E4716

Government of Sindh, Pakistan
Irrigation Department

Sindh Barrages Improvement Project – Guddu Barrage Rehabilitation

ENVIRONMENTAL AND SOCIAL ASSESSMENT

Report by Independent Environmental Consultants
(Reviewed Draft for Disclosure)

December 2014

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List of Acronyms

Ac	Acre
BCM	Billion Cubmic Meter
BP	Bank Policy
CEAP	Construction Environmental Action Plan
CIA	Cumulative Impact Assessment
CO	Carbon Monoxide
CO_2	Carbon Dioxide
CIA	Cumulative Impact Assessment
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CSC	Construction Supervision Consultant
Cumec	Cubic meters per second (m^3/s)
Cusec	Cubic feet per second (cf/s)
dB	Decibels
ECA	Employment of Child Act
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
FAO	Food and Agriculture Oranization
g	Peak ground acceleration
GCA	Gross Command Area
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
MEC	Monitoring and Evaluation Consultant
MAF	Million Acre Foot
MEA	Multilateral Environmental Agreement
mg/l	Milligram per litre
NCS	National Conservation Strategy
NEP	National Environmental Policy
NEQS	National Environmental Quality Standards
NOx	Nitrogen Oxides
OFWMA	On Farm Water Management Project
OP	Operational Policies
OHS	Occupational Health and Safety Specialist
PAK EPA	Pakistan Environmental Protection Agency
PECP	Pakistan Enviornmental Protection Council
PET	Potential Evapotranspiration
PM	Particulate Matter
PMO	Project Management Office
POE	Panel of Experts
RAMSAR	Convention on Wetlands Signed in Ramsar Iran
RAP	Resettlement Action Plan
RPF	Resettlement Policy Framework
SAP	Social Action Plan
SEPA	Sindh Environmental Protection Act
Sindh-EPA	Sindh Environmental Protection Agency
SID	Sindh Irrigation Department
SIDA	Sindh Irrigation and Drainage Authority
SO2	Sulphur dioxide
SMF	Social Management Framework
SSESA	Strategic Sector Environmental and Social Assessment
SWMO	Sindh Water Management Ordinance
t	Tonne, metric ton
TDS	Total Dissolved Solids
WCA	Watercourse Associations
TORs	Terms of reference
USD	United States Dollar
VEC	Valued Environmental Component
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 (cf/s)	0.283 cumec (m^3/s)	1 cumec (m^3/s)	35.315 cusec (cf/s)
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 in 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 this report.

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 contributes 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 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

[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.

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 been 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 marginal bunds surrounding 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 1.1.

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 1200m 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 of land, 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 this main ESA report and an 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. The terms of reference (TORs) for the independent consultants is given in Annex A.

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.

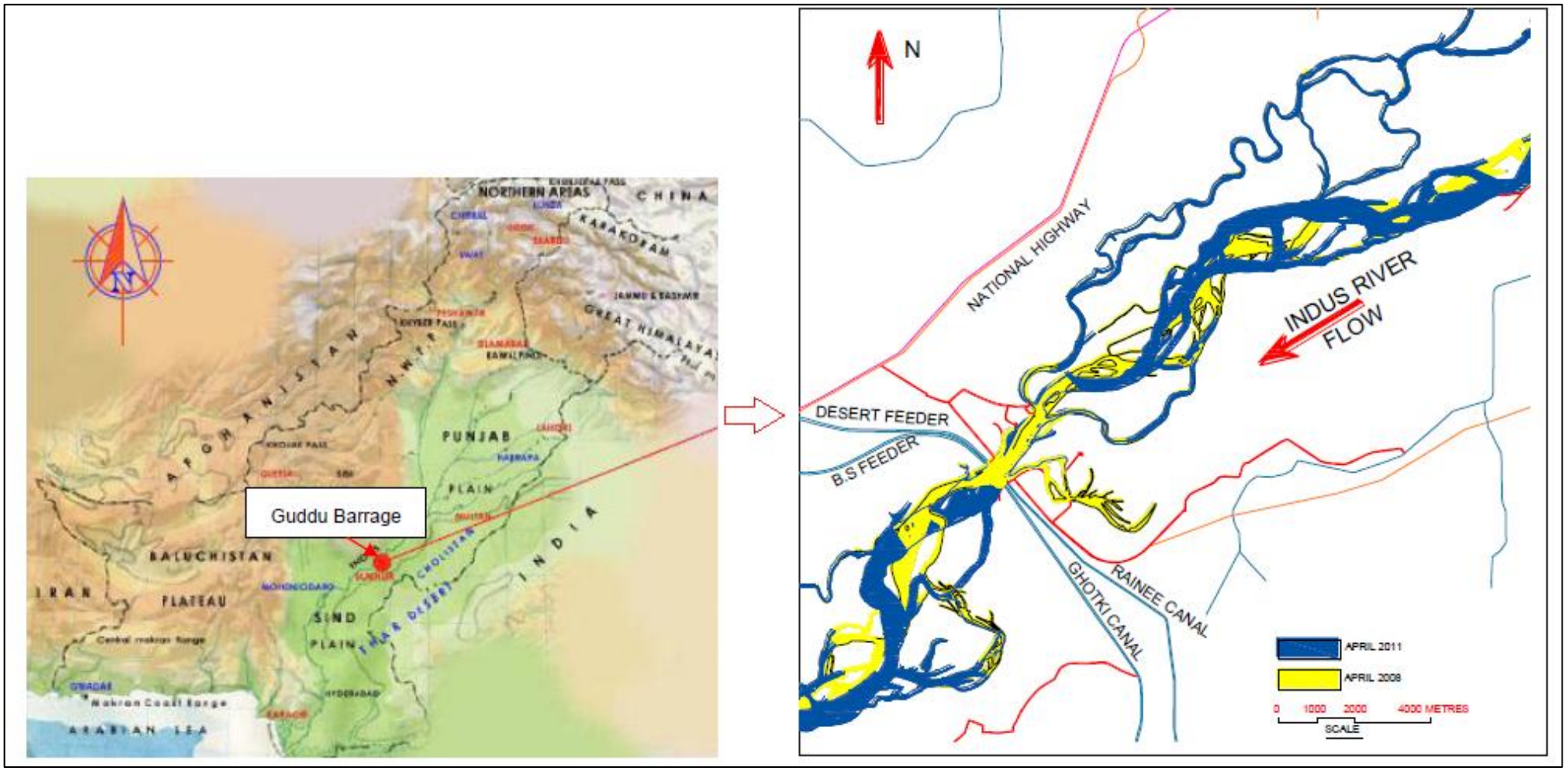


Figure 1.1: Location of Guddu Barrage in Pakistan

2 Policy, Legal and Administrative Framework

2.1 General

This Chapter provides an overview of the legislative structure and environmental assessment process in the province of Sindh as well as a list of key environmental legislation applicable in Pakistan. It also provides an overview of World Bank and other relevant international requirements including identification of applicable World Bank Operational Policies and applicable World Bank Group Environmental, Health and Safety Guidelines.

2.2 Applicable National Environmental Policies and Legislation

2.2.1 National Environmental Policies and Guidelines

National Conservation Strategy (1992)

The Pakistan National Conservation Strategy (NCS) is the principal policy document for environmental issues in the country which was developed and approved by the Government of Pakistan on 1st March 1992. The NCS works on a ten-year planning and implementation cycle. It deals with following core areas:

- Maintaining soils in cropland;
- Increasing irrigation efficiency;
- Protecting watersheds;
- Supporting forestry and plantations;
- Restoring rangelands and improving livestock;
- Protecting water bodies and sustaining fisheries;
- Conserving biodiversity;
- Increasing energy efficiency;
- Developing and deploying material and energy renewable;
- Preventing and abating pollution;
- Managing urban wastes;
- Supporting institutions for common resources;
- Integrating population and environmental programmes;

The National Environmental Policy (2005)

The National Environmental Policy (NEP) describes integration of the environment into development planning through the implementation of the EIA process at the scheme level. The NEP is the overarching framework which aims to protect, conserve and restore Pakistan's environment in order to improve the quality of life of the citizens through sustainable development'.

The policy includes guidelines to Federal, Provincial and Local Governments under the following headings:

- Water supply and management
- Air quality and noise
- Waste management
- Forestry
- Biodiversity and protected areas

- Climate change and ozone depletion
- Energy efficiency and renewable
- Multilateral environmental agreements

National Environmental Quality Standards (2010)

The National Environmental Quality Standards (NEQS) were first promulgated in 1993 and have been subsequently amended including standards for liquid effluent and gaseous emissions. The latest standards for ambient air, drinking water quality and noise levels were published on November, 2010 and standards for motor vehicle exhaust, diesel vehicle and petrol vehicle were published in August, 2009. The following standards are specified therein:

- Maximum allowable concentration of pollutants (32 parameters) in municipal and liquid industrial effluents discharged to inland waters, sewage treatment facilities, and the sea
- Maximum allowable concentration of pollutants (16 parameters) in gaseous emissions from industrial sources
- Maximum allowable concentration of pollutants (8 parameters) in ambient air quality
- Maximum allowable concentration of pollutants (3 parameters) in motor vehicle exhausts
- Drinking water standards
- Noise standards

Guidelines for Sensitive and Critical Areas (1997)

The Guidelines for Sensitive and Critical Areas, 1997, identify officially notified protected areas in Pakistan, including critical ecosystems, archaeological sites, etc., and present checklists for environmental assessment procedures to be carried out inside or near such sites. Environmentally sensitive areas include, among others, archaeological sites, biosphere reserves and natural parks, wildlife sanctuaries and game reserves. These guidelines are applicable as the project area is in the vicinity of wildlife sanctuary (also a Ramsar site) for the Indus dolphin.

Guidelines for the Preparation and Review of Environmental Reports (1997)

These guidelines are a part of package of *Pakistan Environmental Protection Ordinance 1997* and National Environmental Quality Standards, regulations and other guidelines. The scope of this guideline is confined to those aspects of environmental report preparation and review which are of general nature. Sector specific provisions are not included, nor are the subject of public consultation, which is dealt with separately.

Guidelines for Public Consultation (1997)

The Pakistan Environmental Protection Ordinance 1997 requires public participation during the review of an EIA (section 12 (3)). The “policy and procedure for the filing, review and approval of environmental assessments” requires the proponents to consult with the affected community and relevant NGO’s during the preparation of an environmental report.

The Solid Waste Management Policy (2000)

This policy was promulgated which aims to facilitate control on waste by providing principles of good waste management and reducing waste at source. The Guidelines have been consulted during planning and designing the disposal of solid waste from the staff colony and construction camps.

National Legislation

Factories Act (1934)

The clauses of the Factories Act relevant to the project are those which concern health, safety and welfare of workers, disposal of solid wastes and effluents, and damage to private and public property. The Factories Act also provides regulations for handling and disposal of toxic and hazardous materials. As construction activity is classified as 'industry', these regulations will be applicable to the Contractor(s) to be engaged for Guddu Barrage Rehabilitation works.

Forest Act (1927)

Federal Forestry Act of 1927 authorises Provincial Forest Departments to establish forest reserves and protected forests. The Act prohibits any person to set fire in the forest, quarry stone, remove any forest produce or cause any damage to the forest by cutting trees or clearing up area for cultivation or any other purpose

Protection of Trees and Brushwood Act (1949)

The Protection of Trees and Brushwood Act prohibits illegal cutting or lopping of trees along roads and canals planted by the Forest Department. The matter of permission to remove any trees, their compensation, and plantation to replace the lost trees will be taken up with the Sindh Forest authorities.

Antiquity Act (1975)

The Antiquity Act ensures the protection of cultural resources in Pakistan. This act is designed to protect antiquities from destruction, theft, negligence, unlawful excavation, trade and export. Antiquities have been defined in this act as "Ancient products of human activity, historical sites, sites of anthropological or cultural interest and national monuments etc.".

The act prohibits new construction in the proximity of a protected antiquity and empowers the government of Pakistan to prohibit excavation in any area that may contain articles of archaeological significance.

Under this act, the proponents are obligated to ensure that no activity is undertaken in the proximity of a protected antiquity, and during the course of the project if an archaeological discovery is made, it should be reported to the Department of Archaeology accordingly.

No protected or unprotected antiquity has been identified in the project area that may be affected by the project interventions. However a chance find procedure has been included in this ESIA in case of any, as yet, unidentified antiquity.

Wildlife Act (1975)

The Wildlife Act consolidates the laws approach to protection, preservation, conservation and management of wildlife in the country.

Local Government Ordinance (2001)

The Local Government Ordinance empowers the Government of Pakistan and provincial governments to enforce laws for land use; conservation of natural vegetation; air, water, and land pollution; disposal of solid waste and wastewater effluents; and public health and safety, including some provisions for environmental protection. Section 93 of this Ordinance pertains to environmental pollution, under which the local councils are authorised to restrict actions causing pollution to air, water or land.

The Local Councils of the project and surrounding area have been consulted for their views on the project interventions, and mitigations are proposed based on their views.

Motor Vehicle Ordinance (1995)

The Motor Vehicle ordinance deals with the powers of the Motor Vehicle Licensing Authorities and empowers other related agencies to regulate traffic rules, vehicle speed and weight limits, and vehicle use, to erect traffic signs, and to prescribe special duties of drivers in case of accidents. It also prescribes powers of police officers to check and penalise traffic offenders. At the same time, the ordinance also empowers the regional transport authority to operate as a quasi-judicial body at district level to monitor road transport, licensing requirements, and compensations for deaths or injuries to passengers on public carriers.

Highway Safety Ordinance (2000)

The Highway Safety Ordinance includes provisions for licensing and registration of vehicles and construction equipment; maintenance of road vehicles; traffic control offences, penalties and procedures; and the establishment of a police force for motorways and national highways to regulate and control the traffic as well as keep the highways clear of encroachments.

Employment of Child Act, 1991

Article 11(3) of the Constitution of Pakistan prohibits employment of children below the age of 14 years in any factory, mines or any other hazardous employment. In accordance with this Article, the Employment of Child Act (ECA) 1991 disallows the child labour in the country. The ECA defines a child to mean a person who has not completed his/her fourteenth year of age. The ECA states that no child shall be employed or permitted to work in any of the occupation set forth in the ECA (such as transport sector, railways, construction, and ports) or in any workshop wherein any of the processes defined in the Act are carried out. The contractor will be bound by this Act to disallow any child labour at the project sites or camp sites.

2.3 Applicable Provincial Environmental Policies and Legislation

Sindh Environmental Protection Act (SEPA), 2014

Sindh Environmental Protection Act, 2014: The Sindh Environmental Protection Act (SEPA) was 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.

The key features of the Act have a direct bearing on the proposed Guddu Barrage Rehabilitation Project because the project requires an environmental and social assessment. As Guddu Barrage is located in the district of Kashmore, it falls under the jurisdiction of the Sindh Environmental Protection Agency that will accord the approval of the ESIA pertaining to the project.

The following are the key features of the Act that have a direct bearing on the project area.

- Section 11 (Prohibition of Certain Discharges or Emissions) states that “Subject to the provisions of this Act and the rules and regulations made there under, no person shall discharge or emit, or allow the discharge or emission of, any effluent or waste or air pollutant or noise in an amount, concentration or level which is in excess of the National Environmental Quality Standards (NEQS)”.

- **Section 13 (Handling of Hazardous Substances)** requires that "Subject to the provisions of this Act, no person shall generate, collect, consign, transport, treat, dispose of, store, handle, or import any hazardous substance except (a) under a license issued by the Agency and in such manner as may be prescribed; or (b) in accordance with the provisions of any other law for the time being in force, or of any international treaty, convention, protocol, code, standard, agreement, or other Instrument to which Government is a party." Enforcement of this clause requires the SEPA to issue regulations regarding licensing procedures to define 'hazardous substance.'
- **Section 14-1 (Prohibition of Action Adversely Affecting Environment)** requires that "Subject to the provisions of this Act and the rules and regulations, no person shall cause any act, deed or any activity, including - (a) recycling or reuse of hospital waste and infectious waste; (b) disposal of solid and hazardous wastes at unauthorized places as prescribed; (c) dumping of wastes or hazardous substances into coastal waters and inland water bodes; (d) release of emissions or discharges from Industrial or commercial operations as prescribed; (e) recycling or reuse or recovery of hazardous wastes or industrial by-products in an unauthorized or non-prescribed manner or procedure, and (f) any activity which may cause adverse environmental effect due to trans boundary projects of Province of Sindh" which lead to Pollution or impairment of or damage to biodiversity, ecosystem, aesthetics or any damage to environment and natural resources.
- **Section 15 (Regulation of Motor Vehicles):** Subject to provision of this clause of the Act and the rules and regulations made there under, no person shall operate a motor vehicle from which air pollutants or noise are being emitted in an amount, concentration or level which is in excess of the NEQS, or where the applicable standards established under clause (g) of subsection (1) of Section-6 of the Act.
- **Section 17-I (Initial Environmental Examination and Environmental Impact Assessment)** requires that "No proponent of a project shall commence construction or operation unless he has filed with the Agency an IEE or, where the project is likely to cause an adverse environmental effect, an EIA, and has obtained from the Agency approval in respect thereof." The EIA has been prepared for the Guddu Barrage Rehabilitation Project to comply with this Section of the Act.
- **Section 17-2b (Review of EIA):** The Agency shall review the Environmental Impact Assessment report and accord its approval subject to such conditions as it may deem fit to impose, or require that the EIA be re-submitted after such modifications as may be stipulated or rejected, the project as being contrary to environmental objectives.
- **Section 18-1 (Strategic Environmental Assessment)** states that "all provincial government agencies, departments authorities, local councils and local authorities responsible for formulating policies, legislation, plans and programmes to be Implemented in Sindh province which may cause any environmental impact in the Jurisdiction of the province shall, before submitting the same to the competent authority for approval, forward to the Sindh Environmental Protection Agency a strategic environment assessment containing- (a) description of the objectives and features of the proposed policy, legislation plan or programme that are in consonance with the principles of sustainable development, (b) assessment of the adverse environmental effects, if any, likely to be caused during implementation of the policy, legislation, plan or programme along with proposed preventive, mitigation and compensatory measures, (c) analysis of possible alternatives; and (d) identification of those components of the policy, legislation, plan or programme, if any, in respect of which specific environmental impact assessment need to be carried out in due course".
- **Section 19-1 (Environmental Monitoring)** states that "the Agency shall carry out or arrange environmental monitoring of all projects in respect of which it has approved an initial environmental examination or environmental impact assessment to determine

whether the actual environmental impact exceeds the level predicted in the assessment and whether the conditions of the approval are being complied with".

- **Section 20-1 (Environmental Audit and Review)** requires that "the Agency shall from time to time require the person in charge of a project to furnish, within such period as may be specified, an environmental audit or environmental review report or environmental management plan containing a comprehensive appraisal of the environmental aspects of the project".

Sindh Wildlife Protection Ordinance (2001)

The Sindh Wildlife Protection Ordinance of 1972, as amended in 2001, 2010 provides for the preservation, protection, and conservation of wildlife by the formation and management of protected areas and prohibition of hunting of wildlife species declared protected under the ordinance. The ordinance also specifies three broad classifications of the protected areas:

- National Parks: Hunting and breaking of land for mining are prohibited in national parks, as removing vegetation or polluting water flowing through the park
- Wildlife Sanctuaries: Wildlife sanctuaries are areas which are left as undisturbed breeding grounds for wildlife. Cultivation, grazing and residing is prohibited in the demarcated areas. Special permission is required for entrance of general public. However, in exceptional circumstances, these restrictions are relaxed for scientific purpose or betterment of the respective area on the discretion of the authority.
- Game Reserves: Game reserves are designated as areas where hunting or shooting is not allowed except under special permits. The Indus between Guddu and Sukkur barrages is the Game Reserve.

Wild Birds and Animals Protection Act (1912)

The Wild Birds and Animals Protection Act of 1912 provides for the protection of wild animals, birds and plants and for matters connected therewith or ancillary or incidental thereto.

Sindh Fisheries Ordinance (1980)

The Sindh Fisheries Ordinance of 1980 provides rules and regulations for marketing, handling, and transportation, storage of fish and shrimps for commercial purpose and sale of fish used for the provincial trade in the Province of Sindh. Contravention of this Ordinance leads to imprisonment up to 6 months or a fine of 10,000 rupees or both. A provision is made for total ban on use of destructive fishing gear and closed season during June and July.

The Sindh Water Management Ordinance (2002)

The Government of Sindh has promulgated the Sindh Water Management Ordinance (SWMO 2002) on October 26, 2002. SWMO 2002 provided framework for institutional reforms in water sector by decentralizing the water resources management and irrigation and drainage services. Under the SWMO 2002, Sindh Irrigation and Drainage Authority (SIDA) has been established at the provincial level for overall water resources management with a broad involvement from stakeholders. Similarly the Area Water Boards is established at the canal command level, and Farmer Organizations (FOs) at the distributary/minor canal level consisting of water users' associations at the watercourse level. SIDA would therefore be involved in addressing the social and environmental issues under the project and through monitoring arrangements ensure that they are implemented properly.

Sindh Strategy for Sustainable Development (2007)

The Sindh Strategy for Sustainable Development proposes a ten year sustainable development agenda for Sindh level. Its purpose is to highlight the ecological, economic and social issues of

the province and to provide recommendations and strategic actions to address them. The strategy promotes the sustainable use of natural resources to achieve the objectives of poverty alleviation and social development through the participation of the people of Sindh.

2.3.1 EIA Approval Procedure

The Pak-EPA prepared regulations in 2000 for the “Review of IEE and EIA”. These regulations categorize development projects for IEE and EIA into Schedules I, II and III. Projects are classified on the basis of expected degree and magnitude of environmental impacts and are included in different schedules.

The projects listed in Schedule-I include those where the range of environmental issues is comparatively narrow and the issues can be understood and managed through less extensive analysis. Schedule-I projects require an IEE to be conducted, rather than a full-fledged EIA, provided that the project is not located in an environmentally sensitive area.

The projects listed in Schedule-II are generally major projects and have the potential to affect a large number of people in addition to significant adverse environmental impacts. The impacts of projects included in Schedule-II may be irreversible and could lead to significant changes in land use and the social, physical and biological environment. Guddu Barrage Rehabilitation Project is categorized in Schedule II and requires a full EIA. Sindh Environmental Protection Act is approved in March 2014. Figure 2.1 provides an outline of the EIA process in Sindh. Those projects not included in schedule-I and II don’t require IEE or EIA.

Sindh Irrigation Department is responsible for compliance with environmental commitments and mitigation measures proposed in this environmental report and in the subsequent review and approval conditions.

No construction, preliminary or otherwise, relating to the project shall be undertaken until and unless the EIA approval has been issued by the Sindh EPA.

The Sindh Irrigation Department shall submit the Environmental Report on a prescribed application along with a processing fee of Rs. 30,000 to 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.

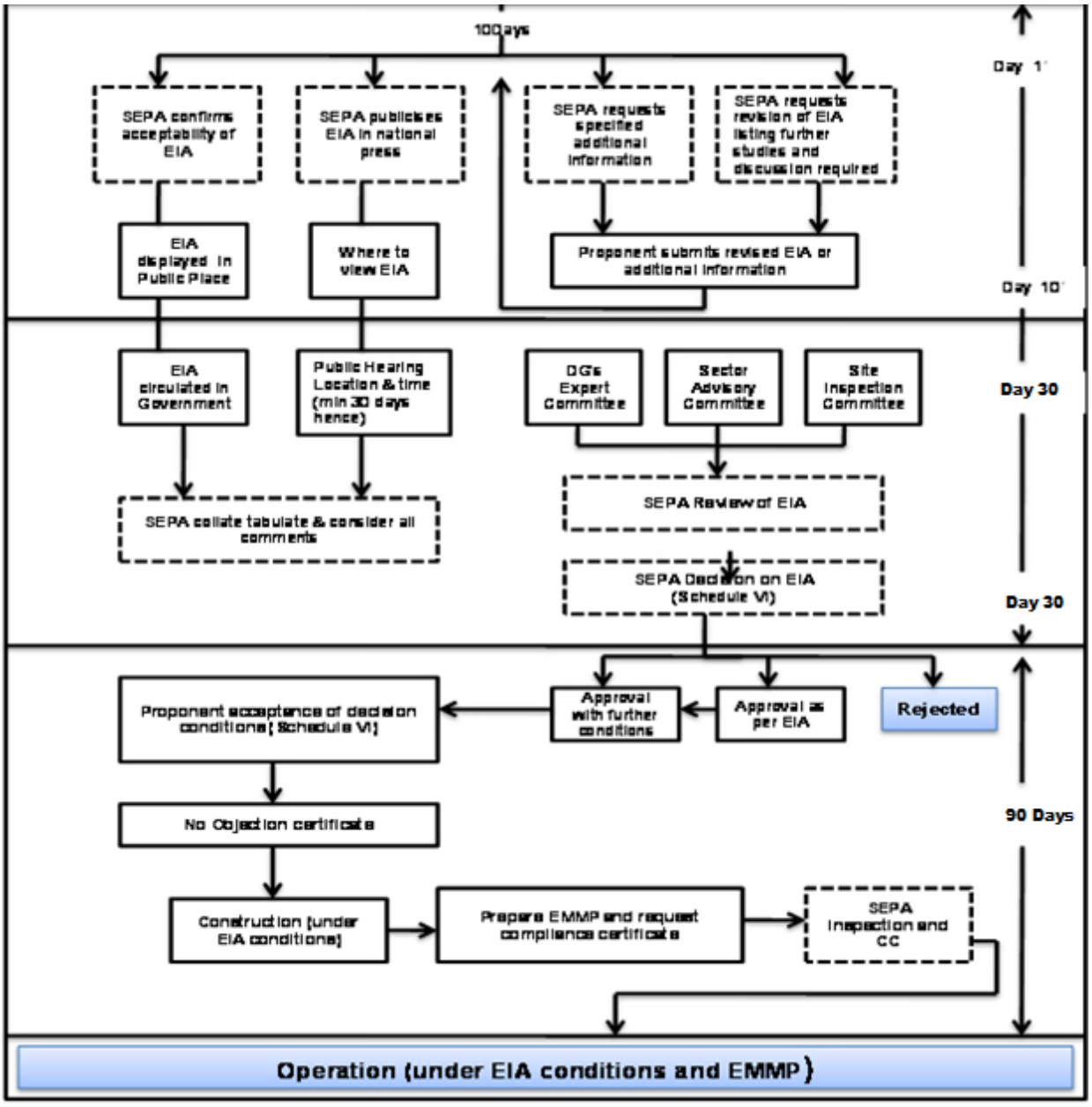


Figure 2.1: EIA Approval Process from Sindh EPA

Policy and Procedures for the Filing, Review and Approval of Environmental Assessments

The Policy and Procedures for Filing, Review and Approval of Environmental Assessments, 2000, define the policy context and the administrative procedures that will govern the environmental assessment process, from the project pre-feasibility stage to the approval of the environmental report.

Guidelines for the Preparation and Review of Environmental Reports

The Guidelines for the Preparation and Review of Environmental Reports, address project proponents, and specify:

- The nature of the information to be included in environmental reports

- The minimum qualifications of the EIA consultant
- The need to incorporate suitable mitigation measures into every stage of project implementation
- The need to specify monitoring procedures.
- The terms of reference for the reports are to be prepared by the project proponents themselves.
- The reports must contain baseline data on the project area, a detailed assessment thereof, and mitigation measures.

2.4 Environmental Regulatory Authorities

The Pakistan Environmental Protection Ordinance, 1983 was the first legislation in Pakistan designed specifically for the protection of the environment. The promulgation of this Ordinance was followed in 1984 by the creation of Pakistan Environmental Protection Council (PEPC).

Pakistan Environmental Protection Council

The PEPC is the highest inter-ministerial statutory body in the country headed by the Prime Minister and is responsible for:

- Formulating national environmental policy;
- Enforcing PEPA 1997;
- Approval of the NEQS;
- Incorporation of environmental considerations into national development plans and policies; and
- Provision of guidelines for the protection and conservation of biodiversity in general as well as conservation of renewable and non-renewable resources.

Climate Change Division

The Climate Change Division, which falls directly under the Prime Minister Secretariat, is the focal point for National Policy, Legislation, Plans, Strategies and programs with regard to Disaster Management, Climate Change including Environmental Protection and preservation. The Division also deals with other countries, international agencies and forums for coordination, monitoring and implementation of environmental agreements.

Pakistan Environmental Protection Agency (PAK-EPA)

The PAK-EPA is headed by a Director General and has wide ranging functions as set out in PEPA 1997. These include preparation and co-ordination of national environmental policy for approval by PEPC, administering and implementing PEPA 1997 and preparation, revision or establishment of NEQS. The PAK-EPA has issued regulations regarding the environmental assessment procedures known as Review of Initial Environmental Examination (IEE) and EIA Regulations, 2000; these provide a firm legal status to the IEEs and EIAs. The jurisdiction of the EPA is applicable to the following projects:

- On federal land;
- Military projects;
- Involving trans-country impacts; and
- Bearing trans-province impacts.

Sindh Environmental Protection Agency

Sindh Environmental Protection Agency (Sindh EPA) is a counterpart of the PAK-EPA at the Sindh. The Sindh EPA is established by the respective provincial/regional governments. They

are headed by a Director General. The IEE and EIA reports pertaining to projects falling within the boundary of Sindh are to be submitted to the Sindh EPA for approval.

2.5 International Treaties and Conventions

Pakistan is a signatory to a number of Multilateral Environmental Agreements (MEAs). These MEAs impose requirements and restrictions of varying degrees upon the member countries, in order to meet the objectives of these agreements. However, the implementation mechanism for most of these MEAs is weak in Pakistan and institutional setup mostly non-existent. The following are the relevant international treaties and conventions that have been ratified by Pakistan, where relevant, these will be discussed in further detail within relevant chapters:

- Basel Convention,
- Convention on Biological Diversity, Convention on Wetlands (Ramsar convention),
- Convention on International Trade in Endangered Species (CITES),
- United Nations Framework Convention on Climate Change,
- Kyoto Protocol,
- Montreal Protocol,
- UN Convention to Combat Desertification,
- UN Convention on the Law of Seas ,
- Stockholm Convention on Persistent Organic Pollutants,
- Convention concerning the Protection of World Culture and Natural Heritage (World Heritage Convention), 1972; and
- International Plant Protection Convention, 1951.

2.6 World Bank Safeguard Policies

The World Bank's environmental and social safeguard policies relevant to the project are summarized in Table 2.1 and include the following:

Environmental Assessment (OP 4.01): provides the framework for World Bank environmental safeguard policies and describes project screening and categorization to determine the level of environmental assessment required. The proposed project involves civil and mechanical rehabilitation works of an existing barrage on Indus River with a potential to affect 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 coffer dam approach to avoid disruptions to irrigation supplies and to reduce environmental footprints.

Natural Habitat (OP 4.04): The policy recognizes the importance of natural habitat in sustaining biodiversity, and requires that projects strictly avoid their significant conversion or degradation (particularly for critical natural habitat), and minimize and mitigate impacts to them including, as appropriate, through creation of offsets and restoration measures. 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): This policy requires that experienced and competent professionals design and supervise construction, and that the borrower adopts and implements dam safety measures through the project cycle. It recommends, where appropriate, that Bank staff discuss with the borrowers any measures necessary to strengthen the institutional, legislative, and regulatory frameworks for dam safety programs in those countries. For large dams, the borrower must engage an independent Dam Safety Panel. 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): Projects on International Waterways may affect the relations between the World Bank and its borrowers, and between riparian states. Therefore, the Bank attaches great importance to the riparian making appropriate agreements or arrangements for the entire waterway, or parts thereof, and stands ready to assist in this regard. A borrower must notify other riparian countries of planned projects that could affect water quality or quantity, sufficiently far in advance to allow them to review the plans and raise any concerns or objections. 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. This ESA report and Executive Summary along with SID's Social Management Framework 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. However 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): sets out the World Bank requirement to avoid or mitigate adverse impacts resulting from project developments on cultural resources. 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): sets out the World Bank requirement to avoid or mitigate adverse impacts resulting from project developments on cultural resources. 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.

Table 2.1: Triggering the World Bank Policies

Directive	Policy	Triggered	Comments
Environmental Assessment	OP/BP 4.01	Yes	As the Project falls into Category A, a full ESA has to be carried out. It is the basis of this ESA document.
Natural Habitats	OP/BP 4.04	Yes	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.
Indigenous Peoples	OP 4.10	No	Not triggered since no Indigenous People or ethnic minorities are living in the area.
Physical Cultural Resources	OP 4.11	No	Not Triggered since 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/BP 4.12	No	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.
Forests	OP/BP 4.36	No	Not Triggered since no forests are located in the project area.
Pest Management	OP 4.09	No	Not triggered. No pesticides, herbicide or fungicides will be used in any of the project activities.

Directive	Policy	Triggered	Comments
Safety of Dams	OP/BP 4.37	Yes	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.
Projects in International Waterways	OP/BP/ GP 7.50	Yes	The Project is located on an international waterway and will require a riparian notification consistent with World Bank.
Projects in Disputed Areas	OP/BP 7.60	No	Not triggered since the project area is not located in a disputed territory.
Access to information			The draft ESA report has been disclosed to the stakeholders in consultative and disclosure workshops 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 Resettlement Framework were also sent to the World Bank InfoShop.

2.6.1 World Bank Environmental and Social Guidelines

The principal World Bank publications that contain environmental and social guidelines are listed below;

- Environmental Assessment Sourcebook, Volume I: Policies, Procedures, and Cross-Sectoral Issues;
- Involuntary Resettlement Sourcebook;
- Social Analysis Sourcebook;
- Physical Cultural Resources Sourcebook; and
- World Bank Group - Environmental Health and Safety Guidelines.

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. Salient features of the barrage are given in Table 3.1. Layout of the barrage river training works and the barrage is shown in Figure 3.1 and Figure 3.2. A typical gate bay section of the barrage is also shown in Figure 3.3.

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).

Barrage regular operation process. The barrage is operated by partially closing the gates along the length of the barrage. The partial closure of the gates reduces the flow area through each gate opening, and through the barrage as a whole, and creates a resistance to the flow of

water through the barrage. All gates are never totally closed, and flow is maintained through the barrage to the downstream river at all times. Gate operation is normally effective up to a discharge of 16,000 -17,000 cumec (55,000-600,000 cusec). For higher flows, the gates are typically fully opened and have little effect on the upstream conditions. The level to which the gates must be lowered is dependent upon the flow in the river and based on the requirement to maintain an upstream water (pond) level of 78m (256ft) above datum. This pond level is required to maintain flow to the offtaking canals. The barrage may be considered in three sections, the left pocket (upstream of which Ghotki Feeder Canal and Rainee Canal offtake), the main weir, and the right pocket (upstream of which Desert Pat and Beghari Sindh offtake). During normal operation, the gates in the left and right pockets are closed in order to reduce flow velocities upstream of the offtaking canals (and promote the accretion of sediment from the flow into the pocket to prevent sediment entering the offtaking canals), and the main weir gates are operated at a level that maintains the upstream pond level

Table 3.1: Salient features of Guddu Barrage

Attribute	**Measurement**
Design Discharge	31,432 m³/s (1.1 million cf/s)
Super Flood	34,000 m³/s (1.2 million cf/s)
Design Pond Level	RL 77.8764 m (255.50 ft)
Afflux at flood discharge	0.61 m (2 ft)
Average Approach Velocity Head	0.30 m (1 ft)
Design Downstream water level	RL 77.65m (254.74 ft)
Design Discharge through weir	9.06 m³/s (320 cf/s)
Design Discharge through left pocket	9.91 m³/s (350 cf/s)
Pond level (During Peak Demand)	RL 78.94 m (259 ft)
No. of Spans in weir	64 Nos. of 18.29m (60 ft) each
Right pocket	07 Nos. of 18.29 m (60 ft) each
Left Pocket	03 Nos. of 18.29 m 3(60ft each)
Navigation lock	One No. of 15.24 m (50 ft)
Over all width of Barrage between abutments	1354.8 m (4445 ft)
Weir crest level	RL 81.16 m (236 ft)
Left and Right Pocket crest level	RL71.63 m (235 ft)
Ordinary piers	2.44 m (8 ft) wide
Abutment piers	3.05 m (10 ft)wide
Right Guide Bank U/S	2439 m (8002 ft)
Right Guide Bank D/S	403.86 m (1325 ft)
Left Guide Bank U/S	2491.7 m (8175 ft)
Right Divide wall pier including fish ladder	5.79 m (19 ft) wide
Left Divide wall pier including fish ladder	7.62 m (25 ft)wide
Lock pier	5.79 m (19 ft) wide
Navigation Lock upstream	RL 70.71 m (232 ft)
Navigation Lock downstream	RL 67.67m (227 ft)
Navigation Lock Pavement level Downstream	RL 67.66 m (222 ft)
Width of crest for under sluices	1.83 m (6 ft)

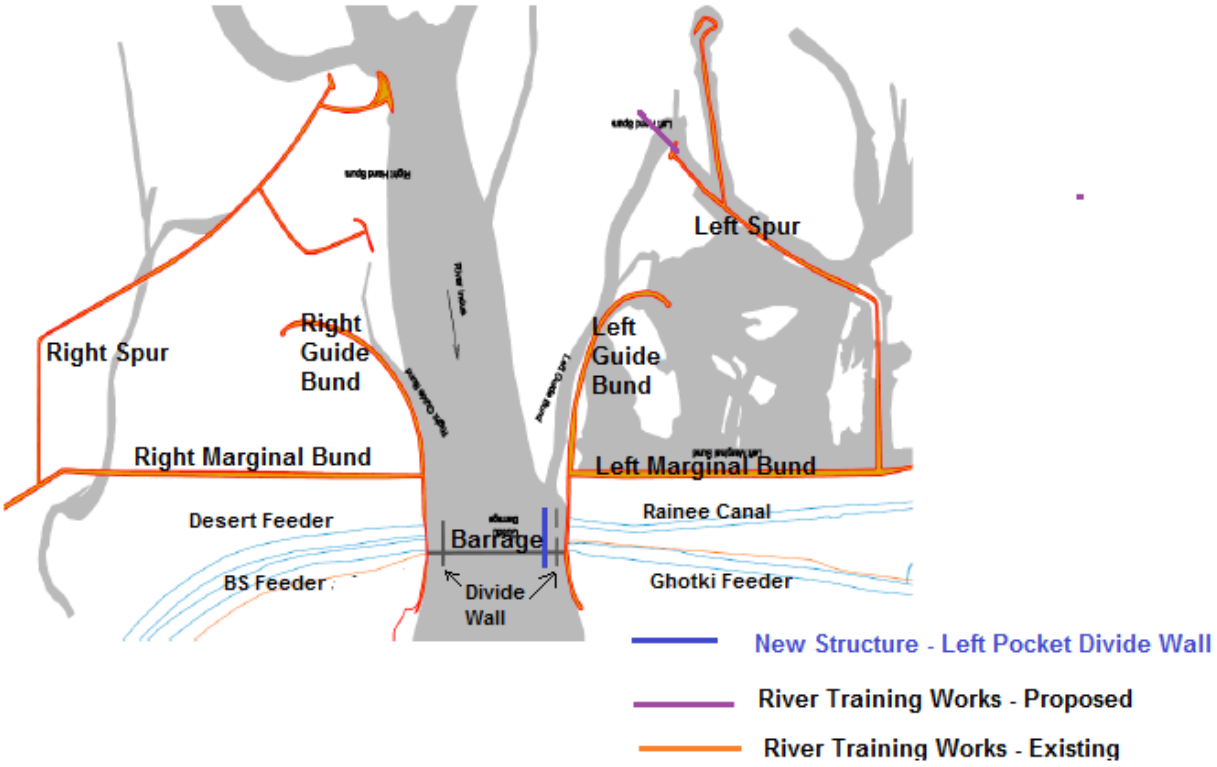


Figure 3.1: Layout of Guddu Barrage Project

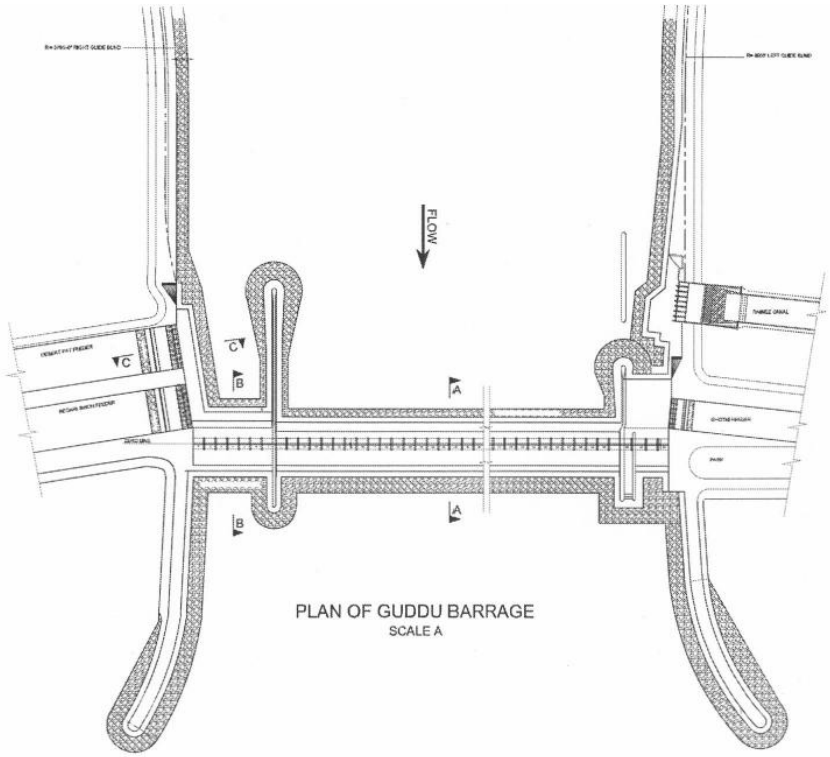


Figure 3.2: Existing Layout and sections of Guddu barrage

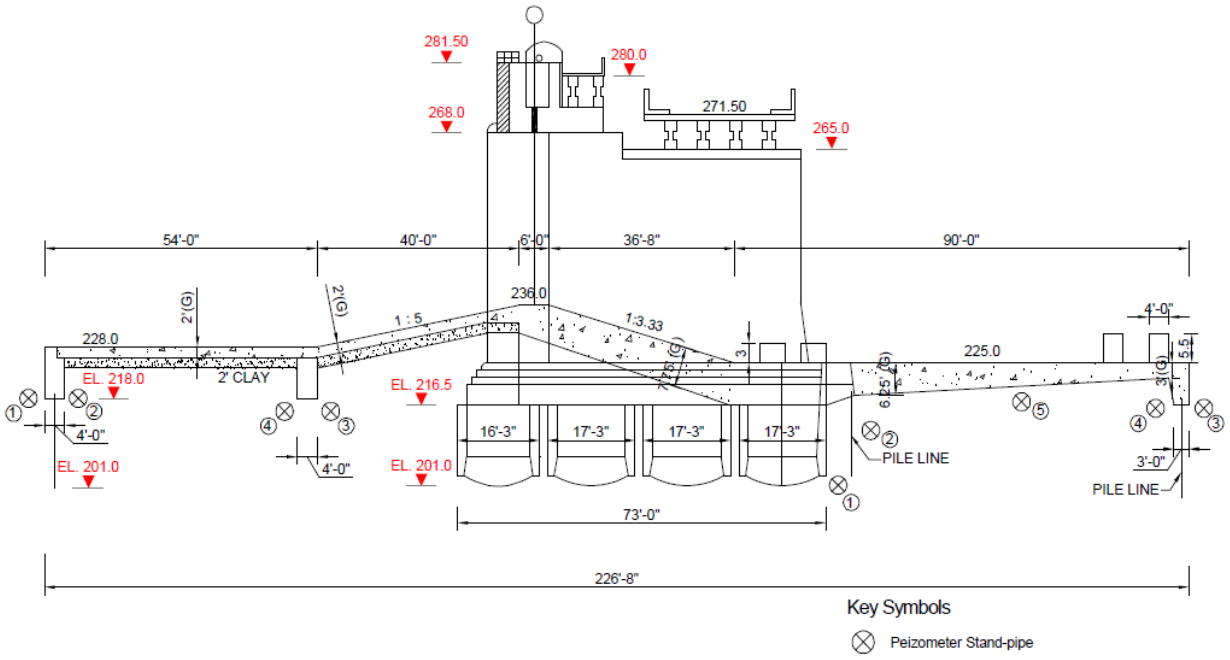


Figure 3.3: A Typical Gate Bay Section of Guddu Barrage

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 100 year return flood.

