GOVERNMENT OF PAKISTAN
MINISTRY OF WATER AND POWER

Tarbela 5th Extension Hydropower Project

ENVIRONMENTAL AND SOCIAL ASSESSMENT – EXECUTIVE SUMMARY

February 2016

Water and Power Development Authority (WAPDA)

National Transmission & Despatch Company (NTDC)

Contents

List of Tables and Figures

List of Acronyms

AF	Additional Financing
BCM	Billion cubic meters
CCGT	Combined Cycle Gas Turbine
CEAP	Construction Environmental Action Plan
CIA	Cumulative Impact Assessment
CITES	Convention on International Trade in Endangered Species
CDAP	Community Development Assistance Program
CLO	Community Liaison Officer
CO	Carbon monoxide
CO_2,	Carbon dioxide
CO_{2e},	Equivalent carbon dioxide
CSC	Construction Supervision Consultant
DB	Diamer-Basha Hydropower Project
DHP	Dasu Hydropower Project
ECP	Environmental Code of Practices
EHS	Environment, Health, and Safety
EIA	Environmental Impact Assessment
EMF	Electro Magnetic Field
ESMP	Environmental and Social Management Plan
EPA	Environmental Protection Agency
ESA	Environmental and Social Assessment
ESMP	Environmental and Social Management Plan
ESMU	Environmental and Social Management Unit
GDP	Gross domestic product
GHG	Greenhouse gas
GLOF	Glacial lake outburst flood
GoP	Government of Pakistan
GWh	Gigawatt hour
Ha	Hectare
HIV/AIDS	Human Immunodeficiency Virus/ Acquired Immunodeficiency Syndrome
HSE	Health Safety and Environment
IBWS	Indus Basin Water System
IEE	Initial Environmental Examination
IFC	International Finance Corporation
ILRP	Income and Livelihood Restoration Program
IPCC	International Panel on Climate Change
IPOE	International Panel of Experts
IUCN	International Union for the Conservation of Nature
Km	Kilometer
KP	Khyber Pakhtunkhwa
kV	Kilovolt
kWh	Kilowatt hour
LARF	Land Acquisition and Resettlement Framework
LLO	Low-Level Outlet
Masl	Meters above sea level
M&E	Monitoring and Evaluation
MW	Megawatt
NEQS	National Environmental Quality Standards
NGO	Non-Governmental Organization
NO	Nitrogen oxide
NTDC	National Transmission and Dispatch Company
OP	Operational Policy
Pak-EPA	Pakistan Environmental Protection Agency
PEPA	Pakistan Environmental Protection Act
PKR	Pakistani Rupees
PM	Particulate matter
PMF	Probable Maximum Flood
PMU	Project Management Unit
RAP	Resettlement Action Plan
RCC	Resettlement Claims Committee
ROW	Right of Way
SRU	Social and Resettlement Unit
TDP	Tarbela Dam Project
T4HP	Tarbela 4th Extension Hydropower Project
T5HP	Tarbela 5th Extension Hydropower Project
TL	Transmission Line
UIB	Upper Indus Basin
USD	US Dollar
WAPDA	Water and Power Development Authority
WB	World Bank
WEC	WAPDA Environmental Cell

1. Introduction

The Pakistan Water and Power Development Authority (WAPDA) and National Transmission and Despatch Company (NTDC) with funding from the World Bank (WB) plan to undertake Tarbela 5th Extension Hydropower Project (T5HP or the Project) by developing 1,410 MW (3 turbines x 470 MW) extension to the power generating capacity of the Tarbela Dam. The additional capacity will be achieved by converting the 5th irrigation tunnel of the Tarbela Dam for hydropower generation. The T5HP has two major components: (i) power generation facilities and (ii) power evacuation facilities. The major works included under T5HP are: (a) modifications to the Tunnel 5 and building a new power house and its ancillaries to generate about 1,800 GWh of power annually (b) a new 50 km of 500 kV double circuit transmission line from Tarbela to Islamabad West Grid Station for power evacuation, and (c) a new 500 kV Islamabad West Grid Station. WAPDA and NTDC have undertaken an environmental and social assessment (ESA) of the Project in accordance with World Bank Operational Policies and Pakistan regulations. This Executive Summary presents the potential environmental and social impacts of the T5HP project as described in the ESA. Mitigation measures are described and included in environmental and social management plan (ESMP) to address potential impacts as well as to enhance the environmental and social benefits of the project.

1.1. Background

The energy sector in Pakistan: Pakistan is suffering from an acute power and energy crisis, which is primarily caused by the increasing gap between the supply and the demand of electricity. The current (2015-2016) generating capability of Pakistan is 18,760MW in summer and 14,833 MW in winter, whereas the current demand is about 22,880 MW. Thus the current short fall is 4,120 MW and 8047 MW in the summer and winter seasons respectively. Pakistan's power needs are increasing with a growth rate of 7 to 8 % (according to Pakistan Electric Power Company, the demand will be 96,000 MW by 2029-2030) whereas the generation additions are too slow to accompany the same pace and there will be insufficient generation to meet the future demand in the coming years.

Government interventions: In an attempt to address the problems in the energy sector the Government of Pakistan (GoP) has initiated a number of policies and programs that are focused on structural change: moving away from high cost heavy fuel oil to low cost cleaner hydropower; improving efficiency in production, distribution and delivery of electricity; introducing cleaner and cheaper technologies on different scales, including options such as demand side management; and improving utilization efficiency to reduce transmission and distribution losses. The World Bank has also been funding some of these GoP interventions through Tarbela 4th Extension Hydropower Project (T4HP), Dasu Hydropower Project (DHP), Electricity Distribution and Transmission Improvement Project, National Transmission Improvement Project, and Central Asia - South Asia 1000-MW Power Transmission Line Project (CASA 1000).

Tarbela Dam: The Tarbela Dam is one of the largest earth-fill dam constructions in the world. The dam is situated on the Indus River in the province of Khyber Pakhtunkhwa (KP) at a distance of about 70 km NW of Islamabad (see **Figure 1**). The reservoir behind the dam is almost 100 km long and measures 243 km² when completely filled. The live storage capacity of the reservoir was initially 11.9 billion cubic meters (BCM), but this has been reduced due to siltation during 35 years of operation to 6.8 BCM. The Tarbela Dam is 2,743 m long, 143 m high and has two spillways cutting through the left bank and discharging into a side valley. At the right bank there are four tunnels, each of about 900 m length as bypass for irrigation releases and/or power generation. Tunnel 5 used for irrigation releases is situated at the left bank.

Power generation from Tarbela Dam: The Tarbela Dam Project (TDP) was developed during the 1970s in the framework of the Indus Basin Water Master Plan. Initially the main purpose of TDP was to supply irrigation water to the densely populated agricultural areas in Punjab and Sindh. Then, starting in the mid-eighties power generation capacity was added in three subsequent hydro-electrical project extensions, installing a total of 3,478 MW generating capacity respectively on Tunnel 1 (700MW – 4 turbines x 175 MW), Tunnel 2 (1,050 MW - 6 turbines x 175 MW) and Tunnel 3 (1,410 MW - 4 turbines x470 MW).

Tarbela 4th Extension Hydropower Project: Currently, WAPDA is implementing the Tarbela 4th Extension Hydropower Project (T4HP) by converting the 4th tunnel for hydropower generation. This project will develop 1,410 MW (3 turbines x 470 MW) additional generating capacity to provide over 3,800 GWh annually. The construction works for this project is expected to be completed by May 2017.

1.2. The Proposed Project

Tarbela 5th Extension Hydropower Project: The proposed T5HP would support the scaling up of power generation capacity by adding 1,410 MW to an existing tunnel number 5 (T5) of Tarbela Dam. The T5 is presently being used to release water for irrigation only when the reservoir level is below the minimum spillway operating level and water releases from the existing power units is not adequate. With T5HP power house installed, the T5 (and overall TDP) would continue to carry out the same function and in addition water released from spillway would be diverted through the tunnel 5 and only remaining water would be passed over the spillway. This would maximize use of the existing TDP facilities and provide the critically needed power for the country. It will generate approximately 1,800 GWh of additional electricity utilizing the same water flows at a very low cost compared to alternative generation from thermal or other hydropower projects, that is because all required infrastructure such as dam and tunnel are already constructed. Environmental and social issues associated with power generation facilities at T5HP are relatively minor, since most of the infrastructure is already in place and no land acquisition and resettlement is required. Basic infrastructure and other facilities like offices, labor camps and residential accommodation are largely available and only have to be renovated and possibly expanded against modest cost. The installation of additional generating capacity will not influence the irrigation release capacity of the dam.

The proposed T5HP works: The primary works involved under T5HP are:

- Power Generation Component: Raising of intake level of tunnel 5; Powerhouse; Tailrace channel; and Switchyard.
- Power Evacuation Component: 50 km of transmission line (500-kV) from new switchyard to Islamabad West Grid Station; and A 500 kV Islamabad West grid station

Location: Locations of the Tarbela Dam and proposed transmission line and grid station are shown in **Figure 1**. The western side of the dam is located within the Swabi District, and the eastern side which includes the Project site is within the Haripur District of KP. The transmission line passes through districts of Haripur and Attock (Punjab province). The proposed Islamabad West Grid Station is located about 30 km northwest of Islamabad.

Implementing Agencies: The power generation facilities of the Project (intake, powerhouse, tailrace and switchyard) will be implemented by WAPDA whereas power evacuation facilities (transmission line and grid station) will be implemented by NTDC. The World Bank will fund this Project by providing additional financing (AF) of T4HP.

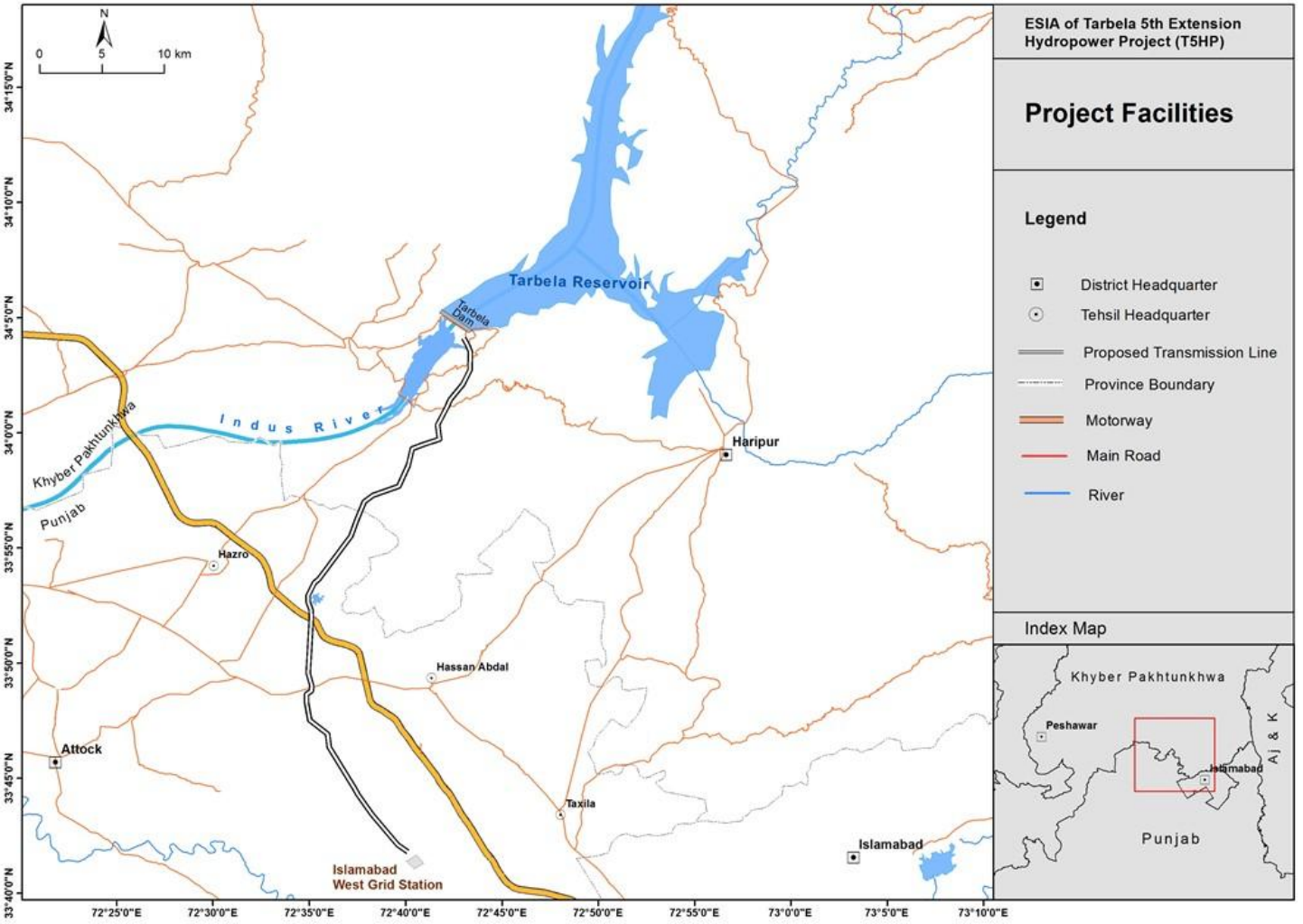
Design and Implementation of T5HP: Feasibility studies for power generation facilities have been completed and feasibility studies for power evacuation facilities will be carried out during 2016-2017. The Project will be implemented over a period of 39 months.

1.3. The Environmental and Social Assessment

Studies and documentation: This executive summary of the ESA is based on field studies and data collected between 2014 and 2015 by various consultant teams hired by WAPDA and NTDC. These studies have been documented in four volumes, (i) Environmental and Social Assessment (ESA) for the entire Project; (ii) Land Acquisition and Resettlement Framework (LARF) for T5HP Transmission Line; (iii) Resettlement Action Plan (RAP) for Islamabad West Grid Station; and (iv) the present executive summary. All these documents are available under separate covers and have been disclosed on the WAPDA and NTDC websites.

Contents of the present document: Chapter 2 reviews the prevailing WB policies, and national and provincial regulatory requirements relevant to environmental assessment. Chapter 3 presents a simplified description of the project, its various components and other salient information relevant for environmental assessment. Analysis of alternatives considered during project planning and design are described in Chapter 4. Description of the baseline environmental and social conditions is presented in Chapter 5. Risks from climate change and earthquakes are described in Chapter 6. Potential environmental and social issues from the Project implementation as well as the appropriate mitigation measures to address these negative impacts have been discussed in Chapter 7. Cumulative impact assessment of T5HP along with other existing future planned projects on upstream and downstream of Tarbela is discussed in Chapter 8. Chapter 9 presents the outline of the environmental and social management plan (ESMP). Finally, Chapter 10 describes the consultations that have been carried out with the stakeholders.

Figure 1: T5HP Location Map



1.4. Composition of Study Team

Independent consultants: WAPDA engaged a team of independent consultants – Dr. Venkata Nukala (team leader, environmental and social), Mr. Abdul Hameed (social) and Mr. Mohammad Ali Durrani (environment) – to assess the environmental as well as social impacts of the project, to prepare the environmental and social management plan, and to compile the main ESA report as well as the Summary ESA report. In addition, Mr. Ayaz Asif (environment), Dr. Ali Nawaz (ecology), and Prof. Zahid Beg Mirza (birds) were also engaged for this ESA. The environmental and social staff of Project Management Unit (PMU) of Dasu Transmission Line Project - Mr. Muhammad Atif Raza (environment and social), Mr. Fawad Ahmed (social) and Ms. Misbah Amanat (environment) – have also participated in the field studies.

Environmental and social study team (Design Consultant for Power Generation Component): The baseline data collection, project description compilation, stakeholder consultations, and initial impact assessment for power generation component was carried out by a team led by Mr. Azmat Beg (environment) with core support from Mr. Ihsan-ul-Haq Farooqi and Ms. Marielle Rowan (sociology), and Mr. Mr. Omer Rasheed, and Mr. Mark Barnard (environment). Ecology surveys were carried out by Dr. Zaheer-ud-din Khan (Flora), Dr. Abdul Aleem Chaudhry (Fauna) and Prof. Dr. Muhammad Ashraf and Dr. Ali Hussain (aquatic ecology). Noise, air quality and water quality surveys were carried out by personnel from the Pakistan Space and Upper Atmosphere Research Commission (SUPARCO).

2. Policy, Legal and Administrative Framework

2.1. Applicable Legislation and Policies in Pakistan

Pakistan Environmental Protection Act, 1997: The Act establishes the general conditions, prohibitions, and enforcement for the prevention and control of pollution and the promotion of sustainable development in the country. It also describes and delineates the powers and functions of the Pakistan Environmental Protection Council, Pakistan Environmental Protection Agency (Pak-EPA), provincial Environmental Protection Agencies (EPAs), and Environmental Tribunals. In particular, the Act creates the authority for delegation of environmental management functions to the provincial EPAs. The requirement to conduct environmental assessment before commencing developmental projects stems from this Act.

Khyber Pakhtunkhwa Environmental Protection Act 2014 and Punjab Environmental Protection Act 1997 (Amended 2012): The Khyber Pakhtunkhwa Environmental Protection Act 2014 (KPEPA 2014) and Punjab Environmental Protection Act of 1997 (Amended 2012) are the provincial versions of the Pakistan Environmental Protection Act, 1997 (PEPA) relevant to the Project. Responsibility for PEPA was transferred from the Ministry of Environment to the provincial governments by an amendment to the PEPA in 2012. The provincial versions continue to remain materially the same as the PEPA except where governmental bodies are referred.

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

- Pakistan Penal Code (1860) deals with offences against public interests, e.g., to control noise, toxic emissions and disposal of effluents;
- Pakistan Explosives Act (1894) provides regulations for handling, transportation and use of explosives used for quarrying and blasting of rock;
- Land Acquisition Act (1894) provides process deals with land acquisition and compensation for the acquisition of private properties for public purpose;
- Factories Act (1934) provides regulations for safe handling and disposal of toxic and hazardous materials by contractors;
- The North-west Frontier Province Wildlife (Protection, Preservation, Conservation and Management) Act (1975);
- Protection of Trees Act (1949) prohibits cutting and logging of trees planted by the Forest Department along roads and canals;
- Pakistan Water and Power Development Authority Act (1958) authorizes WAPDA to develop water and power resources in the country through construction and operation of water storage facilities and powerhouses and erecting electrical transmission lines;
- Antiquity Act (1975) protects antiquities and empowers the GoP to prohibit excavation and construction works in any area that may contain objects of archaeological or cultural historic value;
- Motor Vehicle Ordinance (1965) empowers licensing and other authorities to regulate traffic rules, speed and weight limits and vehicle use;
- Labor Laws: labor rights are provided in the Constitution of Pakistan; various acts and ordinances provide additional rules for working hours, minimum working age and conditions of employment;
- Highway Safety Ordinance (2000) includes provisions for licensing and registration of vehicles and construction equipment;
- Local Government Ordinance (2001) deals with enforcement of laws for land use, conservation of natural vegetation, air, water, disposal of solid waste and wastewater effluents, public health and safety; and
- Project Implementation and Resettlement Ordinance (2001) safeguards the interests of persons/groups having to be involuntarily resettled due to land acquisition caused by a proposed project. The proposed Ordinance is supplementary to the Land Acquisition Act of 1894, as well as other Laws of Pakistan, and included in the Draft Resettlement Policy.

