) population around the project area and community representatives. (ii) farmers in the command area of Guddu barrage and fishing community, (iii) district and provincial government authorities responsible for district administration, roads, forest, rural development, agriculture, fisheries, wildlife and environmental protection, and (iv) conservation agencies such as IUCN and WWF.

Table 9: Number of Persons Covered in Various Consultation Meetings

	Activities	No. of participants
1.	Village wise meetings (31 villages)	526
2.	Individual consultations (Political/Local Leaders/ Officials participated)	21
3.	Focus Group Discussions	245
4	Canal Command Area (43 Minor/ Distributaries)	431
5	Consultation workshops by Independent consultants	47
Total		**1,270**

9.2. Consultations Feedback

A summary of main issues raised with various stakeholders and how these issues are addressed and incorporated are shown in Table 10.

Table 10: Key Issues Raised in Community Consultations

	Comments and Suggestions	Action Point
1	The common concern of all stakeholders is that extended closure of canals will seriously affect socio-economy of the command area. Regular scheduled canal closure period is about 3 to 4 weeks during month of April. If the closure period is extended, it will seriously affect their crop and livestock production. Fodder for livestock cannot be grown if canal closure is extended for more than 6 weeks Livelihoods of agricultural labourers and small farmers will be immediately affected. Women who depend on canal water for their domestic needs are concerned about their children and livestock. Production of Guddu thermal power plant will also be affected if there are extended canal closures.	Canals will not be closed during the construction period. Generally replacement of gates and any instream construction activities will require a prior construction of cofferdams to create a dry work space around the canal entrance area, and hence canals are to be closed during the construction. But a different construction approach will be followed in this project. Replacement of canal gates will be carried using bulk head gate technology and barges, which doesn't require construction of any cofferdams and hence any requirement of closure of canals. Gates will be replaced one by one and other gates will be remained open without affecting irrigation flows. Similarly construction of left bank divide wall will also be carried out using barges. Detailed Proposed construction methodology is presented in Annex 1, However, SMF has proposed mitigation measures to

		address social impacts (such as provision of drinking water supply) should there be any emergency canal closures during construction.
2	The barrage will provide road connection between both the banks for considerable distance and nearest bridge is located near Sukkur. Hence any closure of this road and heavy construction traffic will seriously affect the road communication in this region.	The road will not be closed for the traffic since all the construction activities will be carried out from the river using cranes mounted on the barges. A traffic management plan will be prepared and implemented by the contractor for smooth traffic flow.
3	Local community should be given preference in employment in the construction activities.	It is recommended that contractor should procure all unskilled labour from local community and also skilled labour if available.
4	Access to primary education especially for girls and basic health facilities are very poor in the project area and there is a demand from the community for these facilities.	Under SMF, SAP will support area development plan which would include education and health facilities and community development programs in the project area.
5	Risk of conflict between local communities and contractor's work force and security of the construction workers.	Adequate security will be provided by the district administration for the contractors. Contractor should maintain liaison with the local tribal and influential leaders, and hire the local labourers to a maximum extent.
6	Construction works during night time may cause sleep disturbance to the nearby communities.	Construction related impacts such as noise and dust pollution are addressed in the ESMP and ECPs. No construction activities will be carried out during night time close to the villages.
7	Dolphin game reserve on the downstream of the barrage is in threat due to various anthropogenic external pressures. Risk of river pollution from the construction activities will further aggravate these issues.	Risk of river pollution is considered in the ESA and adequate mitigation measures are proposed in the ESMP. Further a dolphin conservation and management plan has been prepared and will be implemented to promote conservation of the dolphin game reserve.
8	Migration of hilsa (palla) fish is stopped by the barrages in Indus.	Further studies are recommended under ESMP to carry out baseline studies to understand hilsa biology and migration. New fish passes will be built in Sukkur barrage and fish passes in Kotri and Guddu barrages will be rehabilitated based on outcome of the proposed study.