Current status on sedimentation control. The left bank 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

3.4.1 Component A: Rehabilitation of Guddu Barrage

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:

3.4.1.1 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, and replacement of barrage lighting. It also includes some minor concrete works to the barrage where concrete spalling is noticed around the gate grooves and minor honeycombing of concrete is noticed under the road bridge deck.

3.4.1.2 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 (Figure 3.4). 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.

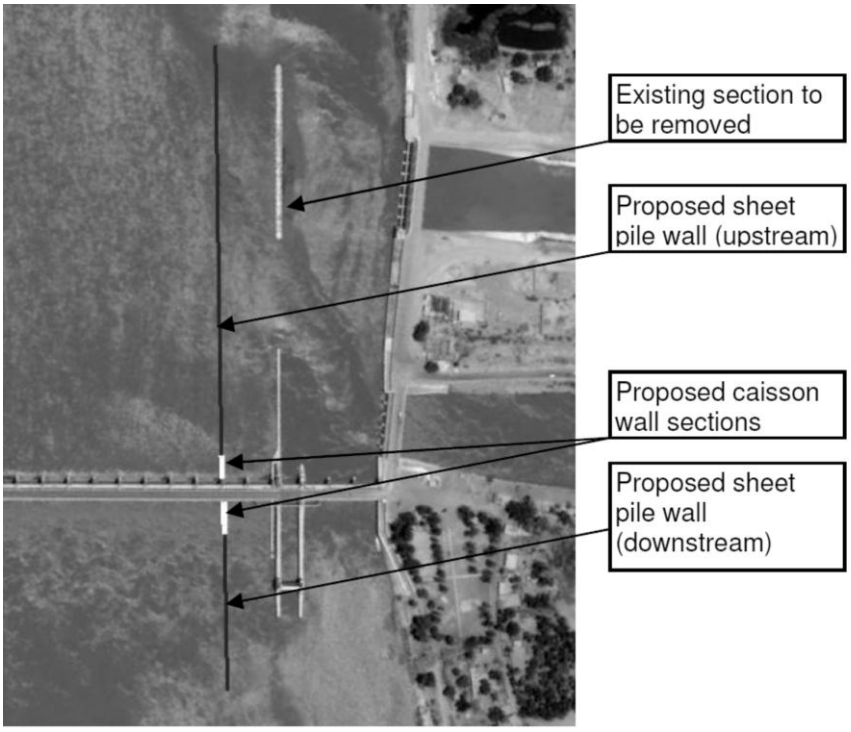


Figure 3.4: Plan of Proposed Left Pocket Divide Wall

3.4.1.3 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.

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 by 1.83m (6ft) to withstand extreme flood events up to 36,000 cumec. In addition at some locations guide bunds and spurs will be provided with stone protection to the slopes and some additional apron protection. A typical cross section of marginal bund is shown in Figure 3.5. Details of river training works that will be strengthened under this project are given below:

- Left marginal bund – upstream (25 km)
- Right marginal bund – upstream (8 km)
- Left & right spurs (14km)
- Guide bunds (6km)

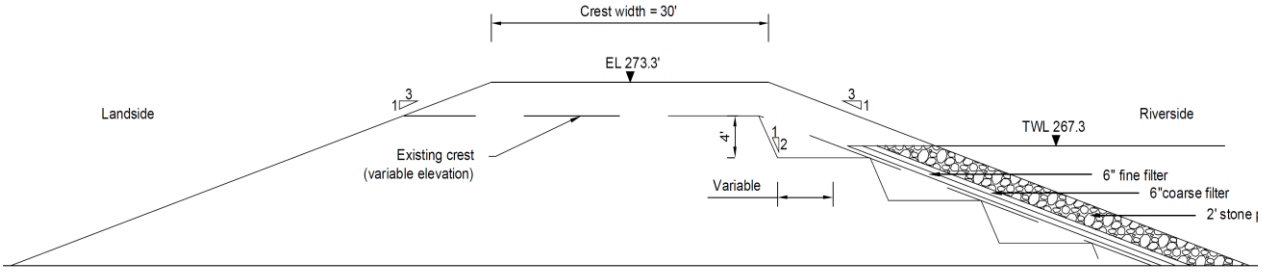


Figure 3.5: Typical Proposed Cross-Section of Marginal Bunds

3.4.1.4 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. Development of colony requires demolition of existing six existing building structures and felling of 260 Eucalyptus trees. These trees will not fall under classification of forests of OP 4.36. Location of the colony site is shown in Figure 3.6. In addition some temporary facilities such as construction yard, labor camp will have to be constructed by the construction contractor.

3.4.1.5 Construction Supervision and Contract Management

This component will cover the cost of consulting services including construction supervision (including social and environmental management plans), contract administration, and quality control, preparation of any additional designs bidding documents and monitoring and evaluation.

Figure 3.6: Location of Guddu Staff Colony (on Right Bank)

3.4.2 Component B: Improved Barrage Operation, Improvement

3.4.2.1 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.

3.4.2.2 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.

3.4.3 Component C: Project Management Coordination and Monitoring and Evaluation, and training

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.

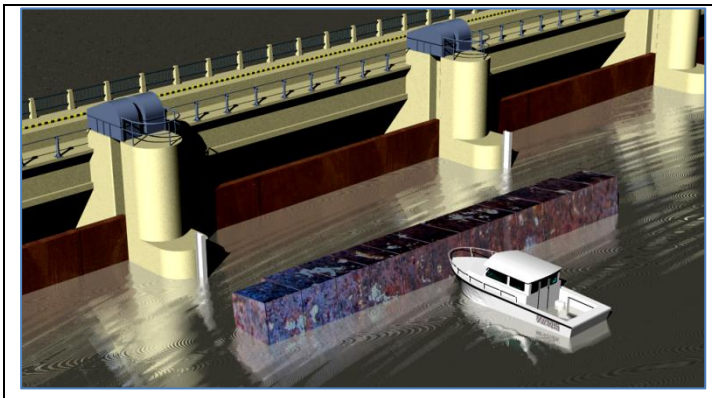
3.5 Construction Methodology

3.5.1 Construction Methodology for Replacement of Gates

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 layer of sandbags will be placed 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. A visual illustration of this methodology is shown in Box 1:

Box 1: 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

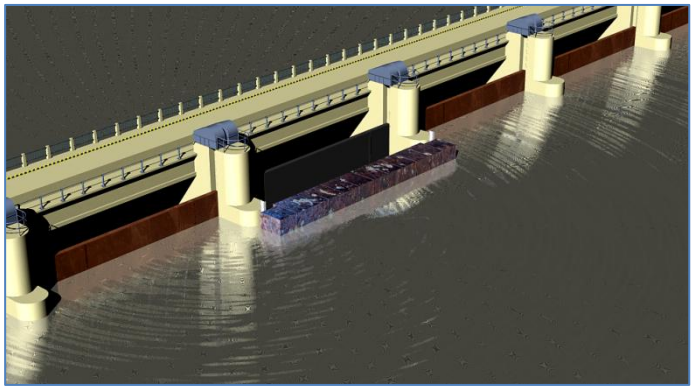


number of bulkhead gates required will depend upon the contractor's methodology, but similar sized projects have been completed with four gate bays being worked on at one time.

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



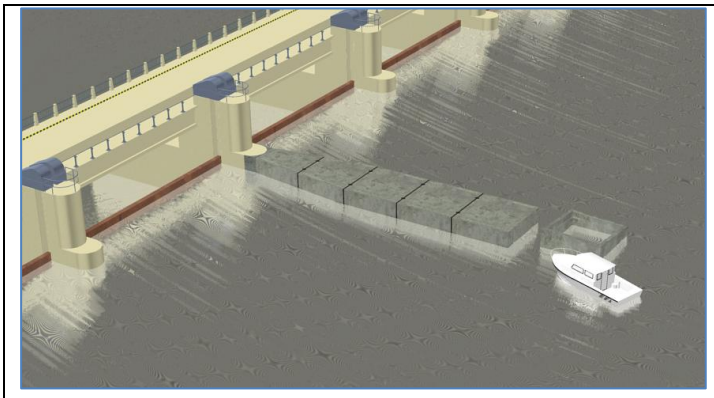
The new gates will be installed in sections using the barge mounted crane. The sections will be joined together by welders working on scaffolding within the barrage bay. Factory fitted location marks, jigs and survey equipment will be used to verify accurate positioning of sections prior to welding. 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.

3.5.2 Construction Methodology for Left Pocket Divide Wall

Construction approach for left bank divide wall is also designed with an intention to avoid construction of cofferdams thereby need for avoiding long term closure of left bank Ghotki Feeder canal. A visual illustration of the proposed methodology for construction of left bank divide wall is shown in Box 2. The existing divide wall attached to the barrage will not be disturbed. However the divide wall located opposite to the Rainee canal, which is a concrete structure will be dismantled by the contractor.

Box 2: 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.

3.5.3 Construction Methodology for Improvement of River Training Works

A total of 2 million m^3 of earth fill will be required for strengthening and raising of embankments and another 0.42 million m^3 of stone is required for toe protection. The earth fill will be obtained from the borrow areas to be established within the upstream marginal bunds of the barrage. The stone will be brought from the existing and government approved quarry sites. Prior approval will be taken by the contractor from project authorities before establishing the borrow sites. These sites will be dry during low flow season and will be flooded during high flow season. The material from the borrow areas will be excavated using the excavators and will be placed over the embankments and will be compacted. Stone apron will be launched to protect the slopes of the embankment on the riverside.

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. A summary of construction material requirements of the project and their sources are given in Table 3.2. It is expected that about 180 trucks per day will be used for transport of quarry material such as stone and rock during the construction periods given in Section 3.8. In addition it is expected that about 280 trucks will be used within the construction areas for transport of concrete and earth fill material. 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.

Table 3.2: Summary of Materials Required During Construction

Material	Unit	Quantity for Staff colony	Quantity (Barrage, Gates and Divide Wall)	Quantity for River training works	Total Quantity	Source of Material
Earth fill	m^3	3,964	-	1,982,000	1,985,964	Local borrow area
Stone pitching	m^3	-	-	425,000	425,000	Rohri
Gravel	m^3	-	-	283,200	283,200	Rohri
Spawl	m^3	2,152	-	124,600	126,752	Rohri
Rock	m^3	-	84,950	679,600	764,550	Rohri
Plain Concrete	m^3	1,416	3,256	-	4,672	Rohri/Rahimyar Khan
Reinforced concrete	m^3	1161	1557	-	96,000	Rohri
Reinforcement Steel	Tonne	130	600	-	730	Rahimyar Khan
Masonry Bricks	m^3	3,681	-	-	3,681	Local Market
Polyethylene Pipe	m	1,219	-	-	1,219	Rahimyar Khan
Reinforced Concrete Pipe	m	2,000	-	-	2,000	Rahimyar Khan
Steel Sheet Piling	Tonne	-	3,000	-	3,000	Karachi
Grout	m^3	-	793	-	793	Rohri
Steel (for gates)	Tonne	-	630	-	600	Karachi
Gate Seals	m	-	2,800	-	2,800	Karachi
Gate Hoists, Wheels & Axles	Number	-	91	-	91	Karachi

Source: Feasibility Study of Guddu Barrage Project, 2014

3.7 Construction Equipment

Table 3.3 outlines the approximate number of major machinery and vehicles that are envisaged to be required for the project construction works:

Table 3.3: Equipment Required for the Project

Equipment	Number	Equipment	Number	Equipment	Number
Excavators	6	Motor boat	1	Generators	5
Concrete Batching Plant	1	Water Tanker	2	Vibratory roller	5
Dump Trucks	10	Water pump	2	Fuel Tanker	1

Bulldozer	6	Pile drivers	1	Concrete mixer	3
Grader	2	Mobile crane	2	Concrete truck	2
De-watering equipment	2	Air compressor	2	Concrete vibrator	5
Welding machine	2	Barge	4	Pneumatic roller	1

3.8 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 improvement 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. A tentative works schedule is presented in Table 3.4 assuming a 5 day work period in a week and one work shift per a day. This schedule is subject to change depending on the procurement process and following award of the contract.

Table 3.4: Tentative works scheduled activity

Works	Start	End
Contract Procurement	June 2014	December 2014
Mobilization of Contractor including Camps	January 2015	March 2015
Construction of Staff Colony	April 2015	November 2015
Strengthening, raising and construction of bunds and spurs	July 2015	June 2017
Replacement of regulator gates and civil repairs	July 2015	October 2018
Construction of left pocket divide wall	July 2015	June 2018
Site restoration	November 2018	December 2018

Note: The starting dates in this table are for indicative purpose only. Actual date of construction depends on the project approval.

3.9 Project Cost

The estimated project cost is shown in Table 3.5.

Table 3.5: 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

During feasibility study and detailed design stages of the project, various alternatives are considered based on the SID previous experiences in Kotri barrage rehabilitation and another ongoing Jinnah barrage rehabilitation project in Pakistan. These alternatives were primarily derived based on numerical and physical modeling studies, with an intention to avoid any adverse environmental and social impacts associated with the canal closure for irrigation supply and traffic closure on the barrage. This Chapter presents the analysis of various alternatives considered and their evaluation highlighting environmental and social aspects. Detailed technical description of these alternatives along with the engineering drawings is available in design consultants ESIA report, which is available on SID's website.

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 farm 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 that 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 be offset by additional requirement to raise the operating pond level to 260ft which would necessitate a slightly taller gate; the main weir gates would be 4.5ft 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 Protection Works for Improved Flood Protection

Seven alternatives were studied for improved flood protection. Alternative 1 includes the raising and strengthening of existing river training works 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. Both these options are rejected due to their high capital cost and huge land acquisition requirement. An overview of all these alternatives are described below

1. Strengthen & Raise Existing River Training Works to Contain 100 Year Flood flows: Existing river training works will be strengthened and the existing marginal bunds shall be raised to 6ft above the modelled 100 year flood levels. Stone pitching would be added to the river side to protect the bunds from scour during flood flows. No land acquisition is required for this option.
2. Earth Fuse Bund on Left Marginal Bund: A sacrificial section for the weaker section of left marginal bund is proposed. The section would be designed to breach causing the flood level upstream of the barrage to reduce, thus reducing the need to raise the existing marginal bunds. This option is cheaper but the downstream of the fuse bund must be maintained clear of all settlements or be evacuated prior to a breach and the area likely to be flooded would be large.
3. Fixed Weir on Left Marginal Bund: This option works in a similar manner to the earth fuse bund; however, instead of the construction of a sacrificial portion of bund which requires reconstruction following a breach, the crest level of this section of the bund is lowered and a concrete weir crest is constructed. The area likely to be flooded

would be larger than above option, but there would be no need for reconstruction of the structure following a breach.

4. Gated Weir on Left Marginal Bund: This option is same as above, except that the crest level of the weir can be reduced by adding gates to the weir. Similar to above two options, this option also requires maintaining large areas to be flooded during floods.
5. Siphon under left bank Canals: Additional capacity to pass water from upstream of the barrage to downstream could be provided by constructing a large concrete siphon (culvert) which passes under the Rainee and Ghotki Canals on the left bank of the barrage. The capital cost of the structure would be far outstripping the existing budget. Maintenance costs on the siphon shall also be high, but will ensure that the siphon can operate at the time of need. It is a long term solution to flooding in the area. Moreover, the flood water of siphon when diverted to river downstream of barrage would add flood pressure to Sukkur barrage.
6. Construct New Marginal Bunds: In this option, construction of new marginal bunds was considered instead of rehabilitation of the existing bunds. However this option was rejected because the existing marginal bunds are technically suitable for rehabilitation.
7. Extend Barrage on Left Bank: This is achieved by providing additional gate bays on the left bank of the barrage. This option would require reconstruction of the left guide bund and the head regulators of the left bank canals. A diversion for these canals would also be required during construction. Major interventions would also be required to manage the alignment of the river approach to satisfy the upstream river morphology and extensive modelling studies would be required. The construction period and costs will be very high. Large scale land acquisition is required along the left bank.

Socially the alternative 1 of raising the current marginal bunds is advantageous compared to other alternatives since it doesn't require any land acquisition and resettlement. All other options require huge land acquisition and resettlement to maintain the permanent flooding areas, which will further result in to series of socioeconomic impacts.

Environmentally also the alternative 1 is preferable compared to other options due to (i) no loss of terrestrial habitat (clearing of natural vegetation and trees) and aquatic habitat (development of additional pondage area) due to additional land acquisition and construction works (ii) lesser requirement of quarry and borrow materials due to lesser construction works, (iii) lesser construction related environmental impacts from construction equipment and vehicles and construction workforce.

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 1200 km is found to be technically, economically and environmentally advantageous alternative due to its shorter length compared to other options. The environmental advantages of the selected option, due to shorter length of river training works, compared to other options include (i) requirement of lesser

quarry and borrow material, (ii) requirement of lesser construction equipment and manpower thus reduced air and noise quality and health impacts (iii) requirement of lesser instream construction activities and thereby less impacts on the river water quality.

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:

1. Construct a new divide wall: It is proposed under this alternative to construct a new divide wall between the 7th and 8th gate bay. Under this alternative, model results showed that the velocities in the left pocket would be much reduced (reductions in excess of those resulting from closure of the gap in the divide wall) which would result in more effective settling conditions and reduced sediment concentration entering the canals. This option would not risk the supply of full discharge to the Ghotki Feeder Canal
2. Join the gap in the existing divide: In this alternative, the gap in the existing left pocket divide wall would be closed (see Figure 3.3) to promote flushing upstream of Rainee Canal and prevent lateral flow upstream of the barrage. This is advantageous as it reduces the risk to the structural integrity of the barrage and reduces the volume of sediment that may enter the Rainee Canal. Numerical and physical modelling of this option identified reduced velocities in the left pocket which is advantageous as it will promote settlement of sediment in the pocket and prevent this entering the Ghotki Canal. However, increased scour on the right hand side of the wall is also identified in the model, and this may undermine the wall itself if remedial works are not implemented and maintained (such as dumped rock to act as erosion protection). Physical modelling also identified that there may be some difficulty in supplying the Ghotki Feeder Canal with its full design discharge following the closure of the gap.

Both the numerical and physical models for above two alternatives 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 collision of dolphins 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 and underwater noise levels are assessed in the ESA and appropriate mitigation measures are proposed in the ESMP. A detailed overview of these methodologies is given below:

1. Construction from river bed in the dry working area: the construction of the divide wall would be split into two or three discrete sections, and a dry working area created for each by constructing a cofferdam extending from the left bank to surround each section of the wall and pumping the area dry. Each cofferdam would be built separately, and removed prior to the construction of the next. While this alternative may simplify the construction methodology as a dry working area is created, it shall require considerable amounts of fill material to be won from borrow areas to construct each cofferdam. It shall also result in the loss of supply to the Ghotki Feeder Canal and Rainee Canal when the head regulators fall within the dry working area that shall be required. To mitigate this, cofferdams could be built from the barrage, extending upstream, however this shall at best significantly reduce the discharge to these canals, and as plant would need to access the dry working area from the barrage itself, this would be disruptive to the traffic using the barrage as a crossing over the Indus. Any reduction in flow to the left bank canals shall have a significant negative impact on all those farming in the command area as well as a significant negative economic impact in the area. Following the installation of each section of the divide wall and use of each cofferdam, the cofferdam shall be removed. Although it would be possible to remove the material from the riverbed and transport it to the river bank, there shall inevitably be an increase in the turbidity of the water downstream which shall negatively impact upon the dolphin reserve. This option also present an important health and safety concern as the failure of any part of the cofferdam and flooding of the working area while construction is in progress would be catastrophic. To mitigate this, significant erosion protection would be required as well as monitoring of seepage through the cofferdam, river water levels and a construction methodology which defines maximum river water levels, beyond which work must be suspended.
2. Construction from a waterborne plant: In this alternative, the divide wall shall be installed from waterborne plant (i.e. sheet piling rigs mounted on barges). This removes completely the need for construction of cofferdam and any associated risks to the water supply to left bank canals and turbidity in the downstream Dolphin Reserve. However, the risk of water pollution is increased as any leaks or pollution from plant shall have a more direct path to the river than if the plant were situated in the dry where it would be possible to control and clean a spill. If such an option were to be adopted, careful management and monitoring of on-site mitigations to prevent pollution events resulting from, for example, leaks of oil or fuel from plant or spills during refueling. Health and safety risks exist when working on water, and provision of floatation aids, rescue equipment and training to staff would be necessary

5 Description of Environment

5.1 Physical Environment

5.1.1 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 (Figure 5.1). 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.

5.1.2 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.

5.1.3 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 moths 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 6 °C. 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. Climate change is also expected to increase extreme precipitation events, and trigger both extremely high precipitations resulting in floods, and extremely low precipitation resulting in droughts. Monthly climate data at Guddu is given in Table 5.1

Table 5.1: Average Climate Data at Guddu

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean	Total
Temp (Mean)	13	16.6	23	29.1	34.2	36.4	35	32.9	32	27.2	20.6	16.2	26.35	
Temp (Max)	22.2	25.8	32	38	43	44.2	41.2	38.9	37.7	35.7	30	24.1	34.4	
Temp (Min)	8.1	11.3	17.3	23	27.6	30.2	30.2	29.2	26.7	20.6	14.1	9.1	20.62	
Rainfall (mm)	6	8	7	6	8	5	21	25	7	1	1	3	8.17	98
PET	81.8	99.3	164.8	227.4	299.5	306.7	257.6	221.4	193.1	163.2	104.3	74	182.76	2193.1
Wind Speed (km/h)	7.2	9	11.52	12.24	14.4	16.2	16.2	14.4	11.52	7.92	5.76	5.4	10.98	

Source: FAO Climate database

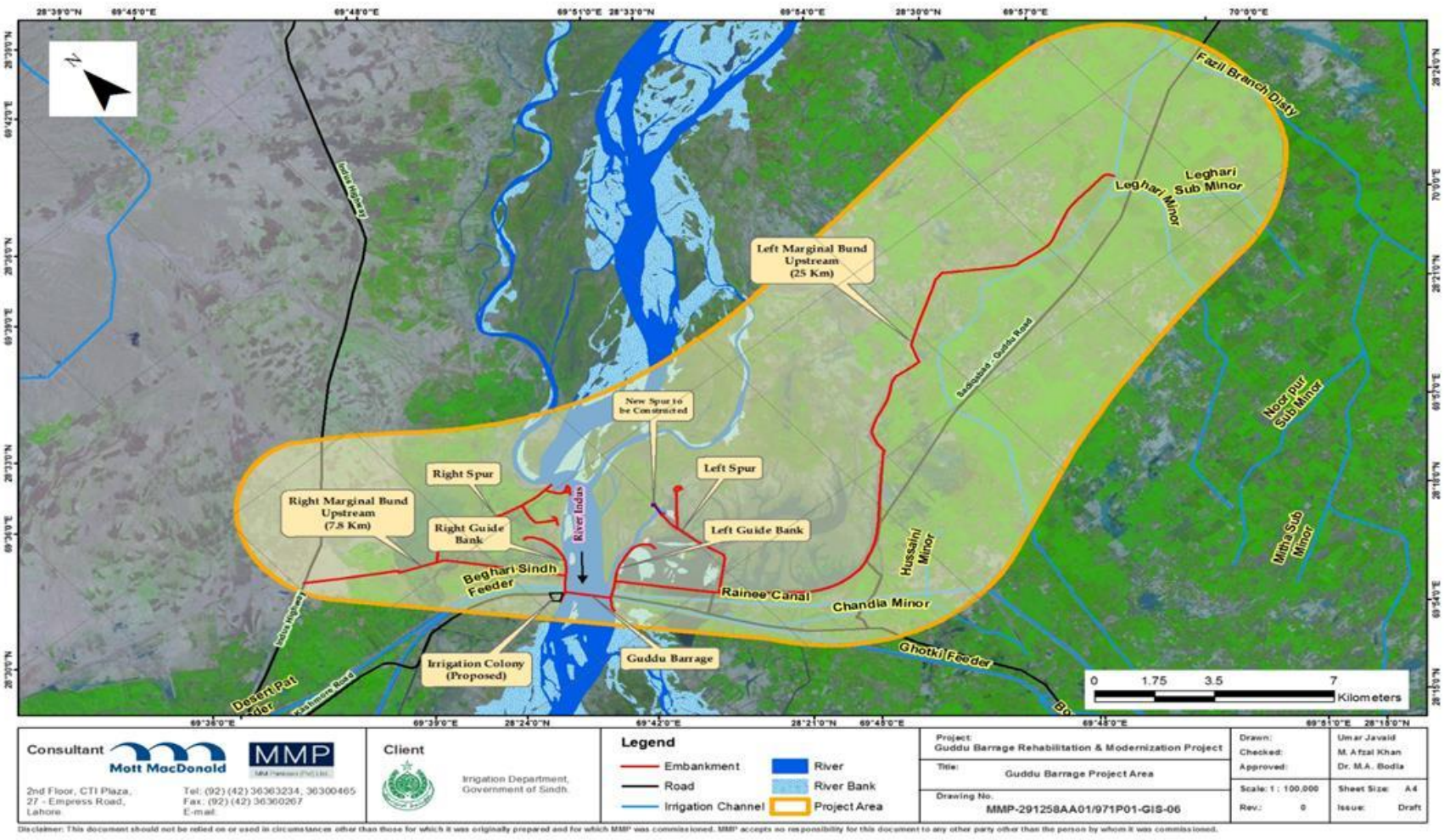


Figure 5.1: Project Impact Area

5.1.3.1 Climate Change and Future Predictions

According to the Pakistan Meteorological Department, Pakistan is particularly vulnerable to climate change as it lies within a region where temperature increases are expected to exceed the global average and its arid and semi-arid land is dependent upon glaciers in the Tibetan plateau to provide water to drive its heavily agricultural dependent economy. These glaciers are reported to be receding due to climate change.

The main effects of climate change predicted within Sindh are increased temperatures and increased frequency of extreme precipitation events, both extremely high precipitation resulting in floods, and extremely low resulting in droughts. Such trends are already evident from recorded data.

Figure 5.2 shows the current trend of increasing occurrence of heat waves (10 days above 40 degrees Celsius) as recorded in Sindh by the Pakistan Meteorological Department.

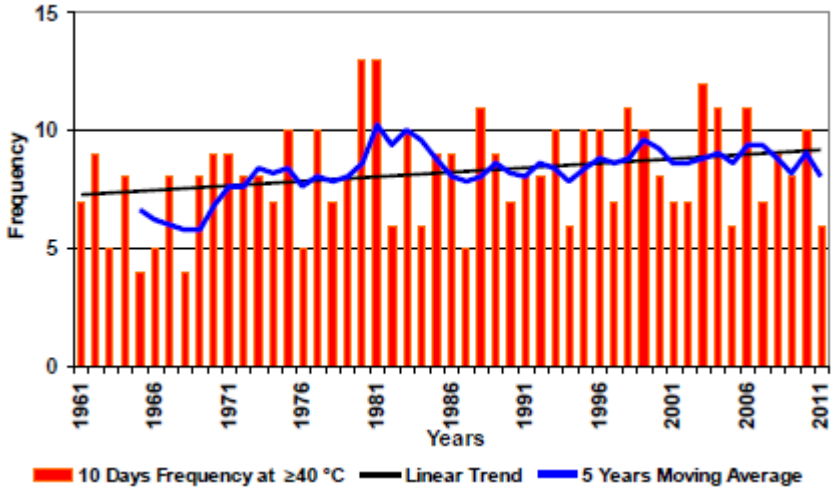


Figure 5.2: Recorded Increase in Heat Waves in Sindh since 1961

The predicted temperature increase in Pakistan, according the Pakistan Meteorological Department, shall be approximately 2 °C by 2050, and 4 degrees Celsius by the end of the century.

Figure 5.3 demonstrates how the frequency of extreme rainfall events has increased in the preceding 45 years.

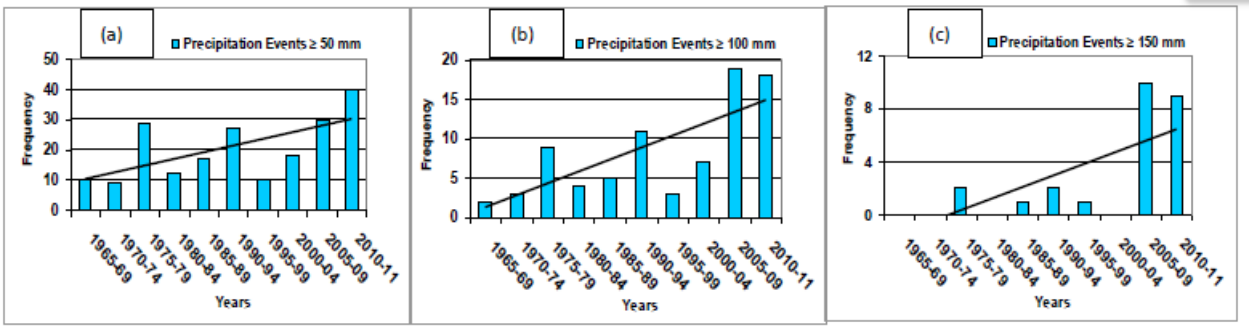


Figure 5.3: Recorded Changes in Extreme Prepetition Events in Sindh

Figure 5.4 compares the precipitation predicted from present day to 2050 to the current average rainfall in Sindh. The figure shows that Sindh is expected to receive heavier than normal rainfall during the monsoon season in the future, and that the monsoon season is expected to move towards the autumn.

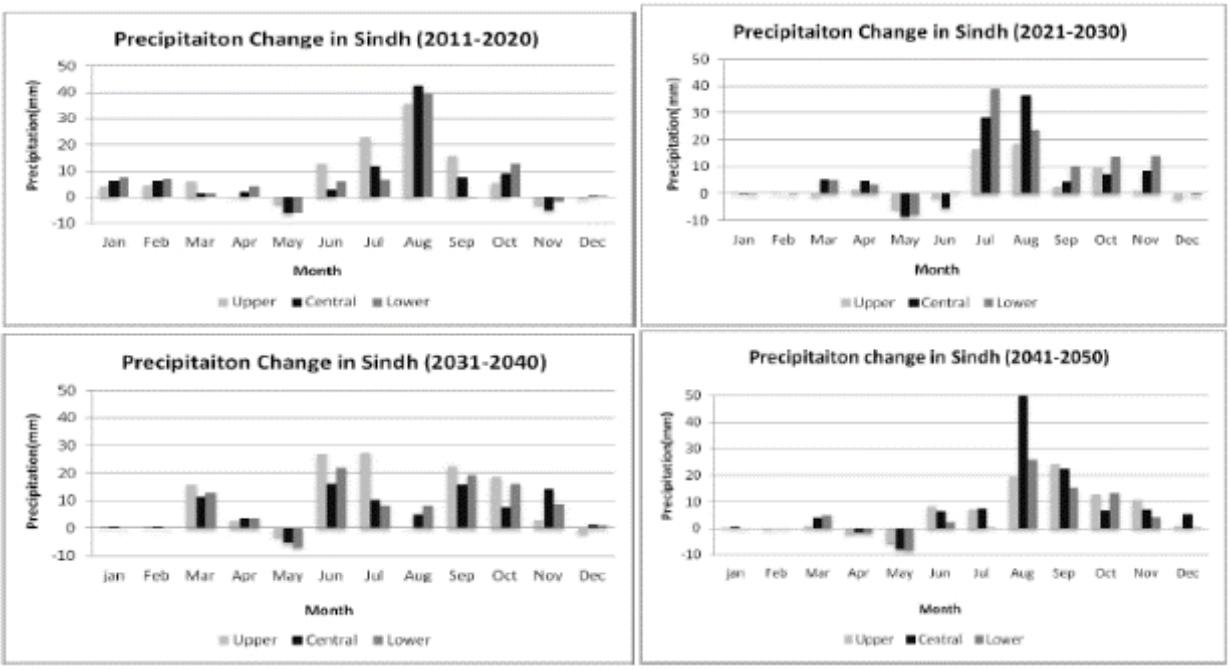


Figure 5.4: Predicted Future Changes in Precipitation in Sindh

5.1.4 Geology

The project area lies in Indus basin, a part of the vast Indo-gigantic plain formed by the gradual filling up (with alluvium or reworked Aeolian sediments) of the trough lying between the foot hills of Himalayas and central core of the subcontinent. The alluvium brought by the river Indus lies over a basement of limestone and sand stone. The thickness of alluvial deposits is more than 150 m as noticed in test drillings carried out during detailed design. The natural surface soil layers in the project area consist of thin alternating layers of silt and clayey silt and combined varied in thickness from 0.5 to 2.0 meters. Substantial disturbance in the upper layer due to local farming activity has occurred. This stratum occasionally contains zones of fine sand and less frequently very thin layers of tiny gravel.

5.1.5 Soils

The project location is surrounded by cultivated land. Soil types range from dark brown sandy loam in most places to light-brown sand in others. The area's soils contain adequate moisture and nutrients for agricultural use. The soils at the barrage site are alluvial in nature and are mainly silty clay, clay loam, and loam soils.

5.1.6 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 0.1g 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.

5.1.7 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. 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. Monthly river flows at Guddu are shown in Figure 5.5. 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.

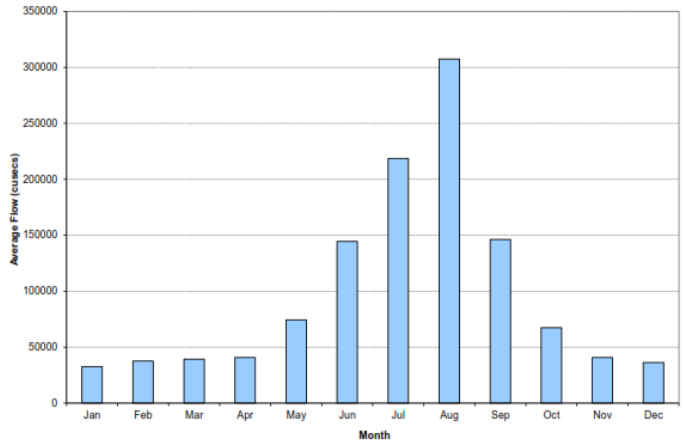


Figure 5.5: Average Monthly Discharges in River Indus at Guddu Barrage

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).

The annual maximum discharge of offtaking canals of Guddu Barrage from 1962 to 2010 is given in Figure 5.6

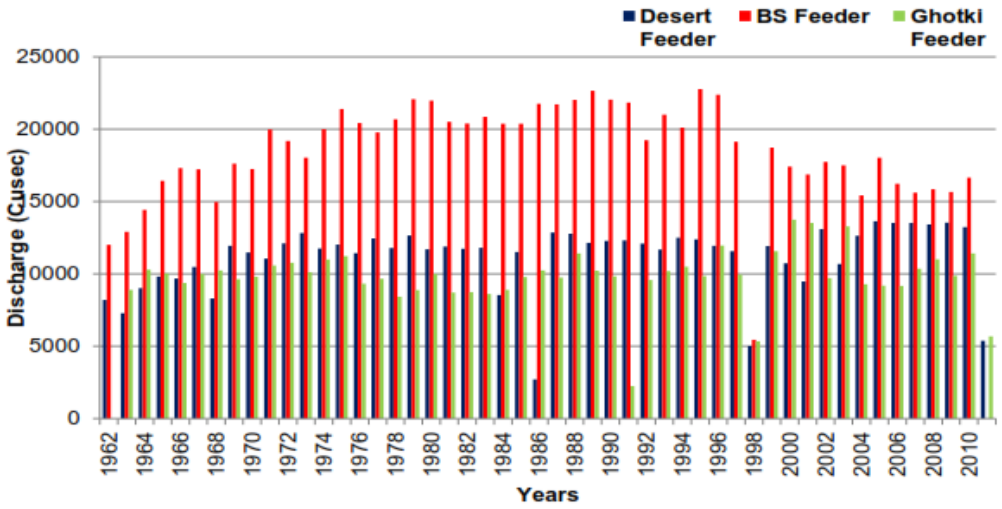


Figure 5.6: Annual Maximum Discharges of Offtaking Canals of Guddu Barrage (1962-

5.1.8 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. Annual maximum flows of Guddu Barrage upstream from 1962 to 2010 are shown in Figure 5.7. The red bars in graph show the super floods during this period.

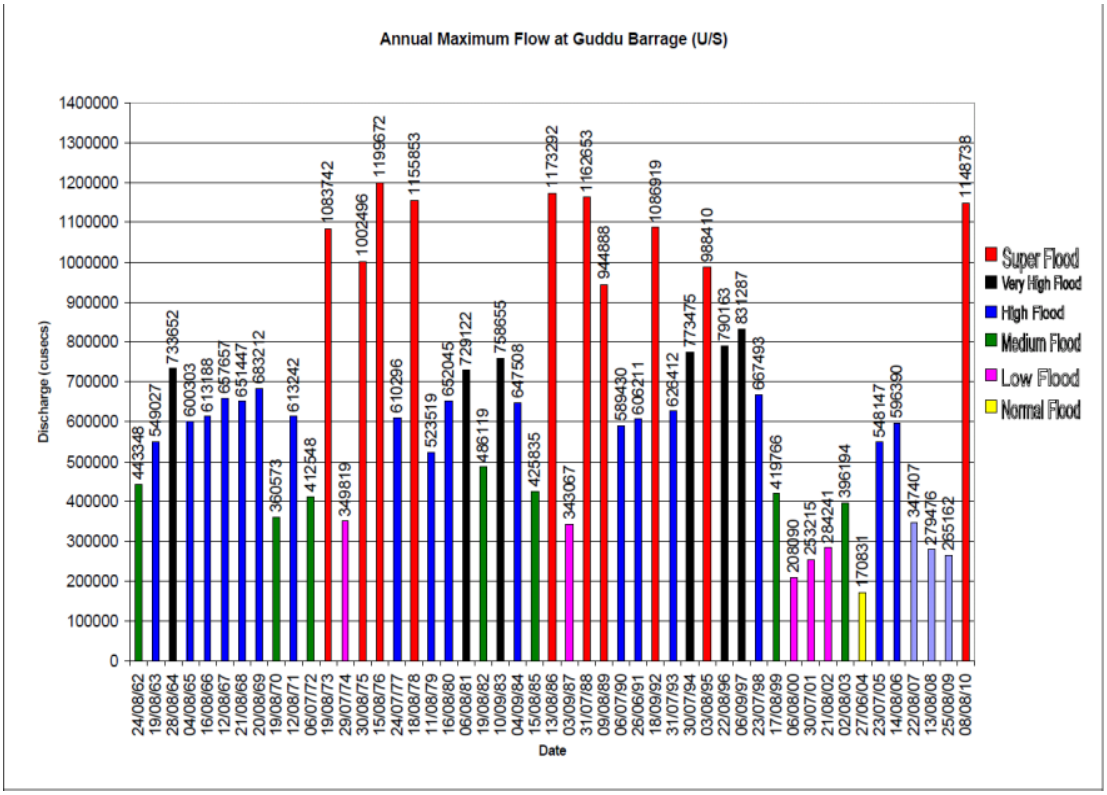


Figure 5.7: Annual Maximum Flow at Guddu Barrage from 1962- 2010

The flood severity levels and their occurrence are referred in Table 5.2 for the River Indus at Guddu Barrage.