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

- Pak-EPA Initial Environmental Examination (IEE) and EIA Regulations (2000);
- National Environmental Quality Standards (NEQS) (2000), with updates in October 2010;
- Guidelines for the Preparation and Review of Environmental Reports (1997);

- Guidelines for Public Consultations (1997);
- Guidelines for Sensitive and Critical Areas (1997); and
- Policy and procedures for filing, review and approval of Environmental Assessments (2000).

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

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

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

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

2.2. Environmental Procedures

Environmental Impact Assessment: In accordance with the Pakistan Environmental Protection Act of 1997 (PEPA) and the Pak-EPA IEE and EIA Regulations, 2000, an EIA is required for hydroelectric power projects exceeding a generation capacity of 50 MW and with transmission lines with a capacity of more than 11 kV. The T5HP will generate 1,410 MW, therefore an EIA for this project is mandatory.

EIA Approval: Since the project area falls in KP and Punjab provinces, their respective EPAs are the relevant environmental regulatory authorities. The provincial EPAs are responsible for environmental regulation and implementing GoP environmental policies in their respective provinces. As part of their roles, provincial EPAs are responsible for reviewing EIA documentation for compliance with provincial EIA requirements and procedures and, using their district based staff, also monitors the implementation of EMPs.

2.3. World Bank Safeguard Policies

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

Environmental Assessment (OP 4.01): The World Bank requires an environmental and social assessment for all projects proposed for Bank financing, in order to ensure that these projects are environmentally and socially sound and sustainable. The T5HP project has been classified as Category A, because of the scope and size of the project involving large-scale construction activities on one of the largest dams in the world, with the potential possibility of affecting the safety and irrigation supplies of the densely populated areas downstream of the dam. The environmental issues that need to be addressed are especially relevant during construction period. In accordance with the requirements of OP 4.01, an ESA for the project has been carried out which incorporates

an Environmental and Social Management Plan to mitigate or minimize all potential adverse environmental and social impacts.

Involuntary Resettlement (OP 4.12): The power generation facilities will be constructed in the land owned by WAPDA. The land is currently uninhabited and no land acquisition and resettlement impacts are anticipated. For power evacuation facilities, land acquisition would be required. About 226 acres of land will be acquired for developing Islamabad West Grid Station. A RAP is prepared for the grid station. Land acquisition requirements for proposed transmission line will be determined during design stage. A Land Acquisition and Resettlement Framework (LARF) is prepared for the 500 kV transmission line to guide the preparation of future RAP for the transmission line.

Safety of Dams (OP 4.37): The dam safety policy is triggered since the construction works are implemented on a large dam including associated infrastructure situated upstream of a densely populated area. Regular inspections and assessments of the Tarbela Dam show that the Dam and its associated structures are safe. Dam instrumentation and monitoring system is in remarkably good conditions compared to similar dams of the same age. In bi-annual meetings, an independent panel of experts reviews the design and the operational and maintenance aspects of the project, particularly the safety and early warning systems. The project includes a component that would upgrade the monitoring system of the Dam, the monitoring of the movement of sediment delta in the reservoir, and associated early warning system.

International Waterways (OP 7.50): Tarbela is located on the Indus River which is an international waterway, thus automatically triggering the international waterways safeguard under OP 7.50. However, the Project consists primarily of the installation of a power unit on the existing Tunnel 5. It does not involve works and activities that would exceed the original scheme, change its nature, or alter or expand its scope and extent to make it appear a new or different scheme. Therefore, given the nature of works envisaged under the proposed Project: (i) the Project would not adversely affect the quality or quantity of water flows to other riparians; and (ii) it would not be adversely affected by other riparians' water use. The Project team has also reviewed Article VII of the Indus Waters Treaty of 1960 between India and Pakistan and concluded that a notification by Pakistan to India under paragraph (2) of the said Article VII is not required, as the Project would not cause interference with the waters of any of the Rivers and would not affect the other riparians materially. Therefore, like T4HP the T5HP also falls within the exception to the notification requirements of OP 7.50, set forth in paragraph 7(a) of OP 7.50. The Regional Vice President has approved the exception to notification under the T4HP that also applies to the T5HP.

Physical Cultural Resources (OP/BP 4.11): The ESA study has shown that there are no known physical and cultural objects or sites inside the project area or its immediate surroundings. However, in the bidding documents for the construction contracts "chance find" procedures will be included, providing guidelines how to deal with unexpected situations when buried physical and cultural property is found during the work.

Access to Information: This policy sets out the Bank's requirements for disclosing and sharing information. The policy reaffirms the Bank's commitment to transparency and accountability in its activities for promoting development effectiveness and poverty reduction. The ESA reports and this Executive Summary have been disclosed at WAPDA and NTDC websites in addition to sharing them with the stakeholders including the local community. The reports will also be sent to and World Bank Info Shop.

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 (WBG EHS) 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.

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

Natural Habitat (OP 4.04): Project will be implemented in areas where natural habitat has mostly been modified. No sensitive habitat exists at or near the project sites including along the transmission line corridor and at site of sub-station. Project activities will mostly have insignificant impacts on natural habitat. Hence this OP is not triggered.

Forestry (OP 4.36): Project will be implemented in areas where natural habitat has mostly been modified. No forests are located in the project influence area. Hence this OP is not triggered.

Pest Management (OP 4.09). The Project does not include any construction, operation or maintenance activities that require the use of pesticide or other agro-chemicals. This includes maintaining of the Right of

Way (RoW) beneath the power evacuation lines. No pesticides or herbicides are used to maintain RoW as per the standard practice of NTDC.

Indigenous People (OP 4.10). This OP defines the process to be followed if the Bank-funded Project affects the indigenous people (i.e., people having the following characteristics: self-identification as members of a distinct indigenous cultural group and recognition of this identity by others; collective attachment to geographically distinct habitats or ancestral territories in the project area and to the natural resources in these habitats and territories; customary cultural, economic, social, or political institutions that are separate from those of the dominant society and culture; and an indigenous language, often different from the official language of the country or region). Since no indigenous people as defined above are known to exist in the area, this OP is not triggered.

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. In order not to prejudice the position of either the Bank or the countries concerned, any dispute over an area in which a proposed project is located is dealt with at the earliest possible stage. This OP is not applicable, since the project is not located in or near any disputed territory.

2.4. Compliance Status with Pakistani Legislation and World Bank Policies

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

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

	Legislation / Policy	Actions Taken to Comply
Government of Pakistan (GoP)	Pakistan Environmental Protection Act, 1997 and provincial EPA acts	WAPDA will submit application for environmental clearance of the projects along with ESA report to KP-EPA and Punjab EPA. Disclosure of ESA to general public and formal public hearing will be organized by EPAs.
	EIA guidelines for Power Projects	Provide safety measures and information on emergency preparedness
	International treaties	Verification of protected sites, Red List and protection of vulnerable habitats in all environmental screenings and assessments under the project. Inclusion of relevant mitigation measures in each EMP for each subproject/activity.
	Disclosure of projects	The draft ESA and ARF reports have been disclosed on WAPDA and NTDC websites. Public consultations were held to disclose the project information and ESA and to solicit stakeholder feedback.
World Bank	Early screening and Scoping	Scoping consultations were held during December 2014 for power generation facilities; and during November 2015 for power generation facilities.
	Participatory approach	Consultation meetings and focus group discussions are held throughout the project area during ESA preparation.
	Integrate environmental and social assessment	Natural environment, public health, and social aspects are integrated in planning documents.
	Risk assessment	Health and safety risks for population and workers are identified in the ESA, and management measures will be included in tender documents.
	Climate Change and floods	Impact of increased snow-melt and climate change and effect on Indus floods studied. Adaptation measures were considering for design of power house.
	Cumulative impact assessment	Cumulative impact assessment has been conducted as part of the ESA to cover the impacts from all components of the Project and other related developments in the Project area.

	Legislation / Policy	Actions Taken to Comply
	Alternatives	Alternatives considered included: "without project" case; Alternatives to project (thermal generation and other hydropower projects); 9 combination of alternatives for T5HP layout and design; 3 alternatives for transmission line routing; and 3 alternatives for siting of 500 kV grid station.
	Pollution	Baseline survey of environmental quality has been carried out. Environmental standards of GoP and World Bank will be complied. Environmental Code of Practices (ECPs) will be included in contractors' bidding documents
	Physical and Cultural Resources	Chance find procedure included in contract documents
	Gender	Gender consultations carried out during ESA.
	Public Health	Public Health aspects addressed in mitigation measures.
	Consultation and Information Disclosure	Stakeholder consultation meetings, focus group discussions and formal public consultations were held. Public consultations were held on 31st December at Tarbela and on 1st January at grid station site. ESA, LARF, RAP and this Executive Summary will be disclosed in WAPDA and NTDC websites; and will be sent to World Bank InfoShop. Executive Summary will also be translated in to Urdu and will be disclosed in WAPDA and NTDC websites.

3. Project Description

3.1. Background

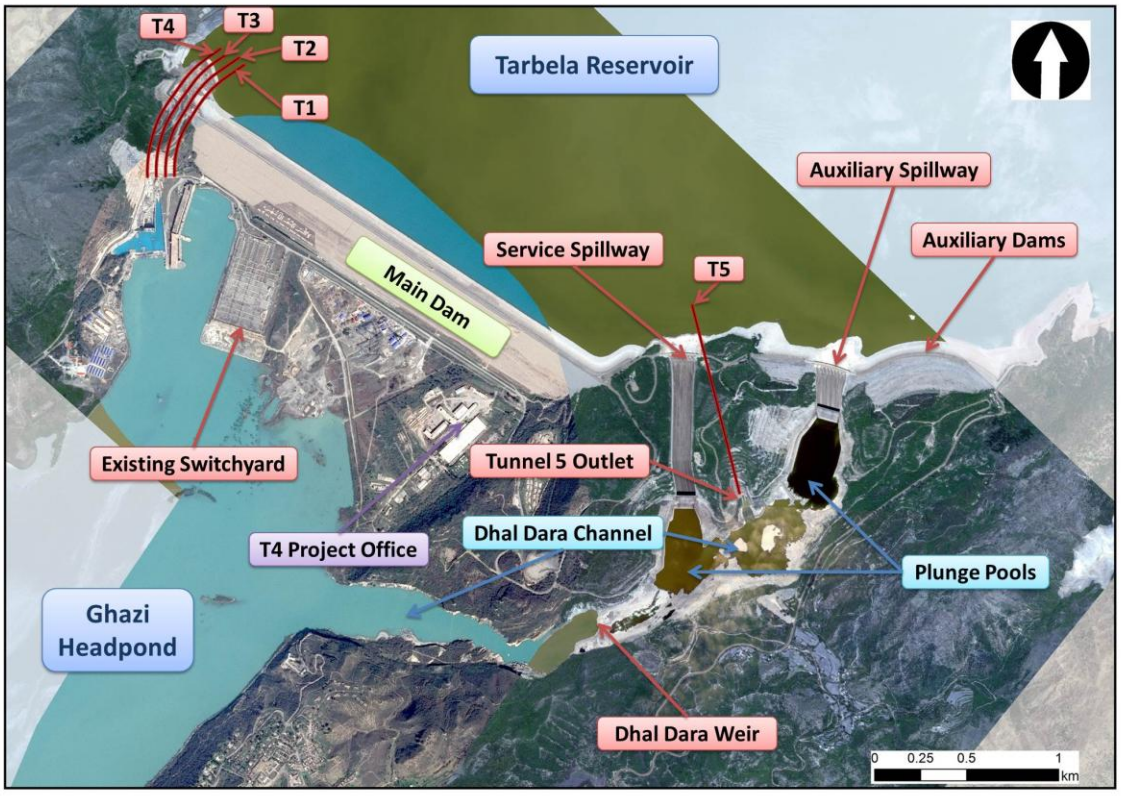
Tarbela Hydropower Project: Tarbela was conceived in the 1960s and commissioned in the early 1970s and its primary function was to store water for irrigation purposes. This remains its main purpose today. Completed in 1976 with commencement of power generation the following year, the original dam is the second largest embankment dam constructed in the world. Along with the Mangla Dam Project on the Jhelum River, the Tarbela has formed the foundation upon which Pakistan's irrigation is based, and they are the only storage dams in Pakistan. The Tarbela was originally designed to provide water storage for irrigation as well as generate hydro power from the irrigation releases with 3,478MW installed on Tunnels 1, 2 and 3 that pass through the right abutment of the dam. Tunnel 4 is currently being converted to hydropower and is under construction; as a result, a further 1,410MW generating capacity is currently being built on tunnel T4. The proposal for T5 will add a further 1,410MW resulting in a total generating capacity of 6,298 MW. Existing layout of Tarbela dam is shown in **Figure 2**.

Ghazi Barotha Hydropower Project: The Ghazi Barotha is a run-of-river project situated on the downstream of Tarbela dam. A barrage is constructed at Ghazi, about seven km downstream of Tarbela dam to divert the Indus water through a 52 km long canal to Barotha village (near Attock) where the power complex is located with a generating capacity of 1,450 MW. Ghazi headpond is the pondage area behind the Ghazi barrage and it extends up to Tarbela dam.

3.2. Project Objective

The objective of the T5HP is to increase the electricity generating capacity of Pakistan in a sustainable way in order to assist in satisfying the increasing demand for electricity in the country. This would be achieved by installing about 1,410 MW hydropower on the existing dam, thus reducing exposure to many social and environmental challenges generally associated with large dam projects - and without affecting the downstream water flows. The Project will provide additional generating capacity more cheaply and cleaner than any thermal alternative with almost no long-term fuel cost.

Figure 2: General Layout of Existing Facilities of Tarbela



3.3. Project Components

Component A: Construction of Power House and Modification to the Tunnel (USD302.7 million). This component would primarily cover civil works required for T5HP under a single contract, including constructing the T5 power house and a penstock connecting Tunnel 5 to the power units. It would also include modifications to the tunnel intake by constructing a raised intake that would connect to the existing tunnel. The construction of the raised intake would prolong the life of the power house operation and safeguard against intake closure because of sudden movement of sediment. The key components and general layout of proposed facilities are shown in **Figure 3** and **Figure 4**, and are briefly described below:

(i) Raised intake (similar to T4 raised intake, but with a sill level of 420m – 5m higher than T4 – and a short section of inclined tunnel joining the drop shaft to the existing T5 tunnel);

(ii) The connecting penstock consists of: cutting back the existing tunnel by 29m; sleeve lining a 36m section of existing tunnel; an expansion and bend immediately after the new portal; followed by two connections to the existing LLO; an inclined section of penstock and a manifold type connection to the powerhouse;

(iii) The powerhouse is to be situated beside the Dal Dara channel between the existing LLO structure and the Service Spillway (no new LLO are required since this arrangement utilizes the existing LLO)

(iv) A tailrace culvert and canal option has been selected that connects the turbine draft tubes to the lower water level in the Dal Dara channel below the Dal Dara weir (providing approximately 11m extra head than discharging directly into the plunge pools). In order for the tailwater level in the canal to be lower than the adjacent water level in the Dal Dara channel, the tailwater flow must to be hydraulically separate from the channel flow by a dividing wall which runs alongside the right-hand side of the canal.

Component B: Power Units and Ancillary Equipment (USD377.7 million). This component would cover the cost and installation of: (B1) turbines, generators, transformers, ancillary and electro- mechanical equipment (USD251.4 million); (B2) transformers and equipment for the switch yard to connect generation to the transmission line (USD68.4 million); and (B3) a new sub-component added to the Project for construction of a new double circuit transmission line from Tarbela to new substation Islamabad West (USD58 million including cost of management and social and environmental management plans of about USD15 million). The generating units for T5HP will be similar to those for T4HP i.e. three vertical Francis generating units each of 470MW rated capacity; as a result, the general internal layout of the mechanical and electrical equipment will be broadly similar.

Figure 3: Key Components of T5HP – Power Generation

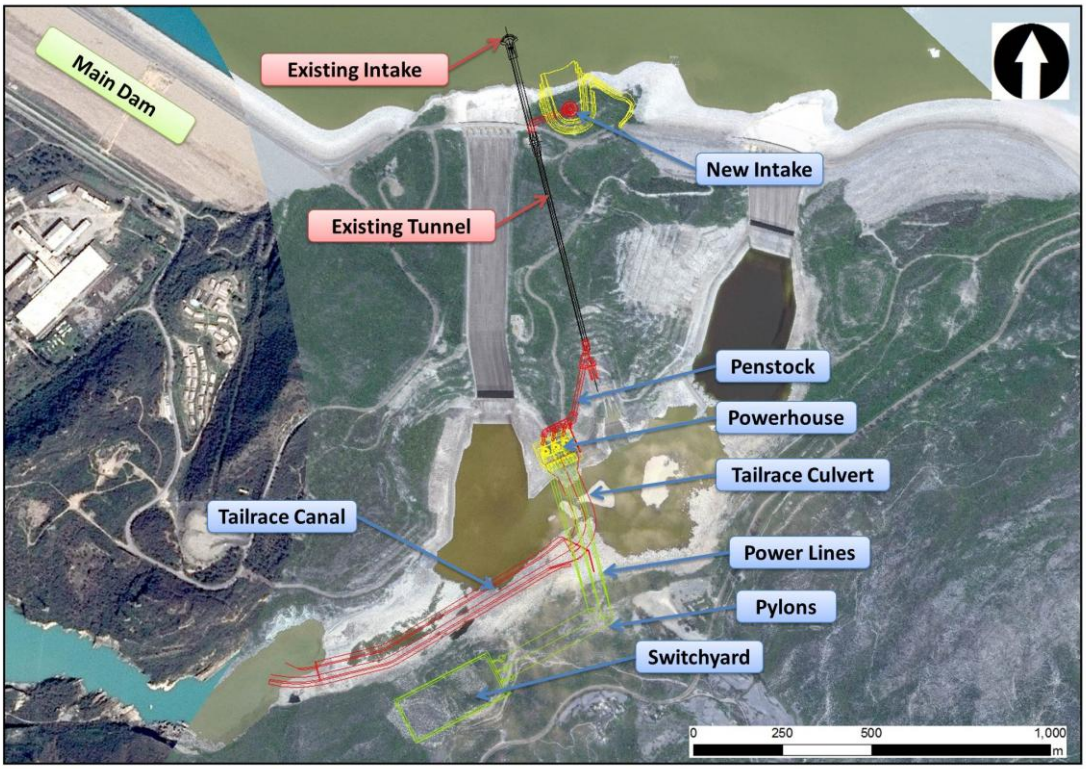
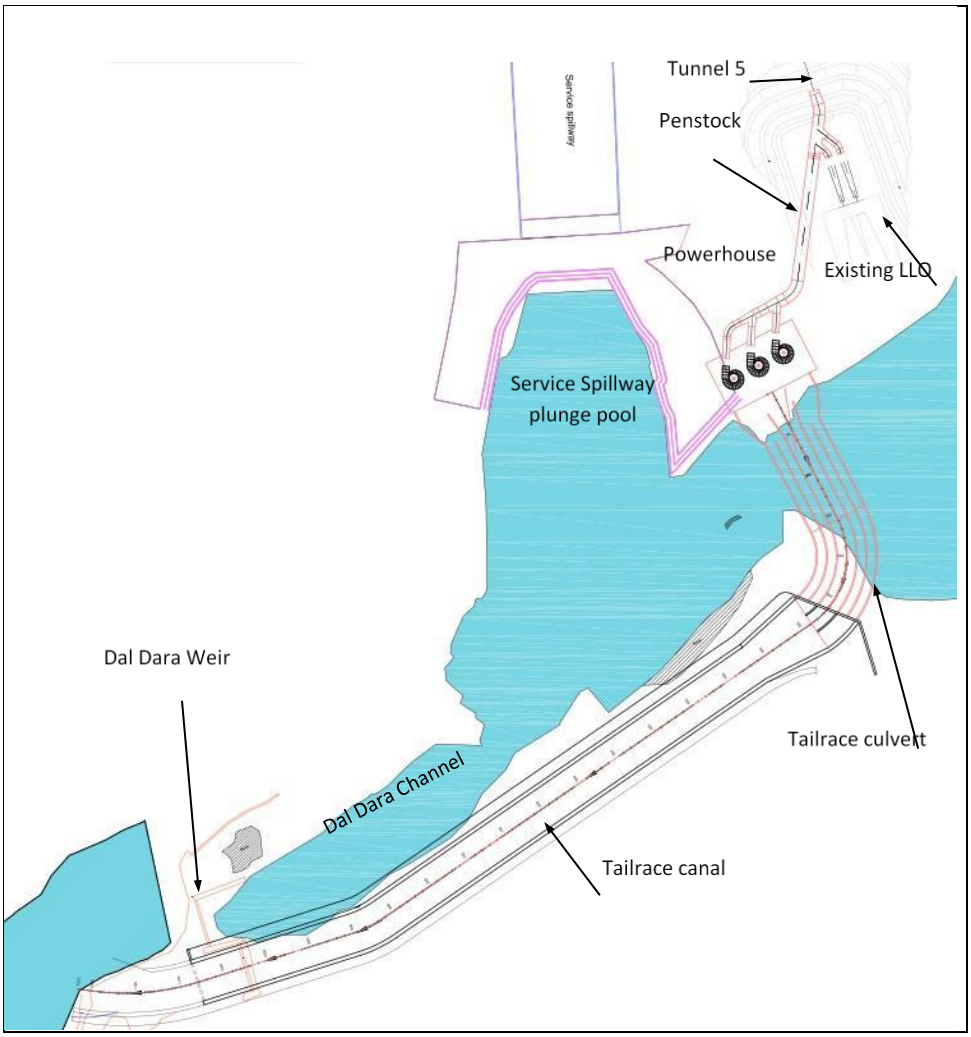