9.3. Disclosure

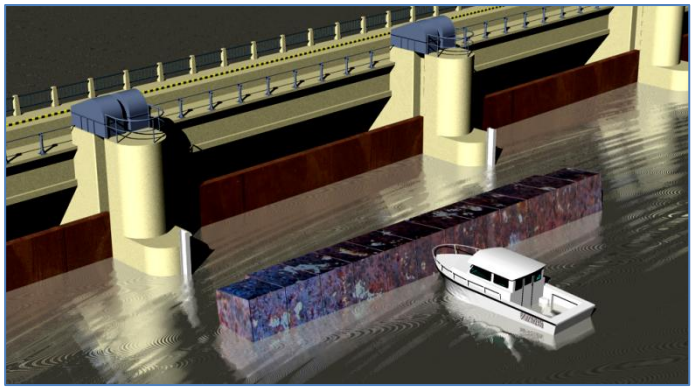
The ESA has been submitted to Sindh-EPA. A final round of consultation and disclosure of the ESA reports was carried out during 28th and 29th October 2014 by the independent consultants. These meetings were held in Guddu and Sukkur, at which respective relevant district organizations and institutes were invited. The consultation meetings were also attended by local community, SID officials, and local civil society representatives. The ESA summary has been translated into Sindhi. The Summary (both English and Sindhi) and the ESA document were uploaded on the website of SID and disclosed on 10 November 2014 and also sent to the World Bank InfoShop.

Annex 1

Construction Methodology for replacement of barrage gates and left pocket divide wall

Construction Methodology for Replacement of Barrage Gates

BULKHEAD GATE INSTALLATION

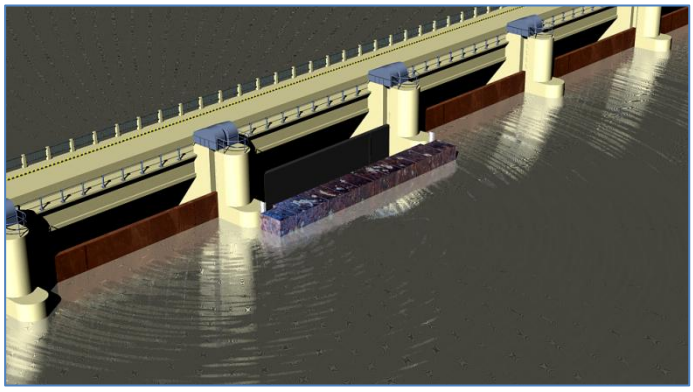


To allow replacement of the barrage gates, temporary bulkhead gates are to be installed across the gate bays. The bulkhead gates will be launched into the river from a docking area and guided to the barrage using work-boats. Prior to fitting of the bulkhead gates a receiving layer of sandbags will be placed by divers in 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 up and lifted out by the barge mounted crane and removed from site.

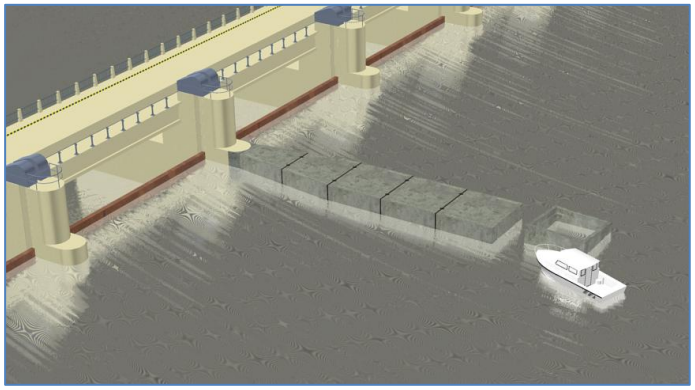
INSTALLATION OF NEW GATES



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 prior to welding. Following welding, inspection of the gate will take place. The gate sections will be coated with 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. Prior to removing the bulkhead gates the new gate will be tested and commissioned to ensure proper operation and to check proper functioning of the seals.

Construction Methodology for Left Pocket Divide Wall

LEFT POCKET DIVIDE WALL



Construction of a new left pocket divide wall on the 7th gate bay is required, to allow the barrage to be operated as originally intended to remove silt from water entering the off-taking canals. In order 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 workboats. 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

In order 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 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.