Table 5.2: Statistics of Historical Floods on the River Indus at Guddu Barrage

Flood Severity	Threshold of Discharge (Cusecs)	No of Years of Occurrence	Average Frequency of Occurrence
Super Flood	Q >900,000	10	19%
Very High Flood	Q < 700,000 ≤ 900,000	6	13%
High Flood	Q < 500,000 ≤ 700,000	17	35%
Medium Flood	Q < 350,000 ≤ 500,000	7	15%
Low Flood	Q < 200,000 ≤ 350,000	9	19%
Normal Flood	Q≤200,000		

Source: Irrigation Department, Govt. of Sindh

A review of flood discharge data at Guddu barrage indicated that

- There is a large difference between the annual minimum discharge (170,831 cusec, June 2004) and annual maximum discharge (1,199,672 cusec, August 1976). The difference is approximately seven times. This large difference between the minimum and maximum annual maximum discharges reflects the true nature of the hydrological condition / variation and behaviour of the Indus River.
- From 1962, 10 Super Floods have been experienced and the recent Super Flood occurred in August 2011 and very recently in 2014, the province of Punjab was seriously hit by the floods.
- On average the occurrence of Super Floods is 1 in every 5 years.
- The occurrence of floods equal to or above Very High Floods is 1 in every 3 years.
- The occurrence of floods equal to or above High is 2 in every 3 years.

5.1.9 Climate Change Impacts on Floods

The impact of climate change is likely to severely affect flows in the River Indus. Climate change may impact upon flows in two ways; Firstly, the source of the Indus is glaciers on the Tibetan Plateau where temperatures are rising, resulting in a retreat of these glaciers and although there is little certainty of the long term impacts of climate change on these glaciers, some scenarios indicate that these glaciers could be lost, resulting in an overall decrease in river flows. Such a decrease could be significant. Secondly, more intense monsoon rainfalls (as observed in 2010) could become more common and result in an increase in peak flows in the Indus at Guddu. Such an increase would negate any reduction in peak flow as a result of upstream regulation.

Based on IPCC Fourth Assessment Report 2007 (AR4), the glacier melting in the Himalayas is expected to increase flooding of Indus and its tributaries for the next two to three decades which will be followed by decreased river flows as the glaciers recede. It is expected that the river flows will decrease after a few decades due to reduced glacier mass to a level that would be determined by the precipitation input at that time. According to the World Bank (2006) report: “Pakistan’s Water Economy: Running Dry”, the western Himalayan glaciers will retreat for next 50 years causing increase in Indus River flows and then the glacier reservoirs will be empty, resulting in decreases of 30% to 40% in river flows in the Indus Basin. In long term, the monthly flow pattern would also change considerably, with more water coming in spring and early summer and less water in the later part of summer. The short term increase of floods due to glacier melting has been adapted, by the design engineering consultant, in the rehabilitation design of flood levels for river training structures in Guddu barrage.

5.1.10 Sedimentation

The sediment deposition at the Guddu Barrages is predominantly sand. It has been observed that the Indus River bed level downstream of the barrage is gradually increasing, indicating that the sediment capacity of the river decreases downstream of the barrage, and sediment is settling out. The deposition of sediments in the downstream of the barrage is mainly due to obstruction of flows by the barrage and reduction in water velocities. The division of this sediment between the discharges passing through the barrage to the downstream system and to each offtaking canal is not currently proportional. A high proportion of sediment is carried into the left bank canals than the right bank canals. On the right bank, there is also a slight discrepancy, with 10% higher sediment concentrations being passed to Beghari Sindh than to Desert Pat Feeder. Such discrepancies are significant during normal flows in the Indus.

5.1.11 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. 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.

5.1.12 Quality of the Environment

5.1.12.1 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. Water quality data of Indus is given in Table 5.3.

Table 5.3: Indus water quality near the barrage

Parameters	Units	Left Bank	In Middle	Right Bank	NEQS
pH		7.84	7.65	7.45	6.5-8.5
Turbidity	NTU	19.11	15.19	21.23	<5
TDS	mg/l	181	178	172	<1000
Calcium	mg/l	36	32	28	
Magnesium	mg/l	33	29	30	
Hardness	mg/l	170	150	150	<500
Alkalinity	mg/l	100	90	100	-
Chloride	mg/l	58	45	52	<250
Conductivity		288	284	274	-
Arsenic	mg/l	0	0	0	<0.05
Fluoride	mg/l	0.32	0.02	0.19	<1.5

Source: Design Consultant's ESIA on Guddu Barrage Rehabilitation Project

5.1.12.2 Groundwater Quality

The groundwater quality in Sindh is generally saline with high total dissolved solids and not suitable for drinking or irrigation or any useful purposes other than fisheries. About 80 percent of Sindh is underlain by saline groundwater. However, the groundwater quality along the floodplains of Indus is generally good with low total dissolved solids due to regular recharge from the Indus. Groundwater quality of the wells located near the banks of Indus is shown in Table 5.4. Total dissolved solids of groundwater generally range 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 probably due to shallow groundwater levels and well depths. Groundwater quality of the boreholes located along the right bank is given in Table 5.4.

Table 5.4: Water quality of borewells (hand pumps) near barrage right bank

Parameters	Units	Well 1	Well 2	Well 3	NEQS
Depth of well	m	15	25	6	
pH		7.28	7.24	7.81	6.5-8.5
Turbidity	NTU	2.54	1.68	1.91	<5
TDS	mg/l	276	265	186	<1000
Calcium	mg/l	44	48	40	
Magnesium	mg/l	24	35	30	
Hardness	mg/l	140	190	160	<500
Alkalinity	mg/l	90	130	120	-
Chloride	mg/l	40	63	58	<250
Conductivity		439	422	296	-
Arsenic	mg/l	0	0	70	<0.05
Fluoride	mg/l	0.46	0.35	0.56	<1.5
Coliform	count/100 ml	6	45	5	0

5.1.13 Air Quality

The baseline ambient air quality (NOx, SO_2, CO, PM_{10}, and $PM_{2.5}$) at Guddu Barrage is shown in Table 5.5. The table shows the maximum, minimum and average air quality data over a 24 hour sampling period. Air quality near the barrage area is found to be within national standards of ambient air quality. Concentration of particulate matter in the air range from 20 to 25 µg/m^3. Emissions from nearby Guddu Thermal Power Plant (a combined power cycle plant) are also found to be within the national emission standards.

Table 5.5: Air Quality on Both Banks of Guddu Barrage

Parameter	Site-I (at right bank)			Site-II (at left bank)			NEQS
	Min.	Max.	Average	Min.	Max.	Average	
NOx	15.4	27.4	30.3	19.2	38.2	25.0	80
SO_2	19.4	39.8	26.5	19.7	41.4	29.0	120
CO	0.9	2.6	1.9	1.1	2.9	2.1	05
$PM_{2.5}$	12.0	27.0	17.2	18.0	36.0	23.1	35
Noise (day)	50.1	64.3	56.7	52.3	66.2	57.8	55
Noise (Night)	45.6	59.9	50.1	47.7	60.2	51.6	45

5.1.14 Noise Quality

Noise levels near the barrage are generally high due to vehicular traffic and have exceeded the national standards. A 24-hour noise monitoring data in the project area Noise quality in the project area recorded high noise levels often exceeding the national standards. The day time and night time average noise levels are given in Table 5.6. 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.

5.1.15 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. The associated traffic count, including daily averages is shown in the Table 5.6 and hourly traffic crossing in Table 5.7.

- The peak hours of Traffic are between 7:00 am to 6:00 pm;
- The peak days of Traffic are Saturday and Monday;
- Traffic on the bridge between 7:00 pm to 7:00 am is extremely low; and
- Larger vehicle crossings account for the vast majority of the night traffic whereas smaller vehicle and non-commercial traffic is almost none between 11 pm and 5 a.m. Heavy traffic mainly belongs to the five fertilizer factories located in the region and sugar factories.

Table 5.6: Daily Average Traffic Count at Guddu Barrage

S.No.	Date	Day	Total vehicles
1	October 21, 2011	Friday	3,374

2	October 22, 2011	Saturday	3,706
3	October 23, 2011	Sunday	3,371
4	October 24, 2011	Monday	3,617
5	October 25, 2011	Tuesday	3,093
6	October 26, 2011	Wednesday	2,963
7	October 27, 2011	Thursday	2,701
	Average of 7 days		3,260

Table 5.7: Daily Average Traffic Flow at Guddu Barrage by Vehicle Type

Vehicle Type	Average Daily Traffic	Percentage
Truck, 6 wheels and above	503	15.43
Mini bus/Bus	130	3.99
Hiace/pickup	787	24.14
Motor cycle	878	26.93
Motor rickshaw	33	1.01
Bicycle	67	2.06
Tractor	99	3.04
Animal driven cart	38	1.17
Car	725	22.24
Total	3260	100.00

5.2 Biological Environment

5.2.1 Fauna

The Indus River and its riparian forests have a unique freshwater ecosystem that supports both terrestrial and aquatic biodiversity. In Sindh, 16 species of mammals, 15 species of reptiles, 4 species of amphibians, 150 species of avifauna, 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.

5.2.1.1 Mammals

The Riverine forest of Indus has highly valuable wildlife habitats for mammals and list of these mammals are given in Annex B. Indus river dolphin is the most significant species and found in huge numbers in Sindh. 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.

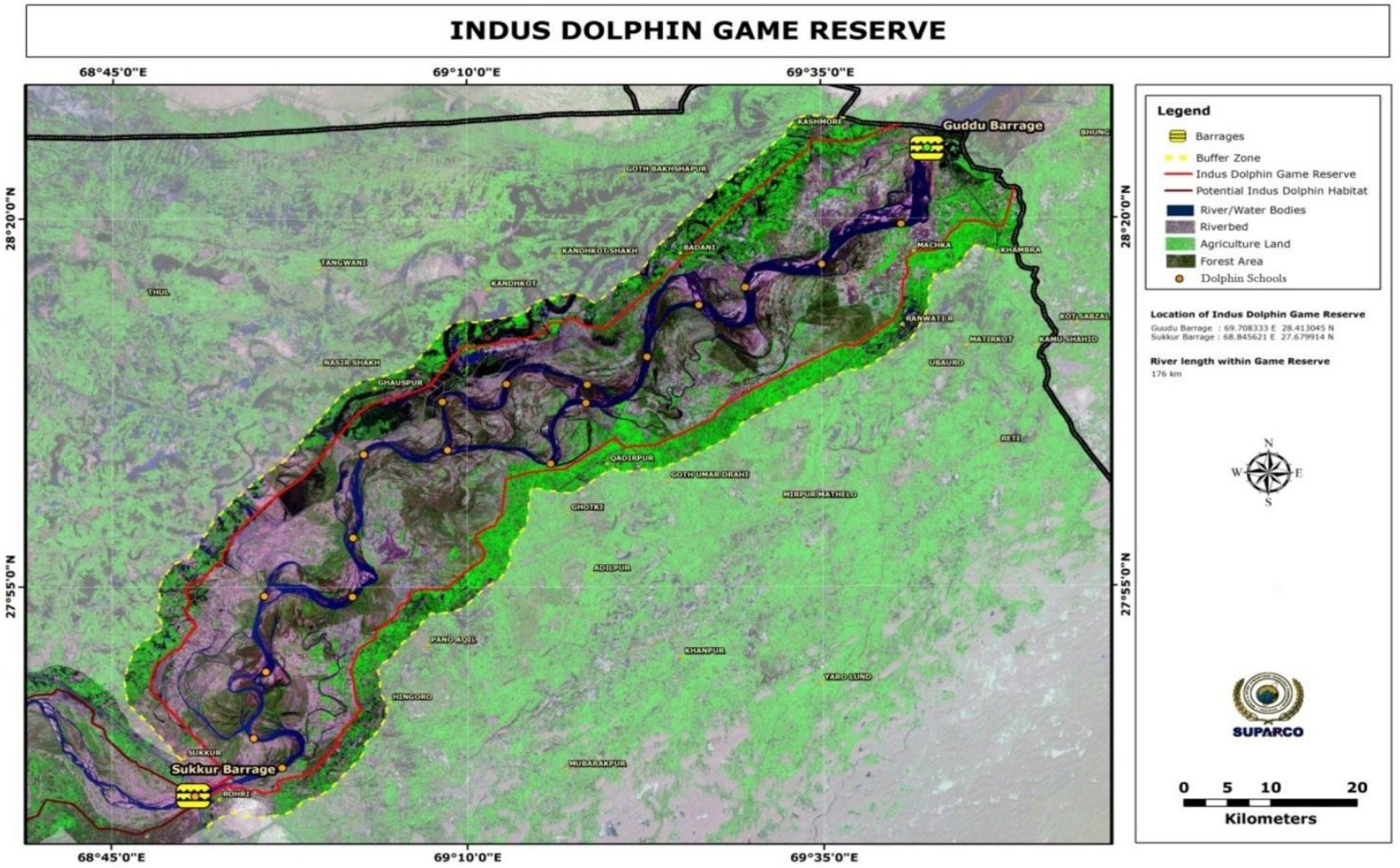
5.2.1.2 Indus Dolphin Game Reserve

A 170 km stretch of the River Indus between two irrigation barrages Guddu and Sukkur is the designated as national protected area for Indus dolphin, and is known as Indus Dolphin Game Reserve[4]. The total area of the reserve is 125,000 ha and has a 3 km buffer zone on the

[4] Government may declare any area to be a game reserve where hunting and shooting of wild animals shall not be

floodplains. This dolphin game reserve was also declared as Ramsar wetland of International Importance in year 2000. According to recent estimates in 2011, the reserve holds a population of 918 dolphins. Whereas in 1975, only 150 dolphins were recorded from this reserve signifying the conservation efforts carried out so far. Location of dolphin game reserve is shown in Figure 5.8.

allowed, except under a special permit, which may specify the maximum number of animals or birds that may be killed or captured and the area and duration for which such permits shall be valid.



Source: Sindh Wildlife Department

Figure 5.8: Indus Dolphin Game Reserve

5.2.1.3 Indus River Dolphin

The Indus Dolphin (*Platanista gangetica minor*) or Bulhan, as it is locally known is an endangered river cetacean that occurs in Pakistan and a recently discovered small population exist in Punjab of India. Other river dolphin species occur in the Yangtze River in China, the Amazon and Orinoco in South America and the Ganges, Brahmaputra and Meghna River System in India, Bangladesh and Nepal.

The Indus River dolphin is a very unusual kind of cetacean. It is thought to have its origin in the ancient Tethys Sea, which dried up around fifty million years ago forcing the dolphin to adapt to its only remaining habitat - the rivers. Living in the turbid waters of the Indus for millions of years has meant that its sight has been replaced by a sophisticated sonar system known as echolocation, which it uses to steer and hunt underwater. This species represents a unique genome, an irreplaceable part of the biodiversity of life on earth.

Habitat Preference of Dolphins

Dolphins are abundant in the long stretches of deep water in association with shallow water meanderings, confluences and mid channel sand bars. The primary habitats preferred by the Indus River dolphins are characterised by an eddy-counter current system in the main river flow caused by a point bar formed from sediments and deposits, a convergent stream branch, or by an upstream meander. They are also found below sand bars and bridges where eddies are formed. Being a mammal, the dolphin can survive a wide range of temperature fluctuations. It can tolerate temperatures as low as 5 °C in the upper reaches of Indus in winter, and as high as 35 °C in the summer in the plains of Sindh. They have also been found in highly turbid water in monsoon and it is thus assumed that the water temperature and turbidity are not significant factors in determining the distribution of this species. Dolphin feeds mostly on fish (particularly on Wallago attu, singari Macrones aor and marakho Catlabuchanani) and invertebrates. It does much of its feeding at or near the bottom, using echolocation, swimming on one side, and probing the river bottom with its snout and its flipper

According to a recent survey conducted by the Sindh Wildlife Department in 2011, from Guddu to Sukkur Barrage total 918 Dolphin were seen in which 804 were mature 47 were the young and 67 were baby. There are more than 18 major schools of dolphin exist at different location between Guddu barrage to Sukkur barrage (Figure 5.8).

Life Cycle

Births of dolphins may take place throughout the year, but appear to peak in July to 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.

Threats

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 in winter, 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 its oil.

5.2.1.4 Reptiles and Amphibians

List of reptiles and amphibians commonly found in and around Indus between Guddu and Sukkur barrages are given in Annex B. These include four species of amphibians, three species

of freshwater turtle, one species of agama (lizard), one species of monitor lizard and ten species of snakes. None of these species are listed in IUCN redlist.

5.2.1.5 Avifauna

River Indus and its associated tributaries provide habitats for both resident and migratory birds. Vegetation on both sides of the river provide ample habitat to forest birds and associated agriculture areas are the source of food for many species. List of birds are given in Annex B.

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.

5.2.1.6 Ichthyofauna

The Indus is home to a number of endemic fishes and here are about 127 species of fresh water fish found in the lower Indus Basin including those inhabiting the estuary of the Indus Delta. 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. List of common fish species are given in Annex B.

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. 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.

5.2.1.7 Invertebrates

Animal species are far more diverse and numerous in inland waters than plants. Apart from fishes, invertebrates form an important group. The important groups include sponges, flatworms, mollusks, polychaete worms, oligochaete worms, crustaceans, insects and numerous parasitic species in various groups. As on land, insects are the most diverse group of organisms in inland waters. Unlike terrestrial fauna, where beetles (Order Coleoptera) are the most diverse, flies (Order Diptera) appear to be by far, the most abundant group in inland waters. Invertebrate diversity of freshwater ecosystems of Pakistan is not properly documented. It is estimated that about five thousand species may exist in inland waters of Pakistan. Two species of freshwater

prawns and two species of insects were observed between Guddu and Sukkur barrages (Annex B).

5.2.2 Flora

5.2.2.1 Natural Vegetation between Guddu and Sukkur barrages

Vegetation data was collected in the entire 170 km river reach between Guddu and Sukkur barrages. The natural vegetation within in the footprints of Guddu barrage mainly consists of 8 species of grasses and herbs. A total of 105 plant species belonging to 81 genera and 36 families have been identified in the right and left bank areas between Guddu and Sukkur barrages. List of these species are given in Annex B. Of them, 15 grass species (Poaceae family) have been identified, which include ground covers, annual to perennial herbs, succulent herbs, sub-shrubs to hardy shrubs to perennial grasses and the trees. This much number of plant species is reflective of the fact that this ecosystem is highly productive. The major plant families which contributed in the formation of vegetation in the area are Poaceae (Grass Family - 14.30%), followed by Asteraceae (7.88%), Fabaceae (6.75%), Mimosaceae (5.70%), Boraginaceae (4.80%), Chenopodiaceae (3.90%) and Amaranthaceae, Capparidaceae, Convolvulaceae, Malvaceae and Nyctaginaceae (2.88%) each. Flora of both sides of the river Indus is dependent on the flow of the river and their frequency increases and decreases according to the water fluctuation in the river.

In addition to Xerophytes, Salt tolerant plant species are also recorded from the area i.e., Halophytes which are equally important in contributing the manifold benefits not only to the environment but also to the masses. All the recorded plant species are very important as far as biodiversity is concerned. The alphabetical checklist of species along their family, life form and habit is provided in Annex B.

There is no aquatic plant species recorded in this area. However, marginal flora is found flourishing quite well. Noteworthy marginal plant species include *Typha angustata* (Pollens of *Typha angustata* are used in a traditional Korean medicine “Silsosangami.” Leaves are used for mating). *Phragmites karka* (Decoction of the root is orally given acts as diuretic and used in kidney, gall bladder’s stones and bleeding piles), *Persicaria glabra*, *Tamarix indica*, *Tamarix dioica* (the leaves form an ingredient of an effective herbal drug, “Icterine” used against jaundice). Both the species of Tamarix are locally referred as Lai. *Polygonum effusum* and *Kohautia retrorsa* have significant economic value and closely associated with the livelihood of the local communities. Bukan Booti Phyla nodiflora is frequently observed creeping branched herb at the margins of the River Indus. It was found dominant not only to downstream but also to upstream region. Its leaves and young shoots are sometimes used in curing indigestion in children; its decoction is considered as cooling agent and used as a demulcent.

5.2.2.2 Riverine Forests between Guddu and Sukkur Barrages

There are no riverine forests near the Guddu barrage area. However, the 170 km river stretch between Guddu and Sukkur barrages (the dolphin game reserve) contains some riverine forests. These forests along river Indus get annual inundation during monsoon. The vegetation in riverine forests is much influenced by the frequent change in erosion and deposition due to changing course of the river Indus. The Riverine Forests have canopy of *Populus euphratica* (Bahan), *Prosopis cineraria* (Kandi), *Acacia nilotica* (Babul), *Tamarix dioica*, *Tamarixindica* (Lai), *Salvadora persica* (Pilu), and *Salvadora oleoides* (Khabbar) etc. Bahan *Populus euphratica* is one of the pioneer indigenous tree species of Pakistan but over the past few years this tree species showed great decline. Shah Belo is the place where Bahan *Populus euphratica* was found dominant. Its wood is used for fuel in Sindh. Kandi *Prosopis cineraria* is a versatile species, providing fodder, fuel, food, timber, and shade, as well as enhancing the fertility of the soil and sand dune stabilization. The flowers are pounded and mixed with sugar, and eaten by

women during pregnancy to safeguard them against miscarriage. The flowers are also valuable in honey production. Babul *Acacia nilotica* is a good soil binder and increases soil fertility through nitrogen fixation. Good quality Babul gum is used in calico-printing and dyeing, as a sizing material for silk and cotton, and in the manufacture of paper. Pods are reported to be effective in urinogenital disorders; the unripe pods are used to make ink, a decoction of the bark is used as a substitute for soap.

In addition to these multi-purpose trees, many other worthwhile small trees / large shrubs are also recorded which includes Acacia jacquemontii, Acacia senegal, Calotropis procera, Capparis decidua, Commiphora stocksiana, Commiphora wightii, Cadaba fruticosa, Cordia gharaf and Euphorbia caducifolia etc. The growth of riverine forests also depends on the flood conditions of the river. The riverine forests in Sindh are under threat from human disturbances due to their conversion in to agricultural and residential lands. Riverine forests are not considered as hotspot for the analysis of project impacts as they were not influenced by the project construction activities and are not located within the project impact area.

5.2.2.3 Medicinal Plants in the Riverine Forests

No medicinal plants are located within the Guddu barrage area. But the riverine forests between Guddu and Sukkur contain some important medicinal plants, which are of high commercial value and over exploited. These are: (i) Cordiagharaf, (ii) Calotropisprocera, (iii) Citrulluscolocynthis, (iv) Daturafistuosa, (v) Solanumalbicaule, (vi) Polygonumeffusum, (vii) Withaniasominifera, (viii) Tribulusterrestris and (ix) Zygophyllum simplex. Some of these species are becoming rare and endangered due to deforestation, overgrazing, over collection and conversion of land due to urbanization. The most serious problem is when plants are uprooted, because their roots are to be utilized in drugs or medicine preparation. The species given in numbers i, ii, iv, v, vii and viii cannot be cultivated as cash crops in the farm lands. The other three species might be economically profitable compared to cash and cereal crops. The growth of medicinal plants depends on the availability of water to the riverine forests. Medicinal plans are not considered as hotspots for the analysis of project impacts as they were not influenced by the project construction activities and are not located within the project impact area.

5.2.3 Planktons

Plankton is made up of animals and plants that either float passively in the water, or possess such limited powers of swimming that they are carried from place to place by the currents. Apart from bacteria, planktonic organisms are the most abundant life form on earth and play a crucial role in the food chain. Without plankton, there would be few living organisms on earth. Planktonic organisms are food for a range of animals. Phytoplankton is the first level of our food chain, followed by the zooplankton, which feeds on the phytoplankton. The zooplankton is then eaten by fish and other crustaceans, which all go on to be eaten by big fish. The food chain continues when these are eaten by mammals. Without plankton, all freshwater and oceans animals would die. Without zooplankton, smaller fish and other crustaceans would have nothing to eat and they would die. In Indus, 61 species of zooplankton and 7 species of Phytoplankton are reported and list of these species are given in Annex B. Composition of phytoplankton is indicative of oligotrophic nature of the water.

5.3 Social and Economic Environment

5.3.1 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. Mud houses or huts are the most common house type (84%) and are built without any planning or consideration of layout. Only 10% houses are built semi pucca and 6% are pucca (bricks or blocks with iron and cement roof). The list of the villages within the project area is given in Table 5.8 and average population of these villages is less than 1,000.

Table 5.8: List of the villages in the Project area

Right Bank Villages	Left Bank Villages
Shakhelo Khan	Farman Ali Mazari
Sher Jan Mazari	Allah Yar Mazari
Abdul Hakim Mazari	Araz Mohammad Mazari
Gul Nawaz Soomro	Allah Bux Mazari
Mohammad Yaqoob	Mohammad Nawaz Malik
Mohammad Alam	Nawaz Khan Mazari
Sakhi Bux Soomro	Mohammad Ponhal Khan
Abdul Rehman Mirani	Piyaro Khan Mazari
Mohammad Sharif	Hazar Khan Dasti
Taj Mohammad Soomro	Noor Hassan Dasti
Mohammad Moosa Khoso	Shabir Ahmed Khan
Mohammad Iqbal Samejo	Haji Nihal Khan
Araz Mohammad Mazari	Wasti Bunda
Mohammad Sharif Mazari	Garhi Dodo
	Akbar Malik
	Mohammad Nawaz Mazari
	Natho Khan Mahar
	Hussain Bux Malik
	Mohammad Hashim Malik
	Arab Kori
	Garhi Khair Mohammad
	Allah Wadhayo Mazari

5.3.2 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 (see Table 5.9). 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.

Table 5.9: Literacy Rate of male and female in the project area

Sr. No Education Level	Male	Female	Total	Percentage
Primary	1384	330	1714	4.58
Middle	274	22	296	0.79
Matric	96	-	96	0.26
Above matriculate	36	-	36	0.10
Sub – Total Educated	1790	352	2142	5.73
Uneducated Adults	14971	17305	32276	86.28
Uneducated Children	1457	1535	2992	7.99
Grand Total	18218	19192	37410	100

Source: Social surveys by the design consultant

5.3.3 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.

5.3.4 Economy and employment

Agriculture is the primary source of income for about 60 percent of the population in the project area. About 11 percent of population own or rent agricultural lands with an average landholding size for the household is about 3 ha. About 50 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 population are: (i) 20 percent working as labourers in non agriculture sector in nearby towns mainly in fertilizer and other factories, (ii) 6 percent employed in government services, mostly in nearby WAPDA's Guddu thermal power plant, (iii) 6 percent own small businesses such as tea stalls and shops, (iv) less than one percent depend on fishing, and (v) 6 percent are working in private sector companies. Average household income of agriculture dependent household is Rs. 10,708 (USD 107) per month (see Table 5.10). 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.

Table 5.10: Average Income Level by Profession

Profession	Average Monthly Income Per Household (Rs)	Average Income Per Capita (Rs./Month)
Farming / Owners	10,708	1,460
Farming / Tenant	7,776	1,099
Commercial (Shop, General Store, Cold Corner, Tea Stall, etc.)	9,913	1,373
Government Service	14,064	1,849
Private Service	8,821	1,199
General Labour	7,817	1,277
Livestock	7,286	1,437
Fishing	7,598	1,125
Total Average	8,475	1,293

Source: Social surveys by the design consultant

5.3.5 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. Majority of the farmers hold between three to four animals. Farmers in the project area generally own high quality breeds. Livestock was the main source of milk, meat and ghee. Livestock was also a source of income as people sell livestock in nearby towns. It was reported that a limited area surrounding the river banks are available for animal grazing. It is the tradition here that the individuals feed their animals by providing fodder/rice straw, wheat straw and also grow fodder crop to feed their animals.

5.3.6 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 mobile phone facilities are available in this area. Access to radio and television is also common. There are no drinking water supply, sewerage and solid waste disposal facilities available. Source of drinking water is mainly shallow bore wells fitted with hand pumps.

5.4 Social and Cultural Aspects

5.4.1 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.

5.4.2 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 thermal power station, due to dacoity and kidnappings.

5.4.3 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.

5.4.4 Physical cultural resources

Districts of Rajanpur and Rahimyar Khan, which are located north of Kashmore district, have rich cultural and historical background with various ancient buildings dating from the Mughal era. However, there are no such sites of historical or archaeological importance located in the project area or in Kashmore district. There are seven mosques and three graveyards located close to the proposed worksites. One graveyard is located adjacent to the right marginal bund.

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 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 criteria and methodology given below.

Impact Magnitude

The potential impacts of the project have been categorized as major, moderate, minor or nominal based on consideration of the parameters such as: i) duration of the impact; ii) spatial extent of the impact; iii) reversibility; iv) likelihood; and v) legal standards and established professional criteria.

The magnitude of potential impacts of the Project has generally been identified according to the categories outlined in Table 6.1.

Table 6.1: Parameters for Determining Magnitude

Parameter	Major	Moderate	Minor	Minimal
Duration of potential impact	Long term (more than 35 years)	Medium Term Lifespan of the project (5 to 15 years)	Limited to construction period	Temporary with no detectable potential impact
Spatial extent of the potential impact	Widespread far beyond project boundaries	Beyond immediate project components, site boundaries or local area	Within project boundary	Specific location within project component or site boundaries with no detectable potential impact

Parameter	Major	Moderate	Minor	Minimal
Reversibility of potential impacts	Potential impact is effectively permanent, requiring considerable intervention to return to baseline	Baseline requires a year or so with some interventions to return to baseline	Baseline returns naturally or with limited intervention within a few months	Baseline remains constant
Legal standards and established professional criteria	Breaches national standards and or international guidelines/obligations	Complies with limits given in national standards but breaches international lender guidelines in one or more parameters	Meets minimum national standard limits or international guidelines	Not applicable
Likelihood of potential impacts occurring	Occurs under typical operating or construction conditions (Certain)	Occurs under worst case (negative impact) or best case (positive impact) operating conditions (Likely)	Occurs under abnormal, exceptional or emergency conditions (occasional)	Unlikely to occur

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. Criteria for determining receptor sensitivity of the Project's potential impacts are outlined in Table 6.2.

Table 6.2: Criteria for Determining Sensitivity

Sensitivity Determination	Definition
Very High	Vulnerable receptor with little or no capacity to absorb proposed changes or minimal opportunities for mitigation.
High	Vulnerable receptor with little or no capacity to absorb proposed changes or limited opportunities for mitigation.
Medium	Vulnerable receptor with some capacity to absorb proposed changes or moderate opportunities for mitigation
Low	Vulnerable receptor with good capacity to absorb proposed changes or/and good opportunities for mitigation

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 6.3.

Table 6.3: 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 6.4.

Table 6.4: 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	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; • Safety training for workers	Minimal

Impact from various activities	Phase	Sensitivity	Magnitude	Significance Prior to Mitigation	Mitigation and Enhancement Measure	Residual Significance
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

6.4.1 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 coffer dams around the canal gates are to be constructed to create a dry work area. If canals are closed, it will severely affect the irrigation, drinking and industrial needs of the command area. This impact is characterized as Moderate Adverse, as shown in Table 6.4.

Mitigation

In this project, an approach using bulkhead gates and construction through barges 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. Hence with the proposed construction approach the residual impact will be reduced to minimal.

6.4.2 Impact on river water quality in dolphin game reserve

Downstream of the barrage area is a designated 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. This impact is characterized as Major Adverse, as shown in Table 6.4.

Mitigation

Following mitigation measures will be carried out by the contractor to minimize the impacts on river water quality in dolphin game reserve.

- 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. The contractor shall include training in the use of this equipment within his training plan and carryout regular drills in the deployment of this equipment
- 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.
- Large quantities of water shall collect in the hull of barges, and boats. The contractor shall be prohibited from bailing or pumping this water into the river, but instead shall be required to collect the bilge water, treat it by separation and dispose of the separated oil and fuel as hazardous waste
- All waterborne plant shall be regularly serviced as per the manufacturer's guidelines and be inspected daily prior to operation.
- Refuelling of barges and boats will be properly carried out to avoid any spills. Refuelling of boats will be done on shore. Spill kits and other absorbent material will be made available at refuelling points on the barges.

With these mitigation measures, the adverse impacts with risk of water pollution have been assessed as minimal.

6.4.3 Impacts on river habitat

Strengthening and rising of river training works, mainly from the construction of spur, and construction of a spur may generate sediment load in the river. Erosion from the construction works and material storage sites also increases the sediment load to the river. Sediment concentrations above natural levels can cause mortality of plankton 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. This impact is characterized as Major Adverse, as given in Table 6.4.

Mitigation

Following mitigation measures will be carried to minimize the impacts on river water quality in dolphin game reserve.

- The contractor will provide silt fences, sediment barriers or other devices 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 material storage sites, 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.
- Contractor will comply with ECP on soil erosion and sediment control.

With the above mitigation measures, the adverse impacts with risk of water pollution have been assessed as minimal.

6.4.4 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 1m) 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 in generally in the range of 170 to 185 dB at a distance of 10m, while impact hammers produce noise levels in the range of 205 to 220 dB at a distance of 10m. Vibratory hammers will be used in the project due to presence of deep alluvial deposits in the river bed. 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[5]. This impact is characterized as Major Adverse, as given in Table 6.4.

Mitigation

Mitigation measures to reduce noise levels from piling and to minimize the impacts on dolphins include:

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

- 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.,
- 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;
- Piling work will adopt a 'soft start'; using a low energy start to the piling operations to give dolphins an opportunity to leave the area, gradually ramp up the sound levels to scare the dolphins and other cetaceans away before piling commences,
- Contractor will use pingers upstream and downstream to chase away dolphins,
- Piling will be avoided in main calving period, which is July to August; and
- Monitoring of underwater noise levels, and use of bubble curtains around the pile if required to reduce the noise levels.
- The contractor will hire a qualified ecologist for implementing the above mitigation measures and monitoring of impacts on dolphins

With the above mitigation measures, the adverse impacts of underwater noise pollution on dolphin have been assessed as minimal.

6.4.5 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 pocket 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. This impact is characterized as Moderate Adverse, as given in Table 6.4.

Mitigation

Following mitigation measures will be adopted to avoid the risk of collisions

- The boat movement on the downstream of the barrage will be limited to the construction related activities of the left pocket divide wall. Otherwise all the boat movement will be on the upstream side of the barrage only.
- Boat movement on the downstream of the barrage will be restricted to within 500 m.
- Restrict motor boats speed within 15 km/h in accordance with best international practices followed in the North America
- Pingers will also be used to chase away dolphins from the construction areas.

With the above mitigation measures, the adverse impacts with risk of dolphin collision have been assessed as minimal.

6.4.6 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. This impact is characterized as Moderate Adverse as given in Table 6.4.

Mitigation

Following mitigation measures will be adopted to compensate the loss of vegetation and mitigate impacts associated with clearance of vegetation

- Vegetation clearance shall be limited to the extent required for execution of works. Care will be taken to make sure bird habitats are not destroyed. If there is no option available, rehabilitate them in other neighbouring trees. Also protect and rehabilitate injured or orphaned birds. The contractor is required to hire a qualified ecologist to carry out a nest survey before vegetation removal.
- Tree planation will be carried out in the colony and other suitable areas near the river training works at a ratio of 5 new trees per each tree cut.
- Plantation will be developed only with indigenous species.
- Landscaping of colony is recommended with the native species
- Contractor will follow ECPs 12 and 13 on Protection of Flora and Fauna while tree cutting

With the above mitigation measures, the adverse impacts tree cutting has been assessed as minimal.

6.4.7 Disposal of barrage gates

Each barrage gate weighs about 50 t and replacement of all barrage gates and regulators will 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. Improper disposal of these huge waste materials occupy lot of land and create soil and water pollution. This impact is characterized as Moderate Adverse, as given in Table 6.4.

Mitigation

The project authorities will sell all the scrap material 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 this waste material will be disposed at the site. With implementation of these two mitigation measures, the residual impact has been assessed as minimal.

6.4.8 Increased traffic on 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 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. This impact is characterized as Major Adverse, as given in Table 6.4.

Mitigation

The following mitigation measures will be employed to minimize the traffic related impacts:

- Transportation of gates via barge shall be carried out instead of using trucks on the barrage itself to minimize disruption and need for road closure
- Closure of road crossing barrage shall not be permitted without prior approval from the Engineer
- Approval for road closure shall only be permitted between 7pm and 7am and following prior announcement of closure
- Blockage of local roads and routes will be minimized. If unavoidable, consultation with the affected communities will be carried out and alternate routes identified.
- With the exception of road closure on the barrage (which is not permitted), traffic by-pass will be allowed in the event of road closure to prevent hindrance to traffic on public roads
- Requests for closure of public roads must be made in advance to the relevant authority (highways department or local authority)
- 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.

With the implementation of above mitigation measures, the residual impact on traffic has been assessed as minor adverse.

6.4.9 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. This impact is characterized as Moderate Adverse, as given in Table 6.4.

Mitigation

The following mitigation measures will be implemented:

- Contractor will prepare and implement a Pollution Prevention Plan prior to the start of the work. Proper baseline data will be collected.
- Contractor will be required to implement the measures prescribed in the Environmental Code of Practices (ECP), which will be included in the contracts. Detailed ECPs are included in the Annex D.
- Contractor will be required to take appropriate measures to avoid and contain any spillage and pollution of the soil and water resources both upstream and downstream of the barrage.
- Permanent and regular monitoring will be carried out.
- Implement ECP 2: Fuels and Hazardous Goods Management
- Contractor to confine the contaminants immediately after such accidental spillage
- Contractor to collect contaminated soils, treat and dispose them in environment friendly manner
- All areas intended for storage of hazardous materials to be quarantined and provided with adequate facilities to combat emergency situations complying all the applicable statutory stipulation

With the implementation of above mitigation measures, the residual impact on risk of soil and water pollution has been assessed as minimal.

6.4.10 Noise and air pollution from construction works and traffic

Air 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 river training works, 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. This impact is characterized as Moderate Adverse, as given in Table 6.4.

Mitigation

The following mitigation measures will be implemented:

- 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 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).
- Contractor will be required to implement the measures prescribed in the Environmental Code of Practices (ECP), which will be included in the contracts. Detailed ECPs are included in the Annex D. ECPs 10 and 11 cover Air Quality and Noise Management
- Construction activities near the settlements will be limited to day time only. High noise producing equipment will be provided with mufflers or acoustic enclosures.

With the implementation of above mitigation measures, the residual impact on noise and air pollution has been assessed as minimal.

6.4.11 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 will be affected due to movement of construction traffic; noise generated from construction activities, 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, the project is not expected to have any impacts on these two threatened species. If any construction activities disturb their roosting, hunting and feeding grounds, they move to another lesser or undisturbed areas without any difficulty. People do not hunt or poach these two species of birds because they do not have any food or economic values. The presence of avifauna in the project area will increase during the winter months, with the arrival of migratory birds. This impact of the project on overall avifauna is characterized as Moderate Adverse as given in Table 6.4.

Mitigations

The following mitigation measures will be implemented:

- The Contractor will introduce and enforce a Code of Conduct and raise awareness about the protection of birds among the work force to reduce impacts such as disturbance and poaching.

- 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.
- Biodiversity monitoring is proposed quarterly within the project area to monitor the status of avifauna in the project area and the impacts of habitat loss. If any of the threatened species are in the project area during the monitoring, it will be informed to the contractor and workers for not disturbing these birds.

- Contractor will be required to recruit a qualified ecologist to implement the mitigation measures and monitor the impacts on birds
  - Contractor will Implement ECPs Protection of Flora, Fauna, and Fisheries by banning hunting, poaching, fishing and trapping of all fauna by all project personnel. ECPs are provided in Annex D.
  - Contractor will minimize dust and noise pollution from the construction activities by implementing relevant ECPs.

With the implementation of above mitigation measures, the residual impact on birds has been assessed as minimal.

6.4.12 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. This impact is characterized as Moderate Adverse, as given in Table 6.4.

Mitigation

The following mitigation measures will be implemented:

- Contractor will prepare and implement solid waste collection and disposal plan
- The contractor will identify suitable sites for disposal of hazardous and non- hazardous waste. The selection will be done in consultation with the PMO and the local municipal authorities.
- The contractor will use the debris generated from the dismantling of existing buildings for embankment protection if suitable.
- Protocols and measures prescribed in the ECPs (Annex D) on the management of solid and hazardous waste will be implemented.
- Contractor to develop and undertake construction waste management strategy for both hazardous and non-hazardous wastes separately.
- Siting of any fuel and hazardous material storage sites, including refuelling 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.

With the implementation of above mitigation measures, the residual impact on solid waste has been assessed as minimal.

6.4.13 Impact from borrow and quarry activities

Strengthening of river training works and construction of colony and left pocket divide wall require huge quantities of stone, aggregates and earth fill. 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. About 2 million m^3 of

earth fill will be required the training works. Improper siting and extraction of these construction materials will have significant impacts on physical and biological environment on the quarry and borrow areas. This impact is characterized as Moderate Adverse as given in Table 6.4.

Mitigation Measures

The following mitigation measures will be implemented:

- 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.
- Borrow areas will be developed within the barrage area (areas between upstream marginal bunds of the barrage) for extraction of earth material for river training works. 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. 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.
- No private lands or agriculture lands will be used for borrowing.
- The borrow areas will be approved by PMO before development. The contractor will prepare borrow area management and restoration plan for PMO approval.
- Minimize volume of borrow material by reusing material excavated elsewhere in the project
- Photographs recorded of each borrow area showing pre-construction baseline for comparison with after rehabilitation
- If borrow areas are located in the dry areas or outside the marginal bunds, the contractor will implement ECPs (Annex D) to restore and landscaping of the borrow areas.

With the implementation of above mitigation measures, the residual impact on borrow sites has been assessed as minimal.

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.

6.5.1 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. The sites will be properly decommissioned after completion of construction works before handing over to the owner.