Figure 4: Layout of T5HP – Power Generation



Component C: Social Action and Environmental Management Plans (USD13 million). Sub-Component C1 (USD4.2 million) and C2 (USD3.0 million) would support implementation of Social Action Plan (SAP) and Environment Management Plan (EMP) respectively. About USD5.8 million would be allocated for Sub-Components C3: Dam Safety and Monitoring Program.

Component D: Construction Supervision Monitoring and Evaluation (USD32 million). Sub-component D1: Construction Supervision and Implementation Support (USD28.5 million). This sub-component covers the cost of consulting and other services for Project implementation, including construction supervision and Project management support. It would also cover implementation of all activities under the Project, including: procurement, contract administration, quality control, certification of payments, financial management, preparation of any additional designs, and bidding documents, etc.

Component E: Project Management Support, Pilots, Capacity Building, Technical Assistance and Training (USD42.6 million). The ongoing project has financed significant capacity building activities and TA for project preparation and strategic studies. The amount allocated under the three sub-components E1: Project Management Support and Audits (USD8.8 million); E2: Strengthening of WAPDA, Independent Panel of Experts and Technical Assistance (USD6.2 million); and E3: Pilots, Future Project Preparation and Strategic Studies (USD27.6 million) to finance the continuation of the project management support, capacity building and training programs for WAPDA officials.

Pilot for Floating Solar Panels in Tarbela Reservoir (USD20 million). Recently in a lake in Japan floating solar panels have been installed. Considering this development, the Tarbela reservoir area offers huge potential for installation of a floating solar power plant, over 7,000 MW. In order or test the floating solar plant in Tarbela reservoir and sort out all implementation, operational and maintenance and management issues of the floating solar plant, synchronization of operation of hydel and solar plants in practice, the project would include pilot for installation of 10MW of floating solar panels in the Tarbela reservoir area.

3.4. Construction Schedule

The construction schedule of T5HP is 39 months. The T5HP expected to start generating power in year 2020 in about 4 years from now.

3.5. Project cost

The cost of T5HP is about USD826 million (**Table 2**). WAPDA would finance about USD124.5 million and NTDC about USD8.6 million, and the remaining amount will be financed by World Bank by providing additional finance (AF) under T4HP.

Table 2: Estimated Cost of T5HP and Financing Plan (USD million)

	Total	WB IBRD AF	AIIB	WAPDA /GoP	NTDC /GOP	Total
A. Power House and Tunnel Works	**302.7**	**92.2**	**150.0**	**60.5**		**302.7**
B. Turbines, generators and auxiliaries						
B1. Turbines generators and related equitment,	251.4	111.1	90.0	50.3		251.4
B2. Transformers, switchyard electrical. connection	68.4	19.7	35.0	13.7		68.4
B3.1 Transmission Line to Islamabad West	43.0	34.4			8.6	43.0
B3.2 EAP and SAP cost of Transmisison line	15.0	15.0		-		15.0
Sub-total B	**377.7**	**180.2**	**125.0**	**63.9**	**8.6**	**377.7**
C. Implementaton of SAP and EMP, Dam Monitoring						
C1. Social Action Plan (SAP) for legacy issues	4.2	4.2		-		4.2
C2. Environmental Management Plan (EMP)	3.0	3.0		-		3.0
C3. Dam saftey and montoring program	5.8	5.8		-		5.8
Sub-Total C	**13.0**	**13.0**		**-**		**13.0**
D. Consultancies for Supervision						
D1. Construction Supervision consulting services	28.5	28.5		-		28.5
D2. M&E, supervision of EMP and SAP, Project	3.5	3.5		-		3.5
Sub-total D	**32.0**	**32.0**		**-**		**32.0**
E. Project Management, TA, Training						
E1. PMU support and audits	8.8	8.8		-		8.8
E2. Capacity building TA, POE, training	6.2	6.2		-		6.2
E3. Strategic studies, pilots and future project preparation	27.6	27.6		-		27.6
Sub-total E	**42.6**	**42.6**		**-**		**42.6**
Fees and IDC	**58.1**	**33.1**	**25.0**	**-**	**-**	**58.1**
Total Project Cost	**826.1**	**393.0**	**300.0**	**124.5**	**8.6**	**826.1**
Share as percentage of Total Cost		48%	36%	15%	1%	**100%**
a/ WAPDA/GOP share - Component A: 20%, Component B: 20%						
Tax Content at 19%	145.9					

4. Project Alternatives

4.1. Without Project Alternative

Pakistan is suffering from an acute power and energy crisis, which is primarily caused by the increasing gap between the supply and the demand of electricity. Power shortages result in long hours of load shedding, impacting households, industrial and commercial activities. Lack of power affects people's quality of life, schools, colleges, clinics and hospitals; shops and businesses, reducing sales and revenues; and industry, reducing productivity. It also deters investment. This means, on a macro level, reduced economic growth which translates into loss of livelihoods, jobs and income. The financial impact of load shedding has been estimated at 3 percent to 4 percent of GDP, costing about USD 10 billion a year. This situation is causing serious economic losses to the country and is responsible for increased unemployment and poverty.

The 'no project alternative' will result increased gap in demand and supply leading to more load shedding and power cuts with considerable social and economic impacts such as impeded economic growth, increased unemployment and poverty. Hence without project alternative is not realistic and Pakistan need to build additional generating plants to eliminate the power shortages.

4.2. Alternatives to the Project

The relevant alternative projects to the proposed T5HP Project can be grouped into three categories: (i) hydropower projects other than T5HP, (ii) other renewable projects such as wind and solar, and (iii) thermal power (coal, oil and gas). The other potential alternatives such as demands side management and improved utilization efficiency, and reduced transmission and distribution losses, are already being undertaken by the government through various projects, but they are unlikely to fully cover the energy shortfall. These projects include World Bank funded Pakistan - Electricity Distribution and Transmission Improvement Project, and Asian Development Bank funded Energy Efficient Investment Program.

Alternative Hydropower Projects: Pakistan has a large potential of renewable and clean energy resources in the form of hydropower. WAPDA has planned a cascade of hydropower projects on Indus river. Out of an estimated potential of 46,000 MW so far only about 6,500 MW or 14 percent is utilized. Compared to these projects, the advantage of T5HP is that power generation part of the project will be free of resettlement and litigation problems, which are often major causes of delay in hydropower projects. Further the land required for all associated facilities such as access roads, powerhouse, switchyard, workers camp, batching plant, spoil disposal areas, etc. are located within the sites owned and managed by WAPDA, and no people live in these areas. The T5HP is also a least cost option compared to other planned hydropower projects and can be implemented in a short time of four years.

Other Sources of Renewable Energy: Alternate renewable sources such as wind and solar power of the scale comparable to T5HP will be very expensive compared to T5HP. Both of these options need to be developed to the extent technically and financially feasible. They are complementary, but not substitutes for T5HP. Moreover, from the perspective of mobilizing the necessary financing for the power sector, they do not compete for the same sources of finance: wind and small hydro can be 100 percent financed from local commercial banks, whose resources are not sufficient for large hydro projects.

Thermal Generation: Investing in hydropower development can provide additional generating capacity more cheaply and cleaner than any thermal alternative, with almost no long-term fuel cost. The domestic gas resources in Pakistan are limited, oil is mostly imported and exploitation of Thar coal is still under investigation. Development of hydropower potential can contribute to reducing the cost of electricity generation, lowering the sector deficit by injecting positive cash flow, saving foreign exchange by displacing imported fuel and reducing GHG emissions. The CO_2 emissions from thermal alternatives vary from 0.68 to 1.74 million metric tons per annum, while CO_2 emissions from T5HP are negligible

4.3. Alternatives to T5HP Layout and Design

The Tunnel 5 of Tarbela is originally designed to release irrigation flows during high flow season between May and July. The T5 is a 213 m length of tunnel, whose intake is located close to the Indus left bank between the main and auxiliary spillways (at an elevation of 362.7 masl) and outlet (a low level outlet, LLO, with a flip bucket structure) is located towards the plunge pool (elevation 361.9 masl). The plunge pool is connected to the main Indus (Ghazi Barotha head pond) through a manmade channel and weir (called Dal Dara Channel and Weir).

The key components of proposed T5HP design are: (i) intake, (ii) connection from T5 tunnel to Powerhouse and LLO, (iii) powerhouse location and type and (iv) tailrace. Several options for each of the above component were considered and described in the following sections.

Intake Options: Tarbela reservoir is being filled up with sedimentation and with ongoing sedimentation process and delta movement, it is expected that current T5 intake will be blocked within next 10 to 30 years. If the intake level is raised above the current level the life of tunnel can be increased, and more power can be generated due to increased head. The following two options were considered for intake:

I. Raised intake (selected option): In this option the intake level will be located at 421 masl, about 58.3 m level higher than the current level. A new tunnel will be built at this point and will be connected to the existing tunnel
II. Existing intake: In this option existing intake level will be kept as it is at 362.7masl

Connections Options from T5 to Power House and LLO: The following potential arrangements were considered for modification of T5 tunnel to connect to the new power house and existing or new LLO. The tunnel can be separately connected to power house and LLO (Options A and B) or directly connected to the new power house and then to the LLO (Options C and D).

A. Bend at the T5 portal with a penstock to the power house and a connection to the existing LLO (selected option)
B. Bifurcation on the T5 tunnel with a tunnel to the powerhouse and using the existing tunnel to the existing LLO
C. Bend at the T5 portal with penstock to the powerhouse and new LLO
D. Straight connection at the T5 portal with new LLO as part of Power house.

Power House Locations: A power house will be required to accommodate three numbers of 482 MW turbines. A number of potential powerhouse locations were identified as described below.

a. Powerhouse to west of T5 using existing LLO (selected option): In this option a new powerhouse will be built on the concrete structure between main spillway and T5 outlet.
b. Powerhouse to west of T5 with new LLO: In this option a new powerhouse will be built in the same location as above option, an in addition a new LLO will be built.
c. Powerhouse on centerline of T5 with new LLO
d. Underground powerhouse before T5 portal: This will be an underground structure.
e. Powerhouse at or below Dal Dara weir

Tailrace Option: The tailrace is the outlet of the powerhouse, returning waters back to the river once the water has been through the turbines. Three options were considered for tailrace as described below. The last two options will allow the turbines to access the lower water level of the Ghazi Barotha to produce more power generation.

P. Tailwater at higher level to plunge pool: In this option the water from the power house will be directly discharged in to the plunge pool

C. Tailwater at lower level to plunge pool and Ghazi Barotha head pond via culvert and canal: In this option, the water from the power house will feel to a culvert across Dal Dara channel (a 360 m concrete structure buried beneath the current channel bed) and then to canal (710 m long), along the left bank of the channel, that will discharge downstream of Dal Dara Weir.

T. Discharge to Ghazi Barotha head pond via either long tailrace tunnel: In this option a new tailrace tunnel of about 1000 m length will be built from the power house to Ghazi Barotha head pond.

Selected Option: The final option for the T5HP layout and design has been selected based on the study of combination of various above options proposed for each component. The combination these options are divided as 11 cases and all these cases were evaluated in terms of their technical, economic, environmental and social impacts. Finally, Case 1C, comprising the following, has been chosen for the T5HP design

- Raised intake to reduce the risk associated with blockage of existing intake due to moving sediment delta
- Modification to the existing tunnel to connect to a new penstock to the power house. The existing LLO structure will be retained through use of existing tunnel.
- Powerhouse situated on the rock promontory between the existing LLO structure and the Service Spillway plunge pool

- Tailwater culvert and canal to allow discharge directly to the Ghazi Barotha head pond level. It is estimated that the proposed tailrace culvert and canal will provide up to an additional 11.3m of head resulting in on average 236 GWh of energy annually when compared to a scheme without these tailrace structures

Environmentally and socially, the selected option has the following advantages:

- More power generation compared to other options. The increase in energy will make the Project similar in performance to the existing power stations at Tarbela.
- Due to increased intake level, the life of T5 tunnel will be increased to minimum by another 10 to 20 years and safeguard against intake closure because of sudden movement of sediment. Without the raised intake the current intake level is expected to be blocked by in another 10 to 30 years. The extended life of T5 tunnel will ensure the irrigation for an extended period of 10 to 20 years.
- The irrigation flows will not be obstructed even when the power house is not in use (e.g. during repairs) due to provision of separate penstock to power house from the main tunnel.

4.4. Alternates to Power Evacuation

Alternatives to Transmission Line: Decision regarding best and least cost option to evacuate additional power to be generated from T5HP has been made by NTDC considering the following three alternatives:

- Option 1: Upgradation of existing 103 km length of single circuit 500 kV transmission line from Tarbela to Rewat with double circuit 500 km transmission line and upgradation of existing 500 kV grid station at Rewat
- Option 2: Reconstruction of existing 35 km length of 220 kV double circuit transmission line from Tarbela to Burhan with a 500 kV double circuit transmission line and reconstruction of existing 220 kV Burhan grid station
- Option 3: A new 50 km length of 500 kV double circuit transmission line from Tarbela to a new grid station located close to Islamabad know as Islamabad West Grid Station. The new Islamabad west grid station is anyhow will be built for evacuation of other hydropower projects from Upper Indus Basin, including Dasu Hydropower Project.

Option 2 of reconstruction of 200 kV line is discarded since it is not technically feasible. Options 1 and 3 are technically feasible and both options need to be considered for further planning and design, and environmental baseline studies have been carried out for both the options as part of this ESA study. Option 3, building a new 500 kV double circuit to the new Islamabad West Grid Station, should be a first priority option since (i) upgradation of existing transmission lines require closure of power transmission through the existing lines during winter months, (ii) technically reliable and low system losses, and (iii) easier to implement. Though new transmission line will have more social impacts compared to other options, but considering the development of grid station at Islamabad for Dasu other hydropower projects, a new transmission line is preferable for the T5HP. However, the potential risk with this option is that the development new grid station may not be completed by the time T5HP is commissioned (expected to be commissioned by 2020) due to risk of delay in land acquisition for the new grid station and its development. In the next one or two years, in case it appears that new grid station cannot be constructed by that time, the Option 1 which uses the existing transmission line and grid station facilities will be considered and developed.

Alternatives to Grid Station: Islamabad west station would be common for both Tarbela and Dasu Projects and it would be an important hub of energy in the northern side of grid serving Islamabad and northern Punjab. It is estimated that about 226 acres of land is required for the construction of proposed grid station to receive power from both Dasu (765 kV lines) and T5HP (500 kV lines). Three sites have been identified by NTDC for developing of this grid station at a distance of 25 to 30 km from Islamabad on northern side close to Brhma interchange on Motorway 1. All these sites are located in Fateh Jang Tehsil of Attock District. These are: (a) Site 1: Moza Kamalpur Miyan, (b) Site 2: Brahma Pathergarh, and (c) Site 3: Moza Chaharat. NTDC also identified two more sites but they were rejected in the preliminary stage. Environmentally there are no sensitive receptors are found at the three sites. Socially the impacts on all the proposed sites would be similar since all these sites are being used for agriculture and devoid of any residential structures. The site 1 at Moza Kamalpur Miyan is selected due to technical reasons such as availability of flat land and existing access road. Further, due to availability of an existing access road, Site 1 it has lesser social impacts compared to other two sites where more land acquisition and resettlement would be required for building the access road.

5. Description of Environment

5.1. Physical Environment

Project Area and Area of Influence. Similar to the T4HP, the influence area of power generation facilities at T5HP has been considered as 5 km upstream and 10 km downstream of the dam and 2 km inland on both sides of the river. Some indirect impacts might be expected at larger distance in quarries and borrow areas situated at some 20 – 40 km from Tarbela. For transmission line, an influence area of 1 km width has been considered.

Area of direct impact: The area of direct impact are the project footprints where all construction activities will be carried out plus 1 km of buffer. For transmission line, the right of way of 40m has been considered as direct area of impact.

Physiography: Tarbela Dam and storage reservoir are located near to the end of a relatively narrow valley of the Indus cutting through the Hazara hills. These hills form a part of the foot slopes of the Western Himalayan Mountains. The river valley near the dam is up to 1.8 km wide and filled with alluvial deposits, which are submerged by the reservoir. The northern part of the reservoir stretches about 100 km upstream and is situated between much higher mountains with elevations over 2400 m. The hill sides near the dam are generally steep and are rising to an altitude around 600 masl. From the Ghazi barrage, the topography slopes more gently via a transitional zone and further down towards the agricultural plains of the Punjab and those along the Kabul River. The initial 5 km of transmission line passes through hilly terrain in Haripur district and then mostly through plains.