6.5.2 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. All these new opportunities for work for local residents could boost employment and improve the social and economic position of the population. This will be a major and

significant positive impact of the project. This impact has been assessed as Moderate Beneficial, as shown in Table 6.4. Populations in project and command areas will be notified these opportunities, as described in the communication strategy in SMF.

6.5.3 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. This impact has been assessed as Moderate Beneficial, as shown in Table 6.4.

6.5.4 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. This impact has been assessed as Major Adverse, as shown in Table 6.4.

Mitigation

The following mitigation measures will be implemented:

- Contractor will develop a traffic management plan in compliance with ECP on traffic management
- The Traffic Management Plan will be implemented with 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 in the colony will have appropriate medical services to treat emergency cases and trauma patients.
- Ensure that all construction vehicles observe speed limits on the construction sites and on public roads
- Provide adequate signage, barriers, and flag persons for traffic control.
- Fit audible warning devices in vehicles to alert during reversing

With the implementation of above mitigation measures, the residual impact on traffic safety has been assessed as minimal.

6.5.5 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. The impact has been assessed as Moderate Adverse, as shown in Table 6.4.

Mitigation

The following mitigation measures will be implemented:

- 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 will be prevented by raising awareness and implementing a Code of Conduct for the workers. The Contractor shall develop a Worker Code of Conduct to govern the behaviour of workers on site, in camps, and in local communities.

- The contractor shall employ a Community Liaison Officer who shall be responsible for the preparation and implementation of a Communication Strategy. This strategy shall detail stakeholders, their information, disclosure, and consultation and participation requirements and shall aim to ensure relevant stakeholders are pre-warned of any activities on site which may result in their disturbance. The Communication Strategy will define a process for receiving, recording and responding to complaints and also monitoring of the success of any responsive action taken.
- In addition, complaints register shall be set up at the Contractor's and Engineer's offices to record any complaints received during the implementation of the works. The contractor will implement ECP on cultural and religious issues (Annex D).
- 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

With the implementation of above mitigation measures, the residual impact has been assessed as minimal.

6.5.6 Increased risk of accidents for workers

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 from the barges and boats and divers are particularly in risk if there is no proper safety protocols are in place Construction activities also pose safety hazards for the site staff. This impact has been assessed as Major Adverse, as shown in Table 6.4.

Mitigation

The following mitigation measures will be implemented:

- Occupational health and safety procedures will be enforced at site. Each contractor will be required to prepare, obtain approval of, and implement an occupational health and safety (OHS) plan. These plans will be prepared in compliance with the ECPs (Annex D) and World Bank Group's Environment, Health, and Safety (EHS) Guidelines. [6]
- Water borne construction workers and divers will be adequately trained and provided with proper personal protection equipment (PPE) before putting them in to work. Frequent supervision will be carried out by supervision consultants to ensure they are wearing proper PPE at all times.
- Contractor OHS plan describe the tasks and methods to be used by workers associated with water borne construction and diving operation, and how to perform them safely and state how potential hazards are identified and handled. Contractor will ensure that the construction workers associated with these works are adequately informed about the OHS plan. Emergency response mechanism will be put in place for to rescue workers from drowning and providing immediate treatment to the injured workers
- Special attention will be focused on safety training for workers to prevent and restrict accidents and on the knowledge how to deal with emergencies.
- Road signage will be fixed at appropriate locations to reduce safety hazard associated with project-related vehicular traffic.
- Liaison with traffic police will be maintained
- Project drivers will be trained on defensive driving.

[6] Download EHS Guidelines: http://www.ifc.org/wps/wcm/connect/554e8d80488658e4b76af76a6515bb18/Final+-+General+EHS+Guidelines.pdf?MOD=AJPERES

- Vehicle speeds near / within the communities will be kept low, to avoid safety hazards.
- The communication strategy complements awareness raising and information dissemination.

With the implementation of above mitigation measures, the residual impact has on workers' health and safety has been assessed as minimal.

6.5.7 Security risks for construction workers

Due to tribal feuds in the project area, the contractor's personnel can be mistaken as members as rival tribes and could be attacked by local community. If not properly managed, conflicts arising as a result of community disturbance and/or in-migration may escalate into violence, led by criminal elements. The impact has been assessed as Major Adverse, as shown in Table 6.4.

Mitigation

The following mitigation measures will be implemented:

- The main mitigation for this impact is the preparation and implementation of the contractor's Communication plan. This plan shall focus on early and continued consultation by the contractor with influential figures within the project area, especially those within the Mazari tribe. Consultation with landlords and politicians were commenced by the design consultants in late 2013, and the Contractor's strategy will seek to build upon consultations with these landlords, who expressed their approval for the project and desire to open a dialogue with the contractor.
- The Communication plan shall also include plan for ongoing consultation in local languages within project affected communities. As for the landlord consultations, the aim of these meetings will be to raise awareness amongst the local community of upcoming activities, and for community members to feedback any concerns or suggestions.
- 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. Cards shall also be issued to all sub-contracted staff and the Engineers' staff active in the project area. The issue of identity cards shall be strictly controlled by the contractor, and following termination/completion of staff contract the identity card shall be destroyed.
- Sindhi speaking staff must be available at all active work sites at all times in order to communicate with the local community.
- All camp sites must be secured with perimeter fences preventing any unauthorised access to the camp(s). Access to the camps must be controlled through gated entrances and entrance and exit logs shall be maintained at each gate. Access shall be restricted to project staff holding valid identity cards only. The SID will provide support to the contractor and Engineer in arranging government security personnel for their camps and the project site.
- Should the contractor chose to engage his own security companies, the contractor shall be responsible to ensure such companies or personnel do not have a history of past abuse and that personnel are trained in the use of force and in the applicable laws so that no contravention of national legislation takes place. The contractor shall provide training to security personnel using the guiding principle that force shall not be used except in defence and in proportion with the nature and extent of the threat.
- Finally, the contractor's emergency response plan shall be required to include details of emergency evacuation of the camp site in the event of an emergency and be supplemented by annual drills.

With the implementation of above mitigation measures, the residual impact has on workers security has been assessed as minimal.

6.6 Environmental Impacts during Operation and Maintenance

6.6.1 Risk of barrage failure by floods and earth quake and emergency preparedness plan

Failure of a section of the barrage or its river training structures from earth quakes or floods 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.

Mitigation

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.

6.6.2 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. Climate change is also expected to increase extreme precipitation events in Sindh. It is expected that Sindh will receive heavier than normal rainfall during the monsoon season. 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 Sindh province, particularly the Indus Delta is the most vulnerable area to the impacts of climate change. Some of them are enumerated below[7]:

- Reduced productivity of crops and livestock due to heat stress and other adverse impacts of change in climate parameters;
- Increased requirements of irrigation water due to higher evapotranspiration at elevated temperatures; while less water will be available.
- Uncertainty to timely availability of irrigation water caused by changes in river flows due to glacier melting and altered precipitation pattern;
- shortage of irrigation water due to inadequate storage capacity;
- Erratic and uncertain rainfall patterns affecting particularly the rain-fed agriculture;
- Increased frequency and intensity of extreme climate events such as floods, drought and cyclones resulting in heavy damages to both crops and livestock;
- Abundance of insects, pests and pathogens in warmer and more humid environment, particularly after heavy rains and floods;
- Degradation of rangeland and further deterioration of the already degraded cultivated land areas such as those suffering from water erosion, wind erosion, water-logging, salinity etc;
- Intrusion of sea water into deltaic region affecting coastal agriculture, forestry and biodiversity;
- Lack of technical capacity to predict with reasonable certainty the expected changes in climatic parameters such as temperature, precipitation, extreme events etc.; and

[7] Pakistan Meteorological Department, 2012. Climate Change in Pakistan Focused on Sindh Province

- Low adaptive capacity to adverse climate change impacts.

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 and the river stretch between the two barrages is a protected area for dolphin, an ecologically sensitive area. If the impacts of the proposed rehabilitation are considered individually for each barrage, they are mostly construction related and temporary in nature, but these impacts may be significant and long term when evaluated in the context of the combined effects of all the existing barrages and proposed rehabilitation works. The objective of the current cumulative impact assessment (CIA) is to evaluate these combined impacts.

Generally the focus of cumulative impacts of the barrages on Indus will mainly lead to the impacts on Indus delta and need for release of environmental flows below Kotri barrage. The overall impacts of Indus Basin Irrigation System (IBIS) on the downstream of Kotri barrage 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 most significant valued environmental components (VECs) related to the barrages in Sindh are identified as dolphins, fish migration and irrigation, and are considered for the current CIA study. Significance of these VECs is described in Section 7.3.2.

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 (Figure 7.1). A Water Apportionment Accord (WAA) was signed by the four provinces of Pakistan in 1991 to make an equitable distribution of Indus flows. 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 with the WAA. The WAA was based on the following parameters:

- Water entitlements were based on existing use of water that is actual average system uses for the period 1977 to 1982 where the ten daily uses would be adjusted pro-rata to correspond the indicated seasonal allocations of the different canal systems and would form the basis for sharing shortages and surpluses.
- An automatic process for adjusting entitlements depending on availability was specified where the ten daily uses would be adjusted pro-rata to correspond the indicated seasonal allocations of the different canal systems and would form the basis for sharing shortages and surpluses.
- Provinces were allowed to use their allocation in any way that they want where no restrictions would be placed on the provinces to undertake new projects within their agreed shares and the provinces will have the freedom within their allocations to modify system-wide and period-wise uses.
- The Accord implied that in major parts of the IBIS, there are, in fact, well-defined entitlements at all levels, from the international, through the interprovincial, down to canal commands, distributaries, outlets, and ultimately to each farmer on a water course.

Consensus on the Minimum Required Escapages below Kotri: IRSA has appointed a team[8] in 2005 to review the minimum required environmental flows released downstream of the Kotri

[8] 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.

barrage. The following aspects were considered to justify the need 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, and (v) prevention of salinity accumulation in Indus Basin.

Recommendations for Escapage (environmental flow) below Kotri: The above review has recommended an escapage of 5,000 cusec (142 cumec or 0.3 MAF at Kotri) at Kotri Barrage 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 Indus flows to various barrages is the responsibility of IRSA and federal 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 a number of projects to address some of these issues including:

(a) Sindh Water Sector Improvement Project: 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 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: Under the Sindh Water Sector Improvement Project (WSIP) through the World Bank financing, the Government of Sindh has been prepared 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 remedial measures for any outstanding deficiencies in the left bank outfall drain system. Other measures include retention and/or safe disposal of drainage, storm and flood water; and improvements 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.

(Fernando, J G et. al. (2005) Review of Studies on Water Escapages below Kotri Barrage, Final Report of IPOE, Delft, the Netherlands).

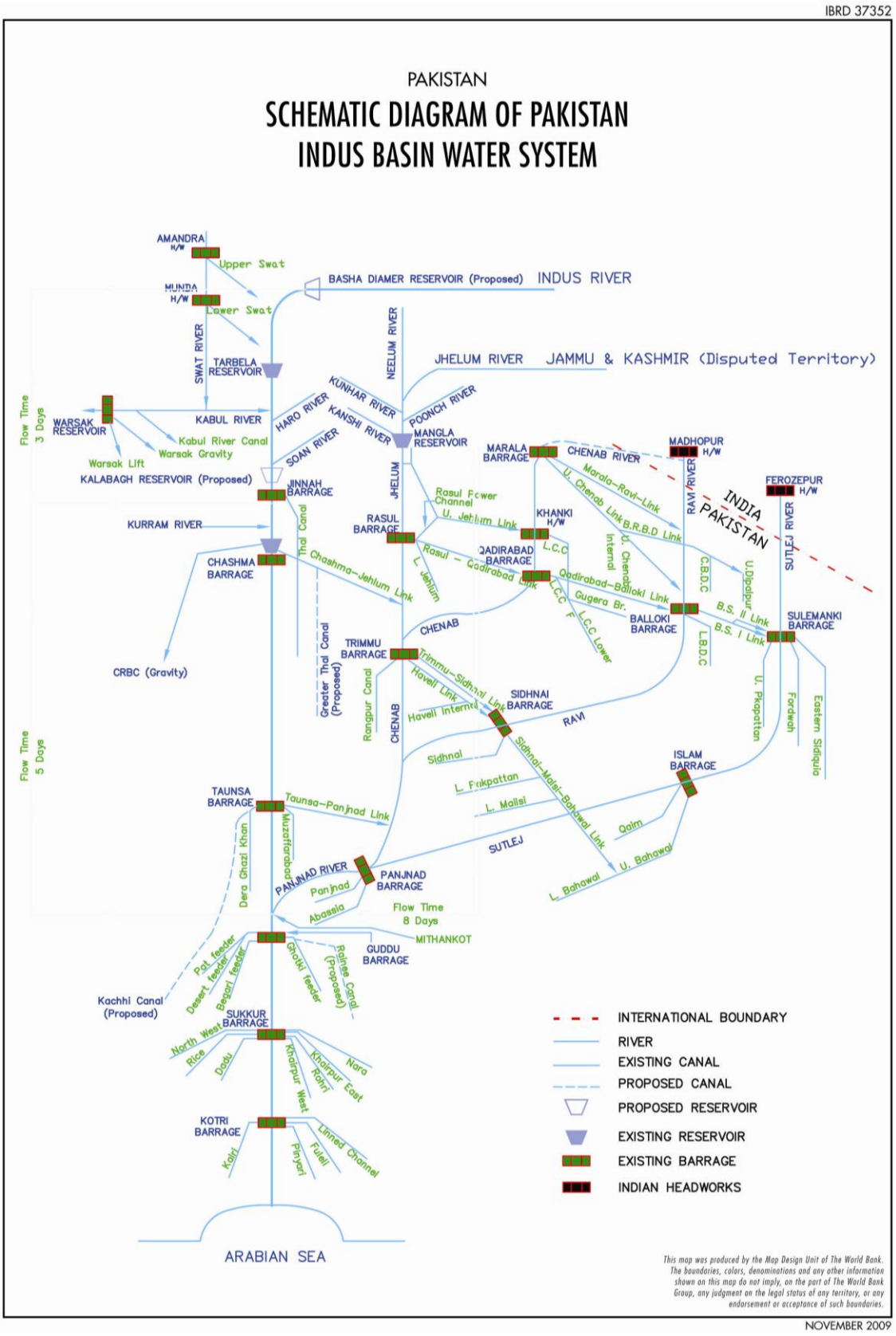


Figure 7.1: The Indus Basin Water System

(d) Sindh Coastal Area Development: Community organizations have been implementing the Sindh Coastal Area Development program under the World Bank financing through 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 destroying the livelihoods and impacting widespread poverty and vulnerability.

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

7.3.1 Study Boundaries

In the context of Guddu barrage, the spatial boundaries of cumulative impact assessment (CIA) 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 in Sindh, 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. Locations of these three barrages are shown in Figure 7.1. Salient features of Sukkur and Kotri barrages are presented below.

Sukkur Barrage: Sukkur Barrage was commissioned in 1932 and it is the world's largest single unified irrigation network consisting of 9,923 km, feeding an irrigation system, with more than 3.05 million ha of command area. Sukkur Barrage was the first barrage constructed on Indus River with a design discharge of 42,475 cumec. The total length of the barrage is 2.91 km, it has 66 spans with 18m length each, and each span has a gate weighing 50 t. The feasibility study for the planned rehabilitation of Sukkur Barrage is currently underway. The stretch of Indus between Guddu and Sukkur Barrages forms the Dolphin Reserve. The barrage has no fish passes. There is a need for rehabilitation of the Sukkur barrage mainly due to expiry of useful life of barrage gates and canal head regulators.

Kotri Barrage: Kotri Barrage was commissioned in 1955. Kotri Barrage is used to control water flow in the River Indus for irrigation and flood control purposes. The barrage has a design discharge of 21,238 cumec. It is a gate-controlled weir type barrage with a navigation lock. The barrage has 44 spans, each 18 m length with a total length of 1,600 m. The maximum flood level height of Kotri Barrage is 13.14 m. It feeds Fulleli, Pinyari, Akram Wah, and Kalri Baghar Feeder

Canals and serving a command area of 1.14 million ha. The barrage has two fish passes. Kotri barrage was rehabilitated recently.

7.3.2 Identification of VECs for the CIA

Based on consultations with various stakeholders, three valued environmental components (VECs) are identified for the CIA study. These VECs and their significance are described below:

- **Dolphins**: Before construction of barrages on Indus, Dolphins are reported to inhabit entire Indus basin. Construction of barrages and diversion of water for irrigation has resulted into fragmentation of dolphins' habitat and finally extirpation of dolphins in many river sections of Indus and its tributaries. Currently dolphin population is limited to lower Indus in Sindh with river reach between Guddu and Sukkur is a protected area for dolphin.
- **Fish migration**: Before construction of barrages in Sindh, hilsa is reported to migrate from sea to Indus to a distance of more than 1,000 km up to Multan in Punjab. After construction of barrages in Indus, the hilsa migration is restricted to Kotri barrage, 300 km from the sea. This has drastically reduced the commercially important hilsa fish catch and its spawning area.
- **Irrigation**: Before construction of barrages, some parts of Sindh were irrigated by traditional inundation canal system, which generally provide uncertain and precarious supplies during crucial sowing and maturity periods. Due to low precipitation and saline groundwater, irrigation is the only source of water for irrigation in Sindh. Construction of barrages have transformed the arid barren lands of Sindh in to vast agricultural lands and brought significant socioeconomic benefits to Sindh.

7.4 Dolphin Habitat Fragmentation

7.4.1 Historical Range decline

The distribution of dolphin (*Platanista gangetica minor*) in Indus was first documented in 1870's, (just prior to the construction of the first major barrage) and at that time the dolphin inhabited the entire lower Indus River system from the delta with the Arabian Sea, to the foothills of the Himalayas.[9] The construction of several irrigation barrages between 1886 and 1971 fragmented the dolphins' historical range into 17 river sections (numbered 1 to 17 on Figure 7.2). A recent study[10] assessed the habitat fragmentation and dolphins' extirpation in the Indus River system. The study collected historical dolphin sightings for all river sections formerly occupied by dolphins except at for the area downstream of Kotri Barrage to the delta and the stretch from Harike to Hussainiwala barrage, which is close to the India-Pakistan border. Figure 7.2 shows the rivers and barrages, river sections with a number and color coded according to whether river dolphins are extant, or the approximate date that they were extirpated. By the early 1990's, Indus dolphins had undergone an 80% reduction in range, having been extirpated from the upper and lower reaches of the Indus and four of the largest tributaries.[11] They are now confined

[9] Anderson, J. (1879). Anatomical and Zoological Researches: Comprising an Account of Zoological Results of the Two Expeditions to Western Yunnan in 1868 and 1875; and a Monograph of the Two Cetacean Genera, Platanista and Orcella. Bernard Quaritch, London, UK.

[10] Braulik GT, Arshad M, Noureen U, Northridge SP (2014). Habitat Fragmentation and Species Extirpation in Freshwater Ecosystems; Causes of Range Decline of the Indus River Dolphin (Platanista gangetica minor). PLoS ONE 9(7): e101657. doi:10.1371/journal.pone.0101657

[11] Reeves RR, Chaudhry AA, Khalid U (1991). Competing for water on the Indus Plain: Is there a future for Pakistan's river dolphins? Environmental Conservation 18: 341–349.

to five contiguous 'river sections' on the Indus mainstream in Pakistan, separated by barrages,[12] and in the Beas River in India[13].

7.4.2 Recent Baseline

The surveys of entire Indus subspecies of dolphin were carried out in 2001 and 2006 using identical survey methods. The estimated population of dolphins was 924 and 1,406 in 2001 and the 2006 surveys, respectively.[14] The largest subpopulation, more than 80% of the total in 2001 and 90% of the total in 2006, is concentrated in the Dolphin Game Reserve between the Guddu and Sukkur Barrages, at the downstream end of the subspecies' range. The next major population is located between Chashma and Taunsa barrages. The most recent counts conducted by Sindh Wildlife Department in 2011 found 918 dolphins between Guddu and Sukkur Barrages and 29 between Sukkur and Kotri barrages.[15]. Dolphin's counts from these three studies are presented in Table 7.1.

Upstream subpopulations may lose individuals downstream if dolphins move through barrage gates when they are open in the wet season. Individuals are unlikely to move upstream through a barrage because of strong downstream hydraulic forces at the gates. While there have been no direct observations of dolphins moving through a barrage, they often swim through regulator gates into irrigation canals, which, although smaller, present a similar obstacle.[16] Encounter rates in the farthest downstream subpopulation (between Guddu and Sukkur Barrages) are very high (about 5 dolphins/km), approaching three and half times those recorded in similar surveys elsewhere for Platanista dolphins.[17]

Table 7.1: Comparison of direct counts of dolphin recorded in 2001 and 2006

Subpopulation	2001	2006	2011[c]
Jinnah to Chashma	2	1	-
Chashma to Taunsa	84	82	-
Taunsa to Ghazi Ghat	45	44	-
Guddu to Sukkur	775[a]	1,275	918
Sukkur to Kotri	18	4[b]	29
Total	**924**	**1,406**	**947**

[a] *In 2001, 602 dolphins were counted, and after extrapolation of a conservative mean encounter rate (3.6/km) to an unsurveyed 33.3 km segment, 725 were estimated (Braulik 2006). As the unsurveyed segment was in a very high density area, application of the encounter rate from adjacent channels (5.0/km) is more realistic and we therefore applied this to generate a revised estimate of 775 animals in 2001 in this subpopulation.*

[b] *The whole Sukkur to Kotri subpopulation was not surveyed in 2006, so figures cannot be directly compared between years.*

[c] *Different survey method was used and only in rivers sections from Guddu to Kotri barrages*.

[12] Braulik GT (2006) Status assessment of the Indus River dolphin, Platanista gangetica minor, March-April 2001. Biological Conservation 129: 579–590.

[13] Behera SK, Nawab A, Rajkumar B (2008) Preliminary investigations confirming the occurrence of Indus River dolphin Platanista gangetica minor in River Beas, Punjab, India. Journal of the Bombay Natural History Society 105: 90–126.

[14] Braulik, G. T., Bhatti, Z. I., Ehsan, T., Hussain, B. (2012). Robust abundance estimate for endangered river dolphin subspecies in South Asia. Endangered Species Research, Vol. 17: 201–215.

[15] Sindh Wildlife Department and Global Environmental Management Services (2012); Baseline Study of Indus Dolphin Guddu to Sukkur Barrage and Sukkur to Kotri Barrage.

[16] Braulik, G.T. 2002. Entrapment of Indus Dolphins (Platanista minor) in irrigation canals: incidence, implications and solutions. International Whaling Commission, Scientific Committee Document SC/52/SM9, Cambridge, UK.

[17] Braulik, G.T. 2003. Indus dolphin conservation project. Comprehensive survey and status report. March-April, 2001. Report for the World Wide Fund for Nature – Pakistan, PO Box 5160, Ferozepur Road, Lahore, 54600, Pakistan.

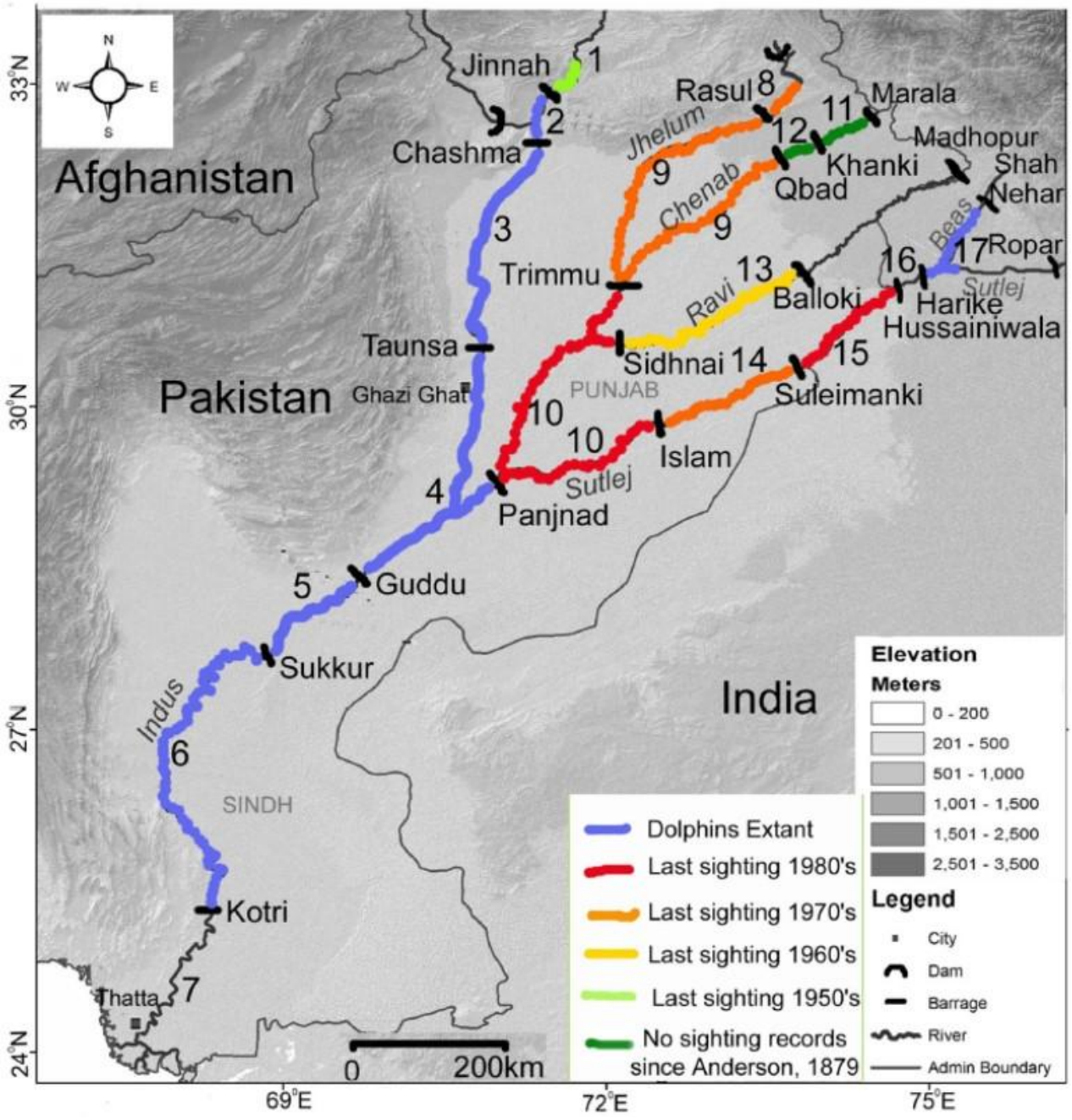


Figure 7.2: Lower Indus River system, barrages, time of river dolphins extant and extirpated[10]

7.4.3 Cumulative Effects

7.4.3.1 Habitat Fragmentation by Barrages

The occurrences of Indus dolphin consistently decreased in the upstream ranges from approximately 3,400 km of the main channel and its tributaries in the 1870s[9] to approximately 1,000 km of the main channel today. An estimated 99% of the Indus dolphin population occurs in only 690 linear km, corresponding to an 80% reduction in the area of occupancy. The study conducted by *Braulic et.al.*,[10] concluded that there is a strong relationship between low dry season river discharge and the decline of the Indus dolphin. Where dolphins are still extant the median monthly dry season river discharge averaged 873 cumec (ranged 205–1,332 cumec), as

compared to an average of 227 cumec (range 0–1,076 cumec) in locations from which dolphins have been extirpated.[10] In general, river stretches where dolphins are still present were fragmented by barrages later, are farther from the range periphery, are of longer length, have a shallower slope and greater dry season discharge compared to those river stretches where dolphins are no longer present. Reduced discharge of Indus River directly affects dolphins by reducing the living space available to them, reducing average water velocity and depth and increasing water temperatures.

7.4.3.2 Consequence of Fragmentation

The consequence of fragmentation of dolphin habitats is very severe, out of seventeen stretches of Indus River system except six, dolphin has been extirpated. The persistence of dolphins in the Beas River, India (Figure 7.2) is likely to be due to the presence of constant water supplies little depleted by diversions. Dolphins in the Beas River occur in an isolated fragmented habitat as the river downstream is virtually dry, and only connected with the rest of the river system for a few weeks each year during the monsoon floods. The persistence of Beas River dolphin demonstrates that in the presence of sufficient water, and in the absence of other threats, river dolphins can persist for decades even in relatively small fragments of habitat near the periphery of their range. Based on the historical pattern of decline, Indus dolphins are most likely to disappear in the future from locations with low river discharge located closer to the range periphery, meaning that dolphins in the Beas (close to range periphery with moderate discharge) and between Sukkur and Kotri Barrages (with low discharge, located in a moderate distance from the former range edge) are most at risk. In addition, the altered hydrological regime on the Indus River has likely reduced the complexity of hydrologic and geomorphologic habitat and ultimately also diminished its carrying capacity and ability to support large numbers of dolphins.

The principal characteristics for declining or threatening a species are the contraction of geographic range. Populations occupy less favourable habitat and occur at lower and more variable densities at the periphery of a species geographic range. Therefore, when a species becomes endangered it is expected that its geographic range will contract inwards, and the population will persist in the range core until the final stages of decline.[18] However, for many endangered mammals the pattern of range decline is instead dictated by a number of factors influencing the decline, with those populations last impacted, regardless of their location, persisting longer than those that were historically large.[18] The range of the Indus dolphin has also been contracted inwards, and dolphins persist primarily in what is assumed to be the former range core or higher density area. The contraction of the range or habitat is due to the greatest threat or water diversion through canals which is primarily in the periphery or the outer range of the dolphin habitat.

7.4.3.3 Other threats to Dolphins

In addition to water abstraction, dolphins in Indus particularly in the game reserve between Guddu and Sukkur barrages are experiencing the following major threats:

- **Mortalities in irrigation canals:** There have been some reports of dolphins trapped in irrigation canals near Sukkur Barrage, since the mid-1990s. Generally dolphins during prey capture enter in canals and come back, but at the time of canal closures for de-siltation, those dolphins which were there, trapped and stayed in the deeper portions of the canal. It was reported that between January 2000 and December 2002, 34 dolphins were trapped in diversion canals of Sukkur Barrage. Twenty-four were successfully rescued by the Sindh Wildlife Department and returned to the

[18] Lomolino, M. V., Channell, R. (1995) Splendid isolation: patterns of geographic range collapse in endangered mammals. Journal of Mammalogy 76: 335–347.

Indus River, while the remainder died.[16]

- **The depletion of prey base:** The sustained and heavy exploitation of small fishes of Indus by the wide spread use of the small size mesh nets in river affected the prey base of the Indus River dolphin. While the rate of renewal of this resource is remarkable, there is no data on prey abundance estimates and further research is required to quantify this threat.
- **Impact of fishing:** Fishing nets are set for extended hours, including overnight, dolphins sometimes get trapped and drown. Entanglement in fishing nets causes significant damage to the local population. The primary cause is believed to be entanglement in fishing gear such as nylon gillnets because their preferred habitat is often in the same location as primary fishing grounds. The problem of accidental killing is expected to worsen with increasing fishing intensity. Accidental killing and damaging through propellers of the boats has also been observed. Illegal fishing by using pesticides is also creating harmful effects on dolphin population directly or indirectly.
- **Pollution (domestic, agriculture, industrial)**: Pollution is suspected to inhibit population increase, a phenomenon likely to be exacerbated by the absence of strong water flow. Untreated sewage especially sewage from all major towns along the river Indus is directly polluting the Indus River. The most of the communities residing along the banks of the River and along irrigation canals do not have proper toilets - sewage goes directly into the water. Furthermore, other activities such as washing clothes and cooking utensils are also a source of pollution.
- **Poaching**: Indus dolphins were sought and killed for their oil and meat to use in traditional medicine until early 1970s. Poaching still occurs sporadically, despite a ban on hunting.

7.4.4 Recommendations under the Project

The following recommendations are made to protect dolphins:

- Preserve aquatic biodiversity by river management focusing on restoring both the timing and duration of flood pulses, as well as on maintaining critical minimum flows in the dry season. This is a national responsibility and SID will engage in consultations with the federal government to resolve it 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.

Dolphin Management and Conservation Action Plan

A dolphin management and conservation action plan is recommended to be carried out under this project to strengthen the conservation measures in dolphin game reserve. The Plan will include the following actions:

- **Action 1. Initiate population status survey**: There is no comprehensive data base available on Indus dolphins. Detailed surveys are required to develop an understanding and knowledge on the species and to develop a detailed management plan for conservation of dolphins. A terms of reference (TORs) for this study is provided in Annex C. Surveys need to be conducted over a period of two consecutive years covering both low flow and high flow seasons in each year. This data will also be used to prepare Indus River dolphin population status reports.
- **Action 2. Threat assessment surveys**: Indus dolphin is facing many threats

although it has been declared as protected species under the Sindh wildlife Protection Ordinance 1972. These threats include both anthropogenic and natural. The above proposed study (TORs in Annex C) will identify these threats and develop a mitigation strategy.

- **Action 3. Setting up of no fishing zones in the Game Reserve**: Based on the results of the above surveys on occurrences and identification of river stretches that support breeding and feeding grounds of dolphin, critical dolphin habitats will be identified that require protection from fishing The study will recommend Sindh Government to declare the critical habitats as no fishing zones through necessary regulations. This will ensure an undisturbed breeding and feeding ground for the dolphins. During the study national and international level consultation with experts and discussions with local communities especially with the fishermen will be required keeping in mind the needs of communities.
- **Action 4. Capacity building for dolphin conservation and management**: Universities and relevant government line departments in Sindh need to be supported to develop programmes to study dolphins and their habitat conditions. There is a need to establish research and training center along the Indus River especially where dolphin population exists. This center can conduct training programmes for government departments and universities on conservation and research methodologies. Doctoral researches in universities on dolphin should be promoted through appropriate funding mechanism.
- **Action 5. Community Involvement in river dolphin Conservation and Management**: The involvement or active participation of local stakeholders like traditional fishing community and other riverbank communities is essential for dolphin conservation. A 'Dolphin Watch' programmes can be developed especially in the easy accessible areas and encourage students to visit those areas with appropriate guidelines and environmental safeguards. Provincial tourism departments and private sector can also initiate these programmes.
- **Action 6. Ensuring Critical Levels of Water Flow in Riverine Habitats of Dolphins**: The survival of the Indus River dolphin and a host of other aquatic wildlife are dependent on riverine ecology in general and the maintenance of an optimum water flow. Based on systematic and continued research and regular monitoring with the involvement of hydrologists and other multi-disciplinary professionals, critical water flow and minimum depths for river dolphin habitats should be determined, and management actions should be set in place to maintain such flow and depth.
- **Action 7. Dolphin rescue programme**: Sind Wildlife Department should be supported in establishing of permanent rescue programme of dolphins. This will include provision of transport vehicles to serve as dolphin ambulances and capacity building or hiring of staff for rescue program.
- **Action 8. Education and awareness**: Education and awareness programme to be conducted to increase the awareness level of all spectrums of the society about dolphin, its habitat requirements and its current threatened status. For example, declaring of dolphin as National Aquatic Animal will create lot of public awareness.
- **Action 9. International conference on dolphin conservation and management**: The project should support in conducting an international conference in Karachi to learn and share dolphin conservation and management options.

7.5 Hilsa Migration

7.5.1 Background

Hilsa (*Tanualosa ilisha)* locally known as palla is a migratory fish which ascends into rivers from the sea for breeding and spawning[19]. Hilsa belong to the family of Clupeidae of order Clupeiformes. Majority of the Clupeied fishes are entirely marine and anadromous, and these fishes before their spawning period accumulate high concentration of oils mainly lipid deposits, primarily triacylglycerols, which are subsequently mobilized to support gonad development and spawning migration.[20] Studies conducted in Pakistan on hilsa gonad revealed that at the beginning of spawning season the oil vacuoles coalesce and eventually a large single oil is formed. Some studies observed the fecundity in hilsa ranges from 87,267 to 614,482 in the females ranging from 210 to 350 mm in length[21] and 64,608 to 1,153,383 in females ranging from 201-408 mm in length. [22]

No detailed studies were conducted on hilsa in Pakistan to understand its migration patterns. Generally hilsa migration from sea to Indus starts from January and will continue until July[23], but it appears that there are two peak migration periods, one in January to February and other between April and July. Before the construction of Sukkur barrage in 1932, the hilsa was reported to travel a distance of more than 1,000 km up to Multan.[24] After construction of Sukkur barrage, hilsa migration was restricted to Sukkur barrage[25] since it doesn't have any fish passes. Kotri and Guddu barrages which were constructed later in 1956 and 1962 have 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 (Jamshoro), 300 km from the sea. This obstruction has deprived hilsa of two-third of their previous spawning area.[26]

7.5.2 Fish Ladders

In Guddu barrage there are two fish ladders installed in the outer piers of each abutment pocket i.e., after gate number 7 (Figure 7.3) and after gate number 61 (Figure 7.4) with 85 m length (upstream length is 35 m and downstream length is 50 m), 3 m width, and 1.5 m depth. Left bank ladder is constructed along with the lock chamber wall. Upstream fish ladder is controlled by a screw gate 0.6 m (2 ft) wide. There are cross partition in ladders entire length that forms series of baffle steps. The right side ladder has two entry gates on the downstream side, one on the left wall and one at the end of the ladder. Both gates are in poor condition. The right side ladder has vertical baffle walls cast into the side of the chute. On the upstream side of the ladder is a single gated opening in the left side wall. This gate was replaced in April 2011 and is in good condition. The left side fish ladder also has two sluice entry gates at the downstream end but the

[19] Day, F (1879), The fishes of India: A Natural History, Reprinted by William Dawson and Sons Ltd. (1958), London.
[20] Bell, J. C. (1998) Current aspects of lipid nutrition in fish farming. Pp 114-145, In: Biology of farmed fish. Eds. Black, K D and Pickering, A. D., Sheffield Academic Press Ltd., Sheffield, England
[21] Panhwar, S K, Siddiqui, G, and Ayub, Z. (2011) Reproductive Pattern and some biological features of anadromous fish *T. ilisha* from Pakistan, Indian J. of Geo-Marine Sciences, Vol. 40(5), pp. 687-696
[22] Narejo, N T, Ali, S S, Jafri, S I H, Hussain, S M (1999). A Study on the age and growth of Palla, *T. ilisha*, from the River Indus, Pakistan Journal of Zoology, 31: 25-29
[23] Bhuiyan N, Islam and G.B. Talbot (1968) Fluvial Migration, Spawning, and Fecundity of Indus River Hilsa, Hilsa Ilisha, Transactions of the American Fiheries Society, 97:4, 350-355.
[24] Aitkin, E. H. (1907), Gazetter of the Province of Sind, Karachi, p.73-74
[25] Qureshi, M R (1968), Problems Concerning Fishery of hilsa, Hilsha ilisha (Ham.), Pakistan J. Sci. Ind. Res. 11:85-94
[26] Bhuiyan, N. I. and Talbot, G B I (1968) Fluvial migration spawning fecundity of Indus river *Hilsa ilisha*. Trans. Am. Fish Soc. 97:350-355

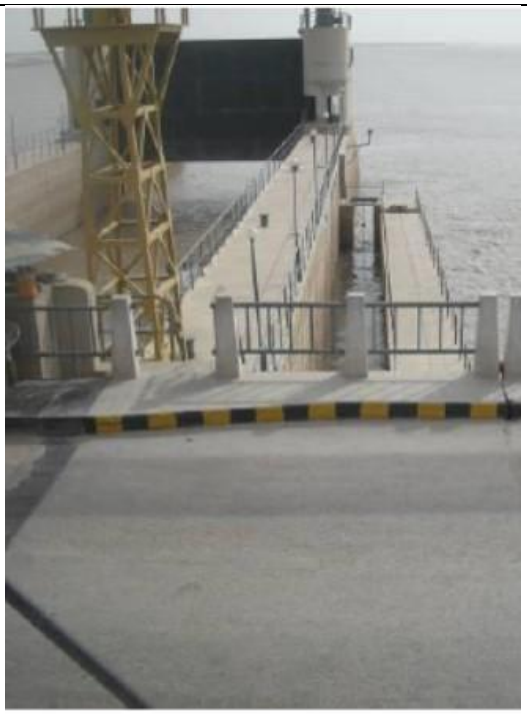
baffles within the chute are horizontal rather than vertical. At the upstream end there is a single sluice gate on the right side chute wall but also two sluice gates on the left side wall.

Turbulence is created at the downstream end of the fish ladders to attract the fish so that they can travel upstream. The fall at the downstream end of the ladders is kept above 0.6 m to create this turbulence. The remaining fall is distributed up to the fish pass, ensuring that the fall at any regulation point does not exceed 0.6 m. Fish ladders are designed to work at Barrage minimum winter pond level. The flow of water regulated by adjusting the gate opening and minimum 0.5 m water depth is maintained in the steps so that fish can easily swim rather than jump.

Upstream end

Downstream end

Figure 7.3: Right side fish ladder at Guddu Barrage (Gate 7)



Upstream end | ***Downstream end***

Figure 7.4: Left side fish ladder at Guddu Barrage (gate 61)

There are two fish ladders in Kotri Barrage with same dimensions like in Guddu barrage located on each of the divide walls.

There are no fish ladders in Sukkur barrage.

7.5.3 Cumulative Effects

7.5.3.1 Impacts of Barrages

During the early stage of migration (January-February) of hilsa there is hardly any water available in downstream Kotri (Figure 7.5) for hilsa to migrate to upstream, the fisherman catch the fish in deltaic region only but later migration during summer monsoon floods (April-July) the palla fishing carried out from Jamshoro to Keti Bunder, on the downstream of Kotri barrage.

Annual hilsa catch of last six decades indicate that in 1950's annual catch was close to 13,000 t, which was decreased to 2,700 t in 1962 and then again started to increase with peak annual catch of 11,800 t in 1973 (Table 7.2). Over the last four decades hilsa annual catch has been reduced from 9,098 t in 1974 to 266 t in 2012.[27] The changes in annual hilsa capture trend may have different factors, but the most logical one could be the construction of Kotri barrage in 1955 and subsequent obstruction of migration patterns. The catch declined up to 1961 (7,800 tons) but not significantly and a major capture of 11,800 t in 1973 may be explained due to the reason of super flood of August 19, 1973, during which hilsa was able to travel through the flood plains in upstream locations and caught by the fisherman. With the advent of fishing nets and motorized fishing boats, since 1970's the captures tend to increase including the juvenile group (undersized catch), which was the beginning of the major decline of hilsa in the estuaries and little space for them to survive in large scale. The major factor severely threatening the fishery is the low flow of freshwater to the sea beginning from the upstream barrages including Guddu

[27] FAO Fishstat J Software, Capture Production 1950-2012 Dataset, (Release date: March 2014)

(Figure 7.6) Sukkur (Figure 7.7) and Kotri (Figure 7.8) and hilsa appears to be the most vulnerable due to its fluvial migration toward the Indus River.[28] Hilsa fishery has been providing livelihood to a large number of fisherman in Sindh, some of them migrate to Jamshoro area from Sukkur and Larkana districts during hilsa migration periods.

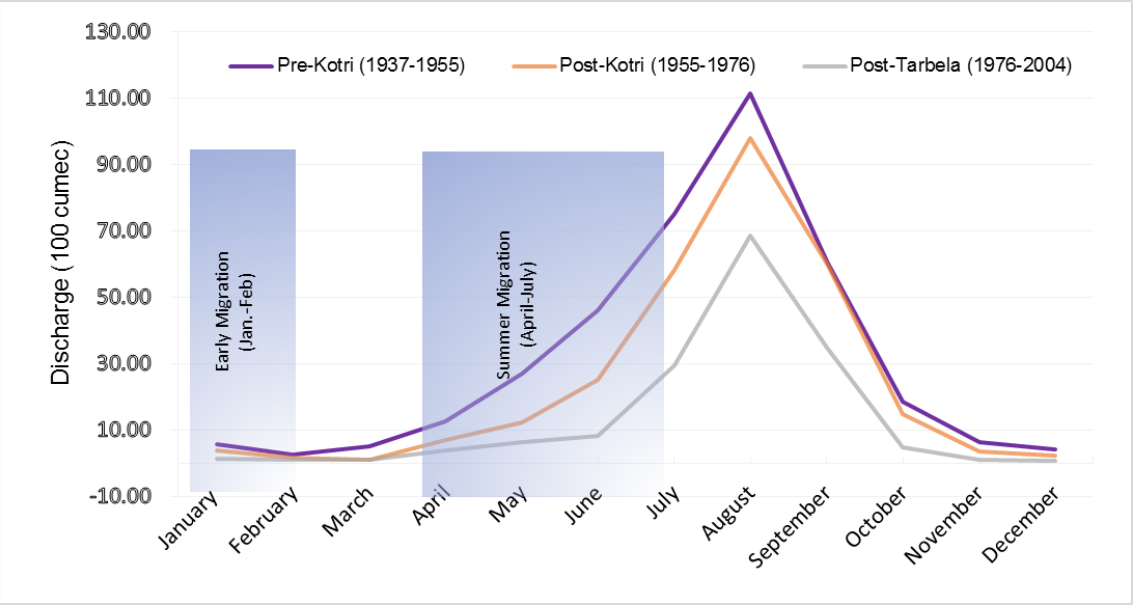


Figure 7.5: Monthly discharge at downstream Kotri and hilsa migration.

Table 7.2: Annual catch of Hilsa in Pakistan

Years	Catch (tons)	Years	Catch (tons)	Years	Catch (tons)
1953	10,000	1973	11,800	1993	796
1954	11,000	1974	9,098	1994	658
1955	12,000	1975	9,474	1995	476
1956	13,000	1976	9,545	1996	562
1957	6,000	1977	9,129	1997	597
1958	8,000	1978	4,813	1998	611
1959	8,000	1979	9,036	1999	502
1960	8,800	1980	4,427	2000	190
1961	7,800	1981	3,923	2001	170
1962	2,700	1982	6,032	2002	174
1963	3,800	1983	1,592	2003	156
1964	4,800	1984	1,527	2004	149
1965	5,500	1985	2,078	2005	189
1966	7,500	1986	1,975	2006	195
1967	6,500	1987	1,843	2007	215
1968	8,200	1988	1,528	2008	255
1969	9,900	1989	875	2009	188
1970	12,700	1990	935	2010	195
1971	11,100	1991	861	2011	254
1972	10,800	1992	823	2012	266
Super Floods, Discharge in cumec:					
	25,485-28,317		*28,317-31,149*		*31,149-33,980*

[28] Jafri, S. I. H., 1988: Biology and fishery of River Indus shad (Palla). A review. Pak. J. Agric. Res. 9, 252–263.

Source: FAO Fishstat J Software, Capture Production 1950-2012 Dataset, (Release date: March 2014)

Sept 26, 2012

January 26, 2005

Figure 7.6: Google Earth Images Guddu Barrage

September 17, 2011

March 27, 2012

Figure 7.7: Google Earth Images of Sukkur Barrage

September 22, 2013	*February 21, 2014*

Figure 7.8: Google Earth Images of Kotri Barrage

7.5.4 Recommendations under the Project

- Fish ladders in Kotri and Guddu barrages must be rehabilitated to work effectively and a new fish ladder in Sukkur barrage to be installed. Further studies are required to understand the biological requirements of hilsa, its swimming capabilities, and water velocities and depth required to attract hilsa to fish ways, breeding habitats and migration route. Based on the understanding of these requirements necessary designs are to be prepared for rehabilitation of fish passes at Guddu and Kotri, and for new fish passes at Sukkur. Terms of reference for this study is given in Annex C. The study will also assess the performance of existing fish ladders of Guddu for movement of local fish species.
- The overall situation of hilsa fishery is in severe stress and vulnerable to overexploitation. On the basis of a recent research it was recommended that serious attention be required to provide appropriate access for the hilsa to the Indus River during the migration period, and impose a ban on fishing during the upstream migration and the prevention of undersized catch for this traditional fishery.[29]
- On the provincial level, the Government of Sindh have framed and promulgated the Sindh Fisheries Rules of 1983 in exercise of the powers conferred by Section 27 of the Sindh Fisheries Ordinance, 1980. It is important that the government enforce Section 9(1) strictly. From the standpoint of marine fisheries, the following provisions of the rules are important.
    - 9 (1): No licensee or lessee of fishing rights shall obstruct or cause to obstruct, migration or movement of palla (Hilsa sp.) fish towards upstream, by using or setting up any kind of set net or any type of fixed engine or device at or near the mouth of the Indus or its branches at any place up to Sachanwari landing centre throughout the year.

[29] Panhwar, S. K. and Liu, Q. (2013) Population statistics of the migratory hilsa shad, *Tenualosa ilisha*, in Sind, Pakistan, Journal of Applied Ichthyology, Volume 29, Issue 5, p.1091–1096.

7.6 Irrigation

7.6.1 Background

Before the construction of Guddu barrage, lands in north of Sukkur and Rohri were irrigated by inundation canal system. The low precipitation prevented rain-fed large scale agriculture development in the province. The people adapted to low and poorly distributed rainfall through either living along river banks or by careful husbandry and management of local water resources. The canals depended for their supplies on favorable river levels of Indus during the summer time. The lands in upper Sindh were irrigated by artificial inundation canals: Desert, Unhar, Begari, Sindh Rajib, and Chitti Canals on right bank and Sehar, Mahi, Dahar, Masu, Mehesro, Lundi, Dingro, Korai, Janib, and Garkino Canals on left Bank. Total cultivated area was 382,428 ha (945,000 acres). The farmers usually used to suffer due to their dependence on the inundation canals.

The three barrages in Sindh over Indus River diverting approximately 59 BCM of water annually to the 14 main canal commands. These canal systems have an aggregate length of 21,445 km, which serve a gross command area (GCA) of 5.6 million ha. There are about 42,000 watercourses (tertiary channels), which have an aggregate length of about 120,000 km (Figure 7. 9). Around 78% of the area in the Province of Sindh is underlain by saline groundwater, which is unsuitable for irrigation. Surface and sub-surface drainage systems are inadequate, resulting in much of the drainage effluent being either retained in the basin or disposed into the rivers and canals. There are 13 existing surface drainage systems in Sindh, which serve a total area of over 2.5 million ha and have an aggregate length of about 6,133 km. In addition, there are two sub-surface drainage systems, which serve an area of 0.04 million ha.

7.6.2 Cumulative Effects

7.6.2.1 Socioeconomic Benefits

The construction of three barrages in Sindh has been diverting about 3,920 cumec to the canals and resulted in irrigation of 5,572,995 ha of land (Table 7.3). The construction of a series of barrages on the Indus River system has a cumulative impact of increased irrigation, which brought the green revolution in this region of the world, and increased the economy many fold.

Table 7.3 : Irrigation supplies and command area of barrages.

Off-taking Source (Barrage)	Discharge (cumec)	Command Area (ha)
Guddu	1,190	1,382,537
Sukkur	1,346	3,054,102
Kotri	1,172	1,136,356
Total	**3,708**	**5,572,995**

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.

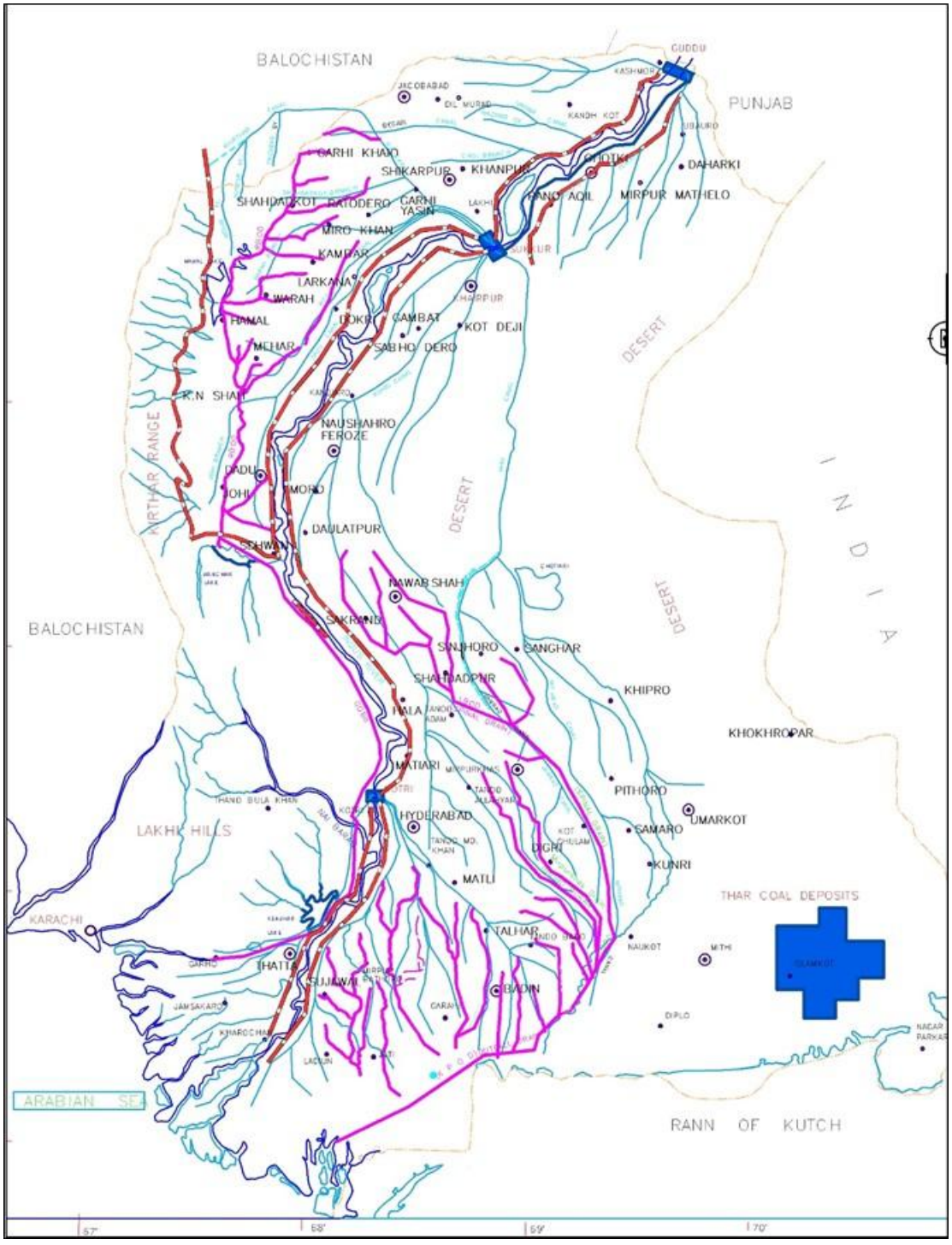


Figure 7.9: Irrigation Network of Sindh

Agriculture is the main stay of Pakistan's economy. The agricultural sector, with a share of about 25%, was the single largest contributor to the GDP. About 68% of the rural population depends on agriculture, which employs over 46% of the labor force and accounts for more than 60% of

foreign exchange earnings.[30] Pakistan's economic development is therefore directly linked to the progress of the agriculture sector. Sindh's contribution to Pakistan's agriculture GDP is 23% with its contribution of major products as follows:

- Wheat, 15%
- Cotton, 23%
- Livestock, 28%
- Sugarcane, 31%
- Rice, 42%
- Marine fish, 70%

The current conditions of all barrages require urgent action to rehabilitate them in order to improve the efficiency and effectiveness of irrigation water distribution in rural Sindh. The rehabilitation work under the project will safeguard the continued operation of Guddu barrage by prolonging the useful life of the structure, and continue uninterrupted water supply to the irrigation network of Sindh.

7.6.2.2 Inefficient Use of Irrigation Waters

Large amount of irrigation water is being wasted by farmers due to inefficient use of irrigation water. There is a tendency of farmers to irrigate crops with more water with the belief that more water results in higher productivity. Further there is also a tendency to grow rice in well permeable soils. It has been estimated that about 35 to 40 percent of irrigation water is being lost through these practices and also from transmission losses. Excess irrigation coupled with the poor drainage system in Sindh has resulted in water logging in shallow groundwater level areas and increased soil salinity. The average severely waterlogged area with water table depth of 0-1.5 m in April-June is about 2.16 million ha in Sindh.[31] Salinity and sodicity are associated with irrigation but these also occur as a consequence of soil formation process over the centuries. Waterlogging, salinity, and sodicity have reduced the drainage capacity of the soils resulting in lower soil fertility, decline in crop yields and loss of crop diversity.[32] Almost 50% of the culturable command area in Sindh does not have drainage facilities. The present surface drainage density is usually not more than 3-7 m/ha which leaves much of the land without a drainage system,[33] therefore water logging permanently exists.

In order to improve the efficiency and effectiveness of irrigation water distribution and drainage system for irrigation productivity, Sindh Government implemented Water Sector Improvement Project and On-Farm Water Management Project. These projects implemented measures of reliability, equity and user satisfaction and better management of water and increased agricultural productivity by the farmers in the project area, supported by improved irrigation infrastructure, and service delivery. The five key outcome/impact indicators identified for the OFWMP were:

- Improved operation and maintenance and water distribution in distributary canals managed by farmers organization (FOs), i.e., improved reliability and equity of irrigation water distribution;

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[30] A. Azad, A., Aslam, M, and Memon, Y (2003) Sindh Water Resources Management – Issues and Options, Food and Agriculture Organization of The United Nations – Rome

[31] Lashari, B. and Mahesar, M. A. (2012) Potentials for Improving Water and Agriculture Productivity in Sindh, Pakistan, Sixteenth International Water Technology Conference, IWTC 16 2012, Istanbul, Turkey.

[32] Shah, A H. et. al. (2011) Sustainable Salinity Management for Combating Desertification in Pakistan, Intl. J. Water Resources & Arid Environ., 1(5): 312-317.

[33] Azad, A. (2003) Sindh water resources management – issues and options, Food and Agriculture Organization of the United Nations –Rome, Investment Centre Division, FAO/World Bank Cooperative Programme.

- Improved water conveyance efficiency in improved watercourses (WCs);
- Increased cropping intensity;
- Increased crop yields; and
- Reduced use of pesticides.

Table 7.4 summarizes the development objectives of OFWMP and achievements in productivity, reliability, efficiency, cropping intensity, and reduction in pesticide use. The overall gain in productivity is close to the target of 10% at the project level. The wheat surpassed the target by 29% and cotton by 27%, whereas sugarcane productivity was lower by 43% from that of the target, but improved from the baseline conditions (74,175 kg/ha).[34] These gains in productivity were achieved after accounting for the loss sustained during the 2010 and 2011 floods. Farmers who apply integrated pest management principles were found to reduce the number of pesticide applications by about half. In the areas covered by integrated pest management, the reduction in pesticide use varied from 70% in cotton producing areas to 22% in rice producing areas, giving an overall average reduction of 53% for all crops.

Table 7.4: Objectives and Outcome of On-Farm Water Management Project

Development Objectives	Baseline	Target	Actual
Increased in Yield Wheat (kg/ha)	2,600	2,795	2,851
Cotton	2,524	2,739	2,796
Sugarcane	74,175	91,235	83,883
Improved reliability, and equity of irrigation water distribution (Delivery Performance Ratio)	0.50	0.80	0.81
Improvement in WC conveyance efficiency (lined and earthen combined) (%)	67	80	83
Increase in cropping intensity (%)	119.3	131.2	137
Reduction in use of pesticides	8 sprays	4 sprays (50% decrease)	53%

7.6.3 Recommendations under the Project

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 in Guddu command area also to reduce the wastage of water, waterlogging and salinity, and reduced use of pesticides. Reduced wastage of irrigation water will allow more water to be discharged in to the downstream of the barrages, which eventually help maintaining the environmental flow downstream of Kotri. The following initiatives will be taken by SID in all its command area as a continuous process:

- Continue to provide support to small and medium size farmers in more productive use of waters.
- Continue to provide trainings in efficient use of water, soil, crop management, alternate use of saved water etc. Training programs designed to optimize the use of water, will benefit the farmers and eventually save the water usage as well.
- Improve the capacity and awareness of local organizations and to allow them to assume a bigger role. The role of Watercourse Associations (WCAs) has to be enhanced beyond routine water course improvement. OFWMP gave output based contracts to WCAs and

[34] The World Bank (2014) Sindh On-Farm Water Management Project, Implementation Completion and Results Report, Report No: ICR00001568.

they performed well in managing quality of lining of water courses and SID should continue these contracts to WCAs. The functions of the WCAs defined in Sindh Water Management Ordinance 2002 (SWMO) 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.

8 Environmental and Social Management Plan

8.1 Objectives of ESMP

The basic objective of the ESMP is to manage adverse impacts of project interventions in a way, which minimizes the adverse impact on the environment and people of the Project area. The specific objectives of the ESMP are to:

- Facilitate the implementation of the mitigation measures identified during the present ESA and discussed earlier in the document.
- Maximize potential project benefits and control negative impacts;
- Draw responsibilities for project proponent, contractors, consultants, and other members of the Project team for the environmental and social management of the Project;
- Define a monitoring mechanism and identify monitoring parameters in order to:
- Ensure the complete implementation of all mitigation measures,
- Ensure the effectiveness of the mitigation measures;
- Maintain essential ecological process, preserving biodiversity and where possible restoring degraded natural resources; and
- Assess environmental training requirements for different stakeholders at various levels.

The ESMP will be managed through a number of tasks and activities and site specific management plans. One purpose of the ESMP is to record the procedure and methodology for management of mitigation identified for each negative impacts of the Project. The management will clearly delineate the responsibility of various participants and stakeholders involved in planning, implementation and operation of the Project.

8.2 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 CSC and PMO before implementation of construction works.

8.3 Institutional Arrangements

The existing organogram of SID and the proposed organizational structure under PMO for implementation of ESMP and SMF is shown in Figure 8.1.

8.3.1 Project Management Office (PMO)

Sindhi Irrigation Department is the project proponent. The PMO established under the secretary of the SID will monitor and coordinate all project implementation activities. 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) consisting of the following staff

- Director, Environmental and Social Unit.
- Deputy Director Environment,
- Deputy Director Social and

- 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.

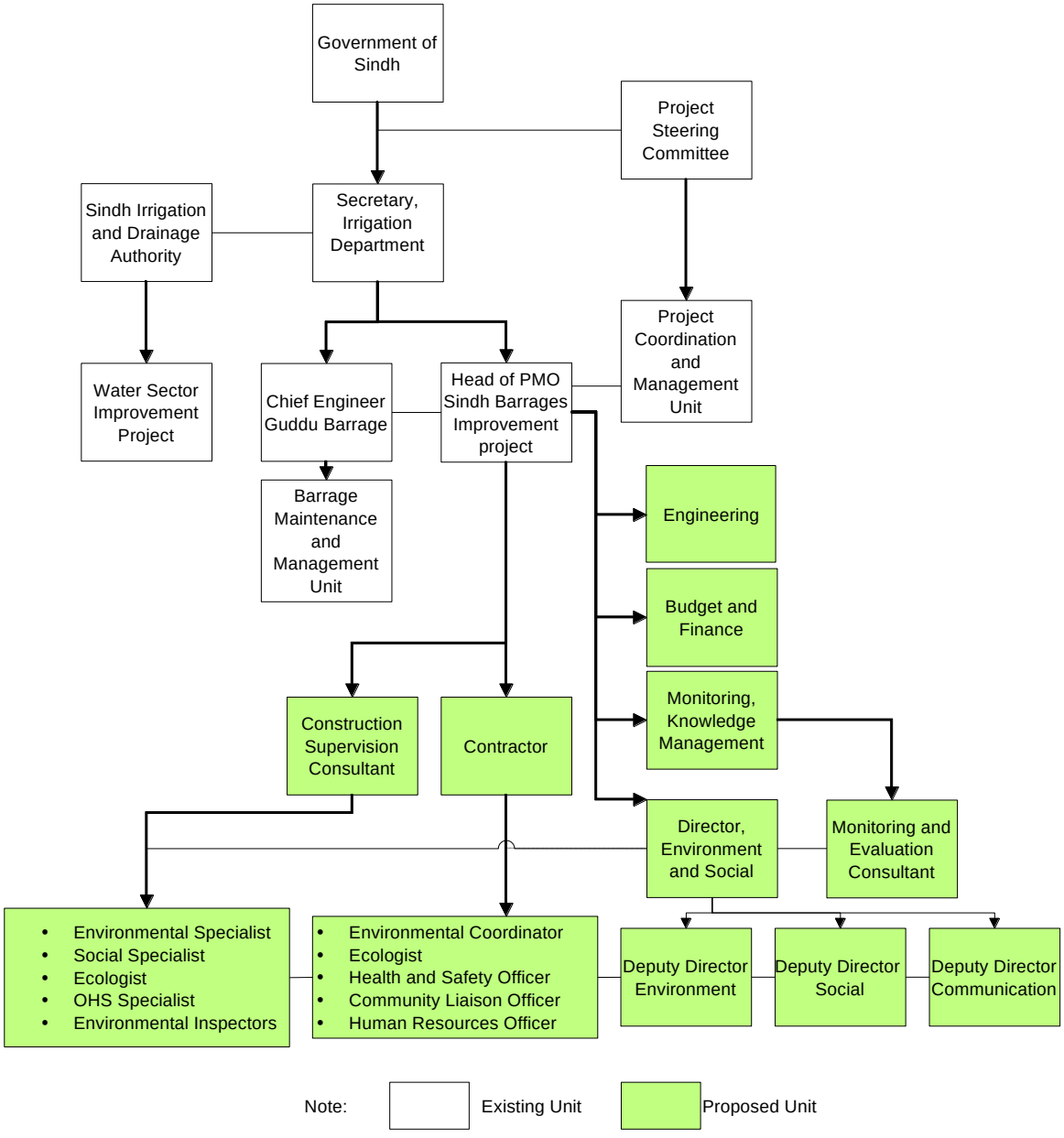

Figure 8.1: Proposed Institutional Structure for Implementation of ESMP

8.3.2 Construction Supervision Consultants (CSC)

The CSC will be responsible for supervising the contractors for the implementation of ESMP and SMF. For this purpose, the CSC will appoint dedicated environment and social staff to ensure the implementation of environmental and social management plans 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.

CSC will have the following environmental staff:

- Environmental specialist
- Social Specialist
- Ecologist
- Occupational Health and Safety Specialist
- Environmental Surveyors

The environment staff of CSC will closely supervise the construction team to ensure that all environmental commitments are incorporated into the construction activities and work processes. Specific responsibilities include:

- Supervising and supporting contractors in achieving their responsibilities as outlined in the ESMP;
- Issuing non-compliance notices to the contractors;
- Providing input, advice, and approval on activity specific work plans relating to ESMP;
- Supervising the implementation of activity specific work plans;
- Regularly reviewing and assessing environmental risks throughout the construction phase;
- Identifying and preparing environmental induction and training materials;
- conducting environmental trainings;
- Assist ESU in addressing and resolving environment-related complaints and grievances
- Responding to environmental incidents as required;
- Managing compliance reporting as it relates to the Project, and preparing monthly ESMP compliance reports;
- Liaise with ESU for effective environmental management at site;
- Liaise with the Resettlement Office and other relevant Project entities;
- Reviewing ESMP and revising it if required on six-monthly basis.

8.3.3 Monitoring and Evaluation Consultant (MEC)

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. MEC will also carry out annual third party auditing of ESMP and make further modifications if required.

8.3.4 Contractors

Contractors are also required to appoint the following environmental staff for the implementation of ESMP in the field, particularly the mitigation measures.

- Environmental coordinator
- Ecologist (specifically to deal with the impacts on dolphins)
- Health and Safety Officer
- Community Liaison Officer

- Human Resources Officer

The contractor will develop various plans directed towards health, safety, the environment and social issues (discussed in Section 8.4.3), and get them approved by the CSC. The contractor will also be responsible for communicating with and training of its staff in the environmental/social aspects before the commencement of the physical works on site. Appropriate numbers of the following personnel are required in the contractor's environmental team:

- Environmental coordinator
- Ecologist
- Health and Safety Officer
- Community Liaison Officer
- Human Resources Officer

The construction contract will have appropriate clauses to bind the contractor for the above obligations.

8.3.5 Chief Engineer, Guddu Barrage

Chief Engineer of Guddu barrage is responsible for regular operation of the barrage and canal closures if required. Communications regarding canal closures, its impact and mitigation will be carried out with close coordination of Chief Engineer Guddu Barrage. Any emergency i.e. unexpected flood due to heavy rainfall in monsoon or shortage of water due to drought would be communicated through Chief Engineer Guddu.

8.3.6 Sindh Irrigation and Drainage Authority (SIDA)

SIDA is responsible in building capacity of farmer organizations (FOs) in the Bank-financed Water Sector Improvement Project. They will facilitate consultations with farmers in project and command areas, including women and vulnerable households.

8.4 Environmental and Social Management

8.4.1 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.

8.4.2 Mitigation Plans

These mitigation plans have been prepared on the basis of the detailed impact assessment covered under Chapter 6. These plans (Table 8.1) are project-specific, and to the extent possible, site-specific, however contractors will be required to carry out further detailing of the key aspects, to prepare site-specific management plans discussed below.

8.4.3 Site-specific Management Plans

These plans are site-specific and where applicable, contract-specific and will be prepared by various contractors prior to the commencement of construction activities. The Plans to be

prepared by the contractors for various aspects of the environmental management will mostly include the detailing of the measures included in the ECPs and Mitigation Plans respectively discussed in Sections 8.4.1 and 8.4.2, providing where applicable, location details, layouts and drawings, timelines, roles and responsibilities, methodologies and procedures, and key performance indicators. A brief description of each of these plans is provided below:

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 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 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 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 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 3. 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 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 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 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,

8.4.4 Social Management Framework

8.4.4.1 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.

8.4.4.2 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.

8.4.4.3 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

8.4.5 Plans to Address Cumulative Impacts

8.4.5.1 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 maintain 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.

8.4.5.2 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.

8.4.5.3 Irrigation Efficiency Improvement Plan

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.

8.5 Mitigation Plan

The mitigation plan given in Table 8.1 is organized around various project activities and includes various actions identified under the mitigation measures discussed in Chapter 6, define responsibilities for implementation as well as monitoring of each action, and also indicate the timing of these actions. Should any changes to the Project design or methods of construction and operation take place post this assessment stage, the impacts and monitoring/mitigation

measures discussed may need to be revised to reflect such changes to allow the environmental and social implications of these changes to be addressed.

Table 8.1: Mitigation Plan

Project Activities	Environmental Impacts	Mitigation/Compensation Measures	Institutional Responsibilities	
			Implementation	Supervision
A. PRE-CONSTRUCTION STAGE				
A.1 Contractors' mobilisation	If contractors are not made responsible to comply with ESMP, there will be several construction related impacts	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. Contractor need to prepare the following site specific management plans to manage and mitigate/reverse potential adverse environmental impacts in compliance with ECPs and mitigation measures proposed in ESA. All these plans are to be reviewed and approved by CSC and PMO • Erosion, sediment and drainage control plan • Pollution Prevention Plan • Waste Disposal and Effluent Management Plan • Traffic Management Plan • Borrow Area Management and Restoration Plan • Occupational Health and Safety Plan • Drinking Water Supply and Sanitation Plan • Management Plan for Protection of Flora and Fauna • Construction Camp Management Plan • Fuel and Hazardous Substances Management Plan • Instream Construction Works Management Plan • Emergency Preparedness Plan • Communication Plan	Contractor	CSC, PMO
A.2 Precautionary measures for gas pipeline	Two gas pipelines are crossing the barrage, there is a potential of damage in their siting and stability, which could lead to supply interruption	SID should coordinate with Sui Southern Gas pipeline Company Ltd., to coordinate any precautionary measures to be taken at the pre-construction stage such as provision of protective sheets and locating works away from pipelines.	PMO	SID
B. CONSTRUCTION PHASE				
B.1. SITE PREPARATION & CLEARANCE (all project activities)				
B.1.1. Temporary land acquisition for construction	Temporary acquisition of about 1.62 ha (4 acre) land for the construction camp.	• Compliance with the social management framework of SID for any land acquisition to be carried out under the project	Contractor	SID

Project Activities	Environmental Impacts	Mitigation/Compensation Measures	Institutional Responsibilities	
			Implementation	Supervision
camp				
B.1.2. Vegetation clearance and tree Cutting	Loss of trees, faunal habitat along river training works, at locations of construction camp, colony, and on access/haul routes	Follow ECPs 12 and 13 on Protection of Flora and Fauna while tree cutting	Contractor	CSC
		Use of existing access tracks and avoid developing of new access roads	Contractor	CSC
		Compensatory planting and aftercare of saplings of native trees at a ratio of 5 trees for each tree cut. The aftercare will be continued until trees are viable and self-sustaining	Contractor	CSC
		Vegetation clearance shall be limited to the extent required for execution of works. Care should be taken to make sure bird habitats are not destroyed. If there is no option available, rehabilitate them in other neighboring trees. Also protect and rehabilitate injured or orphaned birds.	Contractor	CSC
		Biodiversity monitoring of impacts on fauna	ESU-PMO	PMO
B.1.3. Site works	Disturbance of existing graveyards	Fencing to be erected around identified graveyards	Contractor	CSC
	Disturbance to mosques	Maintain access to all mosques in the project area	Contractor	CSC
B.2. CONSTRUCTION CAMPS				
B.2.1. Siting of Camp	Acceptability to community	Execution of agreement with landowner (in case of private land) for temporary acquisition of land and consultation with the community before finalizing the camp location	Contractor	CSC
	Community disturbance	Locate camp at least 500 m away from communities	Contractor	CSC
		Employ a Community Liaison Officer	Contractor	CSC
	Flood risk within camp	Proper drainage network including end discharge should be established to drain storm water (surface run-off) away from the camp and settlements	Contractor	CSC
		Camp shall be located above the design flood level adopted for the project	Contractor	CSC
	Pollution to surface water	Hazardous material should be stored in designated areas and managed as per ECP 2: Fuels and Hazardous Goods Management	Contractor	CSC
B.2.2 Development of Construction camps and construction activities	Damage of local roads Dust, air and noise pollution	• Repair all damaged local roads to their original state after the land filling is completed. • Dust suppression measures with spraying of water should be taken for all roads used for transport. • Comply with the national guidelines on ambient air quality standards Implement ECPs 10 and 11 on Air Quality and Noise Management	Contractor	CSC, PMO
	Impacts on traffic safety	• Implement ECP 15 on Road Transport and Road Traffic Management • Ensure that all construction vehicles observe speed limits on the construction sites and on public roads • Provide adequate signage, barriers, and flag persons for traffic control. • Fit audible warning devices in vehicles to alert during reversing.	Contractor	CSC
B.2.3 Maintenance of	Contamination from solid waste	• Implement waste management activities as given in ECP 1 on Waste Management and ECP 16 on Construction Camp Management	Contractor	CSC

Project Activities	Environmental Impacts	Mitigation/Compensation Measures	Institutional Responsibilities	
			Implementation	Supervision
camps		• All construction materials will be reused, recycled and properly disposed of. All worn out parts, equipment and empty containers must be removed from the site to a proper storage location designated by PMO. • All solid waste will be collected and removed from the work camps and disposed in a solid waste disposal sites.		
	There will be potential for diseases to be transmitted including malaria, exacerbated by inadequate health and safety practices. There will be an increase risk of sexually transmitting infections like HIV AIDS	• Implement Health and Hygiene guidelines in ECP on Construction Camp Management • Implement ECP 18 on Workers Health and Safety • Environmental specialists and occupational, health and safety specialist to be hired to monitor workers health, safety and hygiene for entire construction period of 5 years • A worker code of conduct will be developed by the contractor as part of the OHS or construction camp plan • Contractor will follow the process and standards set in IFC/EBRD guidance note on Workers' accommodation: processes and standards	Contractor	CSC
	Community Conflicts	• Implement ECP 17: Cultural and Religious Issues • Set up of complaints register at contractors and Engineers office • Contractor shall develop a Code of Conduct to govern behavior of workers, and all staff shall sign the code of conduct compliance form. • Contractor shall deliver training on cultural sensitivity to international workforce during induction • Contractor's Community Liaison Officer to consult local communities and focus on impact to women and girls. • Migrant staff prohibited from entering local villages.	Contractor	CSC
	Loss of trees, fisheries, and fauna	• Implement ECPs 12, 13, and 14: Protection of Flora, Fauna, and Fisheries by banning hunting, poaching, fishing and trapping of all fauna by all project personnel. • Provide sufficient fuel for cooking inside the camps, so that workers don't engage in collecting firewood from the project area.	Contractor	CSC
	Loss of life	• Contractor shall prepare an Emergency Plan stating the shut-down procedure and evacuation plan. • Emergency access routes shall be identified and proper traffic sign should be maintained. • Fire extinguishers to be provided throughout the camp • Public areas at risk from fire in camp identified in Emergency Plan with evacuation measures.	Contractor	CSC
B.2.4 Security	Conflict with local communities, attacks	• Contractor will prepare a comprehensive security plan including fencing, communication mechanism, and security arrangements at all camps in	Contractor	CSC

Project Activities	Environmental Impacts	Mitigation/Compensation Measures	Institutional Responsibilities	
			Implementation	Supervision
	on contractor staffs	coordination with police and rangers. Entrance to camps shall be monitored and restricted. • Armed security personnel should be retained by the Contractor for travelling selected project locations where security situation is poor. • Contractor shall provide all staff with identity cards showing their association with the project • Sindhi speaking staff to be available at all active work sites to communicate with local community		
B.3 STORAGE OF MATERIALS (relevant to all project activities)				
B.3.1. Stockpile of materials	Increase in particulate matter	• Implement ECP 10: Air Quality Management • Cover the storage of loose materials with tarpaulins. Materials to be covered in vehicles going to and from the construction sites to reduce spills. • Water sprinkling of any uncovered stockpiles where dust is generated. A water spraying schedule will be prepared by the contractor and will serve as the basis of a dust control program. The Project authorities will regularly monitor this schedule. • Reduce distance between storage of aggregates, cement and sand to batch plant • Compliance with national ambient air quality standards	Contractor	CSC
	Groundwater or surface water pollution	• Implement ECP 6: Erosion and Sediment Control • Locate storage areas away from water courses, drains and transport routes • Store materials only in designated storage areas	Contractor	CSC
B.3.2. Handling of hazardous materials	Deterioration of health and safety due to improper use of hazardous material	• Hazardous material should be stored in designated areas and managed as per ECP 2: Fuels and Hazardous Goods Management • Fuel tanks and other hazardous material containers should be properly marked to easily identify their contents and hazard warning(s). • Storage area should have secondary containment for at least 1.1 times the stored volumes. • Hazardous areas to be secure and access limited to trained personnel only • Keep Material Safety and Data Sheet (MSDS) of each material on site • Provide fire extinguishers • Provide and enforce the use of PPE as per Contractor's health and safety plan	Contractor	CSC
B.3.3 Closure of works	Soil, groundwater or surface water pollution	All excess materials (other than earth stockpiles) shall be removed on completion of works. ECP 8 topography and landscaping should be implemented	Contractor	CSC
B.4 WASTE MANAGEMENT (relevant to all project activities)				
B.4.1. Collection and disposal of sanitary waste	Surface and ground water pollution, and health of staff	Implement ECP 1: Waste Management, ECP 4 Drainage Management and ECP 18: Workers Health and Safety.	Contractor	CSC

Project Activities	Environmental Impacts	Mitigation/Compensation Measures	Institutional Responsibilities	
			Implementation	Supervision
(sewage)				
B.4.2. Collection and disposal of solid waste	Surface & ground water pollution	• Implement ECP 1: Waste Management • Dispose the waste in locally developed designated landfill site • All construction materials will be reused, recycled and properly disposed of. All worn out parts, equipment and empty containers must be removed from the site to a proper storage location designated by PMO.	Contractor	CSC
B.4.3. Collection and disposal of medical waste	Soil, ground and surface water pollution, health and safety hazard	• Medical waste stored on site will be collected by Sindh EPA certified contractors and ultimately disposed of at medical incinerator. • The contractor will retain a Sindh EPA certified sub-contractor to collect the waste from the project site.	Contractor	CSC
B.4.4 Disposal of hazardous waste	Ground, ground water, surface water pollution & health and safety	• Implement ECP 2: Fuels and Hazardous Goods Management and ECP1 Waste Management • Hazardous waste will be collected by Sindh EPA certified contractors for final disposal to designated site.	Contractor	CSC
B.4.5 Disposal of batching plant washout	Ground, ground water, surface water pollution	• Treatment plan to be included in Contractors Pollution Prevention Plan, which will include (as required), flow and load equalization, pH adjustment, sedimentation using settling basins or clarifiers etc. • All washout should be treated to comply with NEQS requirements for industrial effluent.	Contractor	CSC
B.4.6 Disposal of excess excavated material	Loss of habitat, loss of productive land	• Implement ECP 6 Erosion and Sediment Control and ECP 8 Topography and Landscaping • Reuse excavated material for strengthening of river training works and other usage (by ensuring appropriate quality) • Disposal of poor quality excess material in stockpiles on barren land.	Contractor	CSC
B.4.7 Closure of works	Soil, ground and surface water pollution	All solid waste not within landfills shall be removed from the project area on completion of works. ECP 8 topography and landscaping should be implemented	Contractor	CSC
B.5 CONSTRUCTION EQUIPMENT AND VEHICLES (relevant to all project activities)				
B.5.1 Mobilization of equipment and Materials through road	Road Safety and Traffic Management	• Implement ECP 15 on Road Transport and Road Traffic Management. • Ensure that all construction vehicles observe speed limits on the construction sites and on public roads • Provide adequate signage, barriers, and flag persons for traffic control. • Fit audible warning devices in all vehicles to alert during reversing. • Mandatory driver training should be provided to all the vehicular and equipment operators	Contractor	CSC
	Damage of local roads due to movement of heavy axle loads	• Maintain all existing roads in traffic worthy condition ensuring maintenance of uninterrupted movement of traffic. • Temporary bypasses to be constructed and maintained (including dust control) during the construction period.	Contractor	CSC

Project Activities	Environmental Impacts	Mitigation/Compensation Measures	Institutional Responsibilities	
			Implementation	Supervision
		• Form a grievance redress committee in association with affected population before starting the civil work and advance notice must be given to the community about the construction schedule. • Repair the damaged local roads to their original condition after project completion.		
	Dust and emissions from construction vehicles and equipment may cause health problems or accidents and injuries to construction workers and nearby community	• Implement ECP 10: Air Quality Management • Comply with the national guidelines on ambient air quality standards • Each vehicle related to the construction has to have valid "Emission Permit for motor vehicle" during construction • Vehicular traffic through communities will be avoided as far as possible. Vehicle speeds will be kept low if they should pass through communities. • Cover haul vehicles carrying dusty materials • Watering of the un paved roads	Contractor	CSC
B.5.2 Operations at Construction Yards and Construction Sites	Air pollution from material storage sites and mixing sites	• Implement ECP 10: Air Quality Management • Water to be sprayed during the construction phase in all mixing areas where dry materials are handled and / or crushed. Temporary access roads to aggregate sites must be included in the dust suppression program. A water spraying schedule will be prepared by the contractor and will serve as the basis of a dust control program. The Project authorities will regularly monitor this schedule. • Materials to be covered in vehicles going to and from the construction sites to reduce spills. • Comply with the national guidelines on air quality	Contractor	CSC
	Noise pollution from operation of construction yard and construction activities	• Implement ECP 11: Noise and Vibration Management • Provide temporary noise barriers near the sensitive sites • Vehicles and equipment to be fitted with the silencer and maintained accordingly • Use of vehicles, machineries and equipment those are of good quality and generates noise as per their specifications • Comply with the national guidelines on noise level. • Noise monitoring will be carried out in case of complaint by nearby residents or neighbors; and necessary noise reduction measures will be implemented if noise levels are in violation of standards.	Contractor	CSC
	Pollution risk from fuel and other hazardous material storage sites	• Implement ECP 2: Fuels and Hazardous Goods Management • Contractor to develop and undertake construction waste management strategy for both hazardous and non-hazardous wastes separately. • Contractor to confine the contaminants immediately after such accidental	Contractor	CSC