Climate: The climate in the Tarbela area is hot in summer (April to September) with maximum temperatures between 38 and 46 ºC. June is the hottest month. The winters (October to March) are relatively cold with minimum temperatures between 3 and 14 ºC. December and February are the coldest months. Average annual rainfall recorded was 1,026 mm during the last five years. The area is slightly under influence of the southeast monsoon and this causes July and August to be the wettest months with an average of 313 and 173 mm of rain, respectively. The period October to December is dry with an average rainfall of 10- 35 mm/month. In the presence of the reservoir the humidity is relatively high throughout the year (72- 86 percent). The evaporation is high in June with 5 mm/day and in winter very low with less than 1 mm/day.

Geology: The hills near the dam site are composed of crystalline and metamorphic rocks from Precambrian to Permian age. On the left bank the Kingriali formation is dominant with dolomitic limestone and massive beds of quartzite and phyllite. The general orientation of bedding indicates that the banks of the river are the limbs of an anticline, the axis of which has been eroded by the Indus River. The formations along the transmission line are Targillite, sandstone and subordinate limestone. The general trend of these hill ranges is from east to west, parallel with the general trend of the Himalayan ranges further north of which they form the foothills and outer ramparts.

Seismology: The Tarbela Dam is located in an active seismic region associated with the collision of the Indian and Eurasian crustal plates along the Himalayan Mountain range. During the major earthquake of 2005 with a magnitude of 7.6 (Richter scale), which hit North Pakistan no damage was caused at the dam site, although the epicenter was only some 100 km distance northeast of Tarbela. Seismicity of the region was studied as part of T4HP. The results of T4 study were reviewed and included in T5HP design also.

Rock stability and landslides: The rocks from the slopes are characterized by poor stability. Extensive protective measures (e.g. shotcrete and grouted rock bolts) have been taken in the past to improve stability. Also during the rainy season at different places small scale land-slides can be observed in the project area although usually they can be managed rather easily.

Sedimentation: The Indus River is one of the largest sediment producing rivers in the world. When the dam was built the predicted rate annual inflow of sediment inflow was estimated at 294 million m³. This would mean a reduction of 90 percent of the life storage capacity in the year 2025. In reality the actual sediment inflow has been only 36 percent of the predicted rate. Almost 90 percent of the suspended sediment is carried by the river during the period mid-June to mid-August during the flood season. The useful life of the dam is now estimated at 85 years although the usable storage will gradually decline over time. The sediment delta in the reservoir has now advanced to 10 km distance of the dam and the sediment level rises with 1 m per year. As the delta encroaches on the dam the sedimentation rate will decrease and more sediment will pass through the intakes. There are concerns that the sediment may block low-level inlets, including power intakes. Studies have been carried out to reduce the risks of blockage and also to prolong the life of the reservoir. Measures proposed

include the provision of an underwater protection of inlet structures, including raised power intake, sluicing tunnels to remove sediment and operational measures to reduce the proportion of sediment deposited.

Hydrology: The Indus and its tributaries flow over a large distance through the Himalayan and Karakorum Mountains to the point where the river emerges from the foothills at Tarbela. The Indus has a flow characteristic that rises in spring and summer with the snowmelt and monsoon rainfall. The combined peak discharge falls in July and August. During this period the reservoir is filled to its maximum operating level of 478 masl. During the period November to February the flow is only about a tenth of those during summer monsoon and reservoir level is low at 425 masl. Tarbela Reservoir is designed as a multi-purpose dam where irrigation requirements dictate power generation.

The operation of the reservoir is based on the irrigation demand and on safety requirements. The dam also plays a role in flood management, especially in reducing peak flows in the period of filling of the reservoir. The effect is variable depending on the timing of the flood in relation to the reservoir level that is drawn down prior to the wet season. Releases from the reservoir depend upon irrigation indents from the Provinces. The average water release from the dam for irrigation over the last five years (2006-2010) is shown in **Table 3**. These releases are not likely to change during the construction or Operation and Maintenance (O&M) phases of the proposed project. The Haro river is the only major stream crossed by the transmission line.

Table 3: Mean Monthly Flow Release (in BCM) from Tarbela (2006-2010)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Tarbela	1.19	2.28	2.27	2.33	6.38	10.27	12.93	16.88	9.16	4.51	4.56	2.34	75.12

Groundwater: The groundwater table in the river valley is deep. The depth of the aquifers near the Tarbela varies between 48 and 68 m. Along the transmission line, the groundwater depth varies from 20 to 30m. Groundwater is extensively used for drinking and irrigation in the project area.

5.2. Chemical Environment

Sampling and analysis: Surface and groundwater sampling and analysis, and air quality and noise quality analysis were carried out near the dam area during June 2015 at four locations (the plunge pool, Dal Dara channel, Ghazi-Barotha Headpond and at the T5 intake). Groundwater sampling and analysis was carried out at the Islamabad West grid station area at ten locations in November 2015.

Quality of surface water: Generally, the water quality parameters are good to excellent and fall within the Pak-EPA's drinking water standards. However, turbidity – as expected – is high, exceeding the Pak-EPA limit for drinking water. Water quality for the Project was sampled at four locations on 06 June 2015: the plunge pool, Dal Dara channel, Ghazi-Barotha Headpond and at the T5 intake. The results show that all water quality parameters measured are within Class C and/or D with the exception of the pH at Tarbela Dam Reservoir (FMS-1) in October 2015.

Groundwater Quality: Ground water quality of open well at Kukar Chawa shows a total dissolved solid of 347 mg/l and no bacteriological contamination. The ground water in the grid station show an average total dissolved solids of 385 mg/l and all physical and chemical parameters are within national drinking water quality standards. However, in some wells, microbiological contamination is noticed.

Air quality: Monitored concentrations of NO_2, CO, SO_2 and PM_{10} were well below the relevant NEQS; however, concentrations of $PM_{2.5}$ have exceeded the national ambient standards (35 $\mu g/m^3$). The transmission line passes through mostly rural areas and therefore the general air quality of the project area is good.

Noise pollution: Noise pollution in the project area is mainly attributable to vehicular traffic since there is no industry or other noise sources in the area. The sound levels were monitored at the same locations where the ambient air quality was monitored. The noise levels at different locations were found in range of 45.2-66.5 dB, which is within the range of NEQS, but exceeding those of World Bank (WB standards for residential areas are 45 and 55 dBA).

Traffic: The traffic survey also found that peak times for traffic were 07:00 hr to 10:0 0 hr and 17:00 hr to 19:00 hr. Average daily traffic is 8383 vehicles in which trucks are 135 and mini buses are 1316 vehicles.

5.3. Biological Environment

General biodiversity: Pakistan is located within the Palearctic and Indomalayan ecozones. The ecosystems of Pakistan range from coastline in the south to the mountain ranges of the Himalayas and Hindu Kush in the north along with deserts and plains. The vegetation is dry and sub-humid land comprised of xerophytic shrubs and small trees, grasslands and steppe. This variation in relief and climate has bestowed Pakistan with rich biodiversity and many ecosystems, habitats and species of global significance. Pakistan has 195 mammal species (six being endemic), 668 bird species (25 being endemic), 177 reptile species (13 being endemic), 22 amphibians (nine being endemic), 198 fresh water fishes (29 being endemic) and 5,000 species of invertebrates, as well as 5,700 species of flowering plants (over 400 being endemic).

Field Investigations and analysis: Field investigation were carried out to collect primary baseline data on flora and fauna on the project area during April and November 2015. The floral surveys focused on collection of vegetation data stratified into various habitat types. The data collected during the field surveys was finally used to produce a land cover/habitat types map of the project area. For fauna investigations, structured questionnaire surveys were carried out and also sign-based site occupancy surveys were used to measure the use of area by different species. Fish sampling using nets was also carried out near the dam site.

Terrestrial Ecosystem: The project area is located in a zone that can be interpreted as a transition between Sub-tropical scrub forests and tropical thorn forests. However, the forest cover has been variously transformed and converted to agricultural area. The land cover in the project area can be classified in to agriculture (42%), scrub land (37%), range land (14%), water bodies (4%) and built-up area (3%). The broad leaved scrub forests are dominated by the *Acacia modesta* along with admix of *Dalbergia sissoo*.

Flora: species were represented by 130 genera belonging to 50 different families. It must, however, be iterated that this species list is far from complete and the survey was carried out during such a time when most of the seasonal flora has already diminished due to onset of winters. The majority of the plant species belonged to *Dicotyledonae* (n=115) having 95 genera and 41 species. There were only 5 species of *Pteridophytes* that were recorded during the study. *Leguminosae, Asteraceae, Lamiaceae* and *Euphorbiaceae* were the most represented families in the area having respectively 16, 8, 8 and 7 number of species.

Mammals: A total of 29 mammalian species belonging to 16 families and 7 orders have been reported from the segment of the project area from Tarbela to Islamabad. It has two large mammals, eight meso-mammals and eighteen small mammal species. The species *Rattus, Mus musculus*, and *Suncus murinus* are the dominant rodent and insectivore species. *Manis crassicaudata* (Thick-tailed Pangolin, Indian Pangolin) is the only species considered as Endangered (EN) by IUCN.

Reptiles and Amphibians: A total 35 species of herpes belonging to two orders, 13 families and 30 genera are found in the study area including nine amphibians and 26 reptiles. Amphibians included three toad species and six frog species whereas; reptiles included 13 lizard species and 13 snake species. All these species are recorded as Least Concern in IUCN.

Birds: There is a variety of habitats in the study area, which have richness of bird species, adapted these habitats. 89 species of water birds are reported near the Tarbela reservoir and Ghazi Barotha canal. In this list there are only 12 resident aquatic bird species, six irregular year round aquatic bird visitors, three winter aquatic bird visitors and 68 aquatic birds on transit migration through Indus valley over the river. Some of which, may stage for short period at the wetlands at Tarbela. Six bird species in the project area are listed IUCN threated status. These are: Black Stork (*Ciconia nigra*); White-necked Stork (*Ciconia episcopus*); Black-necked Stork (*Ephippiorynchus asiaticus*); Peregrine falcon (*Falco peregrinus);* Sociable Plover (*Chettusia gregaria*) and White-tailed Lapwing (*Chettusia leucura*).

Bird Migration: The migration of waterfowl occurs in north-south direction and vice versa. The birds breeding in central and northern Siberia migrate to various destinations in Pakistan, crossing the Karakoram, Hindu Kush, and Suleiman ranges, and following the Indus valley and plains down to the Indus delta. This flyway of waterfowl and migratory birds is a corridor of international importance, the so-called "Indus Flyway" or "International Flyway No 7." Large numbers of waterfowl and birds like teal, pintail, mallard, gadwall, white-headed duck, houbara bustard and Siberian crane follow the Indus on their way towards the wetlands of southern Sindh, which are the most important major wintering grounds of migratory waterfowl in the region.

Fish: Fish diversity in the Indus is low compared to other major rivers. 177 fish species are reported in the Indus River system, including 12 exotic species. This is substantially lower than in other major rivers in Asia. During the fish surveys carried out in April 2015 a total of 26 fish species belonging to ten fish families were identified. They are *Bagridae, Belontidae, Channidae, Cichlidae, Cobitidae, Cyprinidae, Nemacheilidae,*

Notopteridae, Schilbeidae and *Sisoridae*. The fish community is not considered diverse and is mostly constituted by species adapted to lentic habitats. A few individuals of Mahasheer (*Tor putitora*), an IUCN Endangered species, is recorded in the reservoir and downstream area. Indigenous cold water fish species of Indus such as snow carps is not noticed.

Fisheries: In the past WAPDA has started to cultivate fish in the Tarbela Reservoir. The objective was to establish fish seed hatcheries and to stock fish in the reservoir to rear fish up to a marketable size. Currently the hatcheries are managed by the Provincial Fisheries Department of KP. This department also sells the fishing rights for the Reservoir to contractors and fishermen. The revenue generated from the fisheries sector is about PKR 0.5 million per year. The annual production of fish during 2009-2010 was 67 metric tons. The months of July and August are closed for fishing. For security reasons fishing is prohibited by the authorities in a zone between five kilometers upstream and three kilometers downstream of the dam. There are a few hundreds of fishermen being employed by fishing contractors in the fishery business. It is estimated that about 13,000 anglers visit the reservoirs for recreation per year.

Hotspots in the Project area: The northern edge of the project area is marked by the presence of a scrub land mixed with agriculture and associated settlement areas. The dominant species in this area mainly include Acacia modesta and Dalbergia sissoo. As land from major part of the project area is transformed to cultivation or degraded to barren land, the scrub land appears to be relatively semi-natural. These are the areas where higher signs of mammalian species and bird activity was observed. However, scrub land is low in diversity, as well as, density of plant species. These are heavily invaded by the weedy species like *Lantana camara*. Human settlements are spread across the scrub land and impart heavy grazing pressure, which is evident in the form of stunted growth. Floral investigation indicated that majority of plan species documented in this area are common and have wide geographical range. Overall diversity of large mammals is much lower in the project area. Both questionnaire survey and sign based site occupancy revealed the rarity of the most of the species. Low sighting and sign detections were mainly because of small populations, and disturbances imposed by numerous human settlements in the area. Consequently, the project area is dominated by adaptable species like fox and jackal, while the species which either pose danger (e.g., wolf) or have economic value (ungulates) seems to be locally extirpated. One endangered mammalian species (Indian Pangolin *Manis crassicaudata*) is also present in the area. Its population is presumably low and facing extreme hunting pressure due to commercial value of its skin. It therefore finds refuge in thicklets of forests or rugged terrain away from the project area.

5.4. Social and Economic Environment

Socioeconomic Surveys: Socioeconomic surveys were carried in the project area through structured questionnaire interviews of 49 households and focus group discussions. Household surveys were also conducted in the area identified for Islamabad West Grid Station and along the transmission line route.

General. The project footprints fall in to Haripur District of KP province and Attock district of Punjab province. According to the latest Census (1998) Haripur District had a population of 0.7 million and Attock had 1.3 million. Annual growth rate of the population is high with 2.1 percent and 2.3 percent respectively. In both districts the population is mainly engaged in agriculture and livestock holding. Unemployment, lack of potable water, absence of basic health and education facilities, weak electricity supply and poorly maintained roads are major issues in the area. Regarding culture and religion, Hindko, Pashto and Urdu are most commonly used languages. The mixed caste structures like Awan (45%), Khan (18%), Khattar (14%), Gujjar (5%), and remaining (18%) is existed in the project area. The predominant religion in both districts is Islam (99.2% of the population).

Education and literacy: Education facilities are located in both the districts. The overall literacy rate in the Haripur district is 31.3% and 56.55% in Attock. The female literacy rate in Haripur and Attock District is only 17.35% & 41.1% compared to male literacy rate of 44.35% & 71.75% respectively. However, over-all prevailed literacy rate in the project area is 73%.

Health situation: Due to the poor living conditions of the population, the poor sanitation and the absence of safe potable water there are many diseases in the project area. The most common diseases in the area are malaria, diarrhea, hepatitis, typhoid and skin diseases. A WAPDA dispensary also exists at Right Bank Colony facilitated with medicines, qualified doctors and other related facilities. Outdoor treatment facilities are provided here to WAPDA employees while serious patients can be treated in the WAPDA hospital at the left bank. There is need for improvement of laboratory facilities and health care during emergencies, especially at night.

Agriculture: The main occupation of in the project area is farming. Crops grown by the farmers are predominantly wheat, gram, oil seeds, lentils and vegetables in *rabi* season (October- March). During *kharif* (April – September) rice, cotton, maize and sorghum are grown. Most agriculture in the hilly region around Ghazi is rainfed (*barani*) and dependent on sufficient winter rainfall. On the right bank well developed irrigated agriculture is dominant around Topi. Further southwards more rainfed agriculture can be found on the predominantly sandy and drought-sensitive soils of the Potwar plateau. Livestock raising is an important additional source of income for the farming community, besides providing milk, ghee and meat for their families. Most livestock consist of small herds of cattle, goats and sheep.

Economy and employment: According to socioeconomic survey, agriculture is the primary source of income for nearly 43%, and secondary source of income for another 43% households. The other sources of income are employment and manual labour. The average monthly income of the surveyed household is PKR 39,212. Majority of the households (37%) have monthly income range of PKR17,378 - PKR 30,000, while 24% of the households have an income range of PKR 50, 000. About 20% of household have a higher monthly income is more than PKR50,000 and 19% of the households have lower income levels of less than PKR17,378. The average monthly expenditure of the surveyed households is PKR27,877. These expenditures include food and non-food items like fuel, education, health, clothing, utility charges, and other miscellaneous expenditures.

Roads. The Tarbela dam is located at 70 km distance from Islamabad. The project area can be reached from Islamabad and Peshawar directly via Motorway M1 and the Grand Trunk (GT) Road. By using Burhan and Swabi interchanges on the Motorway Tarbela can be reached in 2-3 hours. From the GT road there is link road leading to Tarbela. These routes can also be used for the transportation of construction material, without much difficulty. Within the project area there are minor roads, which are not open to the public along both banks connecting the cities of Ghazi and Topi with the Tarbela dam. The transmission line and grid station are accessible by the local roads.

5.5. Social and Cultural Aspects

Cultural heritage. The archaeological department has indicated that there are no designated or known historical, archaeological or cultural resources within the project area.

Tourism: The scenic beauty of the area including the Tarbela Dam and Reservoir has attracted a large number of both local and foreign tourists in the past and WAPDA developed viewpoints for visitors to the dam site. However, tourist activities in the Project area are now very limited due to the high security requirements as the project is considered a potential terrorist target.

Non-Governmental Organizations. The NGO sector has made large contributions to the socio- economic development in Pakistan. The Ghazi Barotha Tarqiati Idara (GBTI) and Sungi Development Foundation have both worked in the Tarbela Project area. GBTI was active as NGO in the Ghazi Barotha Hydropower Project. They are still involved in working with communities in the health and education sector.

Role of women: Women in the project area are mostly restricted to household activities. According to socioeconomic surveys, the women participation (74%) in the child caring is comparatively high, 72% in the household activities, 56% participation in social obligation, 30% in livestock rearing, 21% in farm activities, 4% in employment, 3% in business and only 35% women are participating in the sales and purchase of items. The major demands from women in the project area include availability of Sui gas, employment opportunities, access to medical & educational facilities, road infrastructure, availability of potable water and improved sewerage and solid waste system.

6. Climate Change and Other Risks

6.1. Climate change

During the last decade substantial research has been carried out to study the effects of long-term climate change on precipitation, air temperatures and droughts. Some of the main conclusions of these studies are:

- Between 1980 and 2005 the frequency of heat waves (T >40º C) has increased in northwestern Pakistan. It is expected that there will be more frequent periods with extreme drought;
- Based on predictions in scenarios of the International Panel on Climate Change (IPCC), estimates have been made by the Pakistan Meteorological Service of the increase in maximum daily temperatures, which ranges from 2.8ºC to 4.2ºC in the year 2080 for northern Pakistan;
- More heavy rainfall events during monsoon season will occur over northwestern Pakistan instead of over the northeast of the country. Some models calculate 25 percent more rainfall during monsoon. As a result, areas along the western rivers of the country (Indus and Kabul) will be more vulnerable to flood episodes similar to the one experienced during 2010;
- Water availability might increase considerably (during *kharif*) but not when it is required for agriculture in the plains (end of *rabi* season); and
- A shift has been observed in the rainfall pattern with monsoons starting 1-2 weeks earlier and winter rains confined towards February.

Climate Resilience of Tarbela Dam: Tarbela Dam itself is designed to withstand a PMF event which was assumed to include maximum snow melt, maximum storm flood and simultaneous natural dam breach (landslide or glacier), and had a spillway design discharge of 42,000 m3/s. Based on the historical record of last 85 years, the maximum flow recorded so far at Tarbela site is 23,645 m3/s (in 2010), but this was considerably below the design discharge of 42,400 m³/sec. Tarbela dam could therefore relatively easily cope with these high floods. Further, through operation of the reservoir the peak outflow at Tarbela even could be reduced with some 28 percent.

Climate Change Adaptation for T5HP: The rise in flows of Dal Dara channel due to increase release of flows from spill ways (because of climate change) might affect the T5HP powerhouse and tailrace structures. The 2010 flood inflow was 23,645m^3/s and this is estimated to have a return period of approximately 1,000 years. The resulting maximum discharge in Dal Dara channel as a result of this flood was 11,500m^3/s and the water level at service spillway plunge pool (adjacent to the proposed powerhouse) was measured to be at approximately 362m.

The power house and tailrace structures of T5HP are designed to withstand extreme flood events in Dal Dara channel, well in excess of any flood event recorded to date. The design flood level of the powerhouse, has been set at 370m which coincides with a s flow of 25,000m^3/s which has an estimated return period of more than10,000 years. The maximum operational level of the powerhouse (i.e. the turbines will not operate when the water in the channel is above this level) has been set to 365m. This would occur with a spillway channel flow of 15,700m^3/s which has an estimated return period of more than 1,000 years.

Climate change monitoring under DHP and T4HP: The relation between climate change and hydrology is extremely complex. This is because the high variability in data on climate and hydrology, requiring long time series and proper monitoring. Moreover, regional circumstances might vary considerably, especially in high mountain areas. This often leads to conflicting data. More studies and more reliable data should be collected in the coming years. In view of the importance of these data for developing reliable and accurate knowledge of the basin hydrology and on future water availability of the Indus River some initiatives are being taken under DHP and T4HP Projects. These include (i) Glacial Monitoring Program, which includes extensive glacial studies, including satellite monitoring and studies into the effects of glacial outbursts, and (ii) installation of flood monitoring telemetry network in the in the upper reaches of Indus to strengthen the flood forecasting system in the country and complement the above Glacier Monitoring Program

6.2. Net Greenhouse gas emissions

Net greenhouse gas (GHG) emissions from implementation of T5HP are estimated using the World Bank "Guidance Note: Greenhouse Gases Accounting for Energy Investment Operations, Version 1.0, June 2013 The emissions from both power generation and power evacuation of Project and baseline emission of the nearest least-cost alternative are estimated over 30 years.

Net GHG emissions from power generation component: The GHG emissions from T5HP power generation component are given in **Table 4**. T5HP will not create nor contribute to any additional reservoir emissions, and hence reservoir emissions from T5HP is assumed to be zero. The emissions from baseline are also estimated and given in **Table 4**. These are GHG emissions resulting from same amount of electricity generation using other alternate feasible energy sources. The economic and least cost analysis of the Project described CCGT is the most feasible alternative to the Project. Emission Factor for CCGT in Pakistan is 367.56 g CO_2/kWh. Total Baseline Generation Emissions for 50 years are 20.13 million tCO_2e and the construction emissions are 123,352 tCO2e. The net GHG emissions (Project Emissions - Baseline Emissions from CCGT) of T5HP power generation are minus 20.05 million tCO2e.

Table 4: Net GHG Emissions (tCO_2) from T5HP – Power Generation Component

	Emission Type	T5HP - Generation	Baseline (CCGT)	Net
1	Reservoir emissions	0		0
2	Generation Emission		20,134,937	-20,134,937
3	Land clearing	51,700		51,700
4	Embodied Emissions	158,862		158,862
5	Energy emissions in Construction (optional)	0	123,352	-123,352
	Total Emissions	210,562	20,258,289	-20,047,727

Net GHG emissions from power evacuation component: The GHG emissions from T5HP power evacuation component (Tarbela to Islamabad West transmission line and grid station) are given in **Table 5**. The losses in the transmission are estimated as 2%. The direct generation emissions associated with these losses (emission factor 0.6545 tCO2/MWh) is estimated to be 0.7 million tCO2e. Land clearing will be required at the grid station (226 acres) and tower locations (approximately tower will be required for every 300 m and a clearance required for each tower is 20m X 20m), and emissions associated with the clearing are estimated to be 14,938 tCO2e. Circuit breakers containing SF6 will be used in the grid station and the S6 emissions are estimated to be (emission factor is 0.119 gSF6/MWh) 155,800 tCO2e. Embodied emissions and construction emissions have not been calculated since the information will be known only at the construction stage. The total Project emissions from evacuation component are 0.89 million tCO2e.

Baseline emissions for power evacuations are also estimated and presented in **Table 5**. The existing Tarbela – Rewat transmission line has been considered as baseline since this will be the feasible and least cost alternative. The generation emissions from loses associated with the baseline will be similar to the Project. However, no land clearing will be required since the existing towers and right of way will be used. The net GHG emissions (Project Emissions - Baseline Emissions) of T5HP power evacuation are 0.18 million tCO_2e. If the baseline scenario is considered similar to T4HP, where the power is connected to an existing switchyard and existing transmission lines, the baseline emissions would be zero, and the net emissions would be 0.89 million tCO_2e.

Table 5: Net GHG Emissions tCO_2) from T5HP – Power Evacuation Component

	Emission Type	T5HP - Evacuation	Baseline (Tarbela – Rewat TL)	Net
1	Generation Emissions from losses in the project	717,070	717,070	0
2	Emissions from Land Clearing	14,938	0	27,001
3	SF6 Emissions	155,800	0	155,800
4	Embodied Emission (Optional)	0	0	0
5	Energy Emissions in Construction (Optional)	0	0	0
	Total Emissions	887,808	717,070	170,738

6.3. Risk of earthquakes

The Project area is located in a part of Pakistan where earthquakes frequently occur, though usually these are not of an exceptional magnitude. Tarbela is situated in the foothills of the Himalaya and Karakorum mountains. These mountain ranges were uplifted through the collision of the Indian and Eurasian tectonic plates. The zone

of the main trust between the plates is located northeast of the project site at a distance 100- 200 km in Kohistan and Kashmir. However, the influence of associated local tectonic fault breaks can continue until the project area as far as the Potwar plateau, which is situated south of the project area. High incidence of seismic activity through tectonical movements of local faults can be responsible for rupture of ground surface, ground acceleration, failures of natural slopes, and ground liquefaction. Risk of flooding

Seismicity of the region was studied for as part of Tarbela 4 Extension Projects. The results of T4 study was reviewed and included in T5HP design also. The seismic accelerations used in the design of T5HP are:

- Operating Basis Earthquake (OBE) Horizontal Acceleration: 0.21g
- Maximum Design Earthquake (MDE) Horizontal Acceleration: 0.55g

A committee of international panel of experts recruited by WAPDA have reviewed and approved the T5HP design. This was done in accordance with World Bank Policy OP 4.37 Safety of Dams. A seismic monitoring program will be established at the dam site for continuous monitoring.

7. Potential Impacts and Mitigation Measures

7.1. General

The potential environmental and social impacts of the generation component of the Project are mostly limited to the construction stage as the Project would utilize the existing infrastructure and available land within the Tarbela area, which is cordoned off from the public with a fence and security arrangements. The Project would provide significant environmental benefits in the long run by providing renewable, non-carbon energy of 1800 GWh annually without the environmental and social impacts/costs normally associated with hydropower projects. The Project would also help utilize more efficiently the scarce water resources of the Indus Basin by installing modern and more efficient turbines and machines for generation of electricity. While the power evacuation component will have significant impacts due to acquisition of land for transmission line and grid station.

7.2. Impact Assessment Methodology

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

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

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

Assigning Significance: Following the assessment of magnitude, the quality and sensitivity of the receiving environment or potential receptor has been determined and the significance of each potential impact established using the impact significance matrix shown below in **Table 6**.

Table 6: Significance of Impact Criteria

	Sensitivity of Receptors			
Magnitude of Impact	**High**	**Medium**	**Low**	**Negligible**
Major	Major	Major	Moderate	Negligible
Moderate	Major	Moderate	Minor	Negligible
Minor	Moderate	Minor	Negligible	Negligible
Negligible	Minor	Negligible	Negligible	Negligible

7.3. Summary of Assessed Impacts

The project's potential impacts and their significance have been assessed using the methodology described in Section 7.2 above. A summary of potential impacts of the Project and their significance before and after implementation of mitigation measures is given in **Table 7**.

Table 7: Potential impacts and their significance

Impact	Phase	Sensitivity	Magnitude	Significance Prior to Mitigation	Mitigation and Enhancement Measure	Residual Significance
Environmental impacts due to project siting:						
Generation of low carbon and environmental friendly power generation:	Operation	High	Major	Major beneficial	• Implementation of the ESMP to mitigate impacts associated with the construction of the project	High beneficial
Impact on irrigation releases from Tarbela due to raised intake of T5 tunnel	All phases	High	Negligible	Minimal adverse	• If all the five tunnels could not release the required outflow, the power house of either T4 or T5 will be shutdown, the other one will be used to bypass the complement the outflow	Negligible
Loss of natural vegetation and trees due to land clearing under project footprints	All phases	Medium	Moderate	Moderate adverse	• Planting of native trees near the switchyard and grid stations	Minor adverse
Social impacts due to project siting:						
Acquisition of 226 acres of land for grid station and associated livelihood losses	Pre-construction	High	Major	Major adverse	• Adequate compensation and implementation of income and livelihood restoration plan, as per RAP	Minor adverse
Impact on land under Transmission Line towers	Pre-construction	High	Major	Major adverse	• Preparation of RAP for the losses incompliance with LARF • Approval of RAP by the World Bank before starting of line construction	Moderate adverse
Loss of real estate value of land under Transmission Line corridor	All phases	High	Major	Major adverse	• NTDC need to revisit its policies on payment for compensation of land under transmission line corridor and towers	Moderate adverse
Employment generation	All phases	Medium	Moderate	Moderate beneficial	• Hiring of local community for construction works	Moderate beneficial
Environmental impacts during construction stage:						
Impact on irrigation releases from Tarbela during construction activities in T5 tunnel	Construction	High	Minor	Minor adverse	• Release of irrigation releases through other tunnels	Negligible
Impact on irrigation releases from Tarbela during overlapping of construction activities in T4 and T5 tunnels, especially when the commissioning date of T4 is delayed	Construction	High	Major	Major adverse	• Works related to closure of intake of T5 to be delayed until the commissioning of T4	Negligible
Soil and water pollution	Construction	Medium	Moderate	Moderate adverse	• Implementation of ECPs and ESMP	Negligible
Impact on water quality and aquatic habitat	Construction	Medium	Moderate	Moderate adverse	• Implementation of ECPs and ESMP • Compliance with NEQS on waste water discharges	Negligible
Risk of land slides	Construction	High	Moderate	Major adverse	• Slope stability measures; and implementation of emergency response plan	Negligible
Generation of spoils	Construction	Medium	Moderate	Moderate adverse	• Reuse of material for concrete and filling works; and disposal in the existing spoil disposal sites	Negligible
Impact on air quality from emissions and dust	Construction	Medium	Moderate	Moderate adverse	• Emission and dust control measures, as per ECPs and ESMP • Compliance with NEQS for vehicular and equipment emissions	Negligible
Noise and vibration impacts on nearby communities	construction	Medium	Moderate	Moderate adverse	• No night time construction activities near the residential areas. • Noise and vibration control measures, as per ECPs and	Negligible

Impact	Phase	Sensitivity	Magnitude	Significance Prior to Mitigation	Mitigation and Enhancement Measure	Residual Significance
					ESMP; and noise barriers around Kukar Chawa village	
Pollution through solid waste and waste effluents	Construction	Medium	Moderate	Moderate adverse	• Using of existing disposal sites established for T4; and Implementation of ECPs and ESMP • Disposal of hazardous waste through EPA certified contractors	Negligible
Impact on birds and other fauna	Construction	Medium	Moderate	Moderate adverse	• Implementation of measures to protect wildlife, as per ECPs and ESMP • Prohibition of hunting of animals	
Impacts from borrow and quarry areas	Construction	Medium	Moderate	Moderate adverse	• Quarry and borrow areas established for T4HP will also be used for T5HP.	
Impacts from increased traffic and transportation	Construction	Medium	Moderate	Moderate adverse	• Traffic Management Plan, including awareness raising and safety measures	Negligible
Cumulative impacts of T4 and T5 construction activities	Construction	Medium	Moderate	Moderate adverse	• Coordination between PMUs of T4HP and T5HP in using shared facilities at Tarbela	Negligible
Social impacts during construction stage:						
Disturbance, Hindrance, and Safety hazards for the public	Construction	Medium	Moderate	Moderate adverse	• Implementation of Health, Safety and Environment (HSE) plan and traffic management plan	Negligible
Community health and safety	Construction	Medium	Moderate	Moderate adverse	• Preparation and implementation of HSE plan in compliance with World Bank EHS guidelines, ECPs and ESMP	Negligible
Increased load on local services	Construction	Medium	Moderate	Moderate adverse	• Contractor need to source supplies without affecting the local demand	Negligible
Environmental impacts during operation and maintenance stage:						
Avian risks – bird collision and electrocution	Operation	Medium	Minor	Minor adverse	• Insulation of exposed parts of the tower structure	Negligible
Impact on Environmental Flows	All phases	High	Negligible	Negligible	• Continue to release to environmental flows from Ghazi barrage	Negligible
Environmental legacy of Tarbela and Ghazi Barotha projects on the downstream flows to Indus	All phases	High	Major	Major adverse	• Detailed ecological studies on the downstream of Tarbela to assess the impacts of water storage in Tarbela and water diversion from Ghazi barrage; develop and implement management plans	To be determined
Impacts from pilot project on floating solar power panels	Operation	Medium	Moderate	Moderate adverse	• Preparation of mitigation plans and monitoring	Minor adverse
Social impacts during operation and maintenance stage:						
Community health and safety	Operation	Medium	Minor	Minor adverse	• Compliance with World Bank EHS guidelines on power transmission and distribution facilities	Negligible
Workers health and safety	Operation	Medium	Minor	Minor adverse	• Compliance with World Bank EHS guidelines on power transmission and distribution facilities	Negligible
Social legacy of Tarbela and Ghazi Barotha projects – pending claims on compensation	All phases	High	Major	Major adverse	• Reinstatement of Resettlement Claims Committee	Minor adverse

7.4. Environmental Impacts due to Project Siting

Generation of low carbon and environmental friendly power generation: The T5HP would provide renewable, non-carbon energy of 1800 GWh annually. The net greenhouse gases emissions estimated from the T5HP are minus 20 million tCO_2e. The social and environmental impacts generally associated with other large hydropower projects are minimal in the T5HP due to availability of the land with the executing agency WAPDA and existing infrastructure and reservoir.

Impact on irrigation releases from Tarbela due to raised intake of T5 tunnel: The impacts on irrigation releases from the Tarbela (through all five tunnels) will be minimal due to raising of current intake level of T5 from 362.7 masl to 421masl. T5 tunnel is mainly operated during the months of May to July to release the irrigation outflows. Based on the historical record on reservoir water levels and outflows of Tarbela during the months of May to June for last 40 years (1975 to 2014), it is noticed that only during 9 days (3 days in June and 6 days in July) all the five tunnels would not have released the outflows to their fullest capacity assuming that both power houses of T4 and T5 are operational. During these days in future, when both power houses of T4 and T5 were built, WAPDA would shut down one of them and use the by-pass to complement the outflow, as irrigation has the priority.

Impact on natural vegetation due to land clearing under project footprints: Clearance of vegetation is required at the switchyard locations and transmission line towers. The natural vegetation near the dam site and along the transmission line is mostly modified habitat subjected human influence and hence has less ecological significance. Vegetation clearance along the transmission line is not expected since most of the alignment passes through scrub vegetation and agricultural lands, except at a few locations where there are Eucalyptus plantation. Ecologically the felling of eucalyptus trees will be beneficial since they are exotic/introduced species and impacting the growth of native species. Tree planation will be carried out around the switch yard and at the grid station facilities to compensate any losses associated with tree cutting.

Change in land use: The power plant and auxiliary infrastructure will be built entirely on WAPDA-owned land that is uninhabited and exclusively used by WAPDA. The area is characterized by restricted access and is not open for the general public. The construction operations and its associated structures, such as batching plants, workshops and stores, and for the accommodation of the construction force will also be within the same area. The existing land use near the power generation facilities will not be changed. However, at the grid station site, the agricultural land will be converted in to grid station and residential complexes.

7.5. Social Impacts due to Project Siting

Acquisition of 226 acres of land for grid station and associated livelihood losses: About 226 acres of agricultural land, belonging to about 260 owners, will be acquired for construction of Islamabad West Grid station. The land acquisition will have significant impact on the livelihoods of the land owners; 50% of them depend on farming on these lands as the primary source of income. The site is located about 30 km from northwest of Islamabad. Since its proximity to Islamabad, there is lot of private housing development in the areas near the proposed grid station site. Local communities are also eager to sell their lands for the housing developments. Same is the case with the owners of the grid station site, and they are willing to sell their lands for the market rates. NTDC is also planning to buy this land through negotiations with individual owners. A Resettlement Action Plan is prepared for this site.

Impact on land under Transmission Line towers: The proposed 50 km T5 transmission line requires about 167 towers, in which only 32 angle tower locations are tentatively identified by NTDC. The final alignment of the transmission line including siting of tower locations will be done under design built contract. Hence exact land acquisition and resettlement impacts are not known at this stage. Based on sample socioeconomic surveys near the tower locations, it was found that nearly 86 percent of the people who own the tower locations are farmers (for 43% farming is primary source of income and for remaining 43% it is secondary source of income). Each tower requires about 20 m length and 20 m width area and hence total affected area under 167 towers would be about 16 acres. The impacts associated with the towers include permanent loss of land under the foundation of the towers, and disturbance to crops at the time of construction. Detailed impact assessment and Resettlement Action Plan (RAP) will be prepared during the design of transmission line based on the land acquisition and resettlement frame work (LARF). No construction activity will be carried out until approval of RAP by the World Bank.

Loss of real estate value of land under Transmission Line corridor: The presence of transmission lines and towers will significantly reduce the market value and real estate potential of the land under the transmission line corridor (40 m right of way). This impact would be significant particularly in the areas where it passes through

the towns and areas near the Islamabad. At the time of the design and construction, the routing of transmission line will avoid passing over the residences to the maximum extent possible. The minimum clearance required for the top of the building to transmission line is 9.14m and if this cannot be maintained resettlement of those houses would be required. The total land affected directly beneath the 50 km transmission line right of way will be about 50 acres. Historically, the land under the transmission line and corridor have not been acquired by NTDC, and legally also it is not a requirement. However, there is a strong demand from the local communities for compensation for the affected land. World Bank recommends NTDC to consider adequate compensation for the land under the transmission line corridor.

Employment generation: Tarbela power station and Islamabad West grid station would generate employment for about 150 people on permanent basis. During four years of the construction, about 2500 to 300 labour force would be required. This includes unskilled and skilled labor, technicians and employees. Local communities have requested to provide employment preferences to those already living near the project. Using certain quota for employment of local construction workers and other staff will increase the local skill base and provide a boost to the local economy.

7.6. Environmental Impacts during Construction Stage

Impact on irrigation releases from Tarbela during construction activities in T5 tunnel: During modifications of the T5, particularly during connection of the new tunnel coming out from the raised intake to the existing tunnel and low level outlets, the existing intake of T5 need to be closed for about 20 months. This period is scheduled to occur between October 2017 and May 2019. Historically, irrigation flows are only released from T5 during the high flow season from May to July. As such the T5 tunnel would only be inoperable for one high flow season in 2018, and during this period the water will be released from other tunnels and there will be no impact on the irrigation releases. T4HP is scheduled for commissioning in May 2017. The other tunnels will continue to operate throughout the T4 and T5 construction periods. Therefore, in the period during which T5 is scheduled to be inoperable, all other tunnels will be able to release required discharges for irrigation. The combined capacity of T1 to T4 is expected to easily meet irrigation release requirements for the 2018 high flow season.

Impact on irrigation releases from Tarbela during overlapping of construction activities in T4 and T5 tunnels: As explained in the previous paragraph, the intake of T5 needs to be closed for about 20 months and this period is scheduled from October 2017 after commissioning of T4HP in May 2017. For any reason, if T4HP completion is delayed and intake of T5 is closed as planned, the irrigation releases of Tarbela would be affected as the other tunnels together do not have the capacity to release all the required flows. Hence in case T4HP commissioning is delayed, the closure of T5 will also need to be delayed until commissioning of T4HP.

Soil and water pollution: Adverse impacts on soil and water quality (surface and groundwater) of the surrounding areas including Ghazi-Barotha lake would be avoided, since these resources are used for the domestic water supply of the residential areas of the WAPDA colonies as well as nearby communities in Topi and Ghazi. Also accidental spills and leakages that may occur during construction at both ends of Tunnel 5 would be avoided by taking proper safety measures, such as the construction of bunds around oil tanks and storages of chemicals. The contractor(s) according to the Environmental Code of Practices (ECP) will be required to take appropriate measures to avoid and contain any spillage and pollution of the water resources both upstream and downstream of the dam. Detailed ECPs are included in the main ESA volume.

Impact on water quality and aquatic habitat: During construction water quality and flow in the areas immediately upstream and downstream of the inlet and outlet gates might change. Chemicals, cement, and solids used in construction activities in the tunnels might accidentally be spilled in the reservoir and/or the water downstream of the dam and affect aquatic flora and fauna, including fish and turtles. This can be avoided by making temporary drainage works (channels and bunds) where appropriate and feasible. Other mitigating measures are described in the ECP, which has to be followed by the Contractor. Strict monitoring of the water quality is required. The construction of the coffer dam can potentially cause increased water turbidity. However, compared to the turbidity caused during operation of the tunnels these impacts are rather insignificant and can be neglected.

Risk of landslides: Extreme care would be exercised to protect workers and the public from the dangers of sudden landslides, which may occur during excavation and blasting works. Particularly during monsoon periods there might be increased risk of such incidents. Access would be restricted during the periods that slope stability is not yet entirely secured and guaranteed by proper safety measures such as rock bolts, anchors, safety nets and gabion structures. The contractor is required to include safety measures in a Health, Safety and Environment

(HSE) Plan and an Emergency Response Plan. These plans will be prepared during mobilization and approved by Construction Supervision Consultant/PMU prior to the start of the work.

Generation of spoils: Excavations and tunneling works will generate about 3.97 million m^3 of spoils. The major sources waste stream of greatest volume will be spoil arising from intake, penstock, powerhouse and tailrace excavation works. These spoils will be reused in concrete works wherever feasible, and the excess material will be disposed at the existing spoil disposal sites that are currently being used for T4HP.

Impact on air quality from emissions and dust: Air quality will be affected and dust will be generated due to earth moving activities, batching plant operations, vehicle and generator emissions. The Contractor would fit all vehicles and machinery with proper exhaust systems and emission control devices. Machinery and vehicles causing excess pollution would be banned from the project. Dust generation from construction sites would be restricted as much as possible, and water sprinkling would be carried out as appropriate. Air quality would be properly monitored, especially near the population centers and WAPDA colonies.

Noise and vibration impacts on nearby communities: The construction of the new powerhouse and the associated works at the left bank will require some blasting, excavation and reshaping of the side slopes of the valley behind the new powerhouse. Noise from blasting with explosives and drilling will be resonated between the valley slopes and the dam and spread over the Ghazi-Barotha reservoir during excavation and construction works with predominant northerly winds and will reach the residential areas, including right bank and left bank WAPDA colonies, which are both situated at a distance within 2- 3 km from the construction site, while the nearest village Kukar Chawa is located at a distance of 500 m from left bank. Noise pollution would be restricted to day time periods and levels would be properly monitored. Workers in drilling areas will wear suitable ear protection. Noise monitoring at the residential colonies will be required, and if the noise levels at these locations are beyond the acceptable limits (NEQS and WB Guidelines), appropriate mitigation measures such as noise barriers will need to be employed.

Pollution through solid waste and waste effluents from labor camps and construction yards. Site offices, labor camps and barracks would be provided with adequate infrastructure and services in order to prevent pollution by solid waste and waste effluents. Management and disposal of all kind of wastes and waste water would be well organized, also to prevent conflicts with resident population accommodated in the nearby colonies. Also in the construction yards and workshops management of wastes is crucial to minimize impact on the environment. Existing disposal facilities established for T4 will be used to the extent possible for T5HP; and nearest municipal disposal sites for transmission line and grid station works. Before commencing the construction activities, the contractor(s) will be required to prepare Waste Management Plan in accordance with the ECP and submit it to the PMU for their review and approval. Monitoring of the Plan implementation will also be carried out.

Impact on birds and other fauna: Movement of construction traffic, noise generated from construction activities, and removal of natural vegetation from the construction areas may affect the local birds and terrestrial fauna. Noise from construction activities will be reduced by providing mufflers or acoustic enclosures for high noise generating equipment. Bird surveys will be carried out before vegetation removal for protection of nests. Construction workers will be prohibited from hunting of animals.

Impacts from borrow and quarry areas: About 0.56 million m3 of coarse aggregates and 0.37 million m3 of fine aggregates will be required for concrete works. Quarry and borrow areas established for T4HP will be used for the T5HP and there are sufficient quantities are available. Quarry activities will comply with mitigation measures provided in ECP, Site restoration and landscaping will be carried out after completion of the construction works.

Impacts from increased traffic and transportation: Traffic along the existing roads approaching Tarbela and grid station would be increased by the construction related vehicles. For power generation facilities, the current estimate for volume of construction materials including concrete and building materials is approximately 545,815 m3. The volume of steel and other metals required for construction is estimated to be 156,729 metric tons. In addition, contractors will also bring labourers to the site through vehicles. It is estimated that on average daily about 30 vehicles will use the local roads for transport of the material and manpower to the Tarbela. Safety hazards have to be considered along the access roads, especially in the busy commercial centers of the cities of Topi and Ghazi. These impacts would be partly mitigated by preparing and implement a traffic management plan.

Cumulative impacts of T4 and T5 construction activities: The construction works of T4HP will be completed in May 2017 and construction works of T5HP are expected to start from mid-2016. Hence the two

project's construction phases will run concurrently for some time. Although the T4 and T5 tunnels are located more than 500m from each other (meaning cumulative impacts associated with site-specific activities are unlikely), there is some potential for adverse cumulative impacts to occur through the use of shared access roads and associated facilities such as concrete batching and crushing plants. Coordination between contractors of T4HP and T5HP, with support from respective PMUs, are required to minimize the cumulative impacts of both construction activities.

7.7. Social Impacts during Construction Stage

Disturbance, Hindrance, and Safety hazards for the public. The construction activities can potentially impact the residents of the WAPDA Left Bank Colony and residential areas along the transmission lines particularly the movement and safety of school children. In addition, due to increased use of trucks and other vehicles on the local roads, elderly people, women and children will be more exposed to dangerous situations, which may lead to traffic accidents. Measures identified in the Traffic Management Plan will aim at ensuring access to the local communities, preventing of unsafe situation, especially near schools, housing areas, construction areas, camps and offices. Similarly, construction activities such as blasting and excavation may pose safety risk to the nearby population. Appropriate procedures including cordoning off the area and prior information to nearby population will be followed for such activities, and liaison with the community will be maintained. There will be appropriate medical services and a facility with the capacity to treat emergency cases and trauma patients.

Workers health and safety risks: Some of the Occupational Health and Safety risks which are likely to arise during the construction phase of the Project, and are typical to many construction sites, include: exposure to physical hazards from use of heavy equipment including cranes; trip and fall hazards; exposure to dust, noise and vibrations; falling objects; exposure to hazardous materials; and exposure to electrical hazards from the use of tools and machinery. Other risks common to power infrastructure projects, and specifically relevant to this Project, include working around large water bodies; working at height, live power equipment and lines; and exposure to electro-magnetic fields. The contractor will prepare and implement Health, Safety and Environment (HSE) plan in compliance with WB EHS guidelines and ECPs.

Community health and safety: Community health and safety impacts during the construction of power house facilities, transmission power lines and grid station are common to those of most large industrial facilities. These impacts include, among others, dust, noise, and vibration from construction vehicle transit, and communicable diseases associated with the influx of temporary construction labor. Hazards most directly related to power house and transmission lines and facilities occur as a result of electrocution from direct contact with high-voltage electricity or from contact with tools, vehicles, ladders, or other devices that are in contact with high-voltage electricity. The influx and accommodation of a large work force will result in increased concerns for the health and safety of local population, including the spreading of sexually transmitted diseases such as HIV/AIDS. Contractor's HSE plan will also include measures and protocols to protect the nearby community against the risk of accidents and mishaps. In addition, the HSE plan will also include emergency response procedures to be followed in case any accident does take place.

Increased load on local services: The increased load on local services is expected near the power house facilities in Tarbela, which is a restricted area open only for WAPDA employees and their families, with a limited presence of shops, markets, service providers supplying commodities. With the temporary presence of the Contractor with a considerable work force in the area there could be shortage of supplies and resident population might be forced to travel to the commercial centers of Topi and Ghazi to purchase essential supplies. This impact would be mitigated by requesting Contractor to procure their supplies in a manner not significantly affecting the availability of essential commodities in the area for the residents.

7.8. Environmental Impacts during Operation and Maintenance Stage

Avian risk assessment: Bird collision and electrocution are general risks associated with the transmission lines. Small birds such as ring-dove (*Streptopelia decaocto*) and also passerines such as European Starlings (*Sturnus vulgaris*) often use the transmission line poles and wires for perching during winter or for some resident species also in other seasons. It was observed that most bird species usually do not perch on high level transmission lines. However, there is no proper data collection for this in Pakistan. Birds with large wingspan such as storks, cranes and birds of prey there is risk of bird collision with transmission lines. It cannot be concluded that there is bird collision risk with high power transmission lines, nor this risk can be denied in the absence of any authentic reporting. Wire spacing is critical for large-winged birds. Present Power Lines have long spacing of over 3 m between them. It appears these are safe for birds. However, there is need for such observations

information on scientific lines. There is also need of observations on the major flight lines crossing the transmission lines. At such places installation of visibility enhancement objects such as marker balls, bird deterrents and diverters to be attached. Another mitigating measure is to cover and insulate the exposed parts of the towers structure.

Impact on Environmental Flows: Currently about 28 m^3/s of environmental flows are being released on the downstream of Ghazi barrage to Indus during low flow season to meet the requirement of aquatic habitat and drinking water requirements of dewatered section of Indus (between Ghazi barrage and tail race of Barotha power house). Construction T5HP will not affect the overall water regime or operation of Tarbela and hence the release of environmental flows will also not be affected by T5HP.

Environmental legacy of Tarbela and Ghazi Barotha projects: The construction of Tarbela and Ghazi-Barotha projects have influenced the water flows downstream of the Ghazi barrage. Nearly 54 km of the Indus between Ghazi barrage and tailrace of Barotha power station is affected by the water diversion from Ghazi barrage. This section is mostly dry in low flow season (October to April). To compensate the reduced flow, about 28 m^3/s of environmental flow is released from Ghazi barrage to Indus to meet the requirement of aquatic habitat and drinking water requirements. Detailed ecological studies are required in this river section to estimate the legacy of environmental impacts and to develop detailed mitigation plans. It is also reported that seepages form Ghazi head pond and the canals are also affecting the subsurface water levels and agricultural fields along the right bank of Indus.

Impacts from pilot project on floating solar power panels: Feasibility studies will be carried out to develop and implement a pilot project on power generation from floating solar panels in Tarbela reservoir. The potential impacts expected from installation of floating solar panels reduced light penetration into the water, by the obstruction of panels, which may in turn affect the organisms that depend on light for their existence (photosynthesis) and fish; reflection from the panels may induce thermal changes in to the water; changes in the reservoir water quality due to its contact with the photovoltaic panels; and decreased evaporation. Detailed mitigation plans will be developed and monitoring will be carried out during implementation of the pilot project.

7.9. Social Impacts during Operation and Maintenance Stage

Workers health and safety: Workers may be exposed to occupational hazards from contact with live power lines during, maintenance, and operation activities. They are also exposed to occupational hazards when working at elevation during maintenance, and operation activities. Electric utility workers typically have a higher exposure to electromagnetic field (EMF) than the general public due to working in proximity to electric power lines. Occupational EMF exposure should be prevented or minimized through the preparation and implementation of an EMF safety program. World Bank EHS guidelines on power transmission and distribution facilities will be complied. Safe drinking water and sewerage facilities with adequate treatment facilities will be provided to the employee residential colonies in the grid station, and Tarbela

Community health and safety hazards associated with power lines: Hazards most directly related to power generation, transmission lines and facilities occur as a result of electrocution from direct contact with high-voltage electricity or from contact with tools, vehicles, ladders, or other devices that are in contact with high-voltage electricity. The corona of overhead transmission line conductors and high frequency currents of overhead transmission lines may result in the creation of radio noise. Typically, transmission line rights-of way and conductor bundles are created to ensure radio reception at the outside limits remains normal. However, periods of rain, sleet or freezing rain sharply increases the streaming corona on conductors and may affect radio reception in residential areas near transmission lines.

Social legacy of Tarbela and Ghazi Barotha projects: About 33,200 ha of land was acquired for construction of Tarbela in 1970s and another 4,770 ha of land was acquired for the construction of Ghazi Barotha project in 1990s. There are still lot of outstanding claims from the affected communities on the compensations. During T4HP, USD 12.5 million was ear marked to settle the disputes by establishing a Resettlement Claim Committee (RCC). The committee has received 450 cases, 40 from Tarbela and 410 from Ghazi Barotha affectees. The committee has resolved only 15 cases – 14 from Tarbela and one from Ghazi Barotha. The committee is not active now and it needs to be reinstated under T5HP project.

8. Cumulative Impact Assessment

8.1. Background

The GoP is planning to build several hydropower projects in Pakistan including cascade of dams on Indus on upstream of Tarbela, and also to construct new transmission lines and grid stations to transfer from these new hydropower projects. The objective of the current cumulative impact assessment is to evaluate the combined effects of proposed developments within the influence area of T5HP.

Previous Strategic Environmental Studies on Indus: The World Bank has recently carried out a strategic environmental assessment study, "Strategic Sector Environmental and Social Assessment" (2015) to look at the whole Indus Basin for sector wide environmental and social impacts and prioritize the investments in hydropower and storage development options. The study has ranked various proposed hydropower developments in Indus basin based on technical, financial, environmental and social indicators, and cumulative impacts. The study ranked T5HP as a top priority investment with minimal cumulative impacts.

Previous Cumulative Impact Assessment Studies of Projects on Indus: Cumulative impact studies, as part of ESA, have been carried out in the recent past for the World Bank funded Dasu Hydropower Project (2013) and Sindh Barrages Improvement Project (2014). Under Dasu Hydropower Project (DHP), the cumulative impacts were studied for the Indus between Diamer Basha and Tarbela (Upper Indus Basin), while under Sindh Barrages project the impacts were studies for lower Indus on the downstream of Guddu barrage.

Temporal and Spatial Boundaries: As a continuation of the cumulative impact study carried out under DHP, the study in this T5HP ESA focuses on the area downstream of Tarbela dam and Ghazi barrage to the next hydraulic structure on Indus, the Jinnah Barrage. The projects considered for this study are (i) existing Ghazi Barotha and Tarbela Projects and (ii) proposed hydropower developments on Indus over next 20 years, say until 2035. The most significant valued environmental and social components (VECs) related to the proposed study are considered as river hydrology and morphology, irrigation and biodiversity

8.2. Existing and Proposed Water Sector and Transmission Line Projects

Indus Basin Water System: Indus River and its tributaries[1] through extensive networks of canals in the Indus Plains is the main source of water, hydropower and economic growth. For decades it has been engine of growth for the Pakistani economy. The irrigation system in Indus Basin Water System (IBWS) comprises 19 barrages and head works, 12 link canals, 43 commands and some 107,000 water courses.

Tarbela Dam: The Tarbela Dam was commissioned in 1974 under the framework of the Indus Basin Water Master Plan. Initially the main purpose of the dam was to supply irrigation water to the densely populated agricultural areas in Punjab and Sindh. For the project 120 villages along the Indus were submerged and a total of 96,000 persons had to be resettled and 33,200 ha of land to be acquired. At present the Tarbela dam is the most upstream constructed hydraulic structure controlling the Indus waters, its main functions are to supply irrigation water to the IBWS as well as generate power. The initial gross storage capacity of Tarbela has been affected by silt and in 2007 the gross and live storage capacity was 9.955 BCM and 8.442 BCM respectively.

The Ghazi-Barotha project (1450 MW) was completed in 2004 and comprises a barrage and a small regulating reservoir approximately 7km immediately downstream of the Tarbela dam near Ghazi, a 52km long power channel and a power complex near Barotha. The barrage provides a pond which re-regulates the normal daily discharge from Tarbela by diverting the flow into the power channel. The barrage pond has a normal volume of 70MCM.

Jinnah Barrage, constructed in 1946, is the most upstream barrage on Indus and located about 220 km downstream of Tarbela. Irrigation canals from main Indus river starts at this barrage. In 2013, 96 MW of hydropower is also being generated from this barrage.

Proposed Indus Cascade from Basha to Tarbela: The development of the Indus River system has the potential to provide the long term solution for water and electricity sector and growth for the Pakistani economy. The GOP energy strategy (2013) and WAPDA's Vision 2025 emphasizes the development of the

[1] The Indus River has six major tributaries, on eastern side, Sutlej, Beas, Ravi, Chenab, and Jhelum, and on western side Kabul rive. Its annual flow is about 182 billion cubic meters (BCM). The Indus River is sixth largest river of the world. In terms of water carried, the Indus flow is three times the Nile's, ten times the Colorado rivers (in United States and Mexico) and equal to Columbia river's in Canada and United States.

Indus Cascade to add hydropower to the system to bring down the cost of generation which is crucial for the sustainability of the sector. The first step in this long term plan should to develop the segment of Indus Cascade between the Tarbela Dam up to Diamer-Basha (Basha) and exploit all the water and hydropower resources in this segment, followed by investments further upstream. This segment has an annual water flow of about 60 BCM and an elevation drop of about 700 meters between upstream of DB to the Tarbela reservoirs. At this stage, this segment is planned to be developed by four major structures on the Indus River going upwards from Tarbela Dam, Thahkot, Pattan, Dasu and Diamer-Basha. This part of the cascade can be developed over the next 15-20 years, providing about17,000 Mw of newly installed capacity, 75,000, Gwhs of annual generation at round 4-5 cents/Kwhs (at the installation time that would reduce overtime when debt servicing is completed) and 10.7 BCM of storage capacity for water. This in the can change the fuel mix favoring hydropower and has potential to bring the cost of electricity to single digit.

Existing Transmission Line Network and Grid Stations: NTDC operates and maintains twelve 500 KV and twenty-nine 220 KV Grid Stations, 5078 km of 500 KV transmission line and 7367 km of 220 KV transmission line in Pakistan. In addition, Pakistan also consists of about 24,000 km of 132 kV lines and 9,100 km of 66 kV transmission lines. Tarbela has three 500 kV transmission lines and two 220 kV transmission lines. Ghazi Barotha has two 500 kV lines and one 200 kV transmission line.

Proposed Transmission Line Network and Grid Stations: A new 765 kV transmission line is planned from Dasu to Islamabad West grid station.

8.3. Potential Cumulative Impacts

8.3.1. River Hydrology and Morphology

The Indus on the downstream of Tarbela exhibits braided river characteristics with multiple channels and number of river islands (locally known as *Belas*). The diversion of water for power generation for Ghazi Barotha project caused a 54 km of dewatered section between Ghazi barrage and tail race of Barotha power. This section is mostly dry in low flow season (October to April). Kabul river joins the Indus about 40 km downstream of Ghazi barrage. The average lowest flow in Indus on downstream of Tarbela 273 m^3/s. To compensate the reduced flow, about 28 m^3/s of environmental flow is released from Ghazi barrage to Indus to meet the requirement of aquatic habitat and drinking water requirements. High releases from Tarbela occur mostly from June to August and during this season, there will be adequate water in Indus on the downstream of Ghazi barrage.

Proposed hydropower and storage projects have the potential to impact river morphology mainly due to the interception of sediments by reservoirs and reduction in water flows downstream of dams. With construction of Basha, which has a gross storage volume of 7.9 BCM, the storage capability in the Tarbela reservoir could considerably be increased. The change in river hydrology for different scenarios has been determined in a hydrological study for Basha dam carried out by WAPDA in 2012. It has been estimated that by optimizing the operations of Tarbela, Basha and Dasu about 42 percent more flow during the low flow season could be released from Tarbela and about 19 percent in early kharif period (**Table 8**) The impact of these extra releases will be very beneficial for irrigated agriculture in the plains. The changes in the river flows will have a positive benefit on the downstream of Tarbela. This extra flow could also mitigate the reductions in the ecological flow, which is often compromised and reduced by overconsumption in agriculture.

Table 8: Percent of Change in River Flows Downstream of Tarbela under Different Hydropower and Storage Scenarios

Hydropower / Storage development scenarios	Low flow (Oct - March)	Early kharif (Apr-May)	High flow (Jun-Sep)
1. Dasu + Tarbela	0	10	-1
2. Basha + Tarbela	42	9	-11
3. Basha + Dasu + Tarbela*)	42	19	-12

Note: *) Through optimizing the operation of the three dams

Incremental Impacts by T5HP alone

The contribution of T5HP to the cumulative impacts on the hydrological regime of the Indus is negligible since it will not alter the reservoir storage capacity or the downstream water flows.

8.3.2. Irrigation

Indus and its tributaries carry most of their sediment (nearly 97 percent) during high flow season. All hydropower projects will retain these sediments to some extent behind the dams. Thus the sediment content on the downstream flows of the dams will be reduced. This could increase the erosive capacity of the river flows. However, sedimentation in the reservoirs of cascades will have positive impacts on the downstream dams through increased storage. The construction of Basha will have a considerable beneficial impact on both Dasu and Tarbela reservoir in extending the life of both reservoirs. The Basha reservoir with a large storage volume will then act as a sediment trap and the inflow in Dasu reservoir will be reduced to 46 million ton of sediment (mainly fine fraction). The cumulative impacts on sediment transport of both Dasu and Basha together will have a considerable positive impact on water quality and aquatic ecology in downstream areas and on sediment deposition in the Tarbela reservoir. The strong decrease in sedimentation may extend the life of the reservoir with another 50 years (15 years due to the retention of sediments in Dasu and 35 years due to retention in the Basha reservoir).

The changes in the river flows above Tarbela will have a positive benefit on the downstream of Tarbela through alleviation of water shortages for irrigation especially in the beginning of the kharif season, which is a crucial period for development of the summer crops in Punjab and Sindh. The enhanced supplies downstream of Tarbela reservoir, in tandem operation with Basha and Dasu reservoirs, in low flow period is expected to increase the irrigation supplies by 42 percent during October to March and by 19 percent during early Kharif. During high flow season the average flow is 11-12 percent lower, which is also beneficial for downstream areas, since irrigation demand is low and the occurrence of floods caused by monsoon rains in the Northwest of the country is high.

Incremental Impacts by T5HP alone

The contribution of T5HP to the cumulative impacts on the hydrological regime of the Indus is negligible since it will not alter the reservoir storage capacity or the downstream water flows. However, due to raise in the intake level of T5, the life of the T5 will be increased by another 10 years from the risk of blocking of intake by the sedimentation.

8.3.3. Aquatic Biodiversity

Hydropower and storage projects have the potential to impact aquatic ecology primarily by creating a barrier to fish migration but also through changes in sedimentation and alteration of the flow regime. As explained earlier, diversion of water for power generation for Ghazi Barotha project caused a 54 km of dewatered section between Ghazi barrage and tail race of Barotha power plant in low flow season (October to April). Kabul river joins the Indus about 40 km downstream of Ghazi barrage. About 28 m3/s of compensation water is released from Ghazi barrage to Indus to meet the requirement of aquatic habitat and drinking water requirements.

WAPDA Environment Cell (WEC) has carried out various environmental studies including environmental monitoring in relation to the Ghazi Barotha project. The monitoring included surveys of fish species in the 41km river section downstream of the Ghazi Barrage in order to assess the adequacy of environmental flows. The trends in percentage comparison of various fish species throughout the span of 20 years demonstrates that self-propagating and hardy species, just like *Cyprinus carpio* and *Labeo dero* gradually increased in catches and now comprise 80% of total fish. The number of both full time and part time fisherman working in the area has also increased over this time period. However, the native Indus cold water fish species *Schizothorax plagiostomus* (snow carps), whose catch is more than 50 percent before construction of Ghazi barrage has now drastically reduced. WEC concluded that the findings demonstrate sound management and provision of adequate environmental flows in the impacted reach in the low-flow period.

Incremental Impacts by T5HP alone

T5HP will not introduce a new barrier to fish movement and will not influence the low season releases from Tarbela since it will be operated only in high flow season.

8.3.4. Social and Biodiversity Impacts of Transmission Lines

Cumulative impacts of transmission lines will include impact on agricultural lands, loss of property value, life safety issues and collision and electrocution of migratory birds. These potential effects and risks may be outweighed by the benefits of the power transmission lines to the urban and industrial centers of country

Agricultural lands will be affected by the construction of transmission line towers and grid stations. Livelihood of the farmers will be affected if there is a reduced access to the lands occupied by the towers. Transmission lines will seriously affect the real estate value of the property that it passes through. Lands with transmission lines will have less market values compared to the neighboring properties.

Indus valley is flyway for migratory birds from Central Asia to Indian Subcontinent. Thousands of birds will travel through this for wintering grounds in sub-continent. Development of many transmission lines along Indus will affect the birds through collision and electrocution. Electromagnetic waves from the transmission lines may also affect the health of nearby population. In addition, environmental and social issues outlined above for DHP would apply to transmission lines for all planned hydroelectric projects. Smaller lines that supply power to communities near the projects would likely induce urban and industrial development and increase risk of environmental and social effects from such development.

8.4. Recommendations to address Cumulative Impacts

Mitigation measures to address cumulative impacts of proposed hydropower development in Indus cascade were recommended in Dasu Hydropower Project. These mitigation measures and additional mitigation measures proposed under T5HP are described below.

8.4.1. Recommendations from Previous Studies

Ecological/Biodiversity Management of Upper Indus Basin: The activities to be carried out under this component include: Update detailed environmental and ecological baseline information; Prepare and implement robust management plans on fisheries (hatcheries and restocking), wildlife conservation, forest rejuvenation, avian risks, watershed protection, and other pertinent issues in light with the impact assessment presented in Dasu ESA; Prepare and implement the above management plans, update and develop detailed baseline data on flora and fauna of the project area in order to improve the understanding of the ecological landscape in relation with the DHP and other hydropower projects in the Indus Cascade; and Capacity Assessment and assistance in capacity building of local, provincial institutions and WAPDA; and implementation of the capacity building programs

Early Flood Warning and Climate Monitoring Program: For safety of public, improved management of flood waves and safe operation of hydropower projects, it is imperative to have an early warning system for early flood warning in the major catchment areas of the project. A flood telemetry network consisting of 18 automatic rain and river level recording stations were recommended in UIB.

Fish Hatchery and Stocking: A fish hatchery for production of native cold water fish species, snow carps and stocking of fish in the tributaries, reservoirs and downstream Indus is recommended to compensate the loss of fish habitat on the downstream and to address potential downstream impacts. This requires maintenance of an onsite fish hatchery of snow carps for the production of the targeted numbers of fingerlings from hatchery and hauling of the fish fingerlings for open water stocking in the river. The hatchery could be used to stock the fish in the affected areas of other hydropower projects in UIB.

Sediment Management Plan for the Basin and Tarbela: Under the Water Capacity Building Project (WCAP) the World Bank is also assisting the GoP and WAPDA to understand the sediment management issues for the basin and at Tarbela Dam

8.4.2. Recommendations under T5HP

A detailed ecological baseline study is recommended for the 54 km section of Indus on the downstream of Tarbela. The objective of the study is to understand the impacts already caused by Tarbela and Ghazi Barotha projects on the aquatic and riparian ecology of the Indus, and predict future impacts associated with development of Indus Cascade. The study will prepare detailed management plans to address these impacts. The study will be carried out in the first year of implementation of the project and the plans will be implemented from the second year onwards.

9. Environmental and Social Management Plan

9.1. General

Various categories of mitigating measures. The Environmental and Social Management Plan (ESMP) includes the following categories of mitigation measures and plans: (i) generic and non-site-specific measures in the form of environmental codes of practices (ECPs) presented in Annex 5 of the main ESA; (ii) project-specific and site-specific mitigation measures discussed in Chapter 7; (iii) construction environmental action plan (CEAP) requiring site-specific and contract-specific management plans to be prepared by contractors; (iv) resettlement action plan (RAP) covering land acquisition and compensation, income and livelihood restoration, gender and public health; and (v) proposed plans to address cumulative impacts.

Inclusion of ESMP and ECPs in Contract Documents. In order to make contractors fully aware of the implications of the EMP and responsible for ensuring compliance, technical specifications in the tender documents will include compliance with mitigation measures proposed in the EIA and in WBG EHS guidelines. Contractors must be made accountable through contract documents for the obligations regarding the environmental and social components of the project.

Construction Environmental Action Plan: Contractors need to prepare site-specific management plans to address various environmental issues, showing how will comply with the requirements of ECPs and EMP. Plans will be reviewed and approved by construction supervision consultant (CSC) and project management unit (PMU) before implementation of construction works.

Lessons Learnt from T4HP: This ESMP is prepared based the experience gained from the implementation of T4HP ESMP. The key issues identified in T4HP implementation are: lack of adequate staffing and facilities in ESMU, inadequate compliance by contractor with the ESMP requirements, not specifying the ESMP clauses in the contract documents, inadequate compliance with the labor laws in terms of labor rights and working conditions.

9.2. Institutional Arrangements

The proposed institutional arrangements for implementation of ESMP are shown in **Figure 5** and **Figure 6** for power generation and power evacuation works, respectively.

Project Management Offices (PMU) would be responsible for all aspects of project implementation including technical, operational and financial management, and overseeing the implementation of ESMP. The Project will have two PMUs, one for power generation facilities under WAPDA and the other is power evacuation facilities under NTDC. The PMU will include an Environmental and Social Management Unit (ESMU), which will be headed by a Director. The director will be supported by (i) Deputy Director - Environment, (ii) Deputy Director - Social and (iii) various environmental and social consultants. The responsibilities of the ESMU are: (i) supervising, facilitating and coordinating implementation of environmental and social plans; (ii) ensuring that contractors comply with the requirements mentioned in ESMP; (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; and (vi) implementation of contingency plans.

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

Monitoring and Evaluation Consultants will be recruited by PMU to carry out independent monitoring and evaluation of implementation of ESMP. The external monitor will have environmental and social experts and shall carryout external monitoring and evaluation.

Figure 5: Environmental and Social Staff/Consultants of PMU of T5HP for WAPDA

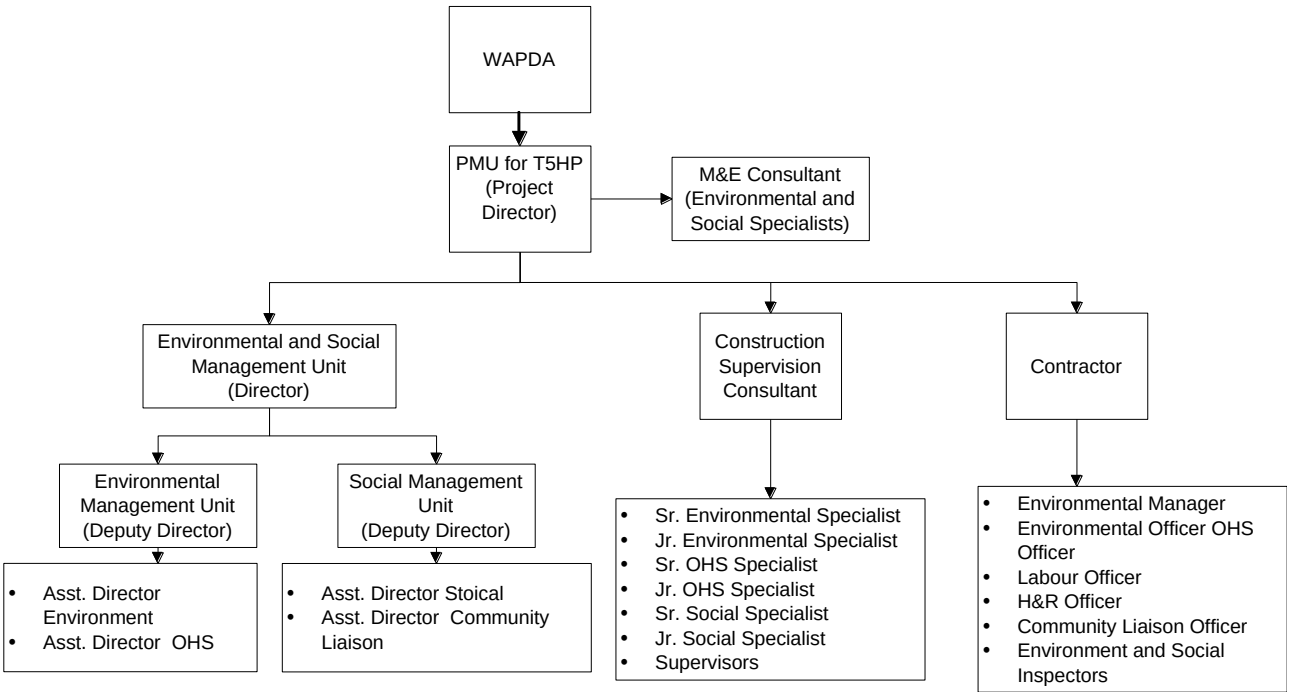
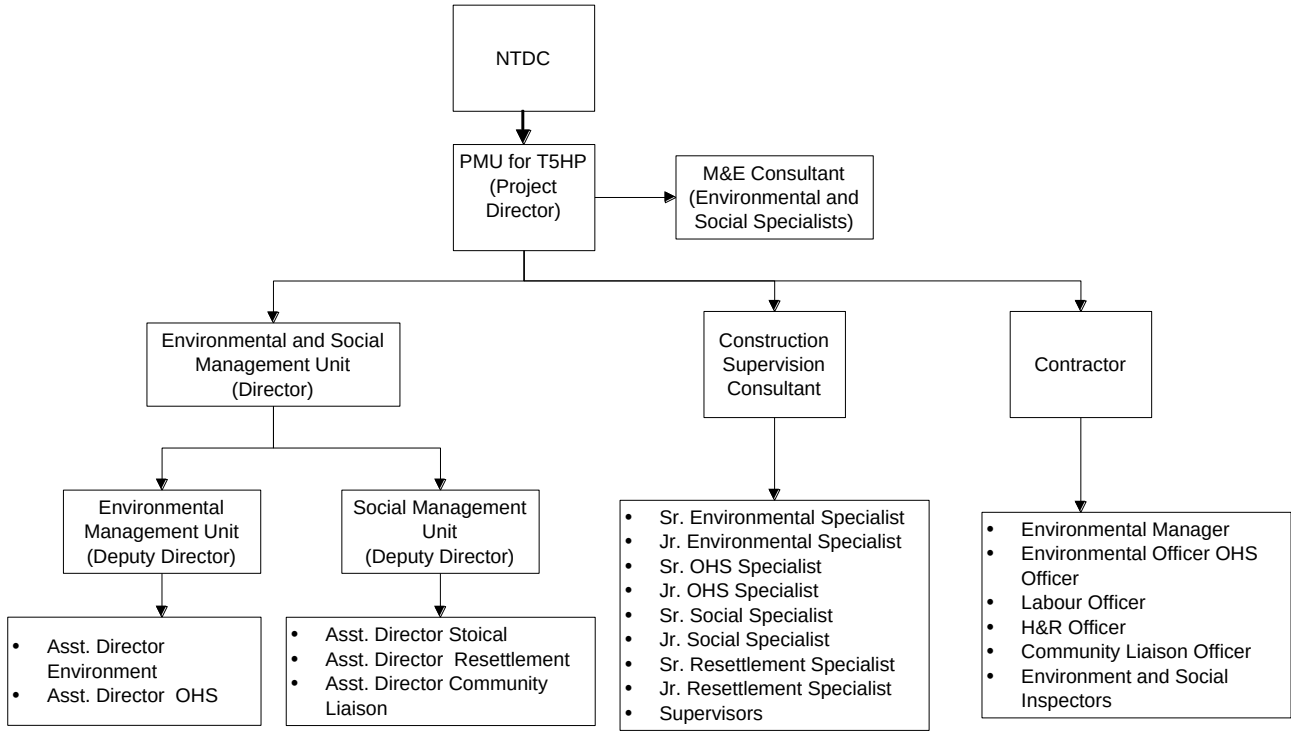


Figure 6: Environmental and Social Staff/Consultants PMU of T5HP for NTDC



9.3. Environmental and Social Management

(a) Environmental Codes of Practice

A set of environmental codes of practice (ECPs) has been prepared for various environmental and social management aspects: ECP 1: Waste Management; ECP 2: Fuels and Hazardous Goods Management; ECP 3: Water Resources Management; ECP 4: Drainage Management; ECP 5: Soil Quality Management; ECP 6: Erosion and Sediment Control; ECP 7: Top Soil Management; ECP 8: Topography and Landscaping; ECP 9:

Quarry Areas Development and Operation; ECP 10: Air Quality Management; ECP 11: Noise and Vibration Management; ECP 12: Protection of Flora; ECP 13: Protection of Fauna; ECP 14: Protection of Fisheries; ECP 15: Road Transport and Road Traffic Management; ECP 16: Construction Camp Management; ECP 17: Cultural and Religious Issues; ECP 18: Workers Health and Safety; and ECP 19: Tunneling and other Underground construction Works. The Contractors will be contractually obligated to comply with these ECPs, presented in **Annex 5** of the main ESA.