Project Activities	Environmental Impacts	Mitigation/Compensation Measures	Institutional Responsibilities	
			Implementation	Supervision
		spillage • Contractor to collect contaminated soils, treat and dispose them in through Sindh EPA certified contractors • All areas intended for storage of hazardous materials to be quarantined and provided with adequate facilities to combat emergency situations complying all the applicable statutory stipulation • Train the personnel in-charge of these sites to control access to these areas and entry to be allowed only under authorization		
	Air and noise pollution from Operation of generators for electricity generation	• Routine maintenance and regular inspection of these generators. • Use of canopy for diesel/gas generators for noise control/reduction • Comply with the national emission standards	Contractor	CSC
	Surface water pollution	• Implement ECP 3: Water Resources Management • Discharge sediment laden construction water into settling lagoons or tanks prior to final discharge • Discharge alkaline water from the concrete works that consists of fine particles into settling lagoons prior to final discharge	Contractor	CSC
	Occupational health and safety issues	• Implement ECP 18: Workers Health and Safety • Ensure construction related safety measures as an integral part of the construction works • Provision of adequate on site First Aid Boxes and treatment facilities	Contractor	CSC
B.6 RIVER TRAINING WORKS				
B.6.1 Excavation in borrow areas	Habitat loss	• Minimize volume of borrow material by reusing material excavated elsewhere in the project • Borrow areas should be identified within the marginal bunds of the barrage. No private or agricultural land will be used for borrow areas • Biodiversity monitoring of impacts on fauna. • Initial disturbance of new borrow areas should avoid breeding seasons to mitigate impacts on young-raising fauna. If there is any possibility of protected or sensitive plants in any areas, there should be preconstruction surveys to identify and mark no-go areas.	Contractor	CSC
	Landscape change	• Photographs recorded of each borrow area showing pre-construction baseline for comparison with after rehabilitation	Contractor	CSC
	Community conflict	• Contractor is responsible for determining ownership of land required for borrow areas and submits record to Engineer • Contractor to provide signed agreement with landowner for use including details of rehabilitation of area if privately owned • Works should be limited between 6am and 6pm	Contractor	CSC

Project Activities	Environmental Impacts	Mitigation/Compensation Measures	Institutional Responsibilities	
			Implementation	Supervision
	Disturbance/damage to unidentified architectural asset or graveyard	• No archaeological sites are reported with in the construction areas. However, in case any artifact or site of archeological, cultural, historical, or religious significance are discovered during construction activities, the works will be stopped in that area, and the Archeological Department will be informed. SID will facilitate the Department in documenting such chance finds and also for whatever actions are possible/feasible for their protection and conservation. Provisions for this will be included in the contracts	Contractor	CSC
B.6.2 Handling of excavated material	Dust emission and noise	• Implement ECPs 10 and 11 on Air Quality and Noise Quality Management • Contractor shall not double-handle material from borrow areas • Excavator operators shall be trained to reduce drop height from excavator to truck • Comply with the national guidelines on ambient air quality standards	Contractor	CSC
B.7 WORKS TO BARRAGE AND REGULATORS				
B.7.1 Removal of gates and lifting gear	Temporary disruption of traffic on the bridge	• Replacement of barrage gates to be achieved using barge mounted crane and hence any major disruptions to road traffic on the barrage is expected. However, if any temporary disruption is required, it should be carried out in nonpeak hours	Contractor	CSC
B.7.2 Operation of equipment and construction water transport in Indus River	Surface water pollution	• Heavy equipment on barges and boats should be regularly serviced to manufacturers recommendations • Equipment to be inspected daily for leaks • Contractor shall keep and maintain flexible boom elements and surface skimmers on site and in good condition, ready for speedy deployment, in the event of any pollution incident. • Training in use of flexible boom and surface skimmers to be included in contractors training plan • Annual drills in the use of flexible boom and surface skimmers to be carried out • Operations of equipment don't result in violation of water quality standards in Indus • Bilge waste must be collected and treated for separation and disposal of oils and fuel as hazardous waste. Contaminated bilge must not be discharged to the river	Contractor	CSC
	Risk of motor boats striking dolphin	• The boat movement on the downstream of the barrage should be limited to the construction related activities of the left bank divide wall. Otherwise all the boat movement should be on the upstream side of the barrage only. • Boat movement on the downstream of the barrage should be limited to within 500 m • Restrict motor boats speed within 15 km/h	Contractor	CSC

Project Activities	Environmental Impacts	Mitigation/Compensation Measures	Institutional Responsibilities	
			Implementation	Supervision
		• Pingers will be used to keep away dolphins from the motor boats		

B.7.3 Sheet piling for divide wall	Impact on dolphin and fish.	• Vibratory hammers should be used for pile driving instead of impact hammers. Under those conditions where impact hammers are required for reasons of seismic stability or substrate type, it is recommended that the pile be driven as deep as possible with a vibratory hammer prior to the use of the impact hammer.
		• Restrict piling during dolphin breeding period (July-August). During other season, an exclusion zone of 500m radius should be monitored for at least 30 minute before the start of piling. If dolphins are observed in the exclusion zone, piling works should be delayed until they have left the area. If dolphins enter the exclusion zone after piling has commenced, piling works should cease until they have left. It is also recommended that adoption of a 'soft start'; using a low energy start to the operations would give dolphins an opportunity to leave the area. In addition, the following mitigation measures are proposed:
		  • Gradually ramp up the sound levels to scare the dolphins away before piling commences
		  • Monitor area for dolphins to ensure they are well away from the piling site – scare them away if they are too close to the site using pingers.
		  • Monitor underwater noise levels to ensure compliance with international standards such as NOAA, and use of bubble curtains around the pile if required to reduce the noise levels.
			Contractor	CSC

	Impact of noise levels on birds	• Acoustic enclosure should be placed to cover the hammer and the exposed pile to reduce the air noise.	Contractor	CSC, PMO, External Monitor
	Risk of water contamination with concrete	• Unused concrete should not be disposed into the river water. • Unused concrete should be collected properly and disposed in the designated waste dumping site.	Contractor	CSC, PMO
B.7.4 Refueling construction water transport	Surface water pollution from fuel spill	• Provide bunding around refueling point for piling rig on barge • Provide spill kits and absorbent pads at refueling point on barge • Refuel small boats on shore • Use handheld auto-shut off delivery trigger and do not jam trigger opener • Close all hoses, taps and valves following refueling • Check the available capacity in the receiving tank before refueling • Training on refueling should be included in contractors training plan • Do not decant fuel manually from containers to fuel tank • Fuel tanks on vessels must be double skinned with 120% secondary containment volume	Contractor	CSC
	Fire	• Provide fire extinguishers at all on and off shore refueling points	Contractor	CSC
B.7.5 Transfer	Surface water pollution	• After filling fuel drums or belly tanks in dinghies, ensure caps are completely	Contractor	CSC

Project Activities	Environmental Impacts	Mitigation/Compensation Measures	Institutional Responsibilities	
			Implementation	Supervision
fuel to barge	from fuel spill	sealed. • Ensure drums and tanks are in the best possible structural condition • Two people must be involved in decanting between fuel drums • Fuel bowsers should be moored when fueling is complete • Fuel containers should not be stored in boats or vessels • Land based refueling points should be established with a concrete pad and bund or drip trays. Spill should be collected and disposed of as per ECP 2: Fuels and Hazardous Goods Management (or reused if possible)		
B.7.6 Replacement of gates and lifting gear	Surface water pollution	• All works associated with gates and lifting gears should be performed in dry areas. • Construction debris and parts should be removed from gate bays prior to removal of bulkhead gates. • Painting, application of protective coating and lubrication in gates and lifting gears should be completed first followed by complete drying prior to removal of bulkhead gates. • Spill kits with absorbent material should be provided within each dewatered gate bay and make available for all spills. Spills must be cleared as soon as possible using absorbent material. Absorbent material must be treated as hazardous waste and disposed of at designated site prior to removal of bulkhead gate.	Contractor	CSC
B.7.7 Construction of divide wall bank	Increased turbidity – impact on dolphin and other aquatic species	• Dredging takes place below the surrounding riverbed • Biodiversity monitoring of impacts on aquatic fauna	Contractor	CSC
B.8 SITE CLEARANCE AT NEW STAFF COLONY				
B.8.1 Demolition existing structures in the colony	Solid Waste, excess materials	• Implement ECP 1 on Waste Management • Reuse of building waste in scour protection of river training works • Disposal of poor quality excess material in designated disposal sites.	Contractor	CSC
	Noise	• Limit hours of works from 6am to 6pm • Community Liaison Officer to notify affected people prior to works	Contractor	CSC
B.9 Occupational Health and Safety				
B.9.1 General construction works	Health and safety of staffs and adjacent communities	• Contractor shall prepare and submit a Health and Safety plan to PMO for approval • Inclusion of regular training of all staff in health and safety best practices in Contractor's training plan. • Provision and enforcement of the use of personnel protection equipment (PPE, such as life jacket, safety harnesses, gloves, safety boots, hard hats, dust masks, ear protectors, safety goggles, personal protective clothing etc.) as per approved Health and Safety Plan. Measures for enforcement of use of PPE to be included in Health and Safety Plan.	Contractor	CSC

Project Activities	Environmental Impacts	Mitigation/Compensation Measures	Institutional Responsibilities	
			Implementation	Supervision
		• Contractor to submit accident reports to the Engineer following any accident on site. Report must detail actions to be taken to reduce risk of reoccurrence • Qualified health and safety manager shall be appointed by contractor • Contractor shall engage a full time doctor or paramedic on site. • Provision of dispensary for treatment of staff. Dispensary to be stocked with appropriate medicines for likely incidents, diseases and ailments to occur on site. Stock to be replenished as necessary • First aid facilities shall be provided at each work site on the project area • The contractor shall include in the health and safety plan a procedure for the transfer of injured staff or community member insured as a result of his works from site to medical facilities, including transport and provision of medical treatment en-route.		
B.9.2 Appointment of unskilled labor	Exploitation of local communities	• Contractor shall not retain, nor allow any third party employer to recruit labors who are less than 14 years of age or pregnant women. • Contractor shall not employ, nor allow a third party employer to recruit any child under the age of 18 years for hazardous tasks • Neither contractor nor third party employers shall engage forced or bonded labor • Contractor shall provide works with information regarding their rights relating to hours of work, wages, overtime and compensation, and ensure third party employers do the same. • Contractor shall provide a grievance mechanism for staff to raise work place concerns and ensure third party employers also maintain a similar mechanism for grievances. • The contractor shall not discriminate against any staff candidate on the basis of gender, race, nationality, ethnic, social and indigenous origin, religion or belief, disability, age, or sexual orientation, and ensure third party employers main the same standards. • Contractor shall ensure workers receive notice of dismissal and severance payments as per national labor law. • The contractor shall provide employment opportunities to members of the local community.	Contractor	CSC
C. CUMULATIVE IMPACTS OF BARRAGES IN SINDH				
C.1 Dolphin conservation and management in the game reserve	Improvement of prey base; less occurrences of stranding and mortality in the irrigation canals, reduction in poaching	• Detailed surveys on population status for two years covering both high flow and low flow season in each year. • Threat assessment surveys and develop mitigation plan. • Recommend no fishing zone in the river stretches that support breeding population. • Capacity building of the line government agencies and universities on dolphin	Consultants	PMO, SID

Project Activities	Environmental Impacts	Mitigation/Compensation Measures	Institutional Responsibilities	
			Implementation	Supervision
	for oil, and less entanglement in fishing nets.	research, conservation and management. • Develop sustainable fishery management plan. • Install screens in the canal gates or dolphin deterrent devices such as pingers. • Involve local communities in dolphin conservation and management. • Support wildlife department in establishing rescue units to rescue dolphins stranded in canals. • Develop education and awareness programs.		
C.2 Fish migration and fish passes in the barrages	Restriction on migratory fish during the breeding, spawning, and growth	• Fish ladders in Kotri and Guddu barrages must be rehabilitated to work effectively and new fish pass should be installed in Sukkur barrage. • Further studies are recommended understanding the biological requirements of hilsa, especially on breeding habitats, spawning grounds, migration route, and depth of water requirement for migration etc. • Study recommended to understand the biological requirements of hilsa, especially on breeding habitats, spawning grounds, migration route, swimming capabilities, water velocity and depth of water requirement for migration etc. • Based on the study findings, redesign the fish passes and rehabilitate them as per the species requirements in Pakistan.	Consultants	PMO, SID
C.3 Proper utilization of irrigation water	Water wastage, water logging, soil salinity, and sodicity	• Support small and medium size farmers in more productive use of waters. • Provide trainings in efficient use of water, soil, crop management, alternate use of saved water etc. • 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 routine water courses improvement for better management of irrigation water.	SIDA	PMO, SID
D. Operation and Maintenance Stage				
D.1. Risk of barrage failures due to floods and earth quake	Loss of infrastructure and life	• Update and approval of draft emergency response plan prepared by the Design Engineering Consultant • Annual review of the plan and carry out mock drills	Chief Engineer, Guddu Barrage	SID
D.2. Hazardous material management	Risk of water and land pollution due to improper management of hazardous material.	• Review of operational practices on hazardous material management and update them in compliance with ECP 2: Fuels and Hazardous Goods Management	Chief Engineer, Guddu Barrage	SID

8.6 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 8.2 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 0.5 million.

Table 8.2: 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
Local roads	Visual inspection to ensure local roads are not damaged	Monthly	Contractor	CSC, PMO

Parameter	Means of Monitoring	Frequency	Responsible Agency	
			Implementation	Supervision
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

8.7 Capacity Building and Training

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. Capacity building will be aimed at strengthening the PMO and Guddu operational staff in the field of environmental management and social development. Members of the ESU responsible for supervision of environmental and social mitigation measures would be trained in environmental management, environmental quality control, ecology, environmental awareness, participatory approach and social development. The contractor will also be required to provide environmental and social trainings to its staff, to ensure effective implementation of the ESMP. A budget of USD 0.25 million has been earmarked for capacity building. The training plan shall include a programme for the delivery of intermittent training, to cover the subjects included in Table 8.3. Training should be carried out initially at induction of staff and repeated throughout the project.

Table 8.3: Training Subjects for Inclusion in Contractors Training Plan

Training Subject	Target Audience
Environmental Code of Practices	All staff
Handling, use & disposal of hazardous material	Construction workers with authorised access to hazardous material storage areas and required to use hazardous material during their works
Waste Management	All staff (construction and camp staff)
Efficient& safe driving practices, including road & vehicle restrictions	Drivers & mobile plant operators
Actions to be taken in the event of major or minor pollution event on land	All construction staff
Use of flexible booms and surface skimmers in event of pollution event in water	All construction staff working on barrage, head regulators and divide wall
Pollution prevention: Best practice	All staff

Training Subject	Target Audience
Refuelling of water borne plant – pollution prevention	Operators of water borne plant & vehicles
Health & Safety: Safe way to work & hazard awareness	All construction staff and O&M Staff
Health & Safety: Safe use of plant & equipment	Operators of plant & equipment
Health & Safety: Working at height	Staff colony, barrage & regulator construction staff
Health & Safety: Working near/on water	All construction staff working on barrage, head regulators and divide wall
Health & Safety: Working near/on water	All construction staff working on barges
Health & Safety: Use of PPE	All construction staff
Occupational Health and Safety	To all persons entering the construction site
Emergency procedures and evacuation	All staff
Diver training	All divers
Spill clean up training	Contractor's spill management staff
Fire fighting	All staff
Site inductions, including requirements under the Environmental Management Plan & details of environmentally sensitive areas of the site	All staff
Culturally sensitive awareness rising on HIV/AIDS and the spread of sexually transmitted diseases. Awareness raising on risks, prevention and available treatment of vector-borne diseases	All staff
Cultural sensitivities of the local population	On induction of all non local staff

8.8 Audits and Annual Review of ESMP

Internal environmental audits will be held with an objective to review the effectiveness of environmental and social management of the project. CSC under the supervision of ESU will carry out annual review of the appropriateness and adequacy ESMP and SMF in the light of its own monitoring and supervision as well as on the basis of the third party monitoring and audits discussed earlier. CSC will revise the ESMP and SMF in case substantial gaps and shortcomings are identified in these plans.

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

8.9 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. 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 Grievance Redress Mechanism is shown in Figure 8.2 and the recommended members of the Grievance Redress Committee are shown in Table 8.4.

Table 8.4: Grievance Redress Committee

Representative	Position
Head of PMO	Chairman
ESU Deputy Director (Social)	Secretary

Representative	Position
Community Representative(s)[35]	Member(s)
Irrigation Department Representative	Member
Construction Supervision Consultants Representative	Member
Contractors Representative	Member
Revenue Department Representative	Member
SIDA Representative	Member

[35] This may be, for example, a landlord in the project area, or any community member representing project affected persons

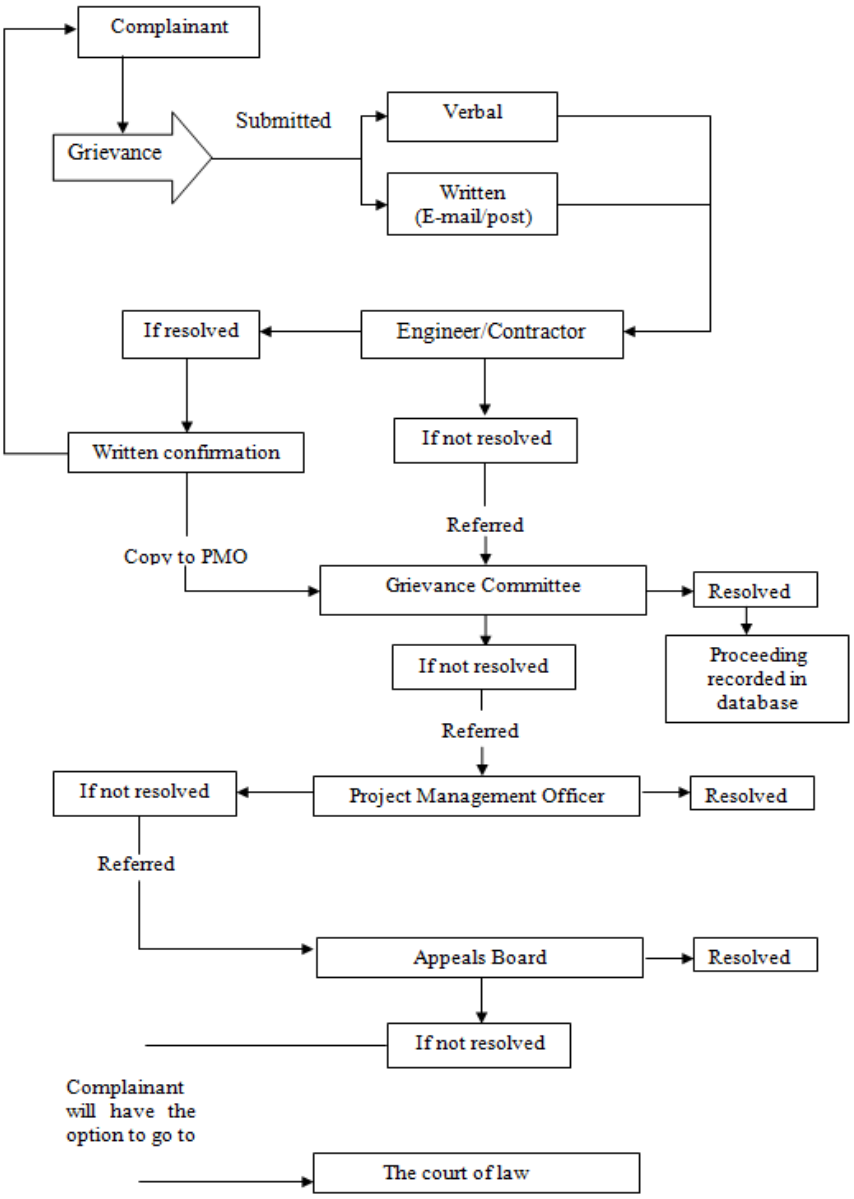

Figure 8.2: Grievance Redress Mechanism

8.10 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 will prepare monthly reports covering various aspects of the ESMP implementation including compliance and effects monitoring, capacity building, and grievance redressal. List of reports to be prepared during implementation are given in Table 8.5.

Table 8.5: Reporting during implementation

Report	Contents	Prepared by	Distribution
Monthly	Non-Compliances observed on sites and actions required	Environmental/Social team of the Engineer (CSC)	ESU – PMO; MEC; SID, Contractor
Monthly	Actions taken on site in response to CSC Monthly report Project progress and works to be undertaken in the coming three months Details of training delivered Details of accidents reported and actions taken	Contractor	CSC ESU – PMO; MEC
Quarterly	Quarterly review on implementation of ESMP including compliance and effects monitoring, capacity building, and grievance redressal	ESU – PMO	PMO Sindh EPA; SID, SIDA, World Bank, CSC, Contractor
Simi-Annual	Semi-annual reporting for OHS, including workhours, number of lost-time accidents/incidents, serious injuries and fatalities, amount of lost time, root cause investigations, etc. There should also be some incident reporting requirements, such as for major spills, fatalities, local unrest, etc.	ESU – PMO	PMO Sindh EPA; SID, SIDA, World Bank, CSC, Contractor
Annual	Results of effects monitoring Independent review of environmental and social performance on site Recommended actions required by all parties	MEC	PMO, Sindh EPA SID, SIDA World Bank, CSC, Contractor

8.11 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 8.6 and Table 8.7 respectively.

Table 8.6: 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 8.7: Social Management Framework 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 stakeholders consulted are given in Table 9.1 and Table 9.2 and they include (i) population around the project area and community representatives. (ii) farmers in the command area of Guddu barrage, (iii) industrial users of the canals, such as Guddu thermal power plant, (iv) district and provincial government authorities responsible for district administration, roads, forest, rural development, agriculture, fisheries, wildlife and environmental protection, (v) community based organizations and (vi) conservation agencies such as IUCN and WWF. Details of consultees are given in Annex E.

Table 9.1: Details of Stakeholders Consulted

General population in Project Area	• Head of households, • Female • Farmers (tenant and owners) • Shop owners • Laborers • Fishermen • Religious Leaders • Motorists
Command Area	• Farmers • Livestock Owners • Guddu Thermal Power Plant • Fauji Fertilizer Plant • Engro Fertilizer Plant • PanoAkil Cant. • Sugar Mills
Local and Provincial Governments	• District administration of Kashmore • Rural development department • Sindh environmental protection agency • Forestry department • Agricultural department • Fisheries department • Sindh wildlife department
NGOs	• Mojaz foundation • Soofi Sachal Sarmast welfare association • Kainat development association • WWF • IUCN

Table 9.2: 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 9.3.

Table 9.3: Issues Raised in Community Consultations

	Comments and Suggestions	Action Point
I	**Consultations carried out by Independent Consultants**	
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, especially from its recently installed combined cycle generators, 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 coffer dams 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 coffer dams 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 Section 4.8. 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 government should consider construction of a new toll bridge parallel to Guddu barrage.	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	An area development plan with a fund of USD 2 million is proposed under the project to develop education and health facilities and community development programs

	community for these facilities.	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	Training programs are to be conducted to the personnel involved in implementation works to ensure effective implementation of environmental and social management plans	Capacity building and training programs will be conducted to PMO staff, Contractors and barrage operation staff involved in implementation of the project for effective implementation of ESMP.
10	Precious irrigation water is being wasted by poor irrigation practices by the farmers, and also due to seepages from unlined water courses	Capacity building programs for farmers' organisations are recommended for improved irrigation efficiency. SIDA is carrying out similar programs through its ongoing WSIP project.
II	**Consultations carried out by design consultants**	
	Primary Stakeholders	
1	The contractor should be required to maintain close liaison with the local population for easy and timely resolution of issues/disputes arising during the construction stage.	The contractor shall employ a full time, qualified Community Liaison Officer for the project who is conversant with the World Bank's social safeguard policies and other community liaison issues
2	Project should ensure free mobility of all, especially women, during the implementation of the project	Contractor will be bound to avoid routes used by the women and girls as far as possible. If unavoidable, alternate routes will be identified for the women in consultation with the community
3	Proper sprinkling of water on access routes should be ensured during the construction stage to control dust pollution	Contractor will be bound to control dust pollution by regular sprinkling on dust prone areas.
4	Disturbance of the population by construction activities at night was a major concern	The noise generating activities will be avoided during night time.
5	Communities showed concerns that a non-local workforce would not be aware of local customs and norms, which may result in conflicts in the community	The Contractor shall develop a Worker Code of Conduct to govern the behaviour of workers on site, in camps, and with local communities. This shall cover cultural awareness or workers from outside the project area, a drugs and alcohol policy with information about testing and penalties for contravention, and information about communicable diseases.
6	The communities showed concerns regarding disturbance of access routes along marginal bunds during construction.	The access roads along with the marginal bunds will be kept operational.

7	Existing unemployment issues in the project area	The requirement for provision of employment opportunities to residents of the project, and surrounding area, shall be included within the contract document.
8	Employment of youth on the project was requested	
9	Rights to employment of local labour in Guddu Barrage project required	
10	Schools in the project area lack furniture and staff	A social development plan is proposed in the Social Management Framework of this project with an objective to develop education and health care in the project area
11	Requirement for establishment of dispensaries in the project villages.	
	Institutional Stakeholders	
12	Concerns over risk of conflict between local communities and contractors labour force during construction	• The main mitigation for this impact is the preparation and implementation of the contractor's Communication Strategy. • This strategy shall focus on early and continued consultation by the contractor with influential figures within the project area. • The Communication Strategy 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.
13	Construction related issues like excavated material, soil erosion and hazards for local communities and labour force should be appropriately addressed during the construction activities.	• Traffic will be limited to work areas and established tracks. • Access roads to be adequately compacted and/or regularly sprinkled to prevent dust generation. • Warning signs will be provided where access routes pass adjacent to settlements. • Vehicle speeds will be limited to 30km/hr. • Safe driving practices included in Contractor's training plan. • Provision and enforcement in use of all necessary PPEs (such as life jacket, safety harnesses, gloves, safety boots, hard hats, dust masks, ear protectors, safety goggles, overalls etc.) as per approved Health & Safety Plan. Measures for enforcement of use of PPEs to be included in Health & Safety Plan.
14	The endangered Indus dolphin may be impacted by project activities.	Dolphin Conservation and Management Plan has been prepared and will be implemented
15	Construction activities in Indus River will exert significant impacts on aquatic life	Impact of construction activities are considered in ESMP
16	Health and safety measures shall be required for the labour force	The Contractor shall be bound to employ a full time Health and Safety Officer who has a relevant qualification and experience.
17	Safe transportation of construction material should be ensured	Traffic management plan to be submitted to Engineer for approval and to include routes for delivery vehicles Flag persons to be provided where partial closure of public highway is required to maintain traffic flow
	Female Consultation	
18	Due to the presence of construction personnel, mobility of women shall be impacted and they will not be able to use areas currently used for toilet needs. The construction of toilets for women in villages by the project was	Avoid routes used by the women and girls as far as possible. If unavoidable, alternate routes will be identified for the women in consultation with the community

	requested.	
19	A mechanism for the resolution of conflicts and grievances arising during construction is required	The Communication Strategy shall 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.
20	Improved secondary education for girls is required	A social development plan is proposed for the project
21	Concern was raised over the demolition of, or damage to, religious sites and graveyards	No religious structure will be disturbed.
22	There is an urgent need for Basic Health Units in the project area	A social development plan is proposed for the project
23	Trained female health visitors should be available in the project area	
24	A maternity health care centre was requested in the project area	
	Government Organizations	
25	Guddu Barrage is located at the Dolphin Reserve and as such the Sindh Wildlife Department should be consulted at all stages of project intervention	Primary level stakeholder consultation has been done with Sindh Wildlife Department. Also, continued consultation with Sindh Wildlife Department and other related stakeholders shall be maintained during construction.
26	The Indus Dolphin is very sensitive to noise and turbidity during construction	Construction related impacts on dolphin are covered in the ESMP
27	Over fishing, use of illegally sized mesh, off season fishing, drought and industrial effluents are considered major factors resulting in the decline in population of commercial fish	These issues are covered in dolphin conservation and management plan
28	Fishermen are interested in developing fish farms but require the lease of suitable land	A social development plan is proposed under the project.
29	Most people are in favour of fish stocking in the pond area as a step towards improving the fish stocks.	
30	Cold storage is required for preserving fish before sale or transfer to market	
31	Concerns over the impact of increased turbidity resulting from the construction and destruction of temporary cofferdams and impacts on fish movement were raised	The proposed construction approach doesn't require construction of any coffer dams
32	River pollution is seen as a major risk to the population of commercial fish	Risk of river water pollution is considered in ESMP and appropriate mitigation measures were proposed.
	Project Landlords	
33	The need for adequate security during construction was stressed	Fencing & security shall be provided by contractor at all camps. Entrance to camps shall be monitored and restricted. The contractor shall include in the Emergency Plan, a procedure for emergency evacuation of camp & practice this procedure. Contractor shall provide all staff with identity cards showing their association with the project

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 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, media, 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 on 10 November 2014.

Annex A

Terms of Reference and scope of the services

For

Independent Team of Consultants to validate and update the existing Social and Environment Safeguard documents as per guidelines of World Bank prepared by the Guddu Barrage Rehabilitation Design Consultants

1. Background

1.1 **General**. Guddu barrage is located in about 13km (8 miles) north-east of Kashmore district of Sindh Province having longitude coordinate of 69^{o} 45'E and latitude coordinate of 28^{o} 25' N. It is first of the three barrages constructed across the Indus River in Sindh Province downstream of Taunsa barrage located in Punjab Province. It is situated at a distance of 630Km from Karachi, 190Km from Sukkur and 130Km from Rahimyar Khan. It is accessible by metalled road from these cities. The nearest airport, where the commercial flights are operative, is at Rahimyar Khan.

1.2 **Guddu barrage**. The primary function of the gated Guddu barrage is to provide irrigation water to over one million hectares of agricultural lands in the Jacobabad, Larkana and Sukkur districts of Sindh and the Naseerabad district of Balochistan, by feeding the Ghotki Feeder and Rainee canals on the left (east) side and the Begari Sindh (BS) Feeder and Desert Pat Feeder canals on the right (west) side. The barrage incorporates two fish ladders. The barrage is also used for river control and flood management. It has been designed to pass a super-flood discharge of up to 33,980 cubic meters per seconds (cumec). The barrage is also an important transport link across the River Indus and provides cooling water for the thermal power station at Guddu. Two major gas lines cross the barrage. The barrage was commissioned in 1962 and has now seen over fifty years of active service. It consists of 64 gates of 18 meters each and 1 navigation lock with a span of 15 meters.

1.3 Since the rate of corrosion cannot be slowed it is considered likely that the gates will fail during normal operation within 5 years. There is already at 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 Due to the recent flood events upstream embankments were breached. The river training works around the Guddu barrage require upgrading to meet the new criteria: they must be able to withstand 1:100 year floods.

1.4 A recently completed feasibility study by an international engineering consulting firm, which was commissioned by the Government of Sindh, indicates that there are serious operational difficulties and safety issues, the most severe problems being: i) up to 60% of the steel of the 65 gates on the main barrage is badly corroded; ii) the lifting mechanisms are badly corroded, with a strong possibility of failure; iii) the switch panels and power distribution network are in extremely poor condition; and iv) 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.

1.5 The project is confined to a single site and involves works that have been designed in detail based on a well-prepared detailed Feasibility Study (FS) of an international standard. The project involves mechanical and civil works on the existing barrage structure (rehabilitation), and no new works are included. By far the largest and most complex element of these works is the removal and replacement of the 65 barrage gates and 25 head regulator gates. A detailed

inspection of each gate shows that wear and tear on the gates, rollers and hoists is considerable and that the probability of failure is evident. There is considerable risk of failure of the main barrage gates within the next five years. Considering that it will take about four years for the project to be completed and for all the gates and mechanical equipment to be replaced, the proposed project needs to proceed, so that the gates are replaced before any failure occur.

1.6 A condition assessment of Guddu Barrage has been carried out as part of the feasibility study, and the following project interventions have been identified as necessary to safeguard the continued operation of Guddu Barrage:

- Raising & strengthening of existing embankments;
- Replacement of gates and lifting gear to barrage and three regulators;
- Minor civil repairs to barrage and three regulators;
- Construction of Left Pocket Divide Wall; and,
- Construction of Staff Colony.

1.7 The Irrigation Department (ID) of Sindh is the executing agency for the Project. ID will execute the Project through Chief Engineer Guddu Barrage by establishing the Project Directorate or by a Project Management Office (PMO).The detailed ESIA studies have already been conducted by the Design Consultants of the Guddu Barrage project and it is proposed that since this is the Category A project under Bank's Safeguard Policy OP.4.01 *Environmental Assessment (The borrower is responsible for carrying out the EA. For Category A projects, the borrower retains independent EA experts not affiliated with the project to carry out the EA.)*. Therefore, a team of independent consultants will be hired for two months as to review and validate the Environmental and Social Impact Assessment study already carried out by the Design Consultants and prepare the full ESA and executive summary for the project. The task will be divided among the team of independent environmental consultants. The following expertise will be required to accomplish the task.

1-Environmental Expert (experience in water resource projects)/ Team Leader **International 25 days**

2- Cumulative Impact Assessment Expert/Environmental Specialist **International 15 days**

3- Environmental Ecologist (vast experience in River Dolphin surveys) **National 25 days**

4-Environmental Engineer (experience in water resources projects) **National 25 days**

1.8 The team will technically review and use already prepared ESIA report as the reference report and update it after finding the gaps, analyze the data provided in the report as per detailed guidelines of Safeguard policies of World Bank. Further the team will also conduct and analyze the impact on dolphin habitat under the declared protected boundary i.e. Guddu barrage to Sukkur barrage and will suggest the best suitable and practical measures to alleviate project impacts on species and habitat, if any.

2. Scope of Work

1.9 The team of independent consultants lead by Mr. Venkata S. Nukala will review and make use of all the existing information available and in particular data, tools and models used in preparing the safeguard documents. This will include, reports, maps, surveys conducted so far, Environmental and Social including the important ecological and species surveys and habitat management and mitigation measures and analysis, etc.

The specific task will cover but not limited to:

i. Review of Design Consultant's ESIA report and identify gaps in the baseline data (environmental and social analysis), and recommend additional data collection by the Design Consultant in reference to the requirements as set out in World Bank's all safeguard policies.to the consultants will also look into the methodology adopted by the Design consultant for scoping and screening of issues and will fill in the gaps in procedures as per WB guidelines and update the analysis; locations of quarry sites, and volume of earth works.

ii. The consultant will also review the chapter on the 'Analysis of alternatives' in the reference report and would assess the coverage, typology, environmental and social aspects for each of the alternative considered including that of without project option and present analysis on project design and construction methodologies with the environmental and social justification for the final recommendation. Information on associated facilities, requirement of resources, etc. Need for the Project and overall analytical framework. A clear narrative to be provided for overall planning and assessment process undertaken by WSIP and Sindh ID to identify this project and arrive at the current project design, and the environmental and social work performed along the way with the assistance provided by Design Consultants.

iii. Indicate the objective, scope and criteria of the validation of its work.

iv. Identify gaps in the social and environment safeguard documents and provide the relevant / necessary information and data as per SEPA guidelines to finalize the documents.

v. The consultants will look into the adequate implementation arrangements of the project construction activities.

vi. After assessing the adequacy and coverage of stakeholders consultation in the reference report, Independent Consultants will consult the relevant departments and stakeholders to document their concerns appropriately and proposed measures to address these concerns properly in the document and share the draft report with them for finalization.

vii. Technically review the safeguards documents in order to fine tune and finalize and get ready for further process of approval from Sindh EPA and Sindh Wildlife Department for obtaining NOC certificate. The final ESA report must also conform to the World Bank's all safeguards policies requirements for category A projects.

viii. They will also available for single coherent stakeholder's consultation and information disclosure organize by the client in public hearing conduct by Sindh EPA for final clearance

ix. The consultants will strengthen the environmental and social management plan (ESMP) in the reference report in a way that the Plan presents very clear actions (corrective and enhanced measures) as against statements of Intents, fix very clearly responsibilities for their execution along with the frequency for monitoring. The Plan would also lay out the protocols for documentation and reporting, and change management, and grievance redressal. The plan would also be appropriately costed.

Environmental Ecologist (Dolphin Expert):

x. Site visits and stakeholder consultations and other gather relevant secondary data.

xi. Analyze the impact of construction activities such as dredging and piling on the fish and dolphin habitats, and strengthening of mitigation and compensation measures. Review and Analyze the impact on sensitive riparian habitat due to construction of bunds and details of restoration measures needed

xii. Assess the performance of the fish ladder and propose improvements or alternatives based on best global practices available technologies if possible.

xiii. Review and update the current status of the Indus dolphin in its reserve area.

xiv. Analyze the impact of the project activities on aquatic ecosystem in general particularly on Indus dolphin as well.

xv. Suggest measures to minimize the negative impacts in general on aquatic ecosystem and particularly on Indus dolphin by the project activities.

xvi. Review EMP and provide short and long term measures for the conservation of Indus dolphins.

xvii. Develop a rescue plan for the potential trapping of dolphin during the construction activities along with clear listing of responsibilities for the implementation of rescue plan.

Water Resource Expert:

xviii. Site visits and stakeholder consultations and other relevant secondary data.

xix. Impact on downstream irrigation and drinking uses during replacement of barrage gates.

xx. Correlate with all the environmental laws and regulatory frameworks on HSE, sustainable use of natural resources and acceptable national and international standards.

xxi. Review and improve monitoring program, parameters and procedures indicated in the EMP for control and corrective actions in case of emergencies and develop emergency response plan.

xxii. Review and analyze the inundation maps for determining the extent of flooding in relation to the people at risk, properties and access routes.

xxiii. Review and identify if not included in the EMP the routes likely to be destroyed indicate the main flow areas.

xxiv. Review and identify the features likely to affect mobility evacuation during and after the event including the impact on infrastructure and the deposition and scour of debris and sediment

Cumulative Impact Assessment Expert/ Environmental Specialist:

xxv. Review the existing reports ESIA of Guddu and Sukkur Barrage prepared by Design consultants. Plan site visits, meetings and gather other relevant secondary data.

xxvi. Undertake cumulative impact assessment of the irrigation infrastructure rehabilitation program on the Indus main and find out the incremental impact likely to happen due to Guddu and other downstream barrages (and other developments around Guddu, such as thermal power plants, Sukkur Barrage) on the valued ecosystem components of Indus such as dolphin or irrigation.

3. Implementation Arrangements

1.10 The Consultant will work closely with Irrigation Department Sindh to whom they will be reporting on a day to day basis and Sindh Irrigation and Drainage Authority coordinate with Project Coordination and Monitoring Unit (PCMU) WSIP Project.

1.11 The Head of Project Management Organization (PMO)/ Project Director, Sindh Barrages Rehabilitation Project, Irrigation Department, will be representative of the client to coordinate all interfaces with the Consultants while WSIP team will support. The lead consultants' will be the principal contact.

1.12 The Consultants shall be responsible for all aspects of performance of services as set forth in the preceding sections of this TOR. Government of Sindh and SID (Sindh Irrigation Department) will be responsible for providing the existing data and information including all reports prepared so far for the project.

1.13 Selection Procedure and Form of Contract. The team of Independent Consultants will be selected on merit based on qualification and experience of the consultants in relevancy to the assignments and following the World Bank's Procurement Guidelines.

1.14 Duration of the Assignment. Duration of the contract will be for two months after final approval and selection by the client.

Beneficiaries

- Irrigation Department, Government of Sindh

Annex B: Baseline Data of Biological Environment

List of Mammals

S.No	Common name	Scientific name	IUCN Redlist	CITES Appendix
1.	Indus Dolphin	*Platanista gangetica minor*	Endangered	I
2.	Smooth-coated Otter	*Lutrogale perspicillata*	Vulnerable	II
3.	Hog Deer	*Axis porcinus*	Endangered	III
4.	Golden Jackal	*Canis aureus*	Least Concern	III
5.	Jungle Cat	*Felis chaus*	Least Concern	II
6.	Wild Boar	*Suss crofa cristatus*		
7.	Indian Hare	*Lepus nigricollis*	Least Concern	II
8.	Fishing Cat	*Felis viverrina*	Endangered	II
9.	Small Indian mangoose	*Herpestes Javanicus*		III
10.	Indian Porcupine	*Hystrix indica*		
11.	Hedgehog	*Hemiechinus spp.*		
12.	Fox	*Vulpes bengalensis*		
13.	Asiatic Jackal	*Canis aureus.*		III
14.	Desert Cat	*Felis silverstris*		III
15.	Five stripped palm squirrel	*Funambulus*		
16.	Indian grey mangose	*Herpestes edvars*		III

List of Amphibian and Reptile species of Indus Dolphin Game Reserve

Common name	Scientific name	Status	IUCN Redlist	CITES Appendix
Skittering frog	*Rana cyanophlyetic*	Common		
Tiger frog	*Rana tigrina*	Less Common		II
Indus toad	*Bufo andersoni*	Common		
Green toad	*Bufo viridis*	Less common		
Checkered keelback	*Xenochrophis piscotor*	Less common		
Marsh snake	*X. cerasogaster*	Less common		
Cat snake	*Boiga trigonata*	Less common		
Dhaman	*Ptyas mucosus*	Less common		II
Royal snake	*Sphalerosophis atriceps*	Less common		
Sand snake	*Psammophis condanarus*	Less common		
Indian krait	*Bungarus caeruleus*	Less common		
Cobra	*Naja naja*	Less common		II
Russell.s viper	*Viper russelii*	Rare		
Saw-scaled viper	*Echis carinatus*	Common		
Monitor lizard	*Varanus bengalensis*	Less Common		I
Spinytailed lizard	*Uromastic hardwicki*	Common		II
Indian softshell turtle	*Trionyx gangeticus*	Less common		I
Indian flapshell turtle	*Lissemys punetata*	Common		
Brown river turtle	*Kachuga amithi*	Common		

List of Avifauna in Indus Dolphin Game Reserve

S.No	Common name	Scientific name	Status	IUCN Redlist	CITES Appendix
1.	Avocet	*Recurvirostra avosetta*	Less common	Least Concern	
2.	Bank myna	*Acridotheres ginginianus*	Less common	Least Concern	
3.	Bay backed shrike	*Lanius vittatus*	Less common	Least Concern	
4.	Black bellied tern	*Sterna acuticauda*	Less common	Endangered	
5.	Black partridge	*Melanoperdix niger*	Rare	Vulnerable	
6.	Black shouldered kite	*Elanus caeruleus*	Less common	Least Concern	II
7.	Black winged stilt	*Himantopus himantopus*	Common	Least Concern	
8.	Black-headed gull	*Chroicocephalus ridibundus*	Common		
9.	Blue rock pigeon	*Columba livia*	Common	Least Concern	
10.	Bonellis eagle	*Aquila fasciata*	Rare	Least Concern	II
11.	Brahminy kite	*Haliastur indus*	Common	Least Concern	II
12.	Collard dove	*Streptopelia decaocto*	Common	Least Concern	
13.	Common Babbler	*Turdoides caudata*	Common	Least Concern	
14.	Common buzzard	*Buteo buteo*	Less common	Least Concern	II
15.	Common Indian myna	*Acridotheres tristis*	Common	Least Concern	
16.	Common sandpiper	*Actitis hypoleucos*	Common	Least Concern	
17.	Common wood shrike	*Tephrodornis pondicerianus*	Rare	Least Concern	
18.	Coot	*Fulica atra*	Common	Least Concern	
19.	Coucal	*Centropus*	Less common		
20.	Crested lark	*Galerida cristata*	Common	Least Concern	
21.	Great horned owl	*Bubo virginianus*	Less common	Least Concern	II
22.	Greater spotted eagle	*Aquila clanga*	Less common	Vulnerable	II
23.	Green sandpiper	*Tringa ochropus*	Less common	Least Concern	
24.	Green shank	*Tringa nebularia*	Less common	Least Concern	
25.	Grey heron	*Ardea cinerea*	Less common	Least Concern	
26.	Grey partridge	*Perdix perdix*	Less common	Least Concern	
27.	Herring gull	*Larus argentatus*	Common	Least Concern	
28.	House bunting	*Emberiza sahari*	Less common	Least Concern	
29.	House crow	*Corvus splendens*	Common	Least Concern	
30.	Indian black kite	*Milvus migrans*	Common	Least Concern	II

31.	Indian house sparrow	*Passer domesticus*	Common	Least Concern	
32.	Indian house swift	*Apus affinis*	Less common	Least Concern	
33.	Indian river tern	*Sterna aurantia*	Less common	Near Threatened	
34.	Indian robin	*Saxicoloides fulicatus*	Less common	Least Concern	
35.	Indian roller	*Coracias benghalensis*	Less common	Least Concern	
36.	Indian sand lark	*Calandrella raytal*	Less common	Least Concern	
37.	Indian sand martin	Riparia riparia	Less common	Least Concern	
38.	Indian scopes owl	*Otus bakkamoena*	Less common	Least Concern	II
39.	Indian tree pie	*Dendrocitta vagabunda*	Less common	Least Concern	
40.	Jungle babbler	*Turdoides striata*	Less common	Least Concern	
41.	Kentish plover	*Charadrius alexandrinus*	Common	Least Concern	
42.	Black drongo	*Dicrurus macrocercus*	Common	Least Concern	
43.	Koel	*Eudynamys scalopica*	Less common	Least Concern	
44.	Lesser sand plover	*Charadrius mongolus*	Common	Least Concern	
45.	Little cormorant	*Microcarbo niger*	Common	Least Concern	
46.	Little egret	*Egretta garzetta*	Common	Least Concern	
47.	Little grebe	*Tachybaptus ruficollis*	Common	Least Concern	
48.	Little green bee-eater	*Merops orientalis*	Common	Least Concern	
49.	Little ringed plover	*Charadrius dubius*	Common	Least Concern	
50.	Little stint	*Calidris minutus*	Common	Least Concern	
51.	Little tern	*Sterna albifrons*	Common	Least Concern	
52.	Long tailed grass warbler	*Schoenicola platyurus*	Less common	Vulnerable	
53.	Marsh harrier	*Circus aeruginosus*	Less common	Least Concern	II
54.	Night heron	*Nycticorax nycticorax*	Common	Least Concern	
55.	Osprey	*Pandion haliaetus*	Less common	Least Concern	II
56.	Pied bush chat	*Saxicola caprata*	Less common	Least Concern	
57.	Pied kingfisher	*Ceryle rudis*	Common	Least Concern	
58.	Plain prinia	*Prinia inornata*	Less common	Least Concern	
59.	Pond heron	*Ardeola grayii*	Common	Least Concern	
60.	Purple Moonrhen	*Porphyrio porphyrio*	Less common	Least Concern	
61.	Purple sunbird	*Cinnyris asiaticus*	Common		
62.	Red shank	*Tringa totanus*	Less common	Least Concern	
63.	Red vented bulbul	*Pycnonotus caffer*	Less common	Least Concern	
64.	Red watlled lapwing	*Vanellus vanellus*	Common	Least Concern	
65.	Rose ringed parakeet	*Psittacula krameri*	Less common	Least Concern	
66.	Rufous backed	*Lanius schach*	Less common	Least Concern	

	shrike				
67.	Short toed eagle	*Circaetus gallicus*	Less common	Least Concern	II
68.	Sindh jungle sparrow	*Passer pyrrhonotus*	Less common	Least Concern	
69.	Sindh night jar	*Caprimulgus mahrattensis*	Less common	Least Concern	
70.	Sindh starling	*Sturnus roseus*	Less common	Least Concern	
71.	Slender billed gull	*Chroicocephalus genei*	Common		
72.	Small blue kingfisher	*Alcedo coerulescens*	Less common	Least Concern	
73.	Small Indian pranticole	*Glareola lactea*	Less common	Least Concern	
74.	Small sky lark	*Alauda gulgula*	Less common	Least Concern	
75.	Sparrow hawk	*Accipiter virgatus*	Less common	Least Concern	II
76.	Spotted owlet	*Athene brama*	Less common	Least Concern	II
77.	Steaked weaver	*Ploceus manyar*	Less common	Least Concern	
78.	Striated babbler	*Turdoides earlei*	Less common	Least Concern	
79.	Whiskered tern	*Chlidonias hybridus*	Less common	Least Concern	
80.	White breasted kingfisher	*Halcyon smyrnensis*	Less common	Least Concern	
81.	White breasted waterhen	*Amaurornis phoenicurus*	Less common	Least Concern	
82.	White cheeked bulbul	*Pycnonotus leucotis*	Common	Least Concern	
83.	White throated munia	*Euodice malabarica*	Less common	Least Concern	
84.	White-eyed buzzard	*Butastur teesa*	Less common	Least Concern	II
85.	Wire tailed swallow	*Hirundo smithii*	Less common	Least Concern	
86.	Yellow eyed babbler	*Chrysomma sinense*	Less common	Least Concern	

List of common Fish Species of Indus Dolphin Reserve

No.	**Species**	**Family**	**Common Name**	**IUCN Redlist**
1	*Aortichthys aor*	Bagridae	*Singhari*	Least Concern
2	*Aspidoparia morar*	Cyprinidae (carp)	*Ray Finned*	Least Concern
3	*Bagarius bagarius*	Sisoridae (catfish)	*Fauji-Khaga*	Near Threatened
4	*Catla catla*	Cyprinidae (carp)	*Theli*	Least Concern
5	*Channa marulias*	Channidae	*Soll*	Least Concern
6	*Chela cachius*	Cyprinidae (carp)	*Chela*	Least Concern
7	*Cirrhinus reba*	Cyprinidae (carp)	*Suhni*	Least Concern
8	*Cirrihinus mirgala*	Cyprinidae (carp)	*Morakha/Morie*	Least Concern
9	*Gudsuia*	Clupeidae	*Pali*	Least Concern
10	*L . calbasu*	Cyprinidae (carp)	*Kalbans*	Least Concern
11	*L. gonius*	Cyprinidae (carp)	*Seereha*	Least Concern
12	*Labeo rohita*	Cyprinidae (carp)	*Rahu*	Least Concern
13	*Macrobrachium malcomsoni (Prawn)*	Palaemonidae	*Samll Jhenga*	Least Concern

14	*Mastacembelus armatus*	Mastacembelidae	*Baam*	Least Concern
15	*Mystus cavasius*	Bagridae (catfish)	*Tengara*	Least Concern
16	*N. chitala*	Notopteridae	*Cheetal*	Least Concern
17	*Notoptreus notoptreus*	Notopteridae	*Butpri*	Least Concern
18	*Palaemon carcinus (Prawn)*	Palamonidae	*Large Jhenga*	Least Concern
19	*Puntius sophore*	Cyprinidae	*Sophor*	Least Concern
20	*Rita rita*	Bagridae	*Khaga*	Least Concern
21	*Salmastoma bacaila*	Cyprinidae	*Small chall*	Least Concern
22	*Wallgo attu*	Siluridae	*Mully/Jarkha*	Least Concern

List of Crustaceans and Water Insects of Indus dolphin Reserve.

Common name	Scientific name	Status
Large jhenga	*Palaemon carcinus*	Less common
Small jhenga	*Macrobrachium malcomsoni*	Less common
Water bug	*Coraixa promontoria*	Common
Water bug	*C. substriata*	Common
Water-scorpion	*Laecotrephes rubri*	Less common

Floral diversity on both banks of Indus Dolphin Game Reserve

S#	Family	Plant Species	Life Form	Habit
1	Acanthaceae	*Blepharis sindica*	Therophyte	Herb
2	Aizoaceae	*Trianthema portulacastrum*	Therophyte	Herb
3	Aizoaceae	*Zaleya pentandra*	Chamaephyte	Herb
4	Amaranthaceae	*Amaranthus graecizans*	Therophyte	Herb
5	Amaranthaceae	*Amaranthus viridis*	Therophyte	Herb
6	Asteraceae	*Echinops echinatus*	Therophyte	Tall Herb
7	Asteraceae	*Eclipta prostrata*	Chamaephyte	Herb
8	Asteraceae	*Grangea maderaspatana*	Therophyte	Herb
9	Asteraceae	*Launaea procumbens*	Chamaephyte	Herb
10	Asteraceae	*Launaea resedifolia*	Therophyte	Herb
11	Boraginaceae	*Coldenia procumbens*	Chamaephyte	Herb
12	Capparidaceae	*Cleome brachycarpa*	Chamaephyte	Herb
13	Convolvulaceae	*Convolvulus prostratus*	Chamaephyte	Herb
14	Convolvulaceae	*Cressa cretica*	Therophyte	Herb
15	Cucurbitaceae	*Citrullus colocynthis*	Chamaephyte	Herb
16	Euphorbiaceae	*Euphorbia hirta*	Therophyte	Herb
17	Fabaceae	*Melilotus alba*	Chamaephyte	Herb
18	Fabaceae	*Melilotus indica*	Chamaephyte	Herb
19	Gentianaceae	*Enicostemma hyssopifolium*	Hemi-cryptophyte	Herb
20	Nyctaginaceae	*Boerhavia diffusa*	Chamaephyte	Herb
21	Nyctaginaceae	*Boerhavia procumbens*	Cryptophyte	Herb
22	Nyctaginaceae	*Commicarpus boissieri*	Phanerophyte	Herb
23	Polygalaceae	*Polygala erioptera*	Chamaephyte	Herb
24	Polygalaceae	*Polygala irregularis*	Chamaephyte	Herb
25	Polygonaceae	*Persicaria glabra*	Chamaephyte	Herb
26	Polygonaceae	*Polygonum effusum*	Chamaephyte	Herb
27	Portulacaceae	*Portulaca oleracea*	Therophyte	Herb
28	Primulaceae	*Anagallis arvensis*	Therophyte	Herb
29	Scrophulariaceae	*Bacopa monnieri*	Chamaephyte	Herb

30	Scrophulariacea	*Schweinfurthia papilionacea*	Chamaephyte	Herb
31	Solanaceae	*Solanum albicaule*	Chamaephyte	Herb
32	Solanaceae	*Solanum nigrum*	Therophyte	Herb
33	Solanaceae	*Solanum surattense*	Chamaephyte	Herb
34	Tiliaceae	*Corchorus depressus*	Chamaephyte	Herb
35	Verbenaceae	*Phyla nodiflora*	Chamaephyte	Herb
36	Zygophyllaceae	*Tribulus terrestris*	Therophyte	Herb
37	Zygophyllaceae	*Zygophyllum simplex*	Therophyte	Herb
38	Amaranthaceae	*Aerva javanica*	Phanerophyte	Shrub
39	Asclepiadaceae	*Calotropis procera*	Phanerophyte	Shrub
40	Asclepiadaceae	*Leptadenia pyrotechnica*	Phanerophyte	Shrub
41	Asteraceae	*Iphiona grantioides*	Chamaephyte	Subshrub
42	Asteraceae	*Pluchea lanceolata*	Phanerophyte	Shrub
43	Asteraceae	*Vernonia cinerascens*	Phanerophyte	Shrub
44	Boraginaceae	*Heliotropium curassavicum*	Chamaephyte	Subshrub
45	Boraginaceae	*Heliotropium ophioglossum*	Chamaephyte	Subshrub
46	Boraginaceae	*Trichodesma indicum*	Chamaephyte	Subshrub
47	Burseraceae	*Commiphora stocksiana*	Phanerophyte	Shrub
48	Burseraceae	*Commiphora wightii*	Phanerophyte	Shrub
49	Caesalpiniaceae	*Senna holosericea*	Chamaephyte	Subshrub
50	Capparidaceae	*Cadaba fruticosa*	Phanerophyte	Shrub
51	Capparidaceae	*Capparis decidua*	Phanerophyte	Large Shrub
52	Chenopodiaceae	*Atriplex stocksii*	Chamaephyte	Subshrub
53	Chenopodiaceae	*Haloxylon stocksii*	Phanerophyte	Shrub
54	Chenopodiaceae	*Salsola imbricata*	Phanerophyte	Shrub
55	Chenopodiaceae	*Suaeda fruticosa*	Phanerophyte	Shrub
56	Euphorbiaceae	*Euphorbia caducifolia*	Phanerophyte	Large Shrub
57	Fabaceae	*Alhagi maurorum*	Phanerophyte	Subshrub
58	Fabaceae	*Crotalaria burhia*	Phanerophyte	Shrub
59	Fabaceae	*Indigofera oblongifolia*	Phanerophyte	Shrub
60	Fabaceae	*Tephrosia purpurea*	Chamaephyte	Subshrub
61	Malvaceae	*Abutilon fruticosum*	Phanerophyte	Subshrub
62	Malvaceae	*Abutilon indicum*	Phanerophyte	Subshrub
63	Malvaceae	*Sida ovata*	Phanerophyte	Subshrub
64	Mimosaceae	*Acacia jacquemontii*	Phanerophyte	Shrub
65	Mimosaceae	*Prosopis glandulosa*	Phanerophyte	Large Shrub
66	Mimosaceae	*Prosopis juliflora*	Phanerophyte	Large Shrub
67	Resedaceae	*Ochradenus baccatus*	Phanerophyte	Shrub
68	Rhamnaceae	*Ziziphus nummularia*	Phanerophyte	Shrub
69	Rubiaceae	*Kohautia retrorsa*	Phanerophyte	Subshrub
70	Solanaceae	*Datura fastuosa*	Phanerophyte	Shrub
71	Solanaceae	*Lycium edgeworthii*	Phanerophyte	Shrub
72	Solanaceae	*Solanum cordatum*	Chamaephyte	Subshrub
73	Solanaceae	*Withania somnifera*	Phanerophyte	Shrub
74	Tamaricaceae	*Tamarix indica*	Phanerophyte	Shrub
75	Tiliaceae	*Grewia tenax*	Phanerophyte	Shrub
76	Zygophyllaceae	*Fagonia indica*	Chamaephyte	Subshrub
77	Mimosaceae	*Acacia nilotica*	Phanerophyte	Tree
78	Mimosaceae	*Acacia senegal*	Phanerophyte	Tree
79	Mimosaceae	*Prosopis cineraria*	Phanerophyte	Tree
80	Salicaceae	*Populus euphratica*	Phanerophyte	Tree
81	Salvadoraceae	*Salvadora oleoides*	Phanerophyte	Tree
82	Salvadoraceae	*Salvadora persica*	Phanerophyte	Tree
83	Tamaricaceae	*Tamarix aphylla*	Phanerophyte	Tree

84	Tamaricaceae	*Tamarix dioica*	Phanerophyte	Tree
85	Poaceae	*Aeluropus lagopoides*	Cryptophyte	Grass
86	Poaceae	*Cenchrus ciliaris*	Hemi-cryptophyte	Grass
87	Poaceae	*Cenchrus pennisetiformis*	Hemi-cryptophyte	Grass
89	Poaceae	*Chloris barbata*	Hemi-cryptophyte	Grass
90	Poaceae	*Chrysopogon aucheri*	Hemi-cryptophyte	Grass
91	Poaceae	*Cynodon dactylon*	Hemi-cryptophyte	Grass
92	Poaceae	*Dactyloctenium aegyptium*	Therophyte	Grass
93	Poaceae	*Dactyloctenium aristatum*	Therophyte	Grass
94	Poaceae	*Desmostachya bipinnata*	Cryptophyte	Grass
95	Poaceae	*Dichanthium annulatum*	Hemi-cryptophyte	Grass
96	Poaceae	*Panicum antidotale*	Hemi-cryptophyte	Grass
97	Poaceae	*Phragmites karka*	Cryptophyte	Tall Grass
98	Poaceae	*Saccharum benghalense*	Hemi-cryptophyte	Tall Grass
99	Poaceae	*Saccharum spontaneum*	Hemi-cryptophyte	Tall Grass
100	Poaceae	*Sporobolus nervosus*	Hemi-cryptophyte	Grass
101	Convolvulaceae	*Convolvulus glomeratus*	Chamaephyte	Climber
102	Fabaceae	*Rhyncosia minima*	Chamaephyte	Climber
103	Cyperaceae	*Cyperus bulbosus*	Cryptophyte	Sedge
104	Cyperaceae	*Cyperus pygmaeus*	Hemi-cryptophyte	Sedge
105	Typhaceae	*Typha angustata*	Cryptophyte	Reed

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Phytoplankton of Indus River in Dolphin Game Reserve

NO.	TAXA
	CHLOROPHYTA
1	*Pediastrum*
2	*Spirogyra*
3	*Cladophora*
4	*Staurastrum*
	CYANOPHYTA
5	*Aphanocapsa*
6	*Oscillatoria*
	BACILLARIOPHYTA
7	*Melosira*

Zooplankton of Indus River in Dolphin Game Reserve

NO.	NAME OF SPECIES
	DINOFLAGELLATES
1	*Ceratium hirundinella*
	ROTIFERA
1	*Asplanchna priodonta*
2	*Anuropsis fissa*
3	*Brachionus amphiceros*
4	*Branchious angularis*
5	*Brachionus budapestinensis*
6	*Brachionus dorcas*
7	*Brachionus falcatus*

NO.	NAME OF SPECIES
	COPEPODA
1	*Diaptomus* sp.
2	*Thermocyclops hyalinus*
3	*Mesocyclops leukarti*
4	*Harpacticoid* sp.
1	*Ceratium hirundinella*
	ROTIFERA
1	*Asplanchna priodonta*
2	*Anuropsis fissa*
3	*Brachionus amphiceros*

8	*Brachionus forficula*
9	*Brachionus plicatilis*
10	*B. quadritentus* f.*brevispinus*
11	*Brachionus quadridentatus*
12	*Brachionus rubens*
13	*B. calyciflorus*
14	*Conochiloides* sp.
15	*Filina longiseta*
16	*Keratella asymmetrica*
17	*Keratella cochlearis*
18	*Keratella cochlearis tecta*
19	*Keratella hispida*
20	*Keratella irregularis*
21	*Keratella javana*
22	*Keratella quadrata*
23	*Keratella squamula*
24	*Keratella testudo*
25	*Keratella tropica*
26	*Keratella valga*
27	*Lecane styrus*
28	*Notholca striata*
29	*Pompholyx complanta*
30	*Polyarthra vuglaris longiremis*
31	*Polyarthra dissimilaris*
32	*Polyarthra mira*
33	*Polyarthra remata*
34	*Schyzocerca sp.*
35	*Synchyta sp.*
36	*Trichocerca sp.*
	CLADOCERA
1	*Alona guttata*
2	*Bosmina longirostris*
3	*Bosminopsis deitersi*
4	*Ceriodaphnia cornuta*
5	*Chydorus ovalis*
6	*Ceriodaphnia reticulata*
7	*Daphnia lumholtzi*
8	*Diaphanosoma brachyurum*
9	*Diaphnosoma sarsi*
10	*Daphnia* sp.
11	*Moina micrura*

4	*Branchious angularis*
5	*Brachionus budapestinensis*
6	*Brachionus dorcas*
7	*Brachionus falcatus*
8	*Brachionus forficula*
9	*Brachionus plicatilis*
10	*B. quadritentus f.brevispinus*
11	*Brachionus quadridentatus*
12	*Brachionus rubens*
13	*B. calyciflorus*
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15	*Filina longiseta*
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24	*Keratella testudo*
25	*Keratella tropica*
26	*Keratella valga*
27	*Lecane styrus*
28	*Notholca striata*
29	*Pompholyx complanta*
30	*Polyarthra vuglaris longiremis*
31	*Polyarthra dissimilaris*
32	*Polyarthra mira*
33	*Polyarthra remata*
34	*schyzocerca sp.*
35	*Synchyta sp.*
36	*Trichocerca sp.*

Annex C

Consulting Services for Preparation of Detailed Management Plans for Dolphin Conservation and Fish Migration in Indus in Sindh

Terms of Reference

BACKGROUND

Pakistan is predominantly an agricultural country where about two thirds of its 135 million population is dependent on agriculture, either directly or indirectly. Fisheries, sub-sector of agriculture, play a significant role in Pakistan's national economy (about 1.0 percent of the GDP or 4% of the agriculture sector) and contribute towards the food security of the country. Fishery sector employ 1% of the country's labor force. There are about 400,000 fisher folks, mainly fishing in the coastal area. The export of fish and fishery products during 1999-2000 reached 92,000 t, this corresponding to a value of $US 139 million[36].

Fish production in Pakistan during 2011 was 712,400 t, of which 487,000 t (about 68%) were from marine waters and 225,400 t were from inland waters. Eighty percent of the freshwater catch came from wild resources of rivers, irrigation canals and natural lakes. Twenty percent of the inland fish production is contributed by aquaculture. Aquaculture in Pakistan benefits from irrigation, about 75% of the fish ponds in the country are supplied with water by irrigation canals[36].

The decline in fisheries diversity is probably the most visible representation of the sorry state of biodiversity loss in this fragile ecosystem. The clear threats to some of the economically important fish species (including Palla) heighten concern over general loss of biodiversity. Two major flagship species of mammals in River Indus, the Indus Dolphin and Smooth Coated Otter are officially classified as threatened.

Millions of people who depend on Indus water are experiencing the consequences of the changes in the biota and in the river environment. Many aquatic flora and fauna are being intensively exploited to meet escalating demand of the wellbeing of the population but their ecological and conservation status is not clearly known.

Sukkur barrage was constructed in 1932, at that time no provision of fish passes were provided for migratory fish species, which has created a barrier for aquatic species. This has resulted in a drastic decrease in the migratory fish stocks. Therefore, the anadromus fish "Palla" was restricted up to the Sukkur barrage, and upstream area was deprived of this particular fishery. In 1956 another barrage was constructed in the downstream of Sukkur barrage near Hyderabad, known as Kotri Barrage with provision of two fish ladders were constructed for fish migration in the barrage, especially for palla. Unfortunately, palla has never used these ladders for upstream migration due to their inappropriate design; which does not support the swimming habits of this migratory fish species. Again, as a result of these faulty fish ladders, palla fishing and breeding were confined up to the downstream of the Kotri. Further, reduction in river flow from downstream Kotri up to the sea has aggravated the situation and created a significant impact on Indus estuary, which is the only link between sea and river Indus. Usually during the winter season the Indus estuary is completely dried up due to the shortage of water and restricted the movement of palla only up to the Indus delta region. As a matter of fact the palla is not the only fish species affected of this habitat

1 Akhtar N, 2010. The use of Irrigation Systems for Sustainable Fish Production in Pakistan. The use of Irrigation Systems for Sustainable Fish Production in Pakistan

destruction of Indus estuary, but also many other aquatic species also vanished which are dependent on the estuarine system. This estuarine habitat destruction has not only caused the biodiversity loss but also created a significant socio-economic loss.

The developmental activities in Indus River Basin have created significant impacts from species to the ecosystem levels. There is a dearth of scientific information regarding the behavior of palla fish and its migration pattern along the Indus River Basin. It is an urgent need to carry out comprehensive bio-ecological scientific information on palla fish to understand its biological requirements for example breeding habitats, migration route, and depth of channel requirement for upstream migration for breeding. This will help in designing of fish ladders and it will be based on the scientific research conducted on the migratory pattern of the fish, especially the minimum water depth requirements in the passes and the slope. Similarly the provision of environmental flow will facilitate the rehabilitation of Indus estuary. All this work will improve the status of migratory fish significantly which ultimately create a positive impact on the socio-economic conditions of the local communities.

OBJECTIVE

Objectives of the proposed study are to develop detailed (i) management plan for long term conservation of dolphin in the game reserve between Guddu and Sukkur barrages, and (ii) management plans to restore hilsa migration by providing appropriate designs for rehabilitation of fish passes at Guddu and Kotri and new fish passes at Kotri. A series of studies are required to prepare these management plans.

The project will cover all five stretches in which dolphin persists. This will involve the tasks that have been designed in the scope of study. The project involves scientific data collection from river Indus (including right and left banks). A detailed study of life cycle of both the species including other related species and factors influencing these species including Physico chemical factor, pray studies, food and feeding habits, behaviors of the species.

2. Scope of Work

A consulting firm with team of independent consultants led by a Hydro-ecologist will review and make use of all the existing information available and in particular data, tools and models used in preparing the documents. This will include, reports, maps, surveys conducted so far, Environmental, ecological and species surveys and habitat management and mitigation measures and analysis, etc.

The specific tasks will include, but not limited to:

For Hilsa fish:

1. Carryout detailed studies to find out hilsa migration range, migration periods and its breeding habitats, triggers for migration and need for migration
2. Conduct detailed studies on the food habits of hilsa in marine phase, where it grows to maturity. Whether the fish feeds at all in the fluvial migratory phase should also be examined?
3. Assessment of fishing activities in the deltaic areas to prevent over and under size fishing.
4. Explore the possibilities of artificial breeding of hilsa in lower Indus areas.
5. Monitor the level and frequency of indiscriminate fishing of young hilsa from deltaic region and offshore areas which is adversely affecting the stock situation.
6. Monitor the ratio of Male and Female hilsa fish catch especially those female with egg sac.

7. Identify subspecies of hilsa. Hilsa migration in Indus is reported during winter and summer months. Carry out studies to determine whether they are same or distinct species. Investigate that these two populations of hilsa live separately in offshore and inshore waters?
8. Conduct stock assessment of hilsa and other targeted species.
9. Search the spawning grounds of hilsa to find whether the winter and summer population of hilsa fish breed in different areas of the river, e.g., brackish or freshwater stretches of the river.
10. Conduct detailed behavioral studies especially with reference to design the fish passage. The most frequent causes of fish pass failure include lack of attraction flow, unsuitable location of the passage, inadequate maintenance; hydraulic conditions (flow patterns, velocities, turbulence and aeration levels) in the fish pass not adapted to the target species.
11. Monitor the effectiveness of existing fish passes/ladders for hilsa migration and movement of local species to assess the peformance of existing fish ladders
12. Explore the effective and practical fish passes for anadromous and catadromous fish species according to their migratory behavior. Organize research and collect information on biological cycle (e.g. breeding and spawning season, migration causes, period and pattern).
13. Identify the spawning grounds of hilsa and make recommendations to declare them protected areas to save this species from extinction
14. Develop a Management Plan for long term conservation of this important species.
15. Develop designs for rehabilitation of fish passes at Kotri and Guddu and new fish pass for Sukkur.

For Indus dolphin:

1. Conduct population status survey: A comprehensive survey on the counts and age distribution will be conducted, follow-up with an estimate of abundance with relative accuracy and precision and migration between dolphin subpopulations through barrages either downstream or both directions to understand the extinction dynamics,
2. Conduct threat assessment surveys to identify the threats and develop a mitigation strategy.
3. Undertake an assessment to define a range core no fishing zone in the dolphin game reserve: Based on the results of the survey on occurrences and identification of river habitats that support breeding and feeding grounds of the Indus River dolphin. A range core should be identified and defined with geo-coordinates. Prepare recommendations for Sindh Government to declare the range core as critically protected area with fishing restrictions. Conduct national and international level consultations with experts and discussions with local communities especially with the fishermen will be required keeping in mind the needs of communities.
4. Capacity building for dolphin conservation and management: Develop programs for universities and relevant government line departments to study dolphins and their habitat conditions.
5. Involve communities in dolphin conservation and management
6. Assess critical levels of water flow in riverine habitats for dolphins
7. Develop a dolphin rescue program for Sind Wildlife Department including the provision

dolphin ambulances and capacity building or hiring of staff for rescue program.

8. Create education and awareness program at all spectrums of the society on dolphin, their habitat requirements and current threatened status.
9. Organize an international conference on dolphin conservation and management.

3. Implementation Arrangements

The Consultant will work closely with the Head of Project Management Office (PMO)/ Project Director, Sindh Barrages Rehabilitation Project, Irrigation Department.

The Consultants shall be responsible for all aspects of performance of services as set forth in the preceding sections of this TOR. Government of Sindh and the Head of Project Management Office (PMO)/ Project Director, Sindh Barrages Rehabilitation Project, Irrigation Department will be responsible for providing the existing data and information including all reports prepared so far for the project.

Duration of the Assignment. Duration of the contract will be for 30 months and in each year team will organize two surveys (pre and post monsoon) to collect data on all the relevant parameters and after each survey report will be submitted to the Head of Project Management Office (PMO)/ Project Director, Sindh Barrages Rehabilitation Project, Irrigation Department. After the completion of the project final report will be submitted to the relevant authority for final approval.

Composition of the team members must have competency in the following areas of specialization with respect to biodiversity:

i) Hydro-ecologist Team Leader
ii) Fisheries and fish biologist
iii) Environmental + civil engineer (experience in design of fish passes)
iv) Socio-economist
v) Herpetologist
vi) Limnologist
vii) Hydro-geologist
viii) Terrestrial ecologist
ix) Databases and database management specialist
x) Legal, policy and institutional framework specialist

All the specialists should have a relevant doctorate degree with at least 15 years of field and research experience.

Annex D
Environmental Code of Practices

Introduction

The objective of the Environmental Code of Practices (ECPs) is to address all potential and general construction related impacts during implementation of the Sindh Barrages Improvement Project (the Project). The ECPs will provide guidelines for best operating practices and environmental management guidelines to be followed by the contractors for sustainable management of all environmental issues. These ECPs shall be annexed to the general conditions of all the contracts, including subcontracts, carried out under the Project.

The list of ECPs prepared for the Project is given below.

- 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

Contractors will prepare site specific management plans, namely Construction Environmental Management Plan (CEMP), in compliance with World Bank and Government of Pakistan guidelines and based on the guidance given in the ECPs. The CEMP will form the part of the contract documents and will be used as monitoring tool for compliance. It is mandatory for the main contractors procured directly by the project to include these ECPs in their subcontracts. Violation of the compliance requirements will be treated as non-compliance leading to the corrections or otherwise imposing penalty on the contractors.

ECP 1: Waste Management

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
General Waste	Soil and water pollution from the improper management of wastes and excess materials from the construction sites.	The Contractor shall • Develop site specific waste management plan for various specific waste streams (e.g., reusable waste, flammable waste, construction debris, food waste etc.) prior to commencing of construction and submit to supervision consultant for approval. • Organize disposal of all wastes generated during construction in the designated disposal sites approved by the Project. • Minimize the production of waste materials by 3R (Reduce, Recycle and Reuse) approach. • Segregate and reuse or recycle all the wastes, wherever practical. • Vehicles transporting solid waste shall be covered with tarps or nets to prevent spilling waste along the route. • Train and instruct all personnel in waste management practices and procedures as a component of the environmental induction process. • Provide refuse containers at each worksite. • Request suppliers to minimize packaging where practicable. • Place a high emphasis on good housekeeping practices. • Maintain all construction sites in a cleaner, tidy and safe condition and provide and maintain appropriate facilities as temporary storage of all wastes before transportation and final disposal. • Potable water should be supplied in bulk containers to reduce the quantity of plastic waste (plastic bottles). Plastic bag use should be avoided.
Hazardous Waste	Health hazards and environmental impacts due to improper waste management practices	The Contractor shall • Collect chemical wastes in 200 liter drums (or similar sealed container), appropriately labeled for safe transport to an approved chemical waste depot. • Store, transport and handle all chemicals avoiding potential environmental pollution. • Store all hazardous wastes appropriately in bunded areas away from water courses. • Make available Material Safety Data Sheets (MSDS) for hazardous materials on-site during construction. • Collect hydrocarbon wastes, including lube oils, for safe transport off-site for reuse, recycling, treatment or disposal at approved locations.

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
		• Construct concrete or other impermeable flooring to prevent seepage in case of spills.

ECP 2: Fuels and Hazardous Goods Management

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Fuels and hazardous goods.	Materials used in construction have a potential to be a source of contamination. Improper storage and handling of fuels, lubricants, chemicals and hazardous goods/materials on-site, and potential spills from these goods may harm the environment or health of construction workers.	The Contractor shall • Prepare spill control procedures and submit them for supervision consultant approval. • Train the relevant construction personnel in handling of fuels and spill control procedures. • Store dangerous goods in bunded areas on top of a sealed plastic sheet away from watercourses. • Refueling shall occur only within bunded areas. • Store and use fuels in accordance with material safety data sheets (MSDS). Make available MSDS for chemicals and dangerous goods on-site. • Transport waste of dangerous goods, which cannot be recycled, to a designated disposal site. • Provide absorbent and containment material (e.g., absorbent matting) where hazardous material are used and stored; and ensure personnel trained in the correct use. • Provide protective clothing, safety boots, helmets, masks, gloves, goggles, to the construction personnel, appropriate to materials in use. • Make sure all containers, drums, and tanks that are used for storage are in good condition and are labeled with expiry date. Any container, drum, or tank that is dented, cracked, or rusted might eventually leak. Check for leakage regularly to identify potential problems before they occur. • Store and use fuels in accordance with material safety data sheets (MSDSs). • Store all liquid fuels in fully bunded storage containers, with appropriate volumes, a roof, a collection point and appropriate filling/decanting point. • Store hazardous materials above flood level considered for construction purposes • Put containers and drums in temporary storages in clearly marked areas, where they

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
		will not be run over by vehicles or heavy machinery. The area shall preferably slope or drain to a safe collection area in the event of a spill. • Take all precautionary measures when handling and storing fuels and lubricants, avoiding environmental pollution. • Avoid the use of material with greater potential for contamination by substituting them with more environmentally friendly materials.

ECP 3: Water Resources Management

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Hazardous material and Waste	Water pollution from the storage, handling and disposal of hazardous materials and general construction waste, and accidental spillage	The Contractor shall • Follow the management guidelines proposed in ECPs 1 and 2. • Minimize the generation of sediment, oil and grease, excess nutrients, organic matter, litter, debris and any form of waste (particularly petroleum and chemical wastes). These substances must not enter waterways or storm water systems.
Discharge from construction sites	Construction activities, sewerages from construction sites and work camps may affect the surface water quality. The construction works will modify groundcover and topography changing the surface water drainage patterns of the area. These changes in hydrological regime lead to increased rate of runoff, increase in sediment and contaminant loading, increased flooding, and effect habitat of fish and other aquatic biology.	The Contractor shall • Install temporary drainage works (channels and bunds) in areas required for sediment and erosion control and around storage areas for construction materials. • Install temporary sediment basins, where appropriate, to capture sediment-laden run-off from site. • Divert runoff from undisturbed areas around the construction site. • Stockpile materials away from drainage lines • Prevent all solid and liquid wastes entering waterways by collecting solid waste, oils, chemicals, bitumen spray waste and wastewaters from brick, concrete and asphalt cutting where possible and transport to a approved waste disposal site or recycling depot. • Wash out ready-mix concrete agitators and concrete handling equipment at washing facilities off site or into approved bunded areas on site. Ensure that tires of construction vehicles are cleaned in the washing bay (constructed at the entrance of the construction

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
		site) to remove the mud from the wheels. This should be done in every exit of each construction vehicle to ensure the local roads are kept clean.
Soil erosion and siltation	Soil erosion and dust from the material stockpiles will increase the sediment and contaminant loading of surface water bodies.	The Contractor shall • Stabilize the cleared areas not used for construction activities with vegetation or appropriate surface water treatments as soon as practicable following earthwork to minimize erosion. • Ensure that roads used by construction vehicles are swept regularly to remove dust and sediment. • Water the loose material stockpiles, access roads and bare soils on an as required basis to minimize dust. Increase the watering frequency during periods of high risk (e.g. high winds).
Construction activities in water bodies	Construction works in the water bodies will increase sediment and contaminant loading, and effect habitat of fish and other aquatic biology.	The Contractor Shall • Dewater sites by pumping water to a sediment basin prior to release off site – do not pump directly off site. • Monitor the water quality in the runoff from the site or areas affected by dredge/excavation plumes, and improve work practices as necessary. • Protect water bodies from sediment loads by silt screen or other barriers. • Minimize the generation of sediment, oil and grease, excess nutrients, organic matter, litter, debris and any form of waste (particularly petroleum and chemical wastes). These substances must not enter waterways or storm water systems. • Do not discharge cement and water curing used for cement concrete directly into water courses and drainage inlets.
Drinking water	Untreated surface water is not suitable for drinking purposes due to presence of suspended solids and ecoli.	The Contractor Shall • Provide the drinking water that meets NEQS standards. Drinking water to be chlorinated at source, and ensure presence of residual chlorine 0.1 ~ 0.25 ppm as minimum after 30 minutes of chlorine contact time.

ECP 4: Drainage Management

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Excavation and earth works, and construction yards	Lack of proper drainage for rainwater/liquid waste or wastewater owing to the construction activities harms environment in terms of water and soil contamination, and mosquito growth.	The Contractor shall • Prepare drainage management procedures and submit them for supervision consultant approval. • Prepare a program to prevent/avoid standing waters, which supervision consultant will verify in advance and confirm during implementation. • Provide alternative drainage for rainwater if the construction works/earth-fillings cut the established drainage line. • Establish local drainage line with appropriate silt collector and silt screen for rainwater or wastewater connecting to the existing established drainage lines already there. • Rehabilitate road drainage structures immediately if damaged by contractors' road transports. • Build new drainage lines as appropriate and required for wastewater from construction yards connecting to the available nearby recipient water bodies. Ensure wastewater quality conforms to NEQS, before it is being discharged into the recipient water bodies. • Ensure that there will be no water stagnation at the construction sites and camps. • Provide appropriate silt collector and silt screen at the inlet and manholes and periodically clean the drainage system to avoid drainage congestion. • Protect natural slopes of drainage channels to ensure adequate storm water drains. • Regularly inspect and maintain all drainage channels to assess and alleviate any drainage congestion problem.
Ponding of water	Health hazards due to mosquito breeding	• Do not allow ponding of water especially near the waste storage areas and construction camps. • Discard all the storage containers that are capable of storing of water, after use or store them in inverted position.

ECP 5: Soil Quality Management

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Storage of hazardous and toxic chemicals	Spillage of hazardous and toxic chemicals will contaminate the soils	The Contractor shall • Strictly manage the wastes management plans proposed in ECP1 and storage of materials in ECP2. • Construct appropriate spill contaminant facilities for all fuel storage areas. • Establish and maintain a hazardous material register detailing the location and quantities of hazardous substances including the storage, and their disposals. • Train personnel and implement safe work practices for minimizing the risk of spillage. • Identify the cause of contamination, if it is reported, and contain the area of contamination. The impact may be contained by isolating the source or implementing controls around the affected site. • Remediate the contaminated land using the most appropriate available method.
Construction material stock piles	Erosion from construction material stockpiles may contaminate the soils	The Contractor shall • Protect the toe of all stockpiles, where erosion is likely to occur, with silt fences, straw bales or bunds.

ECP 6: Erosion and Sediment Control

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Clearing of construction sites	Cleared areas and slopes are susceptible for erosion of top soils, which affects the growth of vegetation and causes ecological imbalance.	The Contractor shall • Prepare site specific erosion and sediment control measures and submit them for supervision consultant approval. • Reinstate and protect cleared areas as soon as possible. • Cover unused area of disturbed or exposed surfaces immediately with mulch/grass turf/tree plantations.
Construction activities and material stockpiles	The impact of soil erosion are (i) Increased run off and sedimentation causing a greater flood hazard to the downstream, and (ii) destruction of aquatic environment by erosion and/or deposition of	The Contractor shall • Locate stockpiles away from drainage lines. • Protect the toe of all stockpiles, where erosion is likely to occur, with silt fences, straw bales or bunds. • Remove debris from drainage paths and

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
	sediment damaging the spawning grounds of fish	sediment control structures. • Cover the loose sediments of construction material and water them if required. • Divert natural runoff around construction areas prior to any site disturbance. • Install protective measures on site prior to construction, for example, sediment traps. • Install 'cut off drains' on large cut/fill batter slopes to control water runoff speed and hence erosion. • Observe the performance of drainage structures and erosion controls during rain and modify as required.
Soil erosion and siltation	Soil erosion and dust from the material stockpiles will increase the sediment and contaminant loading of surface water bodies.	The Contractor shall • Stabilize the cleared areas not used for construction activities with vegetation or appropriate surface water treatments as soon as practicable following earthwork to minimize erosion. • Ensure that roads used by construction vehicles are swept regularly to remove sediment. • Water the material stockpiles, access roads and bare soils on an as required basis to minimize dust. Increase the watering frequency during periods of high risk (e.g. high winds).