(b) Site-specific Plans

The following site-specific plans will be prepared by Contractors, as part of CEAP, to manage and mitigate/reverse potential adverse environmental impacts: These plans will be prepared based on the ESMP and ECPs and World Bank Environmental Health and Safety Guidelines 2007. The contents of these plans are detailed in main ESA.

- Construction Environmental and Social Management Plan
- Operational Environmental and Social Management Plan
- Construction Traffic Management Plan
- Materials and Waste Management Plan
- Spoil Management Plan
- Noise and Vibration Control Plan
- Air Quality Management Plan
- Blast Management Plan
- Oil and Chemical Spill Response Plan
- Sediment, Erosion and Landslip Control Plan
- Chance Finds Procedure
- Water quality management plan
- Ecological Management Plan
- Habitat Removal and Restoration Plan
- Tarbela Occupational Health and Safety Plan / Contractor ESHS Plan
- Emergency preparedness and response plan
- Worker Accommodation Plan
- Stakeholder Engagement Plan
- Community grievance mechanism
- Worker grievance mechanism
- Gender Strategy
- Project Labour Statement
- Recruitment Policy
- Retrenchment Policy
- Human Resources Policy
- Local Content Strategy
- Workers' Code of Conduct

(c) Social Management

Resettlement Action Plan (RAP): The Islamabad West Grid Station will require about 200 acres of land, affect a total of 150 households. The social impacts largely include loss of agricultural land with associated loss of income and livelihoods. To address and mitigate these relocation and resettlement impacts, the RAP has been prepared. The RAP is based on the findings of the inventory and census surveys as well as meetings and consultations with various project-affected persons. The RAP presents (a) type and extent of loss of assets including land, structures and trees; (b) principles and legal framework applicable for mitigation of these losses; (c) the entitlement matrix, (d) relocation strategies and plans, including provision for livelihoods; (e) resettlement and rehabilitation budget; and (f) institutional framework for the implementation of the plan, including monitoring and evaluation. It has been designed as a "development" plan, therefore the overall objective of the RAP is to restore and/or improve the living standards of the affected persons from pre-project level. Land requirements for the Transmission Line will be identified under a separate RAP which will be developed once the design consultants have identified the exact location of towers. Guided by the LARF, it will be prepared and approved by the Bank prior to any construction work.

Income and Livelihood Restoration Program: The RAP has developed income and livelihood restoration programs with the aim of improving or at the least restoring to the earlier level the livelihood of all affected

households/persons. In preparing the program the impact of dislocation on livelihoods and adversely affected income was given due consideration. In addition to income restoration, capacity building and enhancing social capital of the affected communities are major objectives of this program.

Addressing Outstanding Claims of Tarbela and Ghazi Barotha Projects. The social legacy program of T4HP will be continued under T5HP. Under T4HP, only 15 cases were resolved by the Resettlement Claims Committee against 450 claims received. The committee will be reinstated.

Community Development Assistance Program. Under T4HP, WAPDA has developed an out-reach program to provide social assistance to the communities in the immediate vicinity of the project construction areas. Schemes for communities were identified through a consultation process and contracts were awarded to local contractors who used local labor thus generating income for communities. These include construction of dispensaries, water supply, drains and class rooms. This Community Development Assistance Program (CDAP) will also be implemented under T5HP and will target the communities located around Tarbela, transmission line and grid station. The works to be covered under this program will be identified through community consultations but are likely to include schemes such as construction of vocational training institutes, separately for boys and girls; maternity clinics, drinking water treatment, drainage and sewerage facilities, access to Sui gas facilities, etc.

9.4. 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 9** along with the monitoring indicators and frequency.

Table 9: Effects Monitoring Plan

Parameter/ Activity	Location	Means of Monitoring	Frequency	Responsible Agency	
				Implementation	Supervision
Traffic Safety	Access roads and at the work sites	Visual inspection to see whether proper traffic signs are placed and flag-men for traffic management are engaged	Monthly	Contractor	CSC, PMU
Waste Management	Construction camps and construction sites	Visual inspection that solid waste is disposed at designated site; Records of waste generated and disposed	Monthly	Contractor	CSC, PMU
Spoils	At the excavation sites	Visual inspection that spoils are disposed at designated sites; records of spoil generation and disposal	Monthly	Contractor	CSC, PMU
Noise	Construction sites and nearby residential areas	Noise measurement using noise meter; Ensure work restriction between 21:00-06:00 close to the residential areas	Weekly	Contractor	CSC, PMU
Hydrocarbon and chemical storage	Construction camps and yards	Visual Inspection of storage facilities	Monthly	Contractor	CSC, PMU
Air Quality (dust, smoke)	Construction sites	Visual inspection to ensure good standard equipment is in use and dust suppression measures (e.g., spraying of waters) are in place.	Daily	Contractor	CSC, PMU

Parameter/ Activity	Location	Means of Monitoring	Frequency	Responsible Agency	
				Implementation	Supervision
	Material storage sites	Visual inspection to ensure dust suppression work plan is being implemented	Monthly	Contractor	CSC, PMU
Air quality (PM, CO_2, SOx, NOx)	At the baseline monitoring sites	24 hours continuous monitoring with the help of appropriate instruments and analyzers	Quarterly during the construction phase	Contractor through a nationally recognized laboratory	CSC, PMU
Surface water quality	At the baseline monitoring sites	Sampling and analysis of surface water quality (TDS, Turbidity, pH, dissolved oxygen, biological and chemical oxygen demand)	Quarterly during the construction phase	Contractor through a nationally recognized laboratory	CSC, PMU
Soil Pollution	Construction and material storage sites	Ensure no contaminated effluent is leaving to the surface water bodies and nearby agricultural lands	Weekly	Contractor	CSC
Water quality (For all drinking water parameters)	Water wells to be used by contractors for drinking	Laboratory analysis of all drinking water parameters specified in national standards	After development of wells	Contractor trough a nationally recognized laboratory	CSC
Drinking water and sanitation	Camps, offices	Ensure the construction workers are provided with safe water and sanitation facilities in the site	Weekly	Contractor	CSC
Flora and Fauna	At all worksites	Survey and comparison with baseline data	Six-monthly	Consultant	CSC, PMU
Safety of workers Monitoring and reporting accidents	At work sites	Usage of Personal Protective equipment and implementation of contractor OHS plan	Monthly	Contractor	CSC, M&E Consultant, PMU
Cultural and archeological Sites	At all work sties	Visual observation for chance finds	Daily	Contractor	CSC, PMU
Restoration of Work Sites	All Work Sites	Visual Inspection	After completion of all works	Contractor	CSC, M&E Consultant, PMU
Grievances	In the project area	Number of grievances registered and addressed	Monthly	PMU	CSC, M&E Consultant, PMU

9.5. Capacity Building and Training

Capacity building will be aimed at strengthening the environmental and social staff in PMUs in the field of environmental management and social development. Members of the environmental/social unit responsible for supervision environmental and social mitigation measures would be trained in environmental management, environmental quality control, ecology, environmental awareness, participatory approach and social development. Training would not be restricted to PMU staff but selected project staff involved in construction and operation of the project would also be trained. The contractor will also be required to impart environmental and social trainings to its staff, to ensure effective implementation of the ESMP.

9.6. External Monitoring

The WAPDA and NTDC will engage an Independent Monitoring & Evaluation Consultant to conduct external and independent monitoring and evaluation of the ESMP implementation. The main purpose of the external monitoring will be to ensure that all the key entities including ESMU, CSC, and contractors are effectively and adequately fulfilling their designated role for ESMP implementation and that all the ESMP requirements are being implemented in a timely and effective manner.

9.7. Grievance Redress Mechanism

A three-tier "bottom up" system of grievance redress committees (GRCs) will be established for the T5P power evacuation component, comprising: (i) village or subproject level GRC; (ii) Project GRC; and (iii) Project level independent GRC to be led by a retired civil judge. Assistant Director - Community Liaison Officer (CLO) of the T5HP PMU will head the first tier of the GRC. The concerned GRC will review the grievance cases and hold meeting within the stipulated time line. The affected person/complainant or his/her representative will generally register his/her grievance at the Village GRC level or with CLO. The complainant may appear before the GRC to explain and or clarify any issue. If needed, GRC may conduct additional field investigations prior to the decision on specific cases or disputes. If the complainant remains dissatisfied with the outcome, the grievance will then be forwarded to the Project level GRC (headed by Project Director) all documentation. Similarly, unresolved cases from this level will be forwarded to the next tier for review and deliberations. If the disputant/complainant still remains unsatisfied, s/he can go to the formal court of law. In such cases, the complainant will be compensated by the T5HP for any legal and administrative fees paid or incurred pursuant to the grievance redress procedures.

Grievances will be logged in a formal logging system. This will be the responsibility of a staff member with community liaison officer responsibility. People may register grievances using by contacting the CLO or reporting to their village representative. Contact details for the CLO will be included in appropriate project communication materials. The CLO will classify grievances and where investigations are required, project staff and outside authorities as appropriate, will assist with the process. Investigations will aim to identify whether the incident leading to the grievance is a singular occurrence or likely to reoccur. Identifying and implementing activities, procedures, equipment and training to address and prevent reoccurrence will be part of the investigation activities.

9.8. Reporting

The ESMUs with assistance from CSCs, external monitoring consultants, and contractors will produce environmental, health and safety monitoring reports which will be submitted quarterly, and annually for three years after completion of construction. One year after completion of construction, the ESMU will submit a Project Completion Environmental Monitoring Report which will summarize the overall environmental impacts from the Project. The External monitors will submit the quarterly reports throughout the contract time, impact evaluation report at the end of each year and finally a completion Report at the end of contract period.

9.9. Cost of ESMP and RAP

The total cost for the environmental management and monitoring activities has been estimated to be USD 22.4 million. The costs of implementing the ESMP is shown in **Table 10**. In addition, USD 7.2 million will be used for community development assistance programs. The tentative cost estimates for cost of land acquisition for grid station, transmission line towers and corridor are estimated to be USD 17 million as shown in **Table 10**. These budgets are covered under various components of the Project.

Table 10: Cost Estimates for Implementation of ESMP

Description	Generation Component, USD million	Evacuation Component, USD million	Project Component (see Table 2)
ESMP Budget			
Implementing the suite of environmental and social management plans set out in ESA	5.2	1.1	Component A and Component B
Environmental and social monitoring as set out in ESA	2.2	0.6	Component C
Environmental staff (PMU, CSC, M&E Consultants)	3.2	1.1	Component D and Component E
Establishing and maintaining EHSS plans, procedures and management systems	0.3	0.3	Component C
Environmental and social enhancement measures and studies	2.2	0.6	Component C
E&S training and capacity building	2.1	0.6	Component E
Contingency	1.7	1.2	
Sub Total for ESMP	**16.9**	**5.5**	
Social Development			
Community Development Assistance Programs	7.2		Component C
RAP (indicative budget)			
RAP for grid station	14.0		Under Dasu Project
RAP for transmission line towers	3.0		Component C

10. Stakeholder Consultations and Disclosure

10.1. Overview

Extensive consultations were carried out by both social and environmental study teams during the project preparation. Initial consultations, as part of scoping study, were held during December 2014 to January 2015 for power generation facilities and October/November 2015 for power evacuation facilities to share the project objectives and terms of references of the proposed EIA study. Formal public consultations were held on 31 December 2015 and 1 January 2016 in the project area to disclose the results of ESA. Advertisements were given in the local newspapers and formal invitations were sent to relevant stakeholders for the public consultations. Consultations involved multiple methods – for example, key informant interviews, village wise meetings, focus group discussions and workshops. Details on number participants consulted are given in **Table 11** and they include (i) affected communities and population around the project area, (ii) universities, consultants and contractors working for T4HP (iii) national and local government authorities responsible for district administration, wildlife and environmental protection, and (iv) nongovernmental organizations.

Table 11: Number of Persons Covered in Various Consultation Meetings

	Activities	No. of participants
1.	Village wise meetings during scoping for power generation component (December 2014)	117
2.	Village wise meetings during design for power generation component (January 2015)	335
3.	Focus group meetings with women for power generation component (January 2015)	52
4.	Village wise meetings for power evacuation component (November 2015)	202
5.	Public consultations (at Ghazi on 31st December 2015 and near the grid station site on 1st January 2016)	209
Total		**915**

10.2. Consultations Feedback

The main issues discussed with affected persons and communities, and how these issues are addressed and incorporated are shown in **Table 12**.

Table 12: Key issues raised during the consultations and plans to address these issues

Issues raised	Main comments	Stakeholders who raised comments	How they have been addressed in the power generation ESA
Job preference to local people	Job preference shall be given to local people. Hiring process shall be open and transparent and hiring committee shall include participants from every village nearby.	People of Kukar Chawa, Ghari Mera, Ghazi Hamlet, Gala Hamlet, Pontian, Batakra and WAPDA Left, Right Bank Colonies, Kamal Pur Mayian, Bahtar Mehra, Pakki Ban, Noorabad and, Dhoke Khaliq Dad.	This recommendation is included in the ESMP. The contractor will be contractually bound to disclose the "Recruitment Policy" that specifically includes a requirement to prioritise local employment for unskilled and semi-skilled positions that become available.
Lack of health and educational facilities in the area	WAPDA should help in the up gradation of educational and health facilities in nearby villages.	People of Kukar Chawa, Ghari Mera Ghazi, Dhoke Khaliq Dad, Qutab Bandi Kamal Pur Mayian and, Bahtar Mehra,	T4HP is currently implementing a community development programme focusing on health and education. Similar programs will be continued in T5HP.
Polluted	WAPDA should arrange	People of Kukar Chawa,	The T4 community

Issues raised	Main comments	Stakeholders who raised comments	How they have been addressed in the power generation ESA
drinking water	clean drinking water in nearby villages.	Ghari Mera and Ghazi.	development programme includes installing drinking water schemes (filtration plants) at Darra Mohat, Kukar Chawa, Ghazi Hamlet and Topi Area. It also is installing sewage equipment at Ghazi, Pehure, and Topi. Similar programs will be carried out under T5HP.
Risk of traffic accidents during construction phase of the project	WAPDA should rehabilitate the old roads to be used during construction phase to avoid traffic hazards to local community	People of Ghazi Hamlet.	Traffic management plan will be implemented during construction. The access roads damaged by the construction activities will be restored.
Access to Villages	WAPDA should allow easy access to villagers living in Kukur Chawa and Ghari Mera by providing them the security passes. Especially relaxation should be given in case of emergency.	People of Kukar Chawa, Ghari Mera, Minar Kot and Ghazi.	Tarbela is not able to change access issues because of security reasons.
Payment of land compensation	Compensation should be provided for the affected land of both grid station and transmission line	People of Kamalpur Manyan, Burhan, Qila Bandi, Dhoke Khaliq,Umer Khana, and Bharwasa	Compensation will be paid for all the affected land
Transmission line should avoid settlements	The design of transmission line should be such that the houses and settlement should not be affected	People of Kamal Pur Burhan, Qila Bandi, Hamlet Colony	The transmission line alignment will be designed to avoid settlements to the maximum extent possible.
Electrocution concerns	People were concerned regarding electric shocks especially during rainy season.	People of Kamalpur Manyan, Burhan, Ghaara, hamlet Colony, Piplian, Umar Khana, Noorabad	The height of the transmission lines will have a clearance of 9.0m when passing over any structure in order to avoid potential damage from electric fields.
Grid Station site should be changed	There are many other sites available for grid station	People of Kamalpur Manyan	The grid station site has been selected after evaluation of three potential options
Existing transmission line should be used	At present there are existing four transmission lines which could be used for electricity evacuation without having to construct a new one.	People of Kamal pur Manyan, Burhan, Ghaara, hamlet Colony, Umar Khana, Noorabad	The option of using existing transmission lines were also studied, but this option is selected based on technical feasibility and also considering the overall power sector development in the country (development of a new grid station at Islamabad for Dasu and other hydropower projects).
Impacts from	Agricultural lands were	Public consultation	ESA has recommended further

Issues raised	Main comments	Stakeholders who raised comments	How they have been addressed in the power generation ESA
Tarbela and Ghazi Barotha projects	affected by Ghazi Barotha canal. On the left bank water logging is the problem, and on the right bank there is water scarcity. Sewerages from WAPDA colonies are polluting the river water		studies to understand the impacts of downstream impacts of Tarbela and Ghazi Barotha, and to develop appropriate mitigation plans.
Support for development of local area	Roads, drinking water and sewerage facilities, hospitals, parks, access to Sui gas facility, schools, job opportunities, training and skill development,	Public consultations	Social development activities will be continued under T5HP.
Pending Claims	Many cases of compensation are still remaining unresolved. The land acquired originally for Tarbela for borrow areas are no longer in use and should be returned to affectees.	Public consultations	Resettlement Claims Committee will be re-established under T5HP.
Compensation for land acquisition	Adequate compensation should be paid to local people to re-establish their livelihoods. Compensation should also be paid to the transmission line towers.	Public consultations	Adequate compensation will be paid covering all the losses,

10.3. Disclosure

The ESA, LARF and RAP reports will be disclosed in WAPDA's and NTDC websites and will also be sent to World Bank InfoShop. The executive summary of the ESA will be translated in to Urdu and will be disclosed in WAPDA's and NTDC websites. Public consultation meetings were held on 31st December 2015 at Tarbela and on 1st January 2016 at the grid station site to disclose the ESA findings. The ESA reports will also be submitted for KP and Punjab EPAs for their clearance. The EPAs will also arrange public hearing meetings in the project area as part of their review process. The periodic progress on project implementation will also be disclosed in World Bank InfoShop.