ECP 7: Top Soil Management

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Land clearing and earth works	Earthworks will impact the fertile top soils that are enriched with nutrients required for plant growth or agricultural development.	The Contractor shall • Strip the top soil to a depth of 15 cm and store in stock piles of height not exceeding 2m. • Remove unwanted materials from top soil like grass, roots of trees and similar others. • The stockpiles will be done in slopes of 2:1 to reduce surface runoff and enhance percolation through the mass of stored soil. • Locate topsoil stockpiles in areas outside drainage lines and protect from erosion. • Construct diversion channels and silt fences around the topsoil stockpiles to prevent erosion and loss of topsoil. • Spread the topsoil to maintain the physico-chemical and biological activity of the soil. The

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
		stored top soil will be utilized for covering all disturbed area and along the proposed plantation sites. • Prior to the re-spreading of topsoil, the ground surface will be ripped to assist the bunding of the soil layers, water penetration and revegetation
Transport	Vehicular movement outside ROW or temporary access roads will affect the soil fertility of the agricultural lands	• Limit equipment and vehicular movements to within the approved construction zone. • Plan construction access to make use, if possible, of the final road alignment.

ECP 8: Topography and Landscaping

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Land clearing and earth works	Construction activities especially earthworks will change topography and disturb the natural rainwater/flood water drainage as well as will change the local landscape.	The Contractor shall • Prepare landscaping and plantation plan and submit the plan for supervision consultant approval. • Ensure the topography of the final surface of all raised lands (construction yards, approach roads and rails, access roads, etc.) are conducive to enhance natural draining of rainwater/flood water. • Keep the final or finished surface of all the raised lands free from any kind of depression that causes water logging. • Undertake mitigation measures for erosion control/prevention by grass-turfing and tree plantation, where there is a possibility of rain-cut that will change the shape of topography. • Cover immediately the uncovered open surface that has no use of construction activities with grass-cover and tree plantation to prevent soil erosion and bring improved landscaping. • Reinstate the natural landscape of the ancillary construction sites after completion of works.

ECP 9: Quarry Areas Development and Operation

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Development and operation of borrow areas	Borrow areas will have impacts on local topography, landscaping and natural drainage.	The Contractor shall • Prepare quarry area management plan and submit the plan for supervision consultant approval. • Use only approved quarry and borrow sites • Identify new borrow and quarry areas in consultation with Project Director, if required. • Reuse excavated or disposed material available in the project to the maximum extent possible. • Store top soil for reinstatement and landscaping. • Develop surface water collection and drainage systems, anti-erosion measures (berms, revegetation etc.) and retaining walls and gabions where required. Implement mitigation measures in ECP 3: Water Resources Management, ECP 6: Erosion and Sediment Control • The use of explosive should be used in as much minimum quantity as possible to reduce noise, vibration and dust. • Control dust and air quality deterioration by application of watering and implementing mitigation measures proposed in ECP 10: Air Quality Management • Noise and vibration control by ECP 11: Noise and Vibration Management.

ECP 10: Air Quality Management

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Construction vehicular traffic	Air quality can be adversely affected by vehicle exhaust emissions and combustion of fuels.	The Contractor shall • Prepare air quality management plan (under the Pollution Prevention Plan) and submit the plan for supervision consultant approval. • Fit vehicles with appropriate exhaust systems and emission control devices. Maintain these devices in good working condition. • Operate the vehicles in a fuel efficient manner. • Cover hauls vehicles carrying dusty materials moving outside the construction site. • Impose speed limits on all vehicle movement at the worksite to reduce dust emissions. • Control the movement of construction traffic. • Water construction materials prior to loading and

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
		transport. • Service all vehicles regularly to minimize emissions. • Limit the idling time of vehicles not more than 2 minutes.
Construction machinery	Air quality can be adversely affected by emissions from machinery and combustion of fuels.	The Contractor shall • Fit machinery with appropriate exhaust systems and emission control devices. Maintain these devices in good working condition in accordance with the specifications defined by their manufacturers to maximize combustion efficiency and minimize the contaminant emissions. Proof or maintenance register shall be required by the equipment suppliers and contractors/subcontractors. • Focus special attention on containing the emissions from generators. • Machinery causing excess pollution (e.g. visible smoke) will be banned from construction sites. • Service all equipment regularly to minimize emissions. • Provide filtering systems, duct collectors or humidification or other techniques (as applicable) to the concrete batching and mixing plant to control the particle emissions in all its stages, including unloading, collection, aggregate handling, cement dumping, circulation of trucks and machinery inside the installations.
Construction activities	Dust generation from construction sites, material stockpiles and access roads is a nuisance in the environment and can be a health hazard, and also can affect the local crops;	The Contractor shall • Water the material stockpiles, access roads and bare soils on an as required basis to minimize the potential for environmental nuisance due to dust. Increase the watering frequency during periods of high risk (e.g. high winds). Stored materials such as gravel and sand shall be covered and confined to avoid their being wind-drifted. • Minimize the extent and period of exposure of the bare surfaces. • Restore disturbed areas as soon as practicable by vegetation/grass-turfing. • Store the cement in silos and minimize the emissions from silos by equipping them with filters. • Establish adequate locations for storage, mixing and loading of construction materials, in a way that dust dispersion is prevented because of such operations. • Not water as dust suppression on potentially contaminated areas so that a liquid waste stream will be generated. • Crushing of rocky and aggregate materials shall be wet-crushed, or performed with particle emission

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
		control systems. • Not permit the burning of solid waste.

ECP 11: Noise and Vibration Management

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Construction vehicular traffic	Noise quality will be deteriorated due to vehicular traffic	The Contractor shall • Prepare a noise and vibration management plan (under the Pollution Prevention Plan) and submit the plan for supervision consultant approval. • Maintain all vehicles in order to keep it in good working order in accordance with manufactures maintenance procedures. • Make sure all drivers will comply with the traffic codes concerning maximum speed limit, driving hours, etc. • Organize the loading and unloading of trucks, and handling operations for the purpose of minimizing construction noise on the work site.
Construction machinery	Noise and vibration may have an impact on people, property, fauna, livestock and the natural environment.	The Contractor shall • Appropriately site all noise generating activities to avoid noise pollution to local residents. • Use the quietest available plant and equipment. • Maintain all equipment in order to keep it in good working order in accordance with manufactures maintenance procedures. Equipment suppliers and contractors shall present proof of maintenance register of their equipment. • Install acoustic enclosures around generators to reduce noise levels. • Fit high efficiency mufflers to appropriate construction equipment. • Avoid the unnecessary use of alarms, horns and sirens.
Construction activity	Noise and vibration may have an impact on people, property, fauna, livestock and the natural environment.	The Contractor shall • Notify adjacent landholders prior any typical noise events outside of daylight hours. • Educate the operators of construction equipment on potential noise problems and the techniques to minimize noise emissions. • Employ best available work practices on-site to minimize occupational noise levels. • Install temporary noise control barriers where

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
		appropriate. • Notify affected people if major noisy activities will be undertaken, e.g. blasting. • Plan activities on site and deliveries to and from site to minimize impact. • Monitor and analyze noise and vibration results and adjust construction practices as required. • Avoid undertaking the noisiest activities, where possible, when working at night near the residential areas.

ECP 12: Protection of Flora

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Vegetation clearance	Local flora are important to provide shelters for the birds, offer fruits and/or timber/fire wood, protect soil erosion and overall keep the environment very friendly to human-living. As such damage to flora has wide range of adverse environmental impacts.	The Contractor shall • Prepare a plan for protection of flora and submit the plan for supervision consultant approval. • Minimize disturbance to surrounding vegetation. • Use appropriate type and minimum size of machine to avoid disturbance to adjacent vegetations. • Get approval from supervision consultant for clearance of vegetation. • Make selective and careful pruning of trees where possible to reduce need of tree removal. • Control noxious weeds by disposing of at designated dump site or burn on site. • Clear only the vegetation that needs to be cleared in accordance with the engineering plans and designs. These measures are applicable to both the construction areas as well as to any associated activities such as sites for stockpiles, disposal of fill a, etc. • Not burn off cleared vegetation – where feasible, chip or mulch and reuse it for the rehabilitation of affected areas, temporary access tracks or landscaping. Mulch provides a seed source, can limit embankment erosion, retains soil moisture and nutrients, and encourages re-growth and protection from weeds. • Return topsoil and mulched vegetation (in

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
		areas of native vegetation) to approximately the same area of the roadside it came from. • Avoid work within the drip-line of trees to prevent damage to the tree roots and compacting the soil. • Minimize the length of time the ground is exposed or excavation left open by clearing and re-vegetate the area at the earliest practically possible. • Ensure excavation works occur progressively and re-vegetation done at the earliest • Provide adequate knowledge to the workers regarding nature protection and the need of avoid felling trees during construction • Supply appropriate fuel in the work camps to prevent fuel wood collection.

ECP 13: Protection of Fauna

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Construction activities	The location of construction activities can result in the loss of wild life habitat and habitat quality,	The Contractor shall • Prepare a plan for protection of fauna and submit the plan for supervision consultant approval. • Limit the construction works within the designated sites allocated to the contractors. • check the site for animals trapped in, or in danger from site works and use a qualified person to relocate the animal.
	Impact on migratory birds, its habitat and its active nests	The Contractor shall • Not be permitted to destruct active nests or eggs of migratory birds. • Minimize the tree removal during the bird breeding season. If works must be continued during the bird breeding season, a nest survey will be conducted by a qualified biologist prior to commence of works to identify and locate active nests. • If bird nests are located/ detected within the ledges and roadside embankments then those areas should be avoided. • Petroleum products should not come in contact with the natural and sensitive ecosystems. Contractor must minimize the release of oil, oil wastes or any other substances harmful to migratory birds' habitats, to any waters, wetlands or any areas frequented by migratory birds.

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Vegetation clearance	Clearance of vegetation may impact shelter, feeding and/or breeding and/or physical destruction and severing of habitat areas	The Contractor shall • Restrict the tree removal to the minimum numbers required. • Relocate hollows, where appropriate. • Fell the hollow bearing trees in a manner which reduces the potential for fauna mortality. Felled trees will be inspected after felling for fauna and if identified and readily accessible will be removed and relocated or rendered assistance if injured. After felling, hollow bearing trees will remain unmoved overnight to allow animals to move of their own volition.
Night time lighting	Lighting from construction sites and construction camps may affect the visibility of night time migratory birds that use the moon and stars for navigation during their migrations.	The Contractor shall • Use lower wattage flat lens fixtures that direct light down and reduce glare, thus reducing light pollution, • Avoid flood lights unless they are absolutely required. • Use motion sensitive lighting to minimize unneeded lighting. • Use, if possible, green lights that are considered as bird's friendly lighting instead of white or red colored lights. • Install light shades or plan the direction of lights to reduce light spilling outside the construction area.
Construction camps	Illegal poaching	The Contractor shall • Provide adequate knowledge to the workers regarding protection of flora and fauna, and relevant government regulations and punishments for illegal poaching. • Ensure that staff and Subcontractors are trained and empowered to identify, address and report potential environmental problems.

ECP 14: Protection of Fish

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Construction activities in River	The main potential impacts to fisheries are hydrocarbon spills and leaks from riverine transport and disposal of wastes into the river	The Contractor shall • Prepare procedures for protection of fish and submit them for supervision consultant approval. • Ensure the construction equipment used in the river are well maintained and do not have oil leakage to contaminate river water.

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
		• Contain oil immediately on river in case of accidental spillage from equipment; make an emergency oil spill containment plan (under the Fuels and Hazardous Substances Management Plan) to be supported with enough equipments, materials and human resources. • Do not dump wastes, be it hazardous or non-hazardous into the nearby water bodies or in the river.
Construction activities on the land	The main potential impacts to aquatic flora and fauna River are increased suspended solids from earthworks erosion, sanitary discharge from work camps, and hydrocarbon spills	The Contractor shall • follow mitigation measures proposed in ECP 3: Water Resources Management and EC4: Drainage Management.

ECP 15: Road Transport and Road Traffic Management

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Construction vehicular traffic	Increased traffic use of road by construction vehicles will affect the movement of normal road traffics and the safety of the road-users.	The Contractor shall • Prepare a traffic management plan and submit the plan for supervision consultant approval. • Strictly follow the Project's 'Traffic Management Plan' and work with close coordination with the Traffic Management Unit. • Prepare and submit additional traffic plan, if any of his traffic routes are not covered in the Project's Traffic Management Plan, and requires traffic diversion and management. • Include in the traffic plan to ensure uninterrupted traffic movement during construction: detailed drawings of traffic arrangements showing all detours, temporary road, temporary bridges temporary diversions, necessary barricades, warning signs / lights, road signs etc. • Provide signs at strategic locations of the roads complying with the schedules of signs contained in the Pakistan Traffic Regulations.
	Accidents and spillage of fuels and chemicals	The Contractor shall • Restrict truck deliveries, where practicable, to day time working hours. • Restrict the transport of oversize loads.

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
		• Operate vehicles, if possible, to non-peak periods to minimize traffic disruptions. • Enforce on-site speed limit.

ECP 16: Construction Camp Management

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Siting and Location of construction camps	Campsites for construction workers are the important locations that have significant impacts such as health and safety hazards on local resources and infrastructure of nearby communities.	The Contractor shall • Prepare a construction camp management plan and submit the plan for supervision consultant's approval. • Locate the construction camps within the designed sites or at areas which are acceptable from environmental, cultural or social point of view; and approved by the supervision consultant. • Consider the location of construction camps away from communities in order to avoid social conflict in using the natural resources such as water or to avoid the possible adverse impacts of the construction camps on the surrounding communities. • Submit to the supervision consultant for approval a detailed layout plan for the development of the construction camp showing the relative locations of all temporary buildings and facilities that are to be constructed together with the location of site roads, fuel storage areas (for use in power supply generators), solid waste management and dumping locations, and drainage facilities, prior to the development of the construction camps. • Local authorities responsible for health, religious and security shall be duly informed on the set up of camp facilities so as to maintain effective surveillance over public health, social and security matters.
Construction Camp Facilities	Lack of proper infrastructure facilities , such as housing, water supply and sanitation facilities will increase pressure on the local services and generate substandard living standards and health hazards.	Contractor shall provide the following facilities in the campsites • Adequate housing for all workers. • Safe and reliable water supply, which should meet NEQS. Drinking water to be chlorinated at source, and ensure presence of residual chlorine 0.1 ~ 0.25 ppm as minimum after 30 minutes of chlorine contact time (WHO guideline). • Hygienic sanitary facilities and sewerage system.

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
		The toilets and domestic waste water will be collected through a common sewerage. Provide separate latrines and bathing places for males and females with total isolation by location. The minimum number of toilet facilities required is one toilet for every ten persons. • Treatment facilities for sewerage of toilet and domestic wastes. • Storm water drainage facilities. • Paved internal roads. • Provide child crèches for women working construction site. The crèche should have facilities for dormitory, kitchen, indoor and outdoor play area. Schools should be attached to these crèches so that children are not deprived of education whose mothers are construction workers. • Provide in-house community/common entertainment facilities. Dependence of local entertainment outlets by the construction camps to be discouraged/prohibited to the extent possible.
Disposal of waste	Management of wastes is crucial to minimize impacts on the environment	The Contractor shall • Ensure proper collection and disposal of solid wastes within the construction camps. • Insist waste separation by source; organic wastes in one container and inorganic wastes in another container at household level. • Store inorganic wastes in a safe place within the household and clear organic wastes on daily basis to waste collector. Establish waste collection, transportation and disposal systems with the manpower and equipments/vehicles needed. • Do not establish site specific landfill sites. All solid waste will be collected and removed from the work camps and disposed in approval waste disposal sites.
Fuel supplies for cooking purposes	Illegal sourcing of fuel wood by construction workers will impact the natural flora and fauna	The Contractor shall • Provide fuel to the construction camps for their domestic purpose, in order to discourage them to use fuel wood or other biomass. • Made available alternative fuels like natural gas or kerosene on ration to the workforce to prevent them using biomass for cooking. • Conduct awareness campaigns to educate

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
		workers on preserving the protecting the biodiversity and wildlife of the project area, and relevant government regulations and punishments on wildlife protection.
Health and Hygiene	There will be a potential for diseases to be transmitted including malaria, exacerbated by inadequate health and safety practices. There will be an increased risk of work crews spreading sexually transmitted infections and HIV/AIDS.	The Contractor shall • Provide adequate health care facilities within construction sites. • Provide first aid facility round the clock. Maintain stock of medicines in the facility and appoint fulltime designated first aider or nurse. • Provide ambulance facility for the laborers during emergency to be transported to nearest hospitals. • Initial health screening of the laborers coming from outside areas. • Train all construction workers in basic sanitation and health care issues and safety matters, and on the specific hazards of their work. • Provide HIV awareness programming, including STI (sexually transmitted infections) and HIV information, education and communication for all workers on regular basis. • Provide adequate drainage facilities throughout the camps to ensure that disease vectors such as stagnant water bodies and puddles do not form. Regular mosquito repellant sprays during rainy season in offices and construction camps and yards. • Not dispose food waste openly as that will attract rats and stray dogs. • Carryout short training sessions on best hygiene practices to be mandatorily participated by all workers. Place display boards at strategic locations within the camps containing messages on best hygienic practices.
Safety	In adequate safety facilities to the construction camps may create security problems and fire hazards	The Contractor shall • Provide appropriate security personnel (police or private security guards) and enclosures to prevent unauthorized entry in to the camp area. • Maintain register to keep a track on a head count of persons present in the camp at any given time. • Encourage use of flameproof material for the construction of labor housing / site office. Also, ensure that these houses/rooms are of sound construction and capable of withstanding wind storms/cyclones. • Provide appropriate type of fire fighting equipments suitable for the construction camps

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
		• Display emergency contact numbers clearly and prominently at strategic places in camps. • Communicate the roles and responsibilities of laborers in case of emergency in the monthly meetings with contractors.
Site Restoration	Restoration of the construction camps to original condition requires demolition of construction camps.	The Contractor shall • Dismantle and remove from the site all facilities established within the construction camp including the perimeter fence and lockable gates at the completion of the construction work. • Dismantle camps in phases and as the work gets decreased and not wait for the entire work to be completed. • Give prior notice to the laborers before demolishing their camps/units. • Maintain the noise levels within the national standards during demolition activities. • Different contractors should be hired to demolish different structures to promote recycling or reuse of demolished material. • Reuse the demolition debris to a maximum extent. Dispose remaining debris at the designated waste disposal site. • Handover the construction camps with all built facilities as it is if agreement between both parties (contactor and land-owner) has been made so. • Restore the site to its condition prior to commencement of the works or to an agreed condition with the landowner.

ECP 17: Cultural and Religious Issues

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Construction activities near religious and cultural sites	Disturbance from construction works to the cultural and religious sites, and contractors lack of knowledge on cultural issues cause social disturbances.	The Contractor shall • Communicate to the public through community consultation regarding the scope and schedule of construction, as well as certain construction activities causing disruptions or access restriction. • Not block access to cultural and religious sites, wherever possible. • Restrict all construction activities within the foot prints of the construction sites.

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
		• Stop construction works that produce noise (particularly during prayer time) should there be any mosque/religious/educational institutions close to the construction sites and users make objections. • Take special care and use appropriate equipment when working next to a cultural/religious institution. • Stop work immediately and notify the site manager if, during construction, an archaeological or burial site is discovered. It is an offence to recommence work in the vicinity of the site until approval to continue is given. • Provide separate prayer facilities to the construction workers. • Show appropriate behavior with all construction workers especially women and elderly people. • Allow the workers to participate in praying during construction time. • Resolve cultural issues in consultation with local leaders and supervision consultants. • Establish a mechanism that allows local people to raise grievances arising from the construction process. • Inform the local authorities responsible for health, religious and security duly informed before commencement of civil works so as to maintain effective surveillance over public health, social and security matters.

ECP 18: Worker Health and Safety

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Best practices	Construction works may pose health and safety risks to the construction workers and site visitors leading to severe injuries and deaths. The population in the proximity of the construction site and the construction workers will be exposed to a number of (i) biophysical health risk factors, (e.g. noise, dust, chemicals, construction material, solid waste, waste water, vector transmitted diseases etc), (ii)	The Contractor shall • Prepare an Occupational Health and Safety plan and submit the plan for supervision consultant's approval. • Implement suitable safety standards for all workers and site visitors which should not be less than those laid down on the international standards (e.g. International Labor Office guideline on 'Safety and Health in Construction; World Bank Group's 'Environmental Health and Safety Guidelines') and contractor's own national standards or statutory regulations, in addition to complying with Pakistan standards.

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
	risk factors resulting from human behavior (e.g. STD, HIV etc) and (iii) road accidents from construction traffic.	• Provide the workers with a safe and healthy work environment, taking into account inherent risks in its particular construction activity and specific classes of hazards in the work areas. • Provide personal protection equipment (PPE) for workers, such as safety boots, helmets, masks, gloves, protective clothing, goggles, full-face eye shields, and ear protection. Maintain the PPE properly by cleaning dirty ones and replacing them with the damaged ones. • Safety procedures include provision of information, training and protective clothing to workers involved in hazardous operations and proper performance of their job. • Appoint an environment, health and safety manager to look after the health and safety of the workers. • Inform the local authorities responsible for health, religious and security duly informed before commencement of civil works and establishment of construction camps so as to maintain effective surveillance over public health, social and security matters.
	Child and pregnant labor	The Contractor shall • not hire children of less than 14 years of age and pregnant women or women who delivered a child within 8 preceding weeks.
Accidents	Lack of first aid facilities and health care facilities in the immediate vicinity will aggravate the health conditions of the victims	The Contractor shall • Ensure health care facilities and first aid facilities are readily available. Appropriately equipped first-aid stations should be easily accessible throughout the place of work. • Document and report occupational accidents, diseases, and incidents. • Prevent accidents, injury, and disease arising from, associated with, or occurring in the course of work by minimizing, so far as reasonably practicable, the causes of hazards, in a manner consistent with good international industry practice. • Identify potential hazards to workers, particularly those that may be life-threatening and provide necessary preventive and protective measures. • Provide awareness to the construction drivers to strictly follow the driving rules. • Provide adequate lighting in the construction area, inside the tunnels, inside the powerhouse cavern and along the roads.

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Construction Camps	Lack of proper infrastructure facilities, such as housing, water supply and sanitation facilities will increase pressure on the local services and generate substandard living standards and health hazards.	The Contractor shall provide the following facilities in the campsites to improve health and hygienic conditions as mentioned in ECP 16 Construction Camp Management • Adequate ventilation facilities • Safe and reliable water supply. • Hygienic sanitary facilities and sewerage system. • Treatment facilities for sewerage of toilet and domestic wastes • Storm water drainage facilities. • Recreational and social facilities • Safe storage facilities for petroleum and other chemicals in accordance with ECP 2 • Solid waste collection and disposal system in accordance with ECP1. • Arrangement for trainings • Paved internal roads. • Security fence at least 2 m height. • Sick bay and first aid facilities
Water and sanitation facilities at the construction sites	Lack of Water sanitation facilities at construction sites cause inconvenience to the construction workers and affect their personal hygiene.	The contractor shall • Provide portable toilets at the construction sites, if about 25 people are working the whole day for a month. Location of portable facilities should be at least 6 m away from storm drain system and surface waters. These portable toilets should be cleaned once a day and all the sewerage should be pumped from the collection tank once a day and should be brought to the common septic tank for further treatment. • Provide safe drinking water facilities to the construction workers at all the construction sites.
Other ECPs	Potential risks on health and hygiene of construction workers and general public	The Contractor shall follow the following ECPs to reduce health risks to the construction workers and nearby community • ECP 2: Fuels and Hazardous Goods Management • ECP 4: Drainage Management • ECP 10: Air Quality Management • ECP 11: Noise and Vibration Management • ECP 15: Road Transport and Road Traffic Management
Trainings	Lack of awareness and basic knowledge in health care among the construction workforce, make them	The Contractor shall • Train all construction workers in basic sanitation and health care issues (e.g., how to avoid

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
	susceptible to potential diseases.	malaria and transmission of sexually transmitted infections (STI) HIV/AIDS. • Train all construction workers in general health and safety matters, and on the specific hazards of their work. Training should consist of basic hazard awareness, site specific hazards, safe work practices, and emergency procedures for fire, evacuation, and natural disaster, as appropriate. • Implement malaria, HIV/AIDS and STI education campaign targeting all workers hired, international and national, female and male, skilled, semi- and unskilled occupations, at the time of recruitment and thereafter pursued throughout the construction phase on ongoing and regular basis. This should be complemented by easy access to condoms at the workplace as well as to voluntary counseling and testing.

Annex E

Details of Consultees

The details of attendees at the consultations discussed in the preceding sections are given in the following tables.

Table 1: Details of Focus Group Meetings Arranged for Stakeholder Consultations

Sr. No.	Village/Settlement/Goth/Basti/Distr./ Minor	Location	Date	No. of Participants
A: 1st round of Consultations with Primary Stakeholders (Project and surrounding area)				
1	Goth Muhammad Aalam	Within project impact ara	17-09-2011	14
2	Goth Muhammad Yaqoob Soomro	-do-	17-09-2011	15
3	Goth Abdul Hakim	-do-	17-09-2011	15
4	Basti Taj Muhammad	-do-	18-09-2011	15
5	Basti Rasul Bukhsh Sheikhan	-do-	18-09-2011	15
6	Basti Allah Dewaya	-do-	19-09-2011	25
7	Sher Khan Nabi Bukhsh	-do-	19-09-2011	14
8	Basti Gul Nawaz Khan	-do-	26-10-2011	10
9	Basti Shah Gaji	-do-	20-09-2011	21
10	Basti Jam Rahim Bakhsh	-do-	20-09-2011	16
11	Basti Bakht Ali	-do-	23-11-2011	23
12	Basti Bukhshan shah	-do-	14-09-2011	15
13	Mawa Khan	-do-	15-09-2011	30
14	Goth M. Sachal Solangi	-do-	15-09-2011	14
15	Goth Mehan Khan Mazari	-do-	15-09-2011	15
16	Goth Edan Khan	-do-	16-09-2011	14
17	Jaro Khan	-do-	16-09-2011	19
18	Goth Ali Nawaz	-do-	22-09-2011	7
19	Goth Abdul Rahim	-do-	24-09-2011	6
20	Goth Muhammad Sharif	-do-	25-09-2011	21
21	Goth Afzal Khan	-do-	26-09-2011	7
22	Basti Malik Hassan(left Marginal Band	-do-	25-11-2011	22
23	Basti Shello Rathani (left Marginal Band	-do-	25-11-2011	20
24	Basti Parri Khan(left Marginal Band	-do-	25-11-2011	15
25	Basti Dhigana Khan Dasti(left Marginal Band	-do-	25-11-2011	15
26	Basti Mochi (left Marginal Band	-do-	25-11-2011	22
27	Goth Gidu Marani	-do-	14-09-2011	15
28	Goth Natho Khan	-do-	22-11-2011	15

Sr. No.	Village/Settlement/Goth/Basti/Distr./ Minor	Location	Date	No. of Participants
29	Goth Aurangzaib Mazari	-do-	22-11-2011	31
30	Goth Mir Muhammad Mazari	-do-	24-11-2011	15
31	Goth Imam BukhsSolongy(Dolatpur)	-do-	24-11-2011	25
Total:				526

Table 2: Consultation with Fisherfolk representatives during October 2013

S. #	Name	Position
1	Murtaza Mirani	Fisherman
2	Iqbal Mirani	Retailer
3	Mumtaz Ali Mirani	Retailer
4	Baboo	District General Secretary, fisherfolk
5	Karim Baksh Mirani	Fisherman & Retailer
6	Azbolo Mirani	Fisherman
7	Abid Hussain	
8	Fakir Mohammad Mirani	Contractor (Leaser fish farm)
9	Pir Baksh	Taluka president
10	Ishaq Mirani	Fisher folk president Guddu
11	Mohammad Ali Shah	Fisherman's cooperative Kandh Kot

Table 3: 1st Round of Consultations with Institutional Stakeholders (17 Sep., 2011 to 24 Nov., 2011)

S. #	Name	Address
A1: Sindh Irrigation Department		
1	Syed Zaher Hyder Shah	Chief Engineer Irrigation Office at Sukkur
2	Shahnawaz Bhotto	XEN,Guddu Barrage Irrigation Office at Guddu
3	Jaipal Das	XEN (Mech) Mechanical section of Guddu project
4	Ali Akbar	Assistant Executive Engineer; Q&C sub-Division Irrigation Office at Guddu Barrage
5	Nazir Ali Shahani	Assistant Executive Engineer; Regulation sub-Division, Irrigation Office at Guddu Barrage
6	Ghaffar Soomro	Assistant Executive Engineer Irrigation Office at Guddu Barrage
7	Shaukat Mahar	Assistant Executive Engineer Irrigation Office at Guddu Barrage
A2: Sindh Wildlife Department		
1	Mr. Abdul Jabbar Mirani	Wildlife inspector Wildlife department site Office at Guddu Barrage and Kandhkot
2	Mir Akhtar Hussain Talpur	In charge Indus Blind Dolphin at Sukkur Regional Office Wildlife Department Sukkur
A3: Water and Power Development Authority		
1	Abdul Aziz	Medical Officer WAPDA hospital
A4: NGO		
1	Shahzad	Finance Director NGO People in Need
A5: Forest Department		

1	Ghulam Rasool	Clerical Staff Forest Department District office Kandhkot
A6: Agri. Extension		
1	Naimat Ullah Bajarani	District Officer, Agriculture Extension Department Khandkot
A7: Fisheries Department		
1	Mr. Ghulam Mustafa Gopang	D.O, Fisheries Fisheries Department District office Khandhkot
2	Mr. Manzoor Ahmad Banjrani	DO. Fisheries Fisheries Department District office Khandhkot
3	Nazir Ahmed	Senior Clerk Fisheries Department District office Kandhkot
A8: Sindh Wildlife Department		
1	Baqa Muhammad Baloch	D.O.Game officer Sukkur Regional Office Wildlife Department Sukkur

Table 4: Villages Visited as Part of Consultations and Socio-Economic Baseline Data Collection

Upstream Right Side	Downstream Right Side	Upstream Left Side	Downstream Left Side
Shakhelo Khan	Mevo Khan Soomro	Farman Ali Mazari	Gidu Mazari
Sher Jan Mazari	Bilawal Solangi	Allah yar Mazari	Hular Chachr
Abdul Hakim Mazari	Peeral Solangi	Araz Mohammad Mazari	Jam Allah Wasayo Chachar
Gul Nawaz Soomro	Din Mohammad Solangi	Allah Bux Mazari	
Mohammad Yaqoob	Jaro Khan Mazari	Mohammad Nawaz Malik	
Mohammad Alam	Abdul Wahid Brohi	Nawaz Khan Mazari	
Sakhi Bux Soomro	Bakshan Shah	Mohammad Punhal Mazari	
Abdul Rehman Mirani	Fateh Mohammad Solangi	Piyaro Khan Mazari	
Mohammad Sharif	Ghulam Mustafa Khoso	Hazar Khan Dasti	
Taj Mohammad Soomro	Baho Khan Mazari	Noor Hassan Dasti	
Mohammad Moosa Khoso	Kalo Khan Malik	Shabir Dasti	
Mohammad Iqbal Samejo	Mir Afzal Khan Mazari	Haji Nihal Mazari	
Araz Mohammad Mazari	Rehman Khan Mazari	Wasti Bunda	
Mohammad Sharif Mazari	Shah Mohammad Mazari	Garhi Dodo	
	Abdul Wahab Khoso	Akbar Malik	
	Dodo Khan Mazari	Mohammad Nawaz Mazari	
	Qadir Bux Kalwar	Natho Khan Mahar	
	Ghulam Qadir Solangi	Hussain Bux Malik	
	Lali Khan Mazari	Mohammad Hassan Malik	
	Ali Bux Solangi	Arab Kori	
	Hafiz Atta Mohammad	Garhi Khair Mohammad	
	Dhani Bux Mazari	Allah Wadhayo Mazari	
	Nazar Mohammad Samejo		
	Sachal Solangi		
	Ghulam Nabi Mazari		

Table 5: 2nd Stage Consultations in the Primary Impact Zone

S.#	Village	Location	Date	No. of Participants
1	Punho Khan Mazari	Village Otaq	10/11/2013	20
2	Nazir Ahmed Dasti	Village Otaq	12/11/2013	18
3	Jam Mujeeb Jhak	Otak of Jam Abdul Baki	13/11/2013	16
4	Sardar Saleem Jan Mazari	Village Otaq	20/11/2013	22
5	Sardar Shamsher Khan	Village Otaq	21/11/2013	20
	Mazari			
6	Sardar Atif Hussain Mazari	Village Otaq	21/11/2013	18
Total:				114

Table 6: 2nd Stage Consultations with women in the Primary Impact Zone

S.#	Village	Location	Date	No. of Participants
1	Mukhtiar Khan Mazari	Downstream Left Side	27/10/2013	45
2	Bakhshan Shah	Downstream Right Side	01/11/2013	34
3	Village Chachar	Downstream Right Side	28/10/2013	28
4	Village Meerani	Downstream Right Side	29/10/2013	18
5	Mevo Khan Soomro	Downstream Right Side	29/10/2013	27
6	Meho Khan Mazari	Downstream Right Side	30/10/2013	31
7	Sachal Solangi	Downstream Right Side	05/11/2013	25
8	Abdul Rehman Meerani	Upstream Left Side	30/10/2013	22
9	Lahoti Deedan Faqeer Meerani	Upstream Left Side	31/10/2013	30
10	Farman Ali Mazari	Upstream Left Side	31/10/2013	17
11	Sharif Mazari	Upstream Left Side	01/11/2013	12
12	Ghulam Qadir Kori	Upstream Left Side	01/11/2013	32
13	Khan Mohammad Kori	Upstream Left Side	01/11/2013	25
14	Ghulam Nabi Malik	Upstream Left Side	02/11/2013	23
15	Allah Bux Manvani	Upstream Left Side	02/11/2013	20
16	Ali Bux Manvani	Upstream Left Side	03/11/2013	14
17	Meeran Bux Gopang	Upstream Left Side	03/11/2013	12
18	Mohammad Alam Meerbahar	Upstream Right Side	03/11/2013	28

S.#	Village	Location	Date	No. of Participants
19	Rab Nawaz Meerbahar	Upstream Right Side	04/11/2013	35
20	Ghulam Akbar Soomro	Upstream Right Side	04/11/2013	17
21	Arz Mohammad Mazari	Upstream Right Side	05/11/2013	13
22	Momin Shah	Upstream Left Side	05/11/2013	15
23	GidduMeerani	Downstream Left Side	06/11/2013	26
24	RaisGulanChachar	Downstream Left Side	06/11/2013	35
25	Afzal Malik	Downstream Left Side	06/11/2013	16
26	Mohammad Sharif Mazari	Downstream Left Side	11/11/2013	21
27	Gul Nawaz Soomro	Upstream Right Side	11/11/2013	26
28	Arz Mohammad Mazari	Upstream Right Side	12/11/2013	35
29	Naik Mohammad Mazari	Downstream Right Side	12/11/2013	30
30	Khano Bagri	Downstream Right Side	13/11/2013	32
31	BilawalSolangi	Downstream Right Side	13/11/2013	28
32	Allah Wadhayo Mazari	Upstream Left Side	14/11/2013	14
33	Sendhal Khan Mazari	Upstream Left Side	14/11/2013	17
34	Ghulam Rasool Malvani	Upstream Left Side	14/11/2013	22
35	Natho Khan Mahar	Upstream Left Side	15/11/2013	19
36	Mohammad Nawaz Lathani	Upstream Left Side	15/11/2013	23
37	Malik Hassan	Upstream Left Side	16/11/2013	29
38	Luqman Kori	Upstream Left Side	08/11/2013	31
39	Ghulam Akbar Malik	Upstream Left Side	16/11/2013	23
40	Arib Kori	Upstream Left Side	17/11/2013	15
41	Malik Hussain Bux	Upstream Left Side	17/11/2013	26
42	Punhal Khan Mazari	Upstream Left Side	17/11/2013	13
43	Hazar Khan Dasti	Upstream Left Side	18/11/2013	27
44	Shabir Sahib Dasti	Upstream Left Side	18/11/2013	30
45	Garhi Khair Mohammad	Upstream Left Side	18/11/2013	24

Table 7: Stakeholders Consultation at Canal Command Area

S.#	Village	Location	Date	No. of Participants

Ghotki Feeder Canal				
1	Dilwaro Minor	Head	04/10/2013	9
2	Bori Lower	Head	04/10/2013	12
3	Kalwali	Head	05/10/2013	11
4	Saeed Pur	Middle	05/10/2013	10
5	Shah Minor	Middle	06/10/2013	10
6	Bago Daho	Middle	09/10/2013	10
7	Lundi Wah	Middle	09/10/2013	9
8	Mithiri	Middle	10/10/2013	10
9	Gaji lower	Middle	10/10/2013	10
10	Dingro Wah	Tail	10/10/2013	10
11	Barri Wah	Tail	11/10/2013	10
12	Jari Wah	Tail	11/10/2013	10
13	Sabani	Tail	12/10/2013	12
14	Kamal Wah	Tail	12/10/2013	9
15	Mubark Pur	Tail	14/10/2013	10
16	Sangrar	Tail	15/10/2013	11
17	Rohri Forest	Tail	16/10/2013	10
Beghari Sindh Feeder				
1	Gail Pur Distry	Head	24/11/2013	10
2	Gandher Distry	Head	12/11/2013	10
3	Bahadur Pur Minor	Head	24/11/2013	11
4	Noor Pur Minor	Head	24/11/2013	11
5	Hazaro Distry	Middle	15/11/2013	4
6	Choi Branch	Middle	27/11/2013	10
7	Khan Distry	Middle	28/11/2013	10
8	Zarkhail Distry	Middle	27/11/2013	10
9	Channa Distry	Middle	28/11/2013	10
10	Mirza Wah	Middle	28/11/2013	10
11	Katta Distry	Tail	30/11/2013	10
12	Dilmurad Distry	Tail	26/11/2013	7
13	Noor Wah	Tail	30/11/2013	11
14	Hazaro	Tail	26/11/2013	11

	Distry			
15	Koureja Branch	Tail	22/11/2013	10
16	Gul Distry	Tail	26/11/2013	10
17	Seer Minor	Tail	27/11/2013	4
18	Lund Minor	Tail	27/11/2013	14
19	Eiden Minor	Tail	29/11/2013	9
Desert Fat Feeder				
1	Adio Minor	Head	24/11/2013	11
2	Old Frontier Distry	Head	12/11/2013	12
3	Risaldar Minor	Middle	13/11/2013	11
4	Mistri Minor	Middle	13/11/2013	13
5	Garhi Hassan Distry	Tail	17/11/2013	10
6	Bhutta Minor	Tail	18/11/2013	10
7	Jangu Distry	Tail	18/11/2013	10

Table 8: 2nd Round of Consultations with Institutional Stakeholders

Sr. No.	Name of person	Address/ Position/ Contact Date
Sindh Irrigation Department		
1	Mr. Nazir Ahmad Mahr	Chief Engineer Guddu Barrage (04-10-2013)
2	Mr. Ghulam Farooq Chanar	S.E. Desert Pat Feeder Circle (04-10-2013)
3	Mr. Nazir Ahmad Shahani	Sub-Divisional Officer, Guddu Barrage (05-10-2013)
4	Mr. Zameer Hussain Bhangar	Chief Draftsman, Guddu Barrage (05-10-2013)
Sindh Wildlife Department		
1	Ms. Fahmida	Director General (26-10-2013)
2	Abdul Jabbar Mirani	Inspector/Incharge Guddu Barrage (26-10-2013)
Water and Power Development Authority		
1	Mr. Muhammad Yousaf Magsi	Executive Engineer (Civil), Guddu Thermal Power Station (15-11-2013)
2	Mr. Abdul Aziz Khosoo	Sub-Divisional Officer, Guddu Barrage (16-11-2013)
Mojaz Foundation (NGO)		
1	Mr. Abdul Smad	Project coordinator (16-11-2013)
2	Mr. Rajab Ali	Office Manager (16-11-2013)
Forest Department		
1	Mr. Anyat Mazari	Range Forest Officer Forest Department
Agri. Extension		
1	Mr. Nazir Ahmed Khoso	Assistant Director Agri. Extension
3	A. Rahim Chachar	Agri. Officer Agri. Extension

Sr. No.	Name of person	Address/ Position/ Contact Date
Health Department		
1	Dr. Mushtaq Ahmed Khalwar	DMS Health Department
Local Influential Persons		
1	Mr. Punoo Khan Mazari	Local Land Lord (17-11-2013)
2	Nazir Ahmed Dasti	Local Land Lord (17-11-2013)
3	Jam Mujeeb Jhak	(20-11-2013)
4	Sardar Saleem Jan Mazari	(20-11-2013)
5	Sardar Shamsher Khan Mazari	(20-11-2013)
6	Sardar Atif Hussain Hussain Mazari	(20-11-2013)
7	M. Amir Mazari	(22-11-2013)
8	Nazir Ahmed Dasti	(22-11-2013)
9	Mujeeb Jhak	(23-11-2